MODULE 1: SCIENCE EDUCATION

UNIT 1: MEANING AND VALUE OF SCIENCE TO SOCIETY

INTRODUCTION

In your school, there are many subjects on the time-table. You are familiar with subjects such as social studies, business studies, religious studies, home economics, integrated science and others. Each subject demands specific skills, knowledge, tools and training. In addition, each subject has a characteristic set of meanings and values. Science has its own meanings and values. In this unit, you are going to study the meaning and value of science to you and the society.

OBJECTIVES

By the end of this Unit you should be able to:

i. explain in your own words the meaning of science;

ii. State the four steps used in finding truth about evens;

iii. draw a systematic flow chart for solving science problems;

iv. list two broad fields of science;

v. recognize the three major areas m basic science;

vi. state the eight attributes of scientific attitude;

vii. indicate six values of science to the society.

MEANING OF SCIENCE

What is Science?

It is characteristic of man to give meaning to every event in nature. The meaning associated with an event or object gives it a distinctive attribute different from other events or objects. In certain parts of Nigeria, the appearance of a rainbow is usually associated with the laying of eggs by the boa constrictor deadly snake. This is a mere superstition because nobody has yet proved this belief about the snake. You may want to find out the cause of rainbow from your science texts or teacher. There are many such unscientific statements.

You have noticed or heard that when a bottle full of water is kept in a freezer for a long time, the bottle cracks. What causes the crack? In your attempt to answer this question more questions have been raised and answers will have to be sought for them. To answer the questions, you will carry out some tests, observe, re- test and make deductions based on observed patterns. As a result of this systematic process, some vital information ma: be obtained. The piece of information may be used to solve related problems. Information acquired by experience may not be objective enough to justify observed changes in nature. A systematic search for reasons to explain the cause of the cracked bottle and for changes in things or events is called science. Also, the search for truth is called science. That is, science is the search for truth about natural happenings (phenomena) in the universe.

Science is doing, finding out, through organized activity, making careful observation, recording observations accurately and drawing deductions (conclusions) which are independent of the observer. Deductions from science activities are usually never regarded as final, but tentative, until other scientists have verified and confirmed such deductions. Science can be defined as a conscious and systematic search for an organized knowledge about events. For example, when water freezes, it expands, hence the cracking of the bottle. The freezing and expansion of water are the two basic scientific reasons for (explaining) the cracking of the bottle.

How Scientist Works?

If you have misplaced your door key, you will find it helpful to recall some events you had undertaken since the last time you saw the key. This step will make your search for it purposeful. Scientific investigation can be carried out on water, in the field, on the rocks, in the farm and in the laboratory. Many science experiments are, however, conducted in the laboratory because of the availability of necessary facilities there.

A scientist follows certain ordered steps to arrive at the solution to a problem. The first step is to recognize and state the problem in the form of a question or questions. How? What? and Why? For example, how long does it take a candle stick to burn out completely? This is a problem that can be investigated. The second step is to make some intelligent guesses (hypotheses) and select the best one. To our question about the burning candle, the guesses may be 3 or 8 hours. The scientist may take 6 hours as a tentative answer. The third step is to gather evidence through experiments, discussions, observations, library search (reading), going on a field trip, etc. In the case of the candle, he has to conduct experiments. In the process of evidence gathering, he must consider other factors, which may interfere with his experiment (control of variables). The fourth step involves putting together the pieces of information gathered, to arrive at an objective conclusion. The conclusion may lead to a theory, a law, or a new direction for study. This process is known as 'the scientific method'.

ACTIVITY 1

Draw a simple flow chart to show the steps a scientist would take to solve a given problem.

What are the Fields in Science?

Science has two broad fields - basic (or pure) and applied. Basic science has some special fields such as biology, chemistry, and physics. Biology is the study of life. Chemistry is the study of the structure and chemical properties of matter. Physics is the study of matter and energy and their interaction. Each special field has a number of sub-fields. You can find out about the sub-fields in the library. Physical, organic and inorganic chemistry are examples of sub-fields of chemistry, for instance. Also applied science, sometimes called technology, includes many fields of engineering.

VALUES OF SCIENCE TO YOU AND SOCIETY

Acquisition of Science Attitude

Perhaps you are wondering why you should study science. Of what value is science to you? A scientist believes that man should be free to think and to solve problems. The beliefs make the scientist to devote considerable time and work to solve his science problems. While searching for truth, he acquires a set of attributes, usually called a scientific attitude. Through careful study, he acquires a set of attitudes which includes:

Longing to know: The urge to dig deep into the cause(s) of events. Willingness to invest time and energy into finding the truth, and he is not easily bored.

Perseverance: Ability to survive the dangers, frustration and thinking demands of finding the truth.

Curiosity: Ability to pay attention to small details, desire to find examples to observed events.

Honesty: Reporting observations accurately, avoiding misrepresentation of information.

Open Mindedness: Approaching issues, objectives, and events without prejudice.

Withholding or suspending judgment: Ability to wait until available information is convincing

Objectivity: Beliefs in what actually is the truth, and not just in what he believes should be.

Respect for the views of others: Rarely engaging in fruitless arguments. He believes in issues, not personality.

The acquisition of scientific attitudes takes some time to mature. However, its acquisition will enable you to become an effective and functional citizen in your community. The modern age requires citizens to have some basic knowledge and skills in science so as to function effectively.

Career Opportunity

There are lots of career opportunities in science. You can become a botanist, zoologist, chemist, biochemist, medical doctor, agriculturist, animal doctor, engineer (chemical, civil, mechanical, electrical), pharmacist, etc.

Meaning of Superstition

A scientist demands evidence .of claims which can be verified, reproduced experimentally and confirmed by other scientists. Science, for instance, will make you to demand actual evidence that it was the god of iron that was angry each time thunder clap occurs. Many superstitious claims will be challenged by you. As you learn more science information, your confidence to challenge claim will be more strengthened.

Values to the Society

The application of scientific information has brought about a tremendous revolution into human comfort, leisure, culture and happiness. Let us consider some specific examples:

In Industry: The industrial products have their bases in the theoretical information from science. Mass-production of "*Omo*", biro, radio and other products is possible because of the advances in science. Industries provide job for the citizens hence reduce unemployment and its attendant problems.

In Agriculture: Fertilizer is an "artificial manure" produced by application of scientific knowledge. It improves the fertility of soil hence the quality of farm yield. Science knowledge has been used to produce hybrid seed which produce more seeds than their parents. Disease resistant crops are now available because of the scientific advances.

In Leisure: we can watch television, listen to radio, read newspapers and play mechanical games along. These items remove boredom and loneliness. We can talk to our relations who are in distant places through the telephone.

In Health: Scientific knowledge and skills have been used in health care delivery. The production of drugs, antibiotics and antiseptic materials has helped to cure many diseases. Cancer and Acquired

Immunity Deficiency Syndrome, AIDs, which have continued to threaten human existence, are tackled by research scientists. A patient with breathing difficulty can be relieved with oxygen in the hospital.

In Transportation: Man has moved away from trekking long distances to flying over long distances. A journey which used to take months and days, now takes hours. Scientific information has been applied to aircraft. Electric trains are now available to transport many more people rapidly in some pans of the world. The condition of the roads has been improved by tarring.

National Economy: A nation without a strong science education will remain a consumer nation and a parasite to developed nations. Science improves the economy of a nation. It also promotes international relationship, through trade and technical aids.

There are lots of products and services which science gives to the society. Write them down in your notebook.

ACTIVITY 2

Write at least one product which science has contributed to:

i. Health
ii. Agriculture
iii. Commerce
iv. Transport
v. Industry

ASSIGNMENT

1. You are to carry out this assignment in your room. Make sure that all sources of wind flow are shut.
2. How long does it take for ¼ the length of candle to burn out?
   (a) What is science?
   (b) Draw a chart showing 'the scientific method.
   (c) List five attributes of the scientific attitude and explain them.
   (d) Give two sub-fields of physics and chemistry and one of biology.
3. Name ten career choices which are open to science students.
4. Using concrete examples, state any 5 uses of science to a villager in your community.

SUMMARY

In this unit you have leant that:

- science is a conscious and systematic search for organized knowledge about nature.
- a scientist seeks for the truth about an event by, (a) recognizing and stating the problem, (b) making intelligent guesses, (c) gathering evidence, and (d) drawing conclusion.
- There are two types of science - basic and applied
- Basic science unearth truth. Basic science includes biology, chemistry and physics.
- Applied science uses scientific information distilled by basic science for the production of products and services.
- By studying science, you acquire scientific attitude which include (a) longing to know (b) willingness to invest time and energy (c) perseverance (d) curiosity (e) honest (f) open-mindedness (g) withholding or suspending judgment (h) objectivity and (i) respect for the views of others.
- Here are many career opportunities such as becoming specialist scientists, medical doctors, animal doctors, nursing pharmacists, engineers (civil, electrical chemical, mechanic), agriculturists.
- Society benefits from science through its usage in health industry, agriculture, at home, communication, transport etc.

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UNIT 2: PSYCHOLOGICAL BASIS FOR TEACHING BASIC SCIENCE

INTRODUCTION

In this unit, we examine the psychology of the learner. Specifically, we will study four theories of learning, namely those of David Ausubel, Robert Gagne, Jerome Bruner, and Jean Piaget.

OBJECTIVES

By the end of this unit, you should be able to:

1. explain Ausubel's theory of learning and its application in the classroom;
2. discuss theory of Gagne's hierarchical learning;
3. describe Bruner's concepts of discovery learning and the spiral curriculum; and
4. explain Piaget's theory of cognitive development and its implications in science teaching.

DAVID P. AUSUBEL'S THEORY OF LEARNING:

Ausubel stresses the value of prior (i.e. previous) knowledge in learning. It is generally accepted that what a student already knows could aid or hinder new learning. According to Ausubel, meaningful learning occurs where there is appropriate link between prior knowledge and new learning task i.e. interaction between the students appropriate element in the knowledge that already exists and the new material to be learnt. When there is no such interaction, no learning occurs. The parts of the learner's cognitive structure (i.e. prior knowledge) which can provide the interaction necessary for meaningful learning are called **subsumers**.

Ausubel defined subsumers as a principle or a generalised body of knowledge that the learner already acquired that can provide association or "anchorage" for the various components of the new knowledge. That is, a new learning must be linked to the existing knowledge to create meaning. He then suggested what he called "**advanced organiser**" which can be introduced before the new concept is taught.

Implications of Ausubel's Theory of Learning to Science Teaching and Curriculum Development

- Teaching of science must begin with new learning or knowledge in a sequential manner.
- Teacher should ensure that the learner is ready before presenting new curricular materials in Basic science.
- Meaningful learning in basic science depends largely on the quality of the learners’ previous experience. Therefore, science teaching must not begin until the teacher is sure of the learner's previous knowledge relating to the new concept to be taught.
- Ausubel supports the use of expository method in teaching science as this can lead to high level of understanding and generalization.
- Provide advance organizers in and during science instruction when prior knowledge is lacking.

- Contents in the curriculum must be arranged in sequential order.

ACTIVITY 3

1. Explain briefly Ausubel's theory of learning.

2. Mention three implications of Ausubel's theory of learning to basic science teaching.

ROBERT GAGNE'S THEORY OF LEARNING HIERARCHY

Robert Gagne's theory is often referred to as Gagne's Theory of learning hierarchy. He states that "the learning of a new concept or skill depends upon the mastery of prerequisite concepts". This implies that prior (i.e. previous) knowledge determines what further learning may take place, which also implies that materials meant for learning must be sequentially structured by the teacher. Gagne emphasizes the importance of task analysis of instructional objectives. He also believes in task analysis of the concepts, skills and knowledge to be taught. Materials meant for learning (i.e. learning tasks) the desired knowledge (i.e. terminal task) must be sequentially structured so that the learning of one topic (i.e. acquisition of one knowledge) aids the learning of the next higher order topic. Therefore, learning must be sequentially structured from simple to complex, until the desired objective is achieved. In Gagne's hierarchy of learning, problem solving is the highest level, while lower levels involve facts, concepts, and generalisation. Gagne's theory also advocates administration of pre-tests to find out whether learners possess the relevant prerequisites for the next knowledge (i.e. higher order knowledge). The result of the pre-tests will help the teacher to know the entry point for learning to begin in the hierarchy of learning tasks. Gagne also suggests that in a teaching situation the teacher should begin with a question like "*what is it that I want the learner to be able to do?* This implies that there must be well stated performance objectives in every lesson.

Implications of Gagne's Theory of Learning Hierarchy to Science Teaching and Curriculum Development

In this theory of learning, the basic science teacher must observe the following:

1. Content in science subjects should be arranged in hierarchical fashion so that those simpler abilities and concepts which are required for later learning are mastered first.

2, Science teachers need to state the performance objectives for learning any material.

3. He developed a very useful five category system, for examining the different types of learning outcomes which could be applied for science teaching. They are (i) intellectual skills (ii) verbal information (iii) attitudes, (iv) motor skills and (v) cognitive strategies.

4. After completing the structured hierarchy of learning tasks, the teacher administers diagnostic pre-tests in order to find out the point where the learning hierarchy can start.

ACTIVITY 4

1. Explain Gagne's theory of learning.

2. Use Gagne's theory of learning to explain briefly the importance of pre-test in a science classroom.

Jerome Bruner's Concept of Discovery Learning

Bruner was a famous psychologist who championed the idea of discovery learning as a major instructional strategy, particularly in the area of science and technology teaching. For this reason, Bruner is often referred to as the father of discovery learning. According to Bruner, discovery learning takes place when an individual is involved mainly in using his mental processes to mediate some concepts or principles. In other words, it is the mental assimilation by which an individual grasps a concept resulting from physical and mental activity. Bruner declared "I do not restrict discovery to the act of finding out something that before was unknown to mankind, but rather include all forms of obtaining knowledge for oneself by the use of one's mind."

Implications of Bruner is theory of Discovery Learning and Curriculum Development According to Bruner, learners could derive four major benefits when exposed to discovery learning. These are:

1. There is increase in intellectual attainment.
2. Motivation to learn more and discover things changes from external to internal within the child himself.
3. Going through the difficulties discovery learning could improve students' investigative abilities later in life.
4. Learning to investigate and discover leads to better understanding and retention of knowledge.

ACTIVITY 5

1. List any two (2) advantages of discovery learning.
2. List two (2) shortcomings of discovery learning.

Bruner's Concept of Spiral Curriculum

Bruner believes that any subject can be taught effectively to any child at any stage (i.e development in some intellectually honest form). This is the basis of the spiral curriculum we are using in schools today. In the spiral curriculum, a given concept or topic is initiated and discussed at lower levels and the same concept is developed in scope and details with advancing years. For instance, the concept of "energy" can be initiated from the first year of the junior secondary school with increasing scope and details in the advancing years. Spiral Curriculum, Bruner believes. is necessary to emphasize ideas or refresh the memory of ideas.

Jean Piaget's Theory of Intellectual Development

Piaget was a famous Swiss psychologist who specialized in cognitive development in children. The American Educational Research Association recognized Piaget as the most outstanding contributor to that field in 1968. He wrote over 30 books and more than 100 articles on cognitive development in children. According to Piaget, the development of the intellectual capacity occurs in four stages.

Sensori-motor State (Birth - 2 years)

Pre-operational Stage (2-7 years)

Concrete Operational State (8 - 11 years)

Formal Operational Stage (13 and above).

Each development stage has unique features or characteristics as follows:

I. Sensori-motor Stage (Birth - 2 years)

- The behaviour of the child in this stage is controlled by reflex actions.
- Symbolic behaviour gradually emerges
- Language develops as the child grows.

II. Pre-operational Stage (2-7years)

- Child becomes very egocentric
- Child does not conserve, i.e. does not view quantity as constant.
- Child does not develop simple logic in his thoughts and actions.

III. Concrete Operational Stage (8 -11 years)

- Profound re-orientation in thinking
- Child can think in concrete terms.
- Child develops simple logic.

IV. Formal Operational Stage

- Formal abstract reasoning develops
- Child can perform elementary experiments.
- Child can control variables in simple experiments.

ACTIVITY 6

1. Who was Jean Piaget?
2. Outline his biography.
3. List the 4 stages of intellectual development in children.

Implications of Piaget's Theory to Education

In essence, Piaget is saying: "children go through certain stages of intellectual development from birth through adolescence”. These stages materialize when their time comes, and there is little we can do to advance or delay them. What we must do in education is to realize the limits of children's understanding at certain stages and plan our teaching to fall within these limits.

As far as education is concerned, the outcome of Piaget's theory of intellectual development in children should be used by every teacher in planning his lessons. In science teaching, the teacher should create conducive learning environment and situations in which the child her/himself experiments, trying things and ideas to see what happens, manipulating instructional materials that stimulate and motivate the learning process.

ASSIGNMENT

1 Find out the pioneer psychologists who postulated the idea of discovery learning.

2. List the features of Sensori-motor stage.

SUMMARY

In this unit, you have learnt that:

- Piaget was a famous Swiss psychologist who specialized in intellectual development or children.
- Piaget's theory of intellectual development consists of 4 distinct stages, namely:
    i. Sensori-motor Stage (Birth - 2 years)
    ii. Pre-operational Stage (2 -7 years)
    iii. Concrete Operational State (8 - 11)
    iv. Formal Operational Stage (13 years and above).
- The behaviour of the child in Sensori-motor stage is predominately reflex actions.
- The child in pre-operational stage is very egocentric.
- The child in the formal operational stage can think in abstract terms.
- That Bruner was the pioneer psychologist in discovery learning.
- Those children exposed to discovery learning get internal motivation replacing external motivation.
- That Spiral Curriculum is necessary to emphasize ideas or refresh the memory of ideas.
- That one major shortcoming of discovery learning is that it is time-consuming.
- Ausubel posits that the curriculum must be arranged in sequential order.
- The child must not learn new concept until the teacher is sure that the child is ready.
- The child must have a previous knowledge related to the concept.
- Bruner prefers expository method to the discovery methods.
- Gagne' believes that science concepts are hierarchical and so curriculum must be arranged in this fashion
- Science teachers must state clearly the learning objectives in behavioural terms.

- Science content must be taught from simple to complex; concrete to the abstract and from known to unknown.
- Pre-tests are essential to diagnose learners' entry behaviour.

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UNIT 3: METHODS OF TEACHING BASIC SCIENCE I

INTRODUCTION

Now that you already know the nature of science, the content of Basic Science and the psychological make-up of your pupils, you need to know more about how to present science content to your students. In this unit, we discuss the various approaches available to you as a science teacher. The current curriculum which is activity-based provides the framework of what should be taught, how it should be taught, what it should be taught with and how learning outcomes should be assessed. This is in response for the need for the teaching methods to move away from the traditional "chalk and talk" and "minds on" approaches to "hands' on and learning by doing approaches" It has been acknowledged widely that for students to do well in science and to develop practical skills which will be useful to them in their later lives, they must be actively involved in the process of learning.

OBJECTIVES

By the end of this unit, you should be able to:

1) discuss and explain at least three different conventional methods of teaching science;
2) describe alternative methods and instructional strategies for teaching science; and
3) tabulate the merits and demerits of conventional and alternative methods of teaching science.

HOW TO STUDY THIS UNIT

i. Read the unit carefully

ii. Put down major points

iii. Do the activities

CONVENTIONAL METHODS

The following are some of the examples:

Lecture (Chalk and Talk) Method

This involves verbal one-way presentation of ideas, concepts, generalizations and facts. The teacher does most of the activities in form of talking while the pupils are either passive listeners or slightly involved. This lead to rote learning whereby pupils memorise what they have learnt and regurgitate the facts. This method which involves mostly talk-chalk approach will not be effective in the teaching of basic science since it does not promote meaningful learning of science because it appeals to only the sense of hearing. Since the sense of hearing alone easily leads to forgetting, more effective learning goes on when many senses are involved. However, it could be improved upon by combining it with other more effective methods and strategies that are activity-based.

Guidelines

- To make it less boring, you can use demonstration or class activity to support this method.
- Bring concrete objects to facilitate learning in the classroom.

- Allow the pupils to suggest some examples instead of you coming up with everything.
- Provide opportunities for pupils to ask questions and seek clarifications as the lesson progresses.

Merits of Lecture Method

1. Provides an efficient way of conveying factual knowledge and information to pupils.
2. It makes it possible to cover large amount of content materials.
3. It saves time and effort of the teacher; this is because much of the materials to be taught can be covered within very short period of time not even minding the size of the class.

Demerits of Lecture Method

1. It does not encourage the acquisition of manipulative skills. This is because pupils are

   not given the opportunity to engage in purposeful activities.
2. This approach ignores pupils who have hearing problems and other disabilities.
3. It encourages rote learning without necessarily understanding the facts.
4. It does not promote the development of scientific attitudes in pupils. This is because these pupils are never given opportunities to take part in scientific activities. They arc passive listeners.
5. It also ignores pupils' language background and difficulties.

Project Method

In this approach, a central theme, problem or idea is selected by the teacher and the pupils. The task is further divided into sub-themes, ideas or problems. The pupils are encouraged to investigate, collect specimens and analyse on their own. The teacher acts as a guide.

At the end of the investigation, the reports on the project are collated and discussed with the whole class. Examples of projects in basic science include:

i) Investigating different methods of conserving and improving soil fertility.

ii) Assembling a simple aquarium.

iii) Constructing a simple weighing balance.

iv) Making simple models of machines (levers, pulleys).

v) Constructing a simple see saw for the school play ground.

Guidelines

a. Always group brilliant and weak pupils together.

b. Do not pair friends in the same group.

c. Make sure that the project topics are what obtain in the syllabus.

d. Ensure that the project or area of study not pose any danger to the pupils.

Merits of Project Method

I. Activities are centred around the child ensuring that his interest is fully taken care of.

2. The approach makes it possible for inter-disciplinary studies to take place, since a project may contain materials form more than one subject area.

3. The approach is likely to make the pupil learn better, because his interest is involved which form the basis of self motivation.

4. Group or individual projects always result in students gaining socially and intellectually, because they have opportunities to discuss in very relaxed mood without their teachers intimidating presence.

Demerits of Project Method

1. It takes plenty of time and effort to accomplish.

2. Difficult to plan and execute if the class is large and overcrowded.

3. It is easy to deviate from the objectives of the lesson.

ACTIVITY 7: A Temporary Class Pond Project

Build and establish the pond. It is best if the ideas come from the pupils themselves. With your pupils, think of ways to record information about animals and plants in your pond. Perhaps you need a checklist or table for noting the names of all the plants and animals found? How will the work of observing be divided and shared among pupils? How will recording happen? Will you keep a scrapbook near the pond? When you have a good range of observations, try to make a mind map of them. How will it be organised? You could use a large piece of newsprint/paper, the wall or the chalkboard. Next, ask your pupils, in pairs or small groups, to think of deductions that can then be added to the mind map in a separate colour. You could write pupils initials next to their deductions to acknowledge their work.

Field Trip/Excursion Method:

This is the act of taking pupils outside the classroom so that they can learn some science concepts and themes as they occur in actual situations. Below are possible sites for field trip/excursions and the related science concepts:

Area of Field Trip/Execution	Related Science Concepts
School farm/garden, play ground	Insects, living and non-living organisms' seed and plant growth and types, food chain.
Mechanic Workshops e.g. Blacksmith, Electrical Mechanic.	Electricity, Pulleys, Magnetism, Rusting, Heat, Energy Transfer.
Streams and Ponds	Floating and sinking, Aquatic plant and animal
Industries	Working of machines, manufactured products e.g. soap, beverages.

Give your pupils the opportunity to select any area of scientific interest for the field trip. Visit the site before the date of excursion and make adequate arrangements. The science concept to be learnt should have relevance to the core curriculum and pupils should have sufficient time to observe and ask questions. When they return, encourage them to discuss and make a report on the trip.

Guidelines

1. Select an area/location to go with scientific interest for field trip.
2. The concepts to be learnt should have relevance to their core curriculum.
3. Allow the pupils to ask questions based on their observations.
4. The location selected should be safe.
5. Require the pupils to write a report of the trip.

Merits of Field Trip

1. It helps the pupils to use their senses of observation.
2. It aids the development of an enquiring mind, among others.
3. It helps pupils to relate what is taught in the class to outside reality.

Demerits of Field Trip

1. It is time consuming
2. It can be dangerous if not properly planned

ACTIVITY 8: Observing local ecosystems

Talk to your class about the idea of an ecosystem. Brainstorm a list of probable ecosystems near the school. Divide your class into groups and let each one select an ecosystem to adopt and study for the rest of the year. If there is only one suitable ecosystem near your classroom, everyone can study it. Organise pupils to take turns to record the observations. Encourage them to ask questions about the animals that live there and how they might interact with each other. What types of living things (populations) would they expect to find and in what numbers?

What eats what? How might numbers change during the year? Record these questions and predictions for future reference.

Later, make time to visit the sites with pupils, to check their predictions. This becomes an ongoing group project. Make time every few weeks for visits and reports or new information. In this way, the pupils' knowledge and understanding will grow over time in a relaxed and informal way.

Groups could keep a scrapbook or journal to record their growing understanding of the way things happen in their ecosystem. As the project progresses, think about your pupils' involvement - are they motivated by this activity? Do they enjoy this way of learning?

Demonstration Method

Demonstration in basic science class involves carrying out activities to illustrate concepts or ideas. Demonstration can be carried out by:

i) The teacher alone.

ii) The teacher with a pupil.

iii) The pupil who is knowledgeable in the activity.

iv) An invited guest.

Examples: Demonstrations can be carried out to show how:

a) Water evaporates when it is heated,

b) To arrange batteries in series to increase voltage; and

c) Purify muddy water through filtration.

Purpose of Demonstration

i. To help translate an abstract concept or fact into a tangible real life subject

ii. To help develop students skills of observation, recording, measuring, estimation etc.

iii. To build an understanding of place, time, change and their relationships

Guidelines

In carrying out demonstrations, note the following:

a. Purpose of the demonstration must be clear to all participants.

b. All children should see every part of the demonstration.

c. Involve the children as much as possible.

d. Use simple and readily available apparatus in demonstrating.

e. Test the gadget/equipment before lesson to show that they work.

f. Ensure that dangerous experiments are handled by the teacher.

g. Prepare the various chemicals before time.

h. Do not use demonstration method always in order to avoid the students becoming too familiar without gaining anything.

Merits of Demonstration Method

- It provides a concrete and realistic picture of material to be learned, hence it has a more lasting impaction and pupils tend to remember the fact more.
- It creates a high degree of attention concentration and interest which can be further exploited by other techniques.
- It trains pupils to follow plans and sequence when doing things, i.e., it trains pupils to be orderly.
- It is not time consuming.

Demerits

1. It requires a great deal of time to prepare and considerable skills in require for execution.

2. Sometimes the demonstration will display several features, simultaneously and pupils can watch only one thing at a time, and so the most importance feature may go unnoticed.

3. Pupils may not be able to acquire the skill, if the demonstration is too long.

4. If demonstration is too frequently used, the pupils may become passive viewers and listeners rather than active participants.

Inquiry Method

The knowledge we have on how pupils learn requires that we help them discover, see relationships in what they discover and organize their new discoveries into meaningful ideas and not just learning through note.

In the inquiry approach you should give the students opportunity to carry out the search and discovery of facts about events and scientific ideas. This may be through environmental observations, interfering and testing of hypothesis. You should make pupils observe carefully, ask questions, measure, classify, predict and communicate their findings. Inquiry entails practising of attitudinal skills such as honesty, open mindedness and perseverance when carrying out a science task. Inquiry can be open-ended or close-ended. Examples of inquiry lesson on change of state are as follows:

Step 1:
Take the temperature of ice block.
Heat the ice block in a container and record what happens.
At what temperature does the ice melt?
Continue to heat (Record what happens).
At what temperature does steam start coming out?

Take a bottle of cold water and place it over the steam. Describe what happens. Teachers should allow pupils to make observation and draw conclusions for themselves, while he gives necessary guidance

ACTIVITY 9: Describe the steps you would take to teach sinking and floating, using inquiry method.

Guidelines

a. All pupils should participate in the activities

b. Encourage each pupil to report his/her finding.

c. The problem should be properly defined.

Merits of Inquiry Method

1. It enables the pupils to think, ask questions, reason and form conclusions.

2. It enhances the development of process skills.

3. It enhances the development of the attitudes of the scientist such as honesty, open-mindedness, etc.

Demerits of Inquiry Method

1. If the problem is not properly defined, pupils may not be able to tackled it.

2. It is time consuming.

Process-Based Learning Method

Process-based approach lays emphasis on helping the pupils develop process skills through practice or hands -on activities. The teacher should encourage children to learn how to observe objects or events more closely as they use their senses to gather information about the objects or events.

The teacher should make sure that the information that pupils get is of good quality by describing what they actually observed. An example of process-based learning is illustrated in the case of grouping (classification) and observation. For example: Let students observe similarities and differences in a collection of objects or events. Let them order or classify the objects or events into categories based on the defined characteristics for example, estimation of measurements: - Let the pupils estimate their shoe size. They then go on to measure their feet with a ruler or tape rule. Pupils do this by placing a ruler on the floor against a wall and put the foot on top of the ruler.

Encourage them to report their hands-on, process-based activities, either verbally or through writing.

Guidelines

a. Encourage pupils to report their findings during the activities verbally or in writing.

b. Make sure that everyone take part in the activity.

Merits of Process-Based Method

1. It encourages the acquisition of manipulative skills, since the pupils are given the opportunities to engage in purposeful activities.

2. Process-Approach makes pupils active investigators, rather than passive receivers of scientific knowledge.

3. It helps them to develop scientific attitude.

Demerits of Process Based Method

1. It is time consuming.

2. It could be quite expensive.

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UNIT 4: NON-CONVENTIONAL METHODS FOR TEACHING BASIC SCIENCE

INTRODUCTION

In the last unit, we learnt about methods of teaching basic science. In this unit, more methods which are regarded as non-conventional will be addressed.

OBJECTIVES

By the end of this unit, pupils should be able to:

(i) identify non-conventional methods of teaching;

(ii) state some non-conventional methods;

(iii) use any of these methods to teach; and

(iv) identify their merits and demerits of using non-conventional methods.

Cooperative Learning

This is an instructional mode where pupils cooperate with each other to perform or complete a particular task. Teacher assigns pupils to groups and assign roles to them. Teacher creates a classroom environment that includes group work spaces where resources are shared.

Create circumstances for pupils to interact with each other and to express their opinions.

Examples:

Group pupils to discuss:

i. the purification of muddy water

ii. the separation of mixtures.

iii. personal hygiene

Guidelines

a. Group the academically strong pupils with the weak ones.

b. Do not place friends in the same group.

C. Make sure everyone has a role to play.

Merit of Co-operative Learning

1. Pupils develop social skills.
2. It takes care of individual differences.
3. It helps reduce the problems of a large class.
4. Pupils are active learners.
5. They learn how to improve communication.

Demerits of Co-operative Learning

1. The class will be noisy if not well-monitored.
2. It is time-consuming.

Team Teaching

Team teaching can be defined as an arrangement in which two or more experienced teachers share the responsibility for a common group of pupils varying the size of the group and the teaching procedures according to the objectives of the work at hand and the needs of the students.

In essence, team teaching is an educational strategy where multiple teachers develop and present course materials to a class on the fact that each teacher has his/her own area of specialization, preference, content mastery, level of experience, resourcefulness, voice and ability to manage class, with a view to cross pollinate ideas, rob minds in order to improve pupils performance to go along with the saying that ‘two heads that are symmetrically attuned are better than one'

In carrying out team teaching, you should form a group with two or more teachers who will together:

- plan/design
- prepare lessons
- select instructional materials
- conduct and evaluate learning activities for the class.
- must be prepared to pool your resources together to meet the needs and address possible areas of difficulties of the pupils.

Examples:

- Space travel
- Environmental pollination
- Skill acquisition

Merits of Team Teaching

(i) Helps to clarify abstract concepts through practical experience or demonstration

(ii) Helps in better understanding and contextualization through application of the principles of science to situations familiar to the pupils.

(iii) Provides opportunities for using multi-media and multiple senses (hearing, feeling, smelling, sight etc) and helps increase retention of what is learnt

(iv) Integrates multiple teaching/learning methods leading to maximizing creativity and flexibility.

(v) Focuses on learning more from the pupils’ view and less from the teacher's perspective.

(vi) Facilitates the process of "discovery" of problems and solutions and builds self-esteem.

(vii) Teaches a variety of life skills instead of mere subject matter content.

As a science teacher, when you commence the use of this approach you will notice that your lesson takes a little more time to prepare than the "chalk and talk" method. However, you will soon discover that rather than add to your burden, it will promote and support you by providing an opportunity for the creative use of educational materials and ideas. Your lessons will thus become more interesting and satisfying to your pupils. For this approach to be successfully used, a number of teaching techniques will be involved. These techniques are those that could arouse interest and curiosity, provide information and enable systematic processing of information and help formulate codes of behaviour. Some of these include: discussion, questioning technique, think list – pair – share, brainstorming, debates, practical work, simulation, games and plays, small groupings and scaffolding.

Brainstorming Approach

This approach involves the whole class and the teacher.

A topic or a problem is introduced. The whole class is allowed to discuss or find the solution to the problem or for them to make inputs. The role of the teacher is that of a moderator. You may use the group approach to solicit pupils' inputs or record desirable responses from the pupils on one side of the chalk board for comparison. Often, other ideas beyond the scope of the lesson do come up. Such ideas are not ignored or thrown out just like that. They may be kept aside to be treated with a related topic or on another day. You may also give the pupils as homework.

Examples:

- Rain formation
- Earth formation
- Process of digestion

ACTIVITY 10

Give two topics which you can use the brainstorming approach to clarify.

Debates

This is not new in our school system, however, it is associated with the teaching of languages through school competition. Have you ever used this to teach science before? A topic or concept is given on science and the pupils are allowed to think and examine all issues relating to the concept. They then provide facts for and against such issues: This enriches the scope and depth of such topics. However, this depends greatly on the level or the pupils, their degree of exposure and practices as well as understanding of the topic. Ability to express themselves will also come into play. You should take note of the fact that female pupils are always shy to respond but arc more eloquent than their male counterparts, when they get started.

After the debate, you should harmonize, modify and summarize the pupils ' points as appropriate.

Examples:

- Drug abuse
- Use and misuse of renewable and non-renewable

- Population and food suppliers
- Effects of global warming

This approach can also be used to teach some aspects of science effectively. It is also a form of discussion technique in teaching, for example.

Practical Work

Basic science is learnt by doing, as an activity-based subject. Both minds-on and hands-on activities are interwoven. Pupils use their hands, heads and minds as they learn the subject. Practical work in science is carried out through task performance, manipulation of science materials and equipment, observing directly and demonstrations. These are not achieved through laboratory work alone but by exploring the immediate environment of the students through field trips and outdoor lessons. The use of projects either by individual student or group of students also afford them the opportunity to carry out practical activities. Pupils can be encouraged to apply scientific concepts to solve problems within their immediate environment.

Simulation

Simulations are imitations of real-life events or processes. More recently, computer simulations are being used to animate abstract objects and concretize ideas in science. Modelling or various objects and activities are now possible. Models are often used to explain things that are difficult to practicalise or observe such as a revolving planet. Computer packages on simulation in science teaching are available in the market.

Examples:

i. State of matter

ii. Family traits

Active Learning Approach

(Think- List-Pair-Share)

Active learning approaches help to provide pupils with rewarding and joyful learning experiences. Learning and teaching of science thus become fun in the classroom.

The central theme of this method is that the teacher selects a topic and allows the pupils to "think - list - pair - share". The individual pupil is allowed to think about the topic and list out all he/she knows about the topic. Then he/she is paired with someone in the class to compare their lists thereby exchanging ideas. Later, the class is grouped into five for is further exchange of ideas. The group comes up with a list of contributed and refined ideas. At the end of it all, there will be sharing with the whole class from an individual and from each group. These, there would have been interactions and participations, at various levels and collaboration and reflection among them.

Guidelines

a. Encourage each pupil to think and list.

b. Make sure the grouping is not one sided by placing the weak pupils together.

Merits of Think-List-Pair-Share

1. There is active involvement of every pupil.
2. Pupils collaborate and share ideas

Demerits of Think-List-Pair-Share

1. The passive unwilling pupils could be left out.
2. Inadequacy of written and spoken English could hinder full participation b) some.

Scaffolding Method

Scaffolding is used when building high structures such as storey building. Scaffolds are pillars for support to both the building and the builder. As it affects education, the teacher, who is the builder, can use gifted and fast learners as scaffolds to aid or build up the slow learners, having understood the teacher fast. The gifted pupils then serve as go-between through interactions with the slow learners after the class. Pupils learn better and faster from each other. Scaffolding involves the teacher supporting the learning task so that the child is able to solve a problem or perform a task, which would not have been possible without assistance. The teacher should:

- assist the pupil in acquiring skills, which are above him/her.
- identify what the pupil knows already and the new situation.
- revise the previous work and ask relevant questions that will link what is to be learnt with what is already known.
- breakdown complex tasks into manageable bits and reduce the number of steps in the learning tasks to manageable number.

Examples:

- Sources of water
- Importance of ICT

Guidelines

a. The teacher should practice the question before the class.

b. Ensures that all pupils participate.

Merits of Scaffolding method

1. It helps pupils to learn faster.
2. A large proportion of the pupils is catered for.

Demerits of Scaffolding method

1. It is time consuming
2. Some weak pupils may hide under those who are active in the class.

Games and Plays

Play is a major aspect of children’s life because it gives them enjoyment and satisfaction. If games and plays are used in teaching science, it will make pupils lively and actively involved in learning. An educational game is an activity in which players use data and/or skills usually in a competitive situation. It is useful in presenting repetitive learning in normal ways. Games can help in creating awareness, reinforcing facts and knowledge, teaching skills and building values. They provide an innovative educative entertainment and participatory approach to learning. Examples of science games for teaching could include playing fishing with magnetized hooks and classes of food.

Guidelines for Games and play method

As a science teacher, you should use simple games to teach various related basic science concepts. In using games, you should note the following:

a. Games should be simple to play.

b. They should have simple rules.

c. Competition should not be emphasized.

d. Science process skills should be demonstrated.

e. Related science concept should be clearly illustrated by the game.

f. Discuss the main concepts of the game conveyed after the game.

g. The game should be adapted for the needs of a particular level of pupils.

h. Assess the value of game before using it to teach pupils.

Merits of Games and Plays

Educational games help to:

generate high levels of motivation.

create an atmosphere of enjoyment and participation.

bring about high degree retention of what has been learnt due to the dynamic nature of the activity and also the pre and post discussions.

demonstrate effects of discussion and activities which would be used to reinforce appropriate behaviour.

create an altered relationship between the pupils and the teacher whose role is that of a facilitator, while pupils become active partners in the process of learning.

acquire various skills involved in the games.

Demerits of Games and Plays

1. Unserious pupils may learn nothing.

2. It is expensive and equipment may not go round in a large class.

3. Class control can be problematic.

Educational games include matching, mysteries, group competitions, solving puzzles, dictionary, etc.

SUMMARY

In this unit, we learnt about:

- non-conventional methods in general
- co-operative leaning strategy, games and plays, scaffolding, active learning approach, etc.
- the merits and demerit of each methods
- guidelines for the use of each methods have been provided

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UNIT 5: METHODS OF TEACHING BASIC SCIENCE II

INTRODUCTION

Other techniques for teaching basic science to young children include traditional, concept, process, project approaches, field trip, etc. You have studied some of these approaches in Unit 2. In this Unit, you will learn how to use the process, concept, and project approaches, field trip in the teaching of basic science.

OBJECTIVES

By the end of this unit, you should be able to:

1. explain what is meant by process, project and concept approaches,
2 state the skills involved in process approach,
3. plan field trips and
3. discuss how concepts approach can be used to teach basic science:

PROCESS APPROACH TO TEACHING SCIENCE

Over the years there have been many topics in the syllabus which are end results of what earlier scientists did. Such topics as elements, compounds, molecules, atom, laws of gravity, and floatation, tropisms to mention but a few, have continued to be studied and memorized in order to pass examinations. The end of the examination marks the end of what pupils know in these areas. These topics, which serve as a stop gap in the scientific enterprise, are called the products of science where as the methods they use in arriving at these products are called the processes of science.

The processes of science are observation, classification, communication, counting numbers, measurement, raising questions, formulating hypotheses, prediction, making operational definitions, controlling or manipulating variables, experimenting, data collection, interpreting data, inference, and manipulating apparatus.

The current thinking in the teaching of primary science agrees with the statement that "If you give a man a fish, you feed him only once. But if you teach him how to fish, you feed him for the rest of his life". Thus, instead of feeding the pupils with the products of science, they should be exposed to the processes so that they can also be generators of knowledge, rather than being its perpetual consumers. This is what the process approach to the teaching of primary science is all about. The process encourages the active involvement of pupils in the learning process. Rather than being a passive receiver of the knowledge generated by others, he is finding questions and undertaking his investigations or inquiries under your guidance. Each of the process skills listed above will be discussed in the next section.

Observation
This is a common and often misused process skill. It is more than just seeing. One can use all the senses - seeing, hearing, tasting, touch, smelling - to observe. Observations the act of paying particular attention to what one experiences with his senses. To do it requires some training. Give your pupils opportunities to observe living and non living things in their environment. They should be able to differentiate one object from another, using such characteristics as colour, smell, shape, etc. Observations can be made directly using our senses or indirectly using instruments. Our experiences influence observations.

Classification

This depends on careful observation. It is the sorting out of objects into groups according to some properties. If pupils are trained to be good observers, they will be able to classify objects. For instance, objects in the environment can be classified into living and non-Jiving things. Each of the groups can further be classified using plant/animal colour shape, height, size, sex, etc.

Communication

Whatever the scientist discovers will not be known by others, if there is no means of communication. Communication is art of letting others know what one is doing. It can be by speaking, writing, drawing or making gestures with the hands. It involves the use of language in one way or another. You can ask your pupils to draw or describe what they have observed. Allow them to use the language that is easiest for them when they are speaking or describing something in the class. Always insist that your pupils should keep accurate records of what they observe in their science practical.

Counting Numbers

This is basically an arithmetic process but is very important as a process of science. It involves the use of numbers for addition, subtraction, division and multiplication. For instance, having observed and classified objects, the number in each group can be counted. Pupils can work on counting the number of boys and girls in the class: the number of tall ones and short ones, etc.

Measurements

In the skill of counting numbers, we mentioned tall and short ones, measurements can help us to be more accurate in knowing the height of the pupils. The area of the classroom can be found by measuring its length and breadth. Duration of the lesson, speed of a car, room temperature, etc. can be measured using appropriate instrument.

Raising Questions

Scientists would want to know many things in their environment. They therefore ask such questions as how, why, when, to what extent. Such questions lead to investigations. For instance, why does a ball thrown up come down? Why a ripe mango fruit fall from the mango tree? How does blood move all over the body? Pupils should be encouraged to ask questions cither on their own or from the teacher.

Formulating Hypotheses

When scientists raise questions on any aspect of nature, they also make intelligent guesses which arc called hypotheses. These hypotheses are either accepted or rejected after the investigation has been completed. When pupils raise questions which may eventually result in finding out, you can ask them to make intelligent guesses about what will happen.

Prediction

This is foretelling what will happen. It requires more information, observations or measurements than formulating hypotheses. The nature of the event being predicted and the accuracy of our past observations determine the reliability of our prediction. The prediction has to be tested or verified through investigation. Teach your pupils how to make predictions.

ACTIVITY 11

Identify and list the process skills you have learnt so far.

Making Operational Definitions

This refers to defining terms as used in the particular context under reference. This is necessary as it enables the person reading the report of a "scientific investigation understands it the way the writer wants him to understand it. When a word can be interpreted in more than one way, learn how to define the word operationally and teach your pupils same.

Controlling or Manipulating Variables

A variable is something that is capable of change or vary. Pupils in your class are not of the same age, so age becomes a variable. If you want to find out effect of warmth on a germinating seed, you set up two germinating seeds and provide all the necessary conditions to one and remove only warmth from the other. The seed that does not have warmth will have all the other necessary conditions. Warmth is the variable that is being controlled here. This skill is closely linked with experimentation.

Experimenting

This is the art of testing an idea through practical investigation. The investigation can be based on some information or it may be on the basis of trial and error. It may succeed or fail. If it fails, another idea is tried. Experimentation involves controlling or manipulating variables. What has been described above is a simple experiment on seed germinations. You can design simple experiments in collaboration with your pupils in the class and find out what happens. In this way you are also teaching them how to earn out experiments.

Data Collection

This can be a result of experimentation. It is usually involved in many investigations. It is the art of gathering relevant information on the topic at hand. For instance, in the experiment on seed germination, if it is maize, you can measure the coleoptile daily for

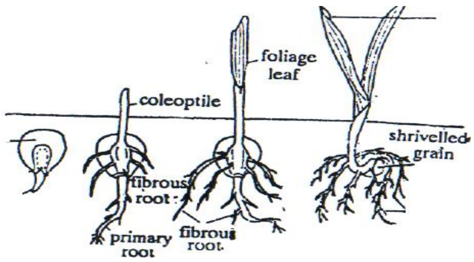

Fig. 4 1: Diagram of germinating seed showing the coleoptile

The measurements you take constitute the data collected. You can ask your pupils to collect data on the dimensions of the desks and benches in the class.

Interpreting Data

The data collected have to be analysed before meaningful interpretation can take place. The interpretation may be in the form of similarities or difference between or among the variables. We may use these hypothetical data for our experiment on seed germinations.

	Seed A	Seed B
	All conditions	No Warmth
1st day	0cm	0cm
2nd day	1cm	0cm
3rd day	3cm	0cm
4th day	6cm	0cm
5th day	9cm	0cm

This can be interpreted that germination takes place in seed A but there is no germination in seed B. Teach your pupils how to interpret whatever data they collect.

Inference
This is a general statement based on the data collected and interpreted. It is possible to make an inference on the experiment on seed germination that "Warmth is a necessary condition for any seed to geminate". You will learn more about this in Unit 8.

Manipulating Apparatus
In their investigations, scientists use various kinds of apparatus, ranging from very simple to sophisticated ones. Glass-wares and chemicals have to be handled with care and there are special techniques for manipulating some apparatus to avoid damage. Teach your pupils how to use some of these apparatus and how to handle them with care.

The process skills discussed above can be developed in your pupils. Make sure that you understand what each skill is about and plan lessons that will enable you teach a combination of skills. You will have noticed how interconnected the skills are because there is hardly any one of them that stands on its own, except, of course, simple observations. The use of the process approach underscores the importance of inquiry in primary science classrooms. Pupils can work individually, or in groups, while you go round to supervise what they are doing.

PROJECT APPROACH

THE PROJECT APPROACH FOR THE TEACHING OF PRIMARY BASIC SCIENCE

The project approach is a method in which pupils are given opportunities to investigate and collect data or specimens of their choice. Under the teacher's guidance, the children have some free hands in choosing the topic and the type of ideas they would want incorporated in the write-up. Very often, the teacher likes giving out a topic with a central theme, idea or problem. The sub-themes, idea and problems arising therefrom are given to individuals or group of children to work on. For instance, a broad topic for children's project could be travelling by (i) land (ii) sea (iii) air. Children are then required to develop these sub-ideas in some details. The overall aim is to encourage children to develop some basic scientific attitudes and skills, through their own activities. For good results, the teacher should always check the activities of the children once the project has started. This would give him first hand information as to whether or not, they are progressing in their various activities. The teacher should actually give a framework of what the project should look like after completion. For instance, the report could contain:

(a) the topic.

(b) objective (s) of work

(c) method (s) adopted.

(d) data collected and their probable re-organisation.

(e) data analysis and probable deductions.

A project may also involve an original creation by the children.

Periodic assignments should be carried out. This could involve oral and written tests or series of questions to indicate whether or not some new knowledge or information has been discovered or acquired. A project could last for a few weeks, a school term or year, depending on the vastness of such topic.

Advantages of the Project Approach

- Activities are centred around the child which ensures that the child's natural interests are fully taken care of during the teaching-learning process.
- The approach makes it possible for inter-disciplinary studies to take place because a project may contain materials from more than one subject area.
- The approach is likely to make the child learn better because his interests form the basis for self-motivation.

Whether projects are organized in groups, or individually, children gain socially and intellectually because they have the opportunity to interact with their teachers or colleagues.

ACTIVITY 12

(a) Identify a possible project topic.

(b) Break it into sub-topics,

(c) Instruct your class to write objectives for the areas they are to work on.

Disadvantages of the Project Approach

Despite the advantages of the project approach enumerated above, it also has some shortcomings. "These are:

- It takes plenty of time and efforts to accomplish. This is perhaps the reason why many teachers do not presently organize and use the project approach in the teaching of science.
- Project is very difficult to plan and execute if the class is large and overcrowded.
- It is easy to deviate from the objectives of the lessen,

Guidelines for the use of the Project Approach

For the project to be successfully applied, you should:

- plan well ahead of time and have good classroom management and control. project work can only be effectively and efficiently executed if there is a conducive atmosphere in the classroom and in fact in the entire school.
- plan and allocate your time in such a manner to enable you have sufficient time to discuss thoroughly all the problems and observations that the children have recorded.
- occasionally, use it together with other approaches (discussion, guided discovery) to help you and the children.

ASSIGNMENT

1. Differentiate between processes and products of science.
2. State an advantage of using process approach.
3. Enumerate ten processes of science.
4. Write a lesson note on a topic, indicate which process skills you want to teach and how you will teach them

5. Explain the project approach for teaching primary basic science
6. Enumerate the advantages of the project approach.
7. List the disadvantages of the project approach
8. Suggest guidelines for better use of the project approach

SUMMARY

In this unit, you have learnt that:

- Processes of science are the methods used by scientist to arrive at scientific knowledge.
- These processes are observation, classification, communication, counting numbers, measurement, raising questions, formulating hypotheses, prediction, making operational definitions, controlling or manipulating variables, experimenting, data coactions, inference and manipulating apparatus.
- The processes are interconnected.
- Process approach makes pupils active investigators rather than passive receivers of scientific knowledge.
- Children are guided to choose topics, collect data and write up in such a way as to develop in them basic scientific attitudes and skills through their own activities.
- Teachers should periodically check and assess to ensure that activities are going according to plan.
- Activities are centred around the child so that his natural interests are well taken care of.
- Make it possible for interdisciplinary studies to take place.
- Make the children learn better as their interests are cared for.
- Children gain socially and intellectually.

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UNIT 6: FIELD TRIPS AND CONCEPT APPROACH

INTRODUCTION

Children enjoy being outdoors, you may have noticed this in your own children or in the pupils you teach. How can this approach be effectively used in the teaching of science? Try to think of an answer to the question. This unit will provide you some more points. It will also attempt to explain how to use the concept approach in teaching.

OBJECTIVES

By the end of this unit, you should be able to:

(i) explain in your own words what field trip means;

(ii) justify the inclusion of field trip in the methods for teaching primary basic science;

(iii) state some guidelines for organizing field trip;

(iv) list some places in your locality suitable for field trips;

(v) identify different kinds of concept; and

(vi) develop a scheme for teaching a chosen concept.

What is Field Trip?

Some people call it 'excursion" or' visits'. You are probably more familiar with the word 'excursion" and 'visit' than field trip. It is the act of taking pupils out of the classroom for the purpose of learning some concepts or processes in science. It is a way of extending the classroom situation to the environment. I remember many years ago when pupils in our school went on an excursion to Kainji Dam. We observed changes in the vegetation from the north to south. There were also changes in how we felt the air. At Kainji Dam we saw the big lake and how the flowing water was used to drive turbines which generated electricity. We were taken round by an officer at the Dam who acted as our guide and explained many things to us.

ACTIVITY 13

Try to picture in your mind a man or a woman facing a group of young boys and girls and explain some things to them outside the classroom. Describe what you think will be happening. If you have actually been involved in an excursion, briefly recount your experience.

Why Field Trip?

Consider the following points in favour of including field trip as a method of teaching primary science.

- It provides pupils with the opportunity to interact with the environment than the classroom.
- It gives pupils first hand information about some things in their environment
- It helps pupils to use their senses and thus sharpen these sense of observation,
- Activities which cannot be carried out in the classroom because of limited spaces can be made possible by organising field trips.

- Visits to some places may make pupils develop interest in some professions which were, unknown to them before.
- It can help pupils develop an enquiring mind about things around them.
- It encourages team spirit and cooperation.

You should be aware of the fact that as useful as field trip is in teaching primary science, it can be very dangerous to the lives of the pupils and the teacher if it is not properly planned. It is also time-consuming. Planning is, therefore, very essential in organising field trip,

Planning for a Field Trip

You may decide to take pupils out at a particular point during the lesson without any prior planning but the gains by the pupils may not be as you expect. When you plan and inform the pupils, however, you are likely going to record a higher degree of success. In planning for a field trip, the following can be useful:

- Identify the concept or skill you want the pupils to learn or acquire through the field trips.
- Visit the site (either within the compound or outside it) and take note of what can be dangerous to the pupils.
- If the site is more than a walking distance, you and the pupils should make arrangements for a vehicle.
- If the site is a factory, industry or workshop, obtain prior permission from the owners of the place. Fix date and time with them.
- Inform students about the proposed field trip and the type of preparation they should make. Ask them to tell their parents or guardians.
- Let the Headmaster/Headmistress of your school know your plans.
- Arrange with other teachers in the school for the release of pupils from their classes.
- Instruct pupils on what they should rake along during field trip.
- Instruct them on what they should do and what they should not do (a) on the way and(b) at the site.
- Inform them of the possible dangers in disobeying the instruction and the punishment awaiting such a pupil or group of pupils.
- After the field trip, engage pupils in class/group discussion/activities, etc.

Possible Sites for Field Trip

The choice of places to go for field trip depends largely on you, the teacher. Such places range from the school compound, garden, field etc. to places outside the school. The following table can be useful if selecting sites for field trip.

	Concepts/skills to teach	Sites for field trip
1	Location of water, plants and animals, pond, stream, river.	Pond, stream, river
2	Behaviour of water plants and animals	Pond, stream, river
3	Science related occupations	Industry, factory, workshop
4	Observing nature	School compound
5	Experimenting on plant and growth	School garden
6	Properties of metals	Blacksmith’s workshop
7	Use of tools	Relevant workshop
8	Arrangement of plant in the forest.	Forest

CONCEPT APPROACH

What is a Concept?

A concept can be a word, a group of words, or a learn symbol which stands for an object or phenomenon. If you hear or read about "man" you already know that this is a human being. He stands on two legs, has two hands, two eyes, two cars, a nose with two nostrils, one head, five fingers on each hand and five toes one each foot. He has one mouth with no lips and thirty-two teeth. These teeth are categorized according to the functions they perform, he can think and converse with other people. All these characteristics qualify him to be a human being. For a human being to be a man, he should have a penis, he should also have short hairs on his head- there should be no bulging breast. If for instance, you see a human being with a bulging breast; long, curly or plated hairs, vagina and large hips, it will not be difficult for you to say that this is a woman and not a man.

You are able to differentiate a man from woman because you know the physical features of a man. You have seen these features common to many men. if you see an individual without one or two of these characteristics, you will easily say that this is not a man. There are other social characteristics by which a man is known. Try to identify these additional characteristics sites. All these features help you to form the concept of a 'man'.

KINDS OF CONCEPT

Such concepts as man, woman, stone, echo, shoe, house, white, red, perfume, food, plant, air, water, etc. can be seen, felt heard or smelt. The senses can be used to carry out the activities in forming the above concepts. Concepts can be observed and are observable. They are measurable in a relatively simple and direct way. Such concepts are called empirical concepts or concrete concepts.

There are some concepts which are neither directly observable, perceived nor measured. Their presence is inferred from the observable concepts, these types of concepts arc called theoretical concepts or abstract concepts. Examples are: atoms, protons, electrons, valence, genes, etc. It is necessary that you know all these in order to make effective use of the concept approach. You should bear in mind that most of the pupils in the primary school form concepts by directly interacting with concrete objects. Therefore, you should expose them to concepts that they can see, feel, hear, taste, smell, measure, etc, in order to make such concepts permanent in their memory. Doing this involves selection of concepts that are mostly common in pupils' immediate environment and also used in their everyday lives.

ACTIVITY 14

List four concrete concepts and three abstract concepts.

Relationship among Concepts and how to use the Concept Approach.

Concepts are related to one another while Concrete concepts are related to abstract concepts. Even within concrete concepts, some are learnt at a higher level than others. In order to identify which concepts to teach your pupils at a particular level, you need to analyze each concept to discover its relationship with others. Your duty is to consider the age and knowledge level of your pupils and select the related concepts which will help them to properly acquire the concept of water. As we said earlier on, it is necessary that you start with

lower concrete concepts → higher concrete concepts → abstract concepts.

ASSIGNMENT

1. What do you understand by the term concept?
2. Classify the following into concrete and abstract concepts: good, goat, gum, girl, density, force, polish, hydra, spirogyra, pressure.
3. Explain with an example what you understand by field trip.
4. State any three reasons for using field trip as a method for teaching primary basic science.

SUMMARY

In this Unit, you learnt that:

- Field trip helps pupils to use all their senses for observation.
- A concept can be a word, a group of words of a term which stands for an object or phenomenon.
- That there are concrete concepts e.g. book, water, air, pin, etc, or abstract concepts such as atom, electron, density etc
- Concepts are related to one another.
- Spiral curriculum treats the same concept at different levels of difficulty.

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UNIT 7: MAKING IMPROVISED MATERIALS FOR TEACHING BASIC SCIENCE

INTRODUCTION

In a basic science lesson, it is necessary for every pupil to be given the opportunity to handle materials and manipulate them to find out facts and make verifications, among others. This easily explains why activity-based approaches are strongly advocated by science educators. It is, however, sad to observe that it is usual to find out that pieces of science equipment and materials are either lacking or grossly in adequate. This situation calls for creativity and resourcefulness on the part of the teacher. In this Unit, we shall discuss how the basic science teacher can make inexpensive laboratory apparatus from available local materials which will help to promote and enliven the learning of Basic Science in the classroom.

OBJECTIVES

By the end of the Unit, you should be able to;

- explain what improvisation means;
- construct some inexpensive teaching materials for lessons on plants and animals.
- demonstrate the use of the constructed materials; and
- describe how to construct some basic science teaching materials.
- list out materials that can be improvised.

IMPROVISATION

What is improvisation?

Sometimes in our classroom teaching, we discover that a particular piece of equipment (say a beaker) we need for effective delivery of a lesson is lacking. If we are able to devise or create a suitable substitute for it, the substitute created is an improvised material. We can, therefore, define improvisation as a technique of originating a totally new tool, instrument, material, devise or modifying existing ones for serving a particular function. For a teacher to be able to improvise, he must be innovative, resourceful and creative in both thinking and manipulative skills.

Why do we Improvise?

Improvisation is a long-standing technique in science. It is probably as old as the study of experimental science. This seems logical if we can recall that the earliest scientists were pioneers in their fields. They had to initiate their ideas, tools and physical demonstration of their validity. However, a more systematic approach to improvisation in science was development in response to the acute shortage of laboratory equipment after the Second World War. The situation in Nigeria today is perhaps more acute than what prevailed after the Second World War as regards scarcity of Science equipment. The explosion in school enrolments and the poor state of the nation’s economy create a serious scarcity of science equipment. Therefore, there is a great need to provide substitutes for conventional science equipment.

There is, however, an additional reason why improvisation is necessary in effective science teaching. Children are likely to show greater interest and participation in science lessons if they co-operate in the production of the local materials used for the lesson. They are also made to realize the interrelationships among the different curricular activities the time table. For instance when materials produced by the children in handicraft lessons are utilized in science or social studies, they will easily see the relationship existing among these subjects. Local production involves the teacher and pupils in realistic problem-solving activities which stimulate learning.

ACTIVITY 15

i. Explain why we improvise materials in the science teaching.

ii. List few examples of science apparatus that you can improvise through substitution process for teaching primary Basic Science.

iii. Explain what is meant by improvisation by substitution in your own words.

Improvising Teaching Materials: By Substitution

Improvisation can easily be made through a process of substitution. This is a technique whereby an already existing local material is used in place or a piece of equipment that is not available. This is a simple form of improvisation which every resourceful teacher should be able to carry out to enrich his teaching. For instance, in science, very often beakers are replaced by jam jars, plastic ice cream containers and plastic margarine containers in our laboratory work. Can you think of other suitable materials that can be used as substitutes for beakers?

There are many pieces of laboratory apparatus that can be improvised through the process of substitution or replacement. A few examples that easily come to mind include the following: bottle tops can be used to replace funnels, plastic basins for bell jars, bottles can serve as substitute for round and flat bottom flasks and Vaseline bottles can be used in place of test tube. You can think of other examples you know.

Improvising Teaching Materials: By Construction

It is not always possible to find suitable substitute, for every piece of science equipment in the laboratory. But the topics requiring` the use of these apparatus have to be taught. In a situation like this the teacher is forced to construct a new instrument to serve this purpose. This is usually done from available local materials. When a teacher improvises a piece of science equipment by making an entirely new material from locally available 'resources or tries to modify an existing instrument to serve the same purpose, he is improvising through a construction process, This is a fairly more difficult form of improvisation than improvisation done through the process of substitution , A teacher needs to be innovative and creative to try this form of improvisation.

Now, let us discuss the construction of a few teaching materials to illustrate how original pieces of equipment can be improvised in the school situation. We shall also attempt to describe how such a constructed material can be used to improve our teaching. Assuming you want to teach a lesson requiring the use of a glass fish pond but it is not available in your school. A resourceful teacher can in this situation provide an improvised one from a cellophane bag well tucked into an empty sugar carton to hold water. Some life fish and tadpoles can be caught and put in it. This will serve as a substitute for a glass fish pond, Have you tried this with your students before? I urge you to try one with your pupils and they-will find it an exciting experience. Suppose you want to teach a lesson on the fish and you do not have an aquarium in your school and there is no nearby stream, how will you teach this lesson effectively? A resourceful teacher in this circumstance can easily improvise an aquarium.

Materials

You need the following materials to be able to construct an improvised aquarium: A small or medium sized strong cardboard box. A large transparent plastic bag or sheet of plastic big enough to hold the box, razor blade or very sharp knife, marker pen, paper clips and marking tape.

Procedure

The process to be followed in the construction is as follows:

- With the top flaps of the box sticking out, mark and cut two windows in each long side and one on each short side as shown here.
- Fold the top flaps inside and cut off any bits that cross the windows you have cut.
- Tape down the top flaps firmly inside the box.
- Place plastic bag or sheet into the pressing it firmly right down into the corners, making neat folds.
- Drape it over the top of the box and temporarily fasten it down with paper clips.
- Put a layer of sand in the bottom making sure that the plastic is in contact with the cardboard at all points, particularly in the corners.
- Move box to its permanent home position since it cannot be moved once it is filled.
- Fill carefully with water and adjust plastic as necessary.
- Trim off the excess plastic and fasten it down with tape.

The improvised aquarium is now completed and can be used to preserve some fishes.

Another important example of an instrument that can be constructed from local materials is an insect net.

Materials

This can be made from the following materials: a broom or mop handle, some heavy wires (the type used to make hangers) and mosquito netting.

Procedure

- Bend the wire into a circle about 38 to 45cm in diameter,
- Twist the ends together to form a straight section at least 15cm in length,
- Then fasten in to the end of the broom or mopper handle by lashing with a wire or by means of staples,
- Cut a piece of mosquito netting to form a net about 75cm deep,

- Sew a piece of cloth to the cut edge of the net,
- Then fasten it to the circular wire frame by stitching. The diagram below represents how your insect net should look like.

An insect net is a very useful instrument which can be used for catching insects when you want to teach a lesson on insects. It can be used in catching flying insects or sweeping the vegetation in search of resting insects. You can send your pupils out in groups at the beginning of a lesson on the grasshopper to hunt for grasshoppers with their insect nets. When the children return to the class, you can start the lesson with each child having a grasshopper before him for a lively discussion.

The examples provided so far are instances where improvisation has taken place through the production of entirely new equipment from local materials, where the manufactured ones cannot be provided. The locally produced materials serve the same purposes which the commercial and sometimes complicated ones also serve. There are many science apparatus that can be improvised in this way. A few biological models of various parts of the human body, mounting boxes, plant press stretching board and animal cages.

What this Unit has attempted to do is to provide few illustrations of how some conventional pieces of science equipment or tools can be improvised for classroom teaching. This can be achieved through two improvisation techniques, viz: substitution and construction. You should, therefore, think of other materials that you and your pupils can produce with local materials for a more productive teaching-learning encounter. It is also advisable that you have a small nature corner in your classroom where children's collections can be kept. It is equally important to reserve a small space in the school premises as a workshop where teacher s and pupils can co-operatively work together to produce improvised teaching materials.

Other items of Improvisation

In a normal classroom situation, it is usually not possible for the teacher to get all materials required for teaching science. A major problem is lack of money to provide these necessary materials for teaching science. A way out of this problem rests on the ability of the teacher to demonstrate his creativity and resourcefulness by making some of the needed simple and inexpensive science materials. The materials listed below will be discussed in details under:- materials needed, methods of construction, operation and safety precautions.

- Can-burner
- Spirit burner
- Tripod stand
- Simple balance
- Simple pulley, and
- Simple rainguage

Now examine how you can make these simple materials for teaching Basic Science.

The Can-Burner

Wherever science is done, whether in the laboratory or the normal classroom, heating is a common process. In the well-stock laboratory, it is common to find materials such as the Bunsen Burner for heating.

Materials

This burner could be improvised to function as the Bunsen burner by using some local materials such as empty *bournvita* or *ovaltine* tin with lid, a wick, kerosene or palm oil. A twig is fixed in.

Procedure

- Make between 3 and 6 holes on the upper half of the body of the tin,
- Make another hole at the centre of the tin lid,
- Put some kerosene or palm oil into the tin.
- Insert the wick into the hole of the tin lid such that its base is in the kerosene or palm oil.
- Allow the wick to stick out of the tin lid.

The Spirit Burner

This is similar to the Can-Burner described above.

Materials

- Jeleen or Vaseline bottle with metal lid
- Wick
- Spirit or alcohol
- A small iron sheet

Procedure

- Make a hoe at the centre of the metal lid
- Roll the iron sheet into a small tube which will be fixed in the hole
- Tighten the tube to the lid at the inner side
- Insert the wick into the hole of the metal lid such that it touches the base of the bottle
- Pour some quantity of spirit or alcohol into the bottle.
- The Simple Tripod Stand

In some rural areas where firewood is used for cooking, we have locally prepared iron standson which cooking. In the science laboratory too, we have a similar material for holding certain objects for heating. Such a material is called tripod stand. Tripod stand can be constructed locally from tin cans by removing either two or three sides of a kerosene tin.

A Simple Balance

The scientist is always engaged in activities of comparing size of objects, time taken for certain events to occur, areas, speeds, weights, temperatures, volumes and so on. An important tool commonly used by the scientist for comparing weights is the balance.

Material and Procedure

The simple balance could be constructed by punching four holes in an old tin can with a nail spacing them equally round the circumference. Pass pieces of thread through the holes and tie them together. Attach the scale pan to a rubber band that is hung from a nail. In the absence of known weights to graduate the balance, use known volumes of water poured from measuring jar so as to make marks on the supporting stick opposite the edge of the scale pan. Then use stones that will give different weights for future use as standard weights. Coins may also be used to show standard weight.

A simple Pulley

Machine is a device that helps to reduce the amount of energy expended in doing work. Among the simple machines commonly used by scientists is the pulley.

Material

A resourceful teacher can make a simple pulley from a clothes hanger and a cotton reel.

Procedure

- At a distance of about 20cm from the hook of the hanger, cut off both wires of the hanger.
- Bend the ends of each of the two wires at right angles and pass them through opposite ends of the cotton reel.
- Make the wires such that they would permit easy turning of the reel.

ACTIVITY 16

A scientist is one who is always conscious about happenings in his own environment. He tries to find out what happens at what time and how it happens. Rainfall is one of such things the scientist tries to find out when and how much of it that occur at any given time and place. Thus, rainguage is a necessary instrument that helps the scientist to determine the quantity of rain that fales at a given location and day.

Materials

We can construct a simple rainguage by the use of a funnel and bottle with a measuring cylinder to measure the amount of water collected in the bottle. It is advisable to use a funnel that has a sharp vertical edge to prevent the bouncing out of rain drops.

Procedure

Bury the apparatus in such a way which makes the funnel appear a few centimeters above the ground level.

It should be noted here that it s not possible to list out all science materials which can be improvised in the science laboratory and treat them one in this Unit. All that we have attempted to do is to draw your attention to some local materials and the techniques used in improvising few common science equipment.

It is hoped that this will sensitize you to provide other suitable science equipment for use in your next basic science class.

ASSIGNMENT

1) List some simple scientific materials you have studied in this Unit that are necessary tools of the scientist which can be made locally by the science teacher.

2) Prepare a simple pulley from the cotton reel and wire from clothes hanger.

3) How can you as a science teacher effectively produce a spirit burner which you lack for your teaching?

4) Describe how you would construct a simple balance for use in teaching Basic Science.

SUMMARY

In this Unit, you have learnt that;

- a can-burner is improvised by using a cylindrical with lid, kerosene or palm oil and wick.
- a jeleen or vaseline bottle is useful in the improvisation of a spirit burner.
- tripod stand can be constructed locally from tin cans.
- spring balance, a very useful tool for scientific investigation can be constructed locally.
- clothes hanger and cotton reel are the materials for improvising a simple pulley.
- a rainguage can be made locally by using a bottle and a funnel with a measuring cylinder to measure the amount of water collected in the bottle

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UNITS 8: SCIENTIFIC PROCESS SKILLS

INTRODUCTION

You learnt that observation is one of the process skills in science. In this unit we shall discuss it in detail. The image often painted of the scientist is that of an absent minded 'person' who spends every working moment either is his laboratory experimenting or curiously observing and subjecting what he observes to critical analysis. There is a certain degree of truth in this conception because experimentation and rigorous observations are the key cornerstones of scientific studies. In fact science can be distinguished from other disciplines because in it observations and experimentation are carried out regularly.

OBJECTIVES

By the end of this unit, you should be able to:

i. define observation;
ii. explain the need for observation in scientific inquiry;
iii. describe the procedure for carrying out observation; and
iv. explain how all the senses are involved in observation.

What is Observation?

Observation is a very important scientific skill which is better describe or explained rather than being defined. It is one of the process skills which every science pupil is expected to acquire as a result of his exposure to basic science learning. Observing as a component of the process skills is explained to mean being accurate, alert and systematic. Observation is one of the most powerful tools with which the scientist gains mastery of his environment. It is a fundamental scientific skill which involves the use of all the senses and particular attention is paid to the object or event being observed. It is a very important scientific skill with which the scientist collects all relevant and vital information about his environment for solving problems.

The Need for Observation in Scientific Work

The scientist is definitely not a magician or a diviner. He does not perform miracles. The scientist is in no position to formulate any hypothesis on the possible solution of a given problems except he/she is well armed with some relevant information on the question at hand. Accurate and relevant information form the raw material from which scientific knowledge is generated. Observation is therefore a very important scientific skill because with it the scientist is able to collect all needed information about any problem whose solution is being investigated. A systematic and objective collection of relevant information is a crucial task for the scientist in his quest for knowledge. Observation is therefore the first phase in any scientific inquiry.

What Does a Scientist Observe?

The scientist does not only observe objects or events. He is equally interested in the frequency of their occurrence. From the rate of occurrence of an incident or object he is observing, he is able to obtain additional information.

Colour is an important physical feature which attracts the attention of the scientist. Ability to describe colours is a very important skill to the scientist. For instance, a biologist needs to describe the colour of the organisms he is observing as this can form a basis for a preliminary classification if the organisms are many. The skill to identify colours is also very important to the chemist because it helps him in the identification of compounds in his laboratory analysis. The ability to identify colours depends on critical and rigorous observation. Without this skill, the fine distinction between the different shades of colour cannot be determined.

The scientist in his observation also pays attention to shapes of objects. To the biologist shape is very important because he uses it as a basis for classification. This is why aspects of the study of biology are devoted to detailed study of the shapes of plants and animals. The chemist is also interested in observing the shapes of crystals which he uses as a basis for classification. Obviously you know how important shapes are in the study of mathematics. Mathematics forms the bedrock in any study of any science since scientific results can be expressed in mathematical form for the purpose of accuracy and precision. The geologist also painfully observes and studies the characteristic shapes of rocks which he uses as a basis for their classification.

Size of objects or organisms is another important physical feature on which a scientist focuses his observation. He is attracted by either the largest or the smallest organism or object. This is why he skilfully designs appropriate instruments for viewing and measuring them. It is important to mention that astronomy is a science that relies heavily on skilful observation. The study of the heavenly bodies has been made possible through observation. In astronomy observation has been aided by the construction of special instruments like the telescope.

ACTIVITY 17

i. Describe the number, shape, colour and size of an animal you saw when coming to school today.
ii. Name one sense organ that is commonly used in observation.

Using other Senses to Observe

Beside the observable characteristics we have discussed, the scientist also uses the sense of feeling in observing the texture of object by touching them. Skin is the organ for the sense of touch. Biologists, for instance, handle haul structure-.like bones, wood and delicate and tender organs like the heart. The texture of the material helps the biologist to know how to handle the material and to determine the type of scientific investigation to carry on it. He also develops observational skill to detect smell and sound in his environment. Nose is used to smell while ear is used to detect sound. The sense of smell is used extensively by the chemist in his analytical work in the laboratory. He is able to identify some of his compounds through the characteristics odour of gases which are produced when they react with other compounds. The hissing sound which accompanies the production of certain gases in the laboratory is also easily detected by the development of appropriate you can appreciate that observation is not mere seeing but a total experience involving all the senses i.e. hearing, seeing, smelling, tasting and touching.

How observation should be carried out?

It is quite demanding to cultivate the appropriate observation skill required for successful scientific work. Stated below are the steps you can take in helping your pupils to develop observation skill.

For observation to be purposeful, it has to be specific and well directed. For observation to be purposeful, we need to articulate the purpose of the observation by specifying the particular thing we want the pupils to observe so that their attention can be fully focused on the details of the feature to be observed. Useful instruction should be given to the pupils to go out and observe any insect they see or hear. In this way, their attention has been directed to a particular animal which they can observe in detail.

Observations should be objective. They are supposed to observe without any bias or prejudice and report as objectively as possible what they have observed. To be able to observe objectively, they must have an eye for details. At the primary level however, pupils should encouraged to make reports in pictorial forms like diagrams, charts and models. But pupils' attention should be directed to the features of what they are observing, so that they can be reported fairly accurately.

Regularity of observation: Observation in scientific work is very highly systematic and not a haphazard activity. Observation should be well planned so that it becomes systematic to yield a reliable result. Observation should be kept on for a while or a period of time for accuracy.

Recording of observations: It is important that we record the results of our observations. Pupils should, therefore, be encouraged anytime they go out on nature survey or field trips to prepare a record of their observations in a note book. These records should be inspected regularly by the class teacher. This helps to develop the skill of careful observations and good records keeping by providing opportunities for nature surveys.

MEASUREMENT OF PHYSICAL QUANTITIES

What is Measurement?

The scientist attempts at all times to present an accurate, precise and objective report of his activities. This is why scientific knowledge is very reliable. The scientist is not impressed by qualitative descriptions like a "large farm" or a "high fence". For the purpose of accuracy and precision, he would prefer to know whether the farm is two hectares or the fence is fifty metres high. In other words, he values quantitative description because it provides accurate information on the definite quantity of the material described. The process by which objects or events are quantitatively described by uniquely assigning numbers to them is called measurement. Because the scientist is concerned with accuracy and precision in his activities, measurement is a very important skill in every fact of the scientific enterprise The scientist meticulously measures all the materials he uses in all his experimental work in order to achieve precise results. Indeed event scientific activity depends more on precise measurement than any other discipline does. This is a major area of differece between science and the other disciplines.

ACTIVITY 18

1. Define measurement.
2. Carry out the following measurements:
   a) Use your strides to measure the length of the classroom.
   b) Compare the masses of a book and a pen by lifting them.
   c) Estimate or guess the time now by observing the position of the sun.
   d) Estimate the quantity of water that can fill an empty *Fanta* bottle

Need for a Standard Measurement

Suppose you ask your pupil to carry out the above activities, you will observe that you are likely come up with different results, it is very likely that your pupils strides will be shorter than yours depending on his age. His estimation of the quantity of water that will fill the *Fanta* bottle might be determined by the number of drinking cups while yours might be in terms of tea cups. You will obviously realise that the inconsistency of the results obtained in these activities shows clearly that the measurements are unreliable, inaccurate and misleading. But science always aims at providing accurate, reliable and reproduceable information. The implication of this is that accurate and common standard of measurements is inevitable because scientists working in different parts of the world share their knowledge together. Modern scientific measurement has evolved a common universally acceptable unit of measurement which implies that a unit quantity measured will convey exactly the same quantity to everybody. This has made it possible for scientists to communicate the results of their work to colleagues working elsewhere.

FUNDAMENTAL UNITS AND QUANTITIES

ACTIVITY 19

i. Measure the length of your classroom with a 30cm ruler
ii. What time is it now from your watch?
iii. Explain the need for standard measurement in science.
iv. State the S.I. units and the quantities they measure.

Other sub-unit of length, mass and time are as follows:

Length: milimetres, centimetre (metre) and kilometre.

Mass: gramme (kilogramme) and tonne

Time: Second, minutes, hours etc.

Derived Quantities and Derived Units

Derived quantities as the name suggests are derived from the fundamental quantities. They are so called because they are obtained from a combination of the fundamental quantities. Examples of derived quantities are area, volume, velocity, acceleration, density etc. The units in which derived quantities are measured are called derived units. Examples of such units are square metre (m^2) for area, metre cube (m^3) for volume, metre per second (ms^{-1}) for velocity etc.

Measuring Instruments

There are various instruments for measurement. Below is a table showing instruments for measuring fundamental quantities.

Quantity	**Instrument**
Length	metre rule, tape, ruler, vernier callipers, micrometer screw gauge
Mass	Chemical, balance, compression balance, and equal arm balance.
Time	watches and clocks of various types

Scientists have also devised some instruments which can measure some derived quantities directly. The table below shows some examples.

Quantity	S.I Units	Instrument
Temperature	Degrees Kelvin (K)	Thermometer
Relative Density	Kilogram per cubic metre (kgm^{-3})	Hydrometer
Atmospheric Pressure	Newton per square meter Pascal ($Nm^{-2}Pa$)	Barometer
Electric Current	Ampere (Amp)	Ammeter
Voltage	Volts (V)	Voltmeter
Relative Humidity	Percentage %	Hygrometer

It is pertinent to mention that scientists have devised many instruments in measuring non-fundamental quantities. They are too many to be enumerated here. The table above furnishes us with a few examples of such quantities and the instruments used in measuring them.

MEASUREMENT OF PHYSICAL QUANTITIES

Measurement of Distance

The vernier slide callipers is used to measure very small distances accurately. Suppose you want to measure the length of your reading table or your note book, what instrument will you use and why? You will probably use the metre rile, a ruler or a small tape to measure because it is convenient to use one of these, considering the distance you are dealing with. But assuming you want to measure the length and breadth of the school compound or the compound in which you live, what instrument will you use? You will notice that because of the distance involved, the most convenient instrument for the measurement will be the tape measure which gives distances from a few centimetres to a few hundred metres.

Measurement of Mass

The mass of a body is a measure of the quantity of matter the body contains, this does not change from place to place. In the laboratory, the mass of an object is measured with a beam balance: the mass of a body is not the same as its weight bin proportional to it, the mass of a body is measured in kilogram (kg) unit: Other units of mass include milligram (mg), centigram (cg), decigram (dg) and gram (g).

10mg = 1cg

10cg = 1dg

10dg = 1g

1000g = 1kg

Mass is also measured in microgram (mg) and tonnes(t). 1 am sure you have learnt about the beam balance and how it is used in the laboratory, it is a very sensitive instrument because it responds to small changes.

Measurement of Weight

You must have learnt that:

- The weight of an object is the force which it exerts on anything that freely supports it.
- The weight of a body varies from place to place.
- Weights of small objects are usually measured by a spring balance and

The weight of an object is measured in Newton (N) units (1N = 10kgf). The weight of heavy objects is measured using weighing machines which work on the same principle as the balance. The only difference is that they have stiffer springs that can resist heavier objects than the one used in the spring balance.

ACTIVITY 20

a) What is the difference between weight and mass?

b) What instrument is used in weighing the quantity of meat you buy in the supermarket?

Measurement of Volume

The volume of an object is the space it occupies and its unit is expressed in cubic metre (m^3), cubic decimetre (dm^3), cubic centimetre (cm^3), and cubic millimetre (mm^3).

$1{,}000mm^3 \quad = \quad 1cm^3$

$1{,}000cm^3 \quad = \quad 1\ dm^3$

$1{,}000dm^3 \quad = \quad 1m^3$

Volume is also measured in litre (1) units

1 litre = $1\ dm^3 = 1{,}000cm^3$

The volume of an object is measured directly or indirectly. Direct measurement of volume of an object is applied when the object has a regular shape. On the other hand, indirect measurement procedure is used when the shape of the object is irregular, e.g. a piece of stone.

Irregular Substances - Liquids

The volume of any liquid substance is usually measured by pouring the liquid into a graduated container e.g. measuring cylinder, burette, pipette etc. Your course tutor will show you samples of these instruments if you have not seen them before.

In reading the liquid level in these instruments, we consider the curving nature (meniscus) of the liquid. Viewed from below, the meniscus of a liquid like water curves upwards while that of mercury curves downwards.

You should note that the liquid whose volume is to be measured is poured into a measuring cylinder or burette. But in the case of the pipette, the liquid is sucked-up through the upper opening.

Irregular Substances - Solids

The volume of an irregular solid is measured by dropping the object into a liquid and measuring the volume of the liquid which the solid displaces. However, the liquid should be such that would neither react with the solid nor dissolve it. Small irregular objects like pebbles are dropped into liquids in graduate cylinders. The difference between the initial and final liquid levels gives the volume of the solid object. For big objects, we use an overflow vessel.

The vessel contains a liquid into which the object is dropped. The liquid that overflows is collected in a graduated cylinder from which its volume (the volume of the solid) can be measured.

Irregular Substances - Gases

Gases are always placed inside containers, you are aware that gases have no definite size and shape. They simply occupy the sizes of their containers. Volumes of gases arc thus measured by measuring the volume of their containers. If the container is a regular object, the appropriate formula of the object is used in computing the volume of the gas it contains (taking note of the thickness of the container). If the container is an irregular object, it could be made to displace some liquid where volume can be measured using cither a measuring cylinder or burette to determine the volume of the liquid so displaced.

ACTIVITY 21

Use a measuring cylinder and an overflow can to measure the volume of a small and a big stone or wood in your environment.

NOTE: This activity should be carried out in the laboratory during contact session. Alternatively you can improvise some materials and carry it out at home.

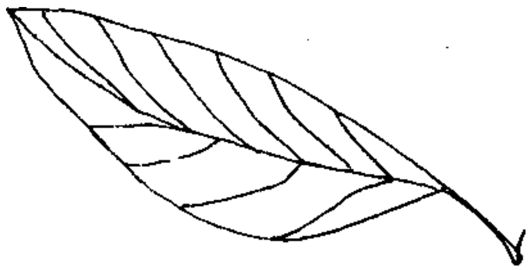
This unit has only attempted to describe how a few physical objects are measured. There arc main physical objects that can be measured but have not been discussed in this unit. Look around you and suggest as many of them as you can. You can consult your course tutor where you have any problem in determining the way any of the physical objects can be measured.

PICTORIAL REPRESENTATION OF SCIENTIFIC RESULTS

What is meant by Pictorial Reporting? The scientist is a very keen observer. In his observation, he pays particular attention to the details of the objects or phenomena he observes. Such details may include physical appearance, size, colour, weight, volume, length or height and frequency of occurrence etc. One way by which the scientists communicate their observation to their audience is through pictures. Pictorial reporting is, therefore, the representation of scientific knowledge through the medium of pictures. Pictures serve three main educational purposes, viz: presenting fact, organizing knowledge and stimulating imagination.

Sketches, Diagrams and Charts

Sketches are simple illustrations to express important information or some structural details. When making sketches, legibility is very essential. It is also important to omit all unnecessary details and fancy. Important scientific information can be reported by means of sketches of organisms a child observes on a visit to the school garden. Such representations of the child provide brief, useful but only qualitative information about the child's observations. It is however important to note that such a scientific report may not be precise and accurate. Nevertheless it saves time as an alternative to pages of verbal reporting. This is one of the defects of using sketches as a medium of reporting results of scientific investigations.



Sketch of a Leaf

Well prepared diagrams often contain more details than sketches when used for reporting scientific result. For example a well labelled diagram of the fish will provide a lot information about its morphology than a sketch made in single lines. Diagrams when carefully drawn as a means of reporting scientific results promote learning. Diagrams like sketches are prepared on the spot as the need arises.

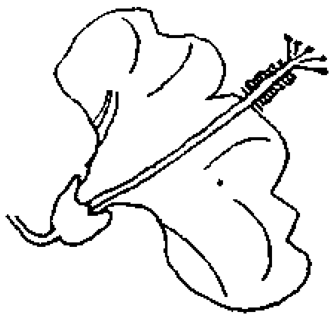


Diagram of a Hibiscus flower.

ACTIVITY 22

1. What is the difference between a sketch and a diagram as reporting media?
2. Make a sketch of a plant in your locality.
3. Make a diagram of a common animal in your locality.

CHARTS

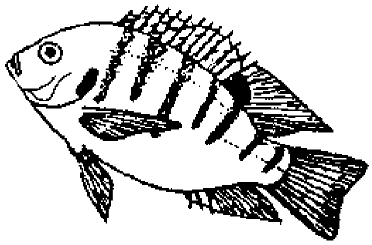
Charts can also be used as a pictorial form for reporting our observation and scientific results. Unlike sketches and diagrams, charts are more elaborated and expensive to prepare. But they have the advantage of being more durable particularly when they are prepared with good quality paper. Charts are of two types-viz: teaching charts used as an aid to teaching and wall charts which are hung to convey useful information.

Basically charts are still pictures which provide a medium for representations of reality through symbols. A chart can be as simple or as complex as the subject and the training situation demand. Its main purpose in pictorial reporting of scientific observation and results is to present facts in a visual form. It can give broad view of a subject and is helpful in making generalisation. It should be noted that charts are a favoured medium through which children communicate their observations and investigations of their environment. Children show particular interest in the charts they produce. They should therefore be encouraged always to make charts of the animals or plants they encounter. Charts like other forms of pictorial reporting provide accurate scientific information.

You will observe that these three forms of pictorial representations differ in their degree of accuracy of expressing scientific information Sketches which are very often hurriedly prepared seem the least accurate to be followed by diagrams and charts in that order. Thus, we observe that while sketches, charts and diagrams may be useful as forms of pictorial reporting of scientific facts, they may not give a true picture of reality. This is their major defect Science attempts to represent the accurate and precise knowledge always. It is therefore necessary to accept with caution the information provided by this category of pictorial illustrations. When pictorial illustration are employed for instructional purposes, it is necessary that they should be bold, carefully and neatly prepared and labelled appropriately.

MODELS

Apart from the pictorial forms of reporting scientific information which we have discussed, can you think of any other pictorial form which a scientist uses in reporting his observations. Occasionally a scientist might decide to report what he observes in a concrete way in the form of a model. A model is a three dimensional copy or representation of an actual object, usually on a smaller scale. Like the actual object, a model has breadth, length and depth and can be looked at from all side.



Model of fish

Models, as a form of pictorial reporting of scientific knowledge, have their merits and limitations. They hold a great fascination for the young and old alike. If things represented are familiar, they are easily recognisable. List familiar subjects can also be easily and readily understood because of their three dimensional nature. Model can draw attention to essentials and omit unnecessary details. For instance a model of an object, building or farm layout can inspire people to work on the real thing as they see a picture of the final result.

Limitations of models include the following:

- Main models are fragile especially when made with mud and some cannot be carried from place to place.
- Storage is sometimes a problem with models.
- In many cases, they can be used only with small groups.
- There is some danger that people will get a wrong idea of the actual thing if reporting is done with small models.
- The information coin-eyed through models is also qualitative in some cases and therefore may lack accuracy-and precision.

But these limitations notwithstanding, models can serve as a useful pictorial medium for reporting scientific knowledge. Can you mention some models displayed in the science laboratory?

PHOTOGRAPHS, FILM STRIPS AND SLIDES

The last form of pictorial reporting which we shall consider in this unit is the photograph. Accurate representation of objects through descriptive pictures can be provided by the photographer. Photograph depicts reality and is particularly useful for reporting events and objects during field trips and excursions. However, like other forms of pictorial reporting of scientific results it has its own limitations. Some new pictures sometimes emphasize dramatic aspects rather than the truth. The production of photographs involves the use of a camera which could be expensive to buy. Photography also requires a special knowledge and skill which not all pupils possess.

It is pertinent to mention here that the pictures we have discussed in this unit are referred to as non-projected still pictures. There is however, another category of pictures which is equally useful for communicating scientific knowledge. These are called projected pictures which maybe still or moving. These pictures are produced in the form of slides or film strips and require sophisticate equipment and procedure for their production and utilisation. A detailed consideration of this group of pictures is not within the scope of this discussion but it is important to note that this category of pictures provides more realistic medium for communicating scientific information. This is particularly the case with the case with the moving pictures.

ASSIGNMENTS

i. Carry out a nature survey of your school farm and prepare suitable diagrams showing two animals and two plants you saw during your survey.
ii. Observe and prepare a model of a familiar animal found in your locality and label its parts.
iii. Mention two forms of pictorial reporting and give a brief description of each.
iv. List two merits and two limitations of one form of pictorial reporting.

SUMMARY

In this unit, you have learnt that:

- scientific knowledge can be reported quantitatively in different pictorial forms
- sketches, diagrams and charts are simple and fairly inexpensive forms of pictorial representation of scientific results.
- pictorial expressions of scientific knowledge does not possess a high degree of accuracy.
- models are a better form of pictorial representation of scientific facts because of their concrete and three dimensional nature.
- photographs depict reality more accurately but suffer the limitation of being more expensive than charts, diagrams or model to reproduce.
- projected pictures are generally superior to non-projected pictures in depicting reality but they are very expensive to produce and utilise.

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UNIT 9: CONTROLLING AND MANIPULATING VARIABLES

INTRODUCTION

In some units back, you learnt the techniques of science teaching, approaches to the teaching of science, the process skills in children. Can you still recall that controlling and manipulating variables is one of the process skills of science?

In this unit, we shall discuss more of the process skills in detailed.

OBJECTIVES

By the end of this unit, you should be able to:

1. explain what is meant by controlling and manipulating variables:
2. explain what variables in an experiment means:
3. state the need to control variables in an experiment; and
4. conduct simple experiments to show how variables could be controlled and manipulated.

What is a Variable?

When a science teacher faces a problem around him, all he has to do is to design and conduct an investigation so as to find the answer to that problem. Like a crime detective, the science teacher does not know which method he should employ to solve the problem but by trying different ways he finally arrives at the answer.

At times, he conducts an experiment to enable him solves the problem. In the process, he manipulates some variables. What then is a variable? A variable is referred to as anything which can have an effect on the results of an experiment. For instance, the conditions necessary for germination of seeds such as water, air and warmth are all variables affecting the germination of seeds. Again, the amount of water, the type of soil, temperature and the amount of sunlight are also regarded as variables that can affect the result of an experiment on the growth of plants. Controlling variables means keeping a certain conditions in check so that they do not affect the results of an experiment. Manipulating variables refers to the ability and skills employed to hold a variable constant such that its presence or absence has no effect on the experiment. Controlling and manipulating variables will then mean the ability and skills employed to put certain elements of an experiment in check such that they do not affect the result of the experiment.

Controlling and Manipulating Variables

Let us use some concrete illustrations to demonstrate controlling and manipulating variables in "an experiment to show that air supports burning." The materials used in this investigation are two candle sticks, matches and a glass beaker. Light the two candle sticks and put each of them standing on a table. After about two minutes of burning, place the jar over one of the candle sticks. What do you observe of the candle stick that was burning in the jar? It went out after sometime.

The variable under control is air. Air is being manipulated in the investigation. This is because we want to know whether air actually supports burning. The air that supported the burning candle got exhausted or used up in the jar and so the flame went off. But the candle that was not covered continued to burn because air was not controlled. This is why lanterns are provided with holes which let in air so as to continue the burning even if the shade covers the flame. The reason is that the air is not controlled and as long as there is adequate supply of it, the lantern continues to burn.

Usually in a science class what one knows serves as the control to what is unknown. Take, for instance, measurement of weight or height. In a bid to compare the unknown object with the known object, you use the known object as control. You want to find out how far the weight of the new object deviates from that of the known object.

Control and Manipulation of other Variables

The example cited on the control of air is suitable as a demonstration lesson for both junior and senior primary school pupils. Let us use one more example to demonstrate what and how variables are manipulated using the pendulum. The pendulum presents a lot of opportunities for controlling and manipulating variables.

The variables that can affect the result of the swinging of the pendulum are:

1. Length of the string
2. Mass of the bob
3. Material of the bob
4. Material of the string and
5. The effect of pulling the bob out further before releasing.

Let us assume that all these conditions or variables are the same among two pendulums, except their lengths. This is to say the pendulums have the same mass of bob, the same make of bob, the same make of string and are pulled out the same distance before releasing, The only difference in this case between the two pendulums is that the length of one string is longer than the other.

What do you think will happen to the two pendulums when they are both pulled at the same distance and at the same time? Think of which of them will first stop, Is it pendulum with longer or shorter string?

It is obvious that the longer the string of a pendulum, the fewer the number of oscillations. This means that the pendulum with the longer string has fewer number of oscillations than the one with shorter string which of the variables of the pendulum do you think is under control? What generalisations can we make from this experiment?

The experiment could be done with pupils in the higher class in the primary school because it requires a bit of higher level of thinking and reasoning than the one earlier conducted on air. In this experiment, all other variables except the length are constant. This means that the same conditions are applied to the two pendulums except the length, so if there is any difference in the number of oscillations, such a difference can be attributable to the difference in their lengths. Each of these variables can be tested so as to see their individual effects on the number of oscillations.

ACTIVITY 23

i. Light a candle stick and put on a cork and float it in a trough with water about lcm high,
ii. Place another candle stick that is not lit on a cork and also float it in a trough with water about lcm high,

iii. What do you observe in them?
iv. Is there any rise in the level of water in the beaker of lit candle?
v. What is being controlled?

Manipulating Variable using Potted Plants

Although this experiment takes a fairly long time to accomplish, it is worthwhile involving pupils to participate in.

Place two potted plants one in a dark cupboard (deprived of sunlight) and the other kept outside where there is sunlight. Provide warmth and water to each other. Leave them for about one week but continue with the provision of water and warmth and observe them. Can you find any difference in their growth? Whereas one was enjoying ample sunlight, the other was kept in the dark. Compare them and show your observation. Sunlight was the variable that was controlled and whatever difference in their growth would be attributed to growth in the dark or sunlight. Controlling a variable enables us to effectively determine the effect of that variable on the object being manipulated.

In scientific experiments there are many variables involved. These include time, weight. Mass, length, resistance, angle, colour, just to mention a few.

ACTIVITY 24

Conduct an experiment on two potted plants, one denied water and the other provided with water. What happens to them? Show why there is a difference in their growth. What variable have you controlled?

FORMULATING MENTAL MODELS AND INTERPRETING DATA

What is a Model?

The term model can be used as a noun to represent an idea, object or a concept, or as a verb to demonstrate, or as an adjective to describe an idea or concept. A mental model therefore is either a concept or an imaginative picture of things in their real perspectives. There are three basic forms of models: iconic, the analogue and the symbolic.

Iconic models art; concrete models that are either moulded or carved to represent objects. This could be found in the form of fish, the eye, ear and other objects. The analogue model could be found in the form of maps, and symbolic models demand representation of ideas and concepts at a relatively higher level of thinking. For example, the model of the area of a room is given as Area = Length x Breadth. This, under normal circumstances, may be difficult for the child to understand at the early ages, but as he reaches maturity, it becomes relatively easy.

MODELS AND SCIENCE TEACHING

All the three types of models are useful in the teaching and learning of science. The application of a given model depends to a large extent on the level of mental maturity of the learners. For instance, of about the age when pupils are in the junior classes of the primary school and indeed up to primary class 6, they need to handle and feel, smell, see, taste where possible and hear. The use of the five sense organs helps pupils to observe things and events around them. These help in the formulation of mental pictures in children. At this stage both the iconic and the analogue models are very necessary. At this stage too children do a lot of classifications. For instance, they can recognize the shape, size and colour of an object. If a collection of buttons is given to a pupil, he would be able to sort them out according to their individual properties.

A teacher would like to create in his pupils the concept of roundness. He provides materials such as bucket, round plates, round buttons and basins. On seeing and touching the object, the pupils make a mental picture about roundness. Other shapes such as rectangle could be taught in the class using 4 - sided blocks, surface of match box, children's desk, their books and ruler. The handling and use of various items emphasising a property created in children a mental picture of that object.

Since at the primary school level the pupil depends on the evidence of his senses (his perception), all the teacher has to do is to provide materials that will enable the child effectively utilize the senses in formulating mental models of objects and events.

As a result of the level of maturity of pupils in the senior primary over those III the junior classes we can use both iconic and analogue models to teach certain ideas and concepts such as length and height to pupils by providing sticks of different lengths and asking pupils to arrange themselves according to their heights. This is a form of classifying the sticks according to their lengths. By so doing pupils get to use phrases such as "longer than" or "shorter than It. We could also ask pupils to line up according to their heights. Here also we compare and use phrases such as "taller than" and "shorter than it.

At a later stage also, the concept of cause-and-effect could be introduced b~ conducting simple experiment since ideas about cause-and-effect are central to the study of science. We can demonstrate this by setting two beakers containing lime water. We allow the exhaled air from a living organism into one beaker and then leave the other. Children observe that the lime water into which exhaled air is breathed turns milky. In this circumstance, the effect is the lime water that turns milky while the cause is presence of exhaled air. In this experiment pupils may not be required to know that it is carbon (IV) oxide that caused the effect observed but adjust the explanation that will enable them to understand that something caused the lime water to turn milky.

From this exercise, children are introduced to abstract ideas which call for higher order thinking or mental abstraction (mental model). The teacher could in teaching measurement of length involve the children in measuring the longer part of the classroom and call it the length, he also measures the length of the shorter part and calls it breadth or width. He can now introduce the concept of area by multiplying the length by the breadth or width; Area = length & breadth. In so doing the pupils formulate a mental model of what and how area is obtained.

Usefulness of Models in Science Learning

Formulated mental models are helpful in the following ways:

- They facilitate learning by reducing complex any difficult situation to simple ones as they relate the known to the unknown.
- They help us to see relationships through the constructive process of model building as they relate one fact to another.
- They allow us to see things in broader perspective.
- They aid in problem-solving and thinking.
- The ability to formulate model is valuable because it is an intellectual exercise not restricted purely to science, rather it can be generalized across all subject areas.

- The field of science calls for thinking activities and models help very much in this direction.
- The mentally formulated models help to substitute the practice of having students to learn generalizable process skills which, although peculiar to science, could have broad transfer effect on other disciplines. They help to integrate the various processes of science.

Interpreting Data

Data are tools with which the science teacher works. He usually engages himself in gathering information from various sources. Although some of these are qualitative and descriptive, most times he is interested in formations that are measurable or quantifiable.

Qualitative data could be found in pictorial forms, like sketches, diagrams, charts. photographs and models. Their interpretations are not usually very informative to the science teacher, hence the need for quantifiable data.

Quantified data are stored in form of tables, pie chart, histogram or line graph. Assuming, your pupils were engaged in the measurement of their heights and weights and presented to you the following records on a table for interpretation. How would you do it?

Table 2.1

No. of Pupils	5	8	7	5	3
Height of Pupils (cm)	120	125	130	135	140

We shall see that the class consists of 28 pupils. Whereas three of them are the tallest with 140 centimetres, 5 are the shortest having a height of 120 centimetres We can also interpret the data to show that majority of the students (8 + 7 = 15) fall within the height range of between 125 and 130 centimetres; indicating that the average class height falls within this range. Pupils will understand taller than and shorter than also through this exercise.

Table 2.2

No. of Pupils	10	7	6	5
Weight of Pupils (kg)	15	20	25	30

This table of weight could also be interpreted as a class of 28 pupils who have weights ranging from 15 to 30 kilograms. Whereas 10 of the pupils weighed 15 kilograms, 5 of them weighed 30 kilograms. The heaviest of them weigh 30 kilograms. 17 of them weigh between 15 and 20 kilograms and 13 weigh between 25 - 30 kilograms. The students will create a mental picture of the average height and weight through their interpretation of the table.

Let us assume again that the pupils went to the school farm and drew up a pie chart of animals thus:

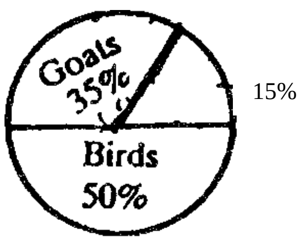

Fig 2.1

The chart could be interpreted as a form that comprises birds, goats and sheep. Majority of the animals are birds (50%), this is closely followed in number by goats (35%) and sheep (15%).

From the graph, we could deduce that 295 maize plants were measured. Out of this number, 45 of them attained a height of 150 cm, 20 of them are the shortest (120cm), and 30 are the tallest (175). Thirty-five (35) of them attained a height between 165 and 170 cm which were the next in height after the 30 maize plants. The average height of the plants will fall between 140 and 155 centimetres. Some information cannot be provided from the graph, for instance, why there is no uniformity in height we cannot tell whether the tallest plants had manure in their soil or not because the graph does not provide such information.

Formulating Hypothesis, Prediction and Inference

Formulating Hypothesis

You will recall from what you learnt in Unit 1 of this Module that a basic thing that pupils have to learn how to do in science is the identification and statement of a problem. There is no doubt that man is faced with many problems daily but if he is unable to identify and state "the problem how will he be able to solve it? Your pupils also encounter problems in their day - to - day activities and they should be provided with the appropriate tool to solve the problems.

Just as the scientist does they need to identify and state the problem After this they should make a tentative guess about how the problem can be solved Making a tentative guess to explain a particular event or observation is here referred to as formulating hypothesis. To enable you grasp the ideas in this unit, let us use an illustration. It does not happen in reality but has been imagine - call it fiction - it has nothing to do with you or your school. Remember, however, that science is not fiction.

Your school has a farm which is divided into six plots. Each plot is taken care of by a class i.e. primary one to one plot, primary two to another and so on. Okro is planted on pan of the plot mat belongs to primary six. As the Okro plant grows and develops, it flowers. After some time, fruits start appearing which make the pupils and teachers to be very happy. When it is time to harvest it. it is discovered that the fruits have disappeared. This makes the teachers as well as the pupils to be annoyed and they start accusing this or that person of stealing the Okro. One boy in the class looks round carefully and notices some footsteps. They are not human footsteps but belong to animals. He makes a tentative guess or formulates hypothesis dial an animal has been coming to eat the Okro in the School farm. You will notice that the hypothesis is not formulated in vacuum. It is based on the boy's careful observation of the environment. An hypothesis is made in such a way that it can be tested by experiment. Hypothesis formulation depends upon questions, inferences and predictions. Pupils should be encouraged to formulate hypotheses and to test their hypotheses by experiments.

Predicting

Predicting means foretelling what is going to happen. Recall that an hypothesis is a tentative guess based on an event or happening. Predicting requires more observations and experience on the part of die person making the prediction. Let us continue on our earlier illustration. The boy makes his observation and hypothesis known to the class teacher who in rum, tells the headmaster of the School. The headmaster visits the school farm and carefully examine the footsteps. The following day he visits the place and sees the same type of footsteps. He now links his observations with what he has heard about an animal called 'deer' that usually eats raw okro. The combination of his observations and experience enables him to foretell or predict that the animal that comes to eat okro in the school farm is called deer.

The accuracy of your past observations and the nature of the event that you want to predict, determine the reliability of your prediction.

Graphs are important tools of prediction in science. A prediction can be tested by an experiment.

Pupils in the lower classes may not be able to predict as such because of their limited experiences. Those in the upper classes may be able to make some predictions. In any case, you should help and encourage your pupils to make predictions.

Inference

An inference is a type of statement based on common characteristics in the data collected. This means mat before an inference can be made, data collection on the hypothesis formulated and prediction made has to take place. After the data have been collected, analysis has to come in to indicate the common characteristics in the data. It is then that an inference can be made. The illustration continues.

The headmaster has predicted that an animal called deer eats okra on the school farm. The school sets traps in many places to catch the animal. The following day two deers were caught. At the conference of headmasters in the locality, he mentions his experience in his school. Many headmasters recount their experiences too to the effect that they caught deer on their okra farm. For the time being, he could make a statement that "Deer eats raw okra". This is an inference based on the data collected.

Knowledge in science changes as more and more data are collected. If later observations show that some other animals also eat *okra*, the inference will also be made to reflect the new observation.

ACTIVITY 25

1. You are using an electric iron in your room and you notice that the iron is no longer hot. . What hypothesis will you formulate?
2. If you press the switch in your room and it lights; you also try the rooms of your neighbours and there is electricity, what will you predict?
3. Your neighbour said his iron could not work again though there was light. Your sister who came from home also said a similar thing about her iron. What will be your inference from the data collected?

ASSIGNMENT

1. After growing two seedlings under the same condition, put one in the centre of the classroom and keep the other near the window. (a) What happens? (b) What variable is being investigated?
2. Leave a piece of bread, corn cob or *eba* for about 3 days. Do you notice any mould? Wet the piece of bread, corn cob, or *eba* keep some in the dark, cover some with a tin and leave some in the sun. Do these variables affect the rate at which mould appears?

SUMMARY

The Units treated scientific skills of controlling and manipulating variables, formulating mental models, interpreting data, predicting and making inference.

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MODULE 2: CLASSIFICATION AND CHARACTERISTICS OF LIVING THINGS

UNIT 1: CLASSIFICATION OF LIVING THINGS

INTRODUCTION

The classifications of matter are into solids, liquids and gases. In this unit we are going to discuss living things.

The world is made up of nearly two million types of living organisms. The animal population is about one million. All these animals do not have the same properties. We need to use common properties to sort the animals into groups. For example, there are animals with backbones, and those without backbones. Within the animals without backbone, we have varieties. As we mentioned in unit 3, the process of sorting out objects or organisms into groups on the basis of selected properties is called classification.

Plant and animals are living things. They have some likenesses and differences. They carry out common activities so as to maintain their survival and existence. These common activities are called characteristics.

In this unit, you will learn about the classification and characteristics of living organisms.

OBJECTIVES

By the end of this unit, you should be able to:
1. explain accurately the meaning of classification;
2. mention three methods of classifying living organisms;
3. describe the characteristics of living things correctly;
4. list, with examples, the four major groups in the plant kingdom; and
5. list, with examples the major classes, or groups, in the animal kingdom.

The world houses over two million types of living organisms. These organisms are plants and animals. Let us sort out the following living things: palm trees, earthworms, snails, *iroko, okro,* hibiscus, Crotalaria, fish, lizard and palm tree. Earthworms, snails, fish and lizards are animals, whereas palm tree, *Iroko,* trees and hibiscus Crotalaria are plants. In sorting out the samples of the living organisms, you must have used common properties. Cats, rats, dogs, man and monkey have head, sense organs and two pair of limbs. You can also use family relationship to sort out insects. Generally, the body of an insect is divided into head, chest and abdomen. These features make fly to be more closely related to spider than to snail.

Plants can be sorted out into flowering and non-flowering plants.

Classification of Plants

Plants have been classified into four main groups - namely-

(a) Simple plants (b) Bryophyta (c) Pteridophyta and

(d) Seed bearing plants-Spermatophyta.

Samples of these groups are common in your environment. You should try to collect the sample.

Simple Plants

Simple plants have neither root, stem or leaf. Mushroom, yeast, moulds on bread or prepared food, wood fungi, spirogyra, and lichens are examples of simple plants.

ACTIVITY 1

Look at the picture below. Can you locate the root, stem and leaf of the sample? Discuss you observation with you tutor during the contact session.

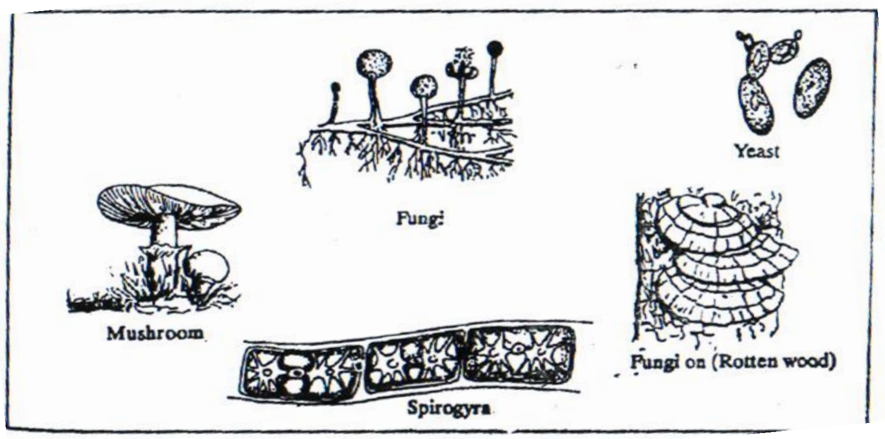


Fig. 2.1: Pictures of Spirogyra, Mushroom, Yeast and Fungi

ACTIVITY 2

Put a small ball of *Eba* or moist bread in a plastic bowl. Keep it in an open place for 3 - 5 days. Observe it daily and record your observations in your notebook. The second group is called bryophyta. Examples are: moss and liverwort. Mosses are commonly found in damp wall or fence, on trees, logs and rocks. Moss has rhizoid leaves in clusters, stalk and spore sac. They grow in clumps. Locate in your environment a damp wail or fence. You will find plenty of them there.

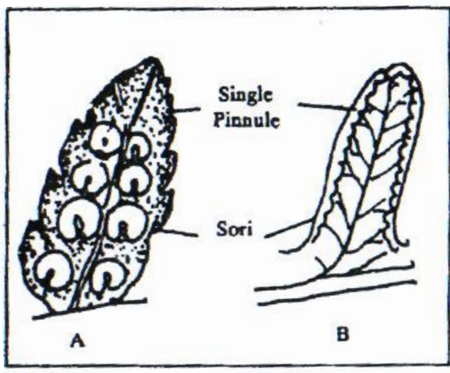
Fig 2.2 Moss

Study Fig. 2.3 (a) and (b). Look for any common features in the two samples.

(a) Liverwort ***(b) Moss***

Fig. 2.3

The third group is called Pteridophyta. Fern is a typical Pteridophyta. Fern has root, stem and leaf. The leaf resemble palm fronds. The under surface of the leaves has rows brown spots at their edges. Ferns are commonly found in ponds or stagnant streams. Ferns also live on palm trees. They are of green and flat structures with a ribbon like projection.



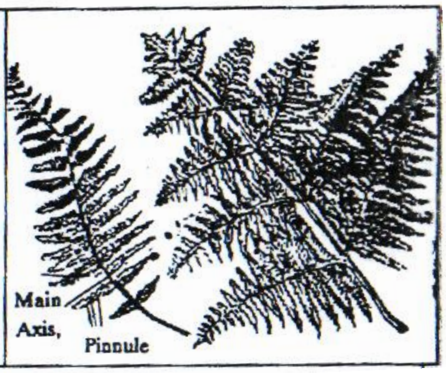


Fig.2.4: Arrangement of Sori in the male fern ***Fig. 2.5: A frond on the male fern***

ACTIVITY 3

Visit a nearby pond and collect fern plants. Look at the under surface for the row of brown spots. Make a sketch of fern in your notebook.

Seed Bearing Plants

Banana, grasses, cocoa tree, pawpaw, weeds and shea better tree are examples of plants which form flower before producing seeds. They are called angiosperms. Maize grain, or millet grain differs from broad bean seed. Maize and millet plants have narrow leaves and fibrous roots. The maize and millet type of plants are called monocotyledonous plants.

Plants which look like the bean, whose leaves are not narrow but with vein in form of net are called dicotyledonous plants.

There is another group of plants which have cones instead of flowers. They are called conifers. They have seeds but their seeds are naked.

CLASSIFICATION OF ANIMALS

There are more animals than plants in the world. Crab, housefly, fish, rat, earthworm, Roundworm, lizard, hen and frog all belong to the animal kingdom. Sort them into groups. Crab, housefly, earthworm, roundworm and spider have no backbones. So animals can be sorted on the basis of those with and those without backbone.

Does a house fly look like the earthworm? No! Does earthworm resemble roundworm? Yes. Housefly resembles spider because they both have head, abdomen and jointed legs. These features are used to classify/place them in one big group - arthropods.

The animal without backbones are called invertebrates.

There are the one - celled animal e.g. amoeba shown in Fig. 2.6.

There are those whose bodies consist of two layers of cells e.g. Hydra jelly - fish.

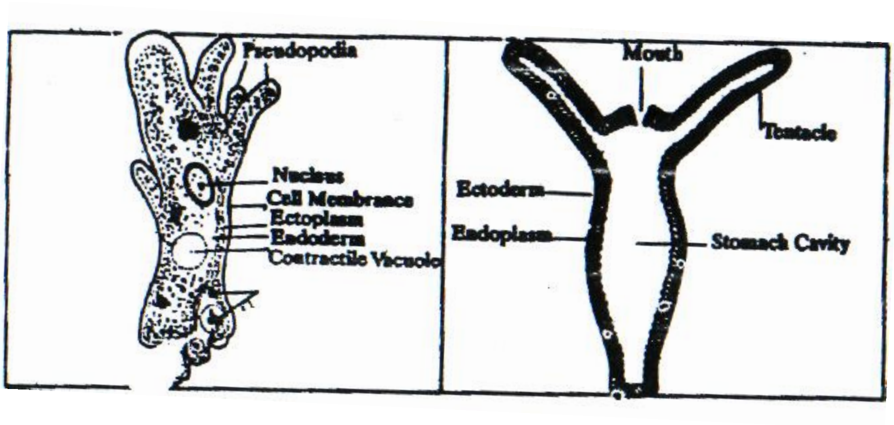


Fig. 2.6 (a) Amoeba ***(b) Hydra***

Earthworms, Tapeworms and roundworms have long body. They are generally called three layered animals. The earthworm group is truly segmented. Its body has three layers too.

There are those with jointed legs. Examples are fly, crab and spider.

All other animals have backbones. They are called vertebrates. They are in 5 groups.

Fishes:	shark, tilapia, cat fish
Amphibians:	toad, frog, salamanda
Reptiles:	lizard, snake, tortoise
Birds:	hawk, duck, pigeon
Mammals:	rabbit, monkey and man

Characteristics of Living Things

Plants and animals have certain common features. They can excrete, move. respire, reproduce, feed and respond to changes in the environment (sensitive). Some of these features are explained further below.

Feeding

Plants and animals do feed. Plants make their own food. Animal search for the food they need. Food is the major source of energy for these organisms. They use energy from food to do work, grow, repair damaged cell and prevent diseases. This feature is called nutrition.

ACTIVITY 4

What do these animals eat? Dog, cow, cat, goat man.

Movement

All living things move. Animal move from place to place to find food to eat and shelter. Plant also move by bending or during growth. This feature is called movement.

The process of moving from one place to another totally is called locomotion. It is a characteristic of animal only.

Respiration

Animals are capable of breathing in and out. When we breathe in air (oxygen) is taken in. When we breathe out, carbon (IV) oxide is given out. The process is called respiration. Air breaks food down to energy, water and carbon (iv) oxide. Plants also respire.

Excretion

Imagine yourself not urinating for two days. Of course, you will be very uncomfortable. Animal and plants do produce wastes. Such have to be eliminated so as not to poison the system. Mention two things which animals eliminate as waste product? The process of getting rid of waste products from body activities is called excretion.

Growth

When you plant seeds, in a matter of weeks, you would have seen evidence of growth. Human babies soon grow up into adults. Plants do grow.

ACTIVITY 5

Put some cotton wool in a fiat bowl. Plant 10 seeds in the flat bowl. Record what happens to them daily. Measure the changes in the length/height of the plant daily.

Reproduction

Plant and animal population has been maintained due to production of young ones. Plants can multiply by seed or cuttings. Animals give birth to young ones or lay eggs. Some animals reproduce through one parent or both parents. The fusion of female and male gametes is called fertilization. The process whereby plants and animals reproduce themselves is called reproduction.

Sensitivity

Animals are sensitive to touch. Some plants do respond to touch. Plants grow towards light. Animals respond quickly to changes in the environment. Land vibration can be perceived easily by snakes. Animals can easily smell odours. Plants and animals are sensitive.

ASSIGNMENT

1. Give example of the following groups of plant and animal
   a. Simple plant
   b. Naked - Seeded plant
   c. Flowering plants
   d. Two - layered animal
   e. Three layered animal
   f. Mammals
2. Name three features you would use to classify living things.
3. List the characteristics of living things.
4, Assign these animal into their various groups:

   liverfluke, oyster, eagle, mudfish, tiger. Alligator. Tsetse fly.

SUMMARY

In this unit you learnt that:

- There are over two million types of living organisms in the world.
- Living things are classified into plants and animals.
- Classification of plants and animals is based on either common features, common plans or family relationship.
- There are four groups of plants-(a) simple plants (b) Bryophyta (c) Pteridophyta and (d) Seed bearing plants.
- Examples are - Mushroom, mould, {simple plants), moss (bryophyta), fern (Pteridophyta) Iroko hibiscus (seed bearing).
- Animals have two major groups: (i) invertebrates, and (ii) vertebrates.
- Invertebrates include amoeba, hydra, earthworm and snails, Vertebrates include fish, fowl, lizard, and rats.
- Plants and animals (living things) can reproduce, grow, excrete, move, respire, feed and are sensitive.

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UNIT 2: COMPARISON OF LIVING AND NON LIVING THINGS

INTRODUCTION

In unit 3, you learnt about living things (plants and animals), consider these and see how you will classify these as living or non-living:-the chair and table made of wood: wool. leather obtained from the body of animals. In fact, plants and animals have in their components solid, liquid and gas.

In this unit, you are going to compare living and non-living things.

OBJECTIVES

By the end of this unit, you should be able to:

i. list no-living materials obtained from living things; and

ii. compare living things and non-living things on the bases of their characteristics.

LIVING AND NON-LIVING THINGS

In units 2 and 3, you learnt about the classification and characteristics of non-living and living things. Classification is sorting out on the basis of certain differentiating features. Living things can move, eat, respond to stimuli, reproduce, grow, get rid of waste products, and respire. These characteristics of living things differentiate them from non-living things. Non-living things cannot be converted to living things. Living things, when they die, become non-living things. We shall use these characteristics to compare them.

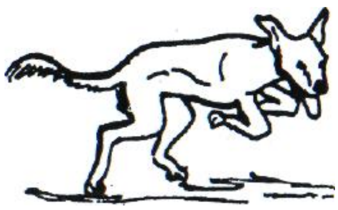
DIFFERENCES BETWEEN LIVING AND NON-LIVING THINGS.

Movement

Living things may move about from place to place, or just in parts. Non-living things are stationary: they can only move when pushed or powered. For example, a car cannot move without the energy from fuel or be pushed.

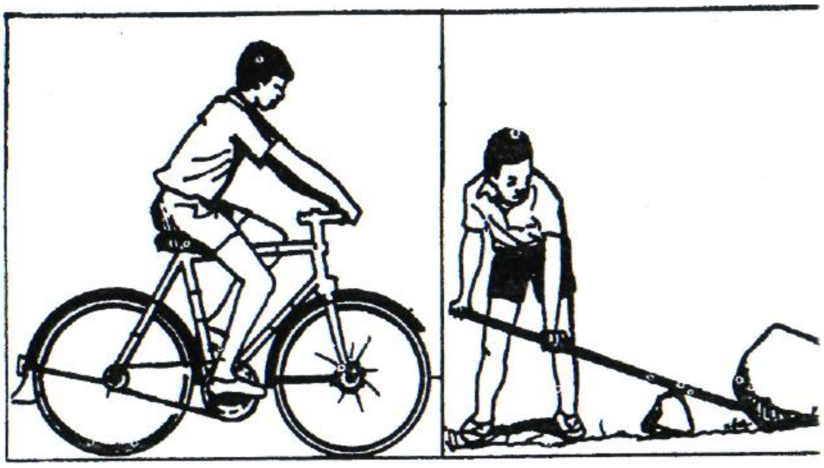
ACTIVITY 6

Look at the pictures in Fig. 2.7 What differences can you see m their movements?



a. A running dog

b. A gliding earthworm



c. A boy riding a bicycle *d A man rolling a stone*

Fig. 2.7: Different types of movement.

Nutrition

Living things eat so as to have enough energy to carry out their daily activities. Does a piece of wood feed? Non-living things do not need energy hence they do not cat food.

Excretion

Living things produce waste matter. Non-living things do not produce waste matter because they do not eat food.

Growth

Plants and animals do grow. A plant seedling grows bigger and develops many branches, leaves and flowers.

Growth in animals is gradual. Non-living things do not usually become bigger and complicated like living things. A piece of stone of glass does not grow. However crystals do grow. Let us find out.

ACTIVITY 7

Problem: Do crystals of a substance grow?

Materials: Alum, 2 beakers (drinking glasses), water, glass rod (biro), siring, funnel, filter paper.

Procedure: Pour some water into the beaker or glass. Place the beaker on Kerosine stove and heat gently. When the water is hot, add crystals of alum to it, stir with a rod. Continue to add more alum until it would not dissolve any more. Decant the hot liquid. The filtrate is now a saturated solution. Allow the filtrate to cool overnight. On the following day decant the saturated solution into another beaker leaving the crystals formed in the beaker. Lake a sizeable crystal forms the newly formed crystals. Suspend the selected crystal in the alum solution.

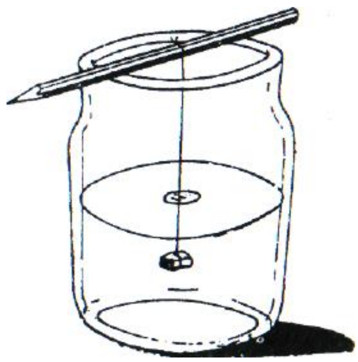


Fig. 2.8: Growing a Crystal

Questions:

a) Why do you have to boil the water?

b) What does a saturated solution mean?

c) Why should the alum solution be decanted?

d) What happened to the suspended crystal?

e) How long does it take to observe a change in the size of the suspended crystal?

f) Is the increase in size reversible? Is this really a growth? Explain.

The answer to these questions would be discussed during the contact session when the activity would be done practically. Biological growth is an increase in size that is not reversible.

Respiration

Non-living things do not require energy and do not feed hence they cannot release energy from food. Living things require energy for their life processes. As a result, food is broken down to release energy.

Reproduction

Living things do reproduce themselves. Animals do so by laying eggs before the young ones emerge or give birth to babies. Non- living things do not reproduce themselves. They do not have reproductive organs.

Sensitivity (Response to Stimuli)

Does a piece of wood know when you matchet it? Of course, no! Snakes, for example, can react quickly to slight vibrations. Living things are sensitive to changes in their environment. Non- living are not sensitive. Plants and animals can be converted to non-living things when they die. For example, when an animal dies, the hair (if any) bones, flesh and other parts of the body become non-living things. Inspite of the efforts of scientists who have continued to probe into the components of living and non-living things, they have not succeeded in producing life from non-living things.

ASSIGNMENT

1) List twenty materials that can be obtained from living things.

2) List five materials whose sources are both living and non-living, e.g. The aluminium pot with wooden handle is made of metal (non- living) the wood is from plant (living).

3) State the products of respiration in man.

4) State four major differences between living and non-living things.

5) Name two non-living things.

6) You are provided with some bean seeds and some grains of processed rice (e.g. Uncle Bens Rice), (i) Which of them is a living or non-living thing? (ii) How would you convince a primary school pupil that one of them is living or dead?

7) List three matters that can be converted from one state to the other when there is change in temperature.

8) Fill in the blank spaces:

The particles of a gas are __________________ packed.

A solid has a high density because of _________ or __________ between its particles.

The ______________ of a solid is the temperature at which it turns to liquid.

Cooling a gas causes the particles to _____________

SUMMARY

In this unit you learnt that:

- The classification of living and non-living things is based on common features, common plan and family relationship.
- Characteristic features of living and non-living things can be used to differentiate them.
- The seven characteristics of living things: movement, reproduction, growth, nutrition, respiration, irritability, and excretions clearly differentiate them from non-living things.
- Classification and characteristics of matter

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UNIT 3: AIR: PROPERTIES AND USES

INTRODUCTION

All living things depend on air for their daily activities. For instance, you breathe in air, the oxygen in the air oxidises the food you eat. The energy released is used to perform your daily activities. Then you exhale the expired air, part of which green plants use in manufacturing carbohydrate (food). Plants also use air. Therefore, without air, living things will not exist. Kerosene, petrol, wood, coal and other fuels release their energies with the aid of air during burning.

OBJECTIVES

By the end of this unit, you should be able to:

i. recall the components of air correctly;

ii. recognize that air is not just an "empty space" but air is a real substance;

iii. name the properties of air;

iv. perform activities to illustrate properties of air;

v. give reasons for the variation in air composition; and

vi. list at least ten uses of air.

What is air?

Air is a mixture of gases consisting of nitrogen, oxygen, carbon (iv) oxide, water vapour, noble gas, dust and other gases. Table 2.1 shows the composition of air, by volume.

Table 2.1: Composition of air

Component	% by Volume
Nitrogen	78.09
Oxygen	20.95
Argon	0.93
Carbon(IV)Oxide	0.03
Other gases	0.003

The composition of air varies from place to place and time to time. In industrialized and urban towns, factories and vehicles pump additional poisonous-gases into the air. The quantity of water is higher during the wet seasons than during the dry season. During the dry season, Lagos and Calabar are more humid than Maiduguri, Kano and Sokoto. Farmers resort to bush burning dry season, and this causes an increase in the quantity of carbon (IV) oxide in the air.

Properties of Air

We can feel air. Whenever a strong current of air (wind) flows across tree branches and other plants we observe the impact. Air has mass. It exerts force. When air is blown into a balloon, that ballon swells up. The air inside the balloon causes an increase in the size of the balloon, the force exerted by air on the walls of the balloon is called air pressure The air inside the bicycle or car inner tubes makes the tyres hard, hence it is able to carry tire weight of the car. Air can be compressed. It also expands when heated or Air helps burning substances. It is present in water. Can you illustrate this? Write down your reason(s). There are air spaces in the soil. Can you explain this also? You will carry out some activities to verify the properties of air. The components of air can be separated experimentally.

ACTIVITY 8

Problem: Does air exist?

Materials: Paper thread, hand fan, bottle, chewing gum, water, bottle, funnel.

Procedure: (a) Make a kite. Fly the kite. What makes the kite to float and be blown about? The presence of air in the atmosphere makes the kite float.

(b) Wave the hand fan on your face. What did you feel? Cool breeze which is air blown by the fan.

(c) Put a plastic funnel into the mouth of a fanta or beer bottle. Seal the joint between the funnel and the bottle with the chewing gum. This must be done properly (see Fig.2.9). Seal the joint between the funnel and bottle properly so that air would not escape through the spaces between the funnel and bottle. Now pour water into the funnel. What happened? You would observe that no water entered the bottle. The pressure of the air in the bottle is able to withstand the pressure being exerted by the water in the funnel. These activities shows that air exists. Note: If water runs freely into the bottle, in (c) repeat the sealing of the joint.

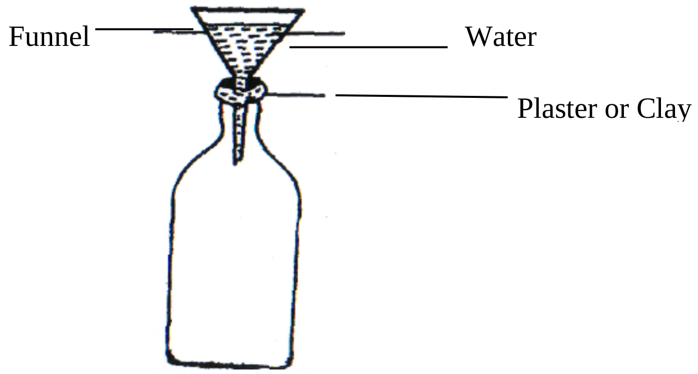

Fig. 2.9: Showing the existence of air

ACTIVITY 9

Problem: Does air occupy space?

Materials: Trough (plastic bowl), bottle and water.

Procedure: (a) Pour water into the trough. Immerse the mouth of the bottle into the

water as shown in Fig. 2.10(a). Record your observation.

(b) Place the bottle horizontally across the surface of water. Apply a gentle pressure such that water goes into the bottle slowly as shown in Fig. 2.10(b). Record your observation

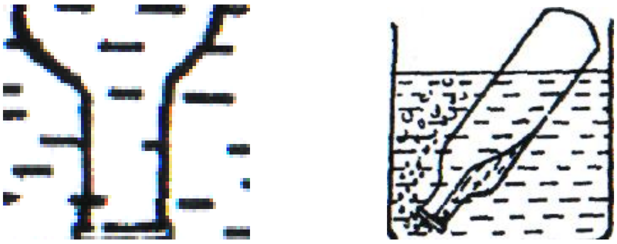

Fig. 2.11 Air Occupies Space.

i. What happened when the mouth of the bottle was immersed into the water position?

ii. Explain your answer.

iii. What happened when water was entering into the bottle in the experiment (b) at the titled position?

You would observe that when the mouth of the bottle was immersed into water (a) no water entered into the bottle because it was full of air. So there was no space for the water to occupy, when the bottle was titled and water started to enter the bottle, it was observed that bubbles of air were escaping from the bottle. The water displaced the air in the bottle hence it escaped. This shows that air occupies space.

ACTIVITY 10

Problem: Does air have mass?

Materials: Drinking straw, thread, nail, two balloons, chewing gum.

Procedure: Drive a nail into the upper wooden frame of the window. Locate the centre of the drinking straw and tie a piece of thread firmly onto the centre. Tie the thread on the nail. Hang two empty balloons on the ends of the straw. Balance them: use chewing gum if necessary. Mark position of one balloon. Blow air into one of the balloons and re-tie back onto the marked spot. See Fig. 2.12

Fig. 2.13 Air has mass

Question:

i. What happened to the set up?

ii. How would you explain your observation?

You would observe that when the empty balloons were hung on the ends of the straw, the straw remained horizontal. When one of the balloons had air blown into it and tied back to one end of the straw, it was observed that the balloon titled to one side. You would recall that when two children are sitting one on each end of a plank (see-saw), the plank normally tilts towards the heavier child and pushes up the lighter one. If you relate this to our activity, it means that the balloon containing air is heavier since the straw tilts to its side, this shows that air has mass.

ACTIVITY 11

Problem: Does air expand?

Materials: hot water, balloon, bottle, bowl.

Procedure: Tie the mouth of the balloon onto the bottle. Put the other end of the bottle into hot water. See Fig. 2.14 (a) and (b).

Fig. 2.14 (a)

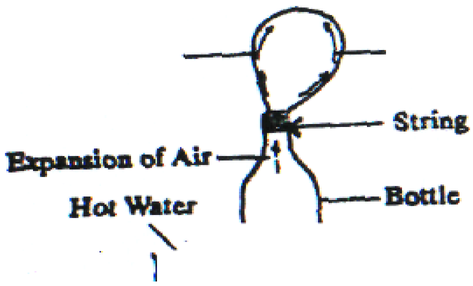

Fig. 2.14 (b)

Experiment to show that air expand when heated

Questions: (i) What happened to the balloon?

(ii) What caused the observed change?

(iii) What is the source of the observed change?

Observation: When the balloon was tied onto the bottle, it laid flat as shown Fig. 2.14(a), When the bottle was put into hot water, the water supplied heat to the bottle and the air in it. Air expands faster than bottle. The mouth of the bottle here was covered, so the air filled the balloon and forced it to become erect. See Fig. 2.14(b). This shows that air expands when heated.

Problem: Does air help burning?

Materials: candle, tall drinking glass, matches and small glass pane.

Procedure: Divide the candle into four parts. Cut one part. Light it and place it on a small glass pane. Allow the candle to burn for one minute. Cover burning candle with the tall glass.

Questions: (i) What is inside the glass?

(ii) What happened immediately you covered the burning candle with the tall glass?

(iii) What happened soon, maybe a minute after?

a) Candle burning freely

b) Candle burning under

c) Candle glass flame out

(iv) What caused the observed change?

Activity 41 showed that air occupies space. Immediately the candle was covered with glass, the candle kept burning but soon after it was observed that the candle stopped burning and the flame went out. This observation is due to the fact that only part of the air supports burning and not all of it. When that part which supports burning was used up, the candle stopped burning. This shows that air helps burning. The part of air that helps burning is oxygen. By this experiment, you can infer that air consists of more parts than just one. Recall other constituents of air besides oxygen.

ACTIVITY 12

Problem: Is there air in soil?

Materials: Loose dry soil, Milo can (small), water.

Procedure: Pour some dry soil to a depth of about half of the can. Pour water into the soil.

Question: what did you observe?

You would observe that as the water sinks into the soil, some air bubbles appear on the surface. The water displaces the air that is present in the soil; this shows that there is air in the soil.

ACITIVITY 13

Problem: Is there water vapour in air?

Materials: A flat plastic or watch glass, common salt.

Procedure: Put some quantity of common salt into a flat plastic or watch glass. Leave it in a place where it cannot be disturbed. Daily observe the set up for one week, and note in your book your observation. Is there any change in the salt?

Question: What caused the observed change? Explain your answer fully.

Explanation: You would observe that the salt becomes wet and some of it dissolve Since no water was poured into the watch glass, it means that the salt absorbed water from the atmosphere. This shows that there is water vapour in the air around us.

Uses of Air

We shall study the uses of each component of air. The components of air are used in various activities in the factories, house, hospitals, aviation, photosynthesis, respiration agriculture and advancement. Write down the components of air before you read the following passages.

OXYGEN GAS

i. In steel industries, such as at Aladja, oxygen is required to remove excess carbon from molten iron. Steel is a vital material in the construction industry.

ii. You have seen welders at work. They use a mixture of oxygen and ethane generate energy for cutting metals and welding them.

iii. Oxygen is used in the hospital to help patients having breathing difficulties.

iv. Divers carry a cylinder of oxygen when they go into water. This helps them to breathe under water.

v. The spacecraft uses liquid oxygen in flight.

PHOTOSYNTHESIS

Carbon(iv)oxide is an essential raw material required by plants for the manufacture of carbohydrate. The carbohydrate is a source of food for animals.

RESPIRATION

Without oxygen, food cannot be oxidised to release energy. You have read about the importance of energy in the daily activities of living things, and so you can appreciate the importance of respiration.

NEON

In big cities like Lagos, Kano, Kaduna and Enugu, you would see decorative lights which display the names of products or of shops. Neon is used to produce those beautiful display of advertised products of business houses.

NITROGEN

i. One of the major components of fertilizer is nitrogen. Nitrogen can be converted into ammonia - an important raw material for making fertilizer.

ii. Oxygen can react with fuel quickly in the aircraft, to prevent this, nitrogen gas is used because it does not react with many substances easily.

iii. In food industries, liquid nitrogen is used as a refrigerant rather than other alternatives.

WATER VAPOUR

Water evaporates into the air as water vapour. When air saturated with water vapour is cooled, clouds form, the clouds eventually give us water in the form of rain.

ASSIGNMENT

1. How would you describe air?

2. Name the components of air?

3. The components of air are not fixed. Explain.

4. Describe an experiment to show that air has mass.

5. It rains more in the southern parts of Nigeria than in the northern parts of Nigeria. Explain.
6. Explain ten uses of air?
7. An inflated balloon was placed near a lighted electric bulb. The balloon bust. Explain why?
8. Nitrogen rather than oxygen is used in the aircraft fuel tanks. Why?
9. What happens when oxygen combines with food in the human body?

SUMMARY

In this unit you learnt that:

- Air is one of the major natural essential commodities supplied to living things.
- air is a mixture of gases
- The components of air are nitrogen, oxygen, carbon (IV) oxide, water vapour, noble gases, and other gases. The composition of air is not constant.
- Air has several properties.
- Components of air can be separated experimentally.
- It can be felt. It occupies space and has mass. It expands when warmed or heated. It helps burning.
- It is present in soil and water. It contains water vapour.
- The components of air are useful in factories, hospitals, in welding and cutting metals, in advertisements, agriculture, photosynthetic process and respiration.

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UNIT 4: WATER AND SOIL: PROPERTIES AND USES

INTRODUCTION

Air and water are the two major essential substances required by all living things. About seventy-five percent of the earth surface is water. Water is present in air, in the soil, under the ground, in the sea, in plants and in animals. Water is everywhere.

In this unit, you will study the properties and uses of water.

OBJECTIVES

By the end of this unit, you should be able to:

i. name the sources of water;

ii. state the properties of water;

iii. perform simple experiments to illustrate two properties of water;

iv. enumerate, with examples, the uses of water;

v. define soil;

vi. list the components of soils;

vii. identify the three types of soils; and

viii. mention uses of soil.

WATER

Water is an important substance to all living things. The human body is over 60% water. Beer, soft drinks and palm wine have about 80% water. Each time you buy beer or soft drink, remember that you are paying for water!

The sources of water are river, rain, sea, lake, well or boreholes, spring and stream. The purest source of water is rain. Other sources of water contain some impurities.

Water can dissolve many substances, hence it is used in making many solutions of substances. But not all substances dissolve in water at the same rate. Each time you take a glass of water, a small amount of glass panicle is taken along with it. This amount of glass particle is not harmful.

The amount of water which falls as rain can be measured by using a rain-gauge. This amount of rainfall is measured in millimetre.

ACTIVITY 14

Problem: How do you measure the amount of rainfall each time it rains? Materials; Plastic, bottle, and measuring cylinder.

Procedure: Cut off the top as shown in Fig 2.15 Use the top as a funnel, dig a hole into the ground. Place the bottom half of the bottle in the ground. Insert the funnel into the bottle. At the end of the rain, i.e. when it had stopped raining completely, remove the bottle from the ground and pour its water into the measuring cylinder, read and record the amount of water collected.

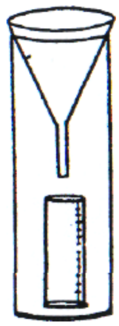


Fig. 2.15   Improvised Rainguage

PROPERTIES OF WATER

Rain, as stated already, is the purest source of water. Pure water is colourless, odourless and tasteless. You should collect water from well, stream or river, spring and pond. Look at their colour, smell them and taste them. Record your observations in your notebook.

CAUTION: ***<u>Be careful in tasting water.</u>***

ACTIVITY 15

Problem: At what temperature does water boil?

Materials: Beaker, water, thermometer and burner (stove).

Procedure: Pour some water into the beaker. Heat it on the burner (stove). Note what happens as the water is being heated. When the water begins to bubble, insert the thermometer. Read the thermometer. When rapid bubbles of water become vigorous read the thermometer.

Questions: What did you observe as the water warmed up gradually? At what temperature did water boil?

NOTE: (i) At thermometer is an instrument of measuring the degree of coldness or hotness (temperature) of an object.

(ii) You must learn how to use the thermometer from your science teacher.

If you cannot secure a thermometer, leave the activity till the contact session. The beaker can be replaced by an empty can like open "*Bournvita*" tin.

ACTIVITY 16

Problem: Does water dissolve substances?

Materials: common salt, sand, blue stone (Copper II tetraoxosulphate (iv) crystal): Alum, chalk, water, 5 beakers, stirring rod.

Procedure: Pour four table spoonfuls of water into each beaker. Label the beakers Substance as A,B,C, D,E- Add some salt into beaker A; sand to beaker B. blue stone to beaker C;

Alum to beaker D. and chalk to beaker E. Stir the content of each beaker. Observe what happens. Record your observation as shown in the table below:

Substance	Rate of Dissociation		
	Immediately	**Slowly**	**Not at all**
Salt			
Blue stone			
Alum			
Chalk			
Sugar			

When you wash your clothes with rain water, it produces a large quantity of lather (foam). But if you wash your clothes with water from stream or well, the quantity of lather will be smaller. However, using more soap, the quantity of lather will increase. The rain water is called soft water and the well, lake, or stream water is called hard water. Hard water contains some dissolved mineral salts.

When we spread a wet cloth on the line to dry, where does the water go? The water has gone into air as water vapour. Water has evaporated from the wet cloth.

USES OF WATER

Can you afford not to use water in a day? In our houses, we drink water, wash or clean materials and our bodies with water. We prepare our food with water. When you want to cool down a hot object, perhaps your first choice is water. Make a list of uses of water in the home.

During the dry season, water is used in maintaining plants in the backyard gardens. Large scale dry season farming activities depend on irrigation. This method of fanning is common in the northern states of Nigeria. This helps to produce more food items, fish breeders make ponds. These ponds contain water in which fishes live and breed. Visit a fish pond in your locality.

In riverine areas, people travel on water from one place to another. Water transport system is used to supplement transportation of goods and human beings.

In the breweries, water is the most important raw material because a large quantity of water is required to produce their products, similarly, almost all factories need water for their products. In the drug factory, water is used to make drug solutions, and lo flush out waste products.

A large amount of electrical power (electricity) comes from dams. The production of such electrical power in the dams depends on the quantity of water available. The frequent power cuts from the electrical corporation, have been associated with the low level of water in Kainji dam. Other fuels can be used to generate power, but water is the cheapest and most abundant.

The availability of clean pure water for drinking can prevent the outbreak of diseases such as cholera, dysentery and typhoid fever. “Pure water” in this context is water that has been treated in the water works. You should boil water from stream or river before you drink it as diseases may be harboured in it. It is also important to wash your hands with water and soap after using the toilets or after being m dirty places. Health is wealth.

SOIL: TYPES AND USES

What is Soil?

Nearly all plants and animals depend on soil. Plants obtain mineral salts and water from the soil, soil also provides air which roots require for their respiration. It also provides anchorage for roots. Small animals seek refuge in soil. What is soil? What types of soil are there? what are the uses of the varieties of soil? You will discover the answers to these questions in this unit.

The rock surface when exposed to changes in temperature do crumble into small particles. When rain falls on the rock surface, it dissolves the rock into tiny particles. The small particles produced by rocks, as a result of changes in temperature, and water form what is called soil. The weathering (break down) of rocks forms soil. There are many agents such as some gases, water, wind and heat which cause the weathering of rock.

TYPES OF SOIL

Soil is a mixture of gravel, sand, silt, clay and some humus. There are three types of soil - clay, sandy and loam. A clay soil contains clay and silt. Sandy soil contains sand and gravel. Loam soil contains a mixture of clay, sand and some quantity of humus.

ACTIVITY 17

Fill a 500 cm^3 measuring cylinder or a large "Ragolis water" bottle with the top removed, with water. Clear a small area of soil and remove some soil into a tin. Pour some of the soil into the water. Shake vigorously. Allow the mixture to settle. Identify the various types of soil. Draw a sketch of the soil layout in the container. Compare your observation with Fig. 2.16

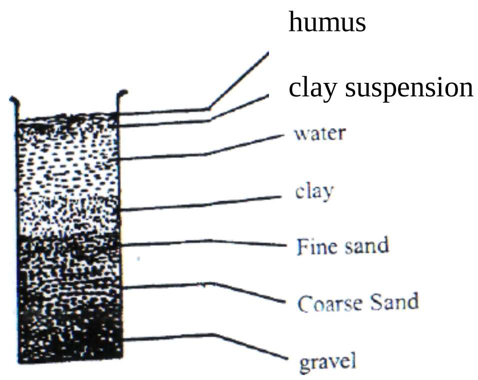


Fig. 2.16 Components of soil.

ACTIVITY 18

i. Get some sand and clay. Spread them in an open place to dry or heat them gently on a stove.

ii. Feel a small quantity of each sample between your fingers. Record your observations

iii. Add few drops of water to sand and clay. Feel each sample between your fingers again. Record your observation.

iv. How do these soil types differ from each other?

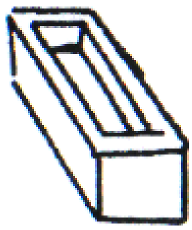
USES OF SOIL

What are the uses of soil? You will remember that nearly all living things live on land. Plants need water, air and mineral salts; soil contains these three substances.

ACTIVITY 19

Look for a hibiscus plant and a maize plant. Pull the hibiscus plant and the maize plant which is easier to uproot? Explain why, compare their root system.

Many small animals hide in the soil for shelter and food. Name some small animals that live in soil.



Block

Fig. 2.17

The walls of almost all houses in the rural areas are made of mud (mud blocks). Also the walls of 'modern' houses are made of blocks which contain some quantity of sand - Fig. 2.17. If you have travelled to the rural farm communities of the drier part of Nigeria, you will find traditional grain store made of clay (Fig. 2.18).

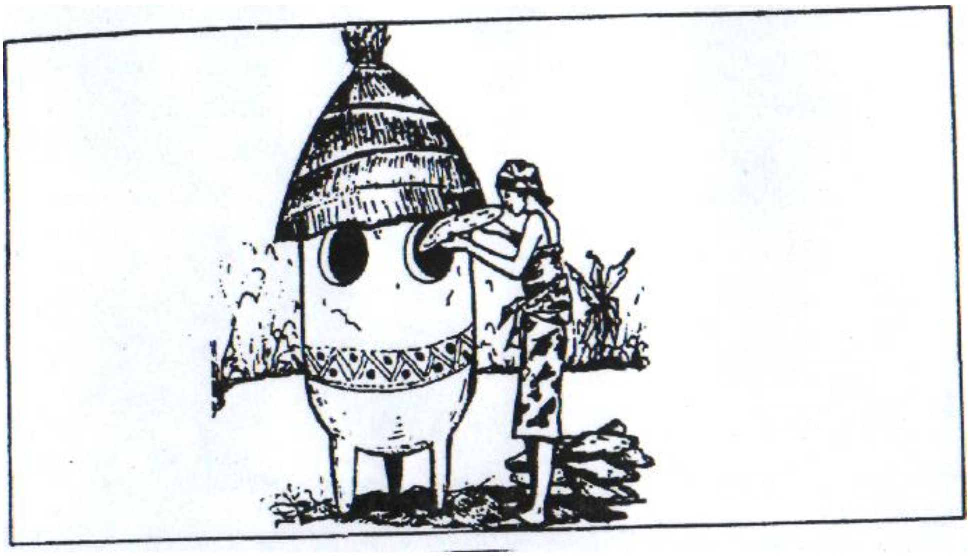
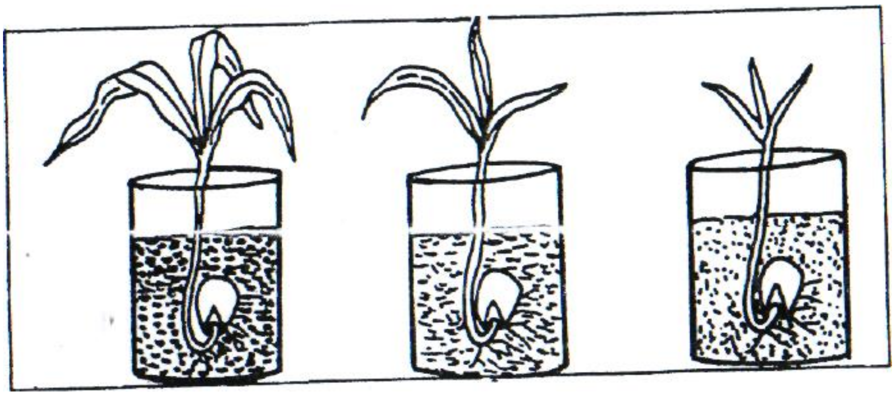


Fig. 2.18 Traditional Grain Store.

Farmers often look for suitable lands on which to plant their crops. They avoid clay land. Why? Similarly, you may not find any farming activity on sandy soil. Why? Look Fig. 2.19

Compare the growth of the plants, which soil is suitable for farming?



Loam Sandy Clay

Fig. 2.19 Rate of Plant Growth on different types of soils.

ACTIVITY 20

Collect three empty cans. Put sand, clay and top soil in each can separately. Plant maize in each can. Note: The growth pattern of the maize in each can for three weeks. Add equal quantity of water if necessary. Which soil will support better farming activities?

Before the advent of plastics and metals as water containers, clay pots were commonly used. Such pots are made of either pure clay or an adulterated clay. Nowadays, clay is a useful substance for making vases and different objects. Metals and mineral ores are also obtained from soil. For example, iron ore is derived from soil. Name other mineral ores.

ASSIGNMENT

1. Name the sources of water.
2. Where else can we find water?
3. What are the properties of water?
4. How would you find out if a water sample is hard or soft?
5. List five fruits which contain large quantity of water.
6. Put a small quantity of water in a beaker; heat it until there is no more water in the beaker, what has happened to the water? Examine the beaker. What did you observe?
7. What are the constituents of soil?
8. What is Soil?
9. Name the three major types of soil?
10. What are the uses of soil?

SUMMARY

In this unit you learnt that:

- Water is everywhere; in and under the soil, in plants, in the air, etc.
- Human body contains over 60% water; and the beer and soft drinks contain about 80% water.
- Sources of water are rain, lake, sea, well, stream, river and spring.
- Water can dissolve many substances. It is often referred to as a universal solvent.
- Pure water has no colour, no smell, and no taste.
- Water can freeze and boil.
- Rain water is soft water and so it produces lather easily.
- River, well, streams are hard water and they do not lather easily.
- Water evaporates e.g. from wet clothes in the sun.
- In the homes, water is used in washing. cooking, flushing and cooling down hot objects.
- Water is used in watering plants in the garden. Large scale irrigation of land depends on it.
- Water is used in breeding fish.
- Boats use water as its route. This helps in riverine transport system.
- Breweries: drug manufacturing industries etc, depend on water.
- Soil contains mineral salts, water and air which plants, need for their growth and for making their food.
- Plants anchor their roots in the soil
- Soil is formed by weathering of rocks.
- Gases, water, wind and heat are weathering agents which cause rocks to break down into small particles.
- Soil is a mixture of gravel, sand, silt, clay and some humus.
- There are three main types of soil namely:-

  a) clay

  b) sand and

  c) loam
- Small animals live in the soil. Some of them feed on the soil.
- Soil is a building material: e.g. brick, concrete, etc.

- Man does a lot of farming activities on good soil. They avoid sandy and clayey soils.
- Clay is used for making pots, vases End palm oil lamps.
- Mineral ores are derived from the soil.

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UNIT 5: CHANGES CAUSED BY LIVING THINGS

INTRODUCTION

You have leant about our immediate environment. Remember that our immediate environment includes air, water, soil, objects, other people, animals and plants around us. You specifically learnt the characteristics and classification of the living things in our environment. The living things, whether big or small, cause some changes in the environment. Right now, start thinking of the changes that you and other people cause to the environment. By the time you complete this unit, you will be able to conveniently identify the' changes caused by living things in the environment.

OBJECTIVES

By the end of this unit, you should be able to accurately

1. identify the components of an immediate environment,
2. describe the changes caused by man in the environment;
3. discuss the changes caused by animals in the environment; and
4. explain the changes caused by plants in the environment.

Our immediate environment consists of all the things and persons around us. Our immediate environment in the room or house differs from when we move out to the school compound or an open field. Similarly, our immediate environment changes when we move from the village to the town or city and vice versa.

Changes Caused by Man

Assuming that man has not caused any change in the environment, everywhere would have been taken over by plants, trees, other animals, and water could have been flowing freely anywhere it pleases. But because of the urge to satisfy the basic needs of man, that is, food, shelter and clothing, he takes his cutlass and cuts the bush.

The place which was originally protected by bush is now exposed to the effect of wind As long as man lives in a place, he will not allow grasses and bush to naturally take over the place.

Man is a lover of beautiful things. He selects the plants that produce beautiful flowers and grows them around his house. Carpet grasses are also planted in the compound or on the field for his use. He does not allow the plants to grow wild but keeps on cutting, moving or trimming them to keep away dangerous animals from making his compound their abode.

He continues to keep the environment clean by sweeping away dusts and dins. In the rural areas, the dirt, refuse, and waste materials removed from homes are deposited in pit not too far from the house. This causes that environment to smell badly.

Burning of bushes, smokes from the kitchen, cigarette, lanterns, local burners cause the fresh air in the environment to be polluted.

ACTIVITY 21

i. List two changes that you can observe which man has caused in your home environment.

ii. List four changes that you can observe which man has caused in your school environment.

Changes Caused by other Animals

The domestic animals such as sheep, goats, cows, dogs, and cats cause some changes in the environment. For instance, cows graze the field and eat available green plants in the environment. In some cases, they eat crops, such as maize and destroy the plantation, thereby causing the farmer to have a low yield. The dungs left behind by the cows emit bad odour and cause the air in the environment to be polluted. The dungs are, however, also useful in increasing or changing the fertility of the soil.

There are insect pests which destroy crops and eat up available green plants. Examples are locusts, ants, and cotton stainers. Cockroaches are commonly found at home. They can destroy books and other materials in the house. Mosquitoes suck blood and earn' diseases from one person to another. When the person is ill, he may not be able to perform his normal duties. Tse-tse fly bites can also cause cows to die.

ACTIVITY 22

Find out and list five changes that named animals cause in your environment.

Name of Animal	Changes caused
1	
2	
3	
4	
5	

Changes Caused by Plants

Even though plants do not move from one place to another as animals do, they cause some changes in the environment where they are located. Earlier in this unit, you learnt that man can change his environment where they are located. Earlier in this unit, you learnt that man can change his environment by planting flowers. Flowers are plants which can cause changes in their environment. Big trees with shades cause changes in their environment. For instance trees at the bank of streams or ponds cause the streams and ponds to be cold because this environment is protected from the direct rays of the sun. Similarly the soil under such trees will he moist and m most cases the younger plants under them do not grow well as they ought to have done it the big trees were not there. Because of the effect of trees on the soil, government has directed that trees should he planted especially in the dry or arid regions of the country. This measure conserves the soil.

The roots of big trees planted close to a building can cause cracks in the walls of that building. If care is not taken, it can cause the destruction of the house. The presence of the trees may be a danger. Why? Imagine the types of animals that can live on such trees! An example of these animals is snake. If the tree is not cut down to send the snakes away, the inhabitants of that area may be in grave danger.

ACTIVITY 23

Find out in your village or town places where plants have caused changes in the environment. Describe two of such places giving details about the location, the name of the tree (if you know it), the nature of the change caused.

Changes Caused by Non-Living Things

Changes Caused by some non-loving things:

Imagine a period when rain does not fall on schedule. What are the possible changes in the environment that you expect? The heat generated by the sun will be unbearable to man and animals. People especially farmers will not want to work or walk in the sun. The usual period of work is changed. The plants and crops will wither for lack of rain. You can imagine the effect of such a situation on man and animals in terms of the supply of food. Apart from matter, when the plants dry up, the soil which would have been under cover is exposed to the biting effect of the sum thereby reducing is fertility.

Rain and sun are not the only non-Jiving factors that cause changes in our environs Others are erosion, fire, storm, flood, oil pollution, explosion, strong dry wind etc. these will be discussed under the changes caused by water, air, fire and chemicals.

Changes Caused by Water

Water is very useful to man, animals and plants. In Module I Unit 7, you learnt that we is used for washing, cooking, watering flowers and crops. It is also used for the generation of electricity. You may stop here and think, how this ordinary water that use can be employed in the generation of electricity. As you think, consider this: If you ever walked through a flowing stream? During or after a heavy rainfall, have you noticed or walked across the rushing mass of water, i.e. flood?

You will notice that the mass of water would be pushing your leg and if you were not careful, you might fall into it. If you fall into it, it might carry you away.

This shows that a mass of flowing water has some force. (Thought water has no hands nor legs, it moves sand and other materials). The force is used to drive the turbines supply electricity. When mass of water is flowing during or after rainfall, it carries many things on its course. As it flows, it washes and sweeps away the soil under it an thus its course becomes deeper. Here the top soil is washed away and that soil become poor for agriculture. In this situation, erosion is said to occur. Features of eroded land are observable in many parts of Nigeria. Locate some in your area.

Fig. 2.24 Eroded Land

ACTIVITY 24

Carefully study Fig 2.24 and describe:

(a) how water could have caused such deep cuts in the soil; and

(b) the changes that have been caused.

The amount of water in a river, stream or a drainage may be contained under a normal situation. If there is increase in the volume of water, it may overflow its banks to places where it is least expected. The volume of such water may be so much that it would enter houses, uproot trees, carry away cars and even people. This type of flood causes damage to property and life. Many such floods have been reported in recent times.

Fig. 2.25 A flooded area

Many changes can be caused by water in our immediate environment. Such changes include:

i. washing away of the top soil;

ii. flooding roads and forcing road users to find alternative roads;

iii. destruction of crops and livestock;

iv. destruction of life, houses, shops and other property, causing man much loss; and

v. subsequently making land barren and unsuitable for agriculture.

Changes Caused by Air

Air is very useful to living things. In fact, without air, there will be no life on earth. One of the properties of air, as you learnt in Module I Unit 6, is that it has force that can be felt. Air has force that may be compared to the force of water that was discussed in the last paragraph. This is why air is able to move a piece of paper or any light material. When air move with much force, it is called wind. Wind is air in motion, in some direction. The direction of wind is detected by means of a wind vane.

In the open grass land parts of Nigeria, the dry wind can be so strong that it can move sand from one place to another and form sand dunes seems commonly in desert areas. Thus, wind can cause landscape changes.

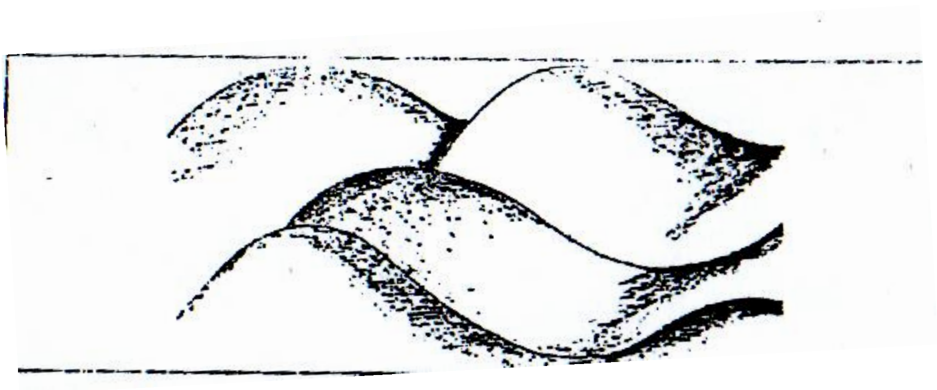

Fig. 2.26 Sand dunes

When the wind becomes very strong especially when it precedes a heavy rainfall, it is called a storm. Just like the strong dry wind, a storm is capable of Wowing dust, sand and other materials. In some cases, it blows off the roofs of houses, uproots trees and destroys other structures. In the class of strong winds we have tornadoes and hurricanes. These are very destructive because they may move at very high speed, of over 50 kilometre per hour.

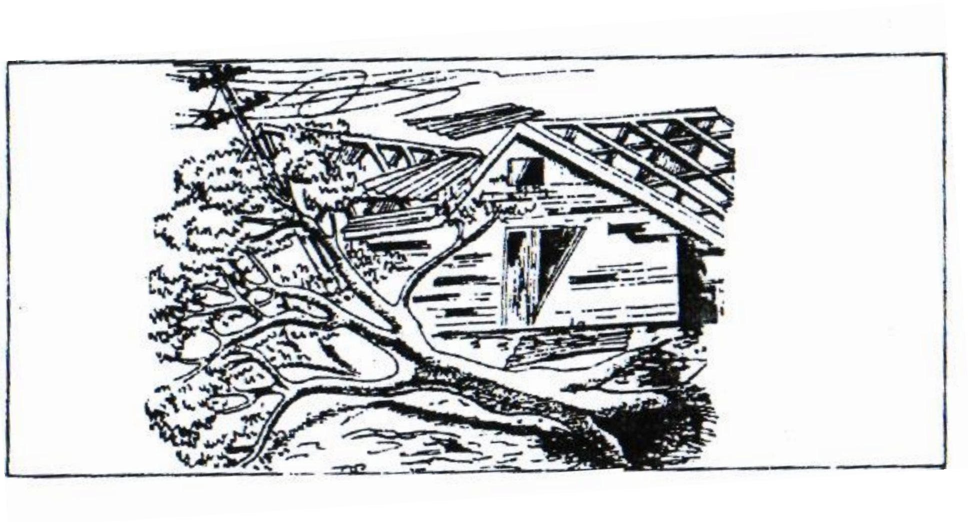

Fig. 2.27(a) Houses with roofs blown off; Trees uprooted.

The changes caused are very glaring as you can observe in Fig. 2.27

ACTIVITY 27

If you have experienced storm in your environment, briefly describe the changes it caused.

If you have not experienced storm in your environment, then study Fig. 2.27 and describe in detail what you have observed.

Changes Caused by Fire

Fire is another useful non-living thing in our environment and can also cause much changes. The heat from fire is used for cooking food. The food is changed from its raw state to a delicious dish which is enjoyed by the members of a family. The heat of fire causes the stiff rod to become soft and pliable. Thus, the iron can be beaten and changed into various shapes because of the effect of fire. The heat of fire is also used for changing a lump of dough to baked bread in the baker's oven.

Fig. 2.28 A blacksmith working with iron.

Fire is used to the farmer. He uses it to burn the slashed or cut bush-and changes it to a cultivable piece of land using hoe or plough with a mechanical device. In addition, fire provides light which changes darkness to light.

ACTIVITY 28

Apart from the ones discussed above, list at least Three other changes that fire can cause in your environment.

A whole forest may be destroyed by fire. There would be a loss of timber. The land becomes exposed for erosion both by wind and by water. Fire is also capable of reducing a beautiful building in an environment to a heap of ashes. For example, in 1986, the twenty-five storey Cocoa House in Ibadan was burnt down. The building lost its beauty. Burnt materials, usually lose their beauty and become charred.

Changes Caused by Chemicals

Chemicals can cause useful of harmful changes in the environment. Fertilizer is a type of chemical. When it is applied to an infertile land, the fertility is regained and the crop yield increases. Shaving powder is another chemical that causes change. When a heavily bearded person applied the shaving powder to his beard, it clears all the hair, giving him a shaven smooth face.

Have you ever seen gun powder before? Ask hunters in your area to show you what it looks like. Gun powder is another type of chemical. Set on fire, it burns vigorously. Some chemicals when ignited in containers tend to explode in the attempt to burn quickly. Other examples are petrol, etc. Such explosives can change the environment

ASSIGNMENT

1. State three non-living things that can cause change in your environment.
2. Briefly describe the changes that (a) Water and (b) fire can cause in environment.
3. Describe an experiment to show that Water can change the environment.
4. List three effects that the changes caused by non-living things in environment may have on life.

SUMMARY

In this unit, you have learnt that

- the presence or absence of rain causes changes in the environment;
- a mass of flowing water has some force;
- erosion causes top soil to be washed away;
- flood can destroy life and property;
- strong wind causes the formation of sand dunes, may blow off the roofs of house and uproot trees;
- fire changes raw food to a delicious dish, but fire can also destroy buildings, proper-forest etc; and
- chemicals such as fertilizers can cause changes in the fertility of the soil.

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UNIT 6: CARING FOR THE ENVIRONMENT (AIR, WATER, AND SOIL)

INTRODUCTION:

From the discussions, you have learnt that the life of every organism is inseparably connected to its surroundings. While the abiotic and biotic factors of the environment directly affects such an organism, the organisms (especially humans) themselves alter the environment a great deal through their activities. In this unit, we shall discuss how to care for our environment (air, water and soil) to avoid its destruction but to maintain it at a level that it can continue to support life, '

OBJECTIVES

By the end of this unit, you should be able

i. mention several pollutions of air, water and soil;

ii. discuss the various methods of caring for our environment;

iii. explain why it is essential to care for the environment; and

iv. show how a polluted environment can be reminded.

EFFECTS OF POPULATION GROWTH ON THE ENVIRONMENT AND ITS CONTROL

You may have noticed that the rate of child birth these days is faster than when you were younger. If you visited a large hospital, they can tell you how many children are born every day. The figures have been increasing in the last two decades. There are two principal reasons for this: improved medical facilities which reduce deaths and the high fertility of people. In Nigeria, therefore, the population is increasing very rapidly. This growth in population as you may have noticed too, is faster in towns and cities due to rural to urban migration. The growth in population has its implications. It means that food, water, housing, power and other amenities have to be greatly increased to keep pace with the growing number of people needing them. The higher the consumption of these commodities (food, water, house, land etc) the more is the waste produced. Can you suggest some waste arising from food, water and other commodities consumed by man?

All the wastes you have named constitute pollutants of the environment. Imagine what would happen if human wastes and rubbish were not properly disposed. The whole place would stink and some epidemics disease would occur and wipe out human population. The source of the diseases would be the polluted air, water or land.

Thus increases in population, apart from creating problems of overcrowding, would lead to the production of excess water and a degradation of the environment. In order to prevent the environment from total destruction, a means of controlling the population growth should be adopted. As you may be aware, family planning programmes intended to check over-population have long been in existence in this country and elsewhere. It is more urgent now than ever before that all parents heed the warning and produce fewer children.

Most hospitals and health centres do give free counseling on family planning. This is a reliable way of keeping down the population.

What do you think should be done about the rural - urban migration?

This can be curbed by spreading the amenities and employment opportunities available in towns and cities to the rural areas.

ACTIVITY 29

Go to a hospital near to you and find out from the records how many children were born in the last three months. Compare this with the records of mortality for the same period. What does that tell you about the population growth?

EFFECTS OF AGRICULTURE ON THE ENVIRONMENT AND ITS CONTROL

Do you ever wonder how everybody in Nigeria gets food to eat even though the population is increasing rapidly. How is food production keeping pace with the population? In order to support the teeming population, a more attention must be paid to agriculture. When farming is widely mechanised and the same oil is cultivated or grazed year after year, there is an over use of the limited land. So there will be depletion of soil nutrients and decrease of its life supporting abilities. You may still ask, how then do we still have adequate food? The simple answer is that, for the soil to continue giving more yields, various types of fertilizer, pesticide, herbicide, insecticide, fungicide etc. are applied. Most of these chemicals are toxic. Some of them contain mercury, arsenic or lead, aldrin, dieldrin, chlorinated hydrocarbons and DDT. These are extremely difficult to breakdown (non-degradable). They remain in the soil posing danger to the biotic factors of the environment.

You may also be aware that agricultural wastes and chemicals washed from crops and soil find their ways into springs, streams, rivers and oceans. These chemicals cause not only death to aquatic organisms e.g. fish, but they are also harmful to terrestrial animals including man.

Practically every agricultural practice employed by the farmer to increase his produce has its negative effect on the environment.

Name some of these practices and for each discuss the way its side effects pollute she environment.

ACTIVITY 30

1) Collect soil samples (i) from a farm land that has been cultivated continually for the last five years and fertilizers applied and (ii) from a farmland in which fertilizers have never been applied. Compare the two samples.

2) What do you observe about the structure, water content and soil organisms? Record your observation and show it to your teacher during the contact session for assessment.

3) What should we do to keep the environment free from these pollutants which arise from agriculture and yet keep up the food production?

As you may have considered, the solutions to this problem are not easy but not impossible. We can take the following steps to ensure the safety of the environment.

a) The very harmful agricultural chemicals should be banned and search for safer alternative fertilizers, herbicides, fungicides and pesticides. Other countries are searching into this and finding solutions.

b) Agricultural chemicals should not be used, except where they are absolutely essential. Even the use of these should be sparing and only those that are degradable should be used.

c) Pest controls using sound biological principles, should be pursued with vigour. Already there is a whole unit for biological control method, (even though of veterinary purpose) at Vom Veterinary Research Institute, Plateau State.

d) Life history of each pest should be studied and crops planted to grow outside the season of the pest, where possible.

e) Crop rotation helps to reduce the build up of pests.

f) Breeding experiments should be stepped up to produce genetic strains which are high yielding and resistant to pest without resorting to use of chemicals.

EFFECTS OF INDUSTRY AND TECHNOLOGY ON THE ENVIRONMENT AND THEIR CONTROL

You may have been to big towns and cities where there are many industries; cars and engines of different types in operation. How do you compare those towns with the village environment in terms of noise, sanitation, the cleanness of the air and water? Many activities in the factories involve the burning of some kind fuel to produce energy that powers the machines. Industrial and technological development means more and more use of machines to do (factory) work and no improve the quality of life. But there are some bad effects to it all.

Whenever fuels are burnt, enormous quality of wastes pass into the atmosphere. Some of these are dissolved by rain droplets and fall as acid-rain which is harmful to plant and animal life. Some of such water runs into rivers and the soil. One of the major air pollutions is sulphur dioxide, a harmful (acidic) gas which is produced mainly by the burning of fuel. This gas can be controlled either by removing it before the burning or retaining after the burning.

Another pollution is the burring of fuel in limited supply of oxygen This produces carbon monoxide. This gas, like oxygen, combines with haemoglobin but irreversibly, thus causing death if too much is inhaled.

You may have heard of "antiknock" in petrol which is a lead compound. Lead is poisonous if it accumulates in the body. Other air pollutions which can be controlled are hydrogen sulphide, nitrogen dioxide and access carbondioxide. These pollutants are produced at dangerous levels and constantly poured into the air we breathe and the water we drink, making them unsafe for animals and plants.

Other industrial wastes from the factories in the form of solid wastes, radioactive wastes and liquid discharged are equally altering the natural environment. Lately the dumping of industrial waste from Europe at Koko in Bendel State started off an awareness of the dangers of such wastes in Nigeria.

Why do you think Europe spent so much money to transport her wastes to dump in our country/ (If the wastes were beneficial they would have retained them in their country).

ACTIVITY 31

Take a trip to an industry and note the colour of the surrounding vegetation and buildings. Also smell the air around; and note noise pollution. Compare this environment, with the non- industrial one. What differences do you observe?

As you may be aw are, the problems of industrial and technological pollution is not only in the air but also in water and on land. Many industries discharge their chemical wastes into streams and rivers.

Some of these wastes, such as, cyanides, compounds of mercury, acids, alkalis, salts etc are toxic and harmful to aquatic organisms and humans. Radioactive wastes are dumped into water especially the oceans. Apart from all these, is the thermal pollution of water by industries and nuclear power stations that use it to cool the reactors.

Newspapers often; report cases of oil pollution of water in various places, including Bendel and Rivers states. Oil fouls up the beaches, the water and all the living things. It has been estimated that about two million tonnes of oil goes into the oceans every year.

The only way to control all these pollution is to stop these avoidable pollution of the environment. In case where water is the only means of disposal, it must be done in such a way is to reduce and limit the bad effects on the environment. Finally the waters, especially the streams and rivers, should be cleaned up of their pollutants.

The lane is not spared from all these pollutants resulting from industries and technology. They include plastic, metal and glass containers, food wrappings, worn-out machinery, old furniture, garbages etc. Most of these result from industries and technology.

For the pollutants on the land, all that we need to do to keep the land clean, is to properly depose of them. Most of them can however be recycled.

OTHER WAYS OF CARING FOR OUR ENVIRONMENT

Can you suggest other way:- by which we can care for our environment? You may note the following:

i. We can plant more trees which help in using up excess atmospheric carbon (IV) oxide for photosynthesis, create shade over the land from direct rays of the sun and rain.

ii. Laws should be made and enforced regarding the dumping of solid wastes, raw sewage and effluent into the atmosphere, on land and into the water.

iii. Erosion should be checked to avoid the wearing away of the nutrients and disfiguring of the environment.

iv. Noise pollution which is an unwanted sound should be kept to the barest minimum.

CARING FOR THE AIR WE USE

Sources of Air Pollution

You have learnt that life depends on air. Have you ever thought of how clean air is? Does the air contain water or solid particles? If the air contains particles what would be the effect of those particles on your health? You must have learnt that human activities produce so many substances which find their way into the air. These substances can be solids, liquids or gases. The sources of air pollution can be broadly divided into two, namely, industrial sources and the internal combustion engines of cars and vehicles. In your environment, you find cars running, factories operating and people burning refuse. Do you think all these activities have any effect on the air you use? If your answer is yes what are the influences of these activities? These activities give out vast quantities of pollutants, including Soot, which comes from unburnt fuel; and industrial ashes from furnaces and power stations.

Gases, such as sulphur dioxide which is emitted from the oxidation of sulphur compounds in fuel; carbon monoxide and nitrogen oxides released into the atmosphere from car exhaust and industrial chimneys due to incomplete combustion of fuels.

Hydrocarbons, produced from incomplete combustion of petrol and engine oil. One of these hydrocarbons is the cancer-causing agent called benzopyrene.

Other factors such as the season of the year also help to increase pollution the dry season for example, there is an additional quantity of dust and sand in the air. The action of sunlight on some of these pollutants may also produce other pollutants referred to as secondary pollution. In bright sunlight example, nitrogen oxides, oxygen and hydrocarbons can interact to produce powerful agents such as zone and Peroxyacetyl Nitrate (PAN). These substances have damaging effects on plant life. They lead to formation of Peroxyacetyl nitrate causes the irritation that is usually experienced in smog. Another category of air pollution is cigarette smoke. This smoke contains a number of hydrocarbons one of which is benzopyrene which causes cancer.

ACTIVITY 32

Collect some refuse in your compound and put then outside your house. Light the refuse and observe the refuse burn. What do you notice? How does this affect the air?

Observe a cigarette smoker light his cigarette. What happens as he smokes he smokes his cigarette? Go very near to the smoker as the cigarette burns. Do you perceive any odour? How does the odour reach you? Has it any effect on life the air?

POLLUTANTS

You should have learnt that the air we breathe is not pure. Do you think that the protective mechanisms in the air passages and lungs guard adequately against air pollution? If you answer is no, what then could be done to control or reduce air pollution? You have noticed that although the respiratory tract is designed to eliminate some particles coming with the air, there is the need to control or reduce all those activities which produce pollution of the air. Let us consider some of the causes of air pollution and their effects on life.

SULPHUR DIOXIDE

Coal and much of the world's petroleum have substantial content of sulphur. The burning, of these fuels oxidises the sulphur compounds to sulphur dioxide. Exposure to lo-concentration of sulphur dioxide causes injury to plants. Also acid rain, which results from the combination of sulphur dioxide with water in me atmosphere causes change in the population of aquatic plants and animals. Practical techniques now exist by which sulphur dioxide could be removed from polluting sources and convened into sulphur, acid which may be used in the manufacture of fertilizers.

CARBON (IV) OXIDE

Industries greatly depend on combustion to provide energy. In combustion, oxygen is used and carbon (IV) oxide formed. Industrial activities increase the quantity of carbon (IV) oxide in the air. The recycling of carbon (IV) oxide in the world ecosystem has kept carbon (IV) oxide level in the atmosphere remarkably constant. However, in recent years, industrial activities have caused a rise of about 10 percent in the level of carbon (IV) oxide in the air. Such rise is dangerous as it could cause the melting of the world's ice which would in turn result in a corresponding rise in the ocean levels and consequently flooding. Such rises have been counteracted by dust particles in the atmosphere which reduces the heat reaching the earth. Excess presence of carbon (IV) oxide can be avoided by bringing in anything which will utilize the carbon (IV) oxide. This could be achieved by extra photosynthesis through forests and green fields.

ACTIVITY 33

Light up two candles. Cover one of the lighted candles tightly with a glass jar and leave the other candle uncovered. Observe the two candles. What happens after a little while? What do you think is the cause of what happened? Can you relate what happened to what happens when a burning fire is left for sometime in a room with the doors and windows closed?

Pick up a broom. Go to a dusty area in your compound or alternatively a dusty room in your house. Stay there for some minutes. Breathe in. How do you feel. Sweep the room. What do you notice as you sweep the room? Breathe in again. How do you feel? Look at your nostrils using a mirror. What do you see? What makes you feel the way you do when you breathe in as you swept the room?

CARBON MONOXIDE

This is another pollutant. It is formed when a hydrocarbons bum in limited supply of air. Most of the carbon monoxide in the air comes from burning of refuse. You must have read or heard of deaths occurring through carbon monoxide poisoning. Such deaths occur when you are exposed for a long time to an environment with large quantity of carbon monoxide and limited quantity of oxygen. Examples of such environments are unventilated rooms or houses with burning fire. Death results when the carbon monoxide combines with the haemoglobin of the blood, preventing the combination of oxygen with the haemoglobin. This leads to suffocation.

Vehicles also pollute the air. Combustion of motor fuel produces lead, nitrogen oxides, carbon monoxide as well as carbon (IV) oxide. The effect of this pollution is so bad that in some countries traffic workers are allowed some times off during their duty hour. This would enable them breathe some purer air elsewhere. Lead from vehicles is also poisonous. When it accumulates in the body it causes sickness.

ACTIVITY 34

Watch a driver starting the engine of a car and pressing on the accelerator. What do you observe? What do you think are the contents of what comes out from the exhaust pipe of the car? What effect has this on the air you breathe?

NUCLEAR FALL-OUTS

These types of fall-outs cause air pollution. The fallouts are formed from atomic tests which release radioactive substances on to the ground. These radioactive substances are carried by rain and are absorbed by plants. These materials pass through the flood web becoming concentrated at each step. A radioactive material such as strontium 90 can be taken up by cattle and passed to man through milk. This substance may end up finally in man's bones where it will affect the bone marrow thereby causing leukaemia or blood cancer. This type of pollution can be avoided by the non-production of nuclear materials. Since you have learnt of the different causes of air pollution you have to note that air pollution can generally be controlled or reduced by the non-production of all these substances which pollute the air.

CARING FOR THE WATER WE USE (Purification of Water)

ACTIVITY 35a

Obtain samples of water from various sources listed above and put each sample in a small flat container. Borrow a hand lens from any of the neighbouring schools. With the aid of the hand lens observe each sample.

Question: What do you observe?

Answer. You are likely to observe that m some samples there are specks of mud, leaves and other traces of dirt that have contaminated the water.

What will you do to make sure this type of sample is, or become, free from these impurities?

The sample will have to be purified.

ACTIVITY 35b

Obtain a sample of muddy water. Buy a little alum from a nearby market. Grind the alum and put a teaspoonful of crushed alum into a cup of mud water. Allow it to remain over night.

Question: What do you observe the following day?

Answer: The upper part of the water is now clear and sparkling. The bottom contain mud and other sediments, which had contaminated the water.

Therefore addition of a chemical like alum helps to make mud water clearer. However, the removal of the clear part may be difficult as the two tend to mix.

ACTIVITY 35c

Obtain a white clean cloth half a metre square. Put it over an empty bucket. Pour a sample of muddy water slowly on the cloth.

The water which comes through the cloth is collected in the bucket.

Is there any difference between the collected water and the original sample of water?

The collected water is very clear and is different from the muddy sample.

Where are the mud and other dissolved particle?

Answer: The mud and other dissolved particles are now on the white cloth.

What is the advantage of this activity over activity 35b.

Answer: In activity 25b it was difficult to separate the clear water from the mud and other particles. But in activity III these have been separated during the process of Alteration.

ACTIVITY 36

(To be carried out during the contact session)

You will be provided with filtering sand, charcoal, fine gravel, coarse gravel and stores. You will use this to make a filter bed as shown in Fig. 5.1.

An in the activity above, pour some muddy water into the filter bed. Collect the water that comes out in a container. Is there any difference between the collected water and the original water sample?

Answer: The collected water is clearer and does not contain dissolved particles. Name a source of water which is similar to the filter bed.

Answer: The spring water. Here rain water seeps through the outer soil to clay soil, then to a layer of rocks and finally it appears as a spring.

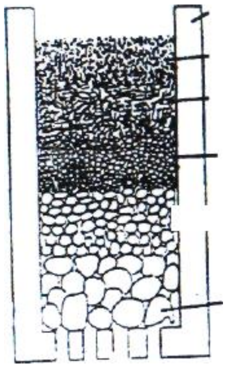

Fig. 2.29 Filter-bed

ACTIVITY 37

(To be carried out during contact session)

Take a sample of collected water in the activity above and samples of river, stream, rain water and examine then under the microscope.

Question: What do you observe?

Answer: You will observe some micro - organisms, may be those called bacteria, even in the filtered water.

You can then see that the process of alteration cannot take care of bacteria and so this method is not sufficient to make water safe for drinking because bacteria are dangerous. However this water can be used for washing, cooking etc.

Question: How can these bacteria be removed from water?

Answer: The bacteria can be killed by boiling the water or by addition of a little quantity of chlorine, you may have noticed that water from public taps smell chlorine, even if just slightly. You have observed from the above activities that Alteration and boiling help to remove solid panicles and living organisms. Is the water so treated now pure and free of all foreign bodies?

HARDNESS OF WATER

ACTIVITY 38

Get equal but small quantities of stream water, tap water, well water, river water and add equal quantities of detergent *(Omo)* to each and shake. You will notice that the water samples formed lather at different times. The ease with which water form lather determines how hard the water is. If a sample of water does not easily form lather you say that the water is hard water.

What would be the effect of using hard water?

If hard water were used for washing, much more soap would be used than if wit water was used. In addition, much effort would be expended. This would also constitute an economic waste. Hence effort is made to remove hardness of water. There are two types of hardness:

(i) temporary

(ii) permanent.

Temporary harness is caused by the presence of calcium hydrgencarbonate (Calcium (II) hydrogentrioxcarbonate (IV) in water. This can be removed either by boiling or by adding slaked lime. Permanent hardness may be caused by the presence of calcium (II) tetraoxosulphate (IV) and can be removed by either adding sodium trioxocarbonate (IV) or by adding permulit to it.

ASSIGNMENT

1) Name six sources of water we use.
2) What is the purpose of filtration?
3) How do you ensure that water is fit for drinking?
4) Identify five air pollutants.
5) Name one industry waste.

SUMMARY:

In this unit the following concepts have been learnt:

- That the water we use come from various sources which include stream, pond, well, dam, rainfall, spring, ocean, etc.
- Water contains impurities
- Caring for the environment
- Effects of population growth on the environment
- Pollutants in the air which include carbon monoxide, carbon dioxide, etc
- Effects of agriculture and other human activities on the environment
- Hardness of water

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UNIT 7: TRANSPORT AND GROWTH IN LIVING THINGS

INTRODUCTION

In a simple unicellular organism such as the amoeba, the exchange of materials between the organism and the environment was simply by diffusion. However, with the elaboration of structure from simple unicellular to multicellular organisms, the diffusion process was no longer sufficient to get the food nutrients and even the oxygen needed to the larger part of the body. It became imperative that the multicellular organisms must device ways of transporting the much needed materials and remove the excretory wastes. The unit is, therefore, aimed at focusing your attention on various mechanisms engaged by multicellular organisms to transport these essential nutrients and wastes. Furthermore, the continuous food intake and even the storage of excess food has resulted in rapid multiplication of the existing cells - a process of growth. The young has continued to grow into massive structures whether it is a plant or an animal. This unit will also be discussing growth and growth processes in living things.

OBJECTIVES

By the end of this unit, you should be able to:-

1. list the materials that are transported in both plants and animals;
2. name the tissues and the organs involved;
3. list the excretory materials;
4. explain how both the food substances, other materials needed' and the excretory products are transported;
5. name the various circulatory systems in both plants and animals;
6. to draw the circulatory system in a manual;
7. define growth;
8. explain the mechanism of growth; and
9. compare growth in plants and animals..

TRANSPORT IN ANIMALS

Materials transported in an animal cell include:

1. Digested food - simple sugars; proteins, fats, mineral salts, water
2. Oxygen
3. Excretory products namely carbondioxide, urea, water
4. Hormones produced by glandular cells.

Generally, the digested foods and nutrients are taken from small intestines (the last digestive point) and transported to liver and body cells; the oxygen is taken from the lungs and circulated to the heart and all body cells. Carbon (IV) oxide is transported from all body cells to the lungs: Urea is transported from the producing glands to the specific organs where it is excreted.

Mechanism of Transportation:

In unicellular, animals transportation is by simple diffusion from region of high concentration to region of lower concentration. Water passes through the semi permeable membranes into the cell by osmosis. Cytoplasm is the medium of exchange.'

In multicellular organisms, the materials, especially digested foods, are in aqueous medium. The medium for this transportation is (a) Blood (b) The lymph (c) intercellular fluid.

The blood in mammals consists of plasma, blood cells (the white blood cells and the red blood cells) and platelets. The plasma consists of water mainly, dissolved substances e.g proteins, waste materials, e.g. urea, digested food, gases and hormones as well as mineral salts. It is the main medium for the transportation of these listed materials.

The lymph: This is the intercellular fluid which is present in the lymphatic vessels that eventually empty its contents into the blood veins. It carries excretory materials such as CO_2 and urea.

The inter-cellular fluid is directly in contact with the body cells and by the process of diffusion, oxygen and carbon (IV) oxide diffuses. The cells extract their food requirements while the excretory products pass into the fluid.

The Circulatory Systems

These are two ways by which the blood circulates: The open and the closed circulatory systems.

The Open circulatory system

In some lower multicellular animals, e.g. the worms without heart, the muscles of the body circulates the blood in a non-rhythmic way to fill open spaces in between the organs. The exchange of materials is directly between the cells and the blood. However in more advanced animals with less developed heart e.g. the insects and molluscs, the heart pumps the blood in given directions to openly bath the organs. In this situation the internal organs exchange materials with the blood. The blood then returns to the heart in a special mechanism. The oxygen needed is not transported by the blood, but passes through a developed tracheal system. The blood of these animals in this open system lack red colour because it contains no haemoglobin.

The closed circulatory system: In this system the blood is carried in special vessels which branch out into smaller vessels - the arteries and arterioles to reach the body cells. After the exchange of materials between the blood and the cells, the blood returns to the heart through ventricles and vein vessels. The much developed heart acts as a pumping station.

Circulation in the closed system are of two types -the single circulation and double-circulation. In single circulation, the blood passes through the heart once for a complete circulation. This is the case in Fishes In the double circulation as in the case of mammals and birds, there are two pathways for circulation.

The pulmonary circulation: This involves the passage of blood from the heart through the lungs for oxygenation and then returns to the heart.

The systematic circulation - during which the new oxygenated blood is pumped from the heart to all body cells and after exchange of materials, the blood returns to the heart through one set of capillary net work. Note that the circulations are parallel and during one complete circulation the blood circulates twice through the heart.

ACTIVITY 39

Draw the circulatory system (double circulation) in a mammal showing in different colours the circulation involving blood with oxygen and blood without oxygen.

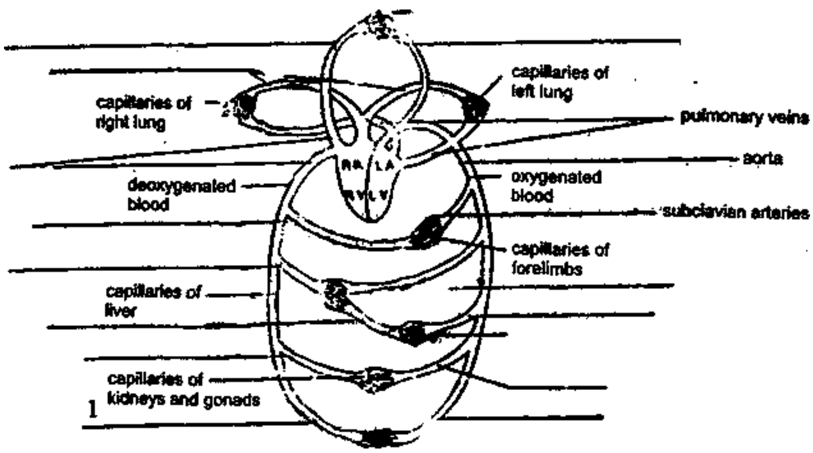

Fig. 3.6

ACTIVITY 40

Draw also the heart to show its four chambers and how blood enters and leaves the heart.

TRANSPORTATION IN PLANTS

Materials transported in plants include:

(a) Mineral salts (from the soil),

(b) Food substances (from the soil or manufactured by plant itself)

(c) Oxygen and carbon (IV) oxide

(d) Pigments

(e) Hormones.

(f) Water

In unicellular organisms e.g. the spirogyra, transportation of the above materials is by diffusion and osmosis just as in the case of animals.

In higher plants: the flowering plants (Angiosperms) and non-flowering plants (Gymnosperms), transportation is by means of a well developed vascular tissue (the xylem and the phloem). The medium for transportation of these materials is the cell sap and the cytoplasm. The cell sap is a fluid and it contains over 97% of water in which both organic substances and inorganic salts are dissolved. The vacuoles contain this cell sap.

By means of osmosis water is drawn from the soil solution into root hairs and the water moves from cell to cell until it gets to the vascular tissues.

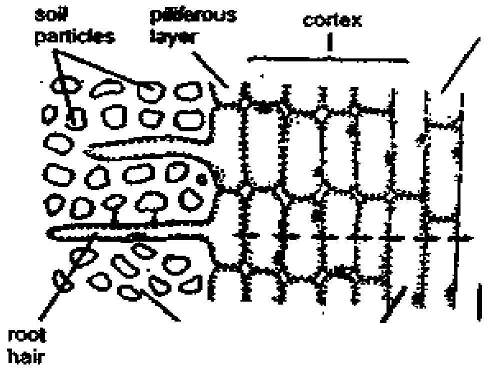

Fig. 3.7

The absorption of mineral salts into the cells of the root hair is by means of diffusion. Because of' the higher concentration of mineral salts in the soil, the mineral ions diffuse into the root hair cells. From the root hairs the ions are transported by diffusion from cell to cell, until the ions reach the xylem of the vascular tissues.

Translocation:

The water and the mineral salts having moved into the root hairs have to be transported to other parts of the plant. The process of transporting these to other parts is called Translocation. This is carried out by the vascular tissue. You have already studied the structure and functions of these cells, however you should refresh your mind that:

a) The xylem is responsible for transportation of water and dissolved mineral salts upwards from the root to other parts.

b) The phloem transports food manufactured from the leaves to other parts where they may be used up or where they are stored.

ACTIVITY 41

Uproot a young water leaf plant (or balsam) without destroying the root hairs. Immerse the root into a beaker containing Eosin solution or red ink (diluted). Leave the young plant until you observe red lines along the veins of the leaves. Cut under water a transverse section of the stem, the root and petiole and examine under the low power of a microscope. The parts stained red correspond to the xylem tissue.

Transpiration: Some water taken in by the plants may have to be lost. Transpiration is the process of losing water from the aerial parts of a plant through the stomata of the leaves by evaporation.

ACTIVITY 42

Demonstrating Transpiration

Collect two potted plants. Remove the leaves from one of them as the control experiment. Place both of them in glass tops and cover each with a bell jar. Seal the lower base with Vaseline to make the set up air tight. Ensure before the sealing that the pots are covered with polythene bags. Leave both in sunlight for about six hours. Record your observation. Test the liquid particles on the gas jar of the leafy potted plant with dry blue cobalt chloride paper or anhydrous copper (II) tetraoxosulphate (VI) salt. Record your observation. (Note, if the cobalt chloride paper turns pink or the anhydrous copper (II) totraoxosulphate (VI) metals turns blue it indicates the presence of water.

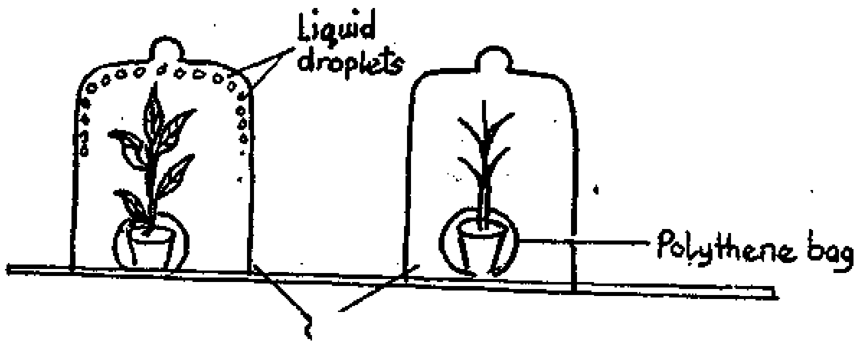

Fig 3.8

Importance of Transpiration:

1. It serves as cooling system for the plant

2. It helps in the transportation of mineral salts to all parts of the plant.

3. Provides the plant with water for chemical and physiological processes.

GROWTH

Definition: Growth is a permanent increase in size of an organism due to synthesis of new cytoplasm. It is a consequence of food assimilation and it is accompanied by rapid cell division and expansion. Every living organism grows, but the rate and system of growth differ in animals and plants.

A study of growth in animals and plants reveals that

1. Growth in animals is limited to a maximum size attainable at adult age, while that of plants is unlimited. Although growth is limited in animals, the rate of growth differs from age to age,- the greatest growth rate being witnessed before the age of eighteen especially in man. Even the rate of growth differs among males and females; the females grow faster at younger age than their male counterpart. The males shoot up more at a later age overtaking the rate of growth of females.

2. In plants growth is throughout life. This is not so in animals. There is a limiting period, after which growth ceases.

3. In animals growth occurs all over the body i.e. every part of the body grows, while in plants growth is limited to the apices - the root and the shoot. This is referred to as apical growth.

4. Growth in animals is limited to a specific shape and size but in plants growth is diffuse, and consequently grows into indefinite shapes.

Measuring growth in animals and plants

The height or weight of an organism measured at given intervals over a period of time gives the growth rate. A plot of the height/weight against time produces a growth curve of the animal.

ACTIVITY 43

Measuring growth rate of an animal; Choose a suitable domestic animal in your home - a young two weeks old dog, pig, chicken, goat and record its weight every one month for a period of 12 months. Carry out a plot of the weights against two weeks interval period.

A curve will be produced which shows the stages of its growth. You may repeat the same experiment using maize seedling. Instead of weight, you will use height every two weeks until the maize starts flowering.

ACTIVITY 44

To demonstrate the region of growth in a root.

Take a just germinated bean seed and mark the radicle with lines 2mm apart,. Place the seedling on a moist filter paper and watch the radicle grow. What do you observe? Make a sketch of the later enlongations and compare whether the 2mm distances are maintained. You will notice that the top area has witnessed greatest elongations:

The multiplication of the cells in this area is very rapid. The cells produced soon differentiate to form epidermal cells and other specialized cells. The root cap protects this meristematic area from injury

Also growth of the stem takes place at the apex of the stem that is in the inter node region. This is the area between the nodes. The node is the place where leaves develop. The leaves that develop at the node often offer protection to this apical meristematic area.

Lateral growth may also be shown by stem of plants. Growth in the stem is achieved by the rapid multiplication of the cambium cells in between the xylem and the phloem. The cambium is referred to as a secondary meristem. It is this type of growth that results into increase in girth. This is described as secondary thickening.

Growth Hormones

The growth hormone is known as auxin. The auxin is produced at the tip of a shoot. This hormone induces the cells behind the tip to multiply rapidly. You will have noticed that if the tip of a shoot is cut off, that tip fails to grow again. Differential secretion of this hormone causes different effects on the shoot. In the shoot it causes the enlargement of the cells whereas the same amount of auxin in the root will not produce the same effect. Generally auxins regulate the development of a plant from seed to maturity when it starts to produce fruits.

ASSIGNMENT

1. List the materials transported in (i) plants (ii) animals.
2. Distinguish between single circulation and double circulation system of a closed circulatory system.

3. Explain the terms translocation and transpiration.

4. Name the tissues that conduct water from the root to the stem and from leaves to root/other parts.

5. Define growth.

6. Describe a simple experiment to show that growth in plants takes place in the apical meristem.

SUMMARY

In this unit, you have learnt that:

- Materials transported from one part to another of an animal or plant include digested food, oxygen, carbon (IV) oxide, excretory products hormones and mineral salts.
- In unicellular organisms, transportation in by diffusions and osmosis.
- In higher animals, the main agency for the transportation is the blood, the lymph and the intercellular fluid.
- Transportation of materials is by open circulatory system in lower animals and by closed circulatory system in higher animals e.g. mammals.
- In the case of closed circulatory system, there are two types; single circulation and double circulation.
- In plants the cell sap present in vacuoles and the cytoplasm are the mediums for the transport of materials.
- The absorption of water and mineral salts is through the root hairs.
- The vascular bundle is responsible for the transportation from one part to another, while diffusion and osmosis account for cell to cell exchanges.
- Translocation is a process of transporting water and mineral salts and manufactured food to different parts of the plant.
- Growth is an activity of all living organism.
- Growth in plants is fairly different from growth in animals.
- Growth is concentrated at the apical meristems of the root and the shoot.

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UNIT 8: POLLUTION

INTRODUCTION

Pollution is the unfavourable alteration of the environment due to the addition of impurities by man to constitute danger to either his health or natural resources. It must be realised that pollution results the by-products of human activities. Pollution impairs the usefulness of the environment.

OBJECTIVES

By the end of this unit, you should be able to:

(i) State the different types of pollution;

(ii) Identify the causes of water, air and land pollution;

(iii) State ways of controlling water, air and land pollution; and

(iv) State the effects water, air and land pollution( )

Pollution is any substance introduced into any environment by man which causes the destruction or impairs the purity of the environment and causing harm to living organism including man.

Major types of pollution

1. Water pollution
2. Air pollution
3. Noise pollution
4. Land pollution

WATER POLLUTION

Water pollution is the discharge into water of any substances (usually by man) which may become harmful to plants and animals in the water and make them unfit for human consumption.

CAUSES OF WATER POLLUTION

1. **Human wastes**

As the industries and population continue to grow, more and more human wastes are produced and dumped into later. Nature's own purification system cannot handle this and as a result, water is over-loaded with impurities. Most streams, rivers, lakes have been fouled with human and animal wastes and debris of all kinds. The human waste such as faeces and urine may contain disease-causing organisms.

2. **Phosphate detergents**

Phosphate detergents increase the quantity of phosphorus in the water and stimulates excess growth of algae leading to algal bloom (eutriphication). The trade names of a few Nigeria are *Omo*, Surf and Elephant. Population of algae upsets the equilibrium aquatic environment.

3. **Oil**

Oil spillage causes the surface of the water to be covered with a film of oil. This film of oil may cut off supply of oxygen to the organism living in the water and also reduce the amount of light entering the water.

4. **Poisonous chemicals**

Poisonous chemicals such as mercury and *gammaline 20* are now finding their ways into our waters. Some factories which make use of mercury discharge it as a waste product into water. Some uncivilized fishermen now use *gammaline 20* to kill fish without knowing the ecological consequences of their action.

5. **Fertilizers**

Fertilizers (nitrates and phosphates) from the farmland cause overgrowth of aquatic vegetation.

6. **Cleared vegetation**

Some farmers dump the cleared vegetation into water. The decay of the vegetation causes the shortage of oxygen in water.

7. **Heat (thermal)**

When heat is added to a stream, river, or sea it is called thermal pollution of water. Some machines in the factories use water as coolant. When the used hot water is returned into a stream, river or lake, the temperature of the water rises making it unsuitable for aquatic plants and animals.

EFFECTS OF WATER POLLUTION

1. **Diseases**

Untreated human and other animal wastes may harbour viruses, bacteria and eggs of worm that cause diseases such as dysentery, cholera, typhoid, hepatitis (jaundice) and bilharziasis.

2. **Destruction of aquatic life**

The immediate effect of aquatic pollution is the destruction of aquatic organisms. Sewage and other organic substances encourage rapid growth of bacteria. The bacteria require-oxygen for decay and the oxygen comes from the water hence the dissolved oxygen in the water is reduced to a point that cannot support aquatic organisms. Fish and all other aquatic organisms die of suffocation. Fish is a source of animal protein. The death of algae from algal bloom and other aquatic plants in fresh and marine waters may lead to shortage of oxygen in the atmosphere. About 65 % of the atmospheric oxygen comes from the sea through photosynthesis; man will, therefore, die of suffocation if water pollution continues unchecked.

3. **Poisonous chemicals**

Drinking water contaminated with either lead, mercury or cyanide is injurious to man's health and death may result. Fish can store mercury in their tissues. When such contaminated fish are eaten by man, death may result. Fertilizers washed from farmlands could be poisonous to man. For instance, if the nitrate concentration in water gets high, it can lead to children mortality and toxicity to adults. Nitrate causes sickness known as **methemoglobinemia** among babies of three weeks old (bluebabies), The nitrate ($N0_3^-$) can be reduced to nitrite ($N0_2^-$). The nitrite in turn oxidizes the ferrous ions (iron II) to ferric ions (iron III). Ferric ions are not capable of transporting oxygen in the blood to the tissues. The victim suffers from shortage of oxygen and may die of suffocation (asphyxiation)

AIR POLLUTION

Air pollution is the addition of air-borne substances such as dust, smoke, soot and sulphur dioxide into the air which alter the composition of the atmosphere causing harm to both plants and animals.

CAUSES OF AIR POLLUTION

1. Carbon (IV) oxide produced from burning of firewood, coal, oil and natural gases. Carbon (II) oxide (carbon monoxide) is produced from exhaust of automobiles.

2. Sulphur dioxide, sulphur trioxide and sulphuric acid. Sulphur dioxide (SO_2) is produced when sulphur or sulphur containing substance such as coal and oil are burnt.

   $S + O_2 \rightarrow SO_2$

Sulphur trioxide is produced by the oxidation of sulphur dioxide with the help of sunlight.

   $2SO_2 + O_2 \rightarrow 2SO_3$

Sulphuric acid is produced when sulphur trioxide reacts with the moisture or rain water in the atmosphere.

   $SO_3 + H_2O \rightarrow H_2SO_4$

3. Nitrogen monoxide (NO) and nitrogen dioxide

   Both gases are produced by automobiles. Nitric acid is produced when nitrogen dioxide reacts with water.

4. Production of organic substances such as alcohol and organic acids to the atmosphere by the incomplete combustion of carbon containing fuels. Evaporation of gasoline, alcohol and acids to the atmosphere also causes air pollution.

5. Dust resulting from construction and wear and tear of roads from automobiles. Lead dust from the fume of petrol.

6. Microscopic organisms, such as bacteria, fungi, parts of insects: such as wings, hairs and legs all pollute the air.

7. Chlorofluorocarbons (CFC) Chlorofluorocarbons are important gaseous chemicals used as coolants in air conditioners and refrigerators. . They are also, used as propellants in aerosol spray cans and in making polyurethane foams. When chlorofluorocarbon escapes into the stratosphere they destroy the ozone in the stratosphere. Recent reports have shown that big holes have been formed in the ozone layer. This means that the ultraviolet rays of the sun are striking the surface of the earth direct. The ozone layer prevents much of the ultraviolet rays from reaching the earth's surface.

THE EFFECTS OF AIR POLLUTION

1. On atmosphere

Air pollution reduces visibility of the atmosphere. Fog, for example, reduces the amount of light reaching the earth. This can disturb air traffic and even cause plane crash.

2. **On vegetation**

Sulphur dioxide causes damage to trees, fruits, vegetables and flowers. Ethylene destroys the petals of various flowers. It also interferes with the action of auxins. The destruction of -plants will lead to shortage of food. The dust particles in the atmosphere reduce the amount of light reaching the earth. The reduction of light reduces the rate of photosynthesis in green plants. Dust particles, smoke and soot may block the stomata of the leaves, affecting adversely photosynthesis, respiration and transpiration.

3. **On soil**

The sulphuric and nitric acids reaching the soil make the soil acidic. This affects the fertility of the soil.

4. **Effects on man**

(a) Acute illness possibly leading to death.

(b) Chronic diseases such as asthma, lung cancer and bronchitis.

(c) Irritations, nervous disturbances, eye and nose irritations and offensive odours.

(d) General discomfort and unhappiness.

5. The effects of destroying the ozone layer

When the ozone layer is destroyed or depleted more ultraviolet rays reach the earth's surface and thus cause the following:

a) Skin cancer, of the eyes and sunburns in human beings.

b) Plankton which form the basis of food chains in all aquatic habitats will be destroyed.

c) In green plants, photosynthesis will be hindered as too much ultraviolet rays destroy the chloroplasts and thus food production will be lowered and consequently 'all animals will face starvation.

d) Beneficial micro-organisms will be killed.

CONTROL

The ozone layer must be preserved. All chemicals that react with ozone to decrease the ozone layer should be banned internationally.

6. **On materials**

Acids corrode metals and destroy papers, textiles and marble. Inhaling lead fumes causes lead poisoning and consequently death may result.

NOISE POLLUTION

Noise pollution is an impairment of the environmental quality of the air by noise. Towns and cities are becoming noisier.

CAUSES OF NOISE POLLUTION

Aeroplanes, automobiles, guns of various types, bombs (especially atomic bombs), musical sets and television sets usually tuned to the highest volume, singing and drumming cause pollution.

THE EFFECTS NOISE

1. Loss of hearing

Noise above 85 decibels from towns and cities is high enough to cause deterioration of hearing as we grow older.

2. Emotional disturbance.
3. Causes high blood pressure.
4. Anxiety and fright
5. General irritation, tension and tiredness
6. Ateriosclerosis (the hardening of the artery
7. Causes short temper
8. Brings about changes in behaviour

Land Pollution

Land pollution is the dumping of rubbish and chemicals on land by man which makes the land infertile and causes harm to both plants and animals.

Pollutants	Sources	Effects	Control
Refuse	Industries, markets, institutions, offices and homes.	1. Provides breeding ground for insect and animal pests such as houseflies and rats which cause harm to man. 2. Harbours germs which are harmful to man. 3. Ugly in sight and causes discomfort due to its offensive odour. 4. Occupies a space which would have been used for farming.	1. Indiscriminate dumping of refuse on the soil must be discouraged. 2. Refuse must be burnt or buried in proper places. 3. All refuse should be deposited in a dustin.
Poisonous chemicals	Factories and laboratories.	1. Very harmful to man when absorbed directly or indirectly. For example, eating fruits from plants which absorb cadmium or zinc from the soil is harmful. 2. Poisonous chemical may be dissolved in ground water which will eventually find its way to drinking water bodies such as wells, lakes and rivers. Drinking water from such bodies may be harmful to man.	Dumping of any poisonous chemicals on land must not be allowed. Government should enact laws to this effect.

Sewage (human faeces, urine and fluid discharges from household and factories)	Homes, offices, schools and factories	1. The stinking odours resulting from decay causes discomfort and nose irritation. 2. Sewage washed from land to source of drinking water may contain harmful organisms such as protozoans and bacteria that cause diseases such as dysentery, cholera and typhoid fever.	1. Using deep pit latrines or septic tank latrines. 2. Sewage should be properly treated before disposal or recycling. 3. Indiscriminate passing of excretes must be avoilded.
Pesticides and herbicides	From the spraying of crops and vegetation to kill insects	1. May kill both harmful and useful insects in the soil. 2. May sink into the soil and kill useful.	Over or indiscriminate use of pesticides and herbicides must be discouraged.
Crude oil	Spillage from oil pipes	1. Burns the vegetation 2. Renders the soil infertile 3. Kills the useful organisms in the soil.	Government should enact laws against oil pollution

ASSIGNMENT

1. What is pollution?
2. State five ways in which air pollution and water pollution are each important to man
3. What are the major causes of air and water pollution?

SUMMARY

In this unit, you learnt about different types of pollution. You should be familiar with these types. Pollution is dangerous to man and must be avoided by all means.

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MODULE 3: PROCESS OF LIFE

UNIT 1: ORIGIN OF LIFE

INTRODUCTION

One of the issues that have faced mankind is the origin of his existence and that of living of things around him. Your Bible or your Koran had insisted that all living things in their present forms were created by God in His own infinite wisdom. A few theories have been developed by scientists to explain the origin of life and the developments that have accompanied it. It is the intention of this unit to review some evidences in support: of the evolution of man, the associated landmark theories of Jean Baptist Lamarck and Charles Darwin and to discuss the strengths and weaknesses of each theory.

OBJECTIVES

By the end of your study of this unit, you should be able.,

i. to summarize some evidences in support of organic evolution;
ii. state the theories of Larmarck and Charks Darwin;
iii. state the limitation of both theories; and
iv. outline what new discoveries (Neo Darwnism) that have given greater credence to Darwin's theory.

Evidences of Organic Evolution

The earliest thinking on the Origin of life (Organic evolution) by some scientists is the idea that living organisms may have started from non-living things - atoms and molecules which organised themselves into minute protoplasm (the living content of a cell enclosed within the cell wall or cell membrane). This simple and minute protoplasm started undergoing gradual self modifications and elaborations which then resulted in different forms of living things with different complexity. This idea of organic evolution went further to explain that the present day simple unicellular organisms such as Amoeba, Paramecium, Spirogyra or a few more multicellalar organisms which have not developed to the stage of mammal or flowering plant are regarded as animals and plants which for one reason of the other failed to attain any structural modification as the present day mammal and flowering plants.

These modifications have come as a result of changes in the environment such as temperature, diet, degree of moisture or rainfall. It is to be noted that in the course of these environmental changes many species have become extinct.

Many evidences of organic evolution have been adduced by scientists such as Lamarck and Darwin to explain the common ancestory of many living organisms. The divergence of living organisms of today are merely due to structural or embryronic changes which these minutests organism have undergone or arc unable to undergo. These include evidences from

a) structural (morphology) comparative studies;
b) study of the embryos of many organisms;
c) geological students;

However for this unit, you will concentrate on structural evidences. Let's consider the pentadactyl limbs which typically has five digits.

ACTIVITY 1

Study the diagram below and record the observable structural changes.

You will notice that in the course of evolution, the limbs of the various vertebrates mentioned have undergone changes to suit their function e.g. The bat (for flying). The whale (for swimming) the monkey (for grasping); the pig (for walking), the anteater (for tearing), the horse (for support and running), the mole (for digging) and man (multipurpose use).

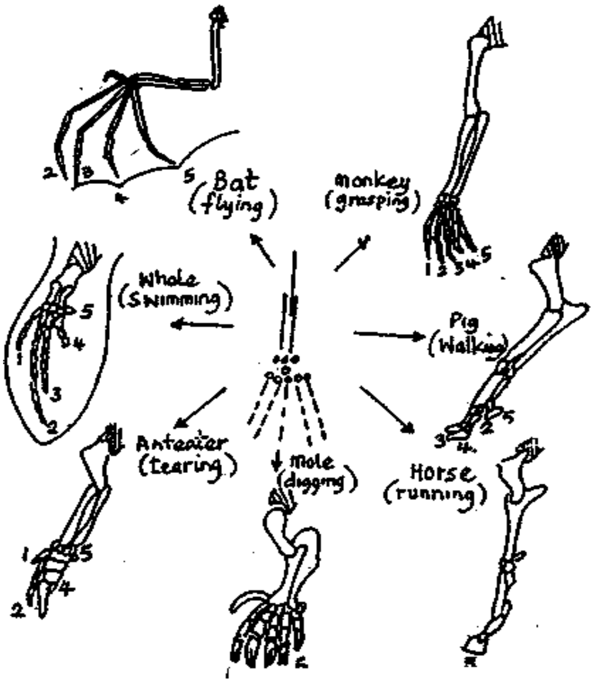

Fig. 3.1

Notice the structural changes. For example in the horse there is the elongation of the 3rd metacarpals to form the canon bone while the other matacarpals have remained vestigial as the splint bone.

As you examine this same pentadactyl limbs in bats, birds, you will observe the attachments of the wings. This will explain why birds are good fliers than bats. In all, there is the suggestion of common origin.

If you again consider all chordates (animals with notochord or back bones), you cannot help but assume that they have come a long way by series of modifications and elaboration-of the same structure which existed in the primitive animals. For example, the monotremes - (egg laying mammal) the ornithorhynchus (Duck -bill Platypus) still have characteristics of reptiles such as large ova, complete pectoral girdle. Their young, ones are still fed by sucking through primitive mammary glands.

Another evidence of structural modification is the appendix in man (an omnivore) which has become vestigial because of lack of use. This structure is well developed in herbivores e.g. apes and completely absent in carnivores. These modifications have come as a result of changes in diet

Theories of Evolution

Some scientists have argued that if the evidences of organic evolution are correct, then there is a process through which this occurred. The theories of Jean Baptist De Lamarck and Charles Darwin give answers to this question.

The Larmarckan Theory: Lamarck proposed his theory of Law of Use and Disuse in which he started that an organ which becomes functionless in an organism will ultimately disappear in the offspring of that specie while that which is constantly used undergoes structural modification to fulfil its function. The factors responsible for these adaptations include temperature, food, light, periodic variations in weather. Larmarck further proposed that these characteristics acquired freshly are inherited by the offspring - inheritance of Acquired characters. He used the giraffe among other examples to illustrate his theory. According to him, the unusual long neck and tall front legs of the giraffe was a consequence of searching for leaves to chew from tall trees when scarcity of leaves within reach of many animals prevailed.

Although his theory of use and Disuse appeared convincing, judging from the present day development of powerful muscles as a result of vigorous and continuous exercise of the muscles, but the inheritance of such acquired characteristics did not appear convincing.

Charles Darwins Theory

Charles Darwin in his own theory referred to as, Theory of Natural Selection proposed that the population of most .organisms for one reason or the other remains constant over a given period in spite of the large number of offspring being produced, e.g. A cod fish produces over seven million eggs while an oyster produces about sixteen million eggs. If all these are to survive and progressively reproduce, their population will increase geometrically. In spite of this seemingly increase, the population of cod or the oyster over a given period remains same or fairly constant. He then argued that some of the offspring do not survive because there is always a struggle for existence, in the population of any given organism. Those that survive must ha-.e certain characteristics which give them advantage over the others (Natural selection) According to Darwin these characteristics or variation are passed on to their offspring. Darwin could not explain how this theory of Natural Selection is achieved. This rendered his theory unacceptable at that time. Thanks however to the monumental work of Gregor Mendel - an Austrian monk whose work on inheritance gave support to Darwins theory of Natural Selection.

Modern Theory of Evolution (New Darwinism)

In these latest theories, Gregor Mendel and others have shown the existence of hereditary characteristics - the genes and the chromosomes in the cell of living organism They have now successfully explained the process of Natural selection by means of genes and gene mutations. You will study the details of this mechanism in a later course.

ASSIGNMENT

1. Name two scientists whose work on the origin of life formed the basis of our present day scientific knowledge of the Origin of life (Organic evolution).
2. State the theories of these two scientists
3. Give one evidence in support of theory of common ancestry in organic evolution
4. State the environmental factors which account for structural changes in an organism.

SUMMARY

In this unit, you have learnt that:

- The origin of life has been explained from two main views namely
    i. Special Creation by God in which by his words Living Things came into being,
    ii. Organic evolution as explained by scientists like Lamarck and Darwin.
- Evidences abound in support of theories of Evolution. These evidences as given here are mainly based on structural changes from age to age.
- These evidences give support to common ancestry. This is to say that the present day chordates for example have come into existence as a result of modifications and elaboration of structures of the primitive chordates which were in existence many thousands of years ago.
- Two main theories of Evolution are those of Larmarks and Charles Darwin while the Larmarckian theory is based on the principle of
    a) Use and Disuse
    b) Inheritance of Acquired characters

Darwin's theory is based on the Theory of Natural Selection which is dependent on the principle of 'Survival of the Fittest'. The Neo Darwin theory especially those of Greggor Mendel on genes and chromosomes and gene mutation have given further insight into Darwinian Theory of Natural selection.

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UNIT 2: CELL TYPES AND FUNCTIONS

INTRODUCTION

In Unit 1, you studied the various theories on the origin of life. In that unit, you learnt that living organisms may have originated from non-living atoms and molecules which organized themselves into minute protoplasm the cell. These cells became life and are able to carry out simple functions of maintenance of life as in unicellular organisms and plants and animals. These cells today constitute the building blocks of present day plants and animals. In this lesson, you will be studying more about this unit of life - the cell, you will be exposed to the various types and the functions associated with each type.

OBJECTIVES

At the end of this unit, you should be able to:

- define a cell;
- differentiate cells into plant or animal cell;
- list the characteristics of animal and plant cells;
- state the general activity carried out in a cell;
- list the different types of plant and animal cells;
- state the functions of each type of cell; and
- draw diagrams of the various cells.

THE CELL

A cell is the simplest functional unit of a living thing. While some organisms are. unicellular e.g. Amoeba, Paramecium and are capable of carrying the processes of life such as respiration, irritability, excretion, other organisms are multicellular.

In such multicellular organisms, cells are highly specialized for specific functions. In such multicellular organisms, the cells form the basic universal building blocks. Such cells are subject to multiplication, giving rise to new cells. Each cell contains the materials which are responsible for continuity of life (These form the cell Theory).

Observing Plant and Animal Cells

ACTIVITY 2

Peel off a very thin piece of onion from the inner side. Put this on a microscope slide and put a drop of methylene blue as well as a drop of water over the onion piece. Put a cover slip over it and observe it under the lower power of the microscope (Your Study Centres will arrange to provide the microscope; the slide and, the stain). Draw what you observe and label any parts you can observe. (You may refer to the drawings in this unit).

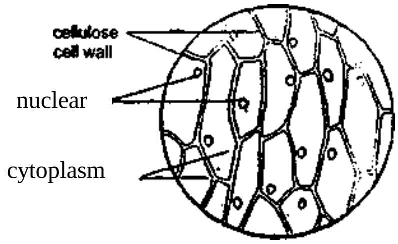

Fig. 3.1: Plant cells from onion leaf.

ACTIVITY 3

Scrape part of your cheek with a blunt material. Spread the scrappings on a slide! Put a drop of methylene blue, and cover it with a cover slip and view it under a low power. Draw what you observe and label.

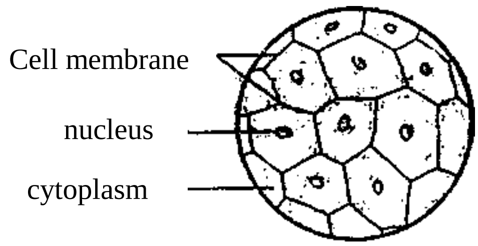

Fig. 3.2: Animal cells from cheek lining

Focus a single cell from (a) the onion cell (b) cheek cells under a high power and observe the details of the cells from each one. Alternatively, your teacher at the study centre will help provide you with prepared slides of both types of cells. Draw the details of each and label. Make a reasoned comparison of both the plant cell and the animal cell.

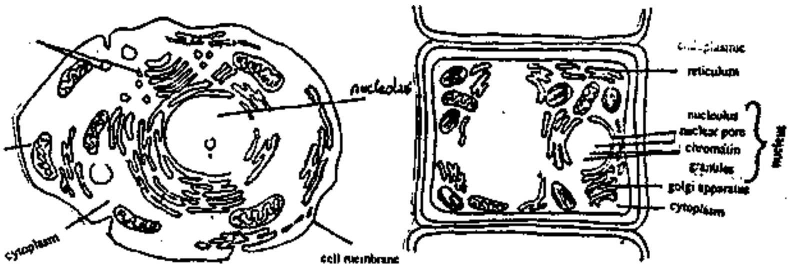

Fig. 3.3: structure of plant and animal cells.

Did you observe the following?

1. The limiting layers of each cell differ. For example the plant has a thick cellulose cell wall which of course accounts for the strength and definite shape of plants while the animal cell wall is a thin membrane which accounts for the softness and flexibility of animals.

2. Plant cell contains pigmented bodies - the chloroplasts which is responsible for the green nature of plants and are important for photosynthesis. Animal cells do not show any such bodies.

3. Plant cells contain large spaces called vacuoles which contain the cell sap. Vacuoles if present in animal cells are small. The vacuoles contain food materials and can be used for purposes of excretion.

4. Centrioles are absent in plant cells, but are present, in animal cells.

5. Granules which act as food storage are present in plants as starch granules and in animal cells as glycogen granules.

6. The cytoplasm in plant cell is limited along the cell walls and is less dense while in animals cells they are very dense and covers very large areas of the cell. They are glandular in animals.

7. The nucleus - is present in all cells. It coordinates many life activities.

Properties of cells in general

Size: Cells are of different sizes ranging from large cells of ostrich egg (about an orange size) to cells which can only be seen by means of a microscope (0.001mm).

Shape: Cells are of different shapes ranging from non-rigid irregular shapes of unicellular organisms such as Amoeba to rigid definite shapes of diatoms and many plant cells.

Chemical activity: Cells carry out the fundamental chemical activities of living things. The activities of the cell can be appreciated by studying the functions of each

a) **The cell wall** which contains cellulose and allows the passage of water and mineral salts in and out of the plant cell by osmosis or diffusion is specially important because it is responsible for the rigidity of the plant and gives it definite shape.

b) **The cell membrane** in animal cell allows selective passage in and out of cell.

c) **The cytoplasm-**is the area in which metabolic processes (building up and breaking down) occur.

d) **The Nucleus**; It stores the hereditary characteristics of any organism – the genes, the chromosomes. Gene mutations occur here. It controls all the cell activities**.**

e) **Vacuoles -** In plant cells, the vacuoles contain cell sap, which maintain turgidity. It also stores excretory products.

There are other parts of a cell which can only be observed with high magnification microscopes that you may not have observed. These include.

i. Mitochondria: These contain enzymes for respiration because it acts as a centre for respiration, so it is an energy source for cell metabolism and cell processes,

ii. Endoplasmic reticulum: This takes care of storing, and transporting proteins. It is also involved in the exchange of materials between the nucleus and cytoplasm.

Specialization of cells and attached function:

A collection of specialized cells are grouped together as Tissues e.g. muscle tissue, Epidermal tissue etc. Different tissues form an organ e.g. Lungs, the Gonads. The organs form the system e.g. The Digestive, the Respiratory systems. The different systems work harmoniously to form the organism. You can therefore appreciate the fact that cells form the basic unit of every living organism.

You will now study the specialized types of cell and their various functions. You will study them as they occur in animals and then in plants.

1. **Epithelial Cells**: These are cells which line the surface of the body -the skin and some organs. They are mainly protective in nature. They are in a process of active division, the new ones replacing the old. They may contain some pigments.

2. **Glandular cells:** These are cells found in many glands e.g. the endocrine glands and the exocrine glands. Their main-function is the secretion of juices or e.g. hormones. Some secrets mucous. The glandular cells are found in the adrenal glands, the ovaries etc.

3. **The white blood cells**: These are cells found in the blood. The white blood cell possess nucleus which are differently shaped. The cells are amoeboid in shape and in motion enabling them engulf the foreign body. The cells are responsible for defending the body against germs and foreign bodies which attack the body. The white blood cells are produced in the bone marrow and in lymph nodes.

4. **Red blood cells:** These are also constituent of blood. They are biconcave in shape and are carried in blood plasma. They contain the red pigment-Haemoglobin (an iron containing substance) which is responsible for transportation of oxygen. It has no nucleus. They have a short life period (about 120 days). The red bone marrow is the factory" from where they are produced. Expired red blood cells are broken down in the liver and used in the formation of bile.

5. **The Nerve cell (the Neurone):** This is highly specialized with series of elongated nerve endings. They are used for transmitting messages as electrical impulses from various stimuli-e.g. of touch, sound, heat to the Central Nervous System.

6. **Spermatozoa cells:** The cells have each an extended tail. The cells are mobile and energetic. The sperm cells contain haploid (half) number of chromosomes which bear the hereditary characteristics.

7. **Muscle cells**: These are flat like elongated cells capable of movement, contraction and extension. These cells form the different types of muscles in animal body. The cells respond to electrical impulses as a result of any given stimulus. Like sperm cells, they are energetic.

These specialized cells mentioned above occur in animal’s gene rally. However there are a number of other specialized cells which occur in some animals lower than the animals which need to be mentioned. They include.

a) **The chromatophores:** These cells are present in amphibians and reptiles. The cells contain pigments which enable the animal to change its colour by altering the concentration of the pigments. This is typical of chameleons.

b) **The Flame cells**:-found in flatworms. They are osmo-regulators

c) **The stinging cells (Nematoblast) -** found in sea anemones, jelly fish and hydra. The cells have elongations which contain toxic liquids which are injected into their prey.

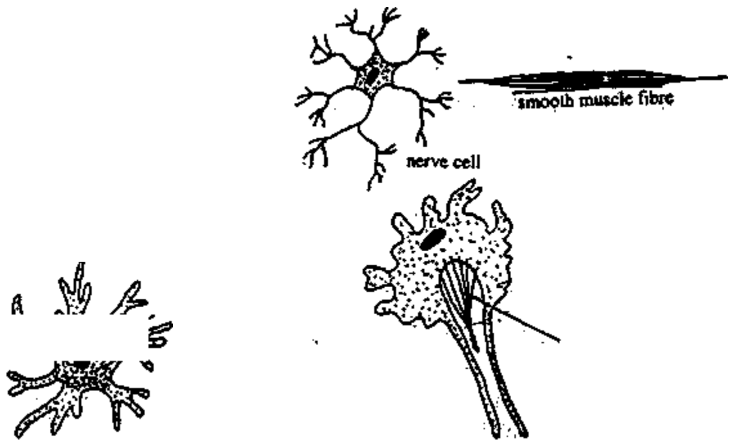

Fig. 3.4

PLANT CELLS

1. Parenchyma Cells: These are loosely but closely packed round cells with air spaces between the cells. Cells are found in the cortex and pitch tissues.

Uses;

i. Filling up of spaces between tissues
ii. Supporting cells of the tissues of plants by absorption of water
iii. Act as food and water storage cells
iv. Help in the conduction of gases and water
v. Divide actively to form cork across any injured part of the plant, so has a protective mechanism
vi. Form the parking tissue.

2. Collenchyma:- These are elongated cells which are thickened at the corners. Functions include:

i. providing strength and support for the young stem
ii. transportation of soluble food materials from one part of plant to another.

3. Epidermal cells: These have waxy cuticle and prevent excessive loss of water from the plant.

4. The xylem and phloem cells: These along with the cambium make up the vascular tissues whose function is the transportation and conduction of water, salt, and food in the plant.

   The xylem cells have lignified cell wall which provide support and strength, to the vascular tissue. The Phloem cells have no lignified walls but possess dense cytoplasm which form the sieve tubes, for the transportation of food manufactured by the leaves and stored in the storage organs.

5. Cambium cells form the cambium tissue. The cell is thick walled. It is found between the xylem and phloem cells. The function is the production of cells which can form either the

phloem or the xylem cells. There are many more specialized cells. You may discuss more of these in later studies.

ACTIVITY 4

Ask your teacher at the study centre to show you permanent slides on these variously named kinds of cells - Mount each one of the microscope. View the cells and draw them and compare with what you have in the course book.

ASSIGNMENT

1. What is a cell?
2. Compare and contrast a typical plant cell from an animal cell.
3. Name any 3 important parts of any cell and state the functions of the parts named.
4. State the cell theory
5. List 4 different types of cells stating whether it is found in an animal or a plant. Give the functions of such cells.

SUMMARY

In this unit, you learnt that:

- A cell is the most fundamental unit of any living organism.
- In unicellular organisms, the cell carries out all the life processes while in multicellular organisms, the cells have become specialized to carry out specialized function for the benefit of the organism.
- A cell undergoes division to multiply itself.
- Living organisms can be divided into plants and animals, so the cells of plants and animals although containing similar parts, can be distinguished especially on the basis of their cell wall, cell membrane and the presence of some plastids (chloroplasts) which are absent in animals.
- Although every cell carries on the chemical activities which keep its life going, yet there are different types of plant and animals cells. These cells have become specialized in other to carry on specific functions for the overall survival of the organism.

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UNIT 3: PHOTOSYNTHESIS

INTRODUCTION

Photosynthesis is the process by which carbohydrates or sugars are manufactured in the green parts of the plants containing chlorophyll by combination of carbon (IV) oxide and water with the aid of radiant energy of sunlight while oxygen is given out as a by-product. It is a very important process which provides food not only for green plants but also for all animals and other plants which lack green pigments. The green pigments called chlorophylls when concentrated into structures are known as chloroplasts. The chloroplasts are disc-shaped in most plants, spiral in Spirogyra and star-shaped in *Zygnema*. Chlorophylls are the only structures capable of trapping the sun energy or other form of light energy. Chloroplasts are also present in very young parts of stems and herbaceous plants enabling them to carry out photosynthesis. All organs of plants with chlorophylls are green in colour.

Carbon (IV) oxide and water are inorganic compounds (raw materials). During photosynthesis, these inorganic compounds are converted into organic products which are stored in plants and used as food. This type of nutrition in which inorganic compounds are converted into organic compounds is known as holophytic nutrition. Holophytic nutrition is only possible in green plants.

The first stable product of photosynthesis is a simple sugar (glucose). The reaction is represented by a chemical equation.

$$6CO_2 + 6H_2O \xrightarrow[\text{chlorophyll}]{\text{Light}} C_6H_{12}O_6 + 6O_2 \text{ (a)}$$

Aquatic green plants obtain carbon (IV) oxide from dissolved air in water by diffusion. In terrestrial green plants, water is absorbed from the soil by the root hairs. The absorbed water moves up the xylem to the leaves. Carbon (IV) oxide from the atmosphere diffuses into the leaves through the stomata to the mesophyll layer. The oxygen formed as a by-product diffuses out of the leaves through the stomata.

Mechanism of photosynthesis
The mechanism of photosynthesis is complex. It involves series of enzymes present in the plant. Two reactions called light and dark are Involved:

A. Light reaction: It is called light reaction because it occurs only in the light. In the light reaction, four steps are Involved:

Step 1

Chlorophyll is energized; The chlorophyll molecules absorb the sunlight energy and become energized.

Step 2

Photolysis of water: The energized chlorophyll supplies the energy (sunlight energy) that split the water molecules into hydrogen (H^+) and hydroxyl (OH^-) ions. This is called photolysis of water. The hydroxyl ion (OH -) gives up its negative electron to the chlorophyll molecules and forms water and oxygen. The oxygen's given out as a by-product.

$$4(OH^-) \rightarrow 2H_20 + 0_2$$

Step 3

Hydrogen is transferred by NADP (Nicotinamide-adenine dinucleotide phosphate)

The hydrogen atom (H_2) released above is immediately picked by a coenzyme called NADP in order to prevent its escape from the cell or recombining with oxygen to form water. NADP is now reduced to $NADPH_2$ having accepted hydrogen atoms ($2H^+$) and serves as an electron carrier of hydrogen ions.

Step 4

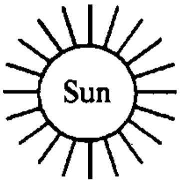
Formation of ATP (Adenosine triphosphate)

Chloroplasts contain ADP (Adenosine diphosphate, an energy carrier). The extra energy hot used in the spliting of water molecules by the energized chlorophyll is released to ADP to form ATP which will be used in dark reaction. All these events take place in the grana of the chloroplasts.

B. Dark reaction: (Calvin cycle):

It is called dark reaction because it does not 'require light energy. Carbon (IV) oxide is reduced by combining with two atoms of hydrogen provided by a coenzyme (NADP H_2) to form sugars after undergoing a series of step wise reactions. Each step is controlled by a specific enzyme. The energy needed for the formation of sugars is provided by ATP from light reaction. These events take place in the stroma of the chloroplasts. The production of glucose is not the end of photosynthetic activities. Some organic compounds at the 3-carbon sugar stage (phosphoglyceric acid) PGA, are set aside for the synthesis of fats, oil, proteins and numerous carbohydrate derived substances.

Light Reaction



↓

Sunlight energy

↓

Trapped by chlorophyll molecules

↓

Energies chlorophyll known energy carrier supplies energy to spit water and the extra energy is given to ADP.

$NADPH_2$

To be used in dark reactions

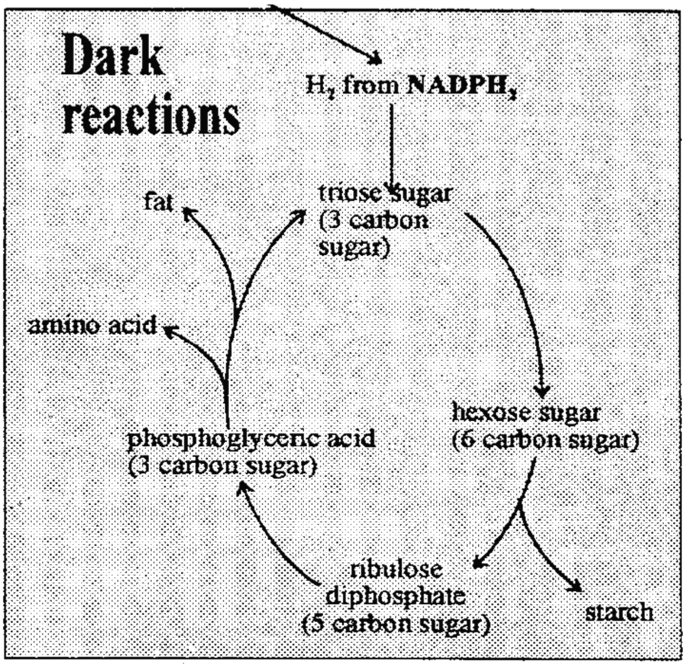


Figure 6.13. The light and dark reactions in photosynthesis

Add equations (a) and (b).

$$12H_20 \xrightarrow[\text{chlorophyll}]{\text{Light}} 12H_2 + 60_2 \text{ (a)}$$

$12H_20 + 6C0_2 + 12H_2 \quad \rightarrow \quad 12H_2 + 60_2 + C_6H_{12}0_6 + 6H_20$

$12H_20 - 6H_20 + 6C0_2 = C_6H_{12}0_6 + 0_2$

$6H_20 + 6C0_2 = C6H_{12}0_6 + 60_2$

Factors which affect photosynthesis is affected by the following factors:

1. Light intensity: Light is necessary for photosynthesis to take place. The rate of photosynthesis increases with moderately high light intensity while the rate is decreased with low light intensity. Very high light intensity reduces-the rate of photosynthesis as chlorophyll is bleached and enzymes denatured.

2. Carbon (IV) oxide: Carbon (IV) oxide is a necessary raw material in photosynthesis. The more carbon (IV) oxide in the photosynthetic cells the faster the rate of photosynthesis.

3. Water: Water is an essential raw material for photosynthesis.

4. Temperature: The light and dark reactions are controlled by enzymes. Low or high temperature will negatively affect enzyme acting hence decrease in the rate of photosynthesis.

5. Chlorophyll concentration: The reduction of chlorophyll level decreases the rate of photosynthesis High light intensity, mineral deficiency diseases and ageing processes reduce chlorophyll concentration.

6. High concentration of oxygen: High concentration of oxygen in the atmosphere decreases the rate of photosynthesis. It has been shown that oxygen competes with carbon (IV) oxide for

active site in the carbon di fixing enzyme (carboxylase) thus reducing the amount of carbon (IV) oxide, thereby decreasing the rate of photosynthesis.

7. Inhibitors: Herbicides such as DCMU (dichlorophenyl diamethyl urea) inhibits the electron flow of the chloroplasts thereby decreasing the rate of photosynthesis.

8. Pollution: Gases and materials of industrial wastes discharged into the atmosphere affect the rate of photosynthesis. Sulphur dioxide and ozone for example damage the leaves of plants. Soot and dust particles block the stomata slowing down the rate of exchange of gases thus decreasing the photosynthetic rate. Soot and dust particles also reduce the intensity of sunlight, hence photosynthetic rate is reduced.

The fate of glucose after photosynthesis

Glucose is the first stable product of photosynthesis. It is used by all living cells for respiration during which energy is liberated. In the presence of sunlight, the glucose in the leaves is quickly converted to starch. This can be proved by testing a leaf for starch. In the dark (where there is no light) photosynthesis stops and starch in the leaves is converted to sucrose (a complex sugar) and translocated out of the leaves to other parts of the plant through the phloem vessels. If present in excess, the sucrose may be reconverted to starch and stored in some of the storage organs in the plant for later use (e.g. underground stems, root tubers and seeds). If not, the sucrose is converted into glucose and used by the living cells for respiration, or used as a starting material for the synthesis of cellulose, proteins, fats, oils and other structural components of the living cells. The synthesis of proteins, fats and oils, for instance, involves the absorption of mineral salts such as nitrates, sulphates and phosphates from the soil which are incorporated into organic compounds with the help of enzymes. Starch, proteins, fats and oils are complex organic matters stored ID the plant body as food.

The importance of photosynthesis in nature

1. An living things require energy for growth and other metabolic activities. It is through photosynthesis that the energy of the sun is converted into useful energy stored in glucose which both plants and animals use during respiration.
2. Glucose, a product of photosynthesis is a starting material for the synthesis of proteins, fats, oil and vitamins which are various forms of food for both plants and animals.
3. Animals and non green plants which cannot manufacture their own food depend on green plants for their food.
4. Oxygen which is a by-product of photosynthesis is necessary for aerobic respiration.
5. Photosynthesis purifies the atmosphere by the constant removal of carbon (IV) oxide.

Experiments on photosynthesis

The occurrence of photosynthesis in plants can be shown by experiments. The easiest proof that photosynthesis has taken place is to test for the presence of starch in the green leaves Experiments should be carried out to show the importance of carbon (IV) oxide, sunlight energy and chlorophyll in photosynthesis. There is need to prove that oxygen is given off during photosynthesis.

Testing a leaf for starch

The usual laboratory test for starch is to bring the testing substance in contact with iodine solution. A blue-black colour confirms the presence of starch. With the green leaf, the test is not so straight forward. Green leaves contain chlorophyll which blocks up the reaction of iodine with starch. Steps are therefore taken to remove the chlorophyll from the leaf before bringing it in contact with iodine.

The following steps must be carried out:

1. The leaf to be tested is detached from the plam after 4-6 hours of exposure to light and put into boiling water for about 10 -15 minutes. This kills the protoplasm of leaf and stops all enzyme activities in the cells. Boiling will also make iodine more easily permeable to starch granules at the time of test.

2. The boiled leaf is put into 70% boiling ethyl alcohol or methylated spirit. This is done to extract the chlorophyll from the leaf. The alcohol is heated to a boiling point in a water-bath to avoid inflammation. When the chlorophyll is completely removed, the leaf becomes white and brittle. It is then dipped into hot water to soften the tissues.

3. The bleached leaf is spread out on a flat surface such as a white tile and few drops of iodine solution are added. It is then allowed to stand for it few minutes. The iodine solution is washed off in cold water. The colour of the leaf can now be observed against a light source.

   (1) If the tested leaf appears bluish-black in colour, it contains starch.

   (2) If the colour is yellowish-brown, it contains no starch.

ASSIGNMENT

Read through the unit again and jot down the major points.

SUMMARY

In this unit, you learnt about:

- Mechanism of photosynthesis;
- Factors which affect photosynthesis; and
- The importance of photosynthesis in nature

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UNIT 4: RESPIRATORY, EXCRETORY AND CENTRAL NERVOUS SYSTEM

INTRODUCTION

You have learnt that a group of organs performing the same function is referred to as a system. There are several systems in the human body, for example, the digestive system (concerned with digestion of food), the circulatory system-(concerned with blood circulation) and many others. In this module, we shall examine three of these systems in man. These are: the respiratory system, the excretory system and the central nervous system.

OBJECTIVES

By the end of this unit, you should be able to:-

l explain the term system;

2. distinguish between external respiration and internal (or cell) respiration;
3. list in sequence the organs that make up the respirator.-system of man:
4. mention the excretory organs of the human body and the waste products they excrete.
5. name the parts that make up the central nervous s\stem of man: and
6. distinguish between voluntary and reflex (involuntary) actions.

BREATHING

You are breathing all the time, though you do not normally take notice of it. For you and I, we all began breathing immediately we were born, and from that moment to this, we have never stopped. However, we may decide occasionally for one reason or the other to hold our breath for sometime, usually a few seconds. Note that once breathing stops, life stops.

ACTIVITY 5

To appreciate the importance of breathing to sustain life, pinch your nose between finger and thumb. What happens after about three seconds?

Place your hands (with the fingers spread out) -the thumb below the breast at the side and the other fingers in front of the chest.

Then, breath slowly and deeply. What happens at the sides and front of the chest?

NOTE: Breathing involves two activities, breathing-in activity called inhaling and a breathing-out activity called exhaling. We inhale the air around us and exhale among other things, the gas-carbon (IV) oxide and some water vapour. Breathing is only the start of the process of respiration. Biologists regard respiration as made up of two activities namely external respiration and internal (or cell) respiration. External respiration otherwise termed breathing, refers to the exchange of gases between the atmosphere and the blood. Internal respiration means the chemical reactions in which energy is released within the cells for the maintenance of life activities.

The organs that make up the respiratory system of man are shown in Fig. 6.1

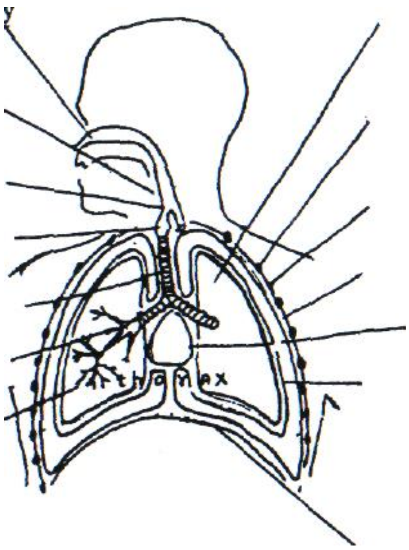

Fig 6.1: The respiratory system of man.

The organs include the nostrils, trachea (or wind-pipe), the bronchus (right-and-left) which divide into smaller branches termed bronchioles. These terminate into air sacs or alveoli (singular-alveolus) in the lungs. The associated structures are the ribs, the intercostal muscles, the diaphragm, the pleural membranes and the pleural cavity.

EXCRETORY SYSTEM OF MAN

In studying the general characteristics of Irving organisms earlier, we noted that excretion is the process by which harmful products are removed from the body. In man, the excretory organs are the lungs, the liver, the skin and the kidneys.

ACTIVITY 6

Examine the lungs, liver and kidneys of cow, sheep or goat when next you go to the market to buy meat. This will help you to have a good idea of how your own looks like. Note particular features of each of these organs.

The lungs excretes (that is get rid of) carbon (IV) oxide and water vapour produced during respiration. The liver produces urea from protein materials taken in during feeding. This soluble substance is carried in the blood to the kidneys. The liver excretes bile pigment formed when red blood cells break down. The kidneys excrete urea in the form of urine - a yellow - coloured liquid containing urea, some water and mineral salts. The kidneys do not only excrete urine but also get rid of excess water and salts. This keeps the concentration of the blood constant. The kidneys are regarded as the main excretory organs of man. This is why the excretory system in man is always associated with the kidneys (fig.6.2).

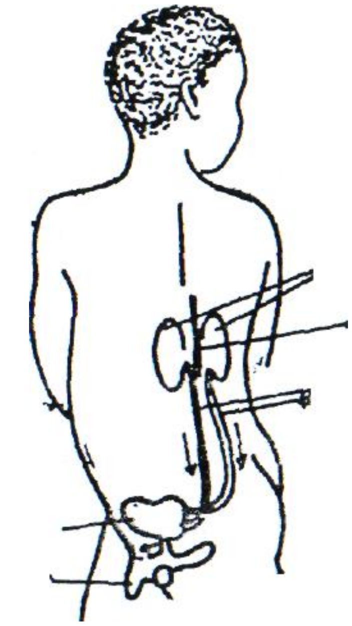

Fig. 6.2

The skin gets rid of water in the form of sweat. When we perspire (that is. sweat), small amounts of waste materials are excreted in the sweat.

ACTIVITY 7

Taste your perspiration. What does it taste like?

THE CENTRAL NERVOUS SYSTEM OF MAN

In man, the central nervous system consists of the brain and spinal cord as shown in fig.6.3

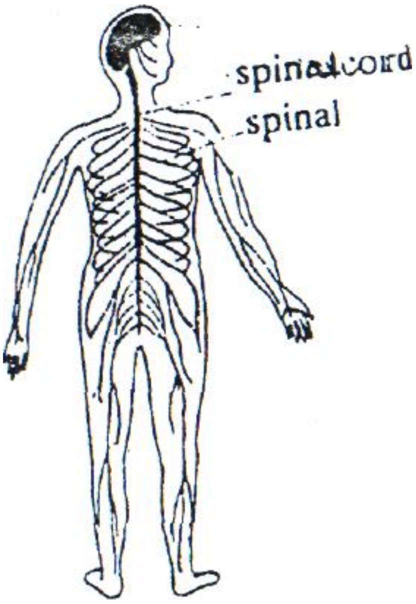

Fig 6.3: The Central Nervous System.

Both the brain and spinal cord consist of a mass of nerve cells which carry impulses (that is messages) from one part of the body to another. To appreciate the importance of the functions of the central nervous system in man, let us carry out some activities.

ACTIVITY 8

1. Move out from a relatively dark room to the outside which is brightened by the sun and attempt to look at the sun.
2. How did your eyes react to this?
3. Did you decide on the way your eyes should react?
4. Leave your reading table in the room and retire to bed.
5. Are you conscious of your decision or what you have now done?

In voluntary (or reflex) action is a rapid, automatic response to a stimulus by an organ or system of organs that does not involve the brain. It is carried out by the spinal cord. Sneezing is an example. Accidentally grasping something hot and dropping it at once is another. Voluntary action, on the other hand, is one carried out by the brain. In other words, it is done consciously. Deciding to study is an example. Taking a seat instead of standing is another.

ASSIGNMENT

1. What do you understand by the term system?
2. Distinguish between external respiration and internal (or cell) respiration.
3. Apart from the associated structures, list in sequence the organs that make up the respiratory system of man
4. What are the excretory organs of the human body?
5. What waste products do they excrete?
6. What organs make up the central nervous system of man?
7. Explain, giving an example, the difference between voluntary and reflex actions.

SUMMARY

In this unit you learnt that:

- A system is a group of organs performing the same function.
- There are several systems in the human body. These include the respiratory, excretory and central nervous systems.
- Breathing is very important for once breathing stops, life stops.
- Breathing involves two activities: a breathing-in activity called inhaling: and a breathing-out activity called exhaling.
- We inhale the air around us and exhale among the things carbon (IV) oxide and some water vapour.
- Breathing is only the start of the process of respiration.
- Biologists regard respiration as being made up of two activities namely external respiration and internal (or cell) respiration. The former, otherwise termed breathing, refers to the

exchange of gases between the atmosphere and the blood. The latter refers to the chemical reactions in which energy is released within the cells for the maintenance of life activities.

- The respiratory system of man is made up of the following organs in sequence nostrils (openings of the nose), trachea (or wine pipe), bronchus (right-and-left), bronchioles, air - sacs (alveoli), intercostal muscles, diaphragm. Pleural membranes and pleural cavity.
- The excretory organs of man are the lungs, the liver, the skin and the kidney.
- The kidneys are regarded as the main excretory organs of man, hence they are always associated with his excretory system.
- The lungs excrete carbon (IV) oxide and water vapour produced during respiration.
- The liver produces urea from protein materials.
- Urea is excreted by the kidney as urine which consists of urea, some water and mineral salts.
- The liver excretes bile pigments formed when red blood cells breakdown.
- The kidneys, in addition to excreting urine, get rid of excess water and salts so keeping the concentration of the blood constant.
- The skin gets rid of water in the form of sweat.
- When we perspire, small amount of waste materials are excreted in the sweat.
- The central nervous system of man consists of the brain and spinal cord.
- Involuntary (or reflex) action is a rapid, automatic response to a stimulus by an organ or system of organs. It does not involve the brain. It is carried out by the spinal cord. Sneezing is an example.
- Voluntary action is one carried out by the brain. In other words, it is carried out consciously. Deciding to seat down instead of standing is an example.

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UNIT 5: SYSTEMS: DIGESTIVE AND CIRCULATORY

INTRODUCTION

The human body consists of several parts. These include the mouth, the nose, the lungs, the stomach, the liver, the brain, the spinal cord. These parts are in fact organs. Organs are numerous units of cells which are grouped together to perform a particular or specific function. For example, in the function of feeding in man. several parts or organs such as the mouth, the teeth, the stomach, etc. come into play. A group of organs performing the same function is referred to as a system. There are several systems in the human body; for example the digestive system (concerned with the digestion of food) the excretory (concerned with elimination of waste products) and many others. In this unit we shall examine two of these systems namely the digestive and circulatory systems.

OBJECTIVES

By the end of this unit, you should be able to:

1. explain the term digestion;
2. describe briefly the digestive system of man;
3. state the composition of the circulatory system of man;
4. distinguish between the arteries, veins and capillaries: and
5. describe briefly blood circulation in man.

THE DIGESTIVE SYSTEM

Digestion is the process by which insoluble food substances are broken down into soluble ones. These materials, in solution, pass through the wall of the intestine and enter the blood stream. Digestion takes place in the alimentary canal which is shown in Fig. 5.1.

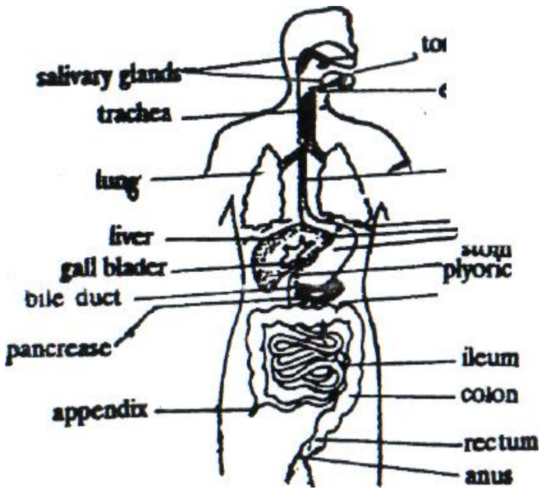

Fig. 5.1: The alimentary' canal of Man.

Digestion is brought about through action of certain chemical compounds referred to as enzymes. The alimentary canal is a muscular tube that runs from the mouth to the anus. To appreciate the changes taking place in the food, it is necessary to consider the digestive processes associated with the various organs of the alimentary canal.

DIGESTION IN THE MOUTH

In the mouth, the food is chewed by the teeth and mixed with saliva. The flow of the saliva is brought about by the sight, smell, taste or thought of food. The saliva is secreted by the salivary glands (three pairs in number) whose ducts lead into the mouth (Fig.5.1). The saliva reduces the food into suitable sizes. The enzyme present in saliva, termed salivary amylase or ptylin acts on starch breaking it down into a simple form termed maltose (a simple sugar). By means of the tongue, the food is 'converted into a round form termed bolus and pushed to the back of the mouth and swallowed. A flap of cartilage called the epiglottis, stops the bolus going down the wrong way into the trachea (wind pipe).

Swallowing is made possible by the wave-like (squeezing and relaxing action of the muscles of the gullet/oesophagus). This wave-tike motion which moves the food through the alimentary canal is called peristalsis.

DIGESTION IN THE STOMACH

Peristalsis carries the food into a muscular bag called the stomach. The food is held in the stomach because a band of muscle called the pyloric sphincter at the outlet of the stomach is closed. In the stomach, the food is mixed with gastric juice secreted by glands in the stomach walls.

The gastric juice contains hydrochloric acid and the enzymes pepsin and renin. Pepsin begins the breakdown of proteins into simpler substance termed peptides. Renin clots the protein in milk.

While the enzymes are working, contractions of the stomach pound the food into a watery paste called chyme. The chyme may be in the stomach for approximately three hours depending on the type of food eaten. The acid conditions in the stomach kill many of the bacteria which may have been taken in with the food. When digestion in the stomach is complete, the pyloric sphincter relaxes allowing a little chime to pass into the first part of the small intestine called the duodenum. The remainder of the small intestine is called the ileum.

DIGESTION IN THE DUODENUM

The duodenum, in addition to its secretion (the intestinal juice), receives two secretions. The first is pancreatic juice received from the pancreas through the pancreatic duct. The second is the bile received from the gall bladder in the liver through the bile duct. The pancreatic juice contains three enzymes which act on carbohydrates, proteins and fats respectively. The pancreatic amylase breaks down starch into maltose. Trypsin breaks down proteins to peptides. and peptides to soluble amino acids. Pancreatic lipase splits fat into fatty acids and glycerols. Pancreatic juice also contains sodium bicarbonate which partially neutralizes the acidic chyme from the stomach. Through this, it creates a suitable environment for the pancreatic and intestinal enzymes to work.

Bile is a green liquid which contains certain salts. These salts cause fats to emulsify (that is, break up into tiny droplets). This allows the fat-digesting enzymes to work. Bile also contains sodium bicarbonate, which neutralizes the acid from the stomach. This helps to produce the alkaline medium needed for digestion in the duodenum. The intestinal juice contains a variety of enzymes. The collective function of these enzymes is to complete the digestion of the various compounds already started by the other secretions. By this stage the insoluble carbohydrates, proteins and-fats in our food are completely broken down to simple and soluble substances. These can be easily absorbed into the blood stream.

ACTIVITY 9

i. Name the contents of the gastric juice and their functions.

ii. What is the function of the sodium bicarbonate contained in the pancreatic juice?

Absorption in the Small Intestine

The whole of the inside surface of the ileum is covered by finger - like projections called villi. Inside each villus is a network of blood vessels and a single lacteal or lymph. The digested food passes into these vessels and is transported to different parts of the body. The large intestine This consists of the colon, rectum and anus. The colon receives water and indigestible material from the ileum. Certain parts of our food are never digested, because we have no enzymes to break down the materials of which they are made. Those materials termed roughage pass through the alimentary canal more or less unchanged. These materials include skins of fruit (cellulose) and vegetable fibres. In the colon, much of the water from the undigested materials is absorbed. leaving a semi-solid waste termed faeces. This is passed into the rectum byperistalses and is expelled at intervals through the anus.

Note: At the point where the ileum joins the large intestine is a small structure called the appendix. This has no function in man. However, in herbivorous (plant-eating) animals, like the rabbit and the horse, the appendix is large and contains bacteria which help to digest cellulose.

CIRCULATORY SYSTEM

The circulatory system of man consists of the blood vessels and the heart (Fig.5.2) Blood flows around the body in these tubular vessels.

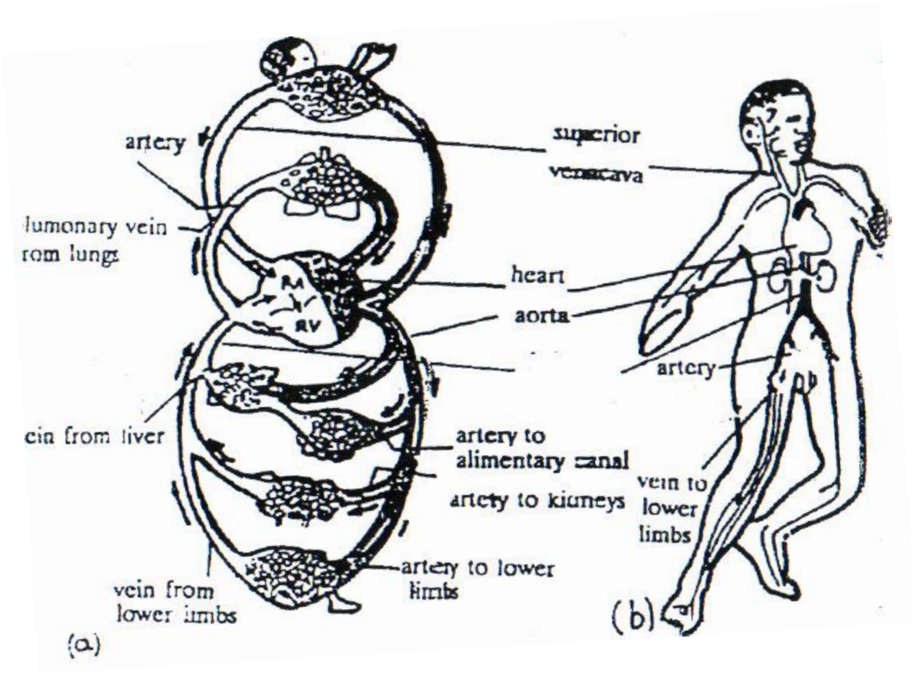

Fig 5.2: The circulatory system of man.

The blood moves continually because of the pumping action of the heart. There are three kinds of blood vessels in your body: arteries, veins and capillaries. Arteries have thicker walls than veins and are more muscular and elastic. Capillaries are very much smaller than either arteries or veins. The muscular heart pumps the blood into a system of arteries. These arteries split up within the tissues into capillaries. Here exchange of materials between blood and cells takes place. From the capillaries, blood is collected up into a series of veins through which it is returned to the heart.

ACTIVITY 10

Name the three kinds of blood vessels.

THE HEART

The heart is divided into four chambers: right and left auricles, and right and left ventricles. (In Fig. 5.1. these are labelled as follows: right auricle-R.A.: left auricle - LA. right ventricle -R.V. left ventricle -L.V.) To appreciate what the auricles and ventricles look like, it is necessary to have an idea of the inside of the heart. Fig. 5.3 shows that the ventricles are larger than the auricle, and have thicker walls. Note the valves between the auricle and the ventricle on each side. These are little doors which close immediately blood begins to flow backwards from the ventricles to the auricles. They help to keep the blood flowing in one direction through the heart.

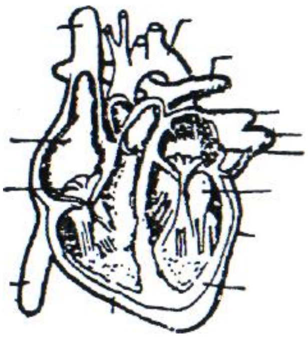

Fig 5.3: The Inside of the heart.

BLOOD CIRCULATION

Arteries carry blood from the heart to all parts of the body. The aorta, the artery into which blood flows from the heart, gives off branches along its length. These are branches to the upper limbs, head, neck, liver, alimentary canal, kidneys and the trunk and lower limbs as seen in Fig. 5.1.

Veins from each of these areas join to form the superior and inferior venae cavae (Singular; vena cava). These large veins carry the blood back to the heart. The lungs have their own circulatory system to and from the heart. The circulatory system derives its name from the fact that blood keeps moving round and round, that is, circulates in the heart.

ACTIVITY 107

Examine afresh animal heart (e.g. cow, sheep or goat) when next you go to market. They are very similar to the human heart. First look at the outside to identify the parts. Feel the parts and note how thick and firm the wall of the ventricle is.

ASSIGNMENT

1. What do you understand by the term digestion?
2. Describe digestion of food in the mouth.
3. Discuss the functions of the intestinal juice, pancreatic juice and bile in digestion.

4. Distinguish between the structure and functions of arteries, veins and capillaries.
5. Describe briefly blood circulation in man.

SUMMARY

In this unit you have learnt that:

- Digestion is a process by which insoluble food substances are broken down into soluble ones.
- Digestion occurs in the alimentary canal which runs from the mouth and ends at the anus.
- Food is digested in the mouth through the action of the teeth and the enzyme ptyalin changes cooked starch to maltose.
- Peristalsis, a wave-like act ion of the muscle of the gullet, ensures swallowing of the food.
- The stomach produces hydrochloric acid and enzymes which act on the food.
- The duodenum receives, in addition to its secretion (the intestinal juice), two other secretions -the pancreatic juice and the bile.
- Absorption of food occurs in the small-intestine through finger-like projections termed villi.
- The large intestine absorbs much of the water from the undigested materials, leaving a semi-solid waste-faeces. This is eliminated through the anus at intervals.
- The circulatory system consists of the heart and the blood vessels: arteries veins and capillaries.
- Arteries carry blood away from the heart; veins return blood to the heart.
- The heart consists of four chambers-the right and left auricles; and the right and left ventricles.
- Blood keeps moving round and round the body with the heart acting as the pumping station.

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UNITS 6: SKELETAL SYSTEM

INTRODUCTION

This unit discusses the skeletal system. It include the function of skeleton, functions of skeleton and structure of a bone. You are expected to follow the discussion as closely as possible.

OBJECTIVES

By the end of this unit, you should be able to:

- define skeletons;
- list functions of skeletons;
- state types of skeleton; and
- describe the structure of skeletons.

What is Skeleton?

The protoplasm is an almost fluid substance in the single-celled organisms like the Amoeba, Euglena and *Chlamydomonas*. The cell membrane, the pellicle and the cellulose cell wall are not firm enough to support the entire cell. A multicellular and complex organism needs a much firmer frame work to support its body and keep it in shape. Examine the land snail, for an example, its shell supports its soft body and gives it the characteristic shape.

Skeleton is, therefore, the hard framework on which the body is built. This hard framework may be made up of sand particles as in Arcellar (a shelled Amoeba), exoskeleton as in insects and snails, cartilage as in the cartilaginous fish, bones and less cartilage in the bony fish and other vertebrates.

Functions of the Skeleton

1. Protection: It gives protection to the delicate organs of the body. For example, the skull protects the brain, eyes and ears. The thoracic bones protect the heart and lungs. The vertebral column protects the spinal cord.

2. Support: The rigid framework of the skeleton gives support to the body. The cervical vertebrae support the head and the bones of the hind-limbs support the upper parts of the body.

3. Muscle attachment: Skeleton provides places for the attachment of muscles.

4. Movement: The movement of certain parts of the body is brought about by the bones when muscles act on them. The contraction and relaxation of the muscles of the legs bring about motion.

5. Manufacture of white and red blood cells The white and red blood cells are manufactured in the bone marrows of the, long bones.

6. Breathing: The thoracic bones aid breathing movement.

7. Shape: Skeleton gives shape to the body.

8. Transmission of sound waves: The three small, soft and light bones found in the middle ear (malleus or hammer, incus or anvil, stapes or stirrups) vibrate and transmit sound waves from the middle ear to the inner ear.

Types of Skeleton

There are three types of skeleton found in animals and they are:

1. Hydrostatic skeleton
2. Exoskeleton
3. Endoskeleton

1. Hydrostatic skeleton

Hydrostatic skeleton is found in soft-bodied animals, like earthworms, It consists of the body fluid secreted by the body wall and stored in the coelom. The fluid being inside a closed system presses against the muscles (longitudinal and circular) of the body wall. These muscles in turn contract against the fluid. Hydrostatic skeleton is thus constructed on the principles of the combined effects of fluid pressure and muscle contraction in a closed system to maintain the shape and form of the animal. It goes further to perform for the animals, the functions of support, protection and movement.

2. Exoskeleton

Any hard structure which gives shape, and forms the framework of the body of the animals, located externally on the animals constitutes the exoskeleton. The exoskeleton may cover the entire external surface of the body, such as in the insects and many other arthropods where it protects the animal against dessiccation in the dry habitat, or serves as hydrofuge against wetting in aquatic habitat. The shells in the molluscs, tortoise and turtle are also of this type. Tortoise and turtle have both exoskeleton and endoskeleton.

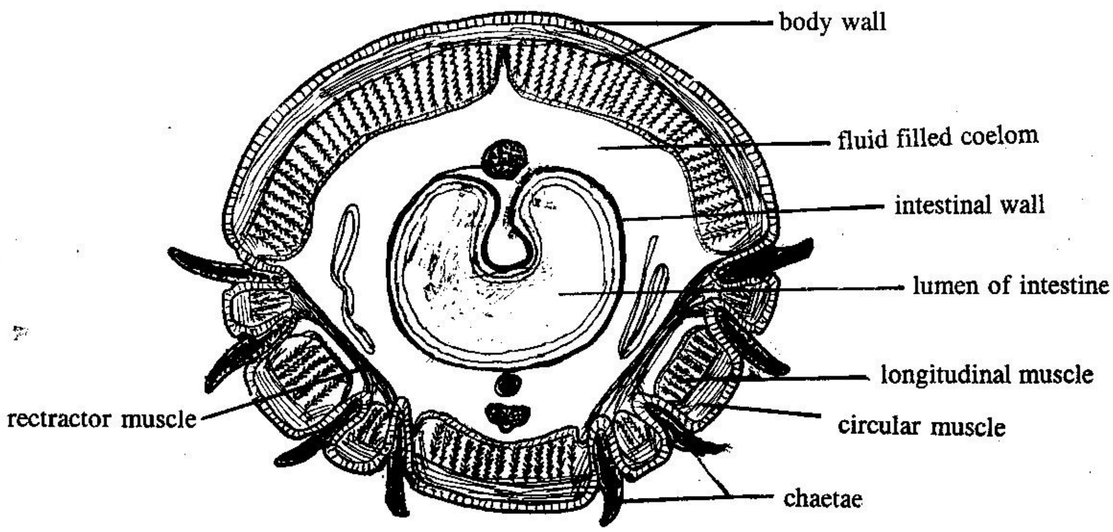


Figure 14.7. Transverse section of an earthworm

3. Endoskeleton

All hard parts of the body found inside the body of the animals (in other words the skeleton that lies inside the body of the animals), on which all the soft parts are built are called endoskeletons. Endoskeletons are found in the vertebrates with very few occurrence in invertebrates such as the corals, (Coelenterata), sepia and octopus. Endoskeletons are made up largely of bone with little cartilage. In the cartilaginous fishes, the endoskeleton is made up entirely of cartilage without bone materials.

Chitin

Chitin is non living and non-cellular and is secreted by the underlying epidermis. It is a protein-carbohydrate compound. It is composed of several different substances. It is really made up of an outer waxy layer, a middle horny layer and an inner flexible layer. These layers are modified among the various arthropods and also among the different parts of the body. In some, the chitin is soft and permeable (aquatic insects) while in others it forms a veritable coat of armour (terrestrial insects). Between joints and segments is flexible and thin to permit free movements. It is harder in crustaceans where it is infiltrated with calcium salts. In general, its structure is admirably adapted for protection of delicate internal organs, for attachment of muscles, for serving as levers and centres of movement, and for preventing the entrance and loss of water.

Although hard protective structures are common among other groups of animals, none has used them so effectively as the arthropods. Chitin in arthropods is used as biting jaws, for grinding in the stomach, as lenses of the eyes, for sound production (e.g. grasshoppers), as sensory organs (antennae and antennules), for coupulatory organs, organs of defence, and for ornamental purposes.

A chitinous exoskeleton limits the size and weight of arthropods. In order to increase in size or grow it has to shed its outer 'Shell at intervals and grows larger. This process is called ecdysis or moulting. The presence of chitin helps arthropods to adapt to different variety of terrestrial habitats.

Cartilage

A cartilage is a tough elastic and semi-transparent tissue devoid of blood vessels and nerves.

Functions of cartilage

1. It prevents friction between two bones and allows smooth and free movement.
2. It absorbs shock between bones. For example the shock resulting from the vertebral bones are absorbed by cartilaginous intervertebral discs.
3. It keeps open the trachea (windpipe) so that air flows into the lungs always. The cartilage of the nose also keeps the nostrils open for in-take of fresh air and output of waste air.
4. The cartilage of the ribs allows contraction and expansion of the thorax, thus enhancing breathing mechanism.
5. It forms cushion in the sockets of bones such as the glenoid cavity of the shoulder and hip sockets.
6. The ear cartilage keeps the pinnae (external ear) erect so as to collect sound vibrations from the air.
7. Cartilage and bone provide the firm areas for attachment of the tendons of the muscles
8. Fibro-cartilage is found in the pubis symphysis where it allows for considerable expansion of the pubis during parturition (child birth) without complete breakage.

Bone

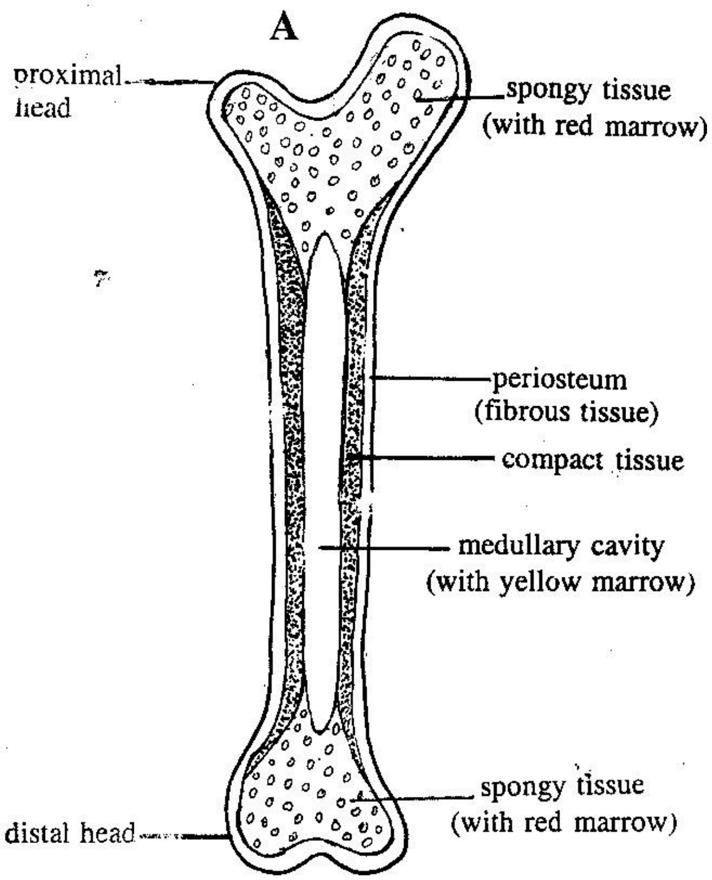
Composition of bone: A fully developed bone is hard and brittle. Bones can break, and a break in a bone is called fracture. The bone is, however, not the hardest substance in the body of man or other mammal. The dentine of the tooth is the hardest substance in the body of a mammal. A bone consists of organic and inorganic materials. The organic materials in a bone are gelatinous and accounts for the tenacity and elasticity of bones. The inorganic components of bone consist of magnesium, phosphorous calcium compounds and other mineral matter which give rigidity arid hardness to bone. The organic matter of the bone is first formed and the laying down of inorganic substances takes place later. The laying down of mineral substances in the bone is called ossification. When bones burn, it is the organic matter that is burnt off, while the mineral salts remain as ash.

The bones of young children are soft and flexible. They are not as brittle as those of the adults. The bones can be more brittle in the very old people. When bones are soaked in dilute acid, the mineral salts in them are dissolved out leaving the organic matter. The three bones in the ears are not ossified. they vibrate to transmit sound waves across the middle ear into the inner ear.

They are the smallest, softest and lightest bones in the body of man. They are called malleus, incus and stapes and are arranged in the inner ear in that order.

The structure of a bone

Each bone has two heads and a shaft in between the heads. The head to the body is called proximal head and the other away from the body is called distal head. A long bone such as the femur of the thigh, the proximal head forms a joint which articulates with the hip bones, ilium, ischium and pubis, while the distal head forms a joint with tibia and fibula as the knee joint with the knee cap keeping them in position. The heads are not ossified and so remain soft throughout. They contain red marrow which manufactures red blood cells, white blood cells and blood platelets. The heads are therefore spongy and not compact so that a lot of capillaries enter them to supply nutrients and remove manufactured blood cells and waste products. The shaft is largely ossified, dense, compact and strong. For this reason, it is hollow at the centre. This cavity contains the yellow marrow which has a rich supply .of blood vessels and fat. In this yellow marrow some white blood cells are manufactured. The shaft has numerous tiny holes called Haversian canals. These canals have blood vessels and nerves which carry nutrients and impulses 'to the cells of the bones respectively. The heads are covered with cartilage while the 'shaft is covered by a tough fibrous tissue called periosteum.



B

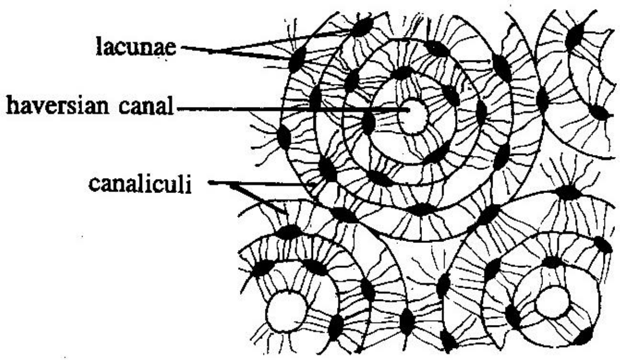


Figure 14.8.

A = Longitudinal section of the long bone of human

B = Transverse section of a compact bone

Kinds of bones

The bones are classified according to their shape and length into four classes.

1. Long bones

The long bones are found in the limbs such as the humerus of the upper arm, radius and ulna of the lower arm in the fore limb. The femur in the thigh and tibia and fibula in the leg and all of the hind limb. The ribs and clavicles are also long bones. The longest of these bones is the thigh bone (femur). All long bones are curved at their shaft in order to give them strength.

2. Short Bones

Short bones are largely made up of spongy tissue covered externally by a thin coat of compact tissue. The bones of the vertebral column, carpals, metacarpals, tarsals, metarsals, phallanges and patella are all short bones.

3. Flat bones

Flat bones are thin and plate -like. A flat bone is made up of two sheets of compact tissue with a narrow layer of spongy tissue in-between. Examples are the bones of the skull, scapula alia ilium.

4. Irregular bones

These bones are peculiar in shape, structure and function. They are the small bones of the middle ear described earlier.

BONES OF THE MAMMALIAN SKELETON

The mammalian skeleton is made up of axial and appendicular skeleton. The axial skeleton consists of skull, vertebral column (backbone) and rib cage (sternum and ribs) while the appendicular skeleton is made up of pectoral and pelvic girdles and the limbs.

Axial skeleton

Skull: The skull consists of two major parts namely the craniwn (brain box) and the facial bones.

Cranium: The cranium is made up of tlar and curved bones firmly fitted together by the saw-like edges called sutures. The main bones making up the cranium are frontal, parietal, temporal and occipital bones. The frontal bone makes up the forehead. The parietal bone consists of top and side walls of the cranium. The temporal bones make up the sides of the cranium while the occipital bone forms the base of the cranium. At the base of the occipital bone exists a large hole called foramen magnum through which the brain joins the spinal cord. The cranium (brain box) encases the brain and protects it.

Facial bones

The main bones of the face are the cheek, nasal and jaw bones. These bones are also fitted together by sutures. The jaw bones are made up of the upper and lower bones. The upper jaw is fused together with the base of the cranium while the lower jaws arc hinged with the cranium so that the mouth can open and close.

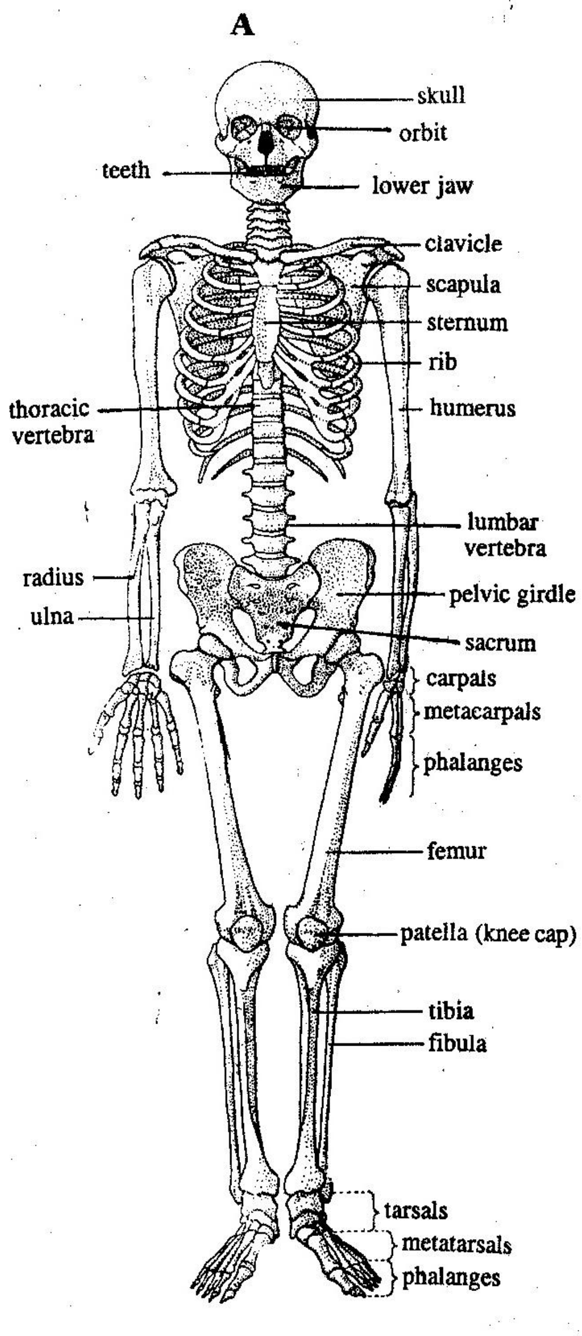


Figure 14.9. Human skeleton

A = Human skeleton

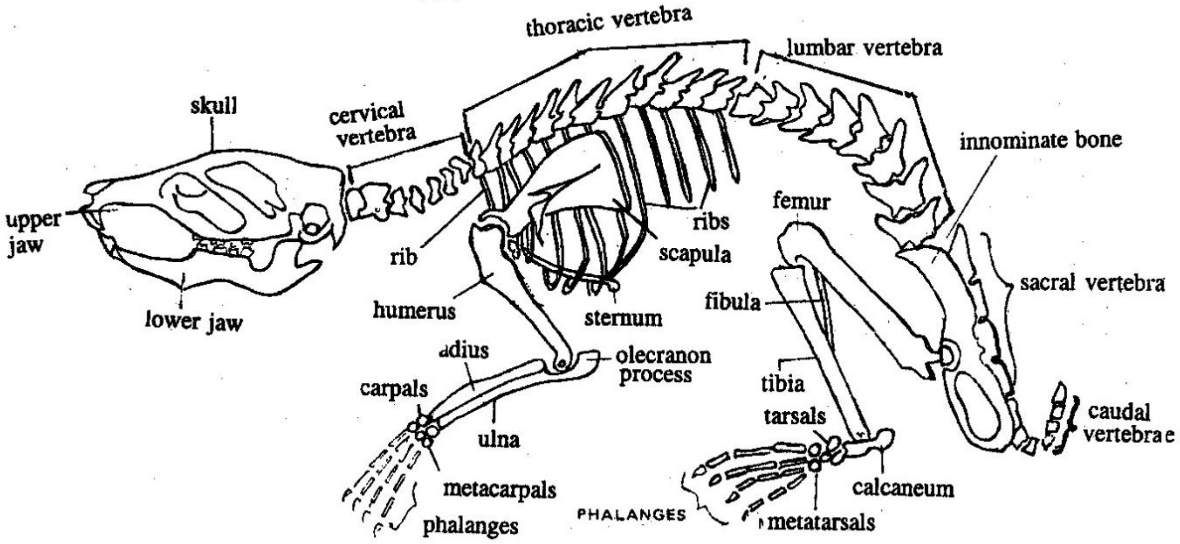


Figure 14.9. Mammalian skeleton

B = Rabbit skeleton.

At birth, some of the bones on the top of the cranium have not yet developed fully. These bones are still connected together by soft fibrous tissues. These soft areas are called fontanelles. When these areas are gently touched with the finger, a pulse beating can be felt. It takes about 18 months for the fontanelles of the top of the head to harden, while those at the back closes up also most immediately. The fontanelles allow movement of the bones of the head so that the head of the baby is properly shaped in order to pass through the pelvic of the mother during delivery.

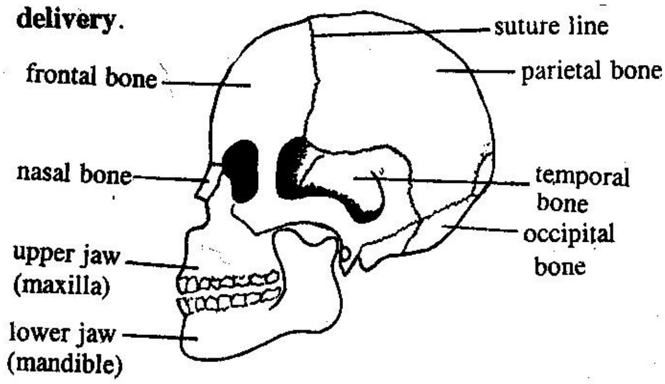


Figure 14.10. Side view of the human skull of man

The vertebral column (Backbone): The vertebral column is also called backbone. It is made up of 33 short bones, each one is called a vertebra (plural: vertebrae).

Common Features of the Vertebrae

1. A fairly wide central hole, the Neural canal is a fairly wide hole of the spinal cord.

2. Neural arch which forms the neural canal. It protects the spinal cord. It provides surface area for the attachment of muscles.

3. Cervical ribs or transverse processes at the sides of the neural arch. These provide surface area for the attachment of muscles. They form articulating facets with the ribs in the thoracic region.

4. The neural spine is also a part of the neural arch. It increases the surface area for the attachment of muscles.

5. Centrum is the thickened base of the vertebra. It forms the main bulk of the vertebra. Centra articulate with one another in the vertebral coloumn (spine) by intervertebral discs.

6. Prezygapophysis is a polished part on the neural arch at the anterior view of the vertebra. There are two prezygapophyses on each vertebra through which they articulate with the vertebra in front of it.

7. Postzygapophysis is a polished part of the neural arch at the posterior view of the vertebra. There are two postzygapophyses on each vertebra through they articulate with the vertebra behind.

There is very little movement at each joint but there is a considerable wide range of movements in the whole column or spine.

The vertebrae are hollow and placed end to end like beads in a string to form a continuous tube through which the spinal cord passes. Each vertebra is separated from the other by a tough fibro-cartilage tissue called intervertebral disc.

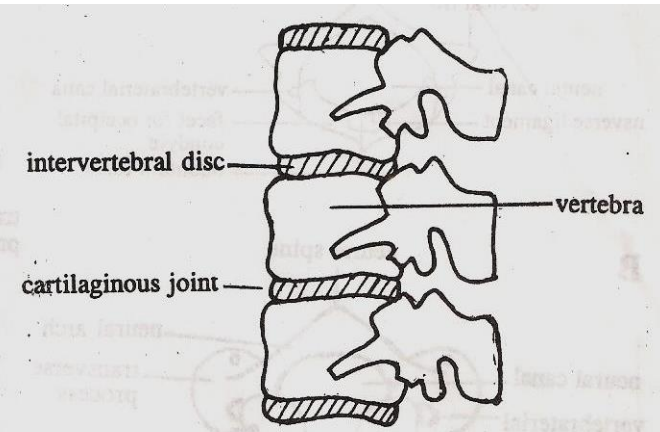


Figure 14.11. A Section of the vertebral column showing gliding joints

Table 51: Distribution of the vertebrae in some mammals

Name of vertebrae	Man	Rabbit	Rat	Where found
1. Cervical vertebrae	7	7	7	Neck region
2. Thoracic vertebrae	12	12-13	13	Thorax
3. Lumbar vertebrae	5	6-7	6	Abdomen
4. Sacral vertebrae	5	3-4	4	Hip
5. Caudal vertebrae	4	16	27-30	Tail
Total	33	44-47	57-60	

Cervical Vertebrae

There are seven vertebrae in the neck region of all mammals whether long as in giraffe or short as in rat.

Characteristic features

1. Presence of transverse process (cervical ribs)
2. Vertebraterial canal on each side.
3. Small neural spine

Functions

Cervical vertebrae

1. Cervical vertebrae give form to (the neck and support the head.
2. The atlas and the axis give nodding and rotating movement to the head.
2. They give protection to the blood vessels particularly the arteries serving the head, by providing holes (vertebrarterial canals) for the vessels to pass through.

Atlas vertebra

The first cervical bone is called atlas. It articulates with the skull on its anterior end and axis on the posterior end. It is ring-like. It has no centrum and no prezygapophyses. It has a reduced or less prominent neural spine. It has rounded and wing-like transverse processes. It has a pair of holes on either sides (vertebrarterial canal) for the passage of blood vessels to the head.

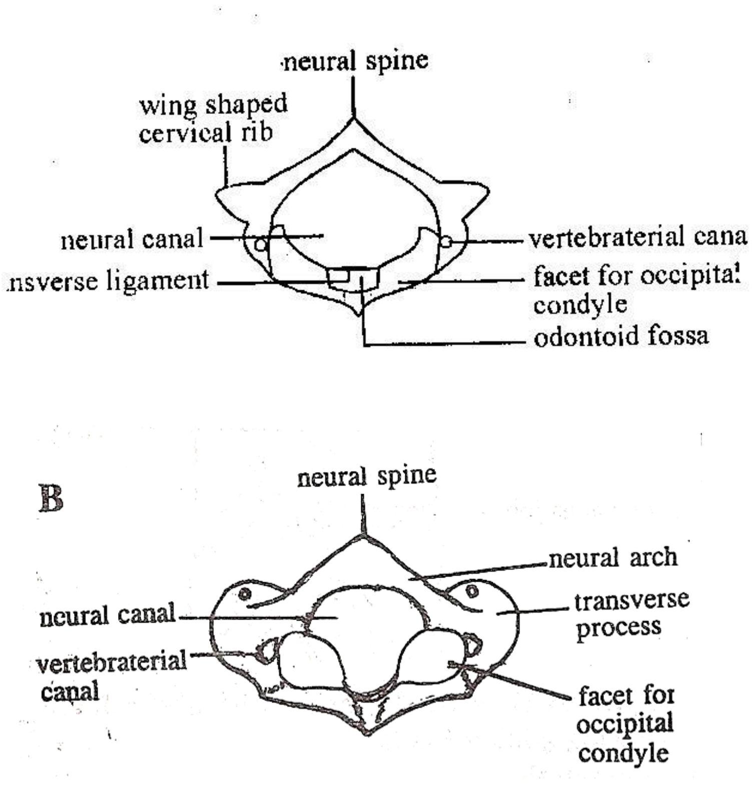


Figure 14.12 Atlas vertebra

A = anterior view

B = posterior view

Axis vertebra

The axis is the second cervical vertebra. It has a well developed centrum. The centrum projects anteriorly as odontoid process. Odontoid process forms in pivot joint with atlas, It's neural spine is laterally flattened. The transverse process is tiny and peg-like.

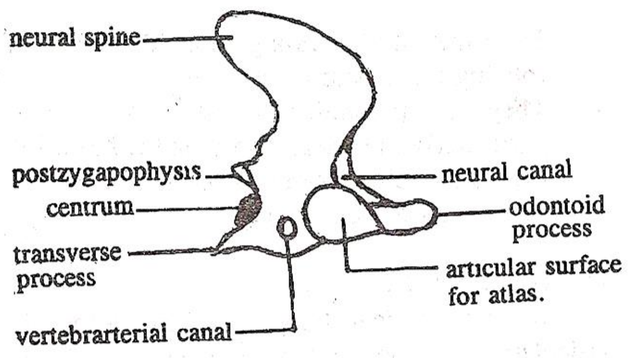


Figure 14.13. The lateral view of the axis,

The normal cervical vertebra

They are the 3rd, 4th, 5th, 6th and 7th cervital vertebrae. They are all similar to the typical bertebra described earlier.

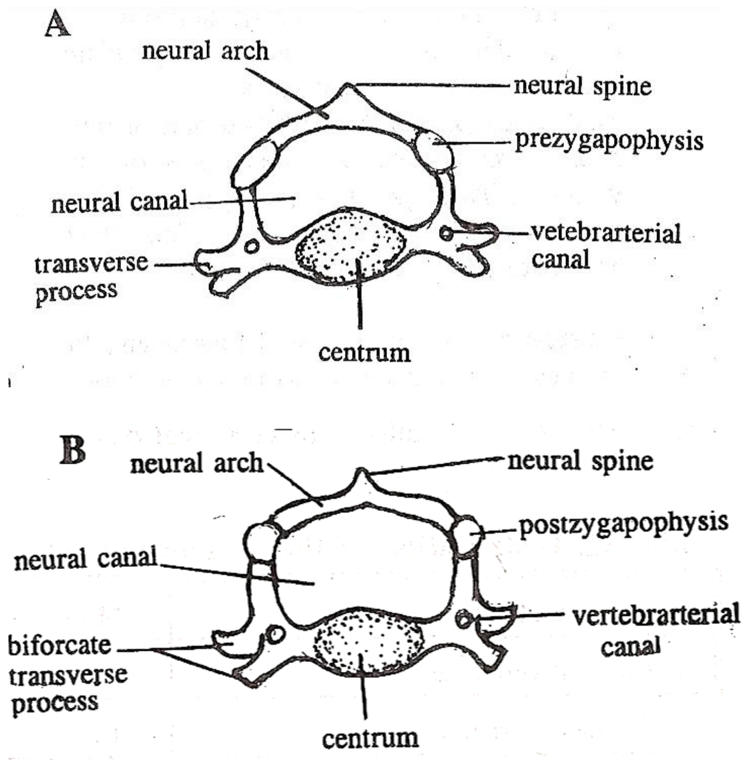


Figure 14.14. Normal cervical vertebra

A = anterior view

B = posterior view.

The special feature of normal cervical vertebrae is the possession Of a short biforcate transverse process.

Thoracic Vertebrae

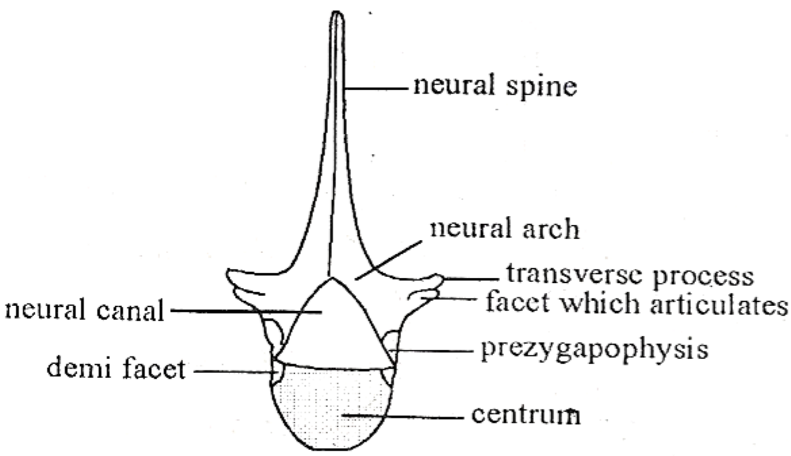
Characteristic features

1. Long neural spines.
2. Tranverse processes have articular facets for movement against the capitular facets and tubercles of the ribs.
3. Demi-facets on centrum for articulation with the capitulum of the rib.

Functions

1. They contribute to the formation of the thoracic cage with the ribs and sternum, which protect the lungs and heart in the thoracic cavity.
2. Their reduced and rounded transverse processes form articulating facets for the ribs.
3. They support the ribs and make it possible for the intercostal muscles to contract against them in the process   breathing in and out.

A



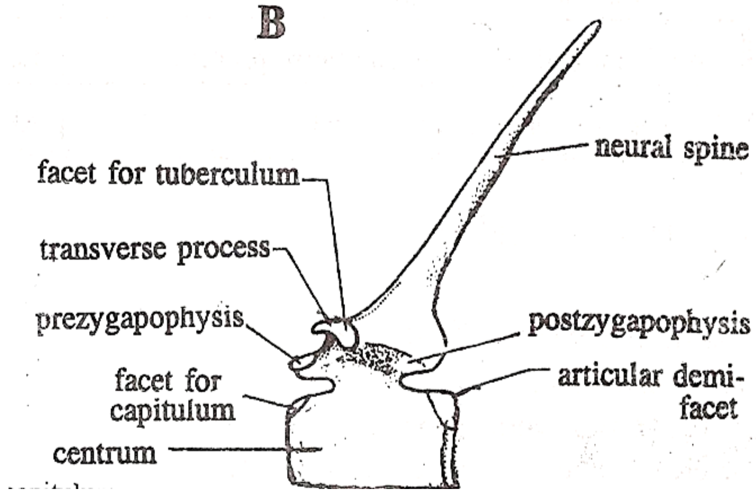


Figure 14.15:

A = anterior view of the thoracic vertebra

B = Lateral view of the thoracic vertebra

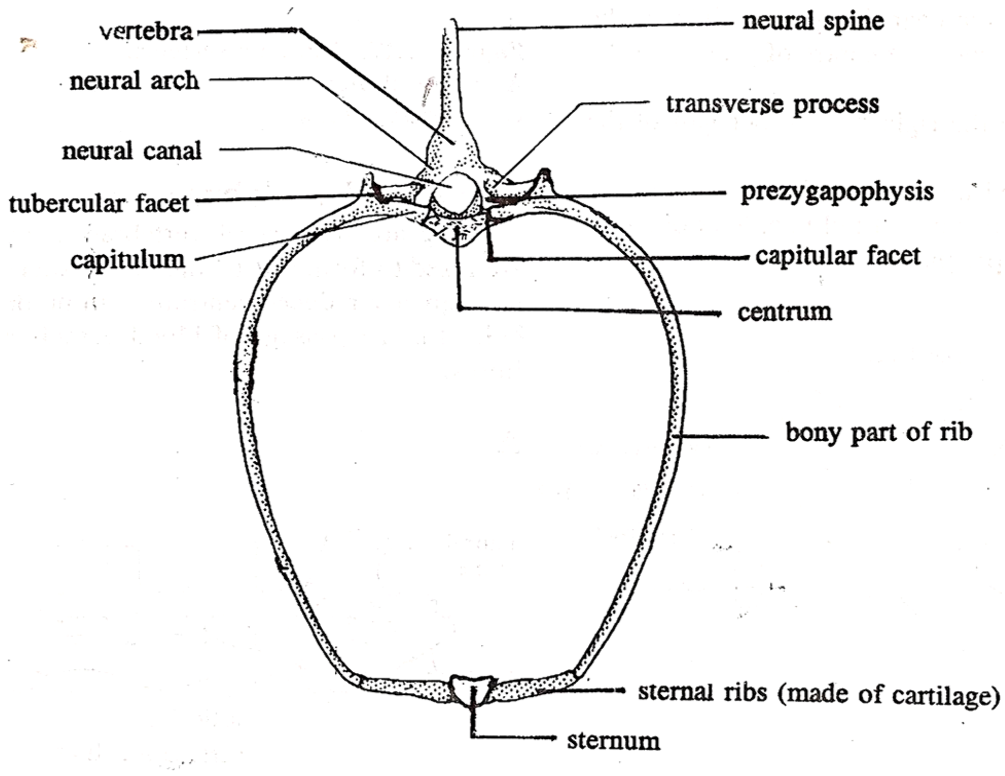


Figure 14.16. Anterior view of thoracic vertebral showing articulation with ribs

Table 52: Difference between certivical and thoracic vertebrae

Cervical vertebra	Thoracic Vertebra
Les prominent neutral spine	Very prominent neutral spine
Prominent and bifurcate transverse process	Less prominent transverse process
Presence of vertebrarterial canal	Absence of vertebraterial canal

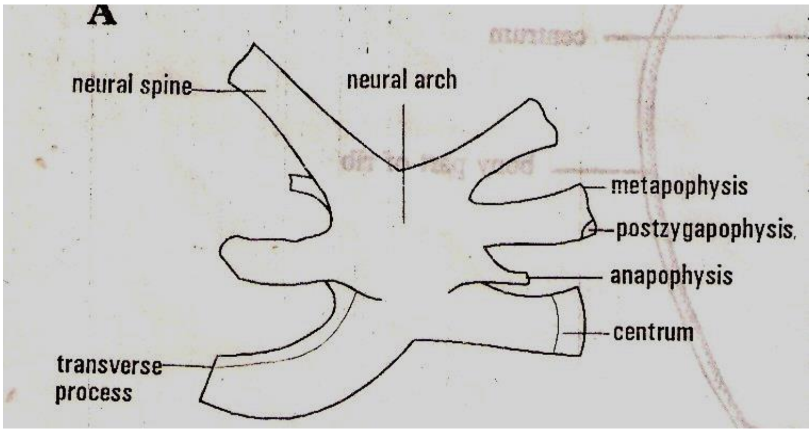
Lumbar vertebrae

Characteristic features

1. Stout vertebra
2. Large transeverse processes
3. Neural spine is braod and massive
4. The centrum and beutra arch are massive
5. Presence of extra process called **anapophysis** for attachment of muscles
6. Metapophyses flank the neural spine on both sides for attachment of muscles

Functions

1. Lumbar vertebrae bear the great weight of the body as they occupy the centre of gravity of the body.
2. They maintain the right and proper gait of the body.
3. Well developed lumbar vertebrae prevent sagging in the posture of tall people at old age.
4. The support pregnancy in the females.



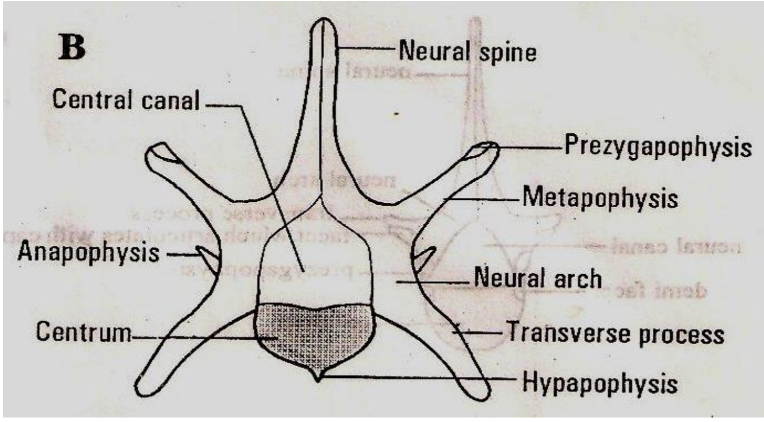


Figure 14.170 Lumbar vertebra

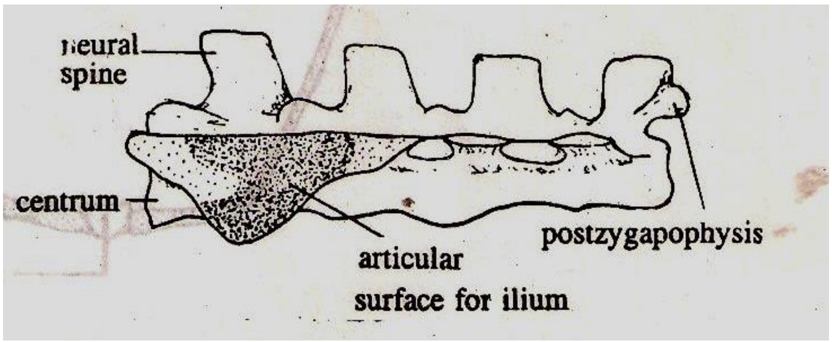
A = lateral view

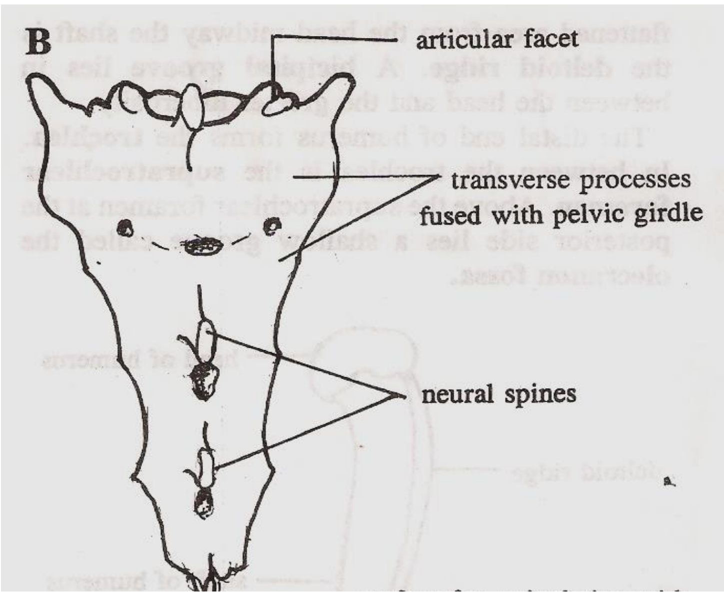
B = anterior view.

The sacral vertebrae

There are five sacral vertebrae in man. They are fused to form a structure called sacrum. They have greatly reduced centrum with numerous tiny holes for the passage of blood vessels and nerve fibres.

A





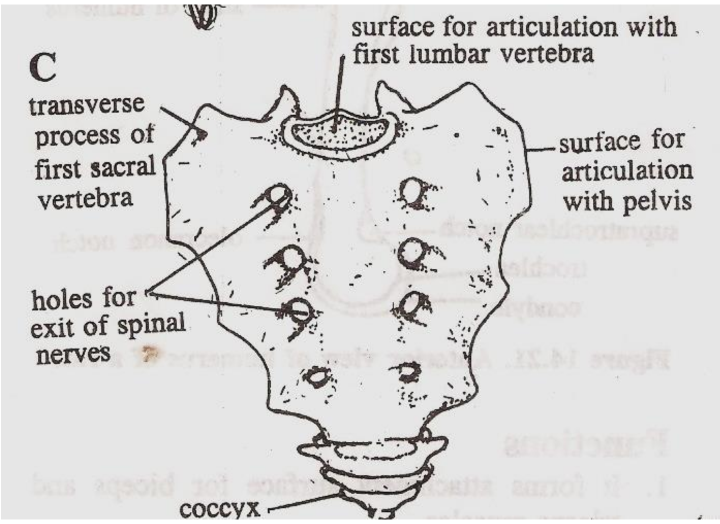


Figure 14.18

A = lateral view of the rat's sacrum

B = dorsal view of the rat's sacrum

C = anterior view of the rat's sacrum

Functions

1. Fused into one piece called sacrum and helps to hold the right and left ileum together at the back.
2. Sacrum has many holes for the passage and protection of nerve fibres serving the lower limbs.

The caudal vertebrae

There are four caudal vertebrae in the vertebral column of man while rat has 27 - 30. They are fused together to form the **coccyx**. They are also greatly reduced down to centrum only. The coccyx is tucked in between the **ischium** in man hence no external tail.

Functions

1. Being internal and fused into a structure called **coccyx** in man, it stabilizes the rigid pelvic girdle.
2. **Coccyx** houses and protects blood vessels and nerve fibres from under the **ischium.**

Appendicular Skeleton

This is made up of the bones of fore-limbs, hind-limbs and pelvic girdles.

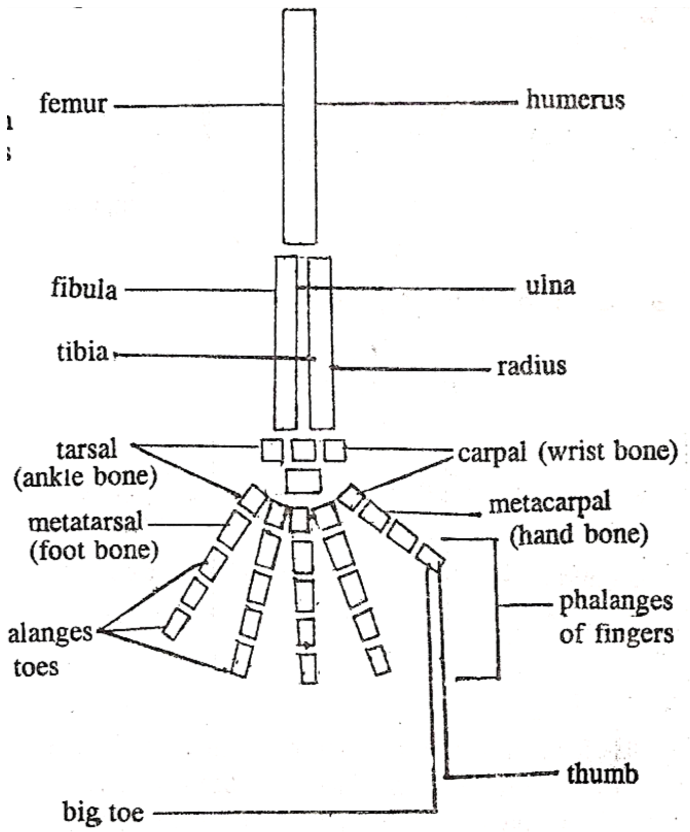


Figure 14.19: The pentadactyl plan of the limb

The Pectoral Girdles

The pectoral girdle consists of a triangular plate of bone called **scapular** or **shoulder blade, ribs** and sternum.

Scapular

Scapular is a flat bone. It has one head-like end with two processes, the corcacoid and acromion with a deep notch called the glenoid fossa or cavity. The rounded head of humerous fits into the cavity. The rounded head of humerus fits into the glenoid cavity in a ball and socket joints. Another bone of the girdle is the collar bone or clavicle which glides over shoulder joint to keep the bones in correct position.

The scapular is not fixed to the spine, it is only bound to the posterior of the thorax by muscles. This allows considerable range of movement at the shoulder.

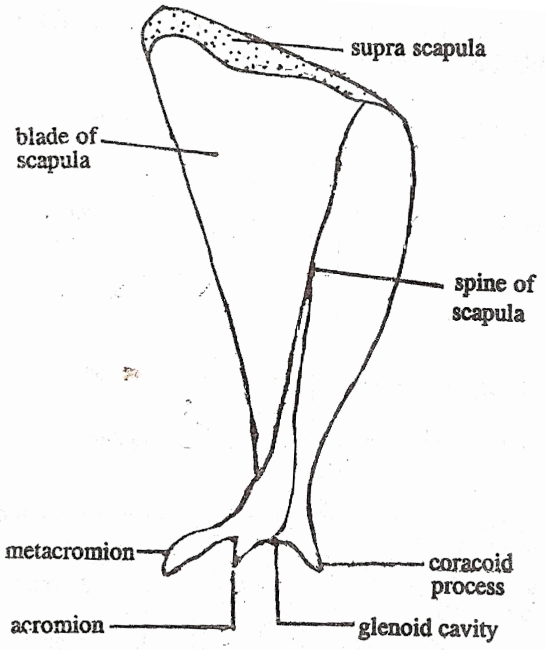


Figure 14.20. Posterior view of scapula of a rat.

Fore-Limb

The fore-limb is made up of a humerus in the upper arm, an ulna and radious in the lower arm, carpals in the wrist and phalanges in the digits.

Humerus

The humerus has a shaft and two extremities. The proximal end consists of a rounded head without a neck. The greater tuberosity lies at the opposite side of the head while the lesser tuberosity is attached below the head. The flattened area from the head midway the shaft is the deltoid ridge. A bicipital groove lies in between the head and the greater tuberosity.

The distal end of humerus forms the trochlea. In between the trochlea is the supratrochlear foramen. Above the supratrochlear foramen at the posterior side lies a shallow groove called the olecranon fossa.

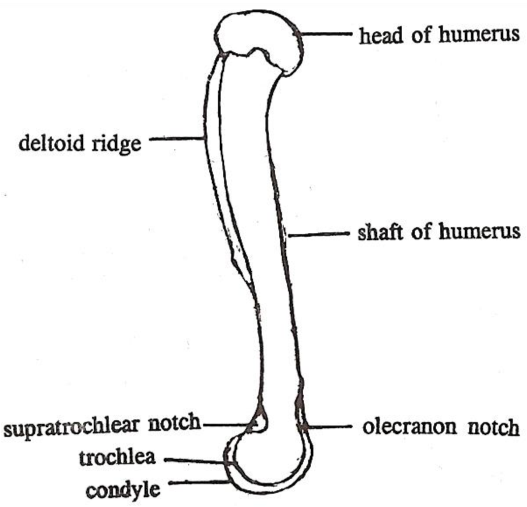


Figure 14.21. Anterior view of humerus of a rat.

Functions

1. It forms attachment surface for biceps and triceps muscles.
2. The bicipital groove anchors the biceps muscles.
3. It forms the ball and socket joint at the shoulder
4. It forms the hinge joint at the elbow.
5. It allows free movement of the arm.

Radius and Ulna

The two bones in the lower arm are the radius and ulna. The radius is shorter and it lies on top of the ulna. They both form the sigmoid notch into which the trochlea of humerus fits in the elbow joint. The ulna projects behind to form the olecranon fossa of humerus to keep the joint in position. The distal

Functions

1. They form the point of attachment for the insertion of the biceps and triceps muscles.
2. They provide large surface areas for the attachment of the extensor and flexor muscles of the lower ann. The muscles attached to the radius and ulna contract and relax to move the hand and digits.

Carpals

The carpals are the wrist bones, which are eight in number, and irregular in shape. They are irregularly arranged in the wrist and held together by tough ligaments.

Function

They form a hinge joint which allows for the movement of the hand along one plane.

Metacarpals

The metacarpals are the bones of the hand. They are long and slender like sticks of chalk or cigarettes. The metacarpal of the thumb is much shorter than the four others. There are five metacarpals in one hand.

Functions

1. Metacarpals form the shape of the hand.
2. They provide surface area for the muscles of the palm.

Phalanges

The bones of the digits are called phalanges. There are two in the thumb and three in each of the four others.

Functions

1. They support the digits
2. They are used for griping and holding on to objects.
3. They are used for walking by tetrapod animals.
4. They bear claws which are used for climbing and digging in some animals
   such as rat’s thumb

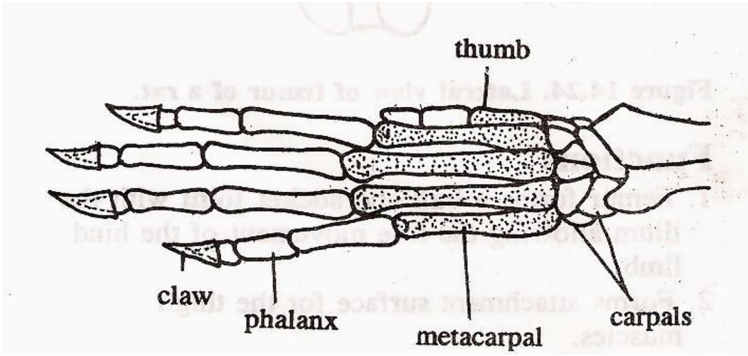


Figure 14.23, Dorsal view of left hand (maIms) of a rat.

Hind-limb

The hind-limb is made up of the femur or thigh bone, thetibia and fibula in the leg, the tarsals in the ankle, the metatarsals of the foot and the phalanges of the digits.

Femur

The femur is the longest bone in the body. It has a cylindrical shaft and two extremities. The proximal extremity bears a head with a separating neck, and on the opposite side is the greater trochanter. Two lesser trochanter are located below the head and the greater trochanter. The distal end bears the condyle and the patella groove.

Figure 14.240 Lateral view of femur of a rat.

Functions

1. Femur forms a ball and socket joint with the ilium allowing the free movement of the hind limb.
2. Forms attachment surface for the thigh muscles.
3. The distal end forms a hinge joint with the patella, tibia and fibula.

The tibia and fibula

The skeleton of the leg consists of the tibia and fibula. The tibia is bigger than the fibula which fuses with it at the distal end to form the tibio¬fibula. The proximal end is broad and has facets for articulation with the condyles of the femur and a notch for the patella to form the knee. The distal end has facets for articulation with the ankle bones.

Functions

1. Tibia and fibula provide large surface area for the attachment of muscles of the leg.
2. Muscles that move the foot have their origin attached to the tibia and fibula.
3. They form the ankle joint which allows the movement of the foot along one plane.

Tarsals

The tarsals are the ankle bones. They are eight in number and irregularly arranged in two rows. The bones are of unequal sizes and irregular in shape. The three behind articulate with the tibio¬fibula in the ankle. The five in the second row articulate with the metatarsals to the anterior of the foot.

Functions

1. The tarsals provide attachment surface for the strong muscles of the legs.
2. They form the ankle for the movement of the foot along one plane.
3. Muscles for moving the foot and toes are attached to the tarsals.

Metatarsals

There are five bones in the foot, called metatarsals. The first metatarsal is shorter than the rest four.

Functions

1. The metatarsals support the foot which is used for walking.
2. The metatarsals bear the phalanges of the toes and support then.
3. Metatarsals provide surface area for the attachment of the foot and toe muscles.

Phalanges

The bones of the digits or toes are called phalanges. The first toe called big toe has two phalanges. The remaining four toes have three phalanges each. The last phalanx in each digit is pointed to fit into the strong and sharp claw.

Functions

1. The phalanges support the toes which are used for walking, gripping and digging.
2. They provide surface area for the attachment of muscles of the foot and toes.

The Pelvic girdle

The pelvic girdle consists of the ilium (hip bone), ischium and pubis all of which are fused together on each side of the body as the innominate bone. These two halves are rigidly joined at the last lumbar vertebra to the base of the spine at the back while in the front they are less rigidly joined at the pubis by the fibro-cartilage symphysis. The distal ends of these bones form a cavity called acetabulum into which the head of femur fits to form the ball and socket hip joint.

Ribs

There are thirteen pairs of ribs in a rat. The first seven pairs of ribs are attached to the .sternum and they are called true ribs. The eighth, ninth, tenth pairs of ribs have their coastal cartilages attached to the seventh pair of ribs. The eighth, nineth and tenth are therefore called false ribs. The last three pairs are attached only to the thoracic vertebrae. They are therefore called floating ribs, Each rib consists of a slightly curved shaft. The dorsal end of the shaft is the capitulum or head. A little behind the capitulum is a tuberculum. The capitulum articulates with the dew-facet of the centrum of the thoracic vertebra while the tuberculum articulates with the transverse process of the thoracic vertebra.

Sternum

The sternum is a jointed and an elongated structure. It is made up of a broad manubrium at the upper part, four sternebrae and a xiphis-ternum into which a xiphoid cartilage is attached.

Functions

1. It protects the heart and lungs as it forms a protective basket with the ribs.

2. It articulates with the ribs to bring about breathing movement of the chest cavity.

Joints

The endoskeleton consists of numerous units of bones joined at appropriate points. The place where two or more bones are joined is called a joint. The ends of the bones involved in a joint are rounded and firmly sealed with cartilage. The space between the articular surfaces of the joined bones is filled with a pad of soft tissue called synovial membrane. The synovial membrane encloses a space called synovial cavity filled with synovial fluid. All these structures act as cushion to reduce friction and absorb shock from landing. Finally, the bones involved in a joint are firmly held together by a strong connective tissue, called ligament.

Types of Joints

There are immovable, gliding, ball and socket, hinge and pivot joints.

1. Immovable or fixed joints: These joints are different from the other conventional joints in that the bones are not held together by any structures. These bones have saw-like edges which interlock to form sutures at the joints. These joints are immovable. The joints are found among the bones of the skull.

2. Gliding joints: The bones involved in gliding joints are held together by discs of fibro-cartilage materials. A small joint cavity is however left to permit a slight movement. . Such joints are found in the vertebral column and between the clavicle and sternum.

3. (a) Ball and socket joint: Here one bone has a rounded head called ball and the other has a cavity called socket. In the shoulder joint, the ball of humerus fits comfortably into the socket of scapula. The hip is another example of the ball and socket joint. This joint is similar to that of the ball and socket joint. This joint is similar to that of the shoulder. The femur or thighbone has a round head, the ball, which fits into the socket of the ischium and ilium, they are held in position by tough ligaments.

   b) Hinge joint: This joint is found in the elbow, finger and knee of man. The ends of the two bones are notched and the process of one is extended to restrict movement on one plane only. In the elbow the hinge joint is between ulna and humerus while in the knee it is between the tibia and femur.

   c) Pivot Joint: As the name suggests one bone fits onto another one on which it pivots e.g. the atlas fits onto the axis by the odontoid process and pivots on it to allow rotating and nodding movements of the head on the neck.

	Bone	**Cartilage**
1	It is hard being made up of hard substances.	It is relatively soft being made up of soft substances.
2	It is not elastic.	It is elastic.
3	It is composed of mineral salt.	It is not composed of mineral salts.
4	Bone cannot be replaced by a cartilage.	Cartilage can be replaced by a bone.
5	Has blood vessels	Has no blood vessels in adults

ACTIVITY 10

Get a skull of a goat or sheep and observe it very well. Can you see the wavy lines in between the bones? These are immovable joints.

2. Hinged joints

ACTIVITY 11

Move your elbow and your knee. What is your observation?
You must have observed that your elbow and your knee can only move in one direction up to 18^o. The joints in your elbow and knee are called hinged joints. Compare the movement of your elbow and knee to the movement of a door held by hinges. Is there any similarity in their movements?

3. Ball and socket joints

These are the joints between the leg and the hips, and between the upper arm and the shoulder. This type of joint allow movement in all directions i.e. up to 360^o

4. Gliding joints

These are found at the ankle and wrist. They allow up and down movement of the hands and feet and also slight rotations.

5. Pivot joint

This is between the first neck bone (the atlas) and the second neck bone (the axis). It allows the rotation of the head.

ACTIVITY l2

Try and move your shoulder and your hips. What do you observe? Move your ankles and wrists. Describe the different movements.

Importance of bones to the bony

As hard structures, the bones give support to the soft tissues of the body and shape to whole body. Well formed and healthy bones therefore mean good posture. Posture means the position of the body. Weak and unhealthy bones will result in some postural defects such as round shoulder (kyphosis), hollow back (lordosis) and spinal curvature (scoliosis). Other defects associated with poorly nourished bones are rickets, poor teeth, bow legs, 'knock knees, enlarged joints and softness of bones.

How to Develop Strong Healthy Bones

1. As bones are built from organic and inorganic materials, food that contains sufficient organic and inorganic materials should be taken always.

2. Balanced diet is essential for strong healthy bones. Eating different kinds or assorted food is - better instead of keeping rigidly to one particular type of food.

3. Vitamins also contribute to the growth of strong healthy bones and so assorted food, vegetables, fruits, fish and meat containing vitamins should be eaten regularly.

4. Live in clean houses and clean surrounding with free flow of fresh air and bright sunshine.

5. Conscious effort at maintaining good posture should be developed and shown in correct standing, sitting and walking posture.

6. Wearing of free and well fitted dresses and shoes help nature in forming good posture.

7. Regular exercises and proper rest are important for the proper development of healthy bones.

ASSIGNMENT

1. Draw the skeleton of man and label at least 20 bones.
2. Name the different bones that make up the appendicular skeleton.
3. a. What is a joint?
   b. Name the different types of joints and give example of where they can be found in the body.
4. List the functions of the skeleton.

SUMMARY

In this unit, you have learnt that:

- The function of the skeleton

- The types of skeletons – hydrostatic skeleton, exoskeleton and endoskeleton
- The types of bone of a human skeleton and their functions
- Bones are hard structures that make up the frame work of the body.
- There are about two hundred and twelve different bones in a full grown human being.
- The skeleton is made up of two parts: the axial skeleton and the appendicular skeleton.
- The functions of bones include protection of delicate organs of the body, allowing movement, manufacturing of red blood cells, giving support and shape to the body.
- Joints are points where two or more bones meet.
- There are five types of joints: fixed or immovable joints, hinged joints, ball and socket joints, gliding joints and pivot joints.

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MODULE 4: LIFE AND SURVIVAL I

UNIT 1: VARIABILITY IN LIVING THINGS

INTRODUCTION

You have already learnt about living things and the different groups in which they are classified. Have you ever bothered to observe plants and animals around you? If you have goats or sheep or cows, are all the goats alike?

You will notice that all of them (goats) are not alike There maybe difference in size, colour etc. The differences and reasons for them are what we are going to study in this unit. We will also look at the major differences between plants and animals.

OBJECTIVES

By the end of this unit you should be able to:

1) define variation;
2) mention types of variation;
3) give examples of the different types of variations;
4) differentiate between plants and animals; and
5) classify organisms into smaller groups within the plant and animal kingdom.

VARIATION

Variation is the difference in trait structure or behaviour of members of the same species. Offspring of the same parents often show differences in their physical appearances, behaviour and intelligence. Variations enable us to differentiate individuals in a population. Organisms of the same species vary because of the differences in the genes each inherits from its parents. When you study unit 4 you will learn about cell divisions in which genes in chromosomes are transferred in gametes especially during a process called crossing-over. As a result of this process, every individual has a unique set of genes. Two main sources of variations among organisms are heredity and environment.

The environment, in which an organism lives, can bring about variation. For example, if some bean seeds are planted in rocky soil and another set planted in a rich loamy soil, it will be found that the one planted in rich loamy soil will grow better than the one planted on rocky soil.

Again identical twins with very similar hereditary characteristics when brought up in different environments show a lot of differences in physical and intellectual development.

TYPES OF VARIATIONS

There are two main types of variations in living things: morphological variations and physiological variations.

MORPHOLOGICAL VARIATION: - This is the variation noticeable in the physical appearance of individuals, of the same species. Examples include variations in size, height, weight, colour of hair, Colour of eyes, shape efface, colour of skin and fingerprints.

ACTIVITY 1

1. Measure the height of pupils in your class that are of the same age. What do you observe?

You will likely observe that there is a steady gradation from very short pupils to very tall pupils. This type of variation is called Continuous variation. In this type of variation, there is a gradation between the two extremes.

Examples of continuous variation include height, weight, shape of body parts, leaf size, root size, size of petal etc.

PHYSIOLOGICAL VARIATION

These are the differences in the ways individuals of the same species behave to certain things or conditions in their environments.

Examples include perception of odours, taste of certain substances etc.

These variations in individuals are without any gradation and hence are known as discontinuous variation.

ACTIVITY 2

I. Give examples of discontinuous variation in humans and plants. Did your examples include these

II. Some people can roll their tongues (tongue rollers)-while others cannot (non tongue rollers).

III. Some people can smell odours of certain things while others cannot.

IV. Some people can detect the taste of certain substances even at very low concentrations while other can do so only at very high concentrations e.g. the bitter chemical called phenylthio carbamide (PTC) in solution can be tasted by some while others cannot.

V. Every human being belongs to one of the four main categories of finger prints called arches, compounds, loops and whorls.

VI. Human beings belong to four blood groups A, B. AB and O.

Examples of discontinuous variations in plants of the same species include colours of flowers, colours of fruits, colours of seed, and shape of seed and fruit

DIFFERENCES BETWEEN PLANTS AND ANIMALS

The major difference between plants and animals is in their method of feeding, Plants have cells with nuclei cell wall and chlorophasts. Plants are able to make own food by the process of photosynthesis while animals eats plants and other plant-eating animals, plants are producers because they produce food for other organisms while animals are consumers You are a great consumer and you depend on other larger consumer such as the cow.

ACTIVITY 3

You should get a plant and animal and observe them carefully. Write down the differences between the two groups in a tabular form.

	Plants	**Animals**
1	Plants usually remain in one place and movement is by growth.	Animals move from one Place to another in search of food shelter etc.
2	Plants produce their own food from simple substances like water, carbon (IV) oxide Form complex substances like sugar and starch.	Animals obtain their food already made by eating plants and other animals.
3	They are producers.	Animals respond rapidly to stimulus e.g. by touch.
4	higher plants are usually green because they contain chlorophyll.	
5	The Plants respond slowly to stimulus by growth Plants.	Animals are called consumers Animals do not contain chlorophyll.
6	Plants usually have branching bodies.	Animals usually have compact bodies.

Using the above information classify the following organisms as plants and animals. Mouse, grass aphids, guinea corn, caterpillar, flamboyant, beetle, beans, bush cat.

MAJOR CLASSES OF ORGANISMS IN THE PLANT KINGDOM

Plants within this kingdom differ in share, size and structure. The most familiar plants arc the large ones which we see around all the time -the grasses. Flowering shrubs and trees these belong 10 the large group called the spermatophyta. They are the most highly evolved groups of plants and they produce seeds. Other groups of plant you may come across are the mosses and live worts. They belong to the group Bryophyia. These are small plants with tiny single - celled rootlets, simple stem and leaves. Closely, related are the Ferns which are placed in the group Filicinophyta/Pteridophyta. The plants in the plant kingdom are grouped into four main groups or phyla. Each group has been divided into sub-groups thus

1. THALOPHYTES

   e.g. Algae

2. BRYOPHYTES

   e.g. Mosses and Liverworts

3. PTERIDOPHYTES

   e.g. true ferns and club mosses

4. SPERMATOPHYTES (Flowering Plants With Seeds)

   Gymnosperms and naked seeds e.g. Casuarina Angiosperms seed enclosed in carpels e.g. Mango

The Angiosperms are the most specialised group of all the plants. They produce flowers and seeds and are the most complex. Angiosperms are the most important group of plants which produces crops that sustain the human population. They can be grown in different ecological environments and vanes in size and form.

Angiosperms also differ in leaf form and root form. The seed is produced within and enclosed by a carpel. As the seeds mature, they are still enclosed and the mature ovary becomes the fruit within which the seeds are located. The fruits exhibit a wide variety of forms -dry fruits, eg. beans, flamboyant, fleshy fruits, e.g. mango, pawpaw. Some of the fruits open at maturity -the beans: while others remain closed -the coconut. Angiosperm has been divided into two main groups monocotyledon and Dicotyledon Examples of monocotyledon plants are corn, oil palm wheat, rice and banana. Dicotyledon plants include orange, pear, okra, tomatoes, water leaf and mango.

ACTIVITY 4

Below are drawings of a monocotyledonous plant (maize) and a dicotyledonous plant (beans). The seed type is drawn beside the plant. Make a comparison between the two in tabular form. Can you sport the differences?

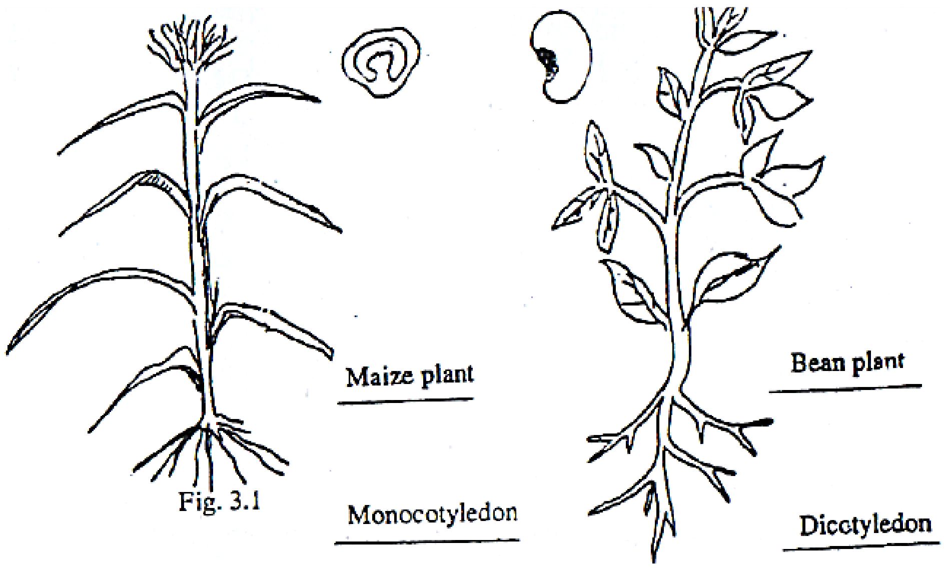

Fig. 3.1

Monocotyledon e.g. maize	Dicotyledon e.g. Bean
Has fibrous root	has tap root system
Parallel variation in leaves	Net variation in leaves
Floral part are in group of threes	Floral parts in fives or multiples of five.
Seed shows one cotyledon	Seed show's two cotyledons.

MAJOR CLASSES OF ORGANISMS IN THE ANIMAL KINGDOM

The animal kingdom has been subdivided into small groups on the basis of common or differentiating features. First are the one-celled ones called protozoa Examples are Amoeba, Paramecium.

<u>Many - Celled Animal (Metazoa)</u> divided into TWO:

(1) Animals without Backbones (Invertebrates)

(2) Animals with Backbones (vertebrates)

Further classification of the Invertebrates and examples are given as follows

1. Coelenterates (two layered animals): Hydra, sea anemone
2. Platyhelminthes (Flat worms): Planaria, Tapeworm
3. Annelids (Segmented Worms): Earthworms, Ringworm
4. Moilusc (Shelled animal): Snails. Limpet
5. Echinoderms (Spiny-skinned Animals) Starfish.
6. Arthropods (Jointed Legged Animals)

a. Insects (Six-Legged animal: Housefly, locust

b. Crustaceans (Many legged animals), lobsters, crab

c. Arachnids (Eight legged animals): Spiders. Scorpions

d. Myriapods (litter-animals): centipede, millipede.

The vertebrate animals are the animals with backbones. The subdivision includes the following.

1. Fish; Skate, Shark, Herrings, Trout, Tilapia
2. Amphibians: Frog, toad, Newt
3. Birds: kite, robbin, fowl, parrot, duck
4. Reptiles: Lizards, snakes, crocodiles
5. Mammal: Cat, dog, man, goat, cow.

In general variations among members of a species are not usually very pronounced. Variations between species arc however more pronounced. We can easily differentiate a maize plant from a rice plant, and scorpions from insects.

THE MECHANISM OF VARIATIONS

l. Natural Selection

Variations arose in the course of evolution where plant and animal structures were modified to suit special circumstances. Also in nature all organisms produce more offspring's than can survive. Accordingly, there is struggle for survival: Competition for food, shelter, etc. During this struggle some individuals survive, while others are eliminated. This results in survival of the fittest. This leads to natural selection where individuals possessing favourable variations survive.

2. Mutation

Another mechanism of variation is mutation. This is a sudden change in a gene or chromosome that leads to the appearance of new features in the organism possessing it. These new features can be inherited and passed on to succeeding generations who will become better adapted to their environment.

3. Recombination of Genes

The nuclei of two gametes fuse to form a new individual during sexual reproduction. This fusion results in a new combination of chromosomes in the offspring. These combinations bring about variations.

ASSIGNMENT

1 (a) What is variation?

(b) Give two examples each of morphological and physiological variation.

2. State four differences between plant and animals.
3. Write down major groups in the plant kingdom and give example of a plant in each group.
4. Write down 4 major groups among the vertebrate and give at least 2 examples from each group.

SUMMARY

In this unit you have learned that:

- Variation exists among living things,
- There are two types of variations; morphological variation which
- Physiological variation which is mostly discontinuous,
- Plants and animals differ from each other in various ways
- Variations between species are more pronounced than those within species.
- Mechanism of variation is natural selection, Mutation and recombination of genes.

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UNIT 2: ECOLOGICAL BALANCE I: ABIOTIC & BIOTIC FACTORS - EFFECTS ON ECOLOGICAL BALANCE

INTRODUCTION

In every ecological community (ecosystem) nature strikes a balance in the population of all living organisms there. However, in such ecosystems there are ecological factors which tend to maintain this balance. If any of these factors -abiotic or biotic is altered or completely absent, there will be a great tilt in the existing natural dynamic equilibrium. Consequently, it will affect the existing population of the organisms in that environment. The ecosystem may breakdown, or in the alternative a new balance may have to be attained by the surviving organisms.

In this unit, you will be examining the factors which affect ecological balance in nature and how each factor contributes or disrupts this dynamic equilibrium.

OBJECTIVES

By the end of this unit, you should be able to:

1. list all the abiotic and biotic factors which affect balance in nature;
2. give examples of how nature maintains this balance;
3. State how each of the factors listed in.(I) above affect ecological balance; and
4. Classify the factors that affect population in terms of (a) density dependent and (b) density independent factors.

There is hardly any individual in any society or group who is completely self dependent. He must need the assistance of another person or some factors in his environment in order to live a fulfilled or purposeful life; so it is in every habitat. In each ecosystem, there must be producers who convert nature's inorganic and organic substances around to produce food. This may result in depletion of the inorganic and organic materials. In this same community if nature's balance is to be maintained, there must be consumers who eat the foods produced. Eventually, these consumers will die, thus returning to the earth the much depleted inorganic or organic materials and so the earth will be replenished. This system can be represented as follows:

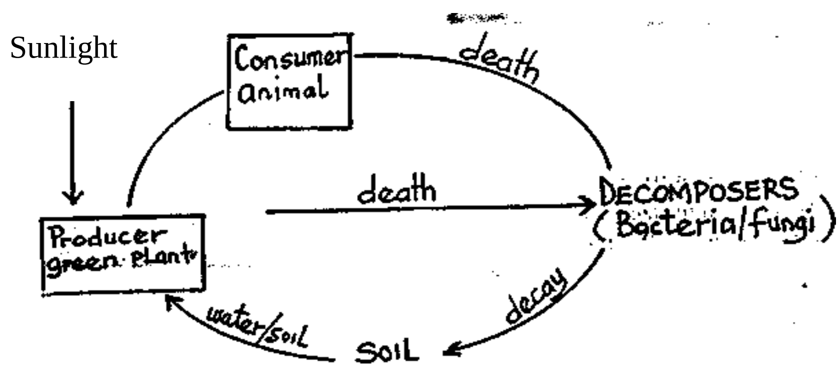

Fig. 3.9: Ecological Cycle

By this process, an ecological balance is maintained. In this simple analogy, you will discover that the factors which maintain the balance between in organic/organic materials (carbon hydrogen, producers and consumers can be grouped into abiotic (non-living) and biotic (living) factors.

ACTIVITY 5

Give one example of any other cycle in nature aimed at the maintenance of balance. Identify the biotic and abiotic factors in the cycle and write down the list.

List the abiotic and biotic factors that may affect this natural balance. Did you include the following - water, temperature, nitrogen in air, soil, bacteria, nitrogenous wastes, the green plants?

Having familiarized yourself with the concept of abiotic and biotic factors, you will now examine in details the abiotic and biotic factors generally and how each affects ecological balance.

ABIOTIC FACTORS

This may be grouped into three - those due to

1) Climate

2) Soil (edaphic)

3) Natural disasters.

The climatic factors include:

1. **Temperature:** The temperature of the environment plays an important rote in all biological activities. In the presence of wide range deviations from the normal, it may slow or increase activities such as feeding, respiration, movements and even reproduction rate. Within these extremes of temperature, some organism may become prone to diseases and death eventually. It is important to note that each ecological niche has a range of temperature within which the population of organisms in the environment will flourish. For cold blooded animals, rise or fall in temperature may affect them adversely.

2. **Water:-**You are aware of the adage - "Water sustains life". Osmo-regulation is a function of all living things. Although water requirements of organism vary. The ability of organisms to conserve water in their system will ensure greater adaptability. Should the water requirement of the environment reduce drastically the life of many organisms will be in grave danger. This will affect the dynamic equilibrium in that ecological system.

3. **Humidity**: Humidity consideration is important because it affects transpiration rate in plants as well as the rate of evaporation of water from the surface of organisms. You know how uncomfortable you feel during high humidity. It may so upset you that you cannot function effectively. This may also affect the ability of organisms to withstand long periods of drought.

4. **Wind and air current**s: This affects mainly plants. During serious wind and air currents many plants maybe blown off their roots, and possibly only those with strong root system may survive. Winds may increase evaporation rates and also play a major role in seed dispersal.

5. **Light:-** Light is important for all photosynthetic activities of plants; so may increase or reduce food availability. It is known that many plants require a maximum light exposure for fruiting. Inadequacy of it affects many plants.

Edaphic (soil) Factors include:

1. **Mineral Salts and trace elements**: The distribution of plants in any environment is governed by the availability of mineral salts and trace elements in the soil required by plants. Hyper quantity of it may become toxic to plants and this limit the distribution range. Soil considerations affect man's farming activity and may limit the type of food to be grown. Thus only plants which can harbour nitrogen fixing, bacteria and carnivorous plants can survive in areas deficient of mineral nutrients.

2. **Salinity:** The importance of this is seen in the distribution of fresh water and marine organisms. Fresh water populations have devices to deal with excess water in their systems while salt water organisms have adaptation to deal with excess salt. Any situation which disturbs the salinity of water (rivers, oceans, brackish) will automatically affect the distribution of organisms in the area and many marine organisms will die.

3. **pH:** Plants are adapted to different pH considerations, some thrive in acid soils, some in alkaline soils. Plants are generally sensitive to pH fluctuations and this may affect their distribution.

4. **Topography:** The distribution of organism may be sensitive to the topography of the area. There are populations that flourish on top of mountains, in the valley, the centre and edges of a stream/river, even under a stone or top of a stone, on walls etc. This type of distribution may be guided by illumination, temperature or moisture considerations. The disturbance of the natural topography of any given population may render such populations extinct and this in turn will affect the food chain in the area and consequently other organisms.

5. **Water Currents/Movements:** Water movements include waves, and tides. Such currents when altered by some factors, especially if they are on the increase may likely wash away many organisms that have adapted themselves to such normal currents or tidal waves. Some organisms find themselves washed into rivers, stream and because they have no adaptation to these currents will eventually die off.

6. **Factors Due to Natural Man-made Disasters**: Various ecosystems are often subject to natural disasters such as floods, drought, bush fire, oil spillage, hurricane. When any of such occur, the effect on ecological balance is disastrous. In the case of flooding, most living organisms especially the minute organisms (plants and animals) are completely swept off. In the case of bush fires which occur frequently during dry seasons the entire population of the ecosystem is wiped off.

BIOTIC FACTORS

In every biotic environment, there are usually organisms. Since no organism is an island unto itself, there are bound to be interactions. Some of the interactions may be favourable and this may result in progressive increase in the population of each e.g. symbiotic living. An example is Bacteria found in root Modules of leguminous plants. In some other case the interaction may lead to the reduction or distribution in the population of one or more of the organisms in the environment. Examples include:

1. **Predation:** Population changes may come as a result of predator-Prey relationships. An organism may be dependent on another for its food, so that predators will always move to areas where they can prey. For example, herbivorous animals are found in areas with good vegetation e.g. Grass cutters will only be found in areas with grass; carnivorous animals in areas where there are insects. There will be population shifts for say the glasscutter. If the grassland is set on fire. Consequently, there will be reduction in the population of grasscutter, some may migrate and some will die. After a short period, if rain is available there will start to appear. Eventually the population of the grass cutters will again increase. In some cases the predator **-** prey relationship can be used for biological control of the spreading of an unwanted organism.

2. **Competition:-** Organisms in an environment may compete with one another for food, light, water, shelter. Competition maybe amongst individuals of the same specie or among individuals of different species. Depending on the availability of things competed for e.g. food, light, competition may be so keen, that it will lead to serious fluctuations in the population of both competitors or the disappearance of one of the populations

3. Some other biotic relationships can be seen in the case of pollination dispersal. Many plants flower at certain periods of the year. During this period there will be increase in the population of insects that feed on the nectar of such flowers. This increase in the specific insect population may result in increased pollination. The population of the insect decreases as soon as season is over. In such cases the flowering plant forms part of the insect's biotic environment. Other biotic factors include natality, diseases, mortality. These may be discussed in the next unit especially as it concerns human activity since man himself is one of the most powerful biotic factors.

Classification of the abiotic and biotic factors

All the factors so far mentioned can be classified on the basis of how it affects population of the organisms in the environment. The factors are therefore classified as;

(a) Density **-** independent factors

(b) Density **-** dependent factors.

Density - Independent Factors:

These are factors which affect the growth of a population no matter what the density of that population is. The factors in this group include mainly the Natural/manmade disaster factors such as bush fire, floods, and hurricane. Let's take the case of bush fire, when a grassland is set on fire, the fire kills all the organisms whether of plant or animal origin. It does not discriminate on whatever maybe the existing population or ratio in that environment. These factors do not maintain any state of equilibrium or ecological balance.

Density - Dependent Factors:

This deals with all those other factors which affect population growth. It may increase or decrease the population density. Such factors include temperature, availability of water. If the temperature of a particular ecosystem is optimal, there will be population growth and if it is unfavourable population density will decrease and so it is for availability of water. All biotic factors are density dependent. For example the migration of locusts reduces the population of locust in one area and increase it in another area.

ASSIGNMENT

1. Explain the following terms

    i. Ecosystem

    ii. Abiotic and Biotic factors

2. List 5 abiotic factors and 3 biotic factors which affect population density. Explain how one in each area affects population density in the environment.

3. What do you understand by the following terms Density – independent and density dependent factors. Give an example of each.

SUMMARY

In this unit you have learnt that:

- Abiotic and biotic factors affect population density.
- Abiotic factors are those non-living factors and biotic factors deal with those factors which are living.
- Abiotic factors include light, water, temperature, humidity, winds/air currents, mineral salts, pH, salinity, topography and natural/manmade disasters.
- Biotic factors include - Predation, competition symbiosis, parasitism, diseases, natality, mortality, dispersal.
- The factors can be classified into density independent factors and Density - dependent factors.

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UNIT 3: ECOLOGICAL BALANCE II: HUMAN ACTIVITY

INTRODUCTION

In unit 2, you were introduced to abiotic and biotic factors and how they affect the population in any ecosystem. Although nature has a way of maintaining ecological balance as seen in various cycles in nature, the human activity in our ecosystem has defied every tendency to achieve this ecological balance. Man being one of the greatest biotic factor has been the major cause of this imbalance. You will in this unit learn of certain human activities that have continued to upset the ecological balance in our ecosystem as well as limit man's population growth.

OBJECTIVES

By the end of this unit, you will be able to:

- list various activities of man which upset ecological balance;
- explain how each of the factors stated affect human population and that of other organisms;
- state the advantages of family planning;
- state the materials that cause pollution of the environment; and
- state the activities of man that affect his population

Unit 2 dealt with factors both abiotic and some biotic factors that affect or sustain ecological balance in nature. A few more of biotic factors not mentioned in unit 2 included natality, mortality, immigration and emigration.

Natality: This deals with birth rate. Many organisms have high birth rate. For example oysters produce about sixteen million eggs while a cod fish produces about seven million per annum. In spite of this large number of eggs the population of oyster or cod remains constant. A lot of the young fishes die off possibly because of depletion of available food. More so, there is competition and only the tough survives. Despite the high birth rate, diseases, high predator and possibly hostile changes in some of the abiotic factors decrease the birth rate.

Mortality: This deals with death rate. As a result of depletion of available food, disease and possibly high predator-rates, many organisms suffer high mortality rate.

ACTIVITIES OF MAN THAT DESTROY BALANCE IN NATURE

These include

i. Urbanization
ii. Pollution
iii. Weapons of war
iv. Farming

Urbanization: The building of house, new settlements, bridges dams and possibly hydro-electricity, road construction which are all aspects of urbanization, disorganize various ecosystems which previously have enjoyed stable balance. Such activities displace many living organisms. Some die in the process because of their exposure to predators and some migrate to new environment.

Pollution: List at least five materials chemicals/gases which cause pollution in you environment. Pollution is the release of harmful substances into the environment by either man. Other animals or chemical and biological processes taking place in our environment through burning, smoke from exhausts of vehicles, fires from kitchen and industries constitute pollution of the environment. Harmful gases such as carbon (IV) oxide from flaring of gases, hydrogen sulphide, sulphur dioxide, oxides of nitrogen, chlorine are some of the many pollutants of the atmosphere. Organisms breathe in these harmful gases. Death or serious complications may result from inhalation of these gases.

Pollution may not be only with air. Water, rivers, streams are seriously polluted. Our industrial wastes are emptied into our rivers. Oil spillage, which is a common occurrence these days, has devastated every ecological system in our environment. The flora and fauna of our environments have disappeared. These have completely upset the ecological balance. You need to take a visit to some areas in the oil producing areas of our Niger-Delta Basin. You cannot help but conclude that nature's ecological balance is a thing of the past. In these areas, there is the disruption of food chain/food web of the ecosystem, causing imbalance. The death of aquatic organisms leads to increase of algal growth, bacterial growth, which reduces the dissolved oxygen. Consequently, more aquatic organisms die.

Weapon of War: Nuclear reactions and many more scientific inventions have further disrupted the balance of nature. Not only do such weapons reduce human population, many other organisms including plants have become victims.

Farming: The tilling of the soil and all other activities of the farmer expose the animals that live in the soil, in burrows to the surface, subjecting them to predators. Plant vegetation is disrupted and so are other organisms that depend on these plants.

HUMAN POPULATION

As observed earlier, human population seems to defy any tendency to achieve a balance as other organisms. Generally, the population of living organisms continue to grow until there is an environmental resistance to further growth so that the habitat can support its population. This trend is not true of human population. Human beings are masters of their environment, consequently, they carry out activities that tend to check the growth of their population.

ACTIVITY 6

1. Write out 3 ways which man adopts to control environmental factors that would have reduced his population.

Did you include the following?

- Increased personal hygiene and sanitation (Health care)
- Better increase in food production
- Application of benefits of science
- Increase in human understanding of himself and the environment.

Increase in Personal Health Care Delivery has given a deathblow to such factors as viruses, germs, disease that would have combined to reduce his population. Increased health care delivery involves a study of diseases, causes, control and treatment. Many more sophisticated drugs have been produced to combat diseases. Man is not relaxing in an effort to find treatment for the much dreaded “HIV AIDS” which, if unchecked, will increase the mortality rate. Increased Health Care Delivery has helped to reduce mortality rate. In the many years past, infant mortality rate was so high that not of a hundred babies less than 50% survive. Today, Nigeria is trying to achieve 100% elimination of the five dreaded diseases of children -whooping cough, measles, poliomyelitis, diphtheria and tuberculosis under the National Programme on Immunization (NPI). We now drink and use only clear and pure water. Our environment has become safer than ever.

Birth rate has also been on the increase with increasing antenatal and post-natal care of mothers and their new babies.

Increased Food Production: Competition for food has been a factor that control population density. Man invented modern means of agriculture to produce more food to feed the ever increasing population, thus reducing competition that would have reduced his population.

Application of benefits of science:-The survival of man and his increasing population is his ability to apply benefits of science in health care delivery, mechanized agriculture or improved variety of seedlings. He has grown to understand his fellow human and has leant to adapt to whatever environment comes his way.

Man's population has been on continuous increase and the need to stabilize the population has forced him to undertake family planning to limit his family size-. There are various methods of family planning to limit population. These include:

Rhythm Method: This involves females knowing their menstrual cycle and allowing intercourse at appropriate times to avoid conception

Withdrawal Method: This involves the withdrawal of penis from vagina before sperms are ejaculated.

Contraceptive Pills: This involves the use of drugs to immobilize sperm cells or prevent ovulation.

Intra-uterine Device (IUD): This is a method whereby a trained doctor or nurse introduces a loop into the woman's uterus.

FACTORS THAT AFFECT BALANCE IN POPULATION IN A COMMUNITY: Ecology of Population

Factors that do not depend on the density of a population:

a. natural and other catastrophes/tragedies such as:

i. earthquakes that destroy farms, homes, forests and cause land slides

ii. wild forest fires which burn forests that are habitats of many animals and plants

iii. floods that uproot aquatic animals to land, land animals into water

iv. chemicals/effluents from factories and oil spillage cause deaths,

v. erosion that destroys land etc. and displaces/destroys plants and animals

vi. sudden or long changes in climate that affect both plants and animals

Factors that are density dependent include:

- the death rate of organisms (mortality) can cause imbalance in a community e.g. A.I.D.S (Acquired Immune Deficiency Syndrome), has been killing able-bodied men and women who can do all the farming, take care of the old, develop the nation. Very soon the aged, who depend on them, would also die. Low production of food will lead to starvation and disease in the nation.

- the birth rate (natality) can also upset the balance in a community e.g. if locusts breed beyond their usual numbers in a community, they would eat up the vegetation. The herbivores that depend on grass would suffer or die. The carnivores that depend on herbivores would consequently suffer or die.

- the age distribution in a community can affect the balance too. If you have more old people than the young in a community, the population would decline.

- Movement patterns in a community can upset the balance in an ecosystem e.g.

- the one-way outward movement (emigration) will greatly reduce the population and upset the balance:

- the one-way inward movement (immigration) would-increase the population in a community, and would upset the balance therein, e.g. food shortages, aggression.

- periodic departure or return (migration) of mass movement of entire populations disorganize communities into or out of which the movement occurs. The facilities that are available would collapse.

The interaction of one population with others in a community can upset the balance in such an environment e.g.

- When there is great influx of mosquitoes in community, there is bound to be increase in malaria fever as they make contact with man .More deaths occur and the population decreases.

- If more quiver birds evade the farms, more plants are destroyed and this affects the herbivores and the carnivores that depend on the herbivores

- The uncontrolled killing of some species of animals and felling of trees cause terrible imbalance of the ecosystem.

In the cycles in nature e.g. carbon, water, nitrogen cycles, any disruption in any stage would upset the balance. Such imbalance will affect the lives of organisms seriously and/or even death e .g. plants will not make food if CO_2 from carbon cycle is missing.

Soil nutrients would be depleted and plants die if Nitrogen (N_2) cycle is disrupted rainfall would be affected if water cycle is disrupted, plants and animals would die.

ACTIVITY 7

1. Watch a farm burn and note:

a) the number of birds flying out/dead

b) the number of insects flying out/dead

c) the number of rodents running out/dead

2. Observe an area destroyed or damaged by erosion and note:

(a) the land/farms destroyed

(b) the plants and animals displaced

(c) the flow of water in the area

(d) record (i) the area and (ii) type of erosion.

3. Note and record what happens:

a) When and where thick industrial smoke/poisonous gas is pumped into the air.

b) When oil is spilt into the rivers/stream near you and the state of the aquatic organisms

ASSIGNMENT

1. Explain the following terms - Natality and mortality.
2. Name three activities of man which destabilize ecological balance in our environment.
3. What indicator points to the fact that man has defied attempts of nature to control its population?
4. State two ways which humans have adopted to prevent limiting of her population by natural factors.
5. Name three methods of family planning or birth control.
6. From the observations and notes made while preparing for the study of this unit:

a) Is there marked difference and/or sequence in the rising and setting of the sun?

b) Do the seasons fell to fall in at their normal time and duration?

c) Does the systematic steps of seed germination, leaves, flowering and fruiting always follow that order.

SUMMARY

In this unit, you have learnt that:

- Man is one of the greatest biotic factors.
- Other biotic factors mentioned here include natality and mortality.
- Urbanization, pollution, farming, weapons of mass destruction are various ways of man to destabilize balance in nature.
- Human population has defied every factor - abiotic or biotic which nature uses to keep its growing population in check.

- Humans have adopted certain measures to control abiotic and biotic factors in his environment by way of:
- unproved health care delivery
- improved production of food
- There are in existence certain methods of family planning to stabilize the ever-growing human population.
- Everything in nature has been made to work out smoothly. The birds fly about to eat insects, the goats and cows eat grass, the plants absorb food, from soil to produce food for animals.
- But at times, insecticides from man kill the insects which birds depend upon. At the times fires, construction, polluting chemicals and oils kill the plants herbivores depend on and man cannot produce food for himself.
- These activities of man upset the balance of stable state in the environment/community with disastrous consequences.
- It is, therefore, necessary to take steps to avoid or limit these activities that destroyer disorganize the balance in nature e.g.
- control of erosion by building drainages, planting trees, avoiding felling of trees, plating grasses;
- avoiding bus burning, oil spillage and release of toxic gases and wastes into the environment
- conserving animals/plants, particularly those with small populations so that their role in the community will not be affected or aborted.
- Movement of populations into, outward or en-mass should be controlled to maintain the balance in the community.
- Factors that encourage the spread of vectors (i.e. organisms that transmit germs that cause diseases) should be controlled since their activities cause so much death that affect the balance of a community.

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UNITS 4: ECOLOGICAL ASSOCIATIONS AND ADAPTIVE MECHANISMS I

INTRODUCTION

In the course of various interactions between living organisms in the ecosystem, certain relationships develop between different species. This relationship that develops between two organisms/species in their interactions is known as Association.

While it is true that habitat factors largely determine the type of plants and animals which live in different areas, it is mainly food needs that determine the type of associations in an ecosystem. Consequently, mechanisms to achieve success in this area are adapted by the respective organisms (the "hunter and the hunted") to co-operate in order to survive.

Apart from the relationship between producers (i.e. bacteria, fungi), there are other interactions between individuals in a community e.g. competition, parasitism, communalism, symbiosis, predation. epiphytism/epizoitism and mutualism.

These relationships in the cause of interactions lead to temporal or permanent association, some of which can be harmful, beneficial or neutral in results.

OBJECTIVES

By the end of this unit you should be able to:

1. list the different types of associations;
2. list the features of each association;
3. describe the adaptive mechanisms in each association; and
4. enumerate the examples of organisms ;

WORD STUDY

Ecology:	the study of organisms at the habitat of in relation to their environment
Association:	a group of two or more organisms for a purpose/benefit
Mechanism:	process or the route through which something is done/action taken
Adaptation:	adjust or rearrange/reorganize to fit into a situation from the normal
Obligate Parasite:	an organism that must live and depend on another to survive

Negative Interactions/association

1. **Predators** i.e. (Predator/prey association) they kill and injure any one they are associating with; the prey

Adaptation

a) the predators have streamlined bodies or shaped that enhances their speed to overcome their prey e.g. lion, tiger and hyena;

b) powerful limbs for running and holding prey;

c) well-developed fangs, paws and the carnassial teeth for crushing and scraping flesh;

d) the prey usually have high reproductive rate to support the predator species; and

e) the predators have high acuity of vision to see their prey and high sense of smell to detect their victims at a long distance.

ACTIVITY 8

1. Watch the under listed animals while catching their prey for food
    a) Cat and mouse/rat
    b) Kite/hawk and chicks
    c) Bird and insects
    d) Toad and insects

Note their preparation for attack

Note the parts-of the body involved and list those which are the predators and which are prey.

2. **Parasites** i.e. (parasite/host association) kill and injure their hosts

    Adaptations

    i. well developed mouth parts and organs of attachment to pierce or bite and to ensure that they are not displaced. They also suck blood and fluids e.g. tick on cows.

    ii. they have enormous ability to lay thousands of eggs e .g. tape warms with suckers and hooks, ascaries in intestine of man absorbs nutrients of host Obligate parasites ensure that host does not die in order to safeguard their own survival.

3. **Allelopathy**

- Harmful substance is produced by one of the interacting species against the other e.g. *pinus spp* (plant).
- The harmful substance prevents the growth of other plants around them.

Positive Interaction/Associations

1. **Commensalisms:** The association between two species where one benefits but the other is not harmed (neutral).

a) Shellfish - it offers shelter and protection e .g. oysters host small crabs in their cavity while the crabs obtain surplus food. The oyster is not harmed.

b) Remora (shark-sucker) and the shark, remora has a hold fast like structure formed by modified dorsal fin. It attaches itself temporarily under the shark. It eats scraps of food from the shark, gets protection and wide distribution. The shark is unaffected/not harmed by this association.

c) Bacteria in large intestine of man they feed on the unwanted food and get protection. Man is however not harmed.

d) Epiphytes/epizoites: the epiphyte on the tree gets a site to get sun light for photosynthesis, support. The relationship is that of attachment with no preference for a specific supporting body. They can develop on any structure, dead or alive that gives satisfactory surface e.g.

i. Epiphytes (plants) Lichens, mosses, pteridophytes/ferns and orchids (flowering plants)

ii. Epizoites (animals) Barnacles on crustacean carapace (i.e. molluscan shells), obellia hydroids on Laminaria fronds, seaweeds on brown algae.

2. Symbiosis

A close and prolonged/living together or association of two or more organisms of different species. The association may be between

i. all consumers

ii. consumers and producers

iii. consumers & saprophytes

iv. producers and saprophytes

It could also be temporary or permanent but both partners gain from the association.

Examples

a) Bacteria/protozoa live in the stomach (rumen) of herbivores (plant eaters) the bacteria digest cellulose (plant matter) which the herbivores absorbs as food, the herbivores offer shelter, protection and conducive atmosphere for growth and development.

b) Cattle and Tick Birds in the bush: The birds remove blood-sucking ticks and flies from the hides of cattle i.e. food the cattle benefits from the parasitic infestation being removed to allow them develop very well

ACTIVITY 9

a) Watch a herd of cattle in the bush feeding

b) Take note of the birds on their back and write down your observations

c) What is the reaction of the cattle to the presence of the birds?

d) Nitrogen fixing bacteria in leguminous plants Rhizobium/bacteria in root nodules convert free nitrogen to organic matter for soil enrichment. The leguminous plants provides shelter and food (sugar and vitamins) for the bacteria.

e) Mycorrhiza Association between a fungus and the roots of a higher plant, especially in poor soil. The fungus transfers inorganic nutrients to the higher plant (acts as its roots). The higher plants give the algae mineral salts.

f) Lichen (found on surfaces of rocks and tree barks) is association between a fungus and alga. Lichen grows where most organisms cannot and withstand desiccation for long periods. Algae manufactures food (by photosynthesis) for both organisms Fungus gives protection from intense light, drying out and absorbs water from the atmosphere

g) Hermit crab and molluscs: Shell - the sea anemone conceal and protect the crab , The crab offers transport, better oxygen supply and some particles of food

ECOLOGICAL ASSOCIATIONS AND ADAPTIVE MECHANISMS II

Adaptive Mechanisms

Some organisms have advanced adaptive mechanisms to ensure their success their environment.

1) **Insectivorous Plants**

The plants trap, digest and absorb nutritive compounds from the body of the insects and small animals. Their mode of feeding is both; autotrophic/holophytic and hetero-trophic/holozoic nutrition. This means that, as plants, they manufacture food by photosynthesis. At another time these plants feed on in sects/small animals to supplement their food.-special structures capture their prey-they have ability to secrete enzymes capable of external digestion

Examples

a) **Sundew**

i. They have glandular hairs or tentacles that fold the insects into the plant.

ii. The leaf surface is sticky always because of secretions such as enzymes that digest proteins.

iii. The glands also absorb digested insects.

iv. The mechanism is set in motion when the leaf is stimulated by the presence of the insect.

b) **Bladderwort**

i. Hairs line the bladders.

ii. Door-like valve guard the opening into each bladder.

iii. There is a low hydrostatic pressure within the bladder.

iv. The bladder is watertight with the membrane.

v. The hairs trap the insect, direct it into the bladder via an opening which closes to entrap it to death. It is then digested and absorbed.

c) **Butterwort**

i. Multi cellular glands secrete sticky fluid to which small animals adhere on contact

ii. There are also hairs and digestive fluid secreted by glands,

iii. The digested food is absorbed through the leaf surface.

2. **Parasitic Plants e.g. Viruses, Bacteria, Fungi**

a) <u>Cassyntha filiformis</u>

i. It has thread like stem that curls round the stem of the host plant

ii. At intervals small suckers or haustoria fix on the stem and grow into the vascular tissues of host to absorb salts, water and organic salts.

iii. The parasitic plant has no roots to absorb soil nutrients, no chlorophyll to enable it manufacture its food except scale-like leaves and spikes of small flowers.

b) Mistletoe (viscum)

i. This grows on trees e.g. cola, cocoa trees with the roots growing into the branch of the host plant.

ii. It then sends suckers/haustoria to absorb salts and water from the host.

iii. Continued development from seed can only continue if early penetration of host tissues is accomplished by your plant', because it makes its own food at times. It is regarded as a partial parasitic plant e.g. Eye bright (Euphrasia), Cow wheat (Melampyrum).

c) Other Parasitic plants include:

i. Phytophthora

ii. Pythium

iii. Pucciriia

iv. Peronospora

v. dodder (cuscuta)

vi. witch weed (striga)

- They do not have chlorophyll which is necessary for them to make their own food.
- They also spread by oospores, air- borne infective structures – they live on a wide range of hosts and this helps them to spread fast and wide, making it difficult to control.
- Usually the suckers/haustoriaused in sucking nutrients from the host do not damage the host's cells. Instead they make their cell membranes permeable to nutrients and pass into the parasite. Some dissolve cell walls of host using enzymes produced by the hyphae of parasite passing into host stomata e.g. in parasitic fungi.

3. Parasitic Animals

a) Ectoparasites e.g. Ticks, lice, fleas, mites, leeches

- They have attachment structures e.g. claws, suckers, hooks which enable them to cling securely to their hosts.
- Their mouthparts are modified for piercing, sucking, boring holes into the hosts tissues to such nutrients, blood or cell cap sap e.g. mosquito, housefly.
- They are capable of producing anti-coagulants to prevent the blood or cell-sap from clotting/coagulating.
- Some are vectors of disease germs e.g. mosquito: some are rarely winged e.g. fleas. Thus mosquito transmits plasmodium which causes malaria; the tick spreads Babesiosis (red water

in sheep) by carrying parasitic protozoa, Babesia; the rat flea transmits plague-causing bacteria.

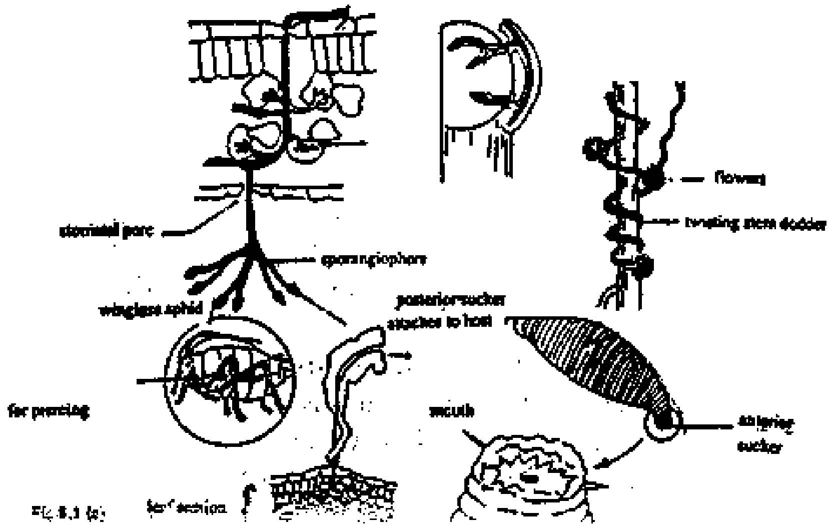
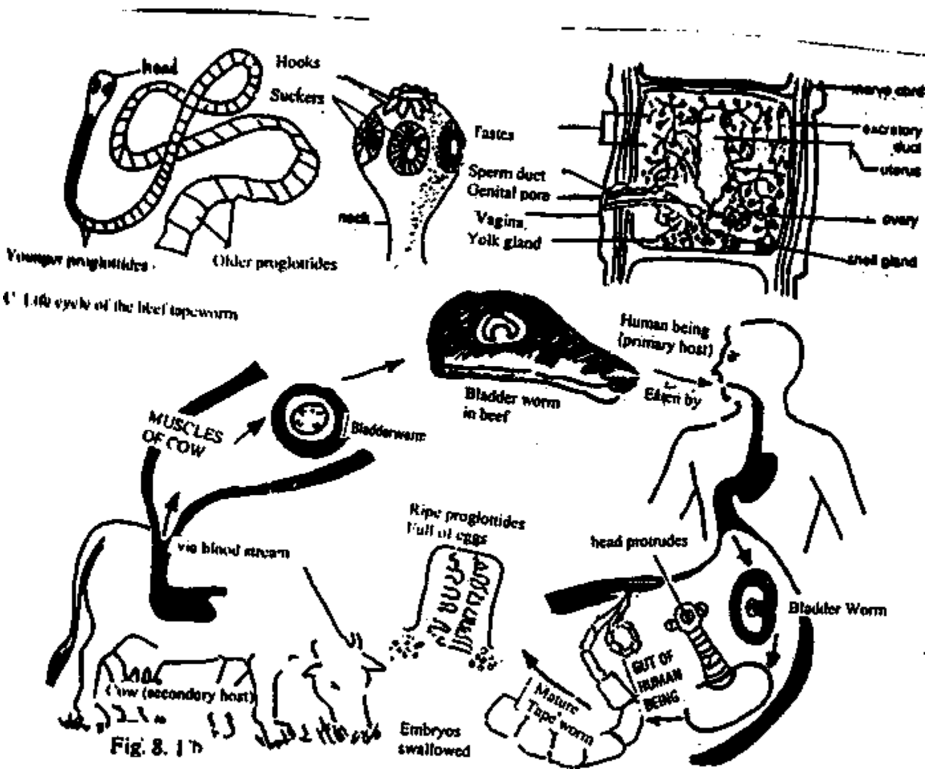


Fig. 3.10:



b) Endoparasites e.g. Tape worms (Taenia) Liver flukes (schistosoma), Fasciola hepatica, Microfilaria (wuchereria bancrofti), Blood fluke (Bilharzia), Ascaris (Round worm) Hook worm (***Ancylnstoma duodenale)***.

- They are mainly flat warms (platy-helminthes); Round worms (Nematodes) and segmented worms (Annelids) they attack both plants and animals (man and domestic animals mostly).

- They may be transmitted through the vectors, bites, larva stages, food contaminated with their eggs/larvae, through water, air and by contacts.

- They have complicated life cycles that need hosts (one stage in one host and another stage in another host) e.g. liver fluke, trypanosome.

- These parasites have highly developed reproductive system that enables them produce millions of eggs and larval stages at short period of time.

- They usually lack or show poor development of feeding. They live inside their hosts and are often obligate or specialized parasites.

Examples

i. Fasciola hepatica (Liver fluke of sheep) it is found in sheep, cattle and other mammals including man. It is a flat worm.

    - Attachment-the suckers fix the parasite in the host's bile ducts; the spines are back-ward directed to ensure that parasite is not washed down the bile ducts.

Cuticle

- thick and the secretion of gland cells protect the parasite from the effects of the host's anti-toxins

Movement

- It has lost all the cilia and well-developed sense organs.

Physiology

- enzymes to enable it penetrate the host tissues at various stages of life cycle-are produced by the parasite

- The parasite also resists the hosts enzymes.

Reproduction

- The adult lays large numbers of eggs and eventually produces over 20.000 larvae forms for infestation.

Transmission

- through infected drinking water or snail or sheep

Fig. 3.11

ii. ***Ancylostoma duodenale*** (Hookworm)

This is a round worm (Nematode) that lives attached to intestine of man. The worm lays large number of eggs passed out of host's faeces. The sere are separate. The larvae are free-living in soil and infest anybody they come in contact with by burrowing into the skin.

The worm sucks blood and produces a chemical to prevent the blood from clotting, leaving the wound bleeding. It leaves the host anaemic. As the young stages wander around the body (blood stream, lungs bronchi, Trachea, oesophagus and finally settle in intestine) they cause inflammations of lungs and tissues.

iii. ***Taenia saliun*** (Pork Tapeworm) T. saginata (cattle Tapeworm) – A flatworm (Platyhelminthes), parasite of man and animals.

Attachment - hooks and suckers by which it fixes to the gut wall to avoid being washed away

Nutrition - No alimentary canal, always bathed in solution of digested food, no mouth and thus absorbs food all over body.

Respiration -No organs for respiration or circulation, it can live anaerobically. Air etc. pass into it by diffusion.

Nervous System - Nervous and excretory systems are poorly developed

Reproduction - A hermaphrodite (male and female organs present in one organism) and produces large quantity of eggs Two hosts (man and another mammal eg. pig, cattle) are involved in the life cycle

ACTIVITY 10

Describe the relationship that exists between each of the following pairs of organisms

a. tsetse fly & zebu calf

b. hydra & algae

c. vulture & corpse of dog.

ASSIGNMENT

1. From the above examples, is there
   a) an ideal association
   b) a way out for the host in a parasitic association?
2. Can you observe any associations between man and any other group?
3. (a) Observe epiphyte in your locality. Does the arrangement fit description in Unit 5.
   (b) The chicks dashing off for cover when the hen signifies the presence of a hawk or kite
4. Draw and label
   (a) Proglottid of Taenia solium
   (b) Fasciola hepatica showing the reproductive organs.

SUMMARY

In this unit, you have learnt that:

- In any community organisms develop some relationships or associations that maybe permanent or temporary, harmful or beneficial and beneficial but not harmful to the other. These relationships are-often related to food and survival.
- This association could be mutualism where both partners gain and nom suffers. It could also be parasitism where one gains and the others loses. A times one gains and the other does not lose, or suffer (commensalisms)
- In each case each organism involved develops structures and techniques to make the association work or to be what it is. We have sited many examples to show that these associations are widespread. We can see them all around us if we are more observant.
- The parasites are a good mirror to the degree of adaptive structures and mechanisms employed by some organisms to make them succeed in their association with others. The modification of their structures and the way they operate show the intricacy of plan and the efficiency of these organisms to survive in their environment.
- Modifications and Adaptive Mechanisms Associated with Obtaining Food include:

  a) loss or reduction of powers of locomotion e.g. Fasciola, Taenia, Sacculina

  b) absence or degeneration of feeding organs and/or alimentary canal e.g. Monocystis, Plasmodium

  c) development of highly specialized mouth parts in some ecto-parasitize animals, especially fluid feeders e.g. Aphis, Glossina and Pulex

  d) development of highly specialized suckers or haustoria e.g. Sacculina, Cuscuta (Dodder)

- Modifications and Adaptive Mechanisms Associated with penetration or maintaining contact with host include:

  a) development of boring devices for entry e.g.

     i. hexacanth embryo of tapeworm

     ii. Ticks, Lice and Mites

     iii. Weevils

  b) development of organs of attachment to enable organisms cling securely on/in the host e.g.

     i. hooks & suckers of Taenia

     ii. suckers of Fasciola, Leeches

     iii. "teeth" of hookworm

     iv. claws of biting lice

c) development of organs associated with giving resistance to Host's reactions

i. thick resistant outer coverings in some parasites e.g. Taenia, Fasciola, nematode (round worms)

ii. rapid means of escape e.g. Pulex (flea)

- Modification and Adaptive mechanisms associated with nutritional Process

i. exo-enzymes produced to digest host tissues external to the parasite e.g. fungi, plasmodium

ii. failure to develop photo synthetic pigment (e.g. chlorophyll) e.g. Cuscuta (Dodder)

iii. production of anti-coagulants (not solidifying) e.g. Hirudo (Leech) Pulex (flea)

iv. production of cell-dissolving (cytohfic) substances to enable gain entry into host e.g. fungi, dodder

- Modifications and Adaptive mechanisms associated with reproduction

i. Hermaphrodite condition that ensure self fertilisation e.g. Taenia, Fasciola, many Fungi

ii. Prolonged association of male and female where male may carry female & vice versa e.g. Bilharzia

iii. Release of sexually mature forms as free living e.g. Horse-hair worms

iv. High production of eggs, larvae, spores, cysts to ensure survival of the species

v. use of secondary hosts as vectors e.g. Taenia in pig

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UNIT 5: OBSERVATION INSTRUMENTS IN ECOLOGY

INTRODUCTION

You have learnt, from the last two units 7 and 8, that organisms (plant and animals) live in populations (groups of the same species) that operate in communities (different populations living in a habitat). They interact among their species or across with other species. This includes animals with animals or plants with animals.

Thus associations are formed which could be temporary or permanent in order to enhance individual or group interests in the community. These relationships may be for mutual benefit (mutualism) loss and gain respectively, parasitism or in some, gains but no one loses (commensalism)

You also learnt that many modifications or changes in structure and different complex methods are used" to build up such associations. All said and done, some dynamic balance or equilibrium is maintained in the ecosystem.

Even though man is at the peak of creation in terms of his high, complex abilities, his sensory organs (eyes. nose, tongue, ears, skin) are still limited in seeing, smelling, tasting hearing and" feeling things and situations around and beyond him. Man, therefore, needs help and some support to improve on these limitations Man has however devised, designed and put in place instruments, machines and gadgets that enable him improve upon his senses. These instruments are many, ranging from the simple to the complex both in operation and structure. In this unit, we shall sample some, particularly those readily available and in use in the school environment.

OBJECTIVES

By the end of this unit, you should be able to

- name instruments commonly used in schools for the study of ecological and laboratory events;
- recognize the instruments and relate them to their functions;
- handle/manipulate the instruments for better results of observation; and
- maintain or service the instruments, using the manufacturers' manual as a guide or make simple but effective instruments for observation of events in the environment.

WORD STUDY

Interact: associate with, work with or relate with

Complex: intricate, compound, involved

Instrument: active, not stationary

dynamic: gadget, equipment for doing something, work

INSTRUMENT FOR OBSERVATION

To "aid" means help or support and to "observe" means to look at something critically to note the details of it.

Listed below are some of the instruments that aid observation of events in and around us and beyond, we will take a few examples for more detailed study.

1. **Quadrant** - An instrument for observation of plants in a marked out area as a representative of the plant growth or population in that part. It is usually made of mood string in square/rectangular form, and of different sizes.

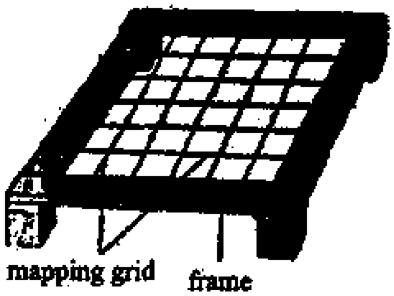


Fig. 3.12

2. **Transact** - instrument for measuring land marked off a stock of plant growth for observation and recording of details about the different sorts of plants making it up (linear).

3. **Net** - different types for different purposes e.g. sweeping, hand, plankton, drag/tow net for catching or collecting some plants and animals and identifying, counting than.

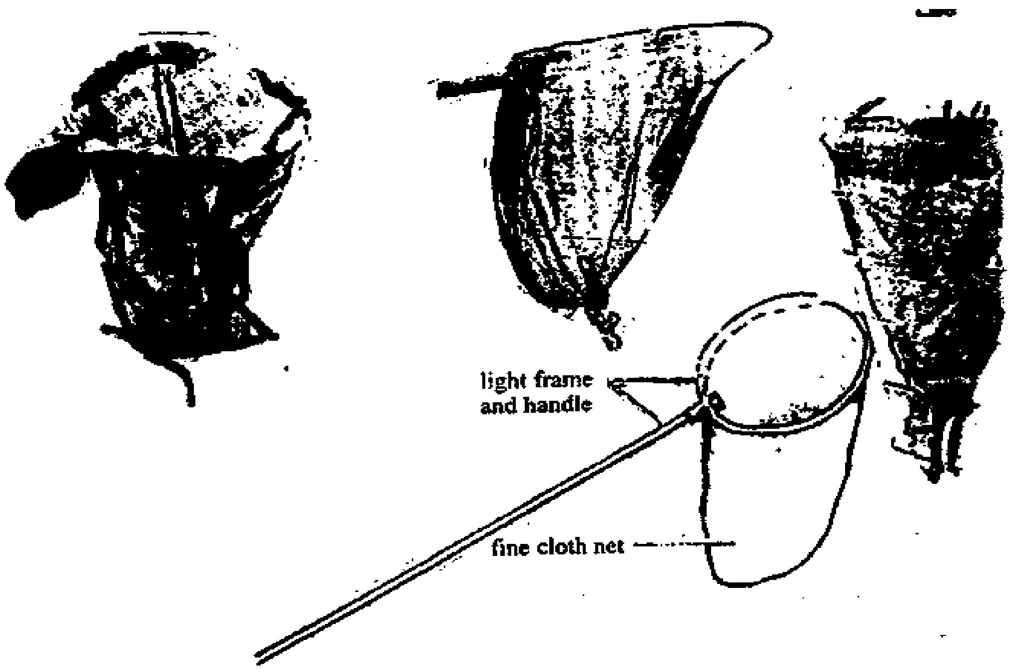


Fig. 3.13

4. **Funnels**

- Tullgren's - to compare the number and type of animals in different soil types.

- Baermann- to collect tiny organisms that inhabit soil water.

5. **Rainguage**: An instrument for measuring the amount of rainfall in a given time; generally in the form of a funnel going down into a narrow- necked vessel marked with a scale.

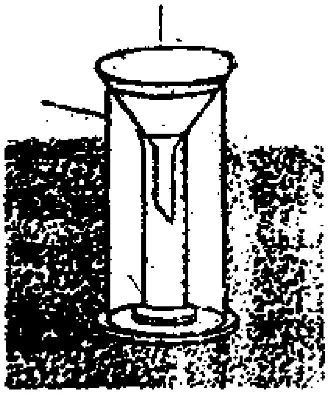


Fig. 3.14

6. **Photometer/Light Meter:**

An instrument for measuring intensity of light in an environment.

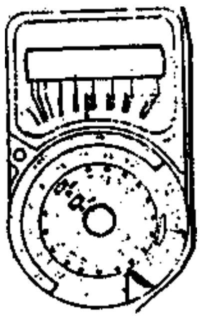


Fig. 3.15

7. **pH Meter:**

An instrument for measuring and recording automatically the degree of acidity or alkalinity in a medium e.g. water, soil.

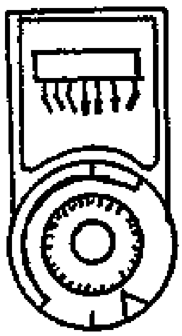


Fig. 3.16

8. **Wind Vane:-**

An instrument put up on top of a building or in open space (without obstructions) for marking the direction of the wind. It is usually made up of fixed frame with arms pointing North, South, East and West, has a level pointer freely moved by the wind over it.

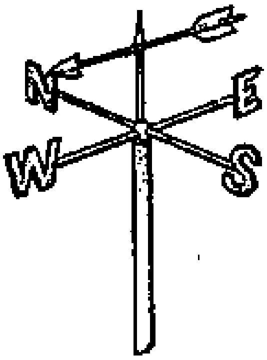


Fig. 3.17

9. **Anemometer.-**

An instrument for measuring force or rate of motion of wind ie the speed

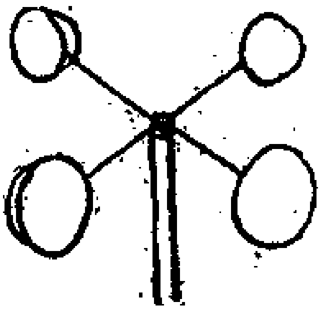


Fig. 3.18

10. **Secchi Disc:**

An instrument used to test or determine the turbidity or how clear a liquid/water is by a comparison of the amount of light coming through them.

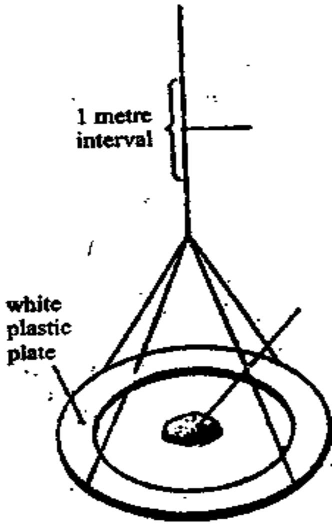


Fig. 3.19

11. Hydrometer-

An instrument for measuring the density (the mass or weight of unit volume of a substance) of a liquid formed of a hollow metal or glass body with a long stem, weighted so as to keep upright in the liquid and frequently market with a scale the degree to which the instrument goes down in the liquid giving the density.

12. Hygrometer

An instrument recording changes in the amount of water in the air or relative humidity a pocket type or the wet/dry bulb thermometer can also serve the purpose.

13. Thermometer-

An instrument for measuring the degree of coldness or hotness of a medium e.g. body, water, soil. The commonest form consists of:

a. a glass bulb opening into a very thin glass pipe shut at the end and

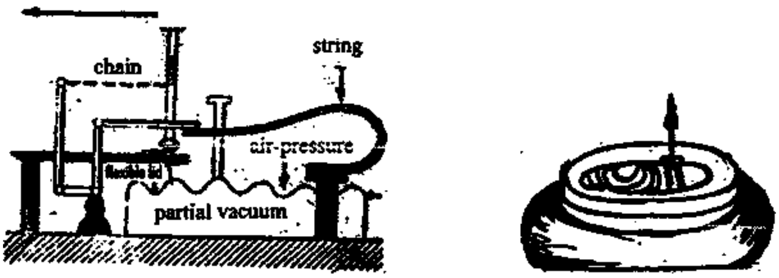
b. marked with a scale, the bulb and part of the pipe being full of mercury

c. the level of which goes up and down the scale as the bulb becomes warmer or colder.

Fig. 3.20

14. Barometer

(Anaeroid)- An instrument for measuring pressure of the earth's atmosphere or air pressure (force pushing against some opposite force). Air pressure decreases with altitude while at sea level it is 760 mm of mercury movable needle air-tight metal box.



The aneroid barometer measures air pressure

Fig. 3.21

15. Slope Guage:

An instrument that measures the gradient of the land (i.e. the distance in which it goes up or down one unit).

16. Water speed Meter

An instrument that measures the rate of water flow. A weighted specimen Boule/tube can also measure the flow or speed of current.

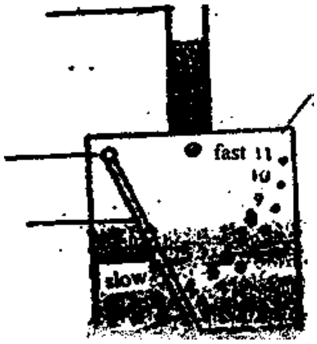


Fig. 3.22

17. Traps-

a. Pit-fall

b. Baited

Instrument for capturing animals so that they can be observed, studied in a confined environment

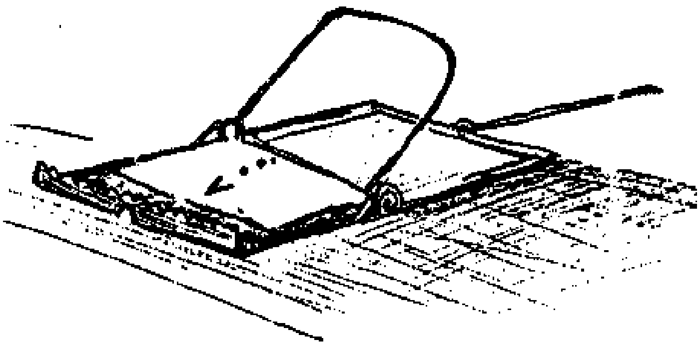


Fig. 3.23

18. Microscope

An instrument used in seeing microscopic/very tiny things better; it is made up of convex lens (simple) or two converging lenses or systems (compound), It enlarges the size/images of very small organisms.

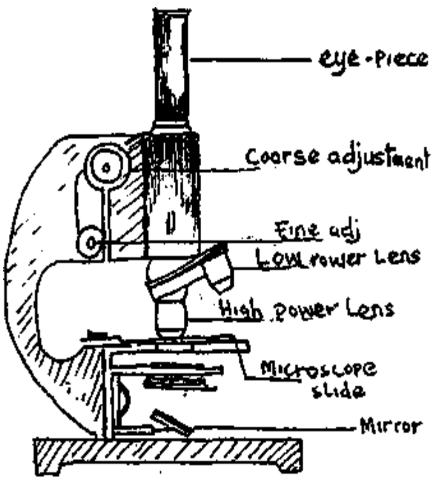


Fig. 3.24

19. Hand Lens:

An instrument used in seeing small/tiny things or organisms better. They are held by hand

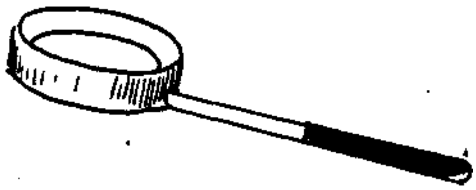


Fig. 2.25

20. Tide Guage:

An instrument that records the variation in tide levels (high or low).

21. Telescope:

An instrument for viewing things at great distance e.g. in the sky. It is made up of

- a long pipe-like structure with a convex lens (object lens) or
- concave mirror at the outer end by which the rays from the object viewed are formed into a small, very bright image and
- a lens or system of lenses or prisms at the other end where the eye is placed, by which the image is greatly increased in size.

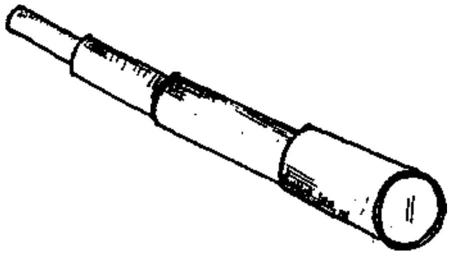


Fig. 3.26

22. Satellite

A man-made body fixed up into orbit (space) round the earth or up in space, by a rocket. One of the uses is to gather information/data about events in the sky e.g. weather, movement of planets, and events on earth.

ACTIVITY 10

Can you lay hands on any of the following instruments in the schools near you?

(a) Microscope

(b) Hand lens

(c) Cage

(d) Thermometer

(e) Meter Rule

- Identify the parts and their function
- manipulate them to see how they work
- what results did you obtain

ACTIVITY 88

a. Cut off a measured portion of old/abandoned mosquito netting

b. Tie it round a circular metal ring with a handle

c. Use it as insect net to catch some insects

ASSIGNMENT

1. Fast-moving, small invertebrates can be captured with a Footer The collecting tube is directed at the animal and it is pulled into the specimen tube by sucking - draw and label a pooter

2. Take the temperatures of

   a. your body (put the thermometer under your arm pit)

   b. the water from your drinking pot or refrigerator

   c. What formula do you use in calculating the amount of rainfall recorded with a Rainguage.

SUMMARY

In this unit,

- You have tried your hands on same basic instruments used in observing some events around you e.g. thermometer for changes in the temperature of your body, soil, water or room?.

- You have also used the hand lens and/or the microscope to observe things or organisms you could not see with your naked eyes - exciting, isn't it?

- Science and technology have been applied by man to produce the instruments he needs to improve on the natural abilities of his senses. He can now test, measure, detect, feel and/or record changes in his daily life with appropriate instruments. The knowledge he obtains from the data (information) he collected enable man to

  a. improve upon his living conditions

  b. improve upon his crop and animal production

  c. improve on his prediction of the weather

  d. improve on his knowledge of events around and even beyond his reach

  e. be in the end, the master of created things using these instruments.

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UNIT 6: GENETICS: HEREDITY IN LIVING THINGS

INTRODUCTION

Genetics is a biological science that is concerned with the study of heredity and a variation. You may have been wondering why members of your nuclear family differ or took exactly as your mother or father and possibly like any of your grandparents.

In unit 1 you looked at the differences among living things. In this unit, you will be looking at the basic component of the cell and the type of cell division that takes place in the living cells which makes heredity possible. The nucleus of every living cell has several thread-like structures called chromosomes. Each of the Human cells contains 46 chromosomes. Each cell of other living organisms, has its own peculiar number of chromosomes present in each of their body cells.

The presence of chromosomes in the nucleus makes the nucleus the most important component of your body cells. The chromosomes are made up of DNA and proteins. The DNA is a set of instructions to the cell. These instructions tell the cell what proteins to make.

OBJECTIVES

By the end of this unit you should be able to:

1. describe the stages of mitotic division;
2. describe the stages of meiotic division;
3. explain terms used in genetics;
4. state Mendel's laws of Heredity; and
5. explain the stages of a Monohybrid cross.

WORD STUDY

Genetics is a biological science concerned with the study of heredity and variation.

Heredity is the tendency of an offspring to possess certain features/characteristics similar to either of or both parents.

The nucleus is that part of the cell that is concerned with reproduction and with transmission of characters from parents to offspring.

Chromosomes are threadlike structures contained in the nucleus. They are made up of DNA and protein.

DNA: Stands for deoxyribose nucleic acid. The molecules contain instructions for making different kinds of proteins. Protein is a substance made up of carbon, hydrogen, oxygen and sometimes contain sulphur.

RNA stands for ribose nucleic acid.

Genes are part of the DNA molecule which gives instructions for the making of a particular protein. There are more than one types of gene in a particular chromosome.

Homozygous chromosomes a pair of identical chromosomes.

Heterozygous chromosomes a pair of unidentical chromosomes

Zygote is a single cell formed as a result of the union of a male sex cell with a female sex cell during sexual reproduction. It is a fertilized egg, containing diploid number of chromosomes.

A gamete is a mature sex cell which takes part in sexual reproduction. It maybe a male (sperm cell) or a female (egg cell). Each gamete contains haploid number o chromosomes.

Allelomorphs are a pair of genes responsible for a pair of contrasting characters, like the red and white flower colour in the common garden pea plant.

A pair of **Allelomorphs** is also known as an allelic pair, in which case each member of the pair of allelomorphs resides on the same position, or locus of homologous chromosomes.

An individual is said to be **homozygous** if the two members of a pair of gene controlling a given pair of contrasting characters are identical.

An individual is said to be **heterozygous** if the two members of a pair of genes controlling a given pair of contrasting characters are different.

A dominant character is a character that produces its effect even though the opposite, or contrasting character is present.

A recessive character is a character which does not produce its effect in the presence of a dominant gene.

A dominant character is controlled by a dominant gene.

A recessive gene is controlled by a recessive gene.

Phenotype is used to describe the individually expressed traits.

Genotype is used to describe the individual's total genes inherited from both parents. These include both the individual's genes that are dominant and recessive genes that are not expressed.

Filial generations are the offspring of the parent generation. First, second and third generations and a represented by the symbols F_1, F_2, F_3 respectively.

STAGES OF MITOSIS

Mitosis is the type of cell division that takes place during growth and development. This type of cell division also occurs in asexual reproduction. Located inside the cytoplasm of the cell is the nucleus. Animal cells and some simple plant cells have structures called centrosomes along side of the nucleus.

The centrosomes are composed of two parts at right angles to the other. In mitotic cell division, you are concerned with what happened to the chromosomes inside the nucleus.

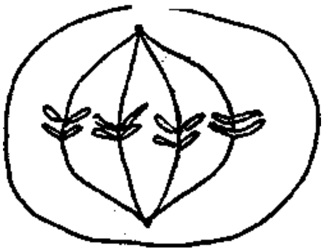
Early Prophase

The centrosomes move to opposite sides of the cells from each centrosome spindle fibres develop.

Late Prophase

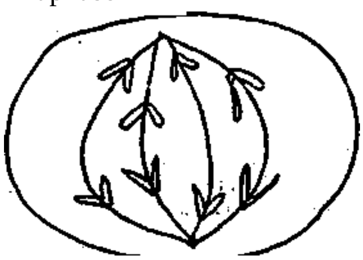
The chromosomes become more pronounced.

Metaphase



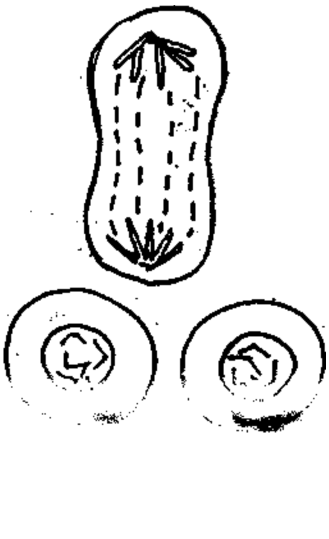
The chromosome move to centre of the cell and line up in pairs.

Anaphase

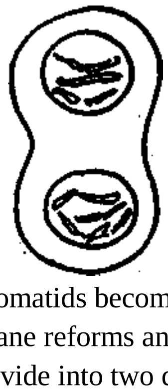


Chromatid separate at the centromere. Each pair move to the opposite pole of the spindle thread.

Late Anaphase



Telephase



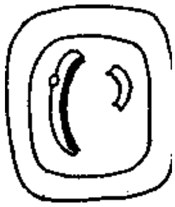
Two sets of chromatids become indistinct. Nuclear membrane reforms and parent cells Constrict and divide into two daughter cells. Each cell contain the diploid number of chromosomes

THE STAGES OF MEIOTIC DIVISION

Meiosis cell division only takes place during the formation of gametes before sexual reproduction. The cells present in the reproductive organs which give rise to sperms and ova undergo mitotic cell divisions. The final cell division which gives rise to the gametes is a meiotic division.

In meiosis, there are two divisions of cells quickly following one another. This division is accompanied by only a single duplication of chromosomes. The result is that haploid nuclei are formed.

Stages of Meiotic Cell Division



Prophase

(a) A diploid number of chromosomes appear.

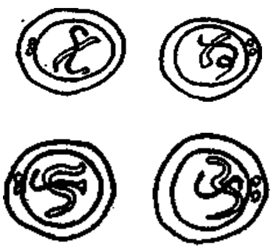
(b) Homologous chromosomes chromosomes pair with each other, and then shorten and thicken.

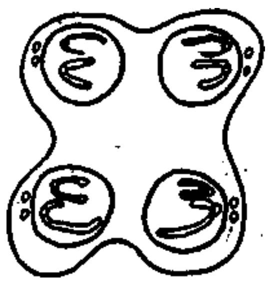
(c) Replication has occurred and the chromatids become visible.

Anaphase

(d) Homologous Chromosomes move Apart except at the chiasma where the chromatids have exchanged portions

(e) A spindle has formed and homologous chromosomes move to opposite ends taking exchanged portions with them.





Second Meiotic Division

(f) Spindles form at right angles to the first one and the chromatides separate

(g) Four nuclei appear, each enclose the haploid number of chromosomes

(h) cytoplasm divides to form four gamete cells.

MENDEL'S IDEAS ON HEREDITY

Gregor Mendel was the first to work on genetics in 1856. His work on genetics was carried out with plants and he tried to find out how hereditary characteristics were transmitted in the plants he studied. Mendel was mainly concerned with garden pea and he worked on various inherited characteristic such as the length of plant, colour of seed, surface of seed coat. As a result, he was able to produce offspring of these plants, both by self-pollination and by cross pollination. From his experiments lee came out with two laws of Heredity.

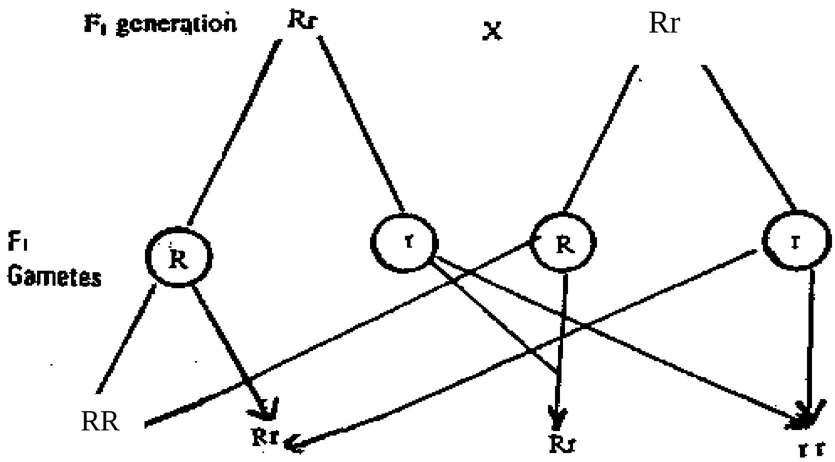
The First Law of Mendel is the law of segregation of genes. The law states that genes are responsible for the development of the individual and they are independently transmitted from one generation to another without undergoing any change.

The Second Law of Mendel is the law of independent assortment of genes, the second law of Mendel states that each character behaves as a separate unit audits inherited independently of any other character.

Mono-hybrid Cross - Complete Dominance

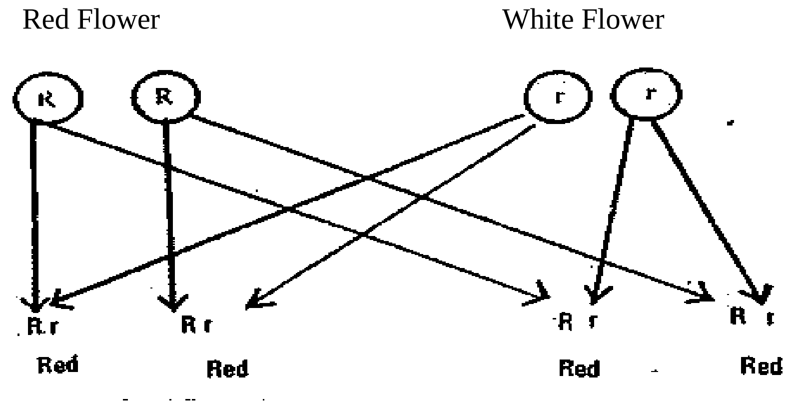
A good example of a Mono-hybrid is the flower colour of the garden pea plant, A pure stock of red-flowers when crossed among themselves will always produce pure red flowers only. In the same way, a pure stock of white flowered pea will ate produce only white flowers. We can say that both the pure red and pure white pea flowers are true breeds. In his experiment, Mendel crossed the red-pure breed flower with a pure- white breed flower. The result of Mendel crossing is shown below.

Monohydrid Cross



The result of the crossing showed that the First generation of pea flowers were, all Ted flowers, the crossing of the F1 generation flowers with two types of genotypes and two phenotypes. The genotypes Appear in the ratio of 1:2:1 or RR homo zygyous white flowers. The phenotype appears in the ratio of 3:1 that is three red flowers to one white flower.

Back-cross is always done to confirm the genotype :of the red flowers in the Fz generation This is done by crossing the red flowers (genotypes Rr or RR) with a true breeding (genotype rr). The Back-cross is shown below.



A red flower homozygous was used so the offspring's were all red Flowers

When the heterozygous red is crossed half the number (2) flowers were red and the remaining 2 flowers were white.

ASSIGNMENT

1. State the two Mendelian laws of Heredity.
2. Describe mitosis. What are the essential differences between mitosis and meiosis?
3. a. Write down the three possible genotype of a pea plant with red flower dominant.

   b. What will be the phenotype of a pea plant which is homozygous for the dominant allele?

   c. What would be phenotype of a heterozygous pea plant.
4. When a pure stock tall pea flower was crossed with a pure stock of short pea flower, the offspring (F1 generation were all tall plants. If only one type of genetic factor is concerned what type of plant would you expect if you cross the flowers of this FI generation Give reason for your answers.

SUMMARY

In this unit you learnt that:

- The nucleus is the most important structure of the cell
- The chromosomes are housed in the nucleus and control the activities of the cell.
- The chromosomes are made of DNA and proteins.
- DNA. is a set of instructions to the cell.
- The cell undergoes 2 types of division: mitosis and meiosis.
- In mitotic division, the cell divides to give 2 daughter cells. They are diploid.
- In Meiotic division 4 daughter cells are produced and they are haploid.

- When pure breed red pea flowers were crossed with true breed white flowers, the phenotype ratio was 3 red flowers to 1 which flower.
- The genotype ratio was 1 red (pure breed) to 2 red flower (heterozygous) to 1 white pure breed (homozygous.)
- Back cross of red homozygous flower with white (homozygous) flowers from Fi generation produced all red flowers.
- Back cross of red heterozygous flower \\ith white (homozygous) flowers produced 2 red flowers and 2 white flowers

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UNIT 7: ECOSYSTEM

INTRODUCTION

The sun releases a tremendous continuous flow of energy of which a small fraction reaches the earth's surface as sunlight. This fraction is called solar flux. About half of this is absorbed by the upper atmosphere or is reflected back to space. Most of the energy that actually strikes the earth's surface is converted into heat energy. Only a fraction or 1 percent is absorbed by green plants and used in photosynthesis. Thus, primary producers in a community are the green plants and all living things in any ecosystem, are sustained by this energy derived from the sun. The process of converting light energy through photosynthesis by green plants into organic matter is called energy fixation. All green plants are called producers. All producers are autotrophic. All other organisms like man and animals are heterotrophic (feeding on others) and are, therefore, called consumers. Animals that derive their nutrition from eating plants directly are herbivores or primary consumers (e.g. goat, cow): Carnivores are secondary consumers (e.g. cat, and lion) as they eat herbivores and thus derive their energy indirectly from the producers. This transfer of energy from one organism to another in a series of trophic levels of eating and being eaten is caJ1ed a food chain. In a community, there are a series of food-consumer relationships and several food chains are interconnected to form a complex series called food web. In a food chain each successive level is known as a trophic level.

OBJECTIVES

By the end of this unit, you should be able to:

- state what energy is;
- describe energy flow;
- describe food chains;
- state law of thermodynamics; and
- describe types of pyramids and forms of energy.

Energy Flow

Energy flow through a food chain from one trophic level to another is utilized in either of the following manners.

a) Production of material is called biomass or is the weight of producers, consumers and decomposers that exist in an ecosystem at a particular time.

b) A part of energy is lost due to respiration. It is this process by which energy is utilized for various metabolic activities.

c) The rest of the energy is lost as heat which is released during various activities.

Energy that is utilized by producers (green plants) is radiant energy, which is converted into chemical energy by green plants which is the energy required by all living organisms. The chemical energy is concentrated in food which is synthesized by the producers. This energy is converted into potential energy by a rearrangement of the atoms of food and is released as kinetic energy by a rearrangement of the atoms. During work, there results a random movement of molecules producing heat energy. The unit of heat energy is the calorie (cal.), a larger unit is kilocalorie (Kcal) composed of 1000 cal. About 500,000 Kcal/m Iyr radiant energy is received on the earth's surface depending on the location and season. Only 1 or 2 percent of the total radiant energy received by the earth is converted into chemical energy by producers. In general, in the transformation of energy through the ecosystem, the energy in magnitude of 10 is lost from one trophic level to another. Thus, about 100 kcal would be converted to herbivore tissue and 10 kcal to first carnivores, if 1000 kcal of plant energy were consumed by herbivores.

The ecological efficiency is the ratio of the energy used by one step in a food chain in unit time to the energy made available to the next step. The ecological efficiency for the plants is about 1 percent. Due to complexity of food chains, it is rather difficult to study food chains in nature. A generalized food chain in an abandoned old field involving mice and foxes.

The vegetation converts about 1 % of the solar energy into plant tissue. The mice consume about 2 % of the available plant food while the foxes about 31 % of the mice. About 75 % of the stored energy in ungrazed vegetation is returned to the soil as dead plant material. Similarly, out of the quantity consumed by herbivores, about half goes to soil as faeces.

Types of food chains

There are two types of food chains.

1. Predator (grazing) food chain:

This is made up of predator species and their prey or food species which are usually alive or freshly killed, when they are eaten.

Grasses → Sheep → Wolves →Lion

In predator (grazing) food chain, the energy source is the sun and the green plants use the solar energy to make food for the ecosystem. Usually, food chains consist of many links. For example, in aquatic habitat, microscopic floating plants called phytoplankton are primarily responsible for the production of organic: matter by photosynthesis. These tiny autotrophic plants are consumed by a cellular and multicellular animal called zooplankton. These zooplankton are eaten by shrimps, lobsters, crabs, small fish and so on. The shrimps, lobsters and crabs may be eaten by small fish and small fish eaten by larger fish. The larger fish then serve as food for various birds or mammals whose final death and subsequent decomposition by micro-organisms of decay end the food chain.

Food chain that Start with dead organisms

For simplicity reason, the food chains are indicated as straight pathways. In fact, these are more complex and are often accompanied by various branching and parallel sequences. Herbivorous plankton may also be directly eaten by fish, which eventually perish and decay thus contributing short branching food chain, connected to the larger one. Thus food web occurs, with all sorts of short circuits and connections occuring in a system.

In this type of food chain the starting material is unused or dead organic material. The feeding species attack only dead organisms. Bacteria and fungi of decay feed on the faeces of animals, the cellulose of fallen trees, dead bodies of mammals etc. As bacteria and fungi of decay exhaust their food supply, most of the members of the bacteria and fungi population die and their remains are decomposed yet by another set of micro-organisms. Again their waste material also serves as food for other micro-organisms. Thus the end products produced by the whole complex of detritus food chains are carbon (IV) oxide [carbon (IV) oxide], nitrates, phosphates, sulphates etc. After the completion of the detritus cycle, no combustible organic matter is left.

Humus → Earthworm →Domestic fowl →Human being → Decomposers

Sewage treatment facilities are designed to provide detritus feeders with an optimal environment, so that they can degrade sewage as fast as possible.

Transformation of energy by autotrophs

As discussed earlier, only 1% of the radiant energy is converted into chemical energy. The rate at which energy is incorporated into a particular component of a community is called the productivity of that component.

Ecological pyramids and laws of thermodynamics

The flow of energy through a community can be represented by a pyramid of energy. The energy flow across different trophic levels is governed by second law of thermodynamics which state that *in any conversion of energy from one form to another, there is always a decrease in the amount of useful energy.*

A good example is in food chain. The transfer of energy between trophic levels is not 100%, that is, successive levels have less energy and support fewer animals. The primary producers (plants) have the highest energy.

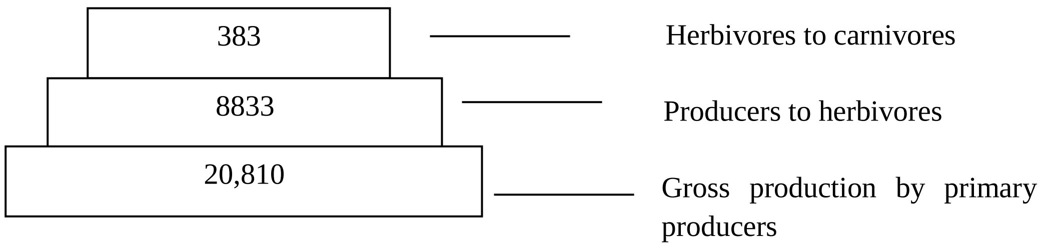

Figure 23.55: Pyramid of Energy

When herbivores consume plants, the energy level is reduced and when carnivores consume herbivores the energy level is further reduced. This conforms with the second law of thermodynamics.

The first law of thermodynamics states *that energy can neither be created nor destroyed*. In order words, one can say that the total amount of energy resulting from any conversion is the same as the initial amount of energy.

A good example is the transformation of solar energy to chemical energy by plants during photosynthesis,

Solar energy = Chemical energy + Heat energy

For example, in Silver Springs River in Florida, the plants absorbed 20,810 kcal per square metre per year. 11,977 kcal per square metre were used up for respiration leaving 8833 kcal/m^2/yr.

Solar energy absorbed by plant = 20.810 kcal/m^2/yr and 11,977 kcal/m^2/yr were used for respiration leaving 8833 kcal/m^2/yr. stored in the plants.

20,810 kcal/m^2/yr = 8833 + 11, 977 kcal/m^2/yr

Adding 8833 to 11,977 will give 20,810. This conforms to the first law of thermodynamics.

The chemical energy can be converted into different forms of energy. For example, in the muscle tissue, the chemical energy in the food is converted into mechanical energy for work.

In an ecological pyramid, the first level or producer level forms the base and successive trophic levels as the upper tiers. Each successive level can support fewer organisms than the previous. This is due to the inefficiency of energy transfer from one trophic level to another. The pyramid's original energy is progressively reduced from plants to herbivores to carnivores. Also there is a reduction of biomass (weight of living organisms) along the food chain.

Types of pyramids

There are three types of ecological pyramids.

1. Pyramid of numbers
2. Pyramid of biomass
3. Pyramid of energy.

These pyramids are graphically represented based on numbers of individuals, total dry weight and energy. These ecological pyramids do not include decomposers, whose number is too large but weight is too small as it becomes inconvenient to be measured or graphed.

1. Pyramid of numbers

In this pyramid, the number of individuals at each trophic level is arranged in a graphic system. It gives a quick idea of the relative abundance of the organisms that constitute each trophic level. The organisms at the base (producers) are the most abundant and other higher successive trophic levels decrease rapidly and finally there are very few carnivores at the top.

The pyramid of numbers over emphasizes the importance of small organisms. The number of organisms decreases at each trophic level since many producers are needed to support fewer herbivores and fewer herbivores are needed to support fewer carnivores (primary, secondary and tertiary consumers).

However, if the primary producers are very large in size for example trees, fewer numbers will feed a higher number of herbivores. Many caterpillars can feed on the leaves of one tree.

Tertiary consumers (e.g. snakes)

Secondary consumers (e.g. Lizards) Herbivores (e.g. Caterpillars, Grasshoppers) Primary Producers (e.g. large trees)

Tertiary consumers (e.g. snakes)

Secondary consumers (e.g. lizards)

Herbivores (e.g. Caterpillars, grasshoppers)

Primary Producers (e.g. large trees)

2. Pyramid of biomass

The pyramid of biomass indicates the standing crop (amount of biomass present at a particular time). Pyramid of biomass over emphasizes the - importance of -large organisms that have heavy weight.

3. Pyramid of energy

It indicates the amount of energy flow at each level and the role which the organisms play in the transfer of energy. The pyramid of energy gives an overall picture of the functional nature of communities and throws light on the rate at which food material passes through the food chain. It also indicates how efficiently the energy can be transferred between trophic levels and the potential number of levels that can be maintained in a system on the assumption that there is a minimum energy requirement to support a trophic level. Energy flow pyramid provides a more suitable index for comparing any and all components of an ecosystem.

Major sources and forms of energy

What is energy?

Energy is defined as ability to do work. Energy supports life and in all life activities, energy is involved. When you walk, speak, eat, laugh, sleep, write, etc. energy is expended.

Major sources of energy

The sun is the ultimate source of energy on earth. Chloroplasts in green plants are capable of sun's energy and converting it into stored in organic compounds during the process of photosynthesis. The stored released is used for work.

Forms of Energy

Basically, energy exists as either potential or kinetic energy.

Potential energy

This is a stored form of energy which is released when the need arises. For example, food in the body is stored as potential energy. When an energy to do work (e.g. running) is required, the stored potential energy is converted into kinetic energy through cellular respiration. Kinetic energy is an energy at work. The released chemical energy from glucose can be converted into different forms of energy. These are:

1. **Electrical energy**

This is used for the conduction of nerve impulses. Nerve cells change chemical energy to electrical energy.

2. **Mechanical energy**

This is used for the contraction of muscles change which brings about movement of different parts. The cells of the muscles change chemical energy to mechanical energy.

3. **Light energy'**

   The light energy is derived from chemical energy during cellular respiration.

4. **Heat energy**

This is used for the regulation of the body temperature. The heat energy is derived from chemical energy during cellular respiration.

5. **Sound energy**

This is energy in form of waves which causes the eardrum to vibrate and is interpreted as sound by the brain.

Eating too much

Eating more than the body requires to produce energy results in the excess food being converted into fats and stored under the skin. The person gains weight and if the habit of eating excess food continues obesity results.

On the other hand, when a person is starving or sick, he derives energy from the stored fats. He now loses weight. When all the stored fats are used up, the tissue proteins are also used for supplying energy. Under this condition, the person becomes very lean and weak.

Nutrient cycles

Except for the radiant energy used in photosynthesis, energy does not move through the biosphere in pure form. It flows through the food chain **unidirectionally** and is coupled with matter in the form of chemical bonds. The matter remains within the biosphere, being constantly recycled between living and non-living components. The pathway that matters follows as it moves from the non-living environment through the food chains of the biotic community and back to the non-living (abiotic) environments form closed loops called biogeochemical cycles.

There are more than 100 chemical elements on earth and only six of the 16 lightest elements, that is, hydrogen, carbon, nitrogen, oxygen, phosphorus sulphur play major role in the metabolism of living organisms. Furthermore, oxygen, hydrogen, and nitrogen dominate the chemistry of biosphere and make about 99 % of world biomass. There are a number of biogeochemical cycles ,but only three are discussed here.

Carbon cycle

The carbon cycle involves the-atmosphere and the ocean. The atmospheric carbon in the presence of sunlight is converted into chemical bond energy during the process of photosynthesis which is shown in the following equation.

$$6CO_2 + 6H_2O \xrightarrow[\text{Sunlight energy}]{\text{673 kilocalories}} C_6H_{12}0_6+60_2$$

Here carbon (IV) oxide and water are used and organic compound and oxygen are produced, whereas respiration has the opposite effect. The carbon (IV) oxide is found in the atmosphere and dissolved in the water of the earth. The amount of carbon (IV) oxide in the atmosphere is 0,03 %. The bulk of the carbon is locked up in the rocky crust as limestone and their rocks. Another source of carbon is fossil fuel (crude oil).

The absorption of carbon (IV) oxide from the atmosphere and water

The carbon (IV) oxide ($C0_2$) in the air and that dissolved in water constitute the reservoir of inorganic carbon. During photosynthesis, green aquatic and terrestrial plants make use of the carbon (IV) oxide to manufacture carbohydrates and other foods. Animals obtain the carbon by feeding on the food of plants containing carbon.

Return of carbon to the atmosphere and water

When terrestrial plants and animals respire, carbon (IV) oxide is produced from the breakdown of the food containing carbon.

Glucose + oxygen $\rightarrow$` Carbon (IV) oxide + Water + Energy

$C_6H_{12}0_6 + 60 \rightarrow$` $6C0_2 + 6H_20$ + Energy

The fermentation of sugar by yeasts also gives alcohol and carbon (IV) oxide.

Sugar $\rightarrow$` Alcohol + carbon (IV) oxide by yeasts

$C_6H_{12}0_6 \rightarrow$`$2C_2H_5OH + 2C0_2$ + Energy

Decay

When plants and animals die, bacteria and fungi cause the decay of the dead plants and animals thereby releasing the locked up carbon as carbon (IV) oxide to the atmosphere.

Combustion

During the combustion of organic materials such as coal, wood and petroleum, the carbon is oxidized to carbon (IV) oxide.

Decomposition in nature

When plants and animals die, their bodies decay. Bacteria and fungi feed on the decaying bodies of these organisms and break: them into simpler molecules. These micro-organisms are called decomposers and constitute the final major trophic group in the ecosystem. The other macro-decomposers are earthworms, termites, mites,

Oxygen Cycle

20% of the earth's atmosphere is oxygen. Oxygen is removed from the atmosphere by respiratory activities of living things. For every molecule of oxygen used in internal respiration, a molecule of carbon (IV) oxide is given out. Also for every molecule of carbon (IV) oxide used, up in photosynthesis, a molecule of oxygen is given out beetles and other small arthropods. Fire in savannah areas also helps as decomposers. The primary function of these decomposers in an ecosystem is to decompose the organic compounds locked up in the bodies of producers and consumers and in their waste matter .such as the faeces of animals, and fallen leaves and twigs of plants.

Water Cycle

Water cycle is the continuous movement of water from the earth to the atmosphere by evaporation and back from atmosphere to the earth by precipitation. The solar energy causes water to evaporate from the hydrosphere into the atmosphere. When the water vapour cools, it condenses. At high altitude, the condensed water forms clouds. The clouds precipitate as rain returning to the hydrosphere.

Plants and animals contribute to the cycle. Aquatic organisms absorb water from their environment. They excrete some of the water back and after death the remaining water returns during decay.

Terrestrial plants absorb water from the soil and some of the water is given to the atmosphere during transpiration.

Terrestrial animals drink water for metabolic perspiration. The remaining water is returned to the hydrosphere through excretion, respiration and perspiration. The remaining water is returned to the hydrosphere by decay when the organisms die.

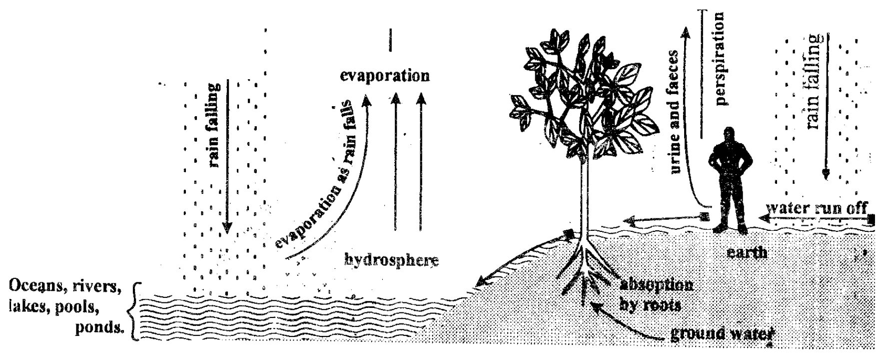

Figure 23.63. Water cycle in nature

Nitrogen cycle

Nitrogen is one of the essential elements. It is utilised by plants for making proteins and chlorophyll. The earth's atmosphere contains about 78 % of nitrogen. Organisms cannot use gaseous nitrogen except some few species of bacteria and blue green algae that are capable of utilising the gaseous nitrogen from the soil. Gaseous nitrogen is converted into nitrates in the following ways.

1. Nitrogen fixation

Free nitrogen bacteria called *Azotobacter*, *Clostridium* and *Rhodospirillum* living in the soil are able to produce nitrates from the free nitrogen in soil.

2. Nitrogen fixing bacteria (symbiotic bacteria)

The species of *Rhizobium* such as *R. leguminosarium* have symbiotic association with roots of some leguminous plants such as groundnuts, beans and Crotalaria. These symbiotic bacteria enter the root hair walls of the legumes and multiply thus causing swellings or nodules in the infected cells. They absorb the atmospheric nitrogen in the soil and build up into nitrates which the roots of the plants absorb to form proteins.

The *Rhizobium* bacteria are not capable of fixing nitrogen if they are free from leguminous roots.

3. Blue green algae *(Anabaena and Nostoc)*

These species are also capable of fixing the atmospheric nitrogen into nitrates.

4. Thunder storms

During thunderstorms, the lightning produced, causes the atmospheric nitrogen to combine with oxygen to form nitrogen (II) oxide (nitrous oxide, NO).

$N_2 + O_2 \rightarrow 2NO$

The nitrogen (II) oxide reacts with oxygen to form nitrogen (IV) oxide (nitrogen dioxide, $N0_2$)

$2NO + O_2 \rightarrow 2NO_2$

The nitrogen (IV) oxide reacts with rain water to form a weak solution of trioxonitrate (V) acid (nitrous acid, HNO_2 and dioxonitrate (III) acid (nitric acid, HNO_3)

$2NO_2 + H_2O \rightarrow HNO_3 + HNO_2$

When this weak solution of dioxonitrate (III) acid reaches the soil, it combines with mineral salts in the soil to form nitrates which the plants absorb.

5. Decay

When plants and animals die, they undergo decay. The protein is decomposed by the bacteria of decay (putrefying bacteria) into ammonia, carbon (IV) oxide and water. Nitrifying bacteria (Nitrosomonas) oxidize ammonia to nitrites and another variety of nitrifying bacteria (Nitrobacter converts nitrites to nitrates which are absorbed by the roots of the flowering plants.

The process of converting ammonia into nitrate is known as **nitrification**.

Return of nitrogen to the atmosphere

The process of returning nitrogen into the atmosphere is called denitrification. Some bacteria such as Pseudomonas denitrificans can convert ammonia, nitrites or nitrates into free nitrogen which escapes into the atmosphere.

The role of decomposers is very essential because without decomposers, the supply of materials to the producers and the consumers cannot be maintained. By their action, the minerals originally absorbed by green plants from the soil and later locked up in their bodies or in the bodies of consumers (animals) once again become available to the soil and in turn to green plants (producers). In modern cities, sewage treatment facilities are designed to provide decomposers with an optimal environment, so that they degrade sewage as rapidly as possible.

Gaseous Products

The. end products produced by decomposers (detritus food chain) are carbon (IV) oxide, water and such inorganic compounds as phosphates, nitrates •and sulphates. When decomposition process is complete, there is no metabolic or combustible organic matter left.

ECOLOGICAL MANAGEMENT

All the members of a single species living in the same area and interacting with each other are referred to as a population. The species of any biotic community live in a state of symbiosis (Greek: sym = together; bios = life). If the species of a community are studied two at a time, there. are only three possible effects that each member of a pair can have on the population growth of the other:

Positive (+) means benefit.

Neutral (0) means no significant benefit or harm.

Negative (-) means harm.

Types of Associations

1. **Neutralism** (0/0) is neither beneficial nor detrimental to either population. For example, the direct interactions between a squirrel and a bird appear to be of this type. Neither serves as food for the other nor do they compete for the same food supply, yet they are part of the same forest community.

2. **Inter-specific competition**: (-1- and -10). It reduces the availability of a resource, such as food, water, sunlight, space, to the members or at least one of the competing species. The competitive interaction between rice plants and weeds (broad-leaved) is an example of inter-specific competition.

3. **Mutualism or Symbiosis** (+ / +). When both populations benefit and at least one of them is so dependent upon the other for some critical resource or function that it cannot survive in the given environment without the other species is referred to as mutualism or symbiosis. The example of symbiosis is the association between the alga and fungus (lichens). The alga carries out photosynthesis while the fungus absorbs rain water through its tangled network of mycelia, which the alga uses to photosynthesize its food. The fungus gets ready-made food from the alga. Both of them are mutually beneficial to each other.

   The relationship between insect pollinated flowers and insect pollinator (e.g. butterfly) is mutualistic. The flowers supply the nectar which the insects feed upon and in return the flowers gain by being pollinated.

The association between human being and the bacteria in his intestine is also .mutualistic. The bacteria make vitamin B12 and carry out some microbial digestion for him. The bacteria benefit by having nutrients and shelter from human being.

Another example of mutualism occurs in herbivorous animals (such as goats, sheep and cows) and cellulose digesting bacteria living in the ceacum and colon of herbivores. These bacteria are able to digest the cellulose of leaves and convert the digested cellulose into sugar which is absorbed by the herbivores. The bacteria gain by being provided with shelter and abundant nutrients in ceacum and colon.

4. **Sapropbytism:** is a feeding method carried out by saprophytes which derive their food from the dead decaying organisms by secreting enzymes on the dead matter and absorbing the nutrient by diffusion. They digest their food externally, that is, outside the body of the saprophytes. Examples are fungi (Mucor and yeasts) and bacteria. Saprophytes play an important role in detritus food chain.

   Mucor**:** It is a saprophyte that grows on organic matter like bread, cheese, leather or dead wood. It produces hyphae which penetrate the host or substratum and absorb

ASSIGNMENT

State major points you have learnt in this unit.

SUMMARY

In this unit, you learnt that:

- Most of the energy that strikes the face of the earth is converted to heat energy.
- Energy flow through food chain is utilized in production of materials, respiration, etc.
- There are different types of food chains. List some of these.
- The flow of energy through a community can be represented by a pyramid of energy.

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UNIT 8: SEX LINKED CHARACTERISTICS

INTRODUCTION

The sex of an offspring is fixed at conception. In man, the male sex cell (the sperm) and the female sex-cell (the ovum) came together to form a zygote which then undergoes rapid development in the body of the woman. Although many sperms may enter the oviduct of the female, only one sperm, fertilizes the ovum. Once the sperm has entered the ovum, no more sperm will usually be allowed in.

Eggs and sperms carry genes from the female and male parents, so the zygote that is formed get one of each kind of gene from each of its parents. The human gamete (the egg or the sperm) contains only 23 kinds of chromosome. Each gamete only has one of each kind of gene. They are, therefore, known ashaploid cells. Your body cells which have the two of each kind of chromosomes are called diploid cells. The zygote which gives rise to the body cells is diploid. The zygotic nucleus has 23 pairs of chromosomes.

OBJECTIVES

By the end of the lesson, you should be able to:

1. explain sex determination of a child;
2. describe the determination of sex of a child;
3. describe the cross between a colour blind male and a normal female:
4. describe the cross between a colour blind female and a normal male:
5. explain the sex-linked disorder in hemophiliacs; and
6. enumerate other characters or traits that can be inherited.

WORD STUDY

Oviduct: is part of the reproductive organ of a woman. Fertilization of the egg takes place in it. There are 2 oviducts: The left and right oviducts.

The zygote: is a fertilised egg/ovum. It has 23 pairs of chromosomes i.e. 46 chromosomes.

A haploid: cell has 23 chromosome (N) A diploid cell has 23 pairs of chromosomes (2N)

Genotype: is the kind of gene in your cell

Phenotype: is the type of gene experienced in your observable

Sex chromosome: is the chromosome that determines whether the developing, foetus will be a boy or girl. A foetus is an unborn child still carried in the womb of the female parent mothers.

SEX DETERMINATION OF A CHILD

Each human cell and your body cell contains 46 chromosomes. The two smallest of these cells are called sex chromosomes. These two chromosomes determine what sex you are.

A woman has two sex chromosomes that are the same. They are X shaped and are known as X-chromosomes. Therefore, a woman has the genotype XX.

A man's two sex chromosomes are different. One is an X chromosome, the other is an even smaller chromosome and it called Y chromosome. A man has a genotype XY.

When a woman's cell divides to make eggs, each egg gets single X chromosome.

The genotype of the egg is X. When a man's cell divides to make sperms, half the sperms gets an X chromosome and half a Y chromosome. Therefore, 50% of the sperm has the genotype X and 50% have genotype Y.

When the-sperm fertilizes an egg there is an equal chance that the sperm will be an X sperm or a Y sperm. If it is X sperm the zygote's genotype will be XX. The baby will be a girl. If the sperm is a Y sperm, the zygote will have the genotype XY and will be a boy.

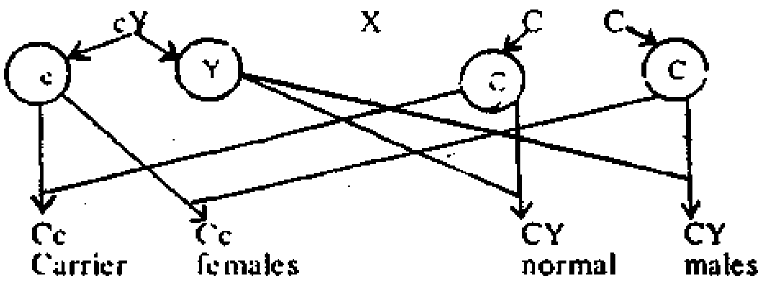
From above description, it is obvious that the sperm determines the sex of one child. This means, if a woman continues to have female children, she is not to be blamed for this. Rather they should accept with thanks as God's gifts.

COLOUR BLINDNESS

Colour blindness is a recessive sex-linked character. A man or woman with this trait is unable to see the difference between red and green colour because the cells of the retina are not functioning properly. The dominant gene which permits colour vision C is only situated on the X chromosome. If its allele, the gene for colour blindness, c, occur on the X chromosome of the male, the latter will be colour blind. The mate chromosome does not have the gene that controls colour vision. A female will only be colour blind if both her X chromosomes carry the gene for colour blindness.

The inheritance of colour blindness as a sex-linked character is illustrated below.

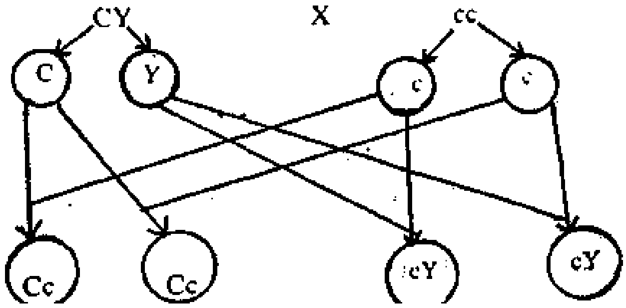
A cross between A colour-Blind male and a Normal Female.



In this first cross, the F_1, offspring consists of carrier females, Cc with the recessive gene for colour blindness but they are not blind themselves. The normal males have CY chromosomes.

In the second cross, the F_1 offspring consist of carrier females Ce and colour blind males CY.

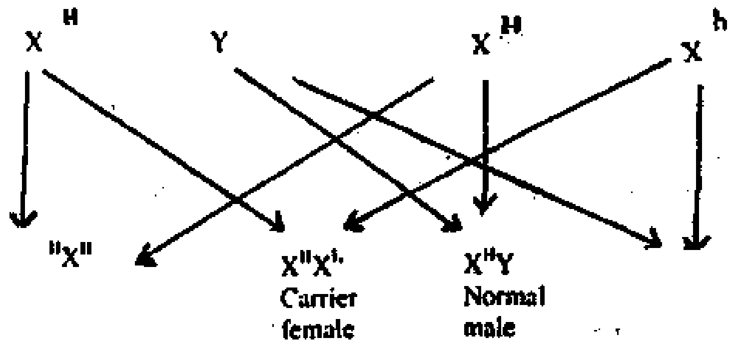
A cross between A colour-Blind Female and a Normal Male.



HAEMOPHILIA ANOTHER SEX-LINKED DISEASE

Haemophilia is a disease in which the blood does not clot properly. A person with haemophilia disease lacks the allele H, which gives the instruction to the cell to produce the chemicals factor 8. Without factor 8, the blood will not clot. As a result, blood often leaks and causes pain for the sufferer.

Only men suffer from Haemophilia. There are two allele of factor 8 gene. The H allele causes normal factor H to be formed. The allele h does not. So H is dominant over h. So if a person has at least one H allele in the cell, they will make normal factor 8.



The factor for 8 gene is situated on X chromosome only and not on Y chromosome.

A woman because she has two X chromosomes will always have factor gene in her cell so instead of having the disease she can only be a carrier. With normal male, the couple has a one in four chance of having a haemophiliac son.

In theory, if haemophiliac male is crossed with a carrier female, it is possible to have a daughter with the genotype XhXh. However, it has been noted that having two h genes is so damaging that the zygote produced with this genotype never develops at all. The fertilised egg never develops. In males, this is not so because they have only one X chromosme and so on having the allele h, suffer from haemophilia.

APPLICATION OF GENETICS TO LIFE

The application of genetics to life can be seen in two important fields: Agriculture and medicine.

WORD STUDY

Genes: is a chemical substance which contain DNA. It is a basic unit of heredity - responsible for the transfer of trait.

Genotype: This is a genetical constitution of an organism. It refers to a total number of genes inherited

Alleles: These are a pair of genes of contrasting character.

Dominant: These are characters that are expressed or manifested on individual.

Recessive Alleles: These are characters that are hidden in the presence of dominant ones.

Agriculture:

Have you ever seen a mixed breed dog? What occurs to you when you pluck an orange fruit and taste some lemon in it? Now read the following under agriculture and get the answers.

Human beings have been cultivating plants and domesticating animals to provide for their needs using the following techniques:'

1. Asexual and sexual reproduction
2. Self and cross - fertilization.

A sexual reproduction and self fertilization

This produces population of offspring that are genetically similar to the parents. So it is useful for propagating individuals. But unfortunately, the population can be easily wiped out by environmental changes or a disease because of genetic uniformity.

Sexual reproduction and cross fertilization

This involves the introduction of genetic variation into the population which gives rise to improved variety of species. There are basically two methods of selective breeding: Inbreeding and out-breeding. While the latter involves crossbreeding individuals of genetically distinct population (for instance two individual plant species, each having its own advantageous traits are crossed in order to combine the two traits in one) the former refers to breeding of closely related individuals in a species. For instance, to build a stock of tomato plants with large fruit size, the seeds of the large tomato fruit would be sown repeatedly until a true-breeding stock of large fruit size tomato plant are gotten. Out breeding will normally produce bigger and healthier individuals that are more resistant to diseases, giving them a better chance of survival.

In animals, selective breeding can also be carried out to improve their performances. For instance, local cattle such as N'dama and Muturu are upgraded by cross-breeding with Friesians. shorthorns. Herefords and Jesseys. Modern technology facilitate this by artificial insemination which aids the transfer of the desirable foreign breeds semen.

In certain plants like wheat, rice, maize, groundnut, soya beans and others, plant breeders also try to improve the crop yield, nutritional quality, resistance to insect pests diseases, and tolerance to adverse climate conditions by breeding.

ACTIVITY 11

In the table provided below is the list of some animals. Fill in what you think the aim of the breeder would be in breeding such animals.

Animals	Purpose of breeding
Dogs	
Horses	
Pigs	
Poultry	
Cattle	

MEDICINE

Do you have a sickler in your family or neighbourhood? Have you ever wondered on the cause of this? This is directly related to genes which medicine looks into.

An aspect of medicine which is becoming important is genetic counselling-directed at married couples who face the risk of having children with genetic disorders. These genetic counsellors also advise married couples with incompatible Rhesus blood factors.

Several serious disorder can be caused by defective genes which may be recessive or dominant and autosomal or sex-linked. For instance, if a couple with the sickle cell trait have a child there is the probability that one of four children would have sickle cell anaemia. This is because both parents are heterozygous carries of the recessive allele for haemoglobin S.

The parents with four children are likely to have

- 1 normal person with genotype AA (homozygous for dominant allele)
- 1 person with sickle cell anaemia with genotype SS (homozygous for recessive allele)
- 2 Persons will sickle-cell trait (heterozygous state) AS.

Such parents are counselled to have fewer children and those who are carriers of the recessive allele for haemoglobin S should pair up with those normal persons with dominant allele A.

The Rhesus system also presents special problem to married couples. People with antigen on the surface of red-blood cells are said to be Rhesus positive and those without are Rhesus negative.

Generally, most people are Rhesus positive, but if a Rhesus negative woman (rr marries a Rhesus positive man RR). The woman has a high probability of having a Rhesus positive child.

ASSIGNMENT

1. Write down the genotypes of:

   i. a colour-blind man

   ii. a normal woman

   iii. a woman who is a carrier for colour blindness

2. If a normal woman marries a colour-blind man, they will not have any of their children colour blind. Explain your answer.

3. Can a colour-blind man pass on his colour-blindness to his son? Explain your answer.

4. List some benefits of genetics to agriculture.

5. State 2 advantages of crossbreeding.

6. State 2 disadvantages of crossbreeding.

7. What would be your advice to a couple intending to get married soon with genotype AS and SS?

SUMMARY

In this unit you have learnt that:

- Eggs and sperms carry one kind of gene from either the female and male parents.
- The sperm cell determines the sex of the child.
- Colour blindness is a recessive sex-linked character which can affect both man and woman.
- Haemophilia is a disease in which blood does not clot and it only affects the males.
- Since a woman has two X chromosomes she rarely suffers from haemophilia disease.
- How genetics can be related to heredity.
- The application of genetics to agriculture in the area of asexual, sexual reproduction, self and cross fertilization about animal and plant breeding.
- You have also seen the application of genes in medicine and the importance of genetic counselling. Now do the following assignment.

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MODULE 5: ASSESSMENT IN BASIC SCIENCE

UNIT 1: WHY ASSESS PUPILS IN BASIC SCIENCE?

INTRODUCTION

Science teaching is a process in which the science teacher, using the resources of knowledge, methodology and equipment, deliberately interacts with his pupils in order to facilitate effective learning of basic science. At one state or another in the process, the teacher has to find out the success or otherwise of his endeavour. This is what is called assessing pupils learning outcome.

Assessment is an integral part of the teaching process and is the focus of this unit. We shall study the concept of assessment in a number of ways. In particular, we shall study types of assessment, the purposes of assessment and the common instruments used to assess pupils' progress in science.

OBJECTIVES

By the end of this unit, you should be able to:-

1. explain in your own words the concept "assessment" and its importance in the school curriculum;
2. define "continuous assessment" pointing out its characteristics;
3. Outline the three domains that have to be considered in an assessment; and
4. enumerate and discuss at least six purposes of assessing pupils in science.

ASSESSMENT AND ITS PLACE IN THE SCHOOL CURRICULUM

ACTIVITY 1

1. What are the roles of examinations in the school curriculum?
2. Explain why you evaluate your daily science lesson.

The term "assessment" may be explained as finding out the achievement or otherwise of goals or objectives of an undertaking for which certain resources have been invested. With reference to education, assessment may be viewed as a method of finding out what the pupil has gained from learning activities that have been purposely organized to achieve certain objectives. Thus the teacher assesses the pupils' performance in a subject, the Ministry of Education assesses the performance of a school using some set-out objectives as the yard stick.

Assessment is thus an important component of the school curriculum. The assessment used by the science teacher may be formative or summative.

Formative assessment is undertaken during a course which is designed to provide information about progress in key areas of work. It is assessment made with a view to prompting remediation and thereby bringing about improvement.

Summative assessment on the other hand is carried out at the end of a course or topic designed to measure level of attainment.

CONTINUOUS ASSESSMENT

Continuous assessment is a method of evaluating pupils' progress on a continuous basis. It evaluates pupils performance in cognitive, affective and psychomotor domains over a given period of schooling. Continuous assessment is usually systematic, comprehensive, cumulative and guidance-oriented in nature.

The continuous assessment has several advantages over the traditional method which concentrates on a single final examination. Continuous assessment which takes into account the learner's performance throughout the entire period of schooling is likely to be more valid and more indicative of the learner's overall ability than a single examination (Federal Ministry of Education Science and Technology, 1985).

ACTIVITY 2

1. List four characteristics of continuous assessment

2. Name two advantages that continuous assessment has over the one-shot final examination.

ASSESSING THE THREE DOMAINS OF THE LEARNER

Educational assessment should cover activities in the cognitive, affective and psychomotor domains of the learner. Benjamin Bloom and his associates (1956) described these domains thus:

2. The cognitive Domain

This refers to the intellectual capacity of the learner. There are six different categories in the cognitive domain which include the following:

Knowledge

This is the lowest level. It involves simple recall of information.

Understanding

Here, a higher level of activity is required of the learner, beyond that of recalling. Understanding is demonstrated when a child translates material from one form to another e.g. one language into another.

Application

This is the ability to use learned material in new and concrete situations, different from the original situation.

Analysis

This is the ability to break down material into its component parts.

Synthesis

This refers to ability to build up new material from given parts.

Evaluation

This is the highest level in the cognitive domain and it involves making judgements, e.g. evaluating ideas, beliefs etc.

2. The Affective Domain

This domain involves values, beliefs, attitudes, interest, social relations, emotional adjustments, habits and life styles. Value relates to the worth an individual attaches to other things. Interest is reflected by active participation in events on the part of the individual.

3. The psychomotor Domain

This deals with manipulative skills and body movement. In science, it IS demonstrated in setting up and manipulating materials and objects.

It should be stressed that our educational assessment of the learner should reflect all the three domains outlined above. The instruments and techniques of assessing behaviours in these domains will be discussed in unit 3 of this module.

PURPOSES OF ASSESSING PUPILS IN SCIENCE

The school science we teach our pupils is assessed for a number of reasons which include the following:

1. to inform the student of his academic standing;
2. to inform the teacher himself and his colleagues of their students academic standing;
3. to inform the student's parents who have the right to knowledge of the performance of their children and wards;
4. for placement purposes at the end of an academic year
5. to evaluate the curriculum and the teaching methods;
6. our employers have to be informed of the child's academic standing in science;
7. the employers who will recruit the student need to know his results;
8. to inform the outside world of progress in science in the school;

To inform the student is an important purpose of assessment in science. Experience shows that students get motivated to learn more when they get feed back of their performance For the teacher, students results are vital in evaluating his instructional methods. Students' parents, their future employers and the general public have the right to know the performance of students in science. Hence the need to assess the pupils in science.

ACTIVITY 3

i. List any six purposes of assessment in science

ii. Discuss any two of the purposes you have identified in (i) above.

ASSESSING WHAT PUPILS LEARN IN PRIMARY SCHOOL SCIENCE

Objectives of the National Core Curriculum for Basic Science

One important question which anybody interested in the assessment of science learning outcomes must answer is: What are pupils supposed to learn from elementary science experiences? The answer to this question should provide an insight into some of the important issues that are likely to come up during the assessment exercise. The National Policy on Education provides some guide on how one might answer this question. This document states that some of the important objectives of primary education should be:-

1. to help pupils achieve permanent numeracy and permanent literacy;
2. to lay a sound basis for scientific and reflective thinking.

In order to achieve these two objectives, the policy goes further to recommend that elementary science must be one of the core subjects to be taught at the primary school.

The objectives which basic science is supposed to help pupils to achieve are clearly spelt out in the revised edition of the National core Curriculum For Primary School Science, published by the Federal Ministry of Education, as follows:

1. to observe and explore the environment;
2. develop basic science process skills including; Observing, manipulating, classifying, inferring, hypothesizing; interpreting data, and formulating models;
3. develop a functional knowledge of science concepts and principles;
4. explain simple natural phenomena;
5. develop a scientific attitude including curiosity, critical reflection and objectivity;
6. apply the skills and knowledge gained through science to solving every-day problems in his environment;
7. develop self-confidence and self-reliance through problem-solving activities and
8. develop a functional awareness and sensitive to the orderliness and beauty in nature.

These objectives are not only comprehensive but they are also child-centered. That is, they emphasise total development of the basic school child.

What Pupils Should Learn from Basic Science?

The objectives we have just stated provides a guide regarding what basic science teachers should help their pupils achieve after being adequately exposed to science teaching and learning experiences. The first two objectives compel science teachers to assist pupils learn certain thinking skills (processes) which scientists, regardless of their area of specialisation, use to attack problems. In other words, children are supposed to learn to think and work like scientists in the science classroom Objectives (iii) and (iv) address issues which are called science products. Science products are the facts, concepts, laws, principles, theories and the generalizations of science. Basic school pupils are supposed to be exposed to aspects of these products which they can easily learn and understand. But the learning should not be for its own sake. As we see in objective (vi), the knowledge and skills learned in science should be used by the pupil to solve problems in his community. The pupil is required to deploy his knowledge of science concepts, facts, laws principles, generalisations, observation, classification, measurement, computation, communication, etc. for arriving at sensible solutions to real life problems. Objectives (v), (vii) and (viii) address the issues of attitudes and values that understand science as a school subject and the scientific enterprise. Basic school science instruction is supposed to assist pupils develop these characteristics. It is also implied that elementary science learning and teaching should not be limited to the facts level. To be meaningful, functional and relevant to the child, science teaching and learning must also address and emphasise concept application and the development of values. In addition, science should teach pupils to have interest in science and develop positive attitude toward scientists and the scientific enterprise.

The Need to Assess Pupil's Attainment of Curriculum/Instructional Objectives

What we have done in the previous section of this unit is to identify the skills, knowledge, attitudes, values which elementary school pupils should learn from their science experiences. Two logical questions and issues that arise from our previous discussions are: to what extent are primary school pupils learning the identified knowledge, concepts, skills, processes, attitudes and values in the science classroom? Which objectives of the core curriculum are elementary school pupils achieving and which ones are not being reasonably achieved? The answers to these questions can only be provided through a carefully planned and well implemented assessment programme.

Assessing what students learn in science classrooms is a very important activity for a number of reasons:

1 . it provides the student a feed back on what progress has been made so far;

2. it helps to identify areas of strength and weakness in students learning and possibly in the teachers instructional methods;

3. it also provides the science teacher a feed back on how effective he/ has been in helping his pupils to achieve instructional objectives.

4. a good assessment procedure will point up what remedial measures need to be taken to improve performance of either pupils and/or the teacher;

5. it is important to assess science learning outcomes most especially the skills for yet another reason. A large number of elementary school pupils may not continue to study science after leaving school. Yet the science processes are survival skills which all pupils will find very valuable in their future life. Hence it is very important to make sure that pupils can use these skills to solve real life problems before they graduate from the i->rimary school.

ACTIVITY 4

Identify two reasons why science teachers must assess what their pupils learn in science classrooms.

ASSESSMENT TECHNIQUES

We have already argued that it is essential for science teachers to assess their pupils learning in science, notably knowledge, attitudes, processes, values and interests. This list is by no means exhaustive. It is equally important to assess pupils practical work, behaviour and activities, e.g.

disciplinary behaviour, activities in the science and technology club, contributions to specimen collection for the science corner, etc, what pupils say in oral reports, class discussion, questions asked and answered in class, what pupils write e.g. notes, reports of projects, readings, tests, assignments, examinations; what students produce, what science literature pupils read, e.g. science books, magazines, news papers, etc, and pupils observance of safety precautions in the science classroom.

One thing which is very true of the above list is that it is very varied. Hence all the outcomes cannot be adequately assessed using only one assessment tool. Different instructional objectives call for different assessment techniques. Some techniques are more appropriate for certain curriculum objectives than others. Hence, one of the challenges before elementary science teachers is to learn how to make a wise selection among the available assessment techniques and also how to match each technique with pupil characteristics and with the objective or task.

Various methods and techniques are available for assessing what pupils learn in science. Some of the important techniques include: testing, written assignment, self report, observation at technique, peer evaluation, project method and oral exchange of questions. These methods will be treated in great detail in unit 3.

TEACHER COMPETENCIES

In order to successfully implement the assessment programme in the science classroom, the teacher must acquire some competencies. These are subject matter knowledge competency and technical competency.

Subject Mater Knowledge Competency

If an elementary science teacher must assess his pupils in science knowledge and take decisions based on the assessment results, then he must be knowledgeable in science. He must also have a sound training in education in case the assessment results suggest some modifications in either his teaching technique or the science curriculum.

Technical Competence

Secondly, the primary science teacher must posses technical competence. This involves ability to select appropriate objectives for his lesson, ability to translate the broad goals and aims of the science curriculum into specific instructional objectives and ability to write objectives in specific behavioural terms, Technical competence also involves ability to design an appropriate test to determine if a specific behavioural objective has been achieved and finally ability to use test results to make very national instructional decisions. The point must be stressed that unless the teacher knows how to state his objectives in terms of very specific behaviours, then the task of achieving an accurate assessment of what pupils learn in science becomes very difficult ifnot impossible.

ASSIGNMENT

Read through the unit and put down 5 major things you have learnt.

SUMMARY

In this unit you have been exposed to the concept of assessment. You have also learnt different types of assessment, resources for assessment in primary science, domains of assessment, etc.

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UNIT 2: ASSESSMENT PROCEDURES (TECHNIQUES)

INTRODUCTION

In unit 1 of this module we learnt about assessment. You could recall that we defined the concept "assessment" as finding out the attainment or otherwise of set out goals or objectives in an undertaking or project in which some resources have been invested. We also concluded that assessment was an integral part of the teaching process.

In this unit, we shall still study assessment but in a different dimension. Our emphasis here centres on techniques of assessing learning. We will therefore study techniques of assessing achievement in the cognitive, psychomotor and affective domains.

OBJECTIVES

By the end of this unit, you should be able to:-

1. identify at least five features of valid assessments;
2. given an overview of techniques used in assessing the cognitive domain;
3. give an overview of techniques used in assessing psychomotor and affective domains; and
4. explain the 3-step procedure of test construction.

The teaching profession faces many challenges and innovations. At the present time, the 6:3:3:4 system, the semester system and the continuous Assessment are the obvious challenges. With reference to the continuous Assessment, the challenges are that we are now operating a mode of assessment which requires teachers to be more accountable to the students, to the parents, to their employers, to the teachers themselves, and to those employers who will recruit the pupils they are now training.

To meet these demands, it is essential that we plan our assessment carefully so that it matches the aims of the course, the teaching and learning strategies employed and the abilities and aspirations of the students being assessed. Walker et al (1986) reflects the view that assessment, if it is to be valid, should:

i involve the student as an active partner

ii. be both formative and summative

iii. act as a motivator for both able and less able students

IV. reflect the complete nature of science, and

v. be as concerned with evaluating the curriculum and teaching methods as with measuring the achievement of the student.

ACTIVITY 5

1. List three innovations of Nigeria educational system.
2. Identify three features of valid assessments.

TECHNIQUES OF ASSESSING THE COGNITIVE DOMAIN

There are many techniques that the teacher can use to assess the cognitive domain. We will have an overview of these techniques. The cognitive domain refers to the intellectual capacity of the child. Can you recall the six levels of the cognitive domain as treated in unit 1 of this module? You can refer to unit 1 if necessary.

Techniques of assessing the cognitive domain include the following:

1. Tests

Tests are very useful techniques of assessment. Paper and pencil tests may be in form of examination, quiz, etc. Tests serve several functions which include the following:

Classroom Functions: Test help to determine achievement or otherwise, effectiveness of teaching method or instructional materials.

Guidance Functions: The guidance counsellor uses test results to guide students in career choice, and other cases.

Administrative Functions: Test results are used by the administrators for placement, promotion, jobs opportunities etc.

2. Project Technique:

Projects are short-term or long-tem1 practical assignments the students carry out for leaming purposes. It is useful in the assessment of not only cognitive domain, but also the affective and psychomotor domains. Relevant projects can be given to the pupils and the projects used to assess their performance.

3. Written Assignments:

This technique involves giving the students some exercise or home work to do at his own convenient time and he brings it to the teacher for marking. The finished product is then assessed by the teacher.

4. Peer Evaluation Technique:

This is a technique in which each student from a group or class is requested to assess his colleagues in a particular exercise in a mini-teaching session.

5. Self-Report Technique

Here, each student is requested to assess himself in terms of how he benefited from a particular experience or course of instruction.

6. Oral exchange of Questions:

This is a technique whereby the teacher uses both the student's answers to his questions and the questions put to the teacher by the student during the teaching-learning interactions to assess students understanding and progress. All the techniques outlined above can be used by the teacher to assess the cognitive domain of his students.

ACTIVITY 6

1 . Outline any two functions of tests.

2. Explain the peer evaluation techniques.

TECHNIQUES OF ASSESSING THE NON COGNITIVE DOMAINS

ACTIVITY 7

a. What are the non-cognitive domains?

b. To which domain does skill and speed in dissecting animals belong?

The affective and psychomotor domains are the non-cognitive domains. We have discussed them in unit 1 of this module. You can refer to unit 1 if necessary.

To measure such qualities as interest, attitude leadership qualities cooperating with others, speed and skills in manual work, we need some techniques other than tests. projects and assignments. Let us examine a few of such techniques.

1. **Observational Techniques**: This is a technique whereby the progress of a student in a learning situation is determined by keeping a systematic record of the various kinds of behaviour and attitude exhibited by the student. Traits such as anxiety and personality, habits, attitudes etc. can be measured or assessed through observation. Needless to point out that observation should be carried out objectively by the observer.

2. **Interview Techniques:** This technique provides opportunity for direct observation, from which the needed traits or qualities are observed and assessed. Its main disadvantage is that the interviewee is aware of being assessed and therefore may be more cautious than he normally would have been. In a formal interview, the observer has particular qualities to look for. He concentrates on these qualities and ignores others. The interview may be structured or unstructured. In the former he has set questions to ask the interviewee. (person being interviewed) In the latter, the questions arc not pre-determined at all. In both cases, the response from the interviewee may be written down or recorded in some way.

3. **Sociometric Technique**: This is used to assess the pattern of relationship in a group of students. For example, how sociable and acceptable to other colleagues each student is can be investigated and determined using a sociometric technique.

4. **Questionnaires:** This is another useful technique of assessing the non-cognitive domains. Traits such as interest, attitudes, habits etc can be investigated using a questionnaire. In a questionnaire, series of questions are asked whose responses may be in form of Yes/No, True/False, Agree/Disagree etc. The respondent will answer the questions as they apply to him. See example below:

Instruction:

For the following items, indicate your opinion by ticking the appropriate column on the right

N/S	Question	Agree	Undecided	Disagree
1.	Because of its benefit to man, science should be made compulsory to all students			
2.	The school science club has been dormant this session.			

All the techniques outlined above can be employed by the teacher to assess achievement in the non-cognitive domain.

The teacher frequently uses tests in the course of his work, such as the monthly tests, the terminal or end of session examinations. The tests may be essay type or objective items depending on the teachers choice. Whatever type of test you would use, the principle of constructing the items is same. It is a 3-step procedure outlined below:

Step I: Formulating Objectives:

This is the first thing the teacher should do. Mager (1963) identifies three conditions that have to be satisfied when stating behavioural objectives. The first condition is to specify, using a measurable verb, what the child should be able to do after receiving some instruction. For example, to identity, to construct, to measure, to draw and label etc. Note that certain verbs e.g. to know, to understand, to enjoy are not easily measurable and should be avoided.

The second condition is to specify the conditions under which the behaviour is to be observed, e.g. using a hand lens, the child should be able to identify.

The third condition is how well the child is expected to perform. Below is one example of an objective which satisfies all the 3 conditions.

At the end of the lesson, the pupils should be able to identify at least 5 parts of a Hibiscus tower using a hand lens.

Step 2: Making Table of Specification

A Table of specification is a 2-dimensional table which shows the objectives in one side and the content area in the other. It is designed to regulate the distribution of test items across the six levels of cognitive domain in a given content area. The weighting assigned to each content area depends on the relative time spent teaching the area in the classroom. The weighting assigned to each of the 6 levels of cognitive domain depends on how deep the topic was discussed in the classroom. Figure 3: 1 below illustrates a table of specification for 60 objective items, to be drawn from 3 content areas across the levels of cognitive domain.

Fig. 3.1: Table of specifications.

Content Area	Knowledge 30%	Understanding 20%	Application 15%	Analysis 10%	Synthesis 10%	Evaluation 5%	Total 100%
(1) 30%	6	4	3	2	2	1	18
(2) 40%	7	5	4	3	3	2	24
(3) 30%	6	4	3	2	2	1	18
Total	19	13	10	7	7	4	60

NB: The figures in the squares indicate the No of questions to be set out of 60 items.

ACTIVITY 8

State is the function of the table of specification?

Step 3: Writing the Test Items

This is the stage when the items are constructed. While writing the test items, the following considerations should be kept in mind.

1. Avoid ambiguity in your writing. Make the items, clear, precise and straight forward.
2. Construct many test items than you actually need so that there will be surplus to select the best.
3. Specify marks for each item so that students will give details in relation to the marks to be earned.
4. Make your items independent of one another. Avoid giving clues to one item in the statement of another.
5. Avoid the use of negative statements double negative). The question can easily be missed due to double negatives.
6. Specify the degree of accuracy required to get full credit.
7. For each group of item, provide clear instructions so that the pupils know exactly what is expected of them.

The 3-step procedure outlined above, may be helpful to you whenever you are constructing examination items. Construction of different types of tests for assessing the cognitive domain is discussed in unit 8.

ASSIGNMENT

Compare this unit with the next unit and bring out areas of similarity and differences

SUMMARY

In this unit, you were exposed to features of valid assessment, the techniques used in assessing the cognitive domain, psychomotor domain and affective domain. The unit ended with procedures for test construction.

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UNIT 3: ASSESSING PUPILS' ATTITUDE AND OTHER AFFECTIVE CHARACTERISTICS

INTRODUCTION

The purpose of assessment is to provide information on the overall educational development of the learner. This development covers the cognitive, psychomotor, and affective domains of the learner. The affective characteristics of the learner generally relates to the development of student's positive attitude to science and the study of science. It further touches on other human characteristics e.g. beliefs, values, social skills etc which are often not overtly shown by the learners, yet these need to be provided. The question, therefore, is how do we assess the affective development in primary school pupils. It is the attempt of this unit to provide the guide.

OBJECTIVES

By the end of this unit you should be able to:

1. identify those characteristics that are of the affective domain in science;
2. identify the area of primary science curriculum that demands the development of science affective characteristics;
3. identify learning experiences or situations that will enable the learner to exhibit the affective characteristics;
4. briefly explain procedure for assessing identifiable affective characteristics; and
5. identify some teacher based problems and difficulties in assessing affective domain in science.

AFFECTIVE CHARACTERISTICS OF SCIENCE

Science is a field of human endeavours and also a social institution involving scientists working together. When scientists go about doing their work, they tend to exhibit certain scientific attitudes or behaviours. These include:

- interest
- Perseverance
- honesty
- objectiveness
- open- mindedness
- curiosity
- willingness
- independence
- cooperation
- enthusiasm
- resourcefulness etc.

All these are important scientific attitudes and should be appropriately assessed. Such assessment if carefully done will provide information about pupils attitudes towards science, their preferences, interest, their commitment and enjoyment of science, also about their honesty and integrity and ability to work in group. Thus all information about the learners affective attitudes towards science can be revealed.

ASSESSING AFFECTIVE CHARACTERISTICS

Modem assessment practice emphasises that pupils assessment in science should be comprehensive enough to provide adequate information about the total aspects of their lives including positive attitudes and other affective characteristics. Despite this emphasis, attempt to assess this area of educational domain is very rare. Perhaps, this unlike assessing cognitive and psychomotor development, is fraught with difficulties. Some of these difficulties are teacher based problems while others are associated with the procedure for assessment. The teacher based problems include:

i. teachers have problem of translating statement of affective characteristics in science curriculum into operational terms;

ii. affective characteristics are not overtly shown by learners, therefore teachers have difficulty in identifying them let alone assess them;

iii. teachers do not make deliberate attempt at integrating in their teaching -learning process aspects of affective domain and therefore not assessed as outcomes of learning; and

iv. teachers do not see it as contributing scores to academic attainment of the learner and therefore do not give consideration to its assessment.

ACTIVITY 9

Identify the personal problems you may have with assessing affective domain in science. These teacher problems can be removed if teachers

1. appreciate the shortcoming of the assessment practice which gives emphasis to only cognitive and psychomotor attainments.

2. can endeavour to give deliberate attention to:

    a. The areas of the science curriculum that make reference to development of affective characteristics

    b. The content of the curriculum that have direct influence on the success of the learner's work: For instance in science, practical work or activities may depend on affective characteristics such as attitudes towards safety procedures, interest, perseverance, honest reporting, resourcefulness, etc. The pupils will attempt to exhibit some of these qualities which can be assessed.

    c. Identify out-door activities, projects, practical work etc that can allow pupils demonstrate those affective qualities of the curriculum content: In general, it has been identified that learners readily demonstrate their affective tendencies when learning is tied towards projects, practical work on any out-door activities. You as, a science teacher, should, therefore, take advantage of this in assessing the affective characteristics of your learners.

3. identify appropriate techniques for the assessment of affective characteristics: The technique identified for the assessment fall into three types.

i) observational technique

ii) interview technique

iii) written test and inventory

The Observational Technique. This involves the observation of the learner in a situation that requires the display of the affective characteristics.

Procedure for observational technique: Observation should be done objectively. To achieve this, there is a standard procedure for observation. This includes:

a. identification of the qualities or behaviour to be observed in the learner e.g. leadership, cooperation, resourcefulness, honesty, objectiveness, etc.

b. determination of appropriate activities e.g. practical work, projects etc that could make the learners exhibit the qualities.

c. determination of method of observation e.g. either by the teacher alone or with the assistance of others persons.

A checklist may be used, see below

d. drawing conclusion in respect of observation made. For objectivity this should be based on several observation in as many situations as possible. On the basis of the conclusion the individual learner can be rated.

The checklist will contain those affective qualities the teacher would want to assess and mark ( ) when the learners exhibits them. The format is shown below.

	Affective qualities					
S/N	Name of pupils	Leadership	Cooperation	Independence	Curiosity	etc.

Interview technique: This provides opportunity for oral dialogue or interaction between the teacher (interviewer) and the learner (interviewee). The focus of the interview should be on those qualities the teacher would want to assess and should be able to identify them in the course of the interview. Through skilful questioning, the teacher can explore the learner's responses and reactions to a wide range of situations and from this the interest, likes, dislikes, attitude, leadership can be gauged.

The interview may be either structured or unstructured. The structured interview uses interview schedule which contains set questions to be asked in specific orders and are short answer questions. The unstructured questions allows pupils to elaborate on the kind of answer they give. For example a students whose preference is in out-door science activities may be asked to give reasons. From the response, a range of affective characteristics may be identified.

ACTIVITY 10

How does the observational technique differ from interview technique?

Written test and Inventory

Written test and inventory are generally good for measurement of attitudes and interest. There are many wel1 established techniques available, among them are:

i. **Questionnaire:** The questionnaires do contain a number of questions which is presented to the learner to which he is expected to answer in writing. The questions should be useful in identifying e.g. interest, work habit and other personality characteristics.

ii. **Likert-type inventory**: this requires the students to indicate, for example, level of agreement or disagreement with particular statement, usually on a five point scale.

    The following examplify this approach

    I do not like science related

    occupations 5 4 3 2 1

    science has provided many useful devices that are more of blessing than harmful ones 5 432 1

    key 5 = complete agreement

    4 = partial agreement

    3 = neutral

    2 = partial disagreement

    1 = complement

The learners are expected to circle the number that closely reflect their feelings. The inventory can comprise of many questions, depending on the number different attitude dimensions to be assessed. The overall score can then be used to arrive at information about the attitude of the learner in or towards a particular situation.

ASSIGNMENT

Obtain the primary science syllabus of your school. Go through the contents of the class you teach and:

i. identify at least 5 different topics that have reference to characteristics.

ii. identify the affective characteristics that your pupils are expected or could learn from the topics

iii. identify any project, practical work or out-door activities that would enable your pupils exhibit the characteristics.

iv. which assessment technique or techniques would you best use in assessing the characteristics.

SUMMARY

In this unit, you learnt:

- the characteristics of the affective domain in science;
- areas of primary sciences curriculum that demands the development of science affective characteristics;
- learning experience that will enable learners to exhibit affective domain characteristics; and
- procedures for assessing affective domain in science

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UNIT 4: ASSESSING PROCESS SKILLS IN PRIMARY SCHOOL SCIENCE

INTRODUCTION

In recent times, a lot of emphasis has been placed on skill acquisition of primary and junior secondary school students. In science education, the development of the science process skills is a very important object of instruction. This is because the processes are very useful for learning the facts, concepts, principles as well as the laws of science. Scientists use them to design and implement procedures for solving problems. They are thought process which when thoroughly learned can be used to solve problems from one subject area to another. Above all, we need science process skills to live useful lives in a science and technology - oriented society. In spite of their importance, very little attention has been paid to the assessment of the process skills in the elementary science classroom. In this unit, the primary concern is to explain what the science process skills are, how they can divide them into groups for assessment purposes, why we need to assess them and how they might attempt to assess them in an elementary science classroom.

OBJECTIVES

By the end of this unit, you should be able to:-

i. state two importance of science process skills;

ii. name two ways of grouping science processes;

iii. make a list of the sub-skills in each of the science processes reflected in elementary science curriculum;

iv. describe accurately at least two techniques for assessing the science process skills; and

v. state the advantages and the disadvantages of using the formal testing technique and the observation technique for assessing the science process skills.

WHAT ARE THE SCIENCE PROCESS SKILLS?

The science process skills are reasoning abilities which are used by scientists to solve problem. Each of the reasoning abilities is complex and it can be broken down into simpler parts or sub-skills. The simpler skills must be understood before the major skill to which it belongs, can be understood. Hence, it is a good idea to help pupils master the sub-skills of a science process before we encourage them to use the complex process for problem solving. The process skills which elementary school pupils are supposed to learn include the following:

1. **Observing -** taking in information about all things around, using all the senses as appropriate and safe; identifying similarities and differences: noticing details and sequence; ordering observation.

2. **Classification** - grouping objects according to one, two or more properties: identifying the criteria used for grouping objects; regrouping objects using other criteria; selecting criteria and grouping objects with reasons according to those criteria.

3. **Raising Questions** - asking a variety of questions through words or actions, recognising questions which can be answered.

4. **Hypothesizing** - suggesting reasons for events or phenomena which can be tested scientifically, applying concepts and ideas from previous experience.

5. **Predicting** - going beyond the immediate evidence, or past evidence, and using this to suggest what will happen at some future time;

6. **Finding Patterns and Relationships** - Putting several pieces of information together and making some sense of the whole, through inferring, identifying trends, or correspondences or relationships drawing conclusions.

7. **Communicating Effectively: -** being able to present information so that it can be understood by others; being able to understand information from others in various forms; using graphs, charts, prose, poetry, models and diagrams appropriately.

8. **Designing and making**:- using materials and scientific concepts to create articles and procedures for solving practical problems;

9. **Devising and Planning investigations**:- proposing how to find out something through practical manipulation of materials; recognising the variable to be controlled and those to be changed and how this can be done; deciding how to collect and record relevant data.

10. **Manipulating materials and Equipment Effectively**:- being able to put into practice the manipulation of objects with the precision required to obtain useful results; using equipment conventionally but in a very creative way; and

11. **Measuring and Calculating:-** using measuring instruments correctly and with the appropriate precision as required by the investigation; being able to compute results from measurement taken.

ACTIVITY 12

Name two science process skills and explain their meaning.

MAJOR GROUPS OF SCIENCE PROCESS SKILLS

It IS often convenient to group science process skills into two major categories namely the cognitive group and the practical abilities group. Examples of the cognitive or reasoning ability group are interpretation, application of information to solve problem and drawing an inference. Examples of the practical ability skills are the manipulative and observational skills. However, for assessment purposes, the process skills are often grouped into six major categories. These are ability to:-

1. use symbols to represent objects;
2. use apparatus and measuring instruments accurately;
3. observe and interpret observations;
4. interpret data and use information to solve problems
5. design an investigation; and
6. ability to carry out practical investigations.

The skills under group 1,3 and 4 can be assessed using paper and pencil tests, projects and assignments. The skills under groups 2, 5 and 6 lend themselves more readily to assessment using practical examinations where the pupil has an opportunity to interact with objects, materials and equipment and to demonstrate his competence in the use of these in making accurate measurements and in carrying out investigations. We shall discuss two of these techniques in some detail later in this unit.

ACTIVITY 13

Name the two major groups of science process skills and give an example of a skill in each group.

WHY ASSESS PROCESS SKILLS?

In unit 2 of this module, we discussed how the science teacher might assess what his pupils learn in elementary science. Do you recall what pupils learn in science? i knowledge, concepts, values, principles, attitudes and processes). If you do not remember these things, you may wish to go back to unit two and revise them. You will also recall that we gave reasons why the teacher needs to assess what his pupils learn in science. Can you state three of such reasons'? The same reasons also explain why we assess science processes. If you do not remember these reasons, they are as follows:

i. Diagnostic purpose: to enable the teacher identify learning problems, match classroom activities with students progress, plan activities, provide feed back to pupils and to the teacher, for reporting and also to enable the teacher record and revise his pupils progress.

ii. one other reason why we assess science processes is for grouping and grading students.

iii. The third reason why we must assess our pupils process skills development is to enable us to keep an eye on the quality of science education our pupils receive in the schools.

INDICATORS OF PROCESS SKILL USE

Imagine that you are in an elementary science classroom watching what goes on between the teacher and his pupils. How would you know whether the pupils are using science process skills to solve problems? How would you determine whether the teacher is emphasising process skill development by the pupils? In the real life classroom setting you watch out for what are called indicators of process skill use. These indicators are student or teacher behaviours or records in the classroom, that is, what the pupils or their teacher do or say. From these things we can make a judgement on whether the process skills are used or not.

ACTIVITY 14

How can we tell whether process skills are being used in the science classroom or not? Each process skill e.g. observation has a set of indicators which one might look out for. Let us now make a list of some of the science processes with some of their indicators.

Observing: There is evidence that children are using the skill of observation to solve problems when they:

- use the senses to gather information (poisonous objects must not be tasted) identify differences between similar objects or events;
- identify similarities between different objects or events;.

- notice fine details that are relevant to an investigation;
- recognise the order in which sequenced events take place;
- look for patterns that may exist in observations; and
- make detailed list of external features of objects etc.

Raising Questions: There is evidence that children raise questions when they:

- ask questions which lead to inquiry;
- ask questions for information;
- ask questions based on hypothesis;
- realise that they can find answers to some of their questions by their own investigation;
- put questions into a testable form; and
- recognise that some questions cannot be answered by inquiry etc.

Communicating Effectively: Children communicate effectively when they:

- use writing or talking as a medium for sorting out ideas or linking one idea to another;
- listen to others' ideas and responding to them. keep notes of actions or observations;
- display results appropriately using graphs, tables, charts, diagrams, models, etc;
- report events systematically and clearly; and
- use sources of information.

Hypothesizing: There is evidence that children are hypothesizing in a classroom where they:

- attempt to explain observations or relationship in terms of some principle or concept;
- apply concepts or knowledge gained in some situation to help understanding or solve a problem in another;
- recognise that there can be more than one possible explanation of an event; and
- realise the need to test explanations by gathering more evidence etc.

Finding Patterns and Relationships: children can be assumed to use their process skill if they:

- put various pieces of information together and infer something from them;
- use patterns or relationships in information measurements or observations to make predictions;
- identify trends or relationships in information; and

- realise the difference between a conclusion that fits all the evidence and an inference that goes beyond it etc.

Devising Investigations: Pupils are using this process skill when there is evidence that they:

- make decision regarding what equipment, material, etc are needed for an investigation;
- identify what is to change or be changed when different observations or measurements are made;
- identify what variable are to be kept the same for a fair test identify what is to be measured or compared;
- consider before hand how the measurements, comparisons, etc. are to be used to solve the problem; and
- decide the order in which steps should be taken in the investigation, etc.

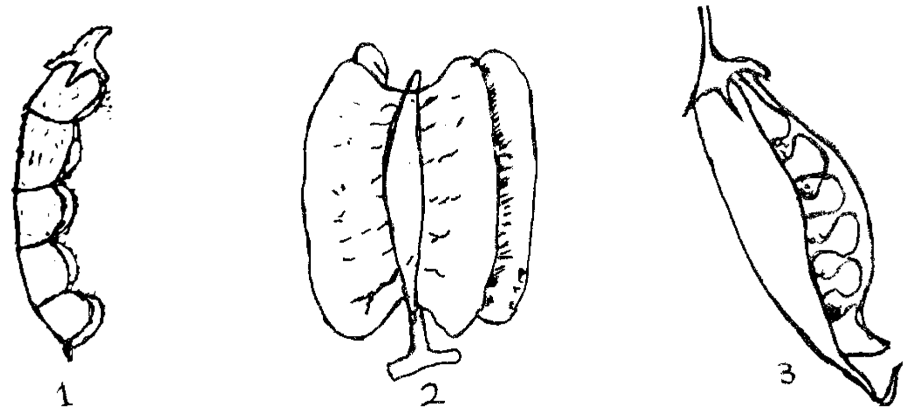
A knowledge of these science process skill indicators is very important for assessment purposes. The indicators make it easy to assess pupils use of science processes using the observation technique.

HOW SCIENCE PROCESS SKILLS CAN BE ASSESSED IN THE CLASSROOM?

There are various methods for assessing pupils use of science processes. We shall discuss only two of them here.

1. Formal Testing Technique:

Tests can be developed to assess whether pupils can use the processes to solve problems. Let us consider the following question which is meant to test the skill of observation: Seeds and fruits are sometimes specially adapted to help them to get away from the parent plant.



Look at seeds 1,2, and 3 and for each one choose one of the methods (A to E) below by which the seeds could be dispersed. Also on your answer sheet, describe what feature leads you to your conclusion.

A. Blown by the wind

B. Carried by water

C. Seed pods blow open to scatter seeds

D. Eaten by animals

E. Stick to animals' hairs.

This test item requires the pupil to use their senses to gather information, identify differences between different objects and relate structures of objects to their functions. Test items similar to this one can be used to sample pupils mastery of the processes.

Using test items to assess pupils use of science processes has advantages and disadvantages.

The advantages are:-

1 . all pupils attempt the same test under the same examination conditions;

2. the results of the test can be quantified.

3. comparisons can be made on the same measure.

The disadvantages are:-

1. the subject matter, that is, the content of questions affects pupils performance.

2. the range of process skills being tested are limited.

3. it is time-consuming to create, take and mark tests.

OBSERVATION

Another method of assessing pupils use of process skills is by observing them at work in the natural classroom setting. The observation might be carried out using a schedule similar to what is illustrated in fig. 6: 1.

Name of Teacher: Opeyemi, A.B. Topic: Living and Non-living Things

School: COE Primary School, Bauchi. Date: 18/03/2013: Class: Pry. 6B

Time in Minutes

S/N	TASKS	1-2	3-4	5-6	7-8	9-10	11-12	13-14	15-16	17-18
1.	Making Observation									
2.	Raising Question									
3.	Suggesting hypothesis									
4.	Predicting									
5.	Suggesting Explanation									
6.	Finding Relationships									
7.	Handling equipment									
8.	Measuring/calculating									
9.	Recording data									
10.	Designing Experiments									
11.	Others (write in).									

Fig. 6.1: Process skill observation schedule.

The schedule in figure 6.1 has been designed for pupil activities for 18 minutes. A similar schedule can be designed for observations of a much longer duration. The whole class or some pre-selected target pupils are observed using the process indicators which we previously described, for making judgement about which process is being used every two minutes. The observed pupil behaviours are recorded with a tick (√) every two minutes. At the end of the observation, the frequencies of each process indicator are computed and interpreted.

The science teacher must note that assessing pupils by observing them requires that he/she:

1. provides opportunities for children to what they can do;
2. gains access to children's ideas and understanding by talking to them and by asking open questions; and
3. listens to what the children are telling them. These requirements are very important aspects of science teaching - Thus, assessment of process skills by observation, when properly carried out, does not support acceptable science teaching practices but it also enhances and informs teaching and learning.

Assessing pupils' process skill outcomes by observation has advantages and disadvantages.

The advantages are:

1. information can be gathered from a whole range of activities;
2. the results obtained are more valid since pupil behaviours are not masked reading and writing skills;
3. observation is carried out within the time for normal activities and hence does not take up extra class time; and
4. it does not require extra preparation time.

However assessing process skill by observation has some disadvantages. These include:

1. opportunity for children to show process skills may not be there in the children's work.
2. the teacher may miss significant events because it is very difficult to observe all the children at the same time.
3. when children work in groups, they may be influenced by group pressures and not show what they can do.

ASSIGNMENT

1. Give two reasons why pupils must be taught to use science process skins to solve problems.
2. Explain the meaning of observing and predicting
3. State four indicators of raising questions.
4. a. Name two methods for assessing the use of science process skills.

   b. State one advantage of each method.

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UNIT 5: CHARACTERISTICS OF CONTINUOUS ASSESSMENT

INTRODUCTION

In this unit, you will learn how to construct continuous assessment, its importance and the technique of constructing it.

OBJECTIVES

By the end of this unit, you should be able to:

1. State the characteristics of continuous assessment;
2. List the various techniques for continuous assessment;
3. Mention the qualities of an assessment technique; and
4. Identify problems of implementing continuous assessment.

ACTIVITY 15

What is the main difference between continuous assessment and the traditional system of assessment?

CHARACTERISTICS OF CONTINUOUS ASSESSMENT

The characteristics of continuous assessment include being:

a. systematic
b. comprehensive
c. cumulative
d. guidance-oriented

Continuous assessment is systematic because it requires knowledge of what measurements of pupils performance to be made, at what time intervals and nature of tools or instruments to be used. Continuous assessment is comprehensive because many types of instruments like tests, projects, assignments, questionnaires, and interviews can be used. Again information is obtained in the cognitive, affective and psychomotor domains:

(Recall what you learnt about these domains in unit 1 of this module)

Continuous assessment is cumulative in that it takes into account all previous decisions on a pupil. It is also guidance oriented because the information obtained is used to guide the pupils for further developments.

TECHNIQUES FOR CONTINUOUS ASSESSMENT

The Federal Ministry of Education (1985) Handbook on continuous assessment stipulates the use of different techniques of assessment in the continuous assessment of pupils' learning.

These techniques include:

1. Testing Techniques: This is the technique of giving the pupil pencil and paper test at the end of a lesson or unit to obtain data on his abilities.

2. Written assignment: This is a technique where the pupil is given some exercise to write at his own time and this is later assessed by the teacher.

3. Peer evaluation technique: Here each pupil is requested to assess others they have benefited from during course of instruction.

4. Self report technique: Here each pupil is requested to assess himself in terms of how much he benefited from the lesson.

5. Observational technique: This is a technique whereby the progress of a pupil' in a learning situation is determined by keeping a systematic record of the various kinds of behaviour and attitude exhibited by pupil.

6. Assessment of project: This is a means of assessing the progress of a student by evaluating the pupils physical product.

7. Oral exchange of Question: This is a technique whereby the teacher uses the pupils answers to his questions, and questions pupils ask in class to assess the pupils progress.

8. Assessment of practical skills: This is a technique in which the progress of a pupil in acquiring manipulative skills is assessed. This is applicable in the higher classes of the primary school.

QUALITIES OF AN ASSESSMENT TECHNIQUE

The choice of an assessment technique should satisfy these criteria

a. It should be valid

b. It should be reliable

c. It should be objective

d. It should be useable

e. It should be discriminatory.

A measuring device is valid when it measures what the measurer intends to measure.

A measuring device is reliable when it gives the same information each time it is used. It is objective when it is free from human error.

Usability refers to the ease of use of instrument in a particular situation.

Discrimination: Tests must discriminate between those who can and those who cannot, those who know and those who do not know.

ACTIVITY 16

1. Name 3 techniques of continuous assessment

2. Mention also 3 qualities of an assessment technique.

Merits of Continuous Assessment

General Merits

1. It is useful in determining teaching-learning effectiveness and comparing obtained measures with pre-determined standards.

2. It provides detailed records of pupils performance to determine individual differences in achievement for use in prescribing individual remedies and determining the next stage of instruction.

3. It provides the system with information about itself.

4. It permits the evaluation of skills.

5. Provides a comprehensive picture of the learner's achievement.

6. It is diagnostic, providing corrective feed back to both the teacher and the learner.

7. It diminishes error of measurement

VALUES TO THE LEARNER

1. Increases regularity of learning activity.

2. Facilitates mastery of prerequisites before proceeding to the next stage in the course.

3. Helps the learner to identify aspects of his learning needing further attention.

4. Provides the learner necessary information on the adequacy or otherwise of his/her learning.

VALUES TO THE TEACHER

1. Provides the teacher an increased sense of control over teaching- learning situation.

2. Assists the determination of alternative instructional procedures to correct learning difficulties.

3. Useful in refining design, procedure and process of instruction.

PROBLEMS OF IMPLEMENTATION OF CONTINUOUS ASSESSMENT

1. Continuous Assessment is time-consuming and energy demanding.

2. Most teachers and head teachers cannot operate the system.

3. Inspectors of schools who should monitor the programme are not conversant with the continuous assessment techniques.

4. It involves a lot of expenditure in things like stationary, equipment and personne..

5. There is the issue of varying standards in different schools.

6. It demands careful record keeping in schools.

ASSIGNMENT

1. Define continuous assessment in your own words.
2. Mention four characteristics of continuous assessment
3. Give 5 techniques of continuous assessment
4. Outline four values of continuous assessment to the pupil.
5. What are the problems affecting the implementation of continuous assessment in schools.

SUMMARY

In this unit you learnt that

- Continuous assessment is a method of finding out what the pupil has gained from learning activities on a continuous basis over a given period of time.
- Continuous assessment is systematic, comprehensive, cumulative and guidance oriented.
- Techniques of continuous assessment include: testing, written, self report. observational, project, oral exchange and assessment of practical skills.
- Qualities of an assessment technique include: validity, reliability, objectivity. usability and discrimination.
- Merits of continuous assessment include among others helping the learner to identify aspects of his learning needing further attention and assisting the teacher to evaluate his work and correct learning difficulties.
- Problems of implementation of continuous assessment include poor attitude of teachers and inspectors of schools to it, it is time consuming and involves much expenditure and careful record keeping.

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UNIT 6: CONSTRUCTING ASSESSMENT INSTRUMENT IN THE COGNITIVE DOMAIN

INTRODUCTION

You have studied in this module several aspects of assessment practices in affective and psychomotor domains. You have also studied continuous assessment in science. In this unit you will study how to construct some assessment instruments for testing performance in areas of cognitive (knowledge) domain.

OBJECTIVES

By the end of this unit, you should be able to:

1. state why assessment instruments are constructed;
2. list some types of cognitive assessment instrument;
3. develop test blue print for assessment in science;
4. describe essay type questions;
5. list and describe objective type questions;
6. differentiate between essay and objective tests; and
7. state important guidelines for scoring essay items.

CONSTRUCTION OF ASSESSMENT INSTRUMENTS

A good assessment tool should be valid, reliable, usuable, objective, economical and able to discriminate among learners. Please revise what you have learnt earlier in this module.

Imagine that you have taught some children for a whole year without asking them any questions. You are not likely to be sure of the quality of work you have done or what the learners have absorbed. In case you intend to know how much they have learnt in the classroom you will give them tests or examinations.

In this section we shall learn how to design reliable and valid test items. The test items (questions) are to be based on a specified course content.

WHY ASSESSMENT INSTRUMENTS ARE CONSTRUCTED

By assessment instrument is meant tests, questions or examinations given to learners. These tests may be called achievement or attainment test, because they measure achievement. The purpose of giving the tests include to:

1. encourage or motivate the learners;
2. find out the level of mastery of content or what pupils have learned;
3. emphasise important points in the lesson;

ACTIVITY 17

1. What is an achievement test?

2. List two reasons why attainment test are given to learners.

Before any test is written, the following guidelines must be adhered to:

1. Behavioural objectives must be formulated. These should be stated in simple clear and unambiguous language.

2. Test blue print or table of specification should be produced.

ACTIVITY 18

1. List two things a test designer must do before writing an achievement test.

2. List two criteria for stating objectives.

CONSTRUCTION OF A TEST BLUEPRINT

Imagine some one who wants to build a house without a plan. He is not likely to build a good or safe house. Writing a test without a plan can be likened to the above illustration. A test blue print is also called table of specifications. It looks like the framework of the test. It is a two dimensional table which consist of (a) An objective and (b) Content aspects. The content refers to the topics covered in each subject with a specified time. The objective refers to how you expect the learner to respond to the test items. The number of items to be written depends on the amount of time available. The shorter the time, the fewer the items to be written. See Fig, 7.1

OBJECTIVES

Topics Or Content	Knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation	Total
Digestion 20% Time	40% 4	20% 2	15% 2	10% 1	10% 1	5% 0	10
Respiration 30% Time	3	2	2	1	1	6	15
Excretion 30% Time	6	3	2	1	2	1	15
Reproduction 20% Time	4	2	2	1	1	0	10
Total	20/50	10/50	8/50	5/50	5/50	2/50	50 Items

Fig. 7.1: **-** Test Blueprint of Objectives on some Biology Topics.

Fig.7.1 shows a test blueprint. It clearly specifies the topics taught as well as the weight (importance) attached to each topic within a particular period.

The test blue print will ensure that all important content areas (topics taught) are sampled in a test i.e. it makes a test content valid. Also it enables the test constructor (may be you the teacher) to ask question at different levels of Blooms Taxonomy of objectives. Please recall Bloom's Taxonomy of cognitive behaviour. These are arranged in increasing order of complexity (K.C.A.A.E.); See Fig. 7.1.

Fig. 7.1 shows that for a certain period, four biology topics were taught: digestion. reproduction, excretion and respiration. Out of 50 objective questions, 10 each were assigned to digestion and reproduction while respiration and excretion were assigned 15 items each. This is based on the fact that 20% of the time was spent on each of digestion and reproduction, 30% of the time was spent on each of respiration and excretion.

Also the questions were spread over 6 cognitive levels. Most of the questions were at the lower levels, knowledge, comprehension and application. Out of 50 items, only 12 were asked on the higher level: analysis, synthesis and evaluation. The last level is the most difficult and consequently has the least number (2 out of 50). However, the test blue print in fig. 8.1 shows the way to plan how to write a test.

ACTIVITY 19

Construct a test blue print of a forty items objective test based on 5 topics in primary science you taught over a period of 8 weeks.

INSTRUMENTS FOR ASSESSING COGNITIVE PERFORMANCE

By cognitive performance is meant what knowledge, skills and abilities a learner has acquired within the learning experience. It can be a written or oral test. It can be quizzes or practical work. The information obtained can be interpreted through scores or grades. Here we will focus on achievement tests commonly used by teachers.

TYPES OF COGNITIVE ASSESSMENT TOOLS

There are two basic types of achievement tests: essay and objective tests.

Essay type of tests: These are tests which involve the learner in of providing the correct answer, organise the answer in his own way to fit into the responses demanded in the test. It has the following characteristics. Essay tests may be restricted or extended response types. There are usually few questions in each paper. They are easy to construct.

Uses: They are useful for assessing a few areas in depth; for finding and product and activity; as well as assessing learner's ability to synthesise and evaluate. For instance an essay question may read (Describe the life cycle of female Anopheles mosquito or Discuss the purification of water.)

However, some of the disadvantages of essay tests include;

- scoring is tedious, time consuming and often subjective and inconsistent or unreliable.
- because few questions are asked, the items do not usually adequately cover all topics taught to learners.

Restricted essay questions refer to those that limit the responses of the learners. Such questions usually contain terms such as, mention, name, identify, label and list. They often ask for specific number of items of information. On the other hand extended essay questions usually permit the learners to express themselves the way they want. Often terms such discuss, describe, compare and contrast are used.

Example of restricted essay questions- Name the factors responsible for germination of seeds.

Extended essay question - Describe circulation of blood in a man.

OBJECTIVE TEST

Unlike the essay tests, objective tests provide answers (in most cases) from which a learner has to choose.

However writing good objective test items is time-consuming and difficult. Answers are easier to guess than in essay. They are not very adequate for sampling ideas about the higher cognitive levels such as synthesis and evaluation answer which is fixed in advance. So there is no question of a scorer having to judge an answer right or wrong.

Objective tests are more appropriate at the lower cognitive levels especially recall. usually they consists of very many items and they can cover a wide area of topics taught. Scoring is easy, fast reliable and objective. They are good for testing skills to find out how much knowledge have been acquired.

Some of the disadvantages of objective tests are construction is difficult and time consuming. Their answers are easier to guess than essay questions. They are not very adequate for sampling information about the higher cognitive levels such as synthesis and evaluation.

GUIDELINES FOR ESSAY ITEM WRITTING

1. Prepare a test blue print.
2. Write many questions (more than you actually need) which define the task you want learners to perform.
3. Do not use long or 'big' words that may confuse the learners.
4. Avoid use of negative statements, do not use double negatives.
5. With primary or junior secondary school students do not expect long answers. Set for them shorter exercises.
6. Give adequate time for the even the weak ones to complete the test.
7. Vary the level of difficulty of the questions to satisfy the above average, average: and even below average learners.
8. Give little or no choice in the number of questions - this will assist in giving" common base for comparing learner's performances in the classroom.
9. Write questions on the same topic together.
10. Let there be some short answer questions e.g. write short notes on ..... Let questions have subdivisions e.g. Question l(a) 1(b) l(c) l(d).
11. Give clear statements telling learners how and what they are expected to respond to each question.

OBJECTIVES TESTS ITEM WRITTING

The most commonly used and versatile type of objective questions is the Multiple choice. The items consist of two parts:

a. the stem i.e. the question or statement of the problem;

b. the options i.e. answers which are usually four or five. Options consist of two parts:-

i) the key i.e. the correct option and

ii) the i.e. those plausible options which are incorrect and may be picked by someone who does not know the real answer.

Multiple choice item is a structured-response item which forces the learner to pick an answer from a list.

Guidelines for constructing multiple-choice items:-

1. Draw up a test blue print.
2. Give clear instruction.
3. Answer choice short.
4. Make all options plausible and of similar length.
5. Avoid use of negative words in the stem, where used it should be italicized or underlined.
6. Avoid the use of all or none of the above.
7. Vary the position of the correct option (Key).
8. Do not give two correct answers or no correct answer.

Consider this good example:

1. Identify the group that is not classified as vertebrates,

A. Mammals

B. Fishes

C. Amphibians

D. Insects

E. Reptiles.

True or false Item (Alternative or Yes or No Choice)

This is a structured response item. The learner's choice is either right or wrong. This leads to a high rate of guessing.

Example 1: Sickle-cell is a hereditary disease. True or False Ans = True.

Writing is easy and fast. Scoring is also easy fast and reliable.

They are good for asking basic facts of recall.

Completion Items

These ask for simple recall of facts. In constructing such items, answers should be about important aspects not trivial. Questions should have only one correct answer put the bank space at or near the end of the statement. In numerical questions indicate the units for the answer. Omit only key words in completion types and keep the statement short. Group items covering the same items together.

Example:

Tsetse fly is a vector of …… Answer sleeping sickness.

They are easy and fast to construct. They discourage guessing. Many questions can be asked, However, they are only good for asking low level type of questions. Scoring may 'e rime- consuming.

Matching Type

These objective type consists of two parts: LIST A = The stem or question aspect and LIST B = The option aspect. The exercise is for the learner to pick answers provided in LIST B, Usually the items in List B are more than those in List A, say ratio 3:2. This is to discourage guessing. They are good for asking knowledge on specific facts. Example: Match items in List A with the correct options in List B.

A	B
Filtration	A. Water borne disease
Gold	B. Metabolic activity
Guinea worm	C. Mineral
	D. Methods of separating mixture
	E. air borne disease

Answers:

1 = D; 2 = C; 3 = A.

HOW TO IMPROVE CONSTRUCTION OF TEST ITEMS

1. Engage in regular and continuous practice in writing various test items.
2. When you write an item, sleep over it.
3. Alternatively let your colleague vet it.

ACTIVITY 20

1. Write out an example each of:

a. Matching test

b. True or false

c. Completion test

d. Multiple choice

in a subject of your choice.

SCORING OF ESSAY TESTS

There are two major types of scoring.

a. Analytical (Point score) method

b. Holistic - (Global) method

Analytical method - This method refers to assigning points to each fact the learner supplies to test items. Usually the points range from 1/2 to 1. The points which correspond to what is in the marking scheme is credited to the respondent. For instance in Biology for a correctly labelled structure the teacher may award 1/2 or 1 to the student. This method is a fairly objective way of scoring essay items. It is a method that is used in subjects where there are specific words, terms, ideas e.g. Biology, Chemistry and Physics. This method is however tedious to use. Hollistic method (Lilosal method) - This method involves reading through an answer and giving a single mark at the end of the general reading. This method may involve the use of some broad ideas which are assigned large number of mark (as compared with small marks of analytical method). For instance this method may be used in subjects such as History, Literature, and English Language. Essays lend themselves to global marking. This method is more subjective than the analytical method.

MARKING GUIDELINES

Whichever method is used, the following guidelines will be found helpful.

1. Prepare a marking scheme or guide as soon as you construct the test items.

2. Mark according to your marking scheme, do not be influenced by a candidate's name, handwriting or any other feature not in the marking scheme.

3. Mark all responses to each question at the same time i.e. if you decide to start your marking from Question 1 mark all scripts with answers to questions/before moving to the next questions.

4. Adopt the strategy 'work-rest-work' angry, annoyed, unhappy,

5. Avoid working when you are tense, tired or not in the mood for marking.

Mark analytically - This refers to giving specific mark(s) to a response as contained in the marking scheme.

ASSIGNMENT

1. a. What is meant by assessment tool?

b. Why do we have to assess learners?

2. a. What is an essay test?

   b. What is an objective test?

3. a. List 3 advantages of essay test

   b. List 3 advantages of objective test.

4. a. Compare and contrast objective and essay test.

   b. State three important guidelines for scoring essay test.

5. Write a test blue print for a 50 items objective test in a named science subject.

SUMMARY

In this unit, you learnt that:

- Assessment tools can be essay or objective test items. These are used for finding out how much knowledge and skills a learner has of a topic he has been taught.
- Test blueprint is a table specifying topics learnt (content) and behavioural objectives learners are expected to respond to.
- Essay types may be extended or restricted response type.
- Objective types may be true or false; completion, matching or multiple choice test items.
- Essay tests may be scored using analytical or global methods.

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UNITS 7: RECORD KEEPING AND PERFORMANCE IN SCIENCE REPORTING

INTRODUCTION

When assessment is conducted the next step is to record the performance of the learners. These records have to be kept properly until they are ready for use. This unit will give some ideas of how to keep records and how to report what is recorded.

OBJECTIVES

By the end of this unit, you should be able to:

1 . state the meaning of record keeping;

2. list what records should be kept;

3. state how records should be kept;

4. state what is meant by reporting; and

5. describe what reports can be used for.

RECORD KEEPING

One of the important aspects of continuous assessment is keeping of records which may be formative or summative in nature. A record of achievement may include profiles of a variety of skills, attitudes and personal achievement while a student is in school as well as his results in public examinations.

The records of learners' achievement ought to be recorded as they are scored and graded and according to the weightings given to each component area that has been assessed.

WHAT RECORDS SHOULD BE KEPT

The records that should be kept are those that produce high benefits in learning. This is because there are different records in many of our primary schools. However, some of the records that are regarded as important include the following:

1. Teacher's class or school Record Book. This is kept by each teacher. It contains.

    a. detailed scheme of work

    b. diary of daily or weekly record of work

    c. progress reports

    (a) and (b) had been discussed earlier on. Please refer to module 3 topics on your education text book.

2. Pupils' cumulative Record Folder

3. Transcript.

Items 1 and 2 if well kept should contain detailed information on each child's performance in relation to what he is taught in the school.

ACTIVITY 21

List three types of records that a teacher should keep.

SCHEME OF WORK AND DIARY RECORD

This record is reserved for the teacher. At the start of a term or year the teacher records what he plans to teach the learners within a given period. As the term unfolds, he records weekly whatever he is able to achieve. This record is useful to the teacher himself as well as his headmaster or supervisor. It can inform everyone concerned how well a teacher is performing in the programme he planned for himself. It can reveal how much scientific skills the teacher planned and executed within a given period of time. If the amount of work is regarded as inadequate, then the teacher will be encouraged to work harder.

PROGRESS REPORT

This report is very important. This is because provision is made for frequent records of learner's achievement. It usually contains forth-nightly or monthly as well as termly progress reports of academic grades. In addition, scores on social development and psychomotor have been incorporated lately.

PUPIL CUMULATIVE RECORDS FOLDER (CRF)

This is a four-page file that has been designed to contain comprehensive information on each child over a period of at least six years. This design makes it useful in the primary levels. It has sections for:

a) Personal information

b) Academic progress report summaries

c) Affective (Behaviour) reports summaries Psychomotor report summaries

d) Results of external examinations

e) Outstanding performance

(Please refer to attached Figs. 8.1,2,3,4.)

Cumulative Record Card (CRC)

Name of School

School's Badge

School's Motto

Etc.

Name: ____

Registration Number: ____

Year: ____

State: ____

School: ____

Pupil: ____

PERSONAL INFORMATION

1. Name: ____

2. Age: ________ Date of Birth: _______ Aver. Age in Class: _________

3. Place of Birth: ________________ Nationality: ________________

4. Sex: ___________ Height: Weight: ____________

5. (a) Father's Name: ______________________________________

   (b) Father's Occupation: ___________________________________

   (c) Father's Permanent Address: _____________________________

6. (a) Mother's Name: ______________________________________

   (b) Occupation: ____

   (c) Permanent Address: ____________________________________

7. (a) Guardian's Name: ____________________________________

   (b) Occupation: ____

   (c) Address: ____

Fig. 8.1

Note: There is no further information required here since it is felt that the child's Cumulative Record Folder will contain detailed information. This card is just a part of cumulative Record Folder (CFR). While the School counsellor keeps the whole CRF, the child keeps the CRC.

Academic Progress Report Summaries and Tests

						Obtainable			
						Obtained			
						Percentile Rank			
						Class Average			
						Position			
						Obtainable			
						Obtained			
						Percentile Rank			
						Class Average			
						Position			
						Obtainable			
						Obtained			
						Percentile Rank			
						Class Average			
						Position			
						Obtainable			
						Obtained			
						Percentile Rank			
						Class Average			
						Position			

……………………………………………………………………………………………… Term

Fig. 8.2

Affective Report ………………………………………………………………….. Term

Rating

Behaviour and Activities	5	4	3	2	1
Punctuality Attendance at class					
Carrying out assignment					
Participation in school activates					
Neatness					
Politeness					
Honesty					
Self Control					
Relationship					
Helping others					
Sense of Responsibility					
Obedience					
Initiative					

Fig. 8.3

Key

5 = Excellent

4= Good

3 = Fair

2 = Poor

1 = Very Poor

Psychomotor Report

………………………… Term

Rating

	5	4	3	2	1
Handwriting Public Speaking 1 Games 2 3 1 Sport 2 3 1 Gymnastics 2 3 Painting Musical Performance (Musical Instrument) Sculpture/Woodwork Drawing Cycling Swimming					

Fig. 8.4

Key

5 = Excellent

4= Good

3 = Fair

2 = Poor

1 = Very Poor

Note:

Schools/States are free to include other activities. In respect of games, sports and gymnastics, the student could be rated on his best three.

With the type of record to be put in the cumulative record folder, the parents will be adequately informed about the child's progress. They can at a glance, compare the child's progress at different periods, since these have been accumulated in the file.

The various state government and the Federal Movement Ministries of Education have designed the CRF. In most parts of this country, it would be seen that the File has very similar design.

ACTIVITY 22

1. List three types of information you would expect to find in a cumulative record folder.

HOW SHOULD RECORD BE KEPT

A perfect recording system may be both very tasking and sophisticated to use. Not everything that occurs should be recorded. It should be what can make learning coherent and sequential.

Teachers are the ones to keep the records. Specifically, it should be the science teacher who should keep records of the learners he teaches.

Primary science leads itself to scoring. Here, the teacher would be interested in the practical skills the learners display or acquire. For instance, a certain percentage of scores in science subjects should be reserved for all activities done and examined. There could he scores for handling of chemicals, plants and animals. Ability to collect and observe certain phenomena and record accurately no matter how simple their observations are; ability to draw and label accurately or carry out activities and behaviour when put to work among classmates are some of the criteria that can be scored and recorded by each science teacher.

The teacher may have to use data summary forms to be able to write reasonable records in the Cumulative Record Folder.

They include:

1. Class/subject marks book. Every teacher keeps this record. There should be more frequent entries into them to make summary meaningful.
2. Termly continuous Assessment Sheets tor cognitive, Affective and Psychomotor Domains.
3. Annual Assessment Summary sheet. It serve as the end of year report sheet that the child takes home.
4. The cumulative Record of the child's performance over a long period summarises his abilities. This is one that he may request for from the school authorities when need be.

   The teacher keeps the marks books; the Headmaster or Guidance counsellor keeps the CRF. The terminal report cards are kept by the Headmaster and released to the teachers when they are actually needed. The children take this report cards home to show their parents. Their parents are expected to study the records and even initial their observations.

The next section will discuss what is actually reported and how the report can be used.

TRANSCRIPT

This is a record of a learner's performance that is kept by the school. It can be issued to the person who needs it on request to the Headmaster. It contains a summary of the learner's achievement and important comment about his special abilities. It is a document the learner may use when he goes on transfer to another school or moves up to another level of education. See Fig: 9.5

Transcript for Transfer or Graduation (Personal Information)

1. School: ____

2. Name: ____

3. Age: ___________________ Date of Birth: ____________________________

4. Place of Birth: ____________ Nationality: ______________________________

5. Sex: _______________ Height: _____________ Weight: ______________________

6. (a) Father's Name: ____

   (b) Father's Occupation: ____

   (c) Father's Permanent Address: ____

7. (a) Mother's Name: ____

(b) Mother's Occupation: ____

(c) Mother's Permanent Address: ____

8. (a) Guardian's Name: ____

(b) Guardian's Occupation: ____

(c) Guardian's Permanent Address: _______________________________________

9. (a) Class on Entry: ____

(b) Class last Completed: ____

(c) Date of entry: ____

(d) Date of leaving: ____

(e) Reason for leaving: ____

(f) Positions/Offices held in school: ______________________________________

Fig 8.5

WHAT IS REPORTING

When scores and information are recorded, they have to be interpreted in such a way as to be meaningful to any interested user. The act of doing this is referred to as reporting. Those charged with this task are usually the subject (science) teacher as well as the class teacher.

The reports are usually based on the cognitive domain i.e. performances in academic (science) subjects. However, the National Policy on Education in introducing continuous Assessment has encouraged the use of affective and psychomotor reports. See Fig. 8.6 and Fig. 8.7

Affective Measures							
Summary of Ratings on Behaviours **YEARLY RATING**							
Punctuality	I	II	III	IV	V	VI	Remarks
Attendance at class							
Attentiveness in class							
Carrying out assignment							
Participation in school activities							
Neatness							
Politeness							
Honesty							
Self Control							
Relationship with others							
Helping others							

This should contain summaries of ratings for each pupil from Primaries I - VI.

Fig.8.6

Psychomotor

Summary of Ratings on Activities

Activities	**Ratings**						
	I	II	III	IV	V	VI	Remarks
Handwriting Public Speaking Games 1 2 3 Sports 1 2 3 Gym 1 2 3 Painting Musical Performance (Instrument) Drawing							
Cycling							
Swimming							
etc.							

This should contain summaries of yearly ratings on chosen activities from Primaries I - VI.

Fig. 8.7

The report that would be recorded on the summative (final) card or report booklet would be a summary of all the characteristic behaviour of the individual.

The reports one reads in the children's report cards are too brief and not informative enough e.g. Integrated science = 60% very fair or Good. The space provided for subject - teachers' remarks is too narrow. A way out is to pass necessary recorded information on each learner to the class teacher. He has a wide space in column called class teacher's Remarks. Some class teachers will be ready to cooperate with colleagues who have extra or special information about some children in their classes. Some of the comments one may put in include:

1. he is interested in conducting experiments

2. he is very observant in science classes

3. he interprets results very reasonably.

4. he does not enjoy science classes.

WHAT ARE REPORTS USED FOR.

Reports can be used to inform:

1. the learner about his progress and about how teachers view him

2. the headmaster about abilities and interest of the learners in the various classes in his school.

3. the local school Board Authorities and other higher level Education Officers about the type of learners in the various schools in their care

4. guidance counsellors about the abilities, interest and attitudes of the learners in their care. More than any other functionary the guidance counsellor is likely to actually use the data in the report on each child. He would need this to guide and counsel learners in their future career aspirations.

S. the parents too need the reports so as to be able to assist in making proper decisions about the progress their children are making.

ACTIVITY 23

1 . Explain the term reporting?

2. Who writes the reports?

3. List 3 people who need results

4. Give one reason why you think one of the named people needs the results.

Scores of learners may be reported in various ways. Generally schools use raw scores (percentages) obtained by the learner. The 'card' containing the report has now been redesigned. It now contains information about the highest class mean and lowest scores, in addition to the learner's scores. This development will assist parents to see the relative standing (performance) of their children.

Some schools use letters' such as A,B,C.D to represent performances. A 'key' to assist in interpreting them is usually provided somewhere on the report. For instance A may stand for Distinction; B for credit, C for passes; D for failure.

ASSIGNMENT

1. What is meant by record keeping?

2. List essential records that should be kept in a school

3. State how records should be kept

4. What is involved in reporting?

5. What is the importance of good reporting?

SUMMARY

In this unit, you learnt that:

- Record keeping is needed to store and transmit information about learner's performance in school.
- Several types of records such as cumulative record folder, progress reports, Transcript are kept.
- Only reliable and valid information should be kept.
- Teachers, headmasters and guidance counsellors should keep records.
- Transcript is issued by headmaster for learner who is transfering to another institution.
- Reporting is act of passing on information in writing about a learner to various people.
- Report come in the form of comments or remarks
- Percentages and letter grades may be used for reporting
- Reports are needed by the learner, head teacher, parent and guidance counsellor.

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MODULE 6: RESOURCE DEVELOPMENT, CONSERVATION AND RECYCLING OF NATURAL RESOURCES

UNIT 1: LIFE AND SURVIVAL

INTRODUCTION

As you read this unit, you will realise that human beings live in an environment where there are millions of other living organisms. These are usually plants and animals. Animals depend more on plants and they prey on each other for survival. You too depend on plants and other animals to survive in the environment.

OBJECTIVES

By the end of this unit you should be able to:

1. state the characteristics of living things;
2. differentiate between plants and animals;
3. give examples of plants and animals in the environment;
4. identify relationships between plants and animals (Food chain and Food Web.); and
5. outline man's use of land with respect to food production.

LIVING ORGANISMS AROUND US

As you go around the school compound, you will see a variety of living things. Some of these-are plants (trees and Shrubs (bushy plants) and some animals. The most obvious animals you are likely to see around will be insects such as butterflies and grasshopper and animals such as birds and lizards. If you turn over dead pieces of wood, and stone or stir up some dead, leaves, you will discover a variety of animals, many of these maybe insects of different kinds of insects. If you also examine the under surface of living leaves, you may also see some insects.

ACTIVITY 1

Make a list of the living organisms in the school compound/garden. Tabulate them into two groups.

1. Plants
2. Animals

Use the living organisms from activity I. You may want to add some other plants and animals to your list.

FOOD CHAINS AND FOOD WEBS

Many animals depend directly upon plants for their food. It is not difficult to obtain evidences of this. If you examine the leaves of common plants such as citrus, you may see that some of them have obviously been eaten. If you are lucky, you may find the insect responsible. You may also see many butterflies and bees close to flowering shrubs. When you watch closely you will observe that these insects are feeding on the plants. Dead plant materials are also eaten, dead wood always show signs of being attacked by termites. Animals that feed mainly on plants are called herbivores.

Some animals eat other animals. It is less easy for you to obtain an evidence for this, as it happens often quickly. By watching quietly, you should be be to see a lizard or bird eating insects. You may also see bigger insects like the mantis eating smaller insects. Dead animals are also eaten by other animals. Dead insects quickly attract ants, while a dead rat quickly attracts a variety of other animals including insects (flies, beetles, & ants) which quickly consume the corpse. Animals that eat other animals up are called carnivores or predators.

You can see that animals feed on both dead and living plants and animals. When an animal eats both plants and animals for food they are called omnivores. It is important to realize that all animals depend upon plants for their food.

Food chains

From your observation of the school compound you will discover that many organisms arc dependent on other organisms for their food.

This dependence gives rise to the idea of a food chain in which there is a series of organism dependent on another for food. Any observation of a link in the food chain. You can represent the links of the chain diagrammatically by A - B which means A provides food for B using this notation, some common food chains that exist in the school compound are:

General form for a food chain is

Plant →herbivores → carnivores/predators

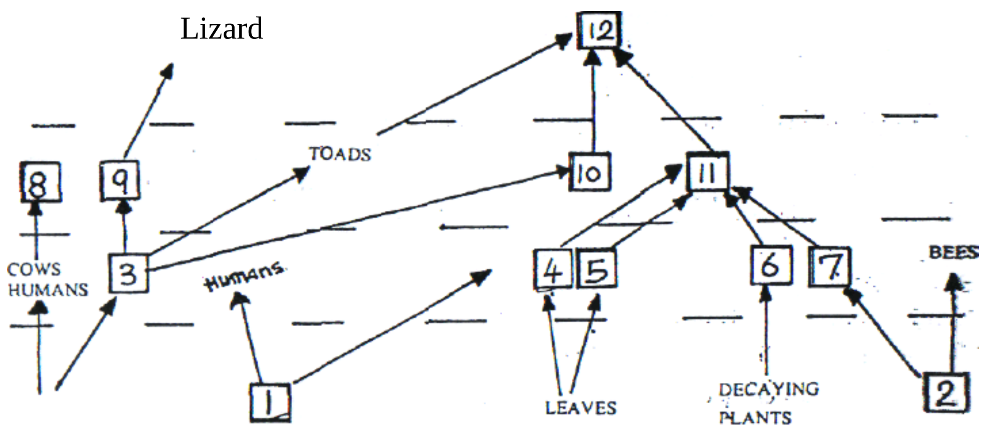
FOOD WEB

This complex feeding relationship around living organism in the environment is generally referred to as the **food web.** A food web generally contain more than one food chain. You will have opportunity to make up a food web in an exercise at the end of this unit.

ACTIVITY 2

A food web shows the inter-relationships of several food chains.

Below is a partly completed food Web.



1. (a) Use the information gathered from the beginning of this unit to identify each of the missing components 1-12.

   (b) What happens to the number and diversity as one goes up the trophic levels? Why?

2. To which class of producer, consumer, or decomposer would you assign the following organisms; a fungus, a plant such as mistletoe which is parasitic on orange; a tapeworm, a fly feeding on cow dung; a camel; mango, a plant which can feed on insects, a tsetse fly: ants feeding upon the honey dew produced by mealy bugs grass?

3. Make a list of the different sorts of food you have eaten during the last twenty four hours and classify the organisms from which they come as producers, primary consumers and so on. To what trophic level does man belong? Are all trophic levels presented in your list? If not, can you suggest any normal terms of human diet, which belong to the missing categories?

MICROBIAL WORLD

MICRO-ORGANISMS AND DISEASES

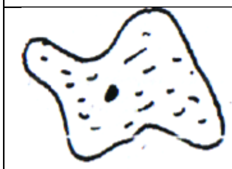
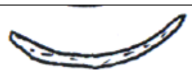
A micro-organism is a living organism too small to be seen with the unaided eye. Micro-organisms are among the most successful living organisms. This group of organisms can be found everywhere in the air, in water in the soil in plants and animals and even in another micro-organism. These organisms can be found in you and other human beings too. They cause in man different kinds of diseases.

The most common kind of micro-organisms in almost any environment are the bacteria. They are very small and you cannot see even with a good microscope. Bacteria cells are different from those of plant and animals cells in that nuclei are not bounded by a nuclear membrane. They belong to the kingdom prokaryota.

Two other group of micro organisms are the protozoa(animal -like) and algae(plant-like) together make up the kingdom protista. The protista can be seen with the ordinary microscope. They can be found in pond water with rotten leaves.

Another group of organisms which is neither plant nor animals are the fungi. Many of the organisms in this group are multicellular but yeast is rather unusual single-celled organism in this group and they all have no chlorophyll. Other members of the group are made up of thread-like structures called hyphae.

TABLE 1: VARIETY OF MICRO-ORGANISMS

MICROBIAL SHAPE	TYPE	MICROBIAL GROUP
	Amoeba	Protozoa
	Paramecium	Protozoa
	Chlamydomonas	Algae
	Malaria Parasite	Protozoa
	Yeast	Fungus
	Treponema pallidum	Bacteria
	Escherichia coli	Bacteria
	Mycoplasma	Bacteria

WHAT IS A DISEASE?

You become ill when your body is infected by a virus or a bacterium. The microbe reproduces inside your body and makes you ill. Very often it is not the microbes themselves that cause the illness but the poisons that they make as they reproduce.

Most diseases have 3 stages

1. Incubation: the microbes reproduce. You may or may not feel ill at all
2. The microbes take control and you feel ill. They make you ill because the can reproduce very fast.
3. Recovery: Your body fights the disease. The microbes are killed and you get better.

A micro-organism that can cause a disease to man or other living organisms is called pathogen. A few protista (e.g. malaria parasite) are pathogens. Several kinds of bacteria are pathogens. Viruses are also pathogens. Pathogens are inside the human body. They destroy cells, and release harmful substances into your body. These two activities make you ill.

ACTIVITY 3

Write down those things that people do that can make them ill.

PATHOGENS: METHOD OF ENTRY INTO OUR BODY

A pathogen can only make you ill when it gets into your body. Different pathogens get into the body in different ways.

1. **Entry through the skin:** Most pathogens can enter through the skin if it is cut. For example the bacteria that causes tetanus, gets into blood through the cut skin.

2. **Entry through the mouth:** The bacteria that causes food poison (Salmonella) is taken in if you eat food in which these organisms are growing. Cholera bacteria and poliomyelitis virus may be swallowed if you drink contaminated water.

3. **Entry through the nose:** Cold and influenza viruses get into your body through your respiratory system. When someone sneezes, blows his nose, or just breathes out tiny droplets of moisture get into air and they may contain these viruses. If you breath these droplets in, you too may get infected.

4. **Entry through the reproductive system:** The AIDS virus can be passed from one person to another during sexual intercourse. Bacteria diseases such as gonorrhoea and syphilis are passed on in this way.

5. **Entry through vectors:** Some pathogens rely on vectors to transfer them from one organism to another. For example the protista that causes malaria (plasmodium) lives inside the human red blood cells. If an infected person is bitten by mosquito, the insect suck up blood and so takes the malaria parasite into its body. The protistan lives in the salivary gland of the mosquito and if it be released into another person when it bites, the person will develop malaria in a few days.

ACTIVITY 4

Write down other ways in which some diseases can be spread/transmitted.

FIGHTING DISEASES THAT ENTER THE BODY

Pathogens do some damage when they enter your body- As a result, the defence system/immune system is set into action. The white blood cells are very important part of the immune system. They go round the body to catch bacteria and viruses which are foreign and strange to your body. When a white blood cell finds foreign cells, it produces new blood white cells rapidly. The new cells produce new chemicals called antibodies, to kill the foreign cells.

Some white blood cells attack foreign cells by flowing around then and taking them into their cytoplasm. Then they digest them. This method of dealing with foreign cells in the body is called phagocytosis. Bacteria and viruses are removed in this way.

Sometimes the number of bacteria in the body gets too many for the body to cope with. In this case an antibiotic drug is used.

People can be injected or vaccinated against some viral diseases e.g. smallpox, Poliomyelitis.

Other natural ways the body protects itself against pathogens are:

1. Blood clotting prevents entry of pathogens after the skin its cut.
2. Food badly infected by bacteria taste or smell awful, so we find it has unpleasant taste. Such food make us vomit. So the pathogens are removed from the body.
3. Hydrochloric acid produced by the stomach kills many bacteria in food.
4. Cilia and mucus in the nose and trachea help to trap particles and bacteria so that they do not reach the lungs.

ASSIGNMENT

1. What kind of microbes cause the following diseases: Cholera, malaria, colds, influenza food poison?
2. Describe what happens when a person has a disease.
3. Explain why the following could be harmful
   a) not using a handkerchief when you sneeze.
   b) not washing your hands before a meal.
   c) not washing a cut or covering it with plaster.
4. Apart from diseases in Questions 1, give
   a) One examples of diseases caused by viruses
   b) three examples of diseases caused by bacteria.
   c) one example of disease caused by protozoa

SUMMARY

In this unit, we have learnt:

- Food chains and food webs
- Micro-organisms and diseases
- Causes of diseases
- Methods of entry of pathogens into our body
- How to fight diseases that enter the body

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UNIT 2: ANIMAL: DOMESTIC, FARM AND WILDLIFE

INTRODUCTION

Out of the numerous animals in nature, man has been able to identify some animals which are not dangerous to live with. These animals can be tamed and domesticated. However, there are some animals which are extremely dangerous to man and other animals. These animals have been left to roam about untamed in the wild.

These wild animals, though not subject to human control, contribute to the wholeness of the natural environment. They also contribute to national economy. For example, Yankari Game Reserve in Bauchi State attracts visitors within and outside Nigeria.

In this unit, we shall look at the domestic, farm and wildlife animals,

OBJECTIVES

By the end of this unit, you should be able lo;

1. identify and name examples of domestic and farm animals;
2. identify with examples wildlife animals;
3. distinguish between domestic, farm and wildlife animals; and
4. mention the values of domestic and wildlife animals.

KINDS OF ANIMALS

Of all the groups of animals you read earlier on, we will concentrate on some birds and mammals, some of the latter are not dangerous, hence they live with people in their homes and in the farm. Goats, sheep, chicken, guinea fowls, pigeons, dogs, pigs and ducks are examples. You have seen these animals living freely among people. Some of these animals are sources of protein to the family. And they also contribute to man's economy. You have seen nomads driving their herds of cattle and sheep in your area. Cattle and sheep provide meat and skin for leather works. Cattle provides us with milk, butter and cheese.

There are some dangerous animals living in their natural environment. Man and other animals fall prey to them. They are wild and cannot be tamed like domestic animals. They also have their values. You will learn about their values later in this unit.

DOMESTIC ANIMALS

It is a common occurrence in the Nigerian community to find goats, sheep, fowls and ducks feeding and living freely in homes. Why do we keep these animals? Apart from being source of meat, their skins are of great economic value to man. Occasionally their owners sell them to meet their financial needs.

ACTIVITY 5

Make a list of all domestic animals in your environment. What are the values of each animal you have listed to man?

FARM ANIMALS

As a result of better method of keeping of animals (husbandry), man has developed methods of keeping a large stock of tamed animals in commercial quantity. In almost all towns and villages, you would see a lot of backyard poultry. Ministries of Agriculture and Natural Resources have pockets of farms or stations where some of these animals are reared. We shall look at the livestock which include poultry, cattle, sheep goats and pigs. Farm animals live in specially built homes with adequate facilities.

POULTRY

Birds such as chicken, ducks, geeses, turkey and guinea fowls are kept in some homes. They receive adequate care than free range birds which are exposed to various hazards. These birds are usually kept in either cages (battery) or on a deep layer of sawdust (Deep-litter). They receive better care, produce high quality products and are protected from danger. They are kept for meat and eggs.

ACTIVITY 6

Visit a local poultry farmer. Ask about the types of birds he keeps. Find out about the advantages of each kind of bird. Ask about birds which are for meat only and those which are both for egg and meat. How are the birds fed? Do they receive innoculation?

CATTLE

You might have seen a herd of cattle being raised in Nigeria. You might have not noticed the different types, but some cattle have long horns (Red Boror); some have short horns (Zebu or Muturu) and some are without horn (N'dama). Cattle feeds on grass, hay or sillage, cattle supply meat, cheese, butter, milk and skins for leather works,

Look at the pictures in fig. 2.1. a,b,c. Identify the type of cattle in the picture.

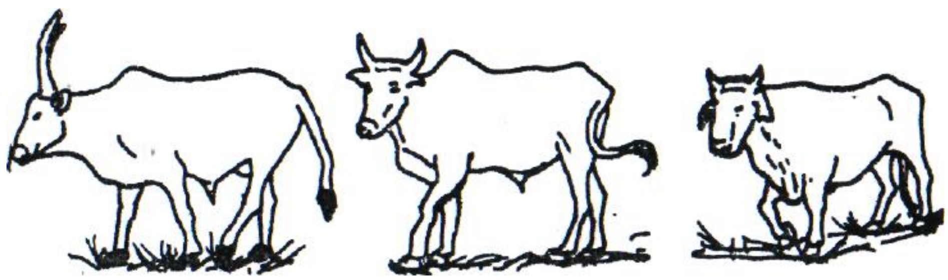

Fig. 2.1 (a) White Fulani 2.1 (b) N'dama 2.1 (c) Muturu

SHEEP AND GOATS

Sheep and goats are only seldom raised in large numbers by Nigerian farmers. These animals prefer to move about freely in search of food and water. They do not thrive better under controlled condition. However, Nigeria's Fulanis do keep flocks of sheep and goats. Sheep and goats are raised for meat and skin. There are two main types of goats the red skinned (Fig. 2.2) commonly found in Sokoto State and the dwarf goat (Fig. 2.3), commonly found in the southern state of Nigeria.

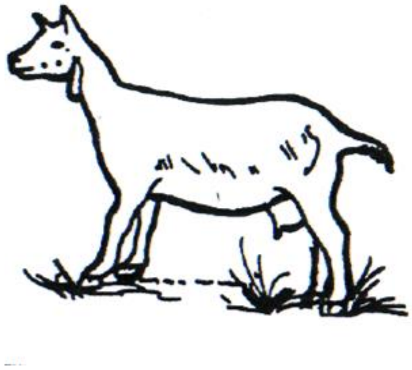

Fig.2.2 The Red Skinned Goat. Fig.2.3 The Dwarf Goat.

PIGS

In some parts of Nigeria, pig farming is not very common because they are regarded as religiously unclean animals. However, with a greater demand for bacon; pig farming is becoming popular in other parts. Pigs are raised in the piggery, receiving adequate cares. Pigs are raised for meat and oil.

WILDLIFE ANIMALS

Lions, giraffe, tiger, elephants and leopard are wild animals, hence they are called wild-life animals. They live in their natural environment. They cannot be subjected easily to human management. However, there are a number of zoological gardens in some universities and cities with some of these animals. If you have ever visited Yankari Game Reserve in Bauchi State, you will find these animals in their natural niche. Without these animals, the natural environment will not be complete.

They contribute to national economy through income from tourists who visit where they have been protected. They are of a great aesthetic value. Look at figure 2.4.

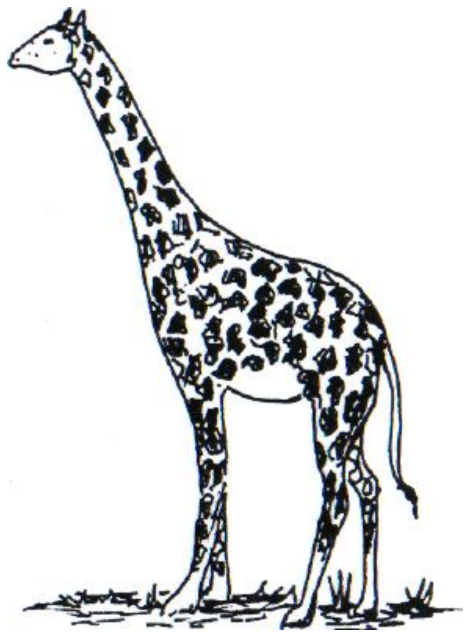

Fig.2.4 A Giraffe

ACTIVITY 7

Visit a zoo in your area. List the wild animals in the zoo.

ASSIGNMENT

1. Name eight domestic and farm animals
2. What do people keep domestic and farm animals?
3. Name six wildlife animals.
4. What is the value of keeping wild animals?
5. How would you differentiate between a wild and a domestic animal?

SUMMARY

In this unit you learnt that;

- Some birds and animals can be tamed and domesticated by man. Examples are goats, sheep, ducks, chicken, geese, pigs, turkey and rabbits.
- Some animals are wild and are not domesticated. They are dangerous to man and other animals; lion, hyena, leopard are some examples.
- As a result of modem method of keeping animals, some tame animals can be kept in large quantity as farm animals.
- Birds are raised for meat and eggs.
- Sheep and goats are also raised for meat and their skins.
- Wild animals contribute to national economy.
- They are tourist attraction
- They have, aesthetic value
- They are a major contributor to balance in nature.

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UNIT 3: WHAT WE GET FROM OUR ENVIRONMENT

INTRODUCTION

In this unit, our attention would be focused specifically on what constitutes our environment and what we get from it.

OBJECTIVES

By the end of this unit, you should be able to:

1. list at least 4 kinds of resources obtained from our environment;
2. explain the term environment; and
3. state at least 2 uses of the resources of our environment.

WHAT CONSTITUTES MAN'S ENVIRONMENT?

ACTIVITY 8

Look around your community or school compound and make a list of the things that you observe.

Everything around an organism, including the living and non-living components constitute its environment. These include the atmosphere, air, soil, rocks, vegetation. water, ponds, seas and lakes. Some physical factors such as rainfall, temperature, wind and humidity help to shape particular environments.

The natural environment is one which has not been tampered or altered by man's activities. In a natural environment, there is usually a balance in nature.

However, man tries to create for himself a more conducive environment in order to improve his standard of living. Some of man's activities tend to alter the balance in nature. For example, in using an air conditioner, we create an artificial environment Clearing of forests to give way to fields and unplanned urbanization are other examples of artificial environments,

RESOURCES OBTAINED FROM THE ENVIRONMENT

Our earth abounds with several resources. There are four kinds of resources. These may be classified as: inexhaustible, renewable, non-renewable and yet - to - be developed resources.

INEXHAUSTIBLE RESOURCES

Are those which we have always. They continue to abound always, even after use. They include air, sunlight, water, and rocks.

RENEWABLE RESOURCES: Include soils, vegetation, animal life and fresh water supplies. These are interdependent and much depends on prudent management. The goal of conservation is to keep our earth as rich and as productive as we found it.

NON-RENEWABLE RESOURCES: **-** Are those that can be used up. These include coal. petroleum oil, natural gas, metals and most minerals are of this nature.

USES OF THESE RESOURCES

i) Air - All life require air for existence. Animals take in oxygen and give out carbon (IV) oxide. Plants use carbon (IV) oxide during photosynthesis and give out oxygen. Air is therefore important to bring about energy transfers in living things.

ii) Minerals - Minerals are important for plants and Minerals arc useful substances (elements or compounds) that could be obtained from our environment. Plant growth depends on minerals. Some are required in small amounts, while others are required in large amounts. Some are used by man for construction of buildings, bridges, tools, cars, ships, trains and other conveniences. Some are highly treasured as jewels. Different minerals are mined continuously without replacement. Examples include petroleum, coal. iron, aluminium, gold, diamond, etc.

iii) Water: - It is very important for all life processes. Plants obtain their food as mineral salts in solution. It is used for washing and drinking by animals.

(iv) Sunlight: - Supplies energy to plants and without it plants would not make their food which all animals depend upon.

ACTIVITY 9

1. identify 3 physical factors commonly seen in the environment.

2. Explain the terms renewable and non-renewable resources in our environment.

COAL: FORMATION, MINING, USES

Formation of Coal

Coal is an impure form of carbon, formed over millions of years from the remains of plants and trees. They are found in many parts of the world, including Nigeria. They occur in stratified deposits both near the earth's surface and at various depths. It is formed by slow decomposition and chemical conversion of immense masses of organic materials (mostly wood).

This slow conversion of wood into coal is brought about by pressure and heat. The oxygen and hydrogen in wood are gradually removed and the percentage of carbon slowly rises.

The wood is first converted' to peat (60% carbon); then to lignite (67% carbon) which is a soft brown coal. Lignite gradually becomes bituminous coal (80% carbon), which may 2-.enmally be converted into anthracite (90% coal) - the hardest form of coal.

COAL MINING IN NIGERIA

Coal mining had been going on in Nigeria since the colonial rule. It was exported in its crude form. and this provided foreign exchange. Enugu. had been at the centre of this operation, hence it is called the coal-city. However, with the discovery of oil in commercial quantity in Nigeria; not much interest and attention was paid to the coal industry. However, with the sudden twist in the economy and the problem of over-dependence in the oil sector, renewed efforts have been put in to revitalise the ailing industry.

Deposits of lignite have been found at Onitsha and Asaba. About 113 million tonnes of coal are mined each year at Enugu in Nigeria.

Coal is mined by digging straight to the deposits in the earth's crust. The crude coal is then excavated and carried to the surface of the earth.

USES OF COAL

Large quantities of coal are burnt to release heat energy required to drive generators. Its immediate local use was to power the locomotive engines used by the Nigerian Railways. These have almost been phased out.

Coal is also used in our homes as fuel for cooking purposes. Coal is also broken down to produce coke, coal tar, ammoniacal-liquor and coal gas by destructive distillation. This is the process of heating coal ill the absence of air. It is converted into solid. liquid and gaseous products.

Coke is a black porous solid. It does not contain the volatile impurities present in coal. It is used industrially in the blast furnaces for the production of iron.

Coal tar contains many substances of great industrial importance. For instance, Benzene is used in the making of drugs, antiseptics.

Ammonia in ammoniacal-liquor is used in the production of fertilizers for agriculture.

ACTIVITY 10

(a) State 3 uses of coal.

(b) List the products of destructive distillation of coal.

SUMMARY

At the end of this unit, we had learnt:

- Resources present in the environment.
- Renewable and non-renewable
- Formation of coal
- Mining and uses of coal

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UNITS 4: MINERAL RESOURCES

INTRODUCTION

In the preview units, we discussed Coal Formation, Mining and Uses. Here in this unit, we shall discuss Iron, Limestone and Hard-water.

OBJECTIVES

By the end of this unit, you should be able to:

1. Describe the formation and mining of Iron, Limestone, etc;
2. Mention the various types of mining of these minerals;
3. List their various uses; and
4. Identify their location in Nigeria

FORMATION, MINING AND USES (YESTERDAY AND TODAY)

Iron is the most common metal of all, and you can see it almost everywhere you look. But mostly you will see it in the form of steel, which is an alloy, made from iron, and dry small amounts of other substances, such as carbon. In fact, iron is rarely used as metal, but always in the form of steel.

The modern world is built from steel. Steel plays an important part in the manufacture of other articles and forms the basis of all machinery. It helps to shape wood, make glass, chisel stone and mix cement. The machinery needed to melt and form other metals and to make plastics is mostly made of steel. Iron is the most important material used in the industry, because so much of it is used to make steel.

Iron has greatly influenced peoples, cultures and civilizations throughout the world. It gave its producers an advantage over their rivals in the manufacture of weapons and tools.

OCCURRENCE

5% of the earth's crust is made up of iron. It is found as an oxide in large concentrated masses at, or near the surface of the earth.

Large deposits of iron ore are found in Nigeria at Itakpe near Okene and Mount Patti near Lokoja.

The major ores of iron are compounds listed below:

Haematite (Fe_2O_3)

Magnetite (lodestone) (Fe_30_4)

Limonite ($Fe2O_3.H_20$).

Siderite ($FeC0_3$)

Iron pyrites (FeS_2)

The centre of the earth is believed to consist of a solid core of iron. Iron ore is found in layers of stratified ironstone running in horizontal lines between clays, limestone, and sand which are called overburden.

ACTIVITY 11

(a) Make a list of some traditional implements used for agricultural purposes. What are these made of?

(b) List some weapons or tools used for hunting; offence or defence used in your community.

EXTRACTION OF IRON

Iron is extracted by reduction of the ores in the blast furnace process. The blast furnace consists of a tower up to 60 metres in height and 10 metres in diameter. It is made from steel and lined inside by fire-proof brick.

At the top of the tower, a mixture of ore, coke and limestone is fed into the blast furnace through the bell hopper. Limestone is used to convert silica (sand), which is an impurity. In the ore, into a slag which can be removed easily.

Near the bottom of the furnace is a ring of pipes called tuyeres from which a blast of hot air is forced up. The coke bums and carbon (IV) oxide is formed. The carbon (IV) oxide is reduced to carbon monoxide as it passes through neighbouring layer of coke. Carbon monoxide reduces iron ore, and the molten iron is collected at the bottom of the furnace.

PHYSICAL PROPERTIES OF IRON

Iron is a hard, shiny solid with a density of 8.0g per cm^3. It is malleable and ductile with great structural strength. It is a good conductor of electricity and heat. It can be magnetized.

CHEMICAL PROPERTIES

Iron rusts rapidly when exposed to air or water. Steel can be made by adding small fixed amounts of carbon and manganese to molten iron. Stainless steel has nickel and chromium added as well. Thus, stainless steel is an alloy of iron with the above mentioned substances.

USES OF IRON:

(a) Transport: Iron and steel is used in making cars, ship strains, and bicycles.

(b) Construction: Iron and steel are used extensively in the construction of bridges and large buildings.

(c) Tools: Iron is used in making tools, ego hammers, axes, spades and nails, etc.

(d) Containers: Iron (protected by tin and zinc) is used in making many types of containers; including tanks.

(e) It is also used in making cutlery, rock drills, watches and electromagnets.

ACTIVITY 12

(1) What is an alloy?

(2) State two physical properties of iron.

LIMESTONE AND MARBLE: FORMATION, MINING AND USES

OCCURRENCE IN NATURE

Limestone, marble and chalk are rocks. They occur in many districts and regions; including Nigeria. For example, large deposits of limestone occur at Nkalagu, Anambra state.

Chalk, limestone and marble have been shown to contain the same elements, viz: Calcium, Carbon and Oxygen. These rocks are called Calcium trioxocarbonate (iv), which for the sake of simplicity we shall refer to as calcium carbonate. Marble is much harder than limestone.

Their chemical formula is $CaC0_3$

ACTIVITY 13

Name 3 elements contained in limestone. What is the chemical formula of marble.

FORMATION OF LIMESTONE (CALCIUM CARBONATE)

The scale inside boilers or kettles in limestone regions is calcium carbonate. Such formation eventually reduces the size of pipes or boilers. If no action is taken to remove total blockage may and may be followed by explosion.

Formation of Stalagmites and Stalactites

When rain falls, part of the atmospheric carbon (IV) oxide is dissolved in rain water to form carbonic acid. In limestone regions, this carbonic acid dissolves part of the limestone and the dissolved limestone percolates through the soil. If the dissolved limestone gets to the roof of a cave in the region part of the solution will evaporate to form solid calcium carbonate. However, part of the solution drips to the floor of the cave where it will evaporate to form a solid too. This process continues over many years and leads to solid calcium carbonate projections from the roof and floor of the cave.

The calcium carbonate projection that grows from the roof of the cave is called stalactite i.e the one that grows from the floor is called stalagmite. The two projections may eventually meet to from a strong pillar. See Fig. 4.1

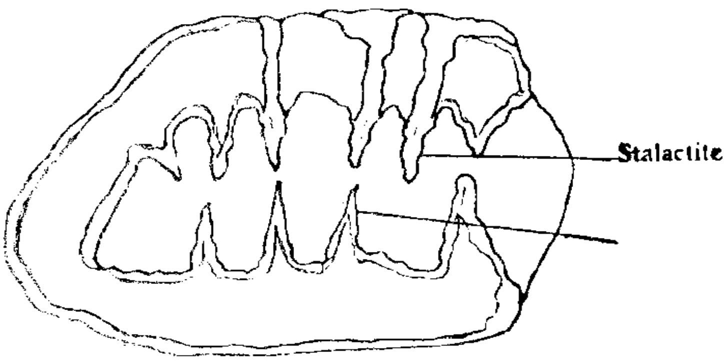

Fig. 4.1 Formation of stalagmites and stalactites

MINNING AND USES OF LIMESTONE AND MARBLE

Limestone has grown in importance in districts where they occur. The importance lies are scraped up; broken up or (quarried). These are found to be very useful in construction work.

Limestone is used in the production of Portland cement which is used to make concretes in building construction. Cement factories have been built in Bende1, Sokoto, Bauchi, Kogi and Benue states, but despite all these efforts, cement for building is still in short supply in Nigeria.

Marble is harder than limestone and it is a more precious stone. It is used as ornaments and in construction work.

Limestone is of great importance because of its products which are all of importance in agriculture; in making mortar; quicklime and slaked lime (for treating soil acidity). Another important product is calcium carbide which is of industrial importance.
Again, limestone and marble are the natural sources of the mineral calcium which is useful in bone and teeth development in children.

ACTIVITY 14

1. What are stalagmites and stalactites?

2. Give one industrial use of limestone.

HARD WATER

Limestone rocks give hard water. But, what is hard water, you may ask? Hard water is one which does not easily form lather or foam with soap.

How is this brought about? When rainwater runs over rocks, it will dissolve any soluble minerals. The presence of dissolved minerals as calcium ions or magnesium ions cause water to be hard.

TYPES OF HARDNESS

We have permanent hardness and temporary hardness

The latter is so-called because the hardness can easily be removed by boiling.

As rainwater passes through the atmosphere, it dissolves some carbon (IV) oxide and forms a dilute trioxocarbonate (IV) acid, H_2CO_3.

$$H_2O_{(1)} + CO_{2(g)} \longrightarrow H_2C0_{3(aq)}$$

This acid reacts with the rock it flows over; forming temporary hard water. Temporary hardness is caused by the presence of either calcium or magnesium bicarbonate Ca(HC03) . This is easily removed by boiling.

$$Ca(HC0_3)_{(aq)} \longrightarrow CaCO_{3(s)} + H_20\ (1) + CO_{2(g)}$$

The calcium ions are trapped in insoluble calcium carbonate and can no longer form scum with soap. The water is no longer hard. Calcium carbonate formed is seen as fur or scale inside boilers or pipes.

REMOVAL OF WATER HARDNESS (SOFTENING OF WATER)

1. Temporary hardness could be removed by boiling. It is expensive for industrial use.

2. Temporary hardness can also be removed by adding exactly calculated amounts of calcium hydroxide (or lime) to water. This precipitates calcium carbonate.

3. Addition of washing soda can remove both temporary and permanent hardness.

4. Distillation process can also remove both forms of hardness; but the method is rarely used because it is not economical.

ADVANTAGES AND DISADVANTAGES OF HARD WATER

Hard water has the following disadvantages:

(i) Form scum with soap and so wastes soap.

(ii) Leaves fur or scale deposits on kettles and boilers.

(iii) Interferes with processes used to tan hides and processes used to dye.

Hard water has some advantages, viz: calcium compounds are good for healthy teeth and bones. Hard water has a more pleasant taste; as pure water has no taste. Hard water is not likely to dissolve lead pipes which is a cumulative poison.

ACTIVITY 15

1. Name two types of hard-water

2. What does removal of hardness of water mean?

UNIT 5: PETROLEUM: FORMATION, MINING, AND USES

INTRODUCTION

In this unit, our discussion shall be on Petroleum, Tin and Limestone; their formation, mining and uses. It also discusses the treatment of hard-water.

OBJECTIVES

By the end of this unit, you should be able to:

1. Identify where petroleum are found
2. State the process of mining Tin and Limestone
3. Mention uses of their minerals
4. State the effects of these minerals on the society
5. Identify hard-water
6. Identify the method of treating hard-water

WHAT IS PETROLEUM OR CRUDE OIL?

Petroleum or crude oil is a thick, dark-liquid that is viscous-it flows very slowly. It is a complex mixture of hydrocarbons (composed of the element hydrogen and carbon only)

FORMATION OF CRUDE OIL

It is believed that crude oil formation occurs slowly, over millions of years from the remains of marine life. Such remains, deposited on the sea beds and subjected to huge pressures over a long period of time, were gradually converted into oil.

OCCURRENCE AND MINING OF CRUDE OIL IN NIGERIA

Crude oil is obtained from the earth by drilling holes through the non-porous rock that traps it there. (See Fig. 5.1)

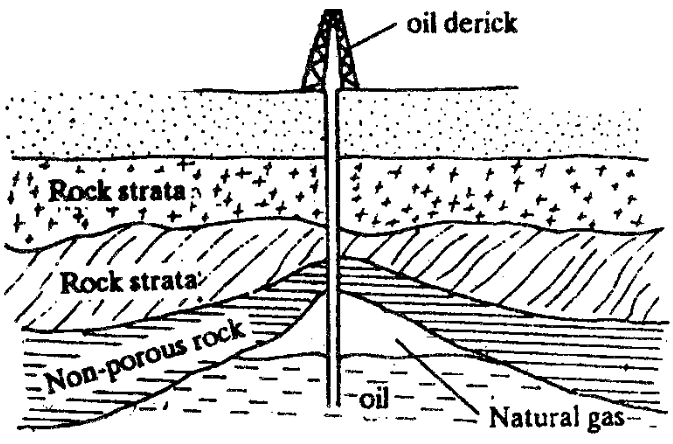

Fig 5.1: Occurrence of oil in the earth.

When a hole is drilled, oil and gas shoot up into the air under pressure. Most of the oil fields in Nigeria arc located mainly in the Delta areas of Rivers and Bendel states, and in Imo state.

The crude oil is transported to the refineries through flow pipes. Nigeria has two of such refineries located at Port - Harcourt and Kaduna. Crude oil undergoes fractional distillation (separated into difference components) at the refineries and the major products or fractions are natural gases, petrol, kerosene, diesel, lubricating oil and bitumen.

ACTIVITY 16

I. What type of rock traps crude oil in the earth?

2. Name four products of fractional distillation of crude oil.

EFFECTS OF CRUDE OIL ON THE SOCIETY

The benefits of crude oil or petroleum have been greatest on the producer nations as Nigeria. It is now our most important export. Its production and transportation provides increased national wealth and employment. Cars, tractors, and trains on our roads and rails consume petrol and oil. Plastics and synthetic fibres are found in all homes. Fuels are important sources of energy.

Many chemicals like paints, detergents, explosives, rayon, synthetic rubber, medicines. insecticides, cooking gas and textiles are derived from petroleum. It has given rise to many new and useful products.

We have also witnessed some dangers of oil spillage and its negative effect on marine life Pollutants are daily added to the atmosphere. Thus, crude oil brings wealth, energy, and useful materials, but it also causes problems. It is important to note that petroleum is a finite resource and will eventually run out.

TIN - FORMATION, MINING AND USES

Formation/Occurrence of Tin

Tin occurs naturally in the earth's crust as mineral cassiterite or tin dioxide in gravels and alluvial deposits in present or former river beds. Gravels and alluvial deposits in river beds are sediments which are the products of weathering of rocks. The amount of tin ore present in alluvial deposits are concentrated enough to be extracted for refining and industrial use.

Deposits of tin oxides are found in commercial quantities around Jos in Plateau state of Nigeria. It is also found in Kano and Bauchi states.

ACTIVITY 17

1. In what form does tin occur in nature?

2. Name two states in Nigeria where deposits of tin ore are found in commercial quantities.

3. Find out from the library four other countries where tin deposits could be found in commercial quantities.

MINING/EXTRACTION OF TIN

Nigeria is the fifth most important tin producer in the world. Some other countries where tin are mined in commercial quantities include: (Use the result of your findings in Activity 17 to fill this gap) ………………………….

Tin is dug out from the mines as tin ore called mineral cassiterite mixed with impurities. To extract tin from the ore, the ore is first crushed and washed to remove less dense impurities. The tin is dried and strongly heated in oxygen in order to burn off other impurities such as sulphur and arsenic.

Finally the concentrated ore is reduced by heating with coke or anthracite in a reverberatory furnace. The molten tin which is produced is allowed to flow out to solidify.

$$SnO_{(s)} + 2C_{(s)} \longrightarrow Sn_{(l)} + 2CO_{(g)}$$

The crude tin obtained by this smelting process still contains impurities of iron, arsenic, and lead. To purify it, the crude tin is re-melted on a sloping hearth. The impurities have a higher melting point than tin and remains as solids but the tin melts and can be run into moulds.

ACTIVITY 18

1. Why is tin ore crushed and washed before extracting tin from it?

2 Name two reducing agents which you can use to extract tin from the ore.

USES OF TIN

Tin is widely used for tin-plating. Tin plating is a process of coating iron and steel materials to protect them from atmospheric corrosion and rusting Tin plated materials are very useful both in industry and at home. They are used mainly for canning foods and drinks because tin is not poisonous and does not contaminate food. Tin-foils are also used for wrapping up foods which need to be heated in an oven or boiled.

Tin is also used in many alloys. Some of the alloys of tin are solder which contains 50% tin and 50% lead; type metal which contains 10% tin, 75% lead. and 15% antimony; and bronze which contains 80% tin and 20% lead.

ACTIVITY 19

1. Mention two uses of tin.

2. Why are tin plated materials very valuable for industrial purposes?

3. Name three alloys of tin.

ASSIGNMENT

1. What is petroleum?
2. How is petroleum formed and how can we obtain it?

   a) Name two places where petroleum is mined in Nigeria and

b) Places where oil refineries are located

3. State 4 uses of petroleum to man

4. What are the related dangers of the petroleum industry in Nigeria?

SUMMARY

- Petroleum is a dark-coloured viscous liquid; obtained by drilling. It is a mixture of hydrocarbon.
- Its formation is slow, taking millions of years.
- Petroleum is trapped under non-porous rocks in the earth.
- Important products of crude oil include gas, petrol, kerosene, diesel, lubricating oil, and bitumen.
- Petroleum yields a lot of revenue for the producer nation.
- Petroleum refining causes environmental pollution.

UNITS 6: CONSERVATION OF NATURAL RESOURCES

INTRODUCTION

Conservation of natural resources is the wise use and safe keeping of natural resources for the good of mankind, to ensure their continuous availability and to preserve the original nature of the environment. For many years now, natural resources have been wasted. Much of the wildlife has been destroyed due to ignorance and carelessness. Growth of towns and agricultural developments which are a must for our existence have also contributed to the destruction of forests and consequently the destruction of the habitats of wildlife.

If the natural resources are misused or poorly managed, the resources become less useful or destroyed entirely. For example, if water that is so essential to man's existence is misused due to pollution, its usefulness is reduced and the organisms living in the water such as fish, crabs and turtles etc., may be killed. Such polluted water may be harmful to man's health if drunk and the death of fish, crabs, turtles etc., means shortage of food for man. Also if forests are set on fire there is the destruction of timber, young trees of future forest, and fertile soil (humus).

OBJECTIVES

By the of this Unit, you should be able to:

(i) Identify the natural resources in your environment

(ii) Identify renewable and non-renewable resources.

(iii) Identify ways of conserving the soil, water, wildlife and minerals.

(iv) State the benefit of conserving the soil, water, wildlife and minerals; and

(v) Describe the effect of excessive use of natural resources

Natural resources

Natural resources are useful things provided by nature. Soil, water, wildlife, forest, minerals, sunlight and air are some examples of natural resources. Natural resources are classified into two categories namely: replaceable and irreplaceable.

Replaceable (renewable) resources

Replaceable resources are those which can only be replaced by offspring that is by reproduction. Trees and animals are examples.

Irreplaceable (non renewable) resources

Irreplaceable resources are those resources which cannot be replaced when the initial stock is used up. Examples are petroleum, coal, gold, diamond, copper and iron. Therefore, those resources must be carefully managed to avoid their shortage until acceptable substitutes are found.

Conservation of soil

The soil needs to be conserved if we are to avoid shortage of food, and famine. Mismanagement of soil results in loss of its fertility. For example, overgrazing and burning of the land promote soil infertility and erosion.

The following practices help to conserve soil:

1. The erosion of the soil must be checked by planting grasses and legumes to prevent the washing away of the fertile top soil. Crops should be planted on ridges across slopes to prevent the top soil from being eroded.

2. Practising shifting cultivation and crop rotation helps to conserve soil fertility.

3. Bush burning should be avoided as burning destroys timber, young trees, seeds and the rich humus on the floor of the forest.

4. Manure should be added to the top soil to make it fertile.

5. Use of cover crops

   Leguminous creeping plants such as centrosema, and mucuna, ground nut and Pueraria sp. are often planted in fallow pieces of land in an attempt to conserve the soil. The spreading of folliage and extensive root systems of these plants effectively check erosion.

6. Mulching

   This involves the spreading of a layer of vegetable material on cultivated farmland. The mulching prevents rain drops from directly striking the soil, an action which loosens soil particles. It also prevents loose particles from being carried off by wind or running water.

7. The "fallow method"

   If a piece of land is left fallow, it is gradually covered with plants. These plants help to conserve the soil of such fallow farm-lands in similar way as cover crops do.

8. Planting of grass and trees

   Trees and grasses serve as wind brakes thus checking wind erosion.

9. Speed brakes

   Where farmlands with gentle slopes are cultivated it is necessary to check the speed of run-off water which results in erosion. This is done by constructing ridges across the slope of the land or bumps at intervals.

Benefit of soil conservation

1. It ensures preservation of soil nutrients, hence healthy growth of plants and therefore increase in food for man.
2. At provides healthy habitats for soil organisms help to aerate and fertilize the soil.
3. It provides raw materials for some industries (for example, clay is an essential raw material for ceramic and brick industries).
4. Preservation of soil fertility is ensured.
5. It prevents desertification.
6. Prevents soil erosion.

Conservation of water

Water is so essential to life that its conservation is very necessary for a normal existence of life. Water is conserved in the following ways:

1. Burst water pipes must be repaired immediately to prevent wastage of drinking water.
2. Planting of trees to provide surface cover for soil. This reduces water evaporation from the soil thereby retaining water in the soil.
3. Recycling of used water after treatment.
4. Damming of rivers to form man-made lakes for good management of water.
5. Storing water in tanks, walls, ponds and reservoirs.
6. Protection of plants to increase transpiration which consequently induces rainfall.
7. Taps must be locked if they are nor in use.
8. Dumping of poisonous chemicals, refuse and sewage must not be allowed. Laws forbidding dumping should be established.

Benefits of water conservation

1. It ensures good water supply for agriculture.
2. It ensures the preservation of the natural, habitats of fish and other aquatic animals thus promoting high yield fish for man's food.
3. It provides water for domestic use.
4. It provides source for hydroelectric power.
5. It provides medium for transportation.
6. It provides recreation such as swimming and sport fishing.

Conservation of wildlife

Wildlife means animals in their natural habitat. These include fish, frogs, reptiles, birds and mammals.

Wildlife can be conserved in the following ways:

1. Indiscriminate killing of wildlife should be discouraged.
2. Establishment of game reserve to protect the animals from being hunted. Hunting in amereserves is not allowed by law unless permitted.
3. Water bodies such as rivers, streams and lakes should be devoid of poisonous chemicals, (such as garmmalin 20 and mercury) sewage and garbage. These kill fish, the food of the fish and other aquatic animals.
4. Killing of young animals should not be allowed. In fishing, size of net that can only catch adult fish should be used.

5. Clearing of aquatic vegetation provides enough space for fish and allows oxygen to circulate freely for the benefit of fish and other aquatic animals. Fish and other aquatic animals will increase in productivity.

6. Constructing dams across rivers should only be allowed when it is of high economic value to the country. Dams disturb fish migration. However, if a dam is constructed, fish ladders (channels around the dam that allow fish to move upstream) should be provided.

7. Deforestation destroys the habitats of animals including birds. Therefore, cutting down of trees and burning of bush indiscriminately should be discouraged. Good conservation of forest s also helps in the conservation of the wildlife.

Benefits of wildlife conservation

1. It provides continuous of food

2. It provides continuous source of raw materials for industries such as fur, hide and skin.

3. It provides recreation for man. Man derives great pleasure from hunting and fishing and hence it promotes tourism. Foreign tourists spend their hard currencies in the country thereby increasing the foreign exchange earnings of the country.

4. Conservation of wildlife will ensure that animal species are protected from extinction.

5. They will be easily available for study in their own natural environment.

Conservation of minerals

Minerals are some of the irreplaceable resources. Therefore careful management is needed to avoid running short of them. Only Federal Government agencies are authorized to mine minerals in Nigeria. Few individuals or private companies may be allowed to mine minerals.

The quantity to be mined is regulated. For example, the number of barrels of crude oil pumped daily is limited. This practice ensures that we do not run out of oil on time.

Benefits of mineral conservation

1. They provide continuous source of energy. For example, coal is used for cooking and driving of locomotives such as trains while petrol is used for driving motor vehicles.

2. They provide raw materials for industries. For example, iron ore and coal are used in iron industry.

3. It ensures continuous availability of common salt (sodium chloride) used for food and industries.

4. When sold to foreign countries, earning is in foreign exchange.

Problems and difficulties of natural resources conservation

Problems abound in attempts to conserve natural resources. Some of the problems are:

1. Limited source of energy

Sources .of energy for cooking are few and limited to fairly and highly rich people of the society who can afford to buy them. Coal, cooking gas and electricity are sources of energy which are too costly for the poor people to use as sources of energy for cooking. The poor people who are in majority in the society resort to destruction of forests for firewood for cooking. It is difficult to stop people especially the poor from using fire-wood when it is the cheapest and most abundant.

2. Bush burning

Bush burning is a major destroyer of natural resources. Some farmers who are too lazy to clear the bush for their farming resort to setting fire on the bush in order to make clearing much easier for them. Some people set fire on the bush to kill animals.
Smokers who throw lighted cigarette stubs to the bush also cause bush burning. Roadmakers and campers are not left out in bush burning. The fire used for cooking is often left on the road side or camp site causing bush burning of massive scale. It is very difficult to stop these destructive practices of the people.

Bush burning as earlier stated destroys timber, young trees, seeds and the humus rich soil. The natural habitats of animals especially mammals and birds are destroyed. This may lead to death of animals in large scale and even extinction of some (such as land snails, tortoises and snakes).

3. Limited land area for development

The human population is fast growing and the demand for land is equally increasing. For some years now buildings, industries and agricultural developments have enjoyed an uninterrupted increase. Many towns have obtained urban status. These have led to clearing of forests and ploughing of fields thereby dwindling the forest area. It will be outrageous to stop developments in preference to forest conservation.

4. Over fishing

Fish population has decreased considerably due to over fishing. All sorts of fish gear have been used indiscriminately including poisonous chemicals such as *gammalin 20*. Fish nets of various mesh sizes capable of catching the young and adult fish are in use. Many fish species have gone into extinction. The problem here is that the' fishermen do not know the after effect of over fishing as most of them are uneducated. Most of them are migrant fishermen and it is difficult to assemble and educate them. Those who like fishing as their sole occupation, believe that fishing everyday, will give them more money and therefore they will not obey the advice of Government officers.

5. Over hunting of animals

Hunting is a profession. Animals especially reptiles, birds and mammals have been over hunted by man for food and commercial purposes. Some of these animals are already rare or have gone into extinction.

6. Overgrazing

When domestic animals graze repeatedly on a piece of land, there will be little vegetation to cover the soil. The animal also trample on the soil thereby compacting it. The structure of the soil is destroyed and water may not infiltrate sufficiently into the soil. The water may collect and flow out as run-off, carrying along soil particles. Also since the soil does not receive sufficient water, it soon dries up and the top soil can be blown away easily.

It is difficult to stop domestic animals from grazing since there is not enough green pastures for them throughout the year. Also the economic value of the animals is assumed to outweigh the over-grazing of the land.

7. Poaching

This is a practice of illegally killing animals for commercial purposes. For example, rhinoceros and elephants are illegally killed in thousands for their horns and tusks (ivory). This unholy practice has led to drastic reduction in elephant population in West and East Africa. Possession of an elephant tusk is a symbol of wealth.

The tusks are in high demand in Japan, North and South Korea, China and Hong kong where they are used in making cutlery, necklace and aphrodisia etc. However, there is now an international ban on ivory trade.

8. Inadequate guards

There are many natural resources to protect and vast. Government officials to guard and protect the resources are few. It is not easy for the few forest guards to guard all forests day and night. Neither will the few fisheries officers guard and protect rivers, lakes, streams and sea all the time. It is also difficult for the police to guard against the abuse of all minerals in the country.

9. Insufficient money and equipment

To enforce the policy of conservation, enough money and equipment must be available. Lack of sufficient money and equipment to execute the policy of conservation have adversely affected the efforts of conservationist. Publicity in radio, television, handouts, posters to educate people and create the awareness all need money.

The effects of man's excessive use of natural resources

1. Excessive use of natural resources will lead to poverty in future. For example, over 85% of Nigeria's income comes from petroleum. Excessive use of the petroleum will lead to its shortage and this will lead to national poverty.

2. Over-use of the forests leads to shortage of trees. Shortage of trees will lead to the closure of furniture and timber industries. Such closure will force us to import furniture at a higher cost from other countries. This will deplete our foreign exchange earnings.

3. The excessive use of forests will deprive wildlife of their natural habitats and their food. Wildlife will eventually die due to lack of habitats and food. The death or reduction of wildlife will result in food shortage for man. Over-hunting of wild life will reduce their population and this will also lead to food shortage for man.

   Over-fishing of our waters will lead to reduction in fish population hence shortage of fish protein.

4. Pollution of the land, air and water results in decrease of plants and animals population. Death may result if the toxicity of the pollutant is above tolerable level.

Ways of ensuring conservation

1. Agencies different agencies to conserve natural resources have been establishments. In Nigeria, the agencies.
   (a) Nigeria Conservation Foundation.
   (b) Forestry and Fisheries Divisions of the Federal and State Ministries of Agriculture and Natural Resources
   (c) Energy Commissions.

2. Conservation education

People need to be educated about the usefulness of conservation of natural resources. Federal, State and Local governments have launched campaigns through the radio, television, cinemas, newspapers, mobile vehicles equipped with loud speakers, handbills and posters about the evils of destroying the natural resources and the usefulness of preserving the natural resources. People are educated to plant two trees where one tree is felled.

A day has been officially set aside every year as a "tree planting day" by Federal Government in which the Minister, Commissioners and Supervisory Councillors of Agriculture and Natural Resources in well publicized ceremonies are to plant trees.

Conservation education is now in the syllabus of primary schools throughout Nigeria. This is the best place to start conservation education as it will create awareness in them as they grow.

3. Conservation laws

Various conservation laws have been passed by different governments to protect and regulate usage of natural resources. In Nigeria, laws against bush burning, exploration of minerals (e.g. petroleum, coal, gold, diamond and bauxite) by individuals, killing of fish with poisonous chemicals (e.g. gammalin 20) and killing of endangered species.

The above laws regulate and protect the exploration of the natural resources.

ASSIGNMENT

1. What is conservation of natural resources?
2. List various natural resources that need to be conserved. State briefly the benefits of conservation of each case.
3. List the problems often encountered in ensuring conservation of natural resources.

MODULE 7: MAN AND ENERGY

UNIT 1: FORMS OF ENERGY

INTRODUCTION

The idea of energy is often expressed in everyday conversations. You may hear people say, "The man is energetic." How do you know that a man is energetic? You would know by what the man can do. An energetic person should be able to work for a long time before getting tired.

Energy is also a concept in science. However, the concept of energy in science is often different from everyday usage of the word.

In this unit you will study the scientific meaning of energy and its different forms.

OBJECTIVES

By the end of this unit, you should be able to

1. define energy;
2. identify activities that constitute work, and
3. identify different forms of energy.

ENERGY

In everyday language, work means all the activities we perform. In science, work has a more precise meaning. Work is done whenever a force is produces movement. The greater the force or the distance moved, the more is done. Pushes. pulls. twists. walking up stairs, chopping wood etc are all activities that signify doing work, Things have energy if they are able to do work i.e. energy IS the ability to do work. A human body, a tank full of petrol, a battery. a book on its shelf all have energy.

The energy possessed by these bodies are of different forms. These different forms of energy are discussed in the next paragraph.

FORMS OF ENERGY

The sun provides us with almost all the energy we use. Heat from the sun keeps us warm. It also generates wind and rain. Light energy from the sun provides essential energy for the growth of plants. This day-to-day energy provides human beings and animals with the food they need but it cannot work many of man's machines. Most machines use fuels such as petrol, coal and natural gas. Fuel were formed from dead plants and small animals which were buried and compressed in the ground over millions of years.

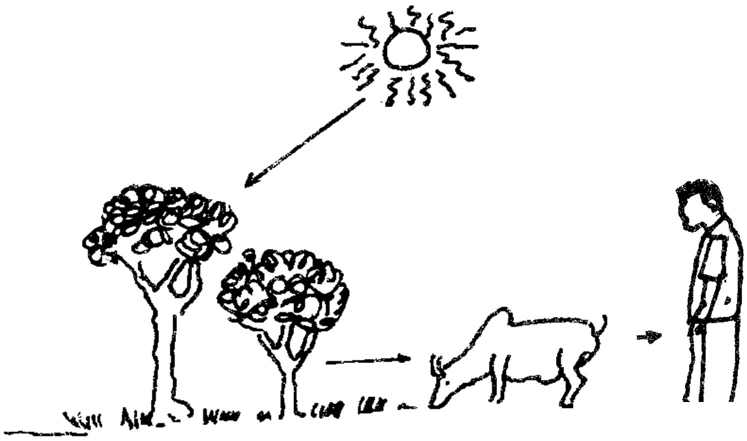

Fig. 7.1

CHEMICAL ENERGY

Can an energetic man remain energetic if he does not eat food for a period of time? Neither can you do any hard work if you do not have enough food. The energy we use comes from food.

Think of vehicles. Can vehicles work without some sort of energy? Some vehicles get their energy to more from petrol, others from diesel or kerosine or coal. All these are termed fuels. Fuels are chemicals. Food is also a complex chemical. Food serves as fuel for all living things. Living things need food to be able to keep on living, reproduce, grow and move. The touch battery and the candle are all made of chemicals and possess chemical energy. Can you remember other examples of chemicals energy source?

MECHANICAL ENERGY

A person running has mechanical energy. A car on motion has mechanical energy. Using hammer to drive in nails involves mechanical energy. There are two forms of mechanical energy- motion energy and place energy.

Motion energy - the type of energy possessed by a moving object. It is also called kinetic energy.

ACTIVITY 1

Have a piece of plank, nails and hammer. Try to drive a nail into the plank by:

(a) merely placing the hammer on it.

(b) hitting the nail gently with the hammer.

(c) hitting the nail hard with the hammer.

Observe which method gets the nail into the plank fastest?

How would you describe the speed of the hammer in (b) and (c)?

Which one is faster? Did the speed of the hammer have anything to do with how hard the hammer hit the nail.

You should be able to conclude that the faster the hammer is moved, the deeper it hits the nail into the plank. In other words, the faster the hammer the more the kinetic energy.

A man falling from a tree, a moving car. the nail moving into the plank all possess kinetic energy.

Place energy - This is the type of energy due to the position of an object. It is also called potential energy. Think of a book lying on the floor of the room. It does not have energy as long as it is lying on the floor. It is only resting on the floor. We can not see it doing some work. Put it on a high table. If it falls off from the table, it can break any fragile material on which it falls. If it fall on your food you will feel it more than if it was resting on your foot. It can do some work. The effect it has on your food is more when it falls from the table than when it was just lying on your foot because of its position relative to your foot before reaching your foot. While on the table, it has energy stored up as a result of its position (position energy) stored up in it. This energy increases as the height of the table increases. Things that are high up have what is called potential energy. This is energy that is there because of the pull of gravity ready to be used when needed.

ACTIVITY 2

1. Get a spring from a mechanic workshop Compress the spring and withdraw your hand suddenly. What do you observe? The spring would jump up as soon as it is released. That shows that the compressed spring had potential energy which was used when it was released. Energy that can be stored is called potential energy.

2. Sort the following according to the type or mechanical energy they possess:

   - a stream;
   - wind;
   - a mango fruit on the tree;
   - a stone on the table;
   - a stretched catapult;
   - a kicked ball.

ELECTRICAL ENERGY

Some machines such as: Torch, fan, radio, television set and so on, can not work unless they are supplied with electric current. Such machine get their energy from electricity. That is to say that electricity has energy called electrical energy. A simple source of electrical energy is dry cell (torch light batteries). Dry cells supply electrical energy to radio, torch and so on. Most of the electrical energy we use in this country comes from the Power Holding Company of Nigeria (PHCN) power generation station at Kainji Dam in Niger State.

Some big organisations like schools, industries and some well to do individuals have their own electric generating plants to supplement the electric supply of PHCN Batteries, generators, hydroelectric plants, steam turbines are all sources of electrical energy.

HEAT ENERGY

Is heat a form of energy? Can heat do work? The oldest form of train engines use steam to work. Heat carries energy from things that are hot to things that are not so hot e.g. from a heated ring boiler to water in a container, or from a stove flame to the cooking pot.

Welder and blacksmiths use heat to cut and mould metals into different shapes. Heat can be produced by burning fuels such as wood, coal, kerosine, and oil, The main source of heat energy is the sun.

ACTIVITY 3

Carry out the following activities and record your observations.

1. Rub your palms against each other continuously for 30 seconds.
2. Put some detergent in your palm and add some drop of water.

LIGHT ENERGY

When a photographer wants to use his camera, he loads it with film. He then points the camera to the object, he wants to take its picture, presses a botton which briefly open the shutter to allow light from the object into the film. A photograph has been taken. When it is developed and printed you get the picture of the object. This picture was not in the film before it was loaded into the camera. The light let into the film has caused this change. Light should have energy to be able to cause this film to change.

In simple explanation, all that is done in taking photograph is to expose the film to the light from the object. The picture is registered on the film. The exposed film can never be like the one not exposed any more. The main source of light is the sun. light carries energy away from s source of light to the immediate surrounding e.g. A dark room becomes bright when a source of light is provided.

SOUND ENERGY

Sound is another form of energy, as in when the thunder strikes. When a musical instrument gives out loud sound, and walls crack. Sound can motion energy, Sound then has energy.

ACTIVITY 4

Try to beat a musical drum, strike the string of guitar, strike a turning fork. You will observe that each of them vibrates as it produces sound. Try to stop the vibration by touching the instrument. You observe that there is no more sound as you stop the vibration by touching the instrument. These activities show that motion energy (vibration) produces sound energy, Also, as cracking of thunder (sound) cause buildings to shake objects are sources of sound energy.

ATOMIC ENERGY

All materials are made up of atoms, Atoms in turn can be split into three electrons, protons and neutrons, Protons and neutrons are bound together in any atom, making up the nucleus. Breaking up of these nucleus by some means releases a large amount of energy. This form of energy is called atomic or nuclear energy, Atomic energy is being used to generate electricity in some parts of the world.

ASSIGNMENT

1. How would you define energy?
2. What form of energy is used to
   (a) make your radio work
   (b) cook your food

(c) blow up big rock

(d) drive a nail into a plank

(e) get a match to catch fire

3. Explain the meaning of atomic energy.
4. Name four types of energy and give two examples of each.
5. Explain why the sun is regarded as the chief source of energy?

SUMMARY

In this unit, you learnt that:

- Energy is the capacity for doing work.
- The sun is the chief source of energy
- Energy exists in different forms such as
- Chemical energy
- Mechanical energy
- Electrical energy
- Heat energy
- Light energy
- Sound energy
- Atomic energy

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UNIT 2: ELECTRICAL ENERGY

INTRODUCTION

In unit 1, you learnt that energy exists in various forms. You will recall that electricity is one of the forms of energy. A lot of things like, radio, torch, television set, fan, electric iron, heater, bulb and so on, use electrical energy.

In this Unit, you will study some basic facts about electricity.

OBJECTIVES

By the end of this unit, you should be able to:

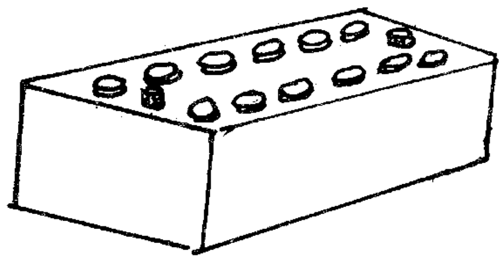
1. mention at least two sources or electrical energy;
2. differentiate between conductor, insulators, and resistors;
3. describe potential difference of cells:
4. make a simple electrical circuit in series and parallel;
5. relate your knowledge of circuit to electrical wiring in the house;
6. mention three effects of electric current; and
7. describe some safety devices for the use of mains electricity.

SOURCE OF ELECTRICITY

Can you recall some of the sources of electricity mentioned in Unit I? They are: batteries, generators, hydroelectric plants (Kainji Dam Power Station) and steam turbines.

The simplest source of electricity is a dry cell. A battery is made of two or more cells. Batteries only provide small electric current. Larger currents needed by cars and other machines are provided by batteries containing liquids e.g. lead/acid cell (see Fig. 2.1)

The electricity supplied at home is called mains electricity. It is generated at Kainji Dam by enormous dynamos making high voltage electricity up of 3300 volts.



Lead/acid cell.

Fig. 7.1

CONDUCTORS AND INSULATORS

ACTIVITY 5

1. Take a dry cell, a bulb and two pieces of copper wire. Connect them together as in Fig 2.2 What do you observe?

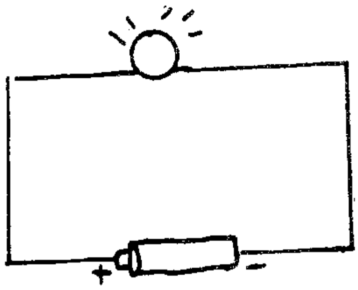


Fig 7.2

The bulb lights up, what makes this possible? An electric current flows from the cell through the wire to the filament of the bulb and back to the cell through the second piece of the wire.

2. Take a cell, a bulb, three piece of wire and two clips. Connect them together a" shown in Fig 7.3 Let the two clips touch each other.

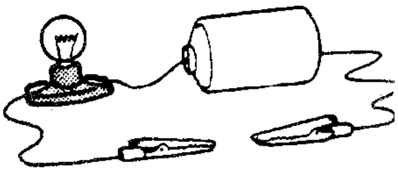


Fig. 7.3

What do you observe? the bulbs lights up showing that a current passes through the wire and clips. Try to connect different materials (such as glass, plastic materials, nail, rubber wooden ruler, piece of paper, pure water, salt dissolved in water, air tin foil) between the two clips.

Put your result into a table by writing Yes or No against each material in the column provided.

Materials	**Does bulb light up?**
Glass	
Plastic materials	
Etc.	

You would observe that some materials allow the flow of electric current through them easily indicated by the lighting up of bulb. Some other materials do not allow current to pass through them as indicated by the bulb not lighting up.

Materials that allows current to pass through them are called conductors. These materials that do not allow the flow of current through them arc called insulators.

All conductors do not allow the flow of current equally. Some conductors oppose the flow of current more than others. This opposition to the flow of current (or electrons) is called resistance. Thus conductors can also be called resistors. When current passes through resistors, heat is generated. All heating elements in many electrical appliances (like iron, bulbs, and heaters) are resistors. Any resistor whose resistance can be charged (increased or decreased) is called variable resistor (or rheostat). This fact is used in the volume controls in electronic circuits e.g. radio, television.

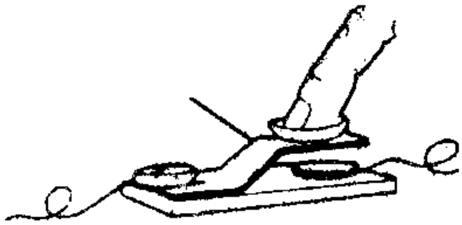
SIMPLE ELECTRICAL CIRCUIT

Your connection in Fig 7.2. is a complete circuit, However Fig 7.2. can be drawn using circuit symbols. You can also introduce the use of a switch.

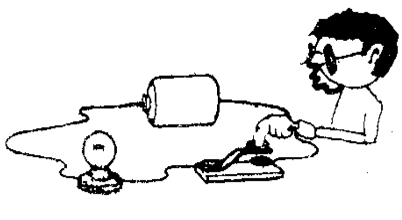
A switch is something to make a gap in circuit which you can close or open at will. Most electric circuits have switches.

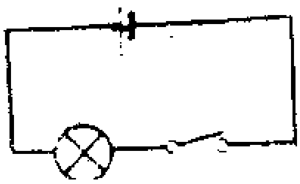
There are many types see Fig .7.4

Springy metal



A simple switch





A circuit with a switch

Fig 7.4

Electrical circuits is simply described as a plan drawing of the wiring of anything that uses electrical energy.

You will observe that when the switch is on or switched off, there is a gap between the metal contacts.

What is there between the contacts when the switch is off? Is this a conductor or an insulator?

MEASURING ELECTRIC CURRENT

The instrument used to measure electric current is the ammeter. It measures in Amperes. ("amps" short form). An ammeter has its terminals marked (+) and (.) The (+) terminal of the cell should go to the (-) terminal of the ammeter.

Note: Never connect an ammeter to a cell without a lamp a resistor or other component in the circuit. Always connect your circuit through a key.

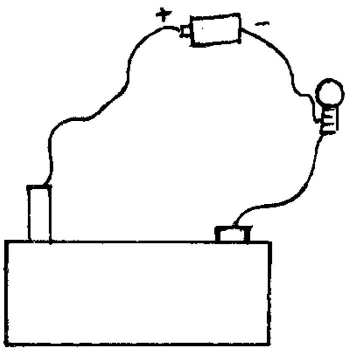


Fig 7.3 Connecting an ammeter to measure current in a circuit

POTENTIAL DIFFERENCE

You may recall that when the circuit is completed as in Fig 7.2. a current flows from the positive terminal of the cell to the bulb and back to the negative terminal lighting up the bulb. The cell is able to drive current through the wire and bulb because the potential energy at the (+) terminal is higher than that of the (-) terminal. Potential Difference at the terminals is measured by a voltmeter in volts.

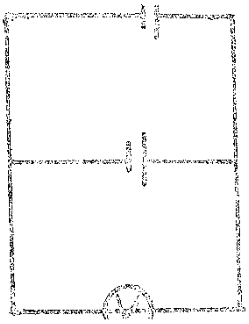


Fig. 7.4(a)

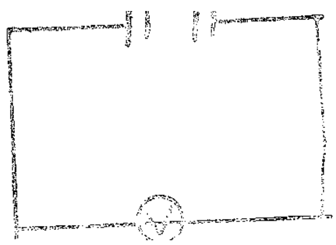


Fig. 7.4(b)

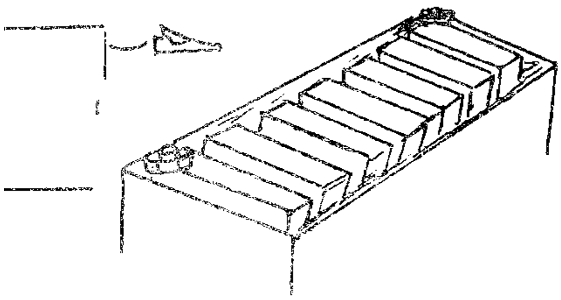


Fig. 7.4(c) A battery of six lead/acid cells

RESISTORS IN ELECTRICAL CIRCUIT

ACTIVITY 6

1. Take four identical bulbs, two identical cells and pieces of identical copper wire. (Recall that resistor could be filament of your bulb, the heating element of your iron and so)

Note the brightness of the bulbs when they are on. Take one bulb out of its socket in circuit (a) and do you observe'? You will observe that in (a) the bulbs are not as fully bright as when the circuit was built with only one bulb and the current is less with two bulbs. When one of the bulbs is taken out its socket there is no light in the second bulb. In circuit (b) both are brightly lit and the removal of one bulb does not affect the other bulbs.

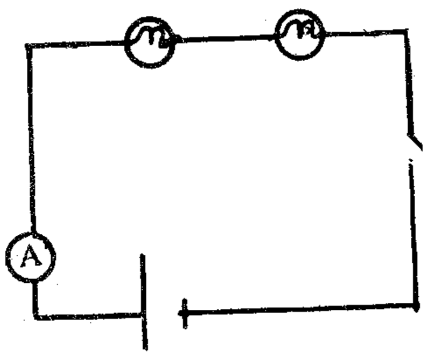


Fig. 7.12 (a)

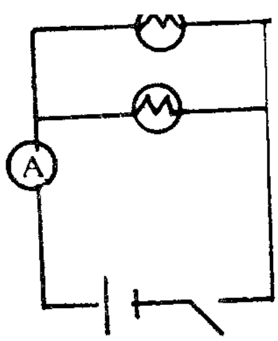
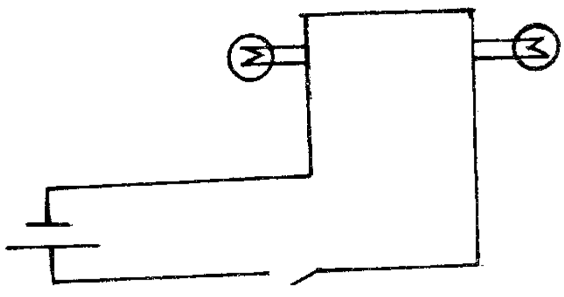


Fig. 7.12 (b)

The bulbs in circuit (a) are said to be in series (one after the other in line). While those in (b) are said to be in parallel (side by side).

The wiring for electric lights in homes is done in such a way that the bulbs are connected in parallel so that not all lights will be on or off at the same time. Another advantage of parallel connection of bulbs is that additional bulbs do no decrease the current in the circuit.

Are these bulbs in the circuit below in series or parallel?



VOLTAGE AND CURRENT

ACTIVITY 7

Get three cells, a bulb and an ammeter. Build the circuits and measure the current.

Record your findings in the form of table below

No. of cells used	Voltage used	Current (Amps)	Voltage current

What do you observe about the value of the current when you used more cells (which means high voltage)?

Note that the voltage of a cell is 1.5 volts. And that when cells are connected in series, you add their voltages.

You will observe that the higher the voltage, the more the current.

What do you notice in your last column? The result is the same in each case. The result of the last column satisfies a law in electric circuits known as Ohm's law. It states that, for a particular resistor, voltage divided by current is constant provided the temperature of the resistor does not change.

Can you tell what is used as resistor in each of the circuits?

EFFECT OF ELECTRIC CURRENT

When electric current flows through a resistor. e.g. the filament of a bulb, heat and light are produced. When a current flows through a solution of water with salt, bubbles of gas are seen. Thus on electric current can produce chemical effect. An electric current can produce magnetic effect as well. If a plastic- covered wire is wound round a piece of iron and the wire connected to a cell. The iron will attract nails or pins and so on when current is on and drop them when the current is off.

ACTIVITY 8

List all the electrical appliances you can think of which produce heat energy.

SAFETY DEVICES

Mains electricity can be dangerous to the user as well as the appliance being used. Fuses and earthing are some of the methods employed to reduce danger.

Fuses are the wires with low melting points linking the circuit. They can easily 'melt' or fuse when a sufficiently high current is passed through them. Houses or appliances can catch fire if the current becomes too high for the wire used. Houses have sealed fuses where the cables enter the house many plugs are also fitted with cartridge fuses so that if the appliance connected to the plug takes too much current the fuse "blow" or 'melt" and it is easy to replace.

Earthing is another safety device. The circuits and all the appliances plugged into them are earthed by connecting the earth (yellow and green) wire to something metal in the ground.

The main electricity comes into the plug through the live (brown) wire. It goes back out of the plugs through the neutral (blue) wire. When the live wire becomes disconnected inside the appliance and touches the case, the electricity is taken to the earth straight away, if the case is earthed. If not the user will get an electric shock when he/she touches the metal part of the case. So, make sure all your electrical appliances with metal parts which you may likely touch are properly earthed. In addition do not operate electrical appliances with wet hands. Always wear rubber-solid shoes.

ASSIGNMENT

1. Are these cells in series or parallel? What is their voltage? if the voltage of each one is 1.5v?
2. Mention two advantages of parallel connection of electrical appliances over series connection.
3. What is the function of a switch in a circuit?
4. Give five examples of things used at home that can serve as resistors in an electrical circuit.
5. In an experiment each cell was found to be l.5. volts. When three of them were connected together they gave a voltage reading of 1.5 volts. In which type of arrangement is this possible, parallel or series?
6. What would the voltmeter reading be for the following circuits? (Assuming each cell has a voltage of 1.5 volts)

SUMMARY

In this unit you learnt that:

- Dry cell is the simplest source of electrical energy.
- The electricity supplied to houses is called mains electricity.
- Conductors are materials that allow the flow of electric current through them easily.
- Insulators are materials that do not allow an electric current to pass through them.
- Resistors are conductors that resist the flow of electric current.
- Electrical circuit is a wiring plan of electrical appliances.
- Ammeter is the instrument for measuring current electricity.
- Potential difference of a cell is the force that drives the electric current from the positive terminal of the cell through the wire and all the components in a circuit back to the negative terminal.
- Potential difference is measured by voltmeter in volts.
- Potential difference of cells arranged in series is the sum of p.d. of each of the cells.
- Potential difference of cells of equal e.m.f. arranged in parallel is the p.d. across one of the cells.
- Resistance in a series circuit increases with additional resistors attached in series to the circuit.
- Resistance in a parallel circuit decreases with additional resistors attached in parallel to the circuit.
- Wiring for electric lights in the house is done in parallel.

- Ohm's law states that: given a resistor the voltage divided by current is constant provided the temperature of the resistor does not change.
- Electric current has

  (a) light effect

  (b) heat effect

  (c) chemical effect and

  (d) magnetic effect
- Fuses and earthing are devised to protect users of mains electricity and the electrical appliances.

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UNIT 3: HEAT ENERGY

INTRODUCTION

In unit 1 of this module you learnt that energy exists in different forms. Try to mention them. You must have mentioned heat energy as well. It is principally a form of energy which we are most conversant with. It affects us in various ways; in the home, in the air, work and even inside us. It is a form of energy which tends to move into everywhere II can get to. But how much do we know about this form of energy. We shall attempt in this unit to study its sources, its nature, how it is transferred and its uses.

OBJECTIVES

By the end of this unit you should be able to:

1. identify various sources by which heat energy can be produced;
2. explain heat as a form of energy:
3. explain how heat is transferred from one point to another; and
4. mention at least 3 uses of heat energy.

HEAT ENERGY

We shall begin the study of this unit by considering the sources from which heat can be obtained. These sources are:

- The sun: The sun is the principal source of heat energy. Its distance to the earth is about 5 x 107 km away from the earth yet we feel its hotness. The heat energy radiates through space and reaches the earth. The earth becomes warmed up in this way.
- Combustion of fuels and other materials e.g. when wool, coal, kerosine, oil and other petroleum products are burnt, heat energy is produced.
- Electricity: Electrical appliances such as heater, stoves, kettles etc are examples of the sources of heat energy.
- Friction: When two things are rubbed against each other the resulting effect is the production of heat.
- Light energy: All sources of light radiate heat energy.
- The earth: Interior of the earth gives out heat produced by radio-active substances. Some of this heat is released when there is Volcanic eruption.

NATURE OF HEAT ENERGY

Heat carries energy from things that are hot to things that are colder then they. As a form of energy, when it is emitted and chanelled it can be made to do some work. You will need to carry out some activities to show that heat performs work.

ACTIVITY 9

a) Put some water into an open kettle and heat it to boil. Observe what happens. After sometimes when the steam issues freely place a plate across the steam to catch back the molecules of water escaping.

Where do the molecules of water obtain the energy that enables them to move out of the water?

b) Make a simple rotor from aluminium foil and a cork as shown in the diagram. (a paper wind vane can also serve). Boil water again in a kettle and when the steam issues out freely, direct it on the blades of the rotor.

Explain what happens to the rotor where has it got the energy required for it to work? Aluminium black

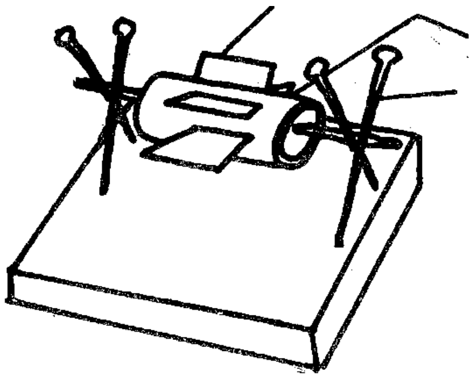

Fig. 7.1 Simple rotor

c) Obtain a small length of copper wire and a strip of iron wire. Connect the two to a meter as shown in the diagram. Heat the two wires in a bunsen burner and take note of what happens to the pointer of the meter.

From the above activities, you would have been able to find out that heat energy from the hot flame can cause movement of molecules in a substance e.g. water, produce mechanical work e.g. moving the rotor, and make metals expand.

The idea that heat energy can cause molecules in a substance to move is explained by is that when substances acquire molecules is increased and experiment supplies the make the escape of molecules of the water in the form of steam possible.

When a metal strip is heated, the particles in the metal gain energy. This causes the molecules to get further apart from each other. The vibration of the particles due to heat energy makes the metal get longer.

Further effect of heat energy on substances.

ACTIVITY 10

Put some water in a beaker and use a thermometer to taker its temperature. Note down this temperature. Now heat the water for about 5 minutes and measure its temperature. What do you notice?

Take some solid ice block in a beaker and heat it over Bunsen burner. Take note of what happens to the ice block. Continue heating until the whole substance disappears. What changes have taken place?

From the experiments you have just carried out, it can be said that heat energy:

Increase the thermal energy of a body. When a substance is heated, the substance gains energy by absorbing the heat. Usually when this occurs, the heat content of the body is increased.

Changes the state of matter. E.g. when solid ice is heated, the ice changes to liquid state, i.e. water and finally the water changes to water vapour (gaseous state). i.e. solid-liquid-gas.

Explanation on the basis of kinetic theory

Solids have their particles closely packed together and are held together by strong . And their particles can only vibrate about. When the solids are heated, the vibration of the particles increase until they are so violent that the force of attraction can no longer hold the molecules together. As the heating continues, the particles acquire to move apart, the solid then crumbles and changes into liquid.

When the liquid boils, the energy of the particles in the liquid become greater than their move out into the space above the liquid thus forming a gas.

So far, we can say the following about heat energy. It is the energy of hotness. It can in a substance, produces mechanical matter and increases the heat content of a body.

USE OF THERMOMETER TO MEASURE THE HOTNESS/COLDNESS OF A BODY

The scientific word for the level of hotness of things is temperature. It is often very important to know the temperature (hotness) of things like water, air, our bodies etc. The thermometer is used for this purpose. Thus the thermometer is the instrument used for measuring the degree of hotness of a body. They are marked to read temperature in degrees Celsius (^{0}C). Its lowest fixed point is ^{0}C (the melting point of ice) while its upper fixed point is 100^0 (the boiling point of pure water). The distance between the 2 marks is divided into 100 degrees. This distance is called the fundamental Interval of tthe thermometer.

Using the Thermometer

The thermometer is dipped into the body whose temperature is to be measured. The mercury thread in the thermometer moves to a point on the scale equivalent to tee temperature of the body.

ACTIVITY 11

Take some quantity of tap water in a beaker and measure its temperature. Heat the water for 5 minutes and measure its temperature. Stir the water well with the thermometer before taking the reading.

TRANSFER OF HEAT ENERGY

We have defined heat energy as a form of energy that is transferred from hot area to colder area. How does this transfer occur?

You must have experienced that when a tea spoon is left for sometimes in a cup of ho: tea, the spoon itself becomes hot. When this happens, heat has been transferred from ho: tea to your hand through the spoon. Most solids especially metals are known to transfer heat from its source to another point.

The movement of heat energy through such solid materials without any obvious movement of the material is known as Conduction Materials that conduct heat are referred to as conductors. Examples are all meta. Non-metals are poor conductors. Liquids and gases are usually poor conductors of heat energy but can transfer heat in another way.

Heat transfer in fluids (liquids & gases)

Heat is transferred through water by a process of convection. The following activity will illustrate this process:

ACTIVITY 12

Set up the apparatus as shown below and using a glass tube put few crystals of Potassium manganate or Aluminium dust at the bottom of the beaker. Heat the water gently and observe the movement of the coloured stream of water.

When liquid e.g. water is heated, the molecules of water close to the source of heat get heated and acquire the heat energy. This causes the water to expand and so the density becomes less. The less dense water rises to the top and as it warms, takes the heat with it. In this manner the heated coloured water molecules rise up and the cold, dense ones above move downwards. A moving stream of coloured water can then be seen circulating round the flask. This movement of the molecules of warm and cold water forms a moving current called convectional current. Gradually the convectional current carries heat from the heat source to other parts of the water and the whole water becomes coloured. The process of heat transfer here is called Convection.

Both conduction and convection of heat require a material medium before heat can be transferred. However, we know that when the sun shines, the heat from the sun reaches the earth. Between the sun and the earth is just an open space, so there is no material medium to help transfer heat, yet the heat reaches the earth. The heat is, therefore, transferred through the space. If a lamp is put on and you place your hand about 5cm before it, you feel the heat given out by the lamp. The heat is moving through the space between your hand and the source of heat despite the fact that no material links your hand to the lamp. This method of heat transfer through space is called Radiation. It is the method of transfer of the sun's heat to the earth.

Therefore heat can be transferred by conduction, convection and radiation. Heat radiation, unlike conduction and convection does not require any material medium for the transference of heat.

MEASURING HEAT ENERGY

The unit of heat energy is the joule.

When a substance - solid, liquid or gas, is heated, its temperature is raised. The quantity of heat needed to raise the temperature of a substance through a given temperature interval depends on; the nature of the substance, the mass of the substance and the temperature interval. In other words, the quantity of heat in a body is a product of its mass, its specific heat capacity and the temperature change.

This is given as $Q = mct$

where Q = Heat capacity of the body

m = mass of the body

c = specific heat capacity

t = temperature interval

Each substance has its own specific heat capacity and this is the number of joules of heat required to raise the temperature of 1 kg of the substance through 1°C e.g. the specific heat capacity of water = 4.2KJ/kg.

Therefore, if the specific heat capacity of a substance is given, the mass is known and the temperature interval is known, the quantity of heat of a body (heat capacity) can be calculated e.g. calculate the Heat capacity of 1.5kg of water whose temperature rose from 10°C to 30°C after it was heated for 5 minutes.

Specific Heat capacity of water is 4.2KJki1k-1 or 4200Jkg-1 K-1

$Q = mct$

$= 1.5 \times 4200 \times (30°C – 10^{0}C)$

$= 1.5 \times 4200 \times 20$

$= 126000J$

ACTIVITY 13

How much heat energy will be needed to warm 200kg of water from 20°C to 50°C.

USES OF HEAT ENERGY

Heat Energy is used in various ways. The various uses are summarised here as:

1. Uses in the home: Heat energy is used for various heating purposes in our homes. This includes cooking, drying, ironing clothes, warming the house and general heating.

2. In automobiles: Heat energy obtained from burning of fossil fuels are used in moving of cars, ships, trains, aeroplanes, rockets etc.

3. Cutting and welding in Industries: Very hot flames produce large quantities of heat energy that could be used in smelting, cutting and welding of metal.

ASSIGNMENT

1. Define the term energy.
2. How do you explain to your pupils that heat is a form of energy?
3. Mention 5 sources of heat energy;
4. Explain 3 broad uses of heat energy;
5. Explain the activities you would engage your pupils in to learn that heat is transferred by Conduction, Convection and Radiation;
6. Explain with the aid of kinetic theory how heat energy brings about change of state.

SUMMARY

In this unit you have learnt that:

- Heat is a form of energy.
- Some sources of heat are; sun, combustion, friction, light, electricity, volcanic eruption and body metabolism.
- Heat, as a form of energy can cause movement, make metals to expand and change state of matter.
- Transference of heat energy occurs by conduction, convention and radiation.
- Some important uses of heat energy are found in our homes in the industries and in automobiles.
- The quantity of heat in a body is given by the product of its mass, specific heat capacity and temperature Q = met.

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UNIT 4: SOUND ENERGY

INTRODUCTION

Energy exists in different forms. The form of energy which carries vibrations to our ears is the sound energy. Sound when transmitted into our ears create different sensations. some of which are pleasant, some noisy or unpleasant depending on its tone and the source from which it is coming.

In this unit you will study the nature of sound energy, its sources and how it is transmitted.

OBJECTIVES

By the end of this unit, you should be able to:

1. explain the nature of sound energy;
2. identify vibrating objects as sources of sound energy;
3. demonstrate that sound travels through material medium; and
4. explain how frequency and amplitude affect the sound you hear.

Sound as a Form of Energy

Sound is the energy of a vibrating body and like other forms of energy it can be made to do work. If for instance, light plastic beads are placed on a cone of a vibrating or sounding loudspeaker, the beads will begin to bounce up and down. If the vibration is increased. some of the beads could even be thrown off the cone. It is the energy of the vibration that results in moving the beads.

Try the following activity.

ACTIVITY 14

For this activity you will need the following materials; a tuning fork, water, small piece of paper tied to a string. Strike the prong of the tuning fork. A sound vibration is produced and place it close to the piece of paper suspended before it. Note what happens?

Again pick the vibrating tuning fork and dip into bowl of water. What happens?

If you carefully carry out the experiments, you will observe that the paper is pushed and the water is splashed by the vibrating prongs. We can therefore conclude that it is the energy of the vibrating prongs that is responsible for the splashing of the water and the pushing of the paper.

Production of Sound

Sound is said to be produced by vibrating objects. You will carry out the following activities to demonstrate this:

ACTIVITY 15

a. Rest your finger gently on your throat and say 'hun”… You will feel your throat vibrating.

a. Clamp a strip of bicycle spoke at one end and pull the other end aside gently and. release it. The spoke will vibrate and a low humming sound is produced.

c. Take a rubber band and stretch it between two pins, which are fixed. Pluck the string and observe carefully to see any vibration. What is heard? The activities and the observations you have made lead to the conclusion that vibrating objects produce sound. Stringed musical instruments, percussion instruments such as drum, are made to vibrate by striking them. As a result of this vibration, different forms of sound are produced.

TRANSMISSION OF SOUND

When sound is produced by vibrating objects, how does it travel from the source to our ears. Does it require any medium for this.

In 1654 Otto Von Guericke, a scientist, carried out an experiment to see whether sound does need a medium or whether it can travel through empty space. For the experiment, he placed a clockwork bell in a sealed bottle which was attached to a vacuum pump. As he pumped the air out, he found that the sound of the ringing bell faded away and became very faint.

ACTIVITY 16

To find out if sound can be transmitted by solids and liquids.

i. Press one ear to bench and cover the other with your hand and ask a friend to tap on the other end of the bench. Do you hear any sound?

ii. Strike a tuning fork and stand an observer about a metre away. Does he hear the sound? If yes, let him note the loudness. Now place a metre rule against the turning fork and place the other end to the observer's ear. Ask the observer to report if he heard the sound and whether the sound is louder when heard through the air, or when hear through the metre rule.

iii. Fill a bowl with water, strike the tuning fork and note the loudness of the sound. Now, place the tuning fork on the surface of the water. Is the sound louder?

Air is not the only medium through which sound travels. The experiments you carried out show that sound can as well be transmitted through liquids and solids. We can conclude here that sound does not travel in vacuum but will require solids, liquids and gasses for transmission from one point to another. What then is the manner in which sound is transmitted through any medium? Find out from the next section following this.

SOUND WAVES

Sound travels in form of waves. Do you have idea of what waves look like? Consider when a number of stones are dropped one after the other into pool of water, ripples will be seen spreading out along the surface from the point where the stone struck the water. Any floating object will be seen to move up and down as the ripples reach it. A snapshot of the water ripples will show it to consist of a series of crests and troughs (waves).

Sound waves behave similarly. They are produced by the vibration of a sounding object. As the sound is transmitted, the wave action compresses and stretches the transmitting medium. The alternate compression and rarefaction of the medium of air continues to take place.

The distance between successive crest or wave is called the **wavelength**.

The number of vibrations made by the layer through which the sound is transmitted per second is the frequency of the vibration.

The amplitude is the maximum distance the vibration moves up and down.

ACTIVITY 17

Demonstrating sound waves.

Your tutor will set up the loudspeaker for this activity. Place your hand on the cone of a vibrating loudspeaker. Do you perceive some vibrations. Now tie a light white transparent cloth or polythene round the vibrating loudspeaker and observe its movement. You will observe the material moves up and down at regular intervals as the loudspeaker vibrates.

Try and represent the up and down movement of the cloth with a diagram.

When the loudspeaker vibrates, the air around the speakers is disturbed and the vibration alternately compresses and stretches as it travels through the air. This causes the air to move in a wave like manner which causes the bubbling up and down movement of the material tied around it.

All vibrating objects such as the prongs of tuning fork, the string of guitar, the mass of air in whistle or flute produce sound waves in a similar manner.

So far the following can be said about sound.

Sound energy is the energy of all vibrating objects. It travels in form of waves and the waves are caused by the vibration from the source of the sound. Sound waves cannot travel in vacuum, material medium such as gases, liquid and solids are needed for its transmission. Sound is louder when it is transmitted through solids and liquids than through gases.

SPEED OF SOUND

The speed of sound varies considerably depending on the material through which the waves are travelling. In general, sound travels more rapidly through liquids than through gases and fastest through solids.

The speed of sound in air is said to be about 330m/s in dry air at 0^0C, in water at about l400m/s and at about 5000m/s in solids. The speed of sound is influenced by temperature change. It tends to increase with increase in temperature.

SOUND REFLECTION AND ECHO

Hard surfaces such as tall walls, ceilings etc will reflect sound waves. When sound is reflected we hear the sound a short time after the original sound, this is called echo. Echo is the reflection of sound. Echoes can be used to estimate the speed of sound.

Suppose a man standing about 100 metre away from a tall wall claps two wooden block together at such a rate that each clap coincides with the echo of the one before. By counting and timing, say 20 claps and noting the time taken to make the 20 claps, the speed of the sound can be calculated by this formula.

ACTIVITY 18

A woman stands 320m away from a high wall. She claps her hands together at a steady rate such that 50 claps were made in 15 seconds. If each clap coincides with the echo of the one before, what is the speed of the sound.

How we hear

The ear is the sense organ for hearing. When sound is made, it travels in form of waves When the waves reach the ear, they are directed by the pinna into the mid ear through the ear drum. The waves cause the ear drum to vibrate. Further vibrations occur when the sound moves into the inner ear through the oval window. In the inner ear the cochlea. changes the vibrations into nerve message. The nerve message is then conveyed by the auditory nerves to the brain where the message is interpreted as sound.

STRUCTURE OF THE EAR

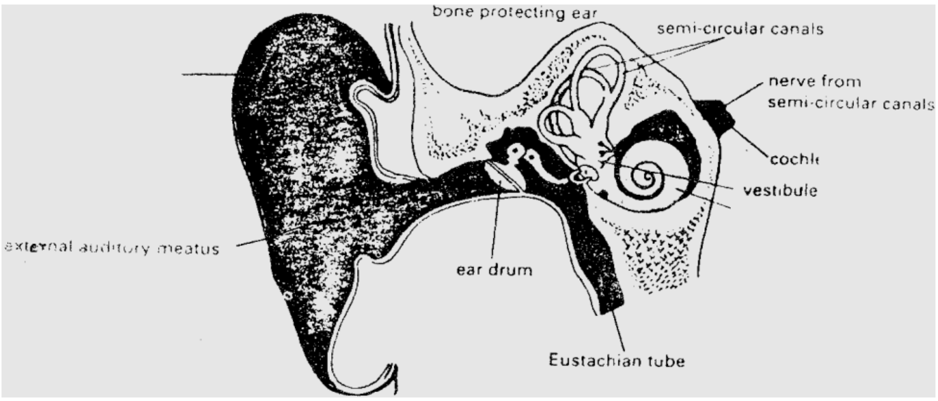

Fig 4.5: Structure of the ear.

HEARING SOUND

Through music, speech and noise, the human ear experience's a wide variety of sound sensation. All these sensations depend on the frequency and amplitude of sound waves entering the ear.

At low frequencies, sound impulses can be detected very well by the ear. As the frequencies increase, a kind of deep humming sound is heard. Individuals differ in their capability to detect sounds waves of different frequencies. The hearing capability of individuals can be determined through an audibility test. This is usually done with a gadget consisting of a signal generator and a loudspeaker. With the aid of such gadget, it has been found that human ear can detect sound waves with frequencies ranging from 20Hz (20 waves per second) and up to 20 KHz (20,000 waves per second). The lowest frequency most people can hear is 20Hz and the upper limit especially for young people is up to 20kHz. The upper limit tends to be affected with age. Thus older people tend to hear lower than 20kHz audibility.

The loudness of sound wave getting into the ear is affected by the amplitude. When an object vibrates sound is produced. If more energy is supplied to the vibrating object, it will vibrate through a greater distance. When it does this, we say the amplitude is increased. When the amplitude of the vibration of the sound is increased, the vibration of the medium transmitting the sound also becomes increased.

When this happens we would hear an increase in volume of the sound. That is, the sound gets louder. Therefore the greater the amplitude of sound wave, the greater the loudness.

ASSIGNMENT

1 . a. What is sound energy?

b. Explain the activities you will engage your class pupils to enable then: learn that sound travels through solids than air.

2. Why is it not possible for sound to travel through a vacuum? How would you show this experimentally?

3. Distinguish between sound and echo. A woman stands 120m away from a high wall. She claps two blocks of wood together at steady rate such that 40 claps are made in 30 seconds. If each clap coincides with the echo of the one before, what is the speed of sound.

4. Draw and label a diagram to illustrate sound wave.

5. Explain how the frequency and amplitude of sound waves affect how you hear the sound.

SUMMARY

You have learned from this unit that:

- Sound is a form of energy and like other forms of energy it can be made to work.
- Vibrating objects produce sounds. Therefore, sound is a form of energy in objects of vibration.
- Vibrating objects make sound to travel in form of waves.
- Sound energy cannot travel in vacuum but requires material medium for its transmission.
- Sound can be reflected and its reflection gives rise to echo. Echo could be used to determine the speed of sound.
- The human ear detect the sound waves up to 20KHz.
- The loudness and audibility of sound depends on the frequencies and the amplitude of the sound waves.

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UNIT 5: LIGHT ENERGY

INTRODUCTION

During day time, all physical objects are seen with the help of the light coming from the sun. At night or in the dark, objects become almost invisible to us. Light, therefore, serves important purpose of enabling us to be aware of our surrounding through our sense of sight. Photosynthesis, an important process in nature upon which our survival depends. also requires the use of light energy before it can occur. What then is this light energy' In this unit you shall study this important form of energy; its nature, sources and how it affects our lives.

OBJECTIVES

By the end of this unit you should be able to:

1. mention various sources of light energy;
2. distinguish between luminous objects and non-luminous objects;
3. explain the characteristics of light.

Light as a Form of Energy

In unit 1 of this module, you learnt that energy is the capacity to do work. Can light really perform some work? Indeed, the answer is yes. It can make things move. This ability of light is very often demonstrated in photo-electric cell. In such arrangement, the solar (photo) cells receive some light from the sun and convert it to electricity. If the photo-electric cell is connected to a meter which measures electricity, the pointer of the meter will move. Hence, light is able to make things move.

These days there are lots of materials or equipments which are similarly powered by light energy. Such materials have solar cells installed in them. The solar cells absorb the light from the sun and use it as source of energy for the equipment. Examples of such materials include: solar wristwatch, solar water pump, solar machines, etc. In fact, there is every hope that before the turn of this century you may be driving or get driven in a solar powered car.

ACTIVITY 19

There are several rural water projects powered by solar energy currently being under taken by the Directorate of Food Road and Rural Infrastructure in Nigeria today. Visit such projects where possible or contact their state office in your state capital for relevant information on how the pumps are powered.

Alternatively, you should visit a library in your area and seek relevant information from daily papers on solar energy. Also look for a solar calculator and see how it works.

LIGHT ENERGY

Sources of Light Energy

Light is given out or emitted by certain bodies which are referred to as sources of light. Such objects are referred to as luminous objects. Some are natural and others are artificial.

Naturally self-luminous bodies are the sun, the stars, and some insects. The artificial light sources include, torch, candle, lanterns, electric bulbs, fluorescent lamps, etc.

Most objects around us do not produce their own light. They are only visible to us because they reflect light from some sources to our eyes. Such objects are non-luminous and are not visible to us at night or in the dark where no light is present.

Nature of Light Energy

During the day time, all physical objects are visible to us, but at night or in the dark where there is no light, artificial sources are needed before we can see things. This is a simple observation telling us that light is a form of energy that enables the eye to see. The following gives a general outline of the nature of light;

- Light is a form of radiation. Light does not need a medium for its transmission. It can travel through a vacuum. Light energy from the sun travelling through space without any medium to get to the earth provides evidence to this.
- Light travels in straight line. This is a phenomenon called rectilinear propagation. It is a fact of everyday life. For instance a flash or a beam of light from cars at night can be seen to have edges which are straight.
- Light is a form of radiation detectable to the eye. That is, it is the only form of radiation that the eye can detect.
- Light travels through empty space and does so at a speed of about 300,000 km/s or 3 x 10 kilometers per second. This speed is equivalent to travelling seven times round the whole Earth in less than a second.
- Light enables images and shadows of objects to be formed.
- Materials gain energy when they absorb light and this causes increase in the thermal energy of the body.
- When white light is allowed to pass through a glass prism it is found to consist of different colours.

Activities on Nature of Light

ACTIVITY 20

Light travels through space or Vacuum. Switch on an electric bulb of 100 watts or light a kerosine lamp. Place your hand 10cm to 15cm away from the source. Do you feel some warmth after some time? Does the light require any medium to get to your hand. This simple activity demonstrates that light energy can travel from its source to another point through space, a process referred to as radiation. Also when the light falls on your skin, Its rays convey some form of energy from its source to your skin which causes an increase in thermal energy of the skin. Thus light energy enables thermal energy to be transferee from one place to another.

ACTIVITY 21

Rectilinear Propagation of light.

Prepare three pieces of cardboard with a hole of same size and of same point in each. Stand the three cardboards with the holes in the same line. Place a lighted candle or lamp at one end and view from the other end. If the cardboards are properly arranged you will see the light from the source. Now shift the centre cardboard. Is the light still visible through the holes?

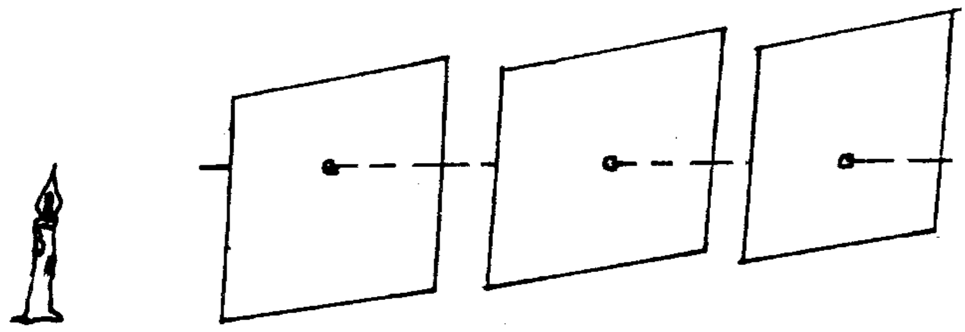


Fig. 5.1 Proof of rectilinear propagation of light.

What conclusion can you deduce from this activity?

ACTIVITY 22

Light forms Shadows.

Light a kerosene lantern in a darkened room and allow its rays to fall on the wall. Place your palm in the path of the rays some 10 - 15cm away. Now look at the wall. What can you see?

COLOUR SPECTRUM AND WHITE LIGHT

Newton (1672) in his experiment on origin of colour found out that when white light is allowed to pass through a glass prism in a darkened room, a patch of coloured light .s produced. This patch of coloured light he called spectrum. The colours of the spectrum, he listed are red, orange, yellow, green, blue, indigo and violet. On the basis of his finding. Newton put forward a theory that white light consist of a mixture of colours.

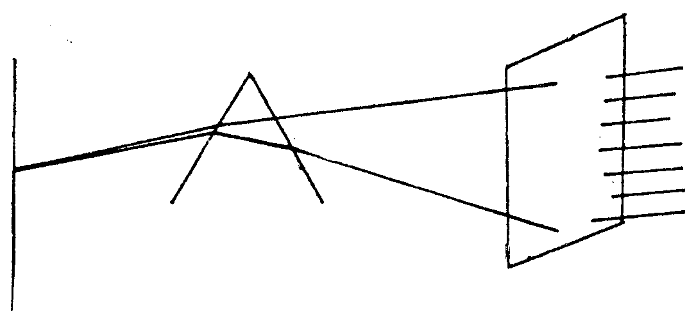


Fig. 5.2 Dispersion of light by Prism

Collect a glass prism from your course tutor and carry out this activity at home. In a darkened room allow rays of light into the room through a small opening. Place the prism on the path of the light and allow the light to fall on white cardboard screen. Try to identify as many colours as you can.

Application of Linear Propagation of Light

1 . Formation of shadows. Shadows are formed because light travels in a straight line. When light shines on an object some of the light is stopped while other rays pass straight on. A shadow is formed where light rays cannot reach. For example, when an opaque body is put in the path of light, the opaque object cast a shadow where the light cannot reach.

Fig. 5.3 Shows how a shadow is formed when a ball is placed between a screen and small touch light bulb.

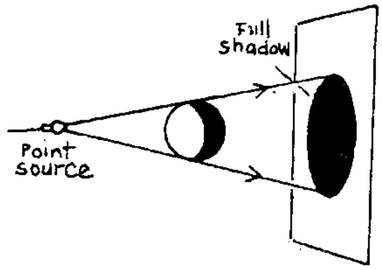
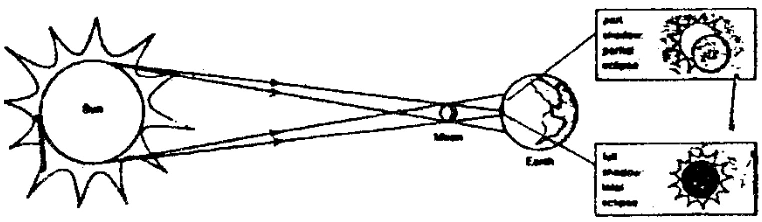


Fig. 5.3 Formation of shadow

The region on the screen forming the shadow marks the point on the screen the rays of light travelling in straight line cannot reach because part of the rays have been stopped by the ball.

If the rays of light are from a large source e.g. table lamp, two regions on the screen, one of full shadow and the other one partial shadow are formed. This is shown in the figure below.



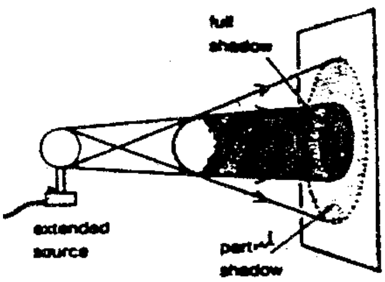


Fig. 5.4 Full and partial Shadow.

The occurrence in above figure is similar to what happens during solar eclipse.

When the moon comes in between the sun and the earth, like the ball, the moon being an opaque or a non-luminous body, the rays of light from the sun cannot get to some points on the earth, resulting in the moon casting its shadow on the earth. This forms what is referred to as solar eclipse. The area of full shadow is called total eclipse. In this area, the sun cannot be seen at all in the region of the earth. The other area of partial shadow has a partial eclipse, part of the sun can be seen. Eclipse means overshadow.

Formation of images in Pin - hole Camera

The formation of images in a pin-hole camera and in real camera arise from rectilinear propagation of light.

Light travelling in a straight line enables image of an object to be formed in a camera. The image formed is upside down and reversed. This is because the rays of light cross each other as they travel in straight lines through the pin-hole. Such image formed on a screen is called real image. Thus the rectilinear propagation of light enables real images to be formed.

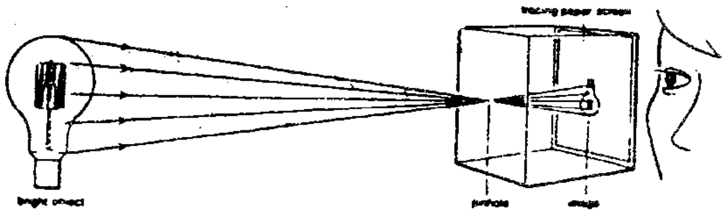


Fig. 5.6 Formation of image in Pin-hole camera.

3. Formation of image in plane Mirror.

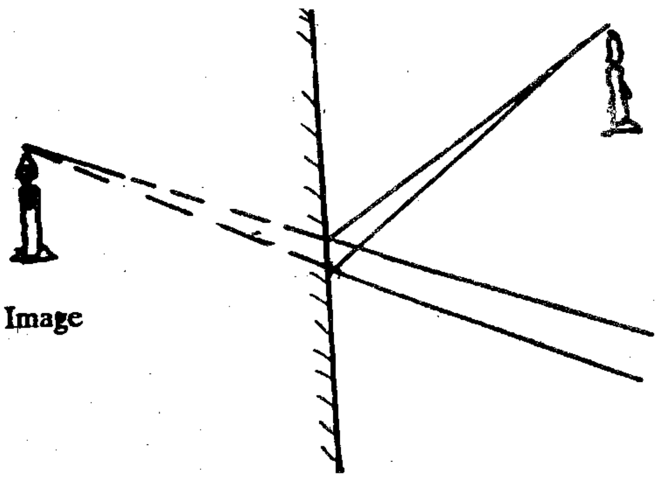


Fig. 5.7 image formation in plane Mirror

Fig. 5.7 shows how an image is formed in a plane mirror. The ray of light from the object is reflected when it strikes the surface of the mirror into the observer's eye. To the observer, however, the rays seem to be coming from X, i.e. the image of the object. Since no light passes through the mirror, such rays do not exist. hence the rays only appear to come from the image formed. As no light passé through the mirror, the dotted lines are just apparent intersection of the light rays. The image therefore formed is said to be a virtual image and not real as :s the case in pin-hole camera. Also the image formed here cannot be projected or screen since there is no light rays coming from X to be projected on the screen.

TRANSMISSION OF LIGHT

Light can travel through space or vacuum and does not need any medium for transmission but can pass through some substances. Substances which allow light to pas: through them and allow some objects, to be seen are called transparent media. While those that allow light to pass through them but do not allow objects to be seen are called translucent media. Substances which do not allow light to pass through are called opaque.

ACTIVITY 23

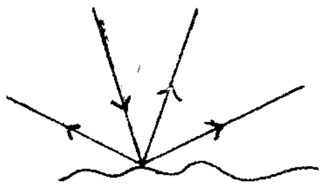
Take plane paper of half-a page size and smell some oil on it. Place it against rays of light and look through. Is it a transparent or translucent medium? Mention 3 objects around you that are opaque and 2 that are transparent to light.

RAYS AND BEAMS OF LIGHT

In science, a ray of light is defined as direction of path taken by light. A beam of light on the other hand is a stream of light represented by a number of rays. There are three types of beams of light.

REFLECTION OF LIGHT

A ray of light changes direction when it strikes the surface of a mirror is called reflection. We can see objects only when light from them enter our eyes. Self luminous objects give off their own light and then become visible. The non-luminous objects reflect light on their surfaces from other sources into our eyes before we can see them. Different types of reflections are obtained from different surfaces of objects. Very smooth surfaces like mirror, polished metals, sheet of glass reflect light in a regular manner when light strikes their surfaces. The reflection is called normal reflection. On the other hand, light reflected from a rough surface e.g. the surface of unpolished table, is scattered in all direction. This reflection is described as diffused.



Rough surface: diffused reflection

Fig. 5.9 Reflection of light by surface

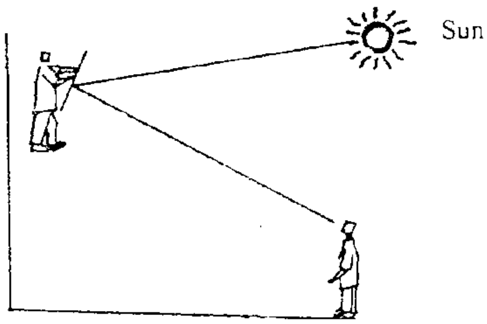


Fig. 5.10: Reflection of light by mirror.

This is an everyday experience we often have when rays of sun light shines on a glass or mirror. The rays become reflected to our eyes if we stand along the rays reflected.

ACTIVITY 24

Explain how a bowl of water in a sunny room can produce a flickering patch of light on the ceiling of the room.

THE LAWS OF REFLECTION

The laws state that;

i) the angle of incidence is equal to angle of reflection i.e. the ray leaves the surface a the same angle as it arrives.

ii) the incident ray, the reflected ray and the normal all lie on the same plane.

That is, all the three can be drawn on the same flat piece of paper.

ACTIVITY 25

Investigating laws of reflection.

For this activity you should secure the following materials:

Small size rectangular mirror, white sheet of paper, office pins, ruler, pencil and protractor.

Draw a line AB on the sheet of paper. Draw another line OP meeting AB (see fig. 5.12) Now put the mirror with its edge on the line AB. Look into the mirror. You will see line OP reflected in it. Find the position on the paper while looking into the mirror and stick -+ pins in the paper so that the pins are in line with the reflection of OP.

Remove the mirror and mark out the position of the pins. Join the points by straight line PR. Draw the normal and using the protractor, measure the angle of incidence and the angle of reflection.

What conclusion can you draw from this investigation.

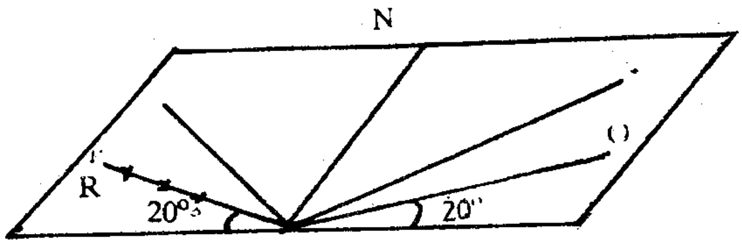


Fig. 5.12: Law of Reflection.

Fig. 5.12 summarised the result of regular reflection that you have just investigated. It shows that the angle of reflection is always equal to the angle of incidence. If a ray of light for instance strike a smooth surface, at an angle of 20, it will have its ray reflected at an angle of reflection of 20.

Application of law of reflection of light.

In construction of Periscope: The periscope is an observatory instrument or aid that enables an observe to see objects that are at a distance and above his position. For example in submarine it is used for viewing objects and following routes on the surface of water.

ACTIVITY 26

Construction of Periscope

This activity you will do in group of four (4). You will require sheets of light plank or carton, nail/glue, 2 mirrors and cellotape. Use the materials to construct a simple periscope similar to fig. 5.13. Make sure your construction is air tight and functional.

Submit the project to your tutor after 2 weeks for grading. The grade shall form part of the continuous assessment for this unit.

REFRACTION OF LIGHT

This is another property exhibited by light. When rays of light pass through a material medium, e.g water or glass, the incident rays become reflected or bent. It is the bending of light rays when light passes from one medium to another that is referred to as refraction.

Fig. 5.14 shows the path of rays of light as it passes from air into water. The ray is bent or refracted towards the normal and the angle of refraction is less than the angle of incidence.

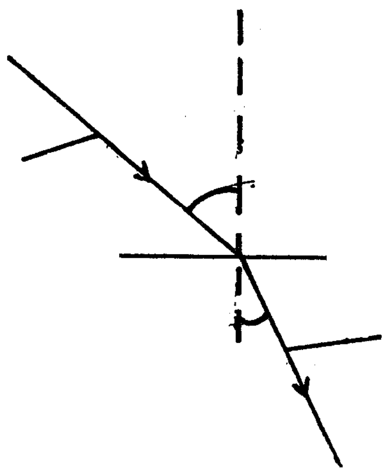


Fig. 5.14:

In general, when light rays pass from less dense medium to a denser medium, the refracted rays are bent towards the normal and the angle of refraction becomes less than the angle of incidence.

ASSIGNMENT

1 . a) Identify 3 sources of light in the home and 2 natural sources.

b) Distinguish between luminous and non-luminous objects, transparent and translucent objects.

2. Explain what light Energy is.

3. a) Explain with the aid of diagram how shadows are formed when an object is placed on

the path of light travelling in a straight line.

b) Describe an activity you can demonstrate to primary 5 pupils that light travels in a straight line.

4. State the law of reflection of light. Illustrate with the aid of a diagram to proof that angle of reflection is always equal to the angle of incidence.

SUMMARY

In this unit you have learnt the following:

- All luminous objects are sources of light energy and that light can be produced by articial means also.
- Light energy is a form of energy detectable by the eyes and have the following properties; travels in a straight line by a process of radiation, can transfer other forms of energy ego thermal energy from one place to another, can increase the thermal energy of a body, it enables images to be formed and travels at a speed of 3 x 105 Kilometer per second. You also learnt that white light is a mixture of the following colours: red, orange, yellow, green, Blue indigo and violet.
- Light can be reflected. It is reflected when it strikes on smooth surfaces of objects. The reflection could either be normal or diffuse.
- Reflection of light is summarised in Laws of reflection which States that: the angle of incidence equals the angle of refraction and that the incident rays, the reflected rays and the normal all lie on the same plane.

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UNIT 6: CHEMICAL ENERGY

INTRODUCTION

You learnt in unit 1 of this module that anything which is able to do work, possesses energy. Also you learnt that, energy is the capacity to perform work. In the same unit, you learnt that energy exists in various forms. Try to name them? In this unit you will learn about another energy i.e Chemical Energy. Chemical energy is perhaps the 11105: important form of energy. Can you suggest any reason for this statement? Coal, petrol the food you eat are stored as chemical energy which can be used to your advantage. For instance engines of cars use the chemical energy in fuel to produce heat or thermal energy that moves the car. Also it is the chemical energy stored in your food that provides you with the needed energy for your various daily activities. In this unit we shall discuss chemical energy, its sources and uses in greater details.

OBJECTIVES

By the end of this unit on chemical energy, you should be able to:

1. define chemical energy;
2. identify various sources of chemical energy;
3. carry out simple experiments to find out that energy is stored in chemical compounds;
4. mention some uses of chemical energy; and
5. explain how chemical energy is released for useful purposes.

CHEMICAL ENERGY

Scientists study forms of energy. By this time you probably have a good idea of what chemical compounds are. Your examples may include table salt, detergent, soap, oil, petrol, kerosine, wood, gunpowder, cooking gas, fertilizer, matches, insecticides, food, etc. Indeed, all substances in the world are chemical substances. We rarely recognise that there is energy in all the substances mentioned above since their energy is locked up in them. We know very well, however, from our experience that we are hungry, we grow weak, an indication that we are running out of energy. The moment food is taken, we immediately regain our strength and become very energetic. Similarly, when a moving vehicle runs out of fuel, the vehicle stops and can only continue working only when some quantity of fuel is put in.

The effect of the food, the fuel and others, is an indication that chemical substances possess some form of energy which is locked up in them. This energy only becomes released during chemical reaction such as combustion or burning and changes to another form of energy that can be used to perform work.

ACTIVITY 27

Pour some quantity of water into a small bowl or container. Take a handful of Omo detergent and close it up in your palm.

Dip your handle in the bowl of water and allow some water into the detergent. Close up your fist and squeeze the detergent.

Can you feel some warmth in your hand? Where does this warmth come from? Does this suggest that the detergent stores up some energy?

ACTIVITY 28

(To be done during the contact session)

The course tutor will provide you the following; some quantity of sodium hydroxyl pelettes; (This substance if not properly handled can bum the skin therefore you must not touch it with your hands.), Spoon or forceps, a thermometer, a small test tube or beaker and water.

Put some water in the beaker about 20 - 25cm^3.

With the aid of the thermometer take the temperature of water.

Now add some quantity of sodium hydroxyl pelettes to the water and allow it to dissolve. Take the temperature of the solution and note it down. Is there any temperature change? Explain your observation and the conclusion you can deduce in your note book. Submit your notebook to your tutor.

RELEASE OF ENERGY FROM CHEMICAL SUBSTANCES

Energy in chemical substances will ever remain locked up in the if they are not released. If' the energy continues to stay there, it cannot be useful to us. Since we need this energy, scientists have identified that by certain chemical reactions, the chemical energy can be transferred to other useable forms of energy. Carry out the following experiments and record the energy forms released.

ACTIVITY 29

Release of energy by burning

i. Put some kerosine in a lamp or spirit in a spirit lamp and light it.

ii. Take a small quantity of any food material e.g. beans, groundnut etc in a spoon and allow it bum by putting it on a flame. Record the energy forms released.

The burning of kerosine, and the food substance is a process of combustion as a result of which chemical energy stored in them is released in the form of light and heat.

You have seen that food can release energy. A similar process occurs to food in your body through the process of respiration. Here the oxygen you breath in combines with food and energy is released in a controlled way. This equation summarises it;

FOOD + OXYGEN --.> ENERGY + CARBONDIOXIDE + WATER.

ACTIVITY 30

Release of energy: Neutralization reaction. Try to secure the following 2M HCI and 2M NaOH and a thermometer.

Procedure:

1 . Take the temperature of each of the solutions and note down the average temperature.

2. Mix the solutions, stir the mixture with the thermometer and note down the temperature change. Which form of energy is released by this reaction and where did it come from.

The reaction between an acid and a base, that .is neutralization reaction which you have just carried out is always accompanied by heat. The heat energy is released from the chemical substances of the acid and the base.

From the above activities you can now identify at least 3 methods by which chemical energy stored in chemical compounds can be released. Namely these are combustion, respiration and neutralization. reaction. The chemical reactions involving combustion and respiration are sometimes described by the term oxidation.

SOURCES AND USES OF CHEMICAL ENERGY

In the previous activities, you have been taught and you should able to demonstrate that chemical substances store energy. The question now is how does the energy get into them? To provide an explanation to this question, you need to remember that all chemical substances are either of plant or animal origin and that the ultimate sources of all forms of energy is the solar energy, that is energy radiated from the sun.

The ultimate source of energy available to the earth is the sun. The solar energy from the sun that reaches the earth surface is used by green plants during the process of photosynthesis to form energy stored in food substances e.g. glucose. When the energy storing foods are eaten by animals, the energy stored in the tissues of plants is transferred to and used by animals and thus spreading throughout the food chain. Also substances which are of plant and animal origin especially manufactured ones acquire the energy and store them up as chemical energy. Further when plants and animals die, the remains their bodies become buried in the sand and mud of swamps and seas. After millions of years they become transformed into fossil fuels (coals, petroleum and natural gas) which store up the energy. These fossil fuels provide the largest percentage of the energy \\hich is chemical energy being consumed by man today. In Nigeria petroleum forms .he main stay of our economy. Indeed the discovery of the fossil fuels opened the way to industrial revolution of the century and subsequent development of Western civilization.

USES

All forms of energy are capable of being transformed in many ways and when this happens the forms of energy could be used to our advantages. Chemical energy in such substances as coal, petrol, kerosine, gas, food, etc could be made available to us and become useful in the following ways:

1. In human body every movement you make (whether it is for breathing, seeing as you read this unit, or for writing, walking etc) requires energy. The energy you require is stored up in the food you eat and only becomes available for use when it is transformed during process of respiration. Here the food becomes oxidised and energy is released in form of heat energy.

   Food + Oxygen ---> Energy.

This energy could then be put into use in various ways such as for keeping up body heat or temperature constant, to provide energy for cell growth and changes further to kinetic energy for movements and various actions.

2. In automobiles. The burning or combustion of petrol, coal, gas, kerosine in automobiles transfor m chemical energy to heat energy or thermal energy which could be used to perform work e.g to move cars, aircrafts, trains, ships and factory machinery.

3. In our homes. Chemical energy stored in coal, kerosine, gas are used in our homes to generate light energy for lightening and heat energy for heating and cooking.

4. In making explosives: Some chemical reactions e.g. combustion of gunpowder produce large quantity of hot gases which can be made to do work. For instance, an explosive in a cartridge in a gun which when triggered produce a large volume of hot gas, under high pressure. The heat is used to accelerate the bullet out of the gun.

5. In generating electricity: Primary cell e.g. batteries are made of chemical substances and during a chemical reaction in the cells, the chemical energy is transformed into electrical which can be used to produce light. Coal can as well be used to make electrical energy which can be used for lighting, cooking heating, etc.

ACTIVITY 31

Name two uses of chemical energy in the home?

ASSIGNMENT

1. Explain how chemical energy differ from other forms of energy you have learnt.

2. What form of energy is stored in dry batteries? Mention other substances or materials in our homes that store same form of energy.

3. What is the main form of energy in fossil fuels. How does it get into them?

4. One of the functions of food to man is to provide energy to the body. What is the nature of this energy and in what form or forms could it be used by the body?

5. Find out from the unit, the scientific terms that could be used to describe reaction in which a chemical compound is burnt to liberate heat.

SUMMARY

You have so far learnt about the nature, sources and uses of chemical energy. Specifically you have learnt that:

- Chemical energy is the form of energy stored in chemical compounds and substances such as glucose, sugar, salts, coal, petroleum, food etc.

- All chemical compounds are therefore sources of chemical energy and the ultimate source of it is the solar energy from the sun.

- Important fossil fuels are important sources of energy and are formed by the decomposition of dead organic matters (plant and animal matters) buried millions of years ago.

- Stored Chemical energy become released and transformed during chemical reactions or during burning or combustion or oxidation to other forms of energy that could be useful to perform work.

- Chemical energy could be used in many ways. It could be used in human bee to produce movement, growth and repair of tissues and for maintenance of body temperature. It could be used to perform mechanical work in internal combustion engines, and also to generate electricity and explosives.

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UNIT 7: MECHANICAL ENERGY

INTRODUCTION

In unit 1 of this module you learnt various forms of energy. Also you have an idea of what WORK means to scientists. In this unit we shall be concerned with another form of energy, specifically Mechanical Energy. This unit therefore begins by considering mechanical work and what mechanical energy is. There is then consideration for kinetic and potential energy and their conservation. This unit also teaches you how to carry out simple calculations involving mechanical energy.

OBJECTIVES

By the end of this unit and carrying out all activities, you should be able to:

1. explain the concept of mechanical energy as energy change associated with mechanical work;
2. explain Potential and kinetic energy as forms of mechanical energy;
3. explain the Principle of energy conservation when mechanical work is done;
4. solve simple problems on mechanical energy;
5. identify at least 5 machines that use mechanical energy; and
6. mention the uses of mechanical energy.

MECHANICAL ENERGY

Work is a product of force and distance and the quantity of work done is equal to the quantity of energy put in. When work is done energy becomes transformed to another form.

Is the above statement true? Think it out before reading this unit. When a force moves something WORK is said to be done. In science work is done when a force can produce movement in a measured distance. That is *WORK = FORCE x DISTANCE.*

Generally for any work done, there must be energy input since energy is the capacity of a system to perform work. The form of energy first recognised from this point of view of energy is mechanical energy. For instance a body in motion does a mechanical work when it moves another body or deforms it as a result of collision. This capacity to do work is recognised as one of the properties of mechanical energy.

Here is a simple experiment to illustrate what we have said so far.

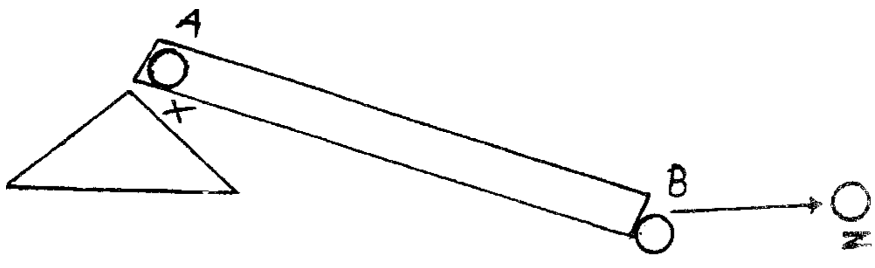


Fig 7.1: Energy and work.

You will need a ruler, and 2 metal balls to set up the experiment as shown in Fig. 7. 1. Having set it up, release the metal ball A so that it rolls down the slope and hits the ball B at the bottom of the slope. What happens to ball B?

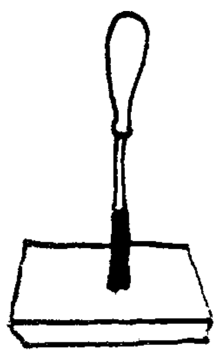
In this experiment, ball A in its stationary state at point x has a form of energy due to its position(Potential energy). When it rolls along the slope, the potential energy gradually changes to motion (or kinetic) energy. It gives this energy to B at point Y and in turn causes B to move to point Z. In the course of all this, energy is used and transformed and work is done. Here the energy involved in such work is simple referred to as Mechanical Energy.

ACTIVITY 32

Explain the meaning of mechanical Energy in your own words. Is your answer in line with what is given here.

Mechanical energy is a form of energy associated with position and movement of a body possessing mass. In other words, it is energy that enables mechanical work to be done and it is of two kinds; potential and kinetic energy.

Examples of mechanical devices or systems that perform mechanical work using mechanical energy include: grandfather's clock, bicycle bells, jack, some machines e.g. water pumping machine, milling machine, pulley, grinder, windmill, machine gun and even yourself. Fig. 7.2 below shows some mechanical devices. All these simple machines enable work to be done using mechanical energy.



Screw Driver

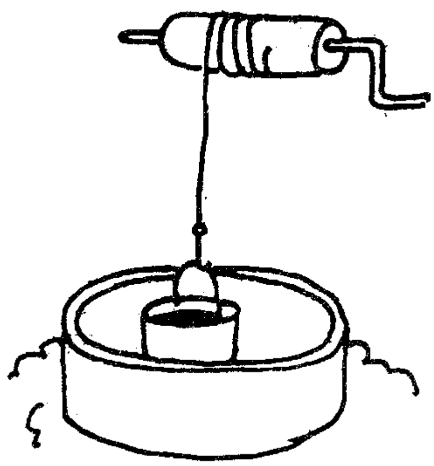


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Fig. 7.2: Mechanical devices.

FORMS OF MECHANICAL ENERGY: Potential and kinetic energy.

Objects have potential energy if they have been moved to a position from which they can do work when released. See fig. 7.3

The stretched spring has potential energy stored in form of strain energy. It does work when it is allowed to spring back to its normal length, The ball held up in the air has got gravitational potential energy. If the ball is released, work is done as the ball is pulled to the ground by the force of gravity.

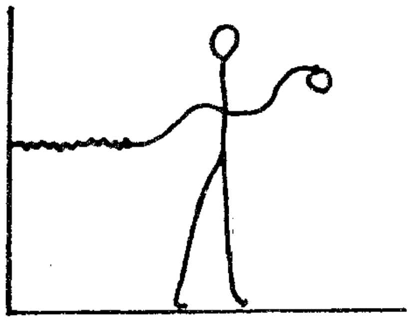

Fig.7.3: Potential energy.

Others such as drawn bow, drawn catapult, gun powder, explosives, all store potential energy. The quantity of energy stored in all the examples given is always equal to the kinetic energy produced when they are released to do work. This is a principle of energy conservation, the detail of which you shall learn later in unit 8.

Moving objects such as fired bullet, arrow, cars, balls etc all have kinetic energy. Spinning objects also have kinetic energy owing to their rotation.

CONSERVATION OF MECHANICAL ENERGY

For mechanical work to be done, the potential energy of the body has to be overcome and subsequently changed to kinetic energy. Thus, the two forms are interchangeable. lf frictional resistance is neglected, the quantity of potential energy (P.E) in a body is :11\\ay5 equal to the kinetic energy (K.E) produced when the body is released to do work. Also if the moving body is brought to rest, the quantity of its K.E converted to P.E remains the same. Thus, in any mechanical system the quantity of the potential energy and that of the kinetic energy remains constant.

Note at every stage as the ball falls the P.E + K.E = constant

The ball in Fig.7.4 starts with 30J of gravitational potential energy. As the ball falls wards the ground, it gains kinetic energy (K.E) at the expense of potential energy (P.E). Therefore, the quantity of the energy always add up to 301. That is

PE + K.E of a body = Constant.

ACTIVITY 33

Energy change between K.E and P.E.

Tie a small weight or bob to a string or thread and suspend it in the air by tying it onto any support to make a simple pendulum.

Raise the bob of the pendulum to a vertical height h and then release it so that it can swing. Repeat this several times raising the bob to different height at each time and nee" the height the bob attains as it swings to the other side C before it swings back.

At the end of this activity use diagram only to explain how the energy changes occur. When the bob is released at height h, it will be seen to swing from A through B to C. On careful observation, it will be noted that the bob from height A will swing to the same vertical height at C. That is, suppose the height at A is 0.5m the bob will swing to same height (0.5m) at C. This is because the total energy of the pendulun i.e. (P.E + K.E remains constant.

CALCULATIONS ON MECHANICAL ENERGY

Potential and kinetic Energy. It is often useful to be able to calculate quantities of energy. This section will show that Remember that quantity of work done is equal to quantity of energy input and both are measured in the same unit -- Joules.

1. Calculating gravitational potential energy.

Gravitational potential energy is the energy which a body possesses because 0:' its position above the ground.

Work is done against gravity to raise the ball to A and to keep it in that position. The potential energy possessed by the ball can be calculated simply from this relationship W = mgh where,

W=Work done

m = mass of the body

g = force of gravity (g= 9.8m1s2 or 10 m/s''). h = height above the ground

Thus an object of mass m at a vertical height h above the ground has a gravitational potential energy of mgh.

Example 1

If a ball of mass 1. 5kg is at a vertical height of 4m above the ground its gravitational potential energy (mgh) is = 1.5 x 10 x 4 = 60 Joules.

Example 2:

What work is done when a mass of 5.00kg is raised through a vertical height of 2.5m? g = 10 m/s)

Work done is equal to the quantity of the gravitational potential energy of the object when released. i.e. Work = Force x distance

= mgh

= 5 x 2.5 x 10 = 125 Joules.

Example 3

A rough object is placed on a floor. It is found that a force of 7.5N is required to move the object to a distance of 6m. How much work is done.

Work done = F x d = 7.5N x 6m = 45 Joules.

Note: In this example, no work is done against gravity since the object is not above the ground. The usual formula mgh does not apply.

ACTIVITY 34

Calculating potential energy

An object has mass of 6 kg, calculate its potential energy 4m above the ground. A wooden block is dragged on a ground level with a force of 10N and to a distance of I5m

1. How much work is done.

Calculating kinetic energy.

All moving objects have kinetic energy. The distance moved by a moving body when a force is applied depends on two factors.

These factors are mass and velocity.

Mathematically kinetic energy of a body is expressed simply as $K.E = ½ mv^2$ where

K.E = *Kinetic energy*

m = *mass and v = velocity of the moving object.*

In other words an object of mass m travelling at a velocity v has a kinetic energy of ½ mv^2

Example 1

If a ball of mass 5kg is moving at a velocity of 4m/s, its kinetic energy can be calculated thus;

Kinetic energy = $½ mv^2$

$= ½ \times 0\ 5 \times 4^2$

$= 0.025 \times 16 = 4$ *Joules*

Kinetic Energy = 4 Joules.

Example 2:

A hammer of mass 5kg is moving with a velocity of 6m/s.

If it hits a nail and drives it into a piece of wood. How much work is done (Assume no energy is lost e.g. to sound or heat)

Kinetic energy $= ½ mv^2 = ½ \times 5 \times (16)^2 = 2.5 \times 36 = 90$ *Joules.*

When the hammer hits the nail the kinetic energy becomes converted to work done. Therefore the work done = 90 Joules.

ACTIVITY 35

1. A ball of mass 2kg was dropped from the top of a roof. The ball hits the floor below at a velocity of 10m/s. What is the kinetic energy of the ball as it hits the floor.

2. A man uses an axe of 0.5kg moving at a velocity of 2m/s to chop a wood.

Calculate the kinetic energy used in doing the work.

USE OF MECHANICAL ENERGY

In a very general sense, mechanical energy enables mechanical work to be done. when a man pedals his bicycle or chops wood with his axe, what he is doing is mechanical work. Some metabolic activities taking place in the body are also mechanical in nature using mechanical energy to enable them function. Mechanical devices also require mechanical energy to perform work.

ASSIGNMENT

1. Explain briefly the meaning of mechanical energy.

2. Why is it that a man who hammers a nail continuously into a plank for 5 minutes is considered to be doing mechanical work?

3. Identify any 5 mechanical devices in the home that rely on the use of mechanical energy. Use anyone of these to explain how energy conservation occurs when it does work.

4. A wooden box of 0.5kg strikes the surface of a river at 20m/s what is the kinetic energy of the box?

5. 10J of work are done in throwing a stone upwards for the ground.

    i. How much energy is given to the stone?

    ii. What is the Potential energy of the stone at its highest point?

SUMMARY

In this unit you learnt that:

Work is a product of force and distance i.e.

Work =F x d.

Mechanical energy is energy change associated with (mechanical) work and it is of two types; potential and kinetic energy.

Work and energy are measured in the same unit - Joule

When mechanical work is done, there is inter-conversion between Potential energy and kinetic energy.

In any mechanical system, neglecting frictional resistance, the quantity of energy the system has remains constant.

Mathematical, Potential energy is expressed as mgh while kinetic energy is given by ½ mv^2

The function of mechanical energy is to enable mechanical work to be done.

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UNIT 8: ENERGY CONVERSIONS

INTRODUCTION

You remember from Unit 7 that energy enables work to be done and when work is done energy becomes converted from one form to another. For example, when a book falls to the ground from a bookshelf, its energy due to its position on the shelf (potential energy changes to energy of motion (kinetic energy). Sound will be heard when the book falls. Thus. further energy change from kinetic to sound and possibly from sound to heat and to potential energy. In other words energy only changes from one form to another when used it is not lost. This is what this unit is concerned with.

OBJECTIVES

By the end of this unit, you should be able to:

1. explain the law of conservation of energy; and
2. apply ideas of energy conversions to machines, power station, and to animal metabolism.

ENERGY CONVERSIONS

Energy cannot exist where there is no form of energy and where it exists it cannot seize to be but can be changed from one form to another. This is a scientific principle that shall engage our attention.

When the ball is thrown upwards, some of the chemical energy stored in the body is transferred into the ball as kinetic energy. The ball slows down as it gains height and it kinetic energy changes into potential energy. As the ball falls back its potential energy changes to kinetic energy. When the ball falls and hits the ground, the kinetic energy changes to sound and thermal energies. These changes can be illustrated in energy chain diagram as shown here:

Chemical --- kinetic ---- potential --- kinetic --- sound --- thermal energy.

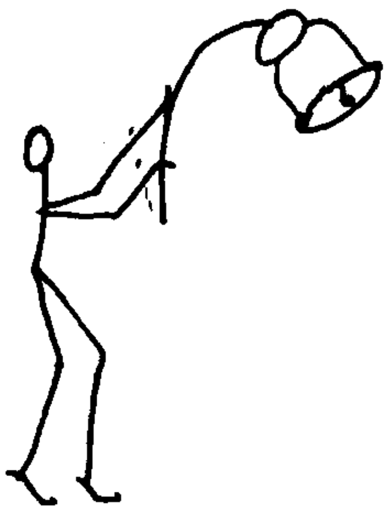

Fig 8.2 Energy change in ringing bell

ACTIVITY 36

Draw energy-chain diagram showing energy conversions occurring in figures 8.1 to 8.3

What energy changes occur in this burning candle?

Having studied the figures, now carry out the following simple activities; Place your palm together and rub them against each other.

What energy change has taken place?

Also strike a match and write down the energy changes involved.

The knowledge and experience you gained from above show that;

- energy is required to start any work e.g. you required energy to throw a ball, to ring bell or to push a car.
- the energy does not disappear when used but becomes transformed from one form to another.

The above view is accepted as a scientific principle which is expressed in a scientific law called the law of Conservation of Energy. It states that;

Energy can neither be created nor be destroyed but can be changed from one form into another.

By this law it can be explained that the total quantity of energy in any system and, in the universe, always remains constant. Although no direct scientific proof exists for this law, but experience shows it to be probably true.

ACTIVITY 37

In this activity you are going to carry out some experiments similar to the ones illustrated in Fig 8.1 to 8.3.

In the column on the right put down the energy conversion that takes place.

S/N	Experiment	Energy change involved
1.	Pour some water in a container. Dip a water heater and plug it to source of electricity.	
2.	Boil some water over a stove in a kettle allowing the steam to escape.	
3.	Make a propeller from thin cardboard or paper and hold it about 15cm over a burning stove.	
4.	Switch on a portable (battery powered) radio.	
5.	Wind up the alarm or a clock and set it to ring after 5 minutes.	
6.	Put a table fan out in the wind or switch on an electric fan.	

Check the end of this unit for correct energy changes.

MUSCLES AS ENERGY CONVERTERS

All movements in our bodies are made by action of muscles.

If you raise a load, your muscles are at work. The energy for doing this work come. from stored chemical energy in the muscles. When work is done by muscles, energy is not only used but equally transformed from one form to another. Let us verify this.

ACTIVITY 38

Place your right hand on a table in the position as shown by Fig 8.4

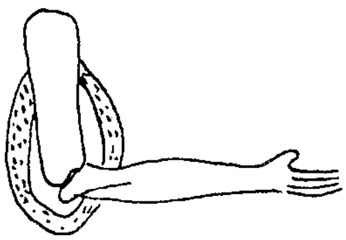

Fig. 8.4: Muscles as energy converter

Place your left palm on the tricep muscle of the right hand.

Now move the lower arm of your right hand up and down several times until you feel warm.

Record energy change involved.

ENERGY CONVERSION IN PHOTOSYNTHESIS

Photosynthesis is a process by which green plants manufacture their food e.g. carbohydrate using solar energy as their source of energy. The process involves the conversion of solar energy from the sun to chemical energy stored in manufactured food.

This is an example of energy conversion occurring in nature.

Fig 8.5 below Illustrate the conversions.

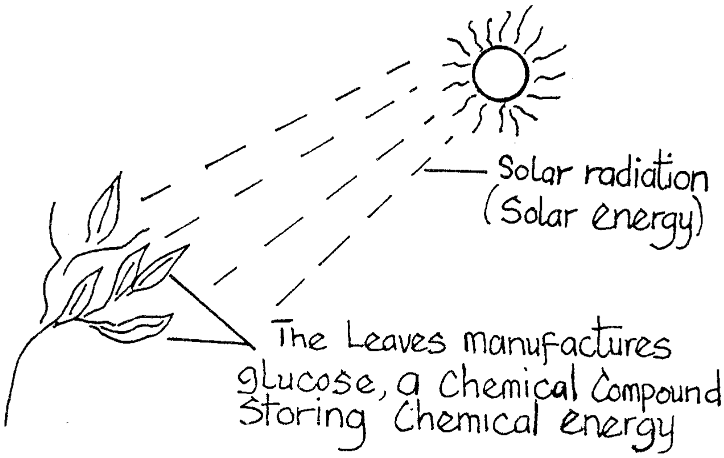

Fig 8.5: Energy conversion in photosynthesis

The energy conversion here is solar energy to chemical energy.

ENERGY CONVERSION IN HYDRO ELECTRIC SOURCE

The energy conversions in hydro - electric station can be studied from the diagram shown below:

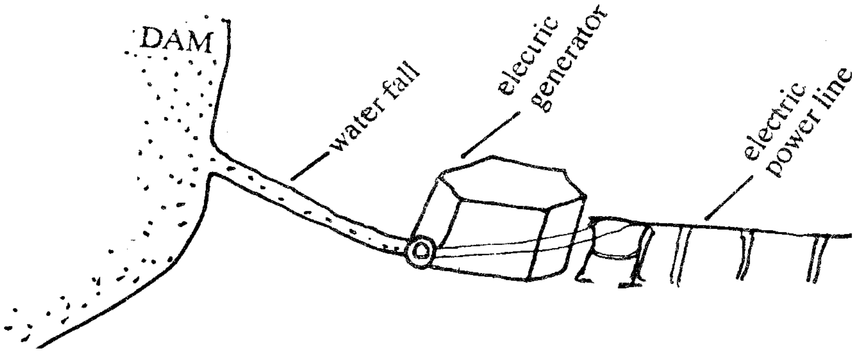

Fig. 8.6. Hydro - electric station

In hydro electric power station, electricity is generated by a dynamo run by water from the dam. The dam stores water in order to control and channel its How. When allowed to How through a fall or a large water pipe, the potential energy of water is changed into kinetic energy. It is this kinetic energy of water that turns the dynamo in electric generate mechanically and from which electrical energy is generated for distribution to homes and industries. Thus the energy conversion taking place here is;

Potential energy --> kinetic --> Mechanical --> Electrical energy

ENERGY CONVERSION IN A BICYCLE

A bicycle is an example of a machine which enables us to perform some work. When a man rides on a bicycle from one point to another distant point, much work is done and a chain of energy conversions takes place.

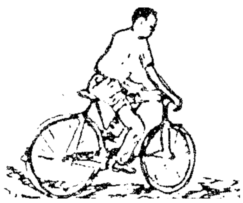

Fig 8.7 Energy change in a moving bicycle

When the man pedals the bicycle, the chemical energy stored in the muscles of his legs is converted to mechanical energy enabling the pedal to move the chain. This in effect produces kinetic energy which moves the bicycle. Thus the following energy conversions take place:

Chemical energy --> Mechanical energy --> kinetic energy

ACTIVITY 39

Identify any 3 machines or devices in the home that are energy converters.

ASSIGNMENT

1. i. Look around you or in your home and identify 5 devices or machines that are energy converters.

   ii. What energy change(s) is or are involved in each when made to do work?

2. Draw up energy- chain showing energy changes taking place in the following Heart beats leading to flow of blood. An aeroplane landing at the air port. A man riding a bicycle

SUMMARY

In this unit you have learnt that:

- The various forms of energy can be transformed into another. This is often the case when work is done.
- In many energy changes heat energy is the final form of energy.
- The transformatory behaviour of energy is expressed as the law of conservation of energy,

- It states that energy cannot be created nor destroyed but can be converted from one form to another.
- Figure 8.8 provides further cues to all you have learnt in this unit. Study it carefully.

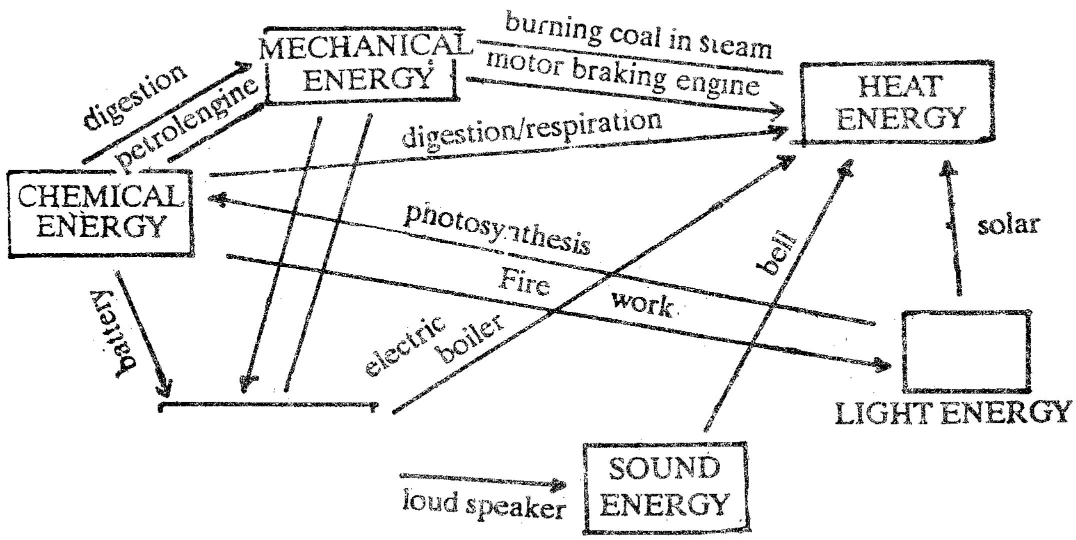

Fig 8.8: Energy conversions

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UNIT 9: MOTION AND LOCOMOTION

INTRODUCTION

You may wish to know that both motion and locomotion mean the same thing. That is the two terms "motion", "locomotion" mean process or power of action of moving. You should bear in mind that motion involves a change of position of a body, depending on time. In this unit, you will be much more involved with the term motion.

OBJECTIVES

By the end of this unit you will be able to:

1. explain the term motion;
2. list the four types of motion;
3. write the equation of motion;
4. define the terms: (a) Speed (b) Velocity (c) Displacement; and
5. distinguish between a scalar and vector quantities.

WORD STUDY

Speed	=	rate of change of distance with time
Velocity	=	speed in a specified direction
Displacement	=	distance, travelled in a given direction
Acceleration	=	rate of change of velocity
Speedometre	=	Instrument for measuring speed of cars.

MOTION

The concept motion involves a change of position of an object, depending on time. There are four types of motion, namely:

1 . Random motion = motion with no pattern to it e.g. gaseous particles.

2. Rotationaimotion = motion that moves in a circle about a centre or an axis e.g. a spinning wheel or a rotating fan.

3. Linear motion = This is a motion in straight line.

4. Oscillatory motion = This is a to-and-fro type of motion e.g. a swinging pendullum.

MOTION IN A STRAIGHT LINE

Four variables are required to describe motion in straight line. These variables or parameters include distance or displacement (s), speed or velocity (v) acceleration (a) and time (t).

SCALAR AND VECTOR QUANTITIES

Scalar and vector quantities are physical quantities. Most quantities measured in science are grouped as either scalar or vector quantities. A scalar quantity is one which has magnitude (or size) but no direction. Examples are energy, temperature, mass, distance, speed etc. These quantities need only a number and unit to specify them. You do not have to ask for their direction.

A vector quantity is a type of quantity that has direction as well as magnitude. Examples are force, acceleration, velocity, displacement, weight etc. To specify these quantities you need to state the directions in which they are acting as well as their magnitude.

ACTIVITY 40

Classify the following as Scalar or Vector quantities; displacement, velocity, speed, temperature, weight mass, acceleration, force, pressure, energy, momentum, density.

DISTANCE AND DISPLACEMENT

You have just learnt about the difference between scalar and vector quantities. Now consider a motor car that travelled a distance of 200m, the expression "200m" is a scalar quantity because the direction in which the motor-car was moving was not stated specified. But if the car happens to be moving along a straight line and the direction of travel is mentioned e.g. 200m due West, you are now dealing with a vector quantity known as the displacement of the car. Thus, Displacement is distance moved in a specified direction. Car driver use speedometer to measure or check their speed.

SPEED

This is the rate of change of distance moved with time, OR

$v = s/t$ *where* $s =$ *change in distance*

$t =$ *change in time*

$v =$ *speed*

Uniform speed occurs when the ratio of change in distance with change in time is constant. Thus speed (v) is said to be uniform if

$$v = s/t = \text{a constant}$$

Average speed is given by total distance divided by total time:

$$\text{average speed} = \frac{\text{total distance travelled}}{\text{total time taken}}$$

The unit of speed is m/s.

VELOCITY

This word velocity is often confused or used in place of speed. In science, however, it:, necessary to distinguish between these two terms. Velocity is defined as the rate of change of distance moved with time in a given direction. Velocity is therefore a vector quantity whereas speed is a scalar quantity.

Uniform Velocity: This occurs if the rate of change of distance moved by an object with time in a given direction is constant. The unit of velocity is m/s.

ACCELERATION

When the velocity of a body is changing, the body is said to be accelerating. Thus acceleration "a" is defined as the rate of change of velocity with time OR

a = *v/t where a = acceleration*

v = *velocity change*

t = *time*

Uniform acceleration: A body is said to move with uniform acceleration if its rate of change of velocity with time is constant. The international system (SI) Unit of acceleration is metre per second squared (m/s-).

ACTIVITY 41

1. Write the SI units of:
   (a) Speed
   (b) Velocity
   (c) Acceleration
2. What is a scalar quantity?
3. Define the term velocity.

THE EQUATION OF MOTION

If an object begins with initial velocity 'u' and accelerates constantly along a straight line with acceleration "a" and covers a distance "s" in a time "t" when its velocity reaches a final volume "v", Then the distance "s" covered by the object is given by

s = *average velocity x time. That is*

$$s = \frac{v+u}{2} \times t \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

If you go by definition, acceleration "a" = rate of change of velocity and since "a" is constant, you have

$$a = \frac{v-u}{t} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

Where:

v = final velocity

u = initial velocity

t = time

a = acceleration

OR

$v = u + at$

Eliminating t from equation (1) and (2) you find

$V^2 = u^2 + 2as$ ……………………………………. (3)

These four equations of motion are used in solving problems associated with constant acceleration motion.

Please, Note that when using the equations you must take care of the following points.

Make sure that all the units of the variables match. That is "v" in metre per second (m/s)

"s" in metre (m)

"a" in metre per second squared m/s?

OR

"v" in km/h, "s" in km, "a" in km/h', "t" in hours.

Each of the equation contains four of the five variables i.e. *"u", "v", "s", "a" and "t"*. You may be given the values of three of the variables and you are expected to find one or both of the unknowns.

To select an equation for solving a problem, you should look at the problem and find out which of the variables is not given, in addition to the one which is required. Then find equation which does not contain the variable that is not given. This gives you the required equation.

Equation (1) does not contain "a" Equation (2) does not contain "s" Equation (3) does not contain "t" Equation (4) does not contain *"v"*

Note the conversion formulae: *1 km/h = 1000 m/s 60 x 60*

OR

36 km/h = 10m/s OR lm/s = 3.6 km/h Do not confuse "s" for distance with the unit of time "s"

ACTIVITY 42

A locomotive train slows down from l20km/h with a constant retardation of $10m/s^2$. H,) long will it take to reach 20km/h, and what is the distance covered?

MOTION UNDER GRAVITY

This can also be referred to as gravitation force. This is a force that pulls object down of towards the earth. Objects falling under gravitational force fall at different rates. A heavy body has a larger force acting on it than a light body, so you should expect it to accelerate more and reach the ground faster.

ACTIVITY 43

Suspend two objects (a stone and feather) on a ceiling with threads. Cut the threads that hold two different objects and observe which get to the floor first. Which of the two objects gets to the floor first, and why?

CIRCULAR MOTION

Uniform circular motion occurs when an object moves with a constant speed in a circular path. In this type of motion the speed of the object remains constant, but its direction is continuously changing so as its velocity changes too. In this type of motion, the direction of motion at any instant is the direction of the tangent at that point.

TANGENT TO A CURVE

This is a straight line touching the curve a point. The tangent to a curve at any point is at right angles to the radius of the circle at that point.

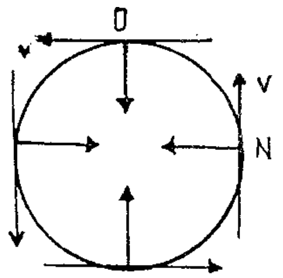

Fig 1.1: Circular Motion.

Looking at figure 1:1, the direction of motion at any instant is the direction of the tangent at that point. For instance, the direction of motion at "N' is almost at right-angles with the direction at "N' and directly opposite the direction at the point "0" (see Fig 1:1).

From here you will notice that a body following a circular path has an acceleration which is acting towards the centre of the circle and which is responsible for making the body move in a circle. The magnitude of this acceleration can be deduced as:

v^2/r where

r = radius of the circular path

v = the uniform speed.

This acceleration is referred to as centripetal acceleration.

SIMPLE HARMONIC MOTION

This is the simplest type of oscillatory motion. It is the motion of a body which is always accelerated towards a fixed point, known as the centre of motion, 0 and moves to and from on a straight line through O.

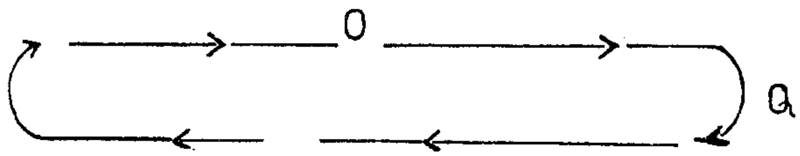

Fig 1.2: Simple Harmonic Motion

The body starts from 0, moves to a point Q then back to 0, passes 0 to the other side and moves to Q^I such that $OQ = OQ^I$ = "I", then back to 0.

The process is repeated, *"I"* is called the amplitude of motion. This is the maximum displacement on either side of the centre of motion 0. The locomotion (movement)

0 > Q -> 0 > QI > 0 is complete cycle. The time taken for one complete cycle is known as the "period" of oscillation, and the number of cycles in one second is the frequency. An example of simple harmonic motion are the motion of a simple pendullum.

ASSIGNMENT

What do you understand by the term motion.

1. List the four types of motion.
2. Define the terms, speed, velocity, and acceleration.
3. Distinguish between scalar and vector quantities.

SUMMARY

In this unit, you have learnt that:

- Motion is the change of position of a body depending on the time.
- There are four types of motion namely Random, Rotational, Linear and Oscillatory motion.
- Scalar quantity has only magnitude.
- Vector quantity has both magnitude and direction.
- Speed is a scalar quantity
- Velocity is a vector quantity.
- Acceleration is the rate of change of velocity with time.
- Circular motion is a type of motion that occurs when objects moves round a circular path.
- Simple harmonic motion is the simplest type of oscillatory motion e.g. simple pendullum.

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UNIT 10: SPEED AND RECTILINEAR ACCELERATION

INTRODUCTION

In considering a motion along a straight line, the actual distance covered is equal to the displacement. For example, the speed is equal to the magnitude of the velocity. Normally, a driver notes his actual speed at any moment by looking at the speedometer. Sometimes, the readings of the speedometer are only approximate. In order to have an accurate value of the speed of a vehicle at any instant, it would be important to take note of the distance moved in a very short interval of time. The most accurate method of measuring the speed of a vehicle, is by using a roadside observer with a special instrument to time vehicle over a measured distance. So long as the time interval is short, there is likelihood that the measured speed is accurate.

OBJECTIVES

By the end of this unit, you will be able to:

1. define the terms, Speed and acceleration;
2. distinguish between scalar and vector quantities;
3. explain the meaning of rectilinear acceleration;
4. sketch a map of distance-time graph of uniform speed; and
5. solve some problems on acceleration.

WORD STUDY

Speedometer: Instrument used for measuring the speed of vehicles.

Rectilinear: In a straight line, consisting of straight line.

Retardation: Negative acceleration

SPEED

Speed is the rate of change of distance moved with time. Thus if a journey from Zaria to Kaduna of about 100km, takes two hours.

$$\textit{The average Speed} = \frac{\textit{Distance moved time}}{\textit{time}}$$

$$= 100/2$$

$$= 50km/h$$

During this kind of journey, the actual speed of the car at any instant will vary considerably from the average speed.

The International System (SI) unit of speed is meter per second (ms^{-1})

Speed is a scalar quantity. A scalar •quantity is that which has only magnitude. E.g. Temperature, Speed. Pressure, density etc.

DISTANCE-TIME GRAPH

For a motion through a straight line, the actual distance travelled is equal to the magnitude of the displacement. Also the speed is equal to the magnitude of the velocity. We can represent this kind of motion on distance-time graphs as in Figures 2.1 and 2.2

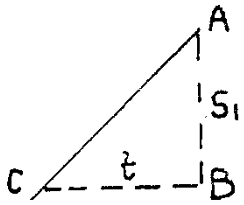

Fig.10.1

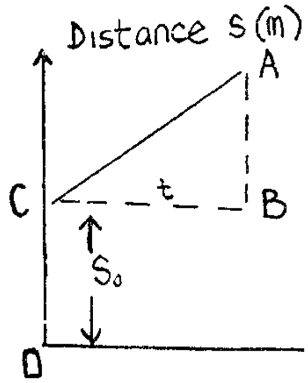

Fig.10.2

DISTANCE-TIME GRAPHS (FOR UNIFORM SPEED)

In Fig 10.1 above, *distance s = 0 when time t = O. This means that timing is started at the when instant when body passes a reference point on the path.*

In Fig 10.2, s = s_o at time = O. This means that timing was started when body is at distance s_o from the reference point on the path.

In this case, the graph is a straight line. Hence the body covers equal distances in equal intervals of time. That is speed is uniform.

ACCELERATION

A body is said to be moving or accelerating when its velocity changes with time. Acceleration means when the velocity increases with time. When the velocity decreases with time, we talk of ***RETARDATION*** which may be considered as negative acceleration. (See Fig. 10.3 below).

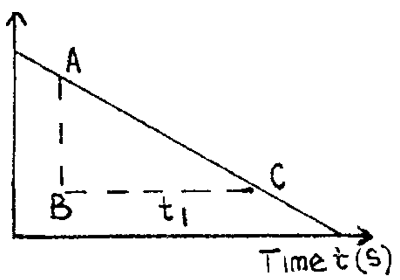

Fig 2.3: Negative Acceleration (retardation)

Thus, acceleration is the rate of change of velocity with time or rate of change of speed with time, in a given direction. The International System (SI) unit of acceleration is metre per second squared, that is metres per second per second ms^{-2}.

Please note that acceleration is a vector quantity. A vector quantity is that quantity which has magnitude and direction. E.g. Velocity, displacement, momentum, acceleration etc.

ACTIVITY 44

a. Write the expression for average speed. Define the term speed.

b. What is a Vector quantity.

c. Give five examples of a scalar quantities.

RECTILINEAR ACCELERATION

This is acceleration taking place in a straight line, or uniform or constant acceleration. A body is said to move with uniform or constant acceleration if its rate of change of velocity with time is constant.

SPEED-TIME GRAPHS FOR UNIFORM ACCELERATION

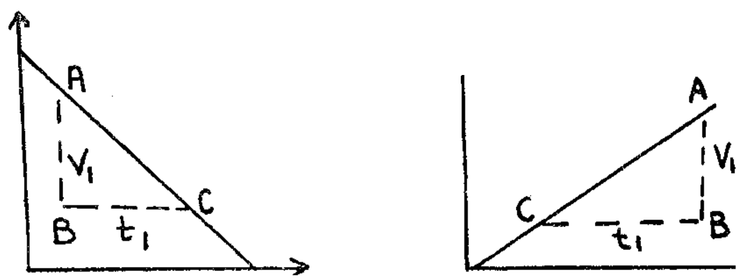

Fig 2.4 (a) (b)

In figure 2.4 (a) v = 0, when t = 0, this means that the body starts from rest.

In figure 2.4 (b), at time t = 0, v = u, but in figure 4(c) v = u_2. These features of the graphs means that the initial speeds of the motion are u, and u_2 respectively.

All three graphs are straight line graphs. (Rectilinear acceleration). This means that in each case, the speed of the body changes at a constant rate. In cases (a) and (b) the speed is increasing while in case (c) the speed is decreasing with time. The slope of the graph in each case is:

$$\frac{AB}{BC} = \frac{\text{Change in Speed}}{\text{Time interval}} = \frac{V_1}{t_1}$$

ACTIVITY 45

What do you understand by the term velocity?

ASSIGNMENT

1. Define the terms speed and acceleration.
2. Make a sketch of a graph speed-time showing RETARDATION.
3. What do you understand by the term RECTILINEAR ACCELERATION?
4. A motor car is uniformly retarded and brought to rest from a speed of 120km/h in 10s. Find its acceleration.

SUMMARY

In this unit, you have learnt that:

- Speed is the rate of change of distance with time.
- Average speed is the distance travelled over time taken to cover the distance.
- Acceleration is the rate of change of velocity with time.
- Scalar quantity is a quantity or measure with only the magnitude.
- Rectilinear acceleration is acceleration occuring in straight lines.

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MODULE 8: NATURE OF MATTER

UNIT 1: STATES AND TYPES OF MATTER

INTRODUCTION

In this unit, you will learn about the various types of matter, classification of matter into solids, liquids and gases and their characteristics at room temperature.

OBJECTIVES

By the end of this unit, you should be able to:

1. define matter;

2. classify matter into solids, liquids, and gases, given different types of matter

3. mention at least two characteristics common to solids, liquids and gases at room temperature; and

4. differentiate between solids, liquids and gases.

WHAT IS MATTER?

There are two characteristics common to all matter. These are:

i. matter has mass, that is, it has some quantity of material in it and;

ii. matter occupies space.

Based on .these two characteristics, we can thus define matter as anything that has mass and occupies space.

STATES OF MATTER

There are many hundreds of thousands of different objects called. matter around us. As you would imagine, it could be difficult to study them without first finding out some system for sorting out different kinds of matter and classifying similar ones together in groups. For the same reason, books in a library must be classified if you are to find the books you want without much waste of time. Thus, things are classified/grouped according to some qualities or attributes such as colour, size, shape and textures. A simple method of classifying matter is to use its physical property as an attribute. Using this method, matter may be separated into three major groups. These are:

(a) matter that is solid;

(b) matter that is liquid; and

(c) matter that is gas.

Each one of these large groups/divisions of matter is called a State of Matter. Matter is thus said to exist in three states: solid, liquid and gas. A stone and a book are examples of matter in a solid state. Water, ink and petrol are liquid matter, and air and steam represent matter, in gaseous state.

Physical Characteristics of Solids, Liquids and Gases at Room Temperature

One important feature of substances is that their characteristics varies according to temperature. Thus, it is necessary to specify the temperature when we are discussing the physical characteristics of any substance.

In this unit, we will discuss the physical characteristics of solids, liquids and gases at room temperature.

(a) Solids

When we hear the word solid, we tend to think that solids are hard and heavy. But this is not always true. Some solids are hard, some are soft, some are heavy and some are light. Think of piece of stone, eba or pounded yam, a piece of iron and a dry leaf. Stone is hard, *eba* is soft, iron is heavy and dry leaf is light and can even float on water, yet all of them are classified as solids.

What then is peculiar to all solids? Can you guess? You are right if you guess that solids have definite or fixed shapes and volume.

A solid stays where you put it and only external force is required to change its position. Similarly force is required to change the shape of a solid. In fact it is not easy to change the shape of a solid. Recall that difficult tasks like wood-word and metal-work, digging earth, and breaking rocks involve changing the shape of solids.

(b) Liquids

Liquids have definite volume but unlike solids have no definite shape. There is no problem in changing the shape of liquids.

Our experiment and other similar experiments confirm that the volume of liquids in a container is constant and infact cannot be changed but their shapes can easily be changed. They always take the shape of the container accommodating them.

(c) Gases

Gases have neither definite shape not volume. They take the shape of any container in which they are put, and always 'completely fill the container. For example, if you break a rotten egg at one end of your room, it would not take long before the bad odour emanating from a little quantity of gas from the egg fills the whole room. This explains why gases e.g. cooking gas, are always stored in sealed. containers. They always tend to fill any space available to them. This property is known as diffusion.

ASSIGNMENT

1. Define matter
2. Water, wood, palm oil, steam, maize, kerosene, air, stew, oil vapour, and gas are all matter. Sort them out into solids, liquids and cooking gases. Write your answer in tabular form.
3. Write down two characteristics common to solids, liquids and gases.
4. Write two characteristics that are peculiar to each state of matter.

SUMMARY

- Matter is anything that has mass and occupies space.
- Matter may be simply classified into three major groups namely solids, liquids and gases.

- Each one of these groups is called a State of Matter. Matter is thus said to exist in three states; solids, liquids and gases.
- Solids have definite shapes and volumes; liquids have definite volume but assume the shape of the container and a gas has no definite shape or definite volume but always tries to fill the available space.

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UNIT 2: PARTICLE THEORY OF MATTER

INTRODUCTION

There are 3 states of matter; that is, matter as a solid state, matter as a liquid state, and matter as a gaseous state. We have studied the physical characteristics of solids, liquids and gases at room temperature.

In this unit, we shall study what matter is made of. We shall use this knowledge to explain some, observed phenomena; for example why matter exists as solids, liquids and gases.

OBJECTIVES

By the end of this unit you should be able to:-

a) state the particulate theory of matter;

b) give at least one reason to support the particulate theory of matter; and

c) use the particulate theory of matter to explain the existence of matter in the form of solid, liquids and gases.

WHAT IS MATTER MADE OF?

In finding out what matter is made of, we shall adopt the scientific method. Looking at matter generally it may be reasonable to think that it is made up of tiny particles which when put together form a solid, liquid or gaseous matter. This idea or thinking is similar to small grains or particles of sugar joining together to form a cube of sugar. The conclusion therefore, is that matter may be made up of particles.

Activity 1

Put a crystal of potassium tetraoxomanganate (VII) (old name potassium permanganate) in a glass of water. Record what you observe. (Note that potassium tetraoxomanganate (VII) is a solid matter and water is a liquid matter).

How can you explain your observation?

A possible explanation is to assume that crystal of potassium tetraoxomanganate (VII) consists of tiny particles which can move freely to all parts of the water, and that water also consists of particles arranged in a such a way that there are spaces among them into which the particles can go. The movement of particles of the crystal is slow but eventually leads to a uniform colouring of water.

This experiment thus provides evidence that both potassium tetraoxomanganate (VII) which is a solid and water which is a liquid consists of very tiny particles.

THE PARTICULATES THEORY OF MATTER

A solid stays where it is put. It has a fixed shape and many solids are hard. We can explain this if we assume that the particles in solids are arranged very close to each other and cannot move very much. Since the particles cannot move very much, there must be something holding them together. This "something" we may call, for the time being, inter-particle force.

A liquid does not have a fixed shape and can flow. Particles of liquids are therefore more free to move about. They are not arranged or packed so closely as particles in a solid and the force holding them must be weaker than that in a solid.

A gas has no fixed shape and volume. A small volume of gas can fill a big volume within a short time. The particles thus move faster than those in a liquid and in all direction. The force holding the particles of a gas must therefore be very weak indeed.

Table 8.1: Arrangements of Particles in a Liquid, Solid and Gas.

Solid	**Liquid**	**Gas**

ASSIGNMENT

1. What is the difference between hypothesis and a theory?

2. State the Particulate theory of matter.

3. Account for the fact that water flows but a piece of stone stays where you put it.

SUMMARY

- Matter is made up of particles
- The idea that matter is made up of articles is known as the particulate theory of matter.
- Particles in a solid are packed close to each other and are held together by inter-particle

  force. The particles of a solid cannot move very much.
- Particles in a liquid are not packed so closely. The particles can move about because the force holding them is weak.
- The force holding the particles of a gas together is very weak, so the particles move about very easily and in all direction.

UNIT 3: CHANGE OF STATE. PHYSICAL AND CHEMICAL CHANGES

INTRODUCTION

Matter is made up of small tiny particles and the arrangements of these particles in solids, liquids and gases are different due to the difference in magnitude of forces holding them together.

In this unit, we are going to discuss in very general terms changes that take place in matter and attempt to classify these changes into physical and chemical changes.

OBJECTIVES

By the end of this unit you should be able to:

1. distinguish between a physical change and a chemical change;

2. give at least 3 examples each of physical and chemical changes; and

3. explain the changes in terms of theory of matter.

CHANGES OF STATE

In Unit 1 of this module, we learnt that matter can exist in three states: solid, liquid and gas. But suppose you are asked, can a solid change to liquid or gas? Can a gas change to liquid or solid? Can a liquid change to gas or solid? The activity that follows will help you to answer these questions.

Activity 2

Place some ice cubes in an empty kettle. Put the kettle on a burner or stove. Keep the flame of the burner low and remove the lid of the kettle. Now look into the kettle .What do you observe? Replace the lid on the kettle and continue heating until the water in the kettle boils. Look at the spout from the side. Between the spout and the steam, what do you see?

In this space is water vapour, that is, water in the form of a gas. (Do not try to touch the water vapour. It is very hot, and will give you a bad burn).

The steam. which begins to appear just in front of the water vapour, is made up of tiny droplets of water. How can you explain this? Upon leaving the spout, the water vapour came in contact with the cooler air, and the gas (water vapour) changed to liquid (water). If you want to prove that this explanation is correct, wrap a towel around the handle of a table-spoon and hold the bowl of the spoon in the water vapour (Be careful). You will notice that drops of water will collect on the spoon.

If you should put the water that collects on the spoon into the freezing compartment of a refrigerator, the water would turn to ice. Thus, you would have an example of matter in the liquid state turning to matter in the solid state.

Conclusion

What conclusion can we draw from Activity I? Our conclusion is that when heat is applied to ice block (solid) it becomes liquid (water) and when water is heated it becomes vapour (gas). When vapour is cooled it becomes liquid and then solid.

This kind of change is called change of state.

Note, however, that ice is not the only solid that changes its state. Many solids usually change to liquid form if sufficient heat is supplied to raise the temperature to a point where such change will take place. For example, iron becomes liquid when it is heated to 1,538° C. If the liquid iron is heated further, until the temperature reaches 2,982° C, the iron boils and becomes a gas. The temperature at which a solid will change to liquid state is called the melting point of the solid and the temperature at which a liquid changes to gas is called the boiling point of the liquid.

PHYSICAL CHANGES

Change of state is one in which a substance (matter) changes from one state (solid, liquid or gas) to another. This kind of change is called a physical change.

In a physical change, no new substance is formed. Only physical state changes and the change is usually easy to reserve. For example, water can be changed into steam by heating, while steam can be changed back to water again by cooling. Also there is no change in weight during physical change, e.g. 50g of water will become 50g of water vapour when boiled or 50g of ice when frozen. Except in the case of water (where we have different names for the different states ice, water, steam) we keep the same name for all three states, e.g. solid sulphur, liquid sulphur, and sulphur vapour, iron and iron vapour, thus showing that there is no change of substance.

Now let us try to answer the question, what really goes on when matter is changing state?

Effect of Heat on Physical States of Matter

Heat is a form of energy. When a solid is heated the particles gain energy. This energy increase the vibration of the particles and weakens the force of attraction between them. If heating is continued, the vibration becomes so great that the particles of the solid which are closely packed together begin to separate. The particles now move about and loose their closely packed arrangement. Now they obtain some freedom for themselves and turn into a liquid. At this point we say that a solid has melted. The temperature at which a solid turns into a liquid is called the melting point of the solid.

If heating is continued, the particles of the liquid will acquire more energy. This will further reduce the attractive forces between them and they will move faster. As time goes on some .particles would have enough energy to escape from the liquid altogether and form a gas. Eventually, when enough heat energy has been supplied, a temperature is reached when large numbers of particles can escape from the liquid. This temperature is called the boiling point of the liquid, the point at which liquid turns to gas.

Cooling Effect

When a substance is cooled energy is removed from the particles and they move slowly. Gas becomes liquid and liquid becomes solid.

If a gas is cooled enough the movement of its particles will slow down, the attractive forces, between them will increase and the particles will come together to form a liquid. At this stage, we say that the gas has condensed.

If a liquid is cooled, the particles slow down and stop moving about haphazardly. Their attractive force will increase and they form the regular pattern of solid structure. When this happens, we say the liquid freezes.

Sublimation

Some solids d o not melt when they are heated, but turn straight from solid to vapour (gas). On cooling they turn directly to solid. This process is known as sublimation.

Sublimation is a process in which a solid turns directly to gas when heated without passing through the liquid stage, and on cooling turns directly back to solid. Examples of substances which sublime are ammonium chloride and iodine.

CHEMICALCHANGES

Apart from physical changes, matter also undergoes chemical changes. The next activity will help you to understand what a chemical change is.

Put bout 15cm of magnesium ribbon in a clean porcelain crucible with a lid. Weigh the crucible with its lid and the magnesium, Record the weight.

Put the closed crucible on a fife-clay triangle and heat it with a clean, non-luminous flame, gently at first and then strongly. After heating strongly for at least five minutes, lift the crucible lid with crucible-tongs, very cautiously, so as to let in a little more air, but take great care that no ash escapes. When you see no more bright flashes of light inside the crucible, remove the lid altogether, and heat the crucible as strongly as possible, After you can see no further change, let the crucible and its contents cool.

Replace the lid, and weigh the crucible and the lid and the magnesium ash. Record your results below.

Weight of crucible + lid + magnesium (Xg)

Weight of crucible + lid + magnesium ash (Yg)

From your result, you will notice that Yg is greater than Xg. This shows that magnesium ash weights more than unbumt magnesium. Also note that magnesium ash is clearly an entirely new substance. It is not possible to get back 'metallic magnesium from the ash. Similarly, if you burn a piece of paper, the paper turns into ash and it is not possible to get back the original paper from its ash. Such changes described above are called chemical changes.

A chemical change is one in which new substance(s) is/are formed, with entirely different properties. Generally chemical change can be made to take place by mixing substances together, heating or burning substances and passing electric current through substances. Different types of chemical changes and methods of effecting them will be discussed in detail in subsequent units.

ASSIGNMENT

1. Which of the following is not a physical change?

a) Some candle wax was put in a test tube and then heated..The candle wax melted and formed a liquid.

b) Some common salt was put in a beaker of water and stirred. After a short time, the salt dissolved and formed salt solution.

c) A piece of dry leaf was put on fire. After a short time, the leaf was burnt to ashes.

d) A cold plate is held over boiling water. After some time drops of water fanned on the under -surface of the plate.

e) A piece of red chalk was put in a mortar and ground to pieces.

2. If you put some iodine in a test tube and heat it with a low flame, you will observe one of the following:

a) The iodine turns into a liquid.

b) The iodine begins to boil

c) The iodine turns into vapour.

d) The iodine melts.

e) The iodine remains unchanged.

SUMMARY

- Heat is a form of energy. Matter changes state when it is supplied with energy or when it loses energy.
- When heat is applied to ice block (solid) it becomes liquid (water) and when water is heated it becomes vapour (gas).
- When vapour is cooled it becomes liquid and then solid.
- This kind of change is called change of state.
- Note that ice is not the only solid that changes in state. Many solids usually changes to liquid form if sufficient heat is supplied to raise the temperature where such change will take place. A physical change is one in which no new substances are formed.
- Change of state is possible because of the rearrangements of particles in matter due to the effect of heat.
- A chemical change is one in which new substances are formed, with entirely different properties.

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UNIT 4: USING KINETIC THEORY TO EXPLAIN CHANGE OF STATE OF MATTER

INTRODUCTION

We understand from the previous units that all matter contains very tiny particles (atoms, molecules, ions). All particles of matter have energy. This energy causes the particles to move. This ideal (theory) of energy and movement is called the kinetic theory. Energy which causes movement is called kinetic energy. The word kinetic comes from the Greek work kineo which means I move.

OBJECTIVES

By the end of this unit, you should be able to:

- State the kinetic theory of matter;
- Explain changes of state using the kinetic theory; and
- derive the ideal Gas laws.

The Behaviour of Gases

One of the aims of scientists is to understand the bulk properties of the three states of matter (solid, liquid and gas) in terms of their constituent's atoms or molecules. In this respect, gases are the easiest to study.

The gaseous state is the simplest of the 3-fundamental states in the liquid or solid state in that it possesses no intrinsic volume, which means that, theoretically, it fully occupies any enclosed space into which it is introduced. This and other properties peculiar to the gaseous state known as the kinetic theory of gases. When we are talking of a 'gas' we are usually discussing an ideal gas whose behaviour is perfectly predicted by the various laws. All 'real gas' whether they be elemental e.g. helium or chlorine or compound e.g. Carbon-dioxide or ammoma differ to some extent from the imaginary ideal gas but it is much more convenient to define the properties of an ideal gas and note particular deviations from this identity than to attempt an individual examination of the behavior of every known gas as though these had no properties in common.

The properties and behavior of an ideal gas can be explained in terms of the kinetic theory.

The Kinetic Theory of Matter

The idea that matter (i.e. solid, liquid, and gas) is made of moving particles is called the kinetic theory. (The word "kinetic comes from the Greek word Greek work kineo which means I move. The main point of the theory are as follows.

1. All matter is made up of tiny, invisible; moving particles.
2. Particles of different substances have different sizes
3. Small particles move faster than heavier ones at a given temperature.
4. In a solid, the particles are relatively very close together, they can only vibrate about fixed position in the solid crystals. They have smaller amount of energy than the same particles in the liquid and gaseous states at higher temperatures. Consequently, solid particles cannot overcome the strong forces of attraction holding them together so, particles in a solid have vibrational and rotational motion but no translational motion.
5. In a liquid, the [articles are a little further apart than in solid and have larger amount of energy. Thus, they are able to overcome the force between each other to some extent. They can move freely around each other whilst in close proximity. The liquid particles have vibrational and translational motion.

6. In gases the particles are much more widely separated than those in solids and liquids and have much larger amount of energy. The gas particles have sufficient energy to overcome the forces of attraction between each other almost completely. They move rapidly, randously or haphazardly into any space available. According to the kinetic theory, an ideal gas can be imagined to consist of a collection of point mass particles in random motion.
7. An increase in temperature causes an increase in the average kinetic energy of particles (i.e. the particles mover faster). The kinetic energy is manifested as vibrational rotational and translational energy in gases and liquids and as vibrational and rotational energy in solids.

Comparing Solid and Liquid and Gases

	Solid	**Liquids**	**Gases**
Volume	Definite (Fixed)	Definite (Fixed)	Takes the volume of their container
Shape	Definite (Fixed)	Take the shape of their container but do not necessarily occupy all of it	Occupy the whole of the container.
Relative Compressibilty	Nil	Almost Nil	Large
Relative density	Large	Large	Small

Activity 3

(i) State the similarities between solids and liquids.

(ii) State the differences between solids and gases

By virtue of the random, independent motion of its molecules, when a gas of a certain density is introduced into a larger space than that which it formerly occupied at the same temperature the molecules redistribute themselves in such a way that each has maximum freedom of movement. The gas then fully occupied the new volume, with a corresponding decrease in its density. This tendency for gaseous molecules to move from a zone of high density to another of lower density, and so achieve a mean equilibrium density is expected in the force of diffusion. It follows that constraint must be placed upon a gas to increase its density – the force of compression.

The effect on a gas of changes in its temperature may also be interpreted in terms of the kinetic theory. Input of heat increases the kinetic energy of the molecoles, enhances their tendency to move even further apart from one another and thus provokes expansion of the gas at constant pressure is for the gas to contract. In a sense, therefore, increasing the pressure and lowering the temperature tend towards the same end.- namely decrease in the volume of the gas.

It follows that the condition of an ideal gas is affected by three (3) – interdependent variables (i) volume (ii) pressure (iii) temperature. Examination of the effect of changes of pressure and/or temperature on the volume of a given mass of ideal gas has resulted in the establishment of certain fixed relations between these factors that are known as Ideal Gas Laws. For the most part; these laws bear the names of their proponent.

The gas laws mathematically relate the temperatures, pressure and volumes of gases their corrected application depends on using the correct units.

Pressure

The first assumption of the kinetic theory allows us to explain why a gas exerts a pressure. This pressure results from the constant bombardment of the walls of a container by the millions of molecules in a gas. The effect is similar to the bombardment by the millions of particles of sand in a sandstorm. Their motion is random and the number of collisions will be the same on all the surface of a container this explain why gas pressure is the came in all directions.

Units of Pressure

Pressure can be measured in atmosphere (atm) or mmHg. More recently the unit has been the Pascal (pa) which is calculated as Newton per square metre (Nm^{-2}) units are related as follows: latmosphere = 760mmHg = 101325$Nm^{-.2}$

Units of Temperature

There are two side of temperature in science. The absolute of temperature was proposed by lord Kelvin 1848. The unit of this scale the Kelvin (k) is named after him. In any absolute scale of measurement only positive values are permitted. Zero on the absolute scale of measurement indicates the complete absence of the quantity been measure. Thus ok is called absolute zero.

The scale of temperature is not absolute since negative values are possible. The SI unit of temperature is the Kelvin. It should always be used for calculation involving temperature. Note that the unit does not have the degree symbol, o.

Temperature can be converted from the Celsius scale to the absolute scale by adding (273)

Convert 10^oC to Kevin

and -100^oC to kevin.

$0^oc = (0 + 273) = 273k.$

$10^oc = (10 + 273)\ k = 383k$

$-100^oc = (-100 + 273)\ k = 173k$

Units of Volume

The SI units of volume are cubic metre(m^3) or cm ^{3}or dm^3

One liter (l) equals $1dm^3$

Note that:

$1m^3 = 1x\ 10^3dm^3 = 1000dm^3$

$1dm^3 = 1\ x\ 10^3cm^3 = 1000cm^3$

Standard Temperature and Pressures

Gas volumes varies with temperature and pressure; thus when comparing volumes of gases the temperature and pressure must be specified. It is usual to quote gas volumes and other physical properties under conditions of standard temperature and pressure. By convention, standard temperature and pressure is 273k (0^oC) and standard pressure (101,325 pa i.e. latin or 760mmHg)

The most recent standard pressure 100 kpa.

Activity 4

1. Using the kinetic theory of gases, explain why gases can easily be compressed.
2. Describe the effect of increasing the temperature of a volume of gas at constant pressure.
3. What happens when temperature of a volume of gas is decreased at constant pressure?

THE IDEAL GAS LAWS

If you put your finger over the end of a bicycle pump and the push the handle in, you compress some air. You have reduced the volume of the air, but its pressure has increase.

In 1662, Boyle found out relationship between pressure and volumes for a fixed mass of gas. Boyle's law states that at constant temperature, the volumes of given mass of gas are inversely proportional to the pressure exerted upon it. In other words, if the pressure is doubled, the volume of gas is reduced to half its original volume; and if the pressure is half its former volume, then the volume is doubled. This means that an isothermal increase of pressure will proportionally decrease the volume of a quantity of gas and vice-versa.

This may be expressed mathematically as

$$V \propto \frac{I}{P}$$

$$V = \frac{K}{P} \quad \text{or } PV = K$$

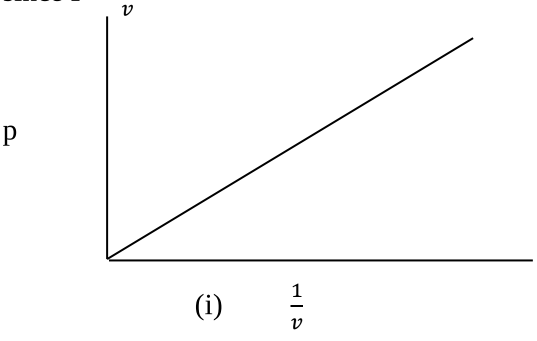
Where V = Volume

P = Pressure

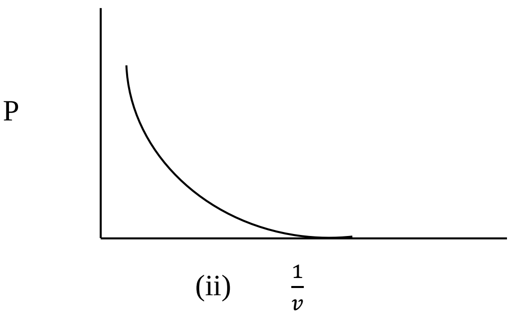
K = Constant

Inversely proportional is a mathematical expression meaning that the volume will decrease as the pressure increases. In terms of kinetic theory, if the volume of a fixed mass of gas is decreased, particles of gas will have less space to move in and will hit the walls of the container more often thereby increasing the pressure.

If a graph of pressure (P) against $\frac{1}{volume}\left[\frac{1}{v}\right]$ is plotted, this will give a straight line through the origin since P $\propto \frac{1}{v}$



(i)



(ii)

Calculation Involving Boyle's Law

Boyle's Law can be written as $PV = constant$. This means that if a given mass of gas at a constant temperature has volume V_1at pressure $P1$ and volume V_2 at pressure P_2, then

$$P_1V_1 = P_2V_2 = \text{constant}$$

In Boyle's Law, calculation of any one of the units of pressure may be used provided P_1 and P_2 have the same units.

Thus, when a gas is allowed to expand (or is compressed) at constant temperature from an initial volume of V_1 to a final volume of V_2, the final pressure P_2 can be calculated in as long as the initial pressure P_1 is known.

Worked Example

At a pressure of 3atmosphere, a given mass of gas has a volume of 300cm^3. What volume would it occupy at a pressure of 1atmosphere (atm) the temperature being constant?

$P_1 = 3atm \qquad V_1 = 300cm^3$

$P_2 = 1atm \qquad V_2 = ?$

By Boyle's law, $P_1V_1 = P_2V_2$

$V_2 = 3 \text{ x } 300\text{cm}^3$

$V_2 = 900\text{cm}^3$

Charles' Law

Charles' Law is in fact based on observation made by GAY-LUSSAC and CHARLES. Gay-Lussac found that gasses expand or contract by $\frac{1}{273}$ of their volume at 0^{o}C for every 1^{0}C that the temperature is raised or lowered respectively. If the temperature is lowered by 273^{0}C then the volume will theoretically be zero (i.e. the molecules will be completely at rest). And so -273^{0}C is known as absolute zero or 0K (Kelvin). 0^{o}C is therefore 273K.

Volume-temperature relationship of gases were also studied by Charles' and he observed that a number of gases had the same volume coefficient of thermal expansion. Combination of Charles and Gay-Lussacs finding gives Charles' Law.

The volume of a fixed mass of gas is directly proportional to the absolute temperature provided that the pressure is kept constant.

A given mass of gas will increase in volume by approximately $\frac{1}{273}$ of its volume at 0^{o}C for every 1^{0}C rise in its temperature and vice-versa.

The mathematical expression is $V \propto T$ or $\frac{1}{273}$ = constant

Where V = volume and T = absolute temperature

If a gas has a volume V_1 at a temperature T_1 and the temperature is changed to T_2 the new volume V_2 at constant pressure is given by the equal $\frac{V1}{T1} = \frac{V2}{T2}$

$V_2 = V_1 \times \frac{T2}{T1}$

Worked example

A gas evolved during the fermentative growth of a bacterial culture had a volume of $580cm^3$; when measured at a laboratory temperature of 17^0C. What was the volume of this gas at growth of 37^oC? Assume that the gas volume were measured at constant pressure.

$T_1 = 17^0C = (17 + 273) = 290K$ $\quad$ $T_2 = 37^0C = (37 + 273) = 310K$

$V_1 = 580cm^3$ $\quad$ $V_2 = ?$

By Gay-Lussac's Law; $\frac{V}{T}$ = constant

$\therefore \frac{V1}{T1} = \frac{V2}{T2}$ and $\frac{580}{290} = \frac{V2}{310}$

Or $V_2 = \frac{580 \ x \ 310}{290}$

$= 620cm^3$

$\therefore$ The fermentative gas would have occupied a volume of $620cm^3$ at 37^0C

The General Gas Law

The Boyles' and Charles' Laws can be combined to yield an expression which predicts the volume change that results from changed in the temperature and pressure of a given mass of ideal gas namely $\frac{PV}{T}$ = constant. This equation is called an equation of state, it describes the relation between the pressure, volume and temperature of a given mass of an ideal gas under different conditions

Boyle's Law = $P_1V_1 = P_2V_2$

Charles' Law = $\frac{V1}{T1} = \frac{V2}{T2}$

Combined to give an expression $\frac{P1V1}{T1} = \frac{P2V2}{T2}$

This equation is called the general gas law and sometimes the combined gas law. This law enables the volume of a to be calculated at a specific temperature as pressure so long as the volume of the gas is known at another temperature and pressure.

Worked examples

1. A certain mass of gas occupies $211cm^3$ at 18^0C and 740mmHg pressure. What volume will it occupy (still gaseous) at -20^0C and 770mmHg pressure.

$\frac{P1V1}{T1} = \frac{P2V2}{T2}$

P_1 = 760mmHg P_2 = 770mmHg

V_1 = 211cm^3 V_2 = ?

$T_1 = 18^0C = (18 + 273) = 291$ $T_2 = -20^0C = (-20 + 273) = 253K$

$V_2 = \frac{P1 \; X \; V1 \; X \; T2}{P2 \; X \; T1}$

$= \frac{740 \; X \; 211 \; X \; 253}{770 \; X \; 291}$

= 176cm^3

2. A certain mass of gas occupies 146cm^3 at 18^{0}C and 738mmHg. Calculate its volume at STP (STP = 0^{O}C (273K) and 760mmHg (1atm)

$\frac{P1V1}{T1} = \frac{P2V2}{T2}$

P_1 = 738mmHg P_2 = 760mmHg

V_1 = 146cm^3 V_2 = ?

$T_1 = 18^0C = (18 + 273) = 291K$ $T_2 = 0^0C = (0 + 273) = 273K$

$V_2 = \frac{P1 \; X \; V1 \; X \; T2}{P2 \; X \; T1}$

$= \frac{738 \; X \; 146 \; X \; 273}{760 \; X \; 291}$

= 133cm^3

ASSIGNMENT

Calculate the final volume of the following gases.

Initial Volume	Initial temperature & pressure	Final temperature and pressure
(a) 273cm^3	0^{0}C and 760mmHg	14^{0}C and 861mmHg
(b) 1638cm^3	0^{0}C and 819mmHg	15^{0}C and 864mmHg
(c) 760cm^3	27^{0}C and 700mmHg	STP

Summary

In this unit, we learnt that

- the three states of matter solid, liquid and gas; the gaseous state is simplest to study because gases have no intrinsic volume i.e. it can occupies any enclosed space into which it is introduced.

- the behaviours of gases can be explained using the kinetic theory of gases.

- the condition of an ideal gas is affected by three interdependent variable – volume temperature, pressure and the examination of these.

- variables on a given mass of ideal gas results to establishing fixed relations known as the ideal gas laws – for example Boyle's law, Charles's law, etc.

UNIT 5: ELEMENT, ATOMS AND MOLECULES, CHEMICAL SYMBOLS, FORMULAE AND SIMPLE EQUATIONS

INTRODUCTION

We had earlier learnt that matter is made up of particles. These particles could be atoms, ions or molecules. In' this unit you will study some of the particles, their symbols, formulate and chemical equations representing interactions between them.

OBJECTIVES

By the end of this unit you should be able to:

1. distinguish between elements, atoms and molecules;

2. write correct symbols of common elements;

3. write correct formulae of compounds; and

4. write simple balanced equations.

ELEMENTS

Particles which matter is composed of are organised into simple substances or units called **elements**. Copper, magnesium, oxygen, hydrogen, carbon, iron, lead, gold, silver to mention but a few are examples of elements.

Everything you know is made tip of an element or combination of elements. For example, Water can be broken into the elements hydrogen and oxygen. Common salt is made up of two elements sodium and chlorine; and sand can be broken into three elements. If you weigh 100kg, for example; your body is made up of roughly 65kg of oxygen, 18kg of carbon, 10kg of hydrogen, 3kg of nitrogen, 2kg of calcium, 1kg of phosphorus. The remaining kilograms consist of iron, zinc, potassium, sodium, chlorine, fluorine, bromine, iodine, magnisium, manganese, copper, chromium, titanium. arsenic, cobalt, silicon, lithium, aluminium, tin, and barium. Altogether, your body has 33 elements.

An element is a substance made up of identical particles (atoms).It is impossible to breakdown an. element into simpler substances by any chemical change. By definition, an element is a substance which cannot be split up into simpler substances by chemical means.

All the 103 elements are grouped in the periodic table (see fig.4.1)

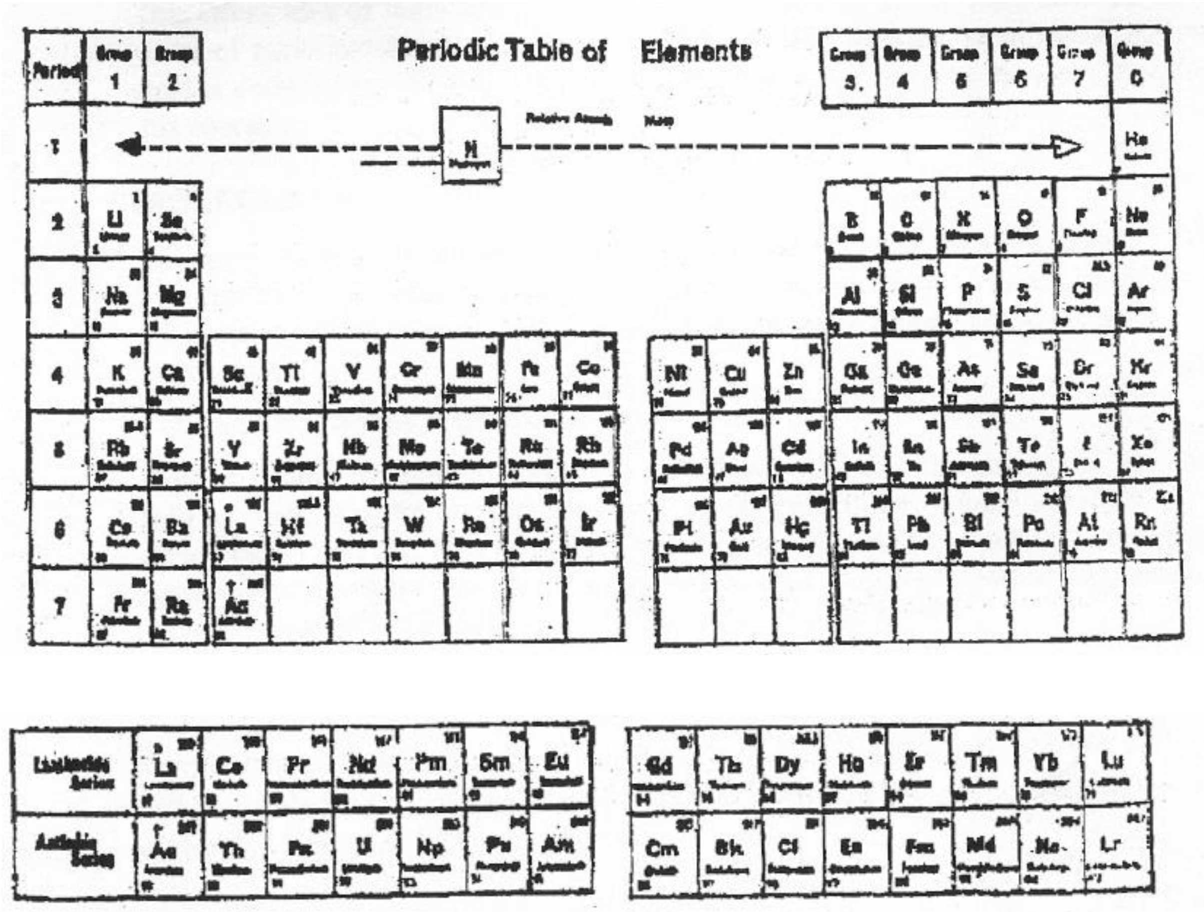


Fig. 8.1: The Periodic Table of the Elements

A periodic table is a chart in which all known elements are arranged in an ascending order of relative atomic mass/atomic numbers.

The vertica1 columns of the periodic table are called groups. All elements in the same group have similar chemical properties. The horizontal columns are caned periods. Elements in the same period show a gradual change from metals, on the left of the table, to non-metals on the right of the table.

ATOMS

Atoms are the smallest particles making up elements. Atoms of the same element behave in the same way. Atoms of one element are different from atoms of other elements.

The idea that atoms are the smallest particles of elements was first put forward by Greek and Roman thinkers. They said that if we were to take a piece of say, gold and cut it up into small pieces, and cut these pieces into smaller pieces, and so on a time would ultimately come when the dividing process would have to stop. The tiny particles of gold which we had then obtained would be incapable of being divided any further; they would be the smallest possible particles of gold which could ever be obtained. The Greeks gave them the Dame "atoms". If the Greeks had been English man they might have called these particles indivisible" for the word "atom" meant to the Greek what "indivisible' 'meant to the Englishman.

This Greek idea of indivisibility of an atom was held for a very long time. However, after many years of experimentation, scientists have discovered that the atom could still be broken into smaller components. You will study these smaller components of the atom in subsequent units of this course.

MOLECULES

You have learned that an atom is the smallest unit of an element. These atoms sometimes exist by themselves, without connection to other atoms, but in most cases atoms form groups with other atoms. There may be only 2 or more atoms in the group. These groups of atoms are called **molecules.**

The number of atoms in a molecule is called **atomicity.**

How do atoms combine to form molecules? We all know that a magnet will attract a piece of iron or steel, and the two magnets will attract each other. Atoms act like tiny magnets. They attract each other and join together. The oxygen of the air for example is made up of molecules. Each molecule of oxygen is made up of 2 atoms of oxygen joined together. Substances like oxygen made from the same kind of atom are called **elements.**

COMPOUNDS

Compounds are molecules made from atoms that are not identical. Water is a **compound**. The atoms in the molecules of water consists of two atoms of hydrogen and one atom of oxygen. This is given by the formula H_2O

Similarly, chalk is a compound. Each molecule of chalk consists of one atom of calcium, one atom of carbon and three atoms of oxygen. This is given by the formula CaCO3. You will learn shortly how to write formulae.

CHEMICAL SYMBOLS, FORMULAE AND SIMPLE EQUATIONS CHEMICAL SYMBOLS

Symbols:

Please refer to the Periodic Table of the elements in fig. 4.1. Above the name of each element in the Periodic table, you will see one or two letters. For instance, above calcium are the letters Ca. These letters are an abbreviation of the name of the element. Scientists find out that using these abbreviations is easier than writing out the whole name of the element. Scientists call the abbreviation chemical symbols.

Some abbreviations are simply the first letter, or the first two letters of the elements in for example iodine (I) or nickel (Ni). Other abbreviations are composed of the first letter and one other letter in the elements' name; for example chlorine (Cl) or platinum (Pt). These are easy to understand but you may have noticed some abbreviations that are not made up of the letters in the elements name; for example gold (Au). Why is this so? Because the latin name of gold is Aurum. Here is a list of those elements whose abbreviations are derived from latinized names:

English Name	**Latin Name**	**Abbreviations**
Gold	Aurun	Au
Silver	Argentums	Ag
Copper	Cuprum	Cu
Iron	Ferrum	Fe
Lead	Plumbum	Pb
Tin	Stannum	Sn
Mercury	Hydrargyrum	Hg
Antimony	Stibnium	Sb
Potassium	Kalium	K
Sodium	Natrium	N

Table4.1: Showing Chemical Symbols

There is one other element whose abbreviation may puzzle you. It is tungsten, whose abbreviations *W*. This is so because the proper name of tungsten is *Wolfram*, but it is a matter of custom in English speaking countries to call this element tungsten.

CHEMICALFORMULAE

(a) Molecules of Elements

Each molecule of an element is made up of a define number of atoms. The number of atoms in a molecule of an element is called its atomicity. Elements could be monoatomic, diatomic or triatomic. For example potassium, sodium, calcium, sulphur, etc. are monoatomic, hydrogen, oxygen, nitrogen, chlorine etc are diatomic and ozone is triatomic. From the above, we can say that the simplest particles present in potassium metal are molecules of potassium each consisting of only one atom where as the simplest particles present in hydrogen gas are molecules of hydrogen each consisting of a pair of atoms linked together.

(b) Combining Powers

Molecules of compounds are formed by the combinations of atoms of different elements in small whole numbers. The whole number ratio in which the atoms of different elements combine to form molecules of compounds is referred to as the combining power or valency of the elements. The valencies of some common elements are listed in Table 8.3. Note that some elements have more than one valency.

Valencies	1	2	3	4	5	6
Non-metals	H Cl	O, S	N	C, S	N, P	S
Metals	Na, K, Cu	Ca, Mg. Cu Zn, Fe, Pb	AI, Fe,	Pb		

Table 4.2: Valencies of some common Elements

(c) Writing Simple Formulae

To write the correct formulae of a compound, write the symbols of the elements that make up the compound. Under each symbol write the valency of the element. Then note that the elements will combine in the inverse ratio of their valencies (a kind of exchange of valencies) thus-

Water	Symbols	H 0
	Valencies	1, 2
Calcium chloride	Symbols	H_2O
	Valencies	Ca, Cl
Iron (III) oxides	Symbols	Fe, O

	Valencies	3, 2
	Formula	Fe_2O_3
Magnesium oxide	Symbols	Mg, 0
	Valencies	2, 2
	Formula	MgO

ASSIGNMENT

Define the term elements, atoms and molecules

An element Y has a valency of 3 and forms compounds with ammonium, tetraoxosulphate (IV) and chloride radicals. Write down the chemical formulae of each compound formed

Lead (II) trioxonitrate.(V) on heating decomposes to form lead (II) oxide, nitrogen(IV) oxide and oxygen. Write a balanced equation for the reaction.

SUMMARY

- A radical is a group of atoms behaving as an ion.
- Chemical equations are shorthands for chemicals reactions. They involve only symbols and formulae.

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UNIT 6: CHEMICAL COMBINATION (BONDING)

INTRODUCTION:

One of the main ideas of Dalton's Atomic Theory if the formation of "compound atoms" by different atoms. Today, we call these compound atoms "molecule".

A molecule is a well defined collection of atoms that are attracted to each other such that the whole molecule may be thought of as a single unit. The attractive interaction between two atoms is called a chemical bond. In order for a compound to be formed between two atoms, there must be a net decrease in the energy of the system. This lower energy state must result in each atom of the compound having net energy lower than their unreacted constituent atoms. Thus, such bondage atoms have the electronic configuration of the noble gas nearest to them. This unit describes this process known as bonding.

OBJECTIVES

By the end of this unit, you should be able to:

- Name at least four types of bonding;
- Illustrate how ionic and covalent compound are formed using electron dot symbols; and
- List four differentiating properties of covalent and electrovalent compound.

ELECTROVALENT BONDING

This type of bonding is also called ionic bonding. It occurs between electronegative and electropositive atoms. Metal atoms generally donate electro while non-metallic atoms generally accept electrons. In electrovalent bonding, there is a complete transfer of electron(s) from a metal to non-metal atom. When an atom donates an electron, the atom becomes positively charged. When an atom gains an electron the atom becomes negatively charged. A charged atom is an ion. Since electrons are lost and gained in an electrovalent bond, electrovalent compounds contain ions hence they are called ionic compounds.

The ions in an electrovalent compound are oppositely charged. Because of this, there is a strong attraction between the ions. This attraction is called electrostatic force. This strong force explains why ionic compounds have high melting and boiling points.

HOW ARE ELECTROVALENT COMPOUNDS FORMED?

The bond is formed when one atom completely one or more electrons from another atom. This process leaves each atom with the electronic configuration of a noble gas. As you know noble gases are stable and the ions in an electrovalent compound are stable.

In a chemical bonding, only the electrons in the outermost shell of the atoms are normally used for bonding. Let us now consider some examples of ionic bonding sodium chloride NaCl

$_{11}Na, 2, 8, 1 \quad ; \ _{17}Cl, 2, 8, 7$

From the configurations given above sodium can easily have the noble gas structure of 2,8 by donating its outermost electron. Similarly chlorine can easily have the noble gas structure of 2, 8, 8 by accepting one electron from sodium. We can represent this process by electro dot symbols involving only the outermost electrons.

ACTIVITY 5

Let us consider another example of electrovalent bonding using $CaCl_2$, calcium chloride.

$_{20}C$; *2, 8, 8, 2* $_{17}Cl$ *2, 8, 7*

1. How can calcium have the noble gas structure of *2, 8, 8?*
2. How can chlorine have the noble gas structure of *2,8,8?*
3. How many electrons must one chlorine atom accept to achieve this?
4. Since calcium must lose two electrons to have a nobles gas structure and since a chlorine atom can only accept one electron, how many chlorine atoms are required to combine with one-calcium atom?

PROPERTIES OF ELECTROVALENT COMPOUNDS

From the discussion above we can summarize the properties of electrovalent compounds as follows. They:

1. contain ions bonded together by strong electrostatic force;
2. conduct electricity in aqueous solutions or molten state;
3. have high melting and boiling points that is they are not easily vaporized, and
4. are crystalline solids soluble in water of ionic solvents.

COVALENT BONDING

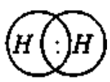
A covalent bond is formed between two atoms by sharing a pair of electrons contributed by each atom. This means that one atom contributes an electron to a common pool and the other atom contributes another electron to the pool. The sharing is done in such a way that at any given time each atom has a duplet or an octect structure of a noble gas nearest to it. The atoms take turns in sharing the pooled electrons.

Let us consider some simple examples

Hydrogen molecule H_2

$_{1}H;1$

A molecule of hydrogen contains two atoms of hydrogen. Each atom has only one electron. To have two electrons in its outermost shell each-hydrogen atom must receive or share one more electron. This is how hydrogen atoms share electrons.

H + H ⟶  or H - H

A shared pair of electrons is represented by a dash (-) This arrangement leaves each hydrogen with a duplet structure through sharing. The electrons are not completely transferred from one atom to the other and so no ions are formed. The compound formed contain just molecules. Covalent compounds contain molecules and these molecules are held together by a weak force called van der waals forces discovered in London many year ago.

ACTIVITY 6

Study the electronic configuration below.

$_1H;1$

$_8O;2,6$

$_7N;2,5$

$_6C;2,4$

1. Given that the above elements combine with each other covalently state how
   a) many hydrogen atoms will be required by oxygen to form an octet:
   b) can hydrogen have a duplet structure if combined with oxygen.
2. Draw the electron dot formulae for the following molecules
   a) water (H_2O)
   b) Methane (CH_4)
   c) carbon(lV) Oxide (CO_2)
   d) Ammonia (NH_3)
   e) ethyne(C_2H_2)
3. a. Using a dash(-) to represent a bond, name those molecules is (2) above

   b. that have multiple i.e. triple or double bonds. How many of them have lone pair of electrons?

DATIVE BONDING

A dative or coordinate covalent bond is formed between two atoms by sharing a part of electrons contributed solely by one of the atoms. Only atoms with lone pair of electrons can be involved in dative bonding. Such atoms include nitrogen oxygen and sulphur. Let us illustrate dative bonding using the reaction between hydrogen ion and ammonia to form ammonium ion (NH^+_4).

The hydrogen ion is a proton. It has lost its electron. Ammonia has a lone pair of electron which it donate and shares with hydrogen ion. The product now carries a positive charge since the particles added (H+) is positively charged.

ACTIVITY 7

Show the electron dot diagram for the hydroxonium ion (H_3O^+)

PROPERTIES OF COVALENT COMPOUND

From the above discussions we can summarize the properties of covalent compounds as follows:

They;

1. contain molecules held together by weak van der Waals force;
2. are generally insoluble in water but soluble in organic solvents e.g alcohol;
3. have low melting and boiling points;
4. are non electrolytes. The solids are insulators.

HYDROGEN BONDING

You saw earlier that hydrogen atom has only one electron or valency number of one. It can share an electron pair in forming a covalent bond or it can gain an electron and form the hydride ion H^-

When covalently bonded to highly electronegative element such as fluorine, oxygen and nitrogen, the hydrogen atom carries a relatively high partial charge. Because it has an extremely small nucleus (a proton only) it can closely approach a second atom with partial negative charge. The closeness of approach allows the formation of a weak covalent bond known as hydrogen bond.

The usual notation for a hydrogen bond indicating one normal covalent bond and one electrostatic interaction between hydrogen and a negative dipole. The most common hydrogen bonded systems are *F-H...F, O-H…O, and N-H…N.* They are involved in many organic acids, alcohols and amines (proteins). Hydrogen bonding is responsible for abnormal high boiling points in some organic liquids and it also explains why sugar, a covalent compound, dissolves in water.

METALLIC BOND

A full discussion of this type of bonding is beyond the scope of this unit. Suffice it to say that the bond with metallic elements is called metallic bond. It simply is an arrangement of metal ions surrounded by sufficient number of mobile electrons to neutralize the charge on the ions. In a bond of a metal no atoms are present, there are only ions surrounded by delocalized electrons. Because the electrons are mobile metals can conduct electricity. Because of strong electromagnetic forces between the ions and the electrons metals have high melting points,

ASSIGNMENT

1. Draw the electronic dot formulae for the following,
   a) $SO^{2-}{}_4$
   b) NaH
   c) $MgCl_2$
   d) Ca_3P_2

e) N_2

2. Tabulate the difference between covalent and ionic compounds.
3. (a) Name two systems that show high degree of hydrogen bonding

   (b) Cite some properties that hydrogen bonding have been used to explain.

   Give specific examples.
4. Explain the following terms with suitable illustrations

a) lone pair of electrons

b) electrostatic attraction

c) van der waals force

d) Octet

SUMMARY

In this unit you learnt the following

- The union between two atoms is called a bond
- There are five main bond types: electrovalent, covalent, dative, hydrogen and metallic bonds.
- In electrovalency electrons are transferred completely from an electropositive element to an electronegative element. As a result ions are formed in electrovalent bonding.
- In covalency electrons are shared by bonded atoms and so covalent compounds contain only molecules.
- Hydrogen bonding occurs when hydrogen is bonded to highly electronegative element. Because of the withdrawal of shared electrons to the highly electronegative element a partial positive charge is created on the hydrogen atom. This enables it' to attract another electronegative atom. This weak attraction between hydrogen and the electronegative, element is called hydrogen bond.
- The properties of compounds are related to the types of bonds in them

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UNIT 7: ACIDS BASE REACTIONS

INTRODUCTION

Air and water are regarded as the commonest chemical substances in the world. There are also other chemical substances which are not just common but are necessary in our everyday life in the home, laboratory, on the farm and in the industry. These are the acids, buei and salts. Many of our fruits contain acids in their juice. Lime which is used in agriculture to reduce soil acidity is a base. We also use kitchen salt in our food. In this unit, we shall be treating this class of chemical substances.

OBJECTIVES

By the end of this unit, you should be able to:

1. define acid, base and salt;
2. State the properties of acids, bases and salts;
3. carry out simple tests for acids and bases;
4. prepare some simple salts;
5. list the types of salts; and
6. list the importance of acids, bases and salts

WORK STUDY

Indicators: are usually weak organics acids or bases which identity a chemical compound as an acid or a base.

ACIDS

ACTIVITY 8

1. Taste the juice of each of the following fruits: an unripe orange, lemon and line.
2. Also taste the following: vinegar, stale liquid, milk palm wine that is about two days stale.
3. Test all the above with litmus paper.

All the above liquids have sour taste and they turn blue litmus paper to red. They all contain acid

Acids can be classified into two based on their sources -the organic acids and the mineral or inorganic acids.

ORGANIC ACIDS

The organic acids are found in plants or animals, examples are: citric acids in lime juice ethanoic acid in vinegar and stale palm wine, ascorbic acid in oranges, lactic acid in stale milk and tartaric acid in grapes.

MINERAL OR INORGANIC ACID

The inorganic (mineral) acids are acids prepared from mineral elements or inorganic matter. The common ones are

- hydrochloric acid, HCl
- trirconitrate (V) acid, HNO_3
- tetraorsuphate(VI) acid H_2SO_4

DEFINITION OF ACID

An acid is a substance which produces hydrogen ions as the only positive ion when dissolved in water. Some acids when in solution release a large number of H^+ ions. These are called strong acids. The weak acids release few H^+ ions in water. The mineral acids are strong acids while the organic acids are weak acids.

From the definition of an acid you have learnt that an acid, in solution, produces hydrogen ions. The number of these hydrogen ions is called the basicity of the acid.

Basicity can then be defined as the number of hydrogen atoms in one molecule of an acid that can be replaced by a metal in solution.

Physical properties of acids

1. Dilute acids have sour taste
2. They turn blue litmus red
3. The concentrated forms of strong acids are corrosive

Chemical properties of acids

ACTIVITY 9

1. Drop a piece of zinc metal (or magnesium ribbon) in a beaker of dilute mineral acid say hydrochloric acid what do you notice? Write equation for the reaction.
2. In another beaker of acid put some marble chips.
3. But some drops of litmus into about 25cm of acid, then gradually pour in a base into it until the colour changes, then stop. The solution formed is neither an acid nor abase.

The above activity shows the chemical properties of acids. These are

1. Acids react with metals to liberate hydrogen gas e.g.

$$2HCl_{(aq)} + Zn(sup(s) \rightarrow ZnCl_2 + H_{2(g)}$$

$$H_2SO_{4(aq)} + Mg_{(s)} \rightarrow MgSO_{4(aq)} + H_{2(g)}$$

2. Acid rest with trioxcarbonate(IV) to liberate carbon(IV) oxide.
3. Acids react with bases to form salt and water

$$HCl_{(aq)} + NaO_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)}$$

Uses of Acid

1. Acids are used in industries in the manufacture of dyes, detergents, fertilizers and drugs.
2. They are also used in industrial processes as drying agents, oxidizing agents and catalysis
3. They are used in the production of some important salts.
4. Vinegar (ethanoic acid) is used as a preservative in the food industry.

BASES

Bases are those substances that react with acids to form salts and water only. They are usually oxides and hydroxides of metals e.g. sodium oxide – Na_2O, Magnesium oxide MgO. Some oxides dissolve in water to form hydroxides e.g.

$$Na_2O_{(s)} + H_2O_{(l)} \rightarrow 2NaOH_{(aq)}$$

There arc some hydroxides that are soluble in water while some are not. An hydroxide which in soluble in water is called an alkali e.g. sodium hydroxide (NaOH). Potassium hydroxide (KOH), Calcium hydroxide (Ca $(OH)_2$) is sparingly soluble so it is a weak alkali Ammonium hydroxide (NH_4OH) in also a weak alkali. The strong alkalis are those which ionize completely in water eg

$$NaOH \rightarrow \quad Na^+ \ OH^-$$

$$KOH_{(aq)} \rightarrow \quad Na^+_{(aq)} + OH^-$$

The weak alkalis are only partially ionized

Physical Properties of Bases

1. They have bitter taste
2. They turn red litmus paper blue
3. They are soapy to touch
4. The concentrated alkalis are corrosive
5. They are either metallic oxides or hydroxides

Chemical Properties of Bases/Alkalis

1. All bases react with acids to form salts and water only

$$NaOH + HNO_3 \quad \rightarrow \quad NaNO_3 + H_2O$$

$$MgO + 2HCl \quad \rightarrow \quad MgCl_2 + H_2O$$

$$CuO + H_2SO_4 \quad \rightarrow \quad CuSO_4 + H_2O$$

NEUTRALISATION

You remember we said in unit 2 that a base react with an acid to give salt and water only. This is neutralisation. The essential reaction of neutralization is always the formation of water molecules from hydroxides and hydrogen ions

$$H^+ \quad + \quad OH^- \quad <=> \quad H_2O$$

Neutralisation can thus be defined as the formation of molecules of water from hydroxide ions (OH^-) and hydrogen molecules (H+) A salt is formed at the same time.

SALT

A salt is an ionic compound formed whenever an acid is neutralized by a base and when an acid react with a metal or trioxocarbonate(IV).

Types of Salt

1. Normal Salts: are formed when all the replaceable hydrogen ions in an acid have been completely replaced by metallic ions.

   e.g. $CaO + H_2SO_4 \rightarrow \underbrace{CaSO_4}_{Salt} + H_2O$

2. Acid Salts: are formed when some (and not all) of the replaceable hydrogen ions in an acid are replaced by metallic ions. They still have acidic properties

   e.g. $NaOH + H_2SO_4 \rightarrow NaHSO_4 + H_2O$

3. Basic salts: are salt that still have some hydroxide ion (OH-) groups. They still have basic properties

   e.g. *Zn(OH)Cl: basic zinc chloride.*

4. Double salts are combination of two salts. They normally ionize in solution to produce three different types of ions, two of which are positively charged and the third one in negatively charged.

   e.g. $KAl(SO_4) .12H_2O$. This is commonly called patash alum.

5. Complex salts: They contain complex ions

   e.g. $K_4Fe(CN)_6$

Methods of Preparing Salts

There are several methods of preparing salts. The method chose for preparing a particular salt will depend on (i) the solubility of the salt in water and (ii) its stability to heat.

The following methods are used for preparing insoluble salts:

1. Double decomposition: This involves solution of two soluble salts reacting together to produce one soluble and one insoluble salt. The insoluble are in now collected, washed and dried. .

e.g. $Ca(NO_3)_2 + Na_2SO_4 \rightarrow 2NaNO_3 + CaSO_4$

The insoluble salt here is the $CaSO_4$

2. Direct combination: Here the salt in synthesized from its constituent elements

   e.g. $Fe + Cl_2 \rightarrow FeCl_2$

Other methods for preparing soluble salts are:

3. Action of dilute acids on metals: The salt in prepared by the direct displacement of the hydrogen ion in an acid by a metal that in more reactive then hydrogen.

   e.g. $Zn + 2HCl \rightarrow ZnCl_2 + H_2$

4. Action of dilute acid on a metallic oxide.

   e.g. $H_2SO_4 + MgO \rightarrow MgSO_4 + H_2O$

5. Action of base on a non-metallic oxide

   e.g. $NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O$

6. Neutralisation: This is a reaction between an acid and a base to give salt and water only

   e.g. $NaOH + HCl \rightarrow NaCl + H_2O$

Use of Salts

Salt are of great important in our everyday life

1. They are used in the manufacture of many industrial agricultural and consumer substances such as chlorine, fertilizer and laxatives.

2. They are also used as food preservatives (e.g. Kitchen Salt - NaCl), drying agents ($CaCl_2$) and antifreeze (NaCl).

ASSIGNMENT

1. Define an acid
2. Mention three chemical properties of acids
3. Mention 3 sources of natural occurring acids
4. Give 2 uses of bases
5. Mention the five types of salts giving an example each
6. List 2 methods of preparing insoluble salts and 3 methods of preparing soluble salts.

SUMMARY

- An acid is a substance which produces hydrogen ions, H+, as the only positively charged ion in aqueous solution

- Acids have sour taste, turn blue litmus red, release carbon(IV) oxide from trioxcarbonate (IV) salts
- A base is a substance which turns red litmus blue and it has a bitter taste, It neutralises an acid to give salt and water only
- An alkali is a soluble basic hydroxide.
- A salt is a compound formed when all or part of the ionizable hydrogen of an acid is replace by metallic or ammonium ions.
- There are five types of salts: normal salts, acid salts, basic salts, double salts and complex salts.
- Insoluble salts can be prepared by:

    (i) direct combination of constituent elements

    (ii) double decomposition
- Soluble sate can be prepared by:. .

    (i) action of dilute acid on metals

    (ii) action of dilute acid on metallic oxides

    (iii) action of base on non-metallic oxides

    (iv) Neutralisation.

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UNIT 8: ALLOTROPES OF CARBON 1

INTRODUCTION

Carbon is one of the most common and most important elements in nature. It occurs naturally and in its pure form as diamond and graphites. Carbon also occurs in an improved form as coal and in the combined state as petroleum, wood and natural gases. It occurs as a constituent of thousands of inorganic and organic compounds.

In this unit, you are going to learn the various forms in which carbon occurs naturally and artificially.

OBJECTIVES

By the end of this unit, you should be able to:

1. Define allotropy;
2. List the various allotropic forms of carbon;
3. List the different types of coal;
4. List the products of destructive distillation of coal and their uses; and
5. List the uses of amorphous carbon.

Allotropes of carbon

Carbon can exist in the crystalline and non-crystalline forms. It can therefore be said to exhibit allotropy. Diamond and graphite are two alltrophic forms of crystalline carbon. Other forms of carbon like, coal, coke, charcoal soot, etc. are referred to as the amorphous forms of carbon and are non-crystalline in nature.

We shall now treat the various allotropes of carbon:

Diamond

Diamond occurs naturally and are the purest form of naturally occurring carbon. The pure diamonds are found as colourless, lustered solids which are used as gems. They are coloured at times by traces of impurities. The diamond crystal is octahedral in shapes. The carbon atoms are closely packed together, each atom being bonded to four other atoms.

Properties

Diamond is the hardest naturally occurring substance known. It is very dense with a high melting point. It is resistant to high temperatures and chemical attack. It does not conduct electricity since it has no full valence electrons in its structure; all it electrons are used in bond formation - each carbon atom is attached to four carbon atoms.

Uses

Because of its hard nature, diamond is used in oil-well drills and cutting tools. It is used in making jewellery.

Graphite

Graphite is another crystalline allotrope of carbon. It occurs naturally as plumbago which is a black solid.

Each carbon atom, in graphite is bonded to three others while the fourth electron is delocalised. This fourth electron is not attached to any particular atom but moves about. The carbon atoms are arranged in layers made up of hexagonal rings.

Properties

Graphite is a soft black material which flakes easily because of its layered structure. It has a high melting point but less dense than diamond. It is a good conductor of electricity because of the free valence electron in the crystal lattice.

Uses

1. Graphite is used as a lubricant in the moving parts of machines.
2. It is used as an electrode in electrolysis.
3. It is mixed with clay to make the 'lead' in pencils.

Amorphous Carbon

Amorphous carbon is the non-crystalline allotrope of carbon. X- ray studies have shown that they consist of little crystal of graphite bound together by impurities; they are therefore not regarded as true allotropes. Amorphous carbon comes in various forms coal, charcoals, lampblack, carbon-black or soot and gas carbon.

With the exception of coal which is mined from natural deposit, the others forms arc prepared in various ways.

1. COAL.

Is a. black, brittle amorphous mineral. It is formed from the carbonization of prehistoric vegetation under pressure and in the absence of air. During the carbonization process, the coal matures in stages and forms four types of coals.

Uses of coal

Coal is mainly used as fuel to generate power in steam engines, electrical plants and factories.

Destructive distillation of coal:

When coal is heated in the absence of air to very high temperatures (600-1000°C) it is converted into solid, liquid and gaseous products. This process is known as the destructive distillation of coal. Various useful products are obtained here.

i. Coke makes up the solid product. Coke is a black porous solid and contains about 98% carbon. It bums with a smokeless flame. It is mainly used as solid fuel and as a reducing agent in the extraction of metals from their ores.

ii. Coal tar and ammoniacal liquor constitute the liquid products. Coal tar is further distilled to get products which are used in the synthesis of dyes, paints, insecticides etc. Ammoniacal liquor is used to make ammonium tetraoxosulphate (VI) fertilizers.

iii. Coal gas: is a gaseous fuel.

2 CHARCOAL

Is of different types- wood charcoal, animal charcoal and sugar charcoal which are respectively prepared by heating hard wood, animal bones and sugar, in the absence of air.

ACTIVITY 10

a. Heat strongly a piece of hard wood, dry bones and sugar in three separate tightly closed crucibles.

b. Put the wood charcoal in a beaker of water and boil (while pressing the charcoal down into the water with a glass rod). After boiling for a few minutes, remove the rod. What do you observe?

c. Dissolve some sugar in water and drop a few drops of ink into it. Then add some of the bone/animal charcoal into it and shake vigorously. Fitter the solution.

Heating of those three samples produced the wood, animal and sugar charcoal. Wood charcoal floats on water but when dipped in boiling water, it sinks – it adsorbs gases.

When animal charcoal was put in coloured sugar, it adsorbed the colour.

Uses of Charcoal

Wood charcoal is used as a domestic fuel and is used in gas masks because of its ability to adsorb smoke and poisonous gases. Animal charcoal is used in removing the brown colouring matter from brown sugar. Sugar charcoal is also used to decolourise water.

LAMPBLACK CARBON BLACK OR SOOT

3. Lampblack carbon black or soot is finely divided carbon particles produced when carbonaceous materials such as petroleum products, natural gas or wood bum in a limited supply of air:

You can collect lampblack from the chimney of your kerosine lantern, carbonblack from the exhaust pipes of cars and soot from the roof of your fireplace. Uses Carbon black is used as a black pigment in printer's ink and-as an additive to rubber in the manufacture of motor car tyres. It is also used in making carbon paper, black shoes polish and in typewriters' ribbon. General

Properties of Carbon

All the different allotropes of carbon are black or grayish-black solids, except diamond. They are not very reactive.

Combustion

All forms of carbon burn in excess oxygen to produce carbon (TV) oxide.

$$C_{(s)} + O_2 \quad \rightarrow \quad CO_2$$

In a limited supply of air, carbon (II) oxide is formed.

$$C_{(s)} + O \quad \rightarrow \quad 2CO$$

As a reducing agent: carbon reduces the oxides of the, less active metals to the metals; so it is a good reducing agent

ASSIGNMENT

1 . What is allotropy?

2. Name the allotropes of carbon

3. Give two uses of graphite

4. Which amorphous form of carbon exists naturally?

5. List the types of coal.

6. Give four products of the destructive distillation of coal.

7. Which charcoal in used in gas masks and why?

SUMMARY

- Allotropy is the ability of an element to exist in various forms in the same physical state.
- The crystalline allotropes of carbon are diamond and graphite.
- Graphite conducts electricity due the presence of free electrons in its crystal lattice.
- The Amorphous allotropes of carbon are coal, wood, animal and sugar charcoals lampblack, carbon black and soot.
- The different types of coal are peat, lignite, bituminous coal and anthracite.
- The products of the destructive distillation of coals are coke, ammoniacal liquor, coal tar and coal gas.
- Wood charcoal adsorbs gases.
- Animal charcoal adsorbs colour.
- Lampblack, carbonblack and soot are got when carbonaceous materials are burnt in a limited supply of air.

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UNIT 9: RATE OF CHEMICAL REACTION I

INTRODUCTION

You must have notice that the time it take one chemical reaction to occur may be different from the time it takes another reaction to go to completion. There are some reactions which go on so slowly that you may not even be able to observe them taking place. Take for instance, the rusting of your metal bucket -1 do hope you know that rusting is a chemical reaction between iron, water and oxygen. For the whole bucket to rust completely, it may take several years; so this is a very slow process. Take time off to watch the women roasting fresh com. When they fan the fire rigorously the charcoal bums off fast, but when the farming is done gently, it takes longer time for the charcoal to bum off.

Can you think of some reactions that are very fast? Examples are explosions and precipitations. These occur within a twinkle of an eye i.e. it takes only a fractions of second. Another example is lighting of a match stick. It bums quickly within a few seconds. That a reaction takes quite a long time to occur means that its rate of reaction is very low. So, for an explosive reaction, the rate is very high.

Most of the reaction you will study in this unit will take place at speeds that you can easily observe. You must have read about reactions in which precipitates arc formed and or gases are liberated.

OBJECTIVES

By the end of this unit, you should be able to:

1. carry out experiments for measuring the rates of chemical reactions
2. calculate the rate of a chemical reaction,
3. explain the principle in the collision theory.

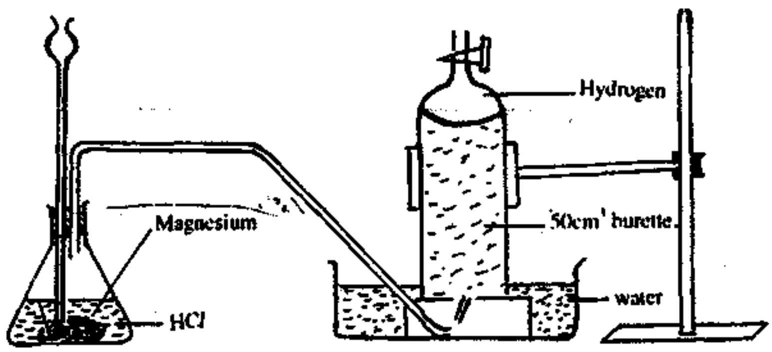
ACTIVITY 11

The experiment you are about to carry out is the reaction between magnesium and dilute hydrochloric acid.

$$Mg + 2HCl \quad \rightarrow \quad MgCl_2 + H_2$$

Instructions

1. Set up the apparatus as shown in the diagram



2. Adjust the water level in the burette to the zero mark

3. Place 1g magnesium granules (or 4cm long magnesium ribbon) in the conical flask.

4. Add about $50cm^3$ of 0.5 HCl to the flask and immediately start the clock.

5. Take reading of the volumes of hydrogen gas formed every 30 seconds until all the magnesium has reacted.

Reading	Time(s)	Volume of $H_2(cm^3)$
1 2 “ “ “	30 sec 60 sec	

6. Plot a graph of the volume of hydrogen gas produced against time.

You will notice that as more magnesium disappears more hydrogen gas is formed. The rate of the reaction is the speed at which the reactants are used up or product are formed.

i. *Rate of reactions* $= \dfrac{\textit{amount of Mg used up}}{\textit{time taken}}$

ii. Rate of reaction $= \dfrac{\textit{amount of HCl used up.}}{\textit{time taken}}$

iii. Rate of reaction $= \dfrac{\textit{amount of } MgCl_2 \textit{ produced}}{\textit{time taken}}$

iv. Rate of reaction $= \dfrac{\textit{amount of } H_2 \textit{ produced}}{\textit{time taken}}$

Now, go to your table, calculate the rate of reaction based on the volume of hydrogen gas produced.

WAYS OF MEASURING REACTION RATES

From the above experiment you have seen that a reaction rate can be determined by measuring the rate at which the mass or concentration of a:

- reactant is decreasing or
- product is increasing.

But if it is not possible to do this, you can measure a physical property which changes proportionately as the mass of a reactant or product. Therefore, reaction rates can also be determined by measuring the:

- decrease in the mass of the reaction system (i.e. where there is escape of a gaseous product)
- Volume of a gaseous product
- Amount of precipitate formed
- Change in total gas pressure
- Change in intensity of colour
- Time taken to arrive at an easily observable stage

RATE CURVE

Refer to your graph, it should look like this

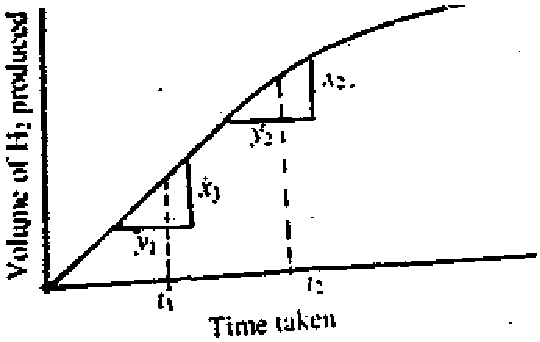


Fig. 7.2

The graph shows the rate of reaction and it is called the rate curve

Did you notice that when the acid was added to the magnesium, the effervescence was more vigorous at the start of the reactions and the vigour was reducing, until it effervescence finally stopped.

Now, calculate the rate of reaction at 30sec, 60sec and 90sec.

E.g. rate of reaction (at 30 sec.) = *gradient of the graph at 30 sec.*

$$= \frac{x}{y}$$

You will notice that the rate of- the reaction is not constant during the course of the reaction. The rate decreases with time, it is highest at the start and decreases gradually to zero (it is zero where the graph is horizontal)

Where die graph is horizontal, it shows that no reaction is taking place again one of the reactions must have been used up.

COLLISION THEORY

The collision theory was propounded by Arrhenius in 1889. He made the following postulates:

i. Chemical reactions occur only if the reactant molecules meet and collide with each other.

ii. Not all collisions lead to chemical reactions

iii. Only few molecules which acquire a certain amount of energy take part in reactions

iv. The minimum amount of energy required for the reaction to occur is called energy of activation.

When reactant molecules meet there may be many collisions between them, but not all result in a reaction. The collisions that result into a reaction are called effective collisions. This shows that if most collisions resulted in a reaction, rate of reaction would be much faster.

You will recall that in kinetic theory, you were taught that particles move about at different speeds as they posses different amounts of energy. And for a chemical reaction to occur, there must be breaking of bonds in the reactant and forming of new bonds to make the products. If a collision does not have enough energy, no bonds will be broken and therefore the reaction will not take place. The minimum amount of energy needed for a reaction to occur is called the activation energy. This same energy becomes an energy barrier which must be overcome before molecules can react. A reaction can only occur if the energy of the colliding reactant parties is equal or more than activation energy. Otherwise, the molecules would just rebound from each other and no reaction occurs Every reaction has its own energy of activation. A reaction with a low activation energy will occur spontaneously at room temperature. The reaction with a high activation energy will only occur if energy is supplied to it in the form of heat, light or electrical energy; addition of catalyst lowers the activation energy.

Let us consider the reaction between hydrogen gas and oxygen gas to produce steam.

$$2H_2 + O_2 \quad \rightarrow \quad H_2O$$

For this reaction to occur, the covalent bends in the hydrogen and oxygen molecules will have to be broken first. This requires energy.

You will recall that this reaction cannot take place unless there is an electric spark. This shows that the H_2 and O_2 molecules can not ordinarily overcome the energy barrier. It is the electric spark" that provides the extra energy to the reaction system.

Study the energy diagram below.

a. Endothermic reaction activated complex

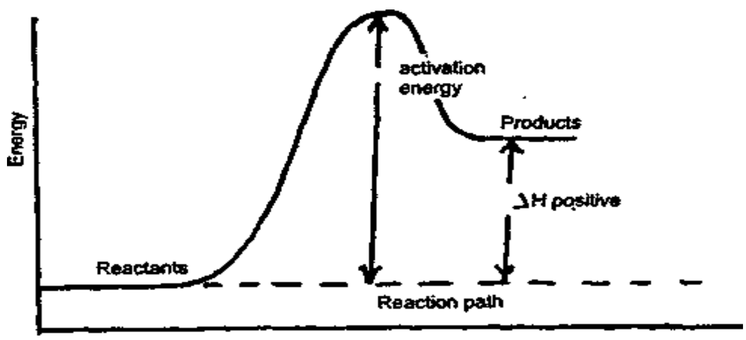


Fig. 7.5

Do you notice that endothermic reaction energy has to be supplied to overcome the activations energy barrier?

For me exothermic reaction, the energy of the products is less than the energy of the reactant. It therefore shows that once the reaction starts the energy involved would be enough to activate more reactant molecules for the reaction to go to completion. No external energy is needed again.

In the endothermic reaction, the energy of the products is higher than the energy of the reactants. This means that the reaction system has to be continuously supplied with energy from an external source to activate the reactant molecules and even for the formation of the products.

ASSIGNMENT

1. Define Rate of chemical reaction (10 mark)
2. Why are some reactions show while some are fast? (10 marks)
3. Mention four (4) ways one can measures the reaction rates of chemical reactions (40 marks)
4. With reference to the collision theory, what are the conditions under which reactant molecules can react? (10 marks)
5. Define activation energy. (10 marks)
6. Draw and label fie energy diagram of an exothermic reaction (20 marks)

SUMMARY

- The rate of a reaction can be determined by measuring the rate at which the reactants are used up or the rate at which the products are formed.
- The rate of reaction is not constant. It decreases as the reactants are used up.
- From the reaction curve, one can determine the rate of a reaction at any given time by taking the gradient of the tangent at that time.
- Where the rate curve becomes horizontal it shows that the reaction has stopped the rate of reaction is zero and one of the reactants must have been used up.
- The collisions theory, assumes that for a reaction to take place, reactant molecules must collide.
- Effective collisions occur when the reactant molecules posses a minimum amount of energy called activation energy.

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UNIT 10: RATES OF CHEMICAL REACTIONS II

INTRODUCTION

In the previous unit you learnt what the rate of a chemical reaction means. You also learnt the various ways the rate can be determined.

You can recall that for a chemical reaction to take place there must be effective collisions between the reactant molecules. And the molecules must posses a minimum amount of energy called the activation energy.

You should expect therefore that anything that will affect the energy of the molecules will definitely affect me rate of a reaction. In our laboratories arid industries, there are situations when it is necessary to slow down or speed up a chemical reaction. In this unit you will study the factors that affect the rates of chemical reactions.

OBJECTIVES

By the end of this unit, you should be able to:

1. determine the factors that can affect the rate of a chemical reaction;
2. carry out experiments to show the effect of each factor; and
3. explain the effect of change in the temperature, concentration/pressure of a reaction system using the principles in the collision theory.

FACTORS THAT AFFECT THE RATES OF REACTIONS

You can see from the principles of the collision theory, that rate of a chemical readied depends on the frequency of effectives collisions between the reactant molecules. Therefore, that rate of a reaction can be affected by any factor that can change any of the following.

- energy content of the reactant molecules,
- the frequency of collision of the molecules
- activation energy of the reaction

Some of the factors are:

1. Concentration/pressure (for gases) of reactants.
2. Temperature
3. Surface area of reactants
4. Presence of catalyst
5. Presence of light.

You will now study each of the factors.

Effect of Concentration of a Reactant

ACTIVITY 12

In this activity you will study the rates of reaction for different concentration of hydrochloric acid in the reaction between the acid and calcium trioxocarbonate (IV)

Instruction

1. Prepare hydrochloric acid of different concentrations 0.5M. 1.5 and 2.0M.
2. Place 10g of powdered calcium trioxocarbonate (IV) in each of four beaker?
3. Get the stop clock ready.
4. Add 100cm3 of the 0.5M acid into the first beaker and record the time it takes the calcium trioxocarbonate (IV) to completely disappear.
5. Repeat (4) with the 1.0M, 1.5M and 2.0M acid in the three other beakers, one after the other, record the time for each.

Discussion

From results, you will notice that the reaction in the last beaker (2.0M acid) was the fastest, followed by the third, second and then the first beaker. Note that the mass of carbon (IV) oxide formed is the same for all the different acid concentrations since the same amount of calcium trioxocarbonate was used.

Write the balanced equation for the above reaction.

When a solution of a substances is said to be more concentrated, it means that there are more of the molecules of the substance within the solution. That is the particles are more crowded. Then if particles are closer together, frequency of collision will increase. This shows that frequency of collision is dependent upon the concentration.

An increase in concentration of any of the reactants will results in a corresponding increase in effective collisions of the chemical reaction. Conversely, as concentration decreases, the rate of reaction tends to decrease.

In case of gases, a lower pressure means having fewer molecules of the gaseous mixture in the containing vessel, hence fewer effective collision. In effect, lower pressure is synonymous with lower concentration and higher pressure stands for higher concentration. Therefore, as pressure of the reaction system increases (decreases) the rate of the reaction increases (decreases).

EFFECT OF TEMPERATURE

ACTIVITY 13

The experiment you will carry out here involves the reaction between hydrochloric acid and sodium sulphurtrioxosulphate (IV)

$$2HCl + Na_2S_2O_3 \rightarrow \quad 2NaCl + H_2O + S$$

The sulphur formed here is a yellow precipitate.

Instructions

1. prepare a solution of sodium thiosulphate by dissolving 4g of it in $250cm^3$ of water

2. place $25cm^3$ of the solution in each of five (5) beakers.

3. Add $5cm^3$ of 2M Hydrochloric acid into the first beaker and heat in a tripod and gauze to 30°C swirl the mixture well and place it on the X

4. Record the time it takes the X to disappear as you view it from above the solution.

5. Repeat (4) and (5) with the remaining four beakers, heating them to 35°C, 40°C, 45^0C and 50^0C.

6. Tabulate your results and plot the graph of time against temperature.

Discussions

In this experiment, what you have just done is to measure the rate of the reaction by taking the time it takes a given amount of sulphur, to precipitate. The amount of sulphur in question is that amount that is enough to cover the *X*. Do you remember mat precipitation was mentioned (in unit 7) as one of the ways of determining rate of reaction?

From your table, you will notice that as the temperature increases, the time taken for the *X* to disappear i.e. the rate of reaction increases. The rate of reaction is inversely proportional to the time taken for the reaction to take place.

Now, refer to your graph. Do you see that the lowest time gives the highest reciprocal (i.e. time) and corresponds to the highest temperature. This shows that the rate of reaction between hydrochloric acid and sodium sulphurtriousulphate increase with increase in temperature.

Let us use the collision theory to describe the conclusion of our experiment when the temperature of the reactions system was increased, the following take place simultaneously.

i. the reactant molecules acquire more energy.

ii. the number of particles with energies equal to or greater than the activation energy increases

iii. the average speed of all the reactant particles increases due to the greater kinetic energy.

iv. the number of effective collisions increases

v. the reaction rate therefore increases.

EFFECT OF SURFACE AREA

ACTIVITY 14

Instruction

1. Put $50cm^3$ of 2m hydrochloric acid in two beakers

2. Measure out 2 portions of marbles chips of weight 5g each Grind one portion to powder.

3. Get the stop clock ready.

4. Pour the powdered marble into the first beaker, check the time it takes all the marble to disappear (i.e. when effervescence stops)

5. Pour the marbles chips into the second beaker and check the time it taken the reaction to go to completion,

Discussion

You will discover that the time it takes the powdered marble to finish reacting is much less than the time it takes the marble chips. This means that the reaction rate is faster in the first beaker (with powdered marble) then in the second beaker.

This is because the powdered marble offers a greater surface area for the acid to come in contact with. You can now conclude that the greater the surface area of the reactant, the higher the rate of reaction.

EFFECT OF A CATALYST

ACTIVITY 15

Instructions

1. Prepare 20% hydrogen peroxide by adding $10cm^3$ of it in $50cm^3$ of water.

2. Set the apparatus as shown

3. Read the volumes of oxygen gas produced at intervals of 2minutes. Take your reading as in Unit 7, Activity I.

4. Repeat the experiment. This time, add about 2.0g of powdered magnesium (IV) oxide into the hydrogen peroxide. Cork immediately and start taking reading.

5. Plot the graph of volume of oxygen produced against time (in minutes). Plot the graph on the same graph/axes.

6. Now study and compare the reading in 3 - without catalyst and 4 - with catalyst

Discussion

The equation for the reaction is

$$2H_2O_2 \quad \rightarrow \quad 2H_2O + O_2$$

Your graph will look like this

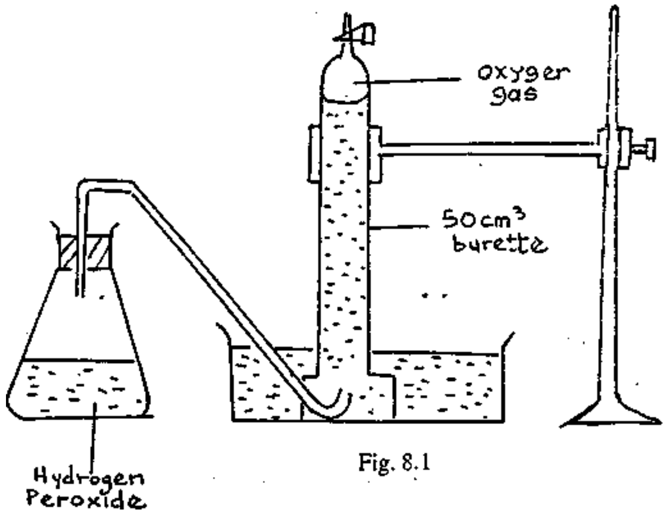

Fig. 8.1

Fig 8.2

You will notice from your reading and graphs that the reaction rate is faster in the presence of a catalyst. Let us define a catalyst then. A catalyst is a substance which alter the rate of a chemical reactions but is itself not chemical changed or consumed in the process. What a catalyst actually does is to lower the activation energy of the reaction. When this happens, more molecules are able to cross the energy barrier. In effect, the rate of the reaction increases.

The energy diagram with and without catalyst is shown below.

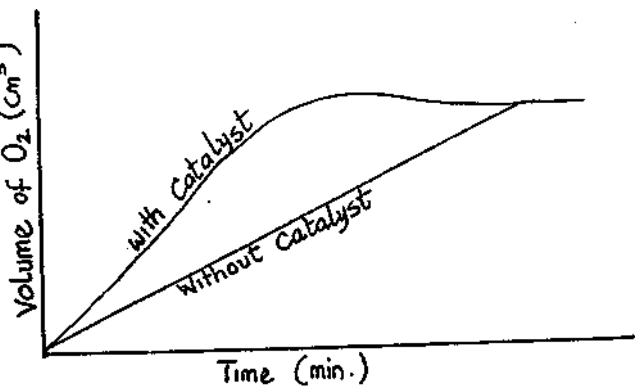

Fig. 8.3 Reaction path

EFFECT OF LIGHT

Light is a form of energy. It therefore means that light can supply some molecules with the energy required for a reaction to take place, thereby increasing the reaction rate.

A very good example of a reaction that is catalyst by light in photosynthesis in plants other examples are:

- precipitation of silver bromide from silver trioxonitrate (V) solution and potassium bromide solution.

- Decomposition of hydrogen to liberate oxygen.
- Reaction of alkanes with chloride.

ASSIGNMENT

1. Mention the factors that can affect the rate of a chemical reaction.
2. Using the principles of collision theory, explain what happens when the temperature of a reacting mixture is increased.
3. Sketch the rate curve of a reaction with and without a catalyst.
4. Give two examples of reaction that are affected by light.
5. There are 3 beakers containing 10g each of marble in three different forms and $20cm^3$ of HCl was added into each.
    a. write and balance the equation for the reaction
    b. Arrange the beaker in order of increasing rate of reaction
    c. Explain why the arrangement should be so.

SUMMARY

- The rate of a chemical reaction depends on
    i. energy content of the reactant molecules
    ii. the frequency of collision of the molecules
    iii. activation energy of the reaction.
- The factors that can affect the rate of a chemical reaction are:

  concentration/pressure of reactions temperature, surface area' of reactants, presence of catalyst and presence of light.
- Increase (or decrease) in surface area of a reactant increases (or decreases) the rate of the chemical reaction.
- Increase in temperature of the reaction system, increases the energy of the reactant particles and hence increases the reactions rate.
- When concentration (or pressure in case of gases) of a reactant is increased, number of effective collisions increases; then reaction rate is increased.
- A catalyst lowers the activation energy of a reaction, thereby increasing the rate of the reaction.
- Light, being a form of energy, can supply reactant molecules with energy to overcome the energy barrier - hence increasing the reaction rate.

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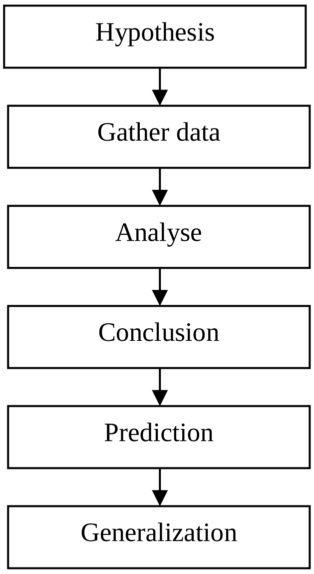
ANSWERS TO ACTIVITIES AND ASSIGNMENT

ANSWERS TO ACTIVITIES

MODULE 1: SCIENCE EDUCATION

Activity 1



Activity 2

(i)	Medicine	-	Vaccine
(ii)	Agriculture	-	Fertilizer
(iii)	Commerce	-	Banking
(iv)	Transportation	-	Aircraft
(v)	Industries	-	Textiles

Activity 3

1. **DAVID P. AUSUBEL'S THEORY OF LEARNING:**

Ausubel stresses the value of prior (i.e. previous) knowledge in learning. It is generally accepted that what a student already knows could aid or hinder new learning. According to Ausubel, meaningful learning occurs where there is appropriate link between prior knowledge and new learning task i.e. interaction between the students appropriate element in the knowledge that already exists and the new material to be learnt. When there is no such interaction, no learning occurs. The parts of the learner's cognitive structure (i.e. prior knowledge) which can provide the interaction necessary for meaningful learning arc called subsumers i.e. prior knowledge or knowledge already existing in the cognitive structure of the learner is referred to as a subsumers.

Ausubel defined subsumers as a principle or a generalised body of knowledge that the learner already acquired that can provide association or "anchorage" for the various components or the new knowledge. That is a new learning must be linked to the existing knowledge to create meaning. He then suggested what he called "advance organiser" which can be introduced before the new concept is taught.

2. (i) Teaching of science must begin with new learning or knowledge in sequential manner.

   (ii) Teacher should ensure that the learner is ready before presenting new curriculum materials in basic science.

   (iii) Meaningful learning in basic science class depends largely on the quality or the student previous experience.

Activity 4

1. Gagne's theory believes that materials meant for learning (i.e. learning task) in order for the learner to acquire the desired knowledge (i.e. terminal task) must be sequential I) structured so that the learning of one topic (i.e. acquisition of one knowledge) aids the learning of the next higher order topic (i.e. acquisition of the next higher knowledge). This invariably implies that learning must be sequentially structured by the teacher from simple to complex until the desired objective is achieved. In Gagne's hierarchy of learning, problem solving is the highest level while lower levels involve facts, concepts, and generalisation.

   Gagne's theory also advocates administration of pre-tests to find out whether the students possess the relevant prerequisites for the next knowledge (i.e. higher order knowledge). the result of the pre-tests will help the teacher to know the entry point for learning to begin in the hierarchy of learning tasks. Gagne also suggests that in a teaching situation the teacher should begin with a question like "what is it that I want the learner to be able to do? This implies that there must be well stated performance objectives in every lesson.

2. The importance of pre-test in a science classroom is that it enables the teacher to find out the point where the learning hierarchy starts.

Activity 5

1. Two advantages of discovery learning

   i. motivations to learn more

   ii. finding out things by themselves.

2. One shortcoming of discovery

   (i) it is time consuming

3. Jerome Bruner.

Activity 6

1. Jean Piaget was a Swiss Psychologist who specialized in the cognitive development of children.

2. He was recognized by American Educational Research Association as the most outstanding psychologist in cognitive development of children. He wrote over 30 books and more than 100 articles.

3. Four stages of intellectual development in children are:

    i) Sensory – motor stage (0 – 2yrs)

    ii) Pre-operational stage (2 – 7yrs)

    iii) Concrete operational stage (8 – 11yrs)

    iv) Formal operational stage (12yrs and above)

Activities 7 & 8 - projects

Activity 9

Sinking and floating using inquiry method

Step 1: Select different materials (items)

Step 2: Fill a bowl with water

Step 3: Drop one item at a time into the bowl of water

Step 4: Record your observation

Step 5: Repeat 3 and 4 for all items

Step 6: Group item into three that float and those that sink.

Activity 10

i) Characteristics of living things

ii) Ecosystems

Activity 11

Identified process skills learnt – observation, measuring, recording, classifying, inference, etc

Activity 12 - Project

Activity 13 – Class discussion

Activity 14

* 4 Concrete concepts: e.g. Stone, boy, plant & water

* 3 abstract concepts: e.g. atom, gene, air, energy, force, etc.

Activity 15

1. Improvisation is a replacement for the original item with locally available ones.

2. Examples of apparatus that can be improvised are

- Metre rule with a stick
- Ragolis water bottle top for funnel
- Lower part of Ragolis water bottle for beaker

3. Using available materials in the locally to serve same purpose as a standard ones.

Activities 14 – 18

Projects

Activity 19

Class activity

Activity 20

(i) **Weight** is measured in Newton kg while **mass** is measured in gramme or kg.

(ii) Scale

Activity 21

Improvisation and class project activity

Activity 22

(i) Sketch is a free-hand drawing while diagram is a scaled drawing with accuracy

Activities 23, 24 & 25: Projects

MODULE 2: CLASSIFICATION AND CHARACTERISTICS OF LIVING THINGS

Activities 1, 2, 3 - Class Projects.

Activity 4

Dog - Flesh, bone, etc

Goat - Grass and Plants

Cat - Flesh, rats, etc.

Cow - Grass and plants

Man - Plants and animals

Activity 5 - Class project

Activity 6 - Class project

Activities 7-14 - Class projects.

Activities 15-20	**-**	Class experiment.
Activities 21-22	**-**	Class group discussion
Activity 23	**-**	Individual excursion
Activity 24	**-**	Whole group or small group
Activities 25 & 26	**-**	Project (group)
Activities 27 & 28	**-**	Field trip
Activities 29 & 30	**-**	Group experiment
Activities 31-36	**-**	Whole class or small group experiment
Activities 37 & 38	**-**	Class activity
Activities 39-42	**-**	Projects

MODULE 3: PROCESS OF LIFE

Activity 1	**-**	Group activity
Activities 2-4	**-**	Experiment
Activities 5 & 6	**-**	Outdoor and classroom activity
Activities 7 & 8	**-**	Individual activity
Activities 9 & 10	**-**	Class discussion
Activity 11	**-**	Visit to the meat stall
Activities 12-14	**-**	Class discussion

MODULE 4: LIFE AND SURVIVAL I

Activities 1-5	**-**	Classroom activity and discussion
Activities 6-8	**-**	Outdoor activity
Activity 10	**-**	Class discussion
Activities 11 & 12	**-**	Class activity

MODULE 5: ASSESSMENT IN BASIC SCIENCE

ACTIVITY 1

i. Examinations play an important role in the school curriculum. It is the instrument with which achievement is measured in school.

ii. The daily science lesson is evaluated because at the end of the lesson the teacher need to know whether or not his objectives have been attained.

ACTIVITY 2

1. Characteristics of continuous assessment are:

   (i) systematic (ii) Comprehensive (iii) Cummulative and (iv) guidance-oriented.

2. Two advantages of continuous assessment over one-short final assessment are:

   i. It is cummulative and this gives students many more chances of being assessed.

   ii. Teachers who translate the curriculum at the classroom level get much more involved in assessing their pupils.

ACTIVITY 3

(1) Six purposes of assessment include:

   (l) To inform the student

   (2) To inform the parents

   (3) To evaluate the curriculum

   (4) For employers

   (5) To the general public

   (6) For placement purposes.

2. To inform the student

   (a) Knowledge of result tends to motivate the pupil to learn more. The child has the right to know his academic standing at any given time.

   (b) The parents have the right to know the results of their own children. They pay school fees; supply textbooks etc. and they therefore should know how their children are performing.

ACTIVITY 4

1) to observe and explore the environment

2) to explain simple natural phenomena

3) to develop scientific attitudes including curiosity, critical reflection and objectivity.

ACTIVITY 5

Science teachers must assess what their pupils learn:

a) to provide pupils with feedback on their progress.

b) to provide the teacher with feedback on the effectiveness of his teaching methods.

ACTIVITY 6

i. knowledge competence

ii. technical competence

ACTIVITY 7a

1. Three innovations of our educational system

a) The 6:3:3:4 system of education

b) The continuous Assessment CA,

c) The semester system

2. Valid assessment should have these features

a. Both formative and summative

b. Should motivate the students

c. Should reflect complete picture of science.

ACTIVITY 7b

1. Two functions of tests

i) Classroom function - used to determine academic achievement in class.

ii) Administrative functions - used for placement & promotions/admissions.

2. Peer evaluation is a technique in which students in a group assess themselves after an exercise e.g. mini-teaching.

ACTIVITY 8

a) The non-cognitive domains are:

1 . affective and

2. psychomotor domains.

b) Skills and speed in type writing belongs to the psychomotor domain.

ACTIVITY 9

Three advantages of objective test items

- covers syllabus widely
- Easy to mark
- objective assessment,

1. Three shortcomings of essay test items

- Difficult to mark
- Subjective assessment
- Covers narrow syllabus

ACTIVITY 11

1. Three conditions for good behavioural objectives

- Measurable terminal behaviour
- Conditions specified
- Minimum acceptable level of performance.

2. (a) After the lesson, students should be able to describe the arrangement of molecules in solid, liquid and gas using a diagram to illustrate.

(b) At the end of the lesson, students should be able to give at least 2 examples of liquid and 3 examples of gas.

ACTIVITY 12

The function of table of specification is to regulate or guide the distribution of questions.

ACTIVITY 13

Perseverance, Objectivity, Interest, Open-mindedness, resourcefulness, curiosity, willingness independent, cooperation, enthusiasm. (Any five)

ACTIVITY 14

a. Observing - it means taking in information about all thing around, using all the senses as appropriate and safe, identifying simrnilarities and differences, noticing details and sequence, ordering and observations.

b. Raising Questions - It means to ask a variety of questions through words or actions, recognising questions which can be answered through scientific investigation.

ACTIVITY 15

i. cognitive process skills e.g. interpreting data.

ii. manipulative or practical skills e.g. observation.

ACTIVITY 16

1. We can tell whether process skills are being used for solving problems by looking out for process skill indicators.

ACTIVITY 17

(a) Matches, Hoes, Knives, Spades, Files. Axes, etc.

They are made of steel

(b) Spears; Traps; as Guns; Hooks (for fishing) etc.

ACTIVITY 18

1. An alloy is a metal to which fixed amounts of one or more substances have been added in order to improve its properties.

2. Iron is a hard, shiny, solid. It is a good conductor of heat It can be magnetized. It is ductile and malleable.

ACTIVITY 18

1) Non-porous rock

2) Natural gases, petrol, kerosene, diesel, lubricating oil and bitumen

ACTIVITY 19

1. As mineral cassiterite or tin (IV) oxide

2. Plateau, Kano, and Bauchi State (Any two)

ACTIVITY 20

i) **Terrestrial planets** are: - Mercury, Venus, earth and mars (any two).

Giant planets are:- Jupiter, saturn, uranus, and Neptune (any two)

ii) **a)** The law of gravity states that all bodies in the universe attract each other with what is called a gravitational force

b) The strength of gravitational force between two bodies depends on their masses and the distance between them. The force of attraction increases with increase in mass and decreases with increase in distance between them.

MODULE 6: RESOURCE DEVELOPMENT, CONSERVATION AND RECYCLING OF NATURAL RESOURCES

Activities 1-5	**-**	Classroom discussion
Activities 6 & 7	**-**	Visit to a poultry farm and to the zoo.
Activity 8	**-**	Field trip
Activities 9-11	**-**	Class discussion
Activities 12-19	**-**	Class activity after reading the text

ANSWERS TO ASSIGNMENTS

MODULE 1: SCIENCE EDUCATION

1. The ability to list at least five of the improvised tools studied under this unit carries 5 marks each = 25 marks.

2. Ability to collect the necessary materials for the pulley - 5 marks.

   Ability to construct the pulley such that permits the turning of the cotton reel - 15 marks.

   Neatness of the construction - 5 marks. Sub-total- 25 marks.

3. Ability to collect the right type of empty can - 5 marks.

   Effective construction of the burner and make it generate heat - 15 marks. Neatness of the construction- 5 marks. Subtotal - 25 marks.

4. Ability to collect the raw materials - 5 marks.

   Ability to actually construct the balance for use -15 marks.

   Neatness and utility - 5 marks. Sub-total - 25 marks. **Total = 100 marks**.

ANSWERS TO ASSIGNM ENT

1.

Solids	**Liquids**	**Gases**
Wood	Water	Oxygen
Desk	Petroleum	Hydrogen
Gravel	Urine	Ammonia
Yam	Orange	Air
Mud	Juice	

2 marks each for every correct answer (26)

2. (i) Particles in solids are closely packed together. Solids have definite shape. The forces binding the molecules together are high hence they have high density. Solids are also rigid unlike liquids and gases. (6)

   (ii) The particles making up gases are far apart. They can be pressed together compressed, reducing such spaces between the particles, the molecules. (6)

   (iii) There are three states of matter. When liquids are strongly heated, the molecules become faster and escape through the liquid surface to the air in the form or steam vapour. (6)

   (iv) When ice is heated, the particles (molecules) which are together are separated far apart from each other therefore the solid ice turns into liquid water (6) Total (24 marks)

3. (i) The particles of a gas are loosely packed (4)

   (ii) A solid has a high density because of its rigid (4) body or lack of space between its particles (4)

(ii) The melting point of a solid is the temperature at which it turns to liquid

(iv) Cooling of a gas causes the molecules (particles) to come close together (8) (26)

4. The states of matter are: Solid, liquid and gas (3) Named substance: Water (4). It changes from ice (Solid) (4) to Water (liquid) (4) to Steam or Vapour (gas) (4) (24). Total = 100 marks

ANSWERS TO ASSIGNMENT

1. (a) Any two names

   (b) Conifer.

   (c) Any 5 names must include monocotyledonous and cotyledonous plants.

   (d) Any 2 names.

   (e) Any 4 names

   (f) Any five from vertebrates. (40 marks).

2. Likeness, family relationship, common plan. (18 marks)

3. All the seven must be listed (14 marks)

4. Liverfluke (three layered Invertebrate)

- Oyster (molluscs Invertebrate)
- Eagle (birds Vertebrate)
- Mudfish (Fish Vertebrate) Tiger (Mammal Vertebrate)
- Alligator (Reptile Vertebrate)
- Tsetse fly (Arthropod Invertebrate) (28 marks).

ANSWERS TO ASSIGNMENT

1. Books, shoes, belt, cloth, wool, door, chair, oil, milk, cheese, butter, drugs. planks, paper fan, frond fan, calabash, tyre, inner tube, crude oil grease or any relevant one.
2. Cutlass, hoe, guiter, belt, matches.
3. The products of respiration in man are; Energy, Carbon, (iv) Oxide and water
4. Living things can reproduce while non-living thing cannot. Living things can move while non-living cannot. Living things can respire while non-living thing cannot, Living things excrete while non-living things cannot. Living thing can eat while non- living things cannot. Living things can respond to stimuli while non -living things cannot.
5. (a) Living things can be converted to non-living things when they die.

   (b) Living things can grow, non-living things can not, However, crystals do grow.

6. (i) Broad Bean – living

   (ii) Rice non-living because the grain has been boiled before being sold.

   (iii) To convince a primary 2 School child: plant the broad bean seed and the grain of rice, you would observe after some days that:

ANSWERS TO ASSIGNMENT

1. A mixture of gases 4 Marks

2. Nitrogen, oxygen, carbon (iv) oxide, water vapour, noble gases, dust and other gases 5 Marks

3. (a) Bush burning activities increase the component of air (2)

   (b) Water vapour in wet region is higher than in the dry region. Water vapour (humidity) decreases as one moves from coastal area to the desert.

   (c) Industrial activities increase the concentration of other gases. 12 Marks

4. Must mention problem, materials, procedure, precaution, observations and conclusion 25 Marks.

5. Differences in water vapour content of the atmosphere. 8 Marks

6. Must mention at least one use of each components of air. The remaining four can come from anywhere. 14 Marks.

7. Heat from bulb increases the mobility of the air molecules/particles in the balloon. This increases the pressure of the air. This internal pressure becomes higher than atmospheric pressure hence the burst. 10 Marks.

8. Nitrogen does not react with many elements hence it will not react with fuel. It also prevents the presence of air in the tank. 10 Marks.

9. Food is oxidised to release energy. 'Water and carbon (iv) oxide. Food + oxygen ----> Energy + water and carbon (iv) oxide 10 Marks. **Total = 100 Marks**

MODULE 2: SCIENCE AND SOCIETY

ANSWERS TO ASSIGNMENT

1. Problem - (1)

Materials - candle, matches, ruler watch (4)

Procedure - Candle length measured - (1) and divided into 4 equal parts- (2) Each part was marked (1)

As the candle was being lit- (1) the starting time (1) was taken. When 114 quarter had burnt - (1) time was also taken

Observation ------------------------(10)

Conclusion --------------hours or ----------mins ------------secs - (5)

Precaution:- drought was prevented - (3) (30 marks)

2. (a) Science is a conscious and systematic search for organized knowledge about nature. (5 marks)

   (b) (i) Longing to know: The urge to dig deep into the cause of events

   (ii) Perseverance: Ability to endure the hazards, frustration and thinking demands of finding truth.

   (iii) Honesty: Reporting observations accurately; abhors falsification of information

   (iv) Open-mindedness: Approaching issues, objects and events without prejudice.

   (v) Respect for the views of others: Rarely engaging in fruitless arguments. Believe in

   issues not personality. etc. 2marks each (10)

   (c) Physics - Heat, light optics etc. Any two (2)

   Chemistry - Organic, in organic, physical. And two (2)

   Biology - Botany, Zoology (1)

3. Dentist, radio logist, cardiologist, analytical chemist, chemistry teacher (teaching) research chemist, pharmacist, soil chemist, civil engineer, electronics engineer - (15 marks)

4. Uses of science to a villager.

   a U se of fertilizer which is product of science.

   b. Use of *Omo* and other detergents

   c. Use of radio for leisure and as source of information.

   d. Use of Bicycle, cars and lorries for transport.

e. Medical treatment and use of drugs. (10 marks) Total = 100 marks

ANSWERS TO ASSIGNMENT

1 . A mixture of gases 4 Marks

2. Nitrogen, oxygen, carbon (iv) oxide, water vapour, noble gases, dust and other gases 5 Marks

3. (a) Bush burning activities increase the component of air (2)

   (b) Water vapour in wet region is higher than in the dry region. Water vapour (humidity) decreases as one moves from coastal area to the desert.

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8. Nitrogen does not react with many elements hence it will not react with fuel. It also prevents the presence of air in the tank. 10 Marks.

9. Food is oxidised to release energy. 'Water and carbon(iv) oxide. Food + oxygen ----> Energy + water and carbon (iv) oxide 10 Marks. **Total = 100 Marks**

ANSWERS TO ASSIGNMENT

1. Rain, Sea, Lake, River, Stream, Spring, Well. (14 marks)

2. In soil, under the soil, in the air, in plants, in animal (10 marks)

3. Freezes, boils, soft and hard water, evaporates, dissolves substances, colourless, odourless, tasteless. (28 marks)

4. Wash material (cloths) with water and if it lathers easily - soft water if it does not lather easily hard water (16 marks)

5. Orange, pine-apple, pawpaw, water melon, apple, any other acceptable one (20 marks)

6. Evaporates, rings of solid material remain (12 marks) Total = 100 marks

ANSWERS TO ASSIGNMENT

1. Goat, sheep, duck, turkey, cattle, pig, rabbit 16 Marks

2. People keep domestic animals for meat, eggs, for economic reason, and skins for leather works etc. 16 Marks

3. Lion, tiger, hyena, leopard, bear, dear, elephant, monkey, gorrilla, giraffe, (Any 6 -3 each) 18 Marks.

4.
   i. They contribute to national economy
   ii. They are tourist attraction
   iii. They contribute to the wholeness of natural environment
   iv. They have aesthetic value 20 Marks

5. Wild animals cannot be domesticated, they are wild and restless. They can attack or charge at their prays. Domestic animals can be trained, tamed and can be controlled by human manipulation. 30 Marks. **Total = 100 marks**

MODULE 3: PROCESS OF LIFE

1. Name of two scientists are

   (1) Jean Baptiste Larmarck.

   (2) Charles Darwin (10 marks)

2. Larmarckian theory of Use and Disuse states that an organ which becomes functionless in an organism will disappear in the offspring which that which is constantly used undergoes structural modification to fulfil its function and that these modifications acquired will be inherited by the offspring (25 marks)

   Darwin Theory of Natural Selection states that all living organism in any population or environment are engaged in struggle for existence. Those that survive and reproduce are those organism that have developed new characteristics or variation which equip them for the environment. Consequently these variation or characteristics are passed on to their young ones (25 marks)

3. An evidence in support of the theory of common ancestory is that of the development of the pentadactyl limb as seen in the modification undergone by bats and birds which suit flying, the monkey in which the five metacarpals are developed for grasping then to horses in which some of the metacarpals form the cannon bone suited for strength and speed. (25 marks)

4. The environmental factors include

   (a) Temperature

   (b) Search for food

   (c) Light and periodic variations in weather (15 marks) **Total 100 marks**

ANSWER TO THE ASSIGNMENT

1. Materials transported in the plant includes:

   1. mineral salts

   11. Food substances (carbohydrates, protein, simple sugars)

   111. Oxygen and carbon (IV) oxide.

   IV. Pigments

   v. Hormones

   VI. Water

In the case of animals the materials include;

1. Digested foods
2. Oxygen
3. Excretory products (C02, urea, water)
4. Water
5. Hormones. (20 marks)

2. The closed circulatory system is one in which the medium (blood) for transportation is enclosed in vessels: It is of two types - single circulation and double circulation.

   In single circulation blood passes through the heart once for a given complete circulation as in blood circulation of the fish.

   In double circulation, the blood passes through the heart twice. It involves pulmonary circulation during which deoxygenated blood from the heart passes through the lungs to obtain oxygen. It becomes oxygenated and goes back to the heart to be pumped out.
   The second circulation involves the heart pumping out the oxygenated blood to the various cells. The blood loses its oxygen. It then returns to the heart to be pumped back to the lungs. (20 marks)

3. Translocation is a process which involves the movement of food and water to various parts of the plant. This is achieved through the vascular bundle consisting of the xylem and phloem. While the xylem transports water and dissolved mineral salts upwards from the root to the other parts, the phloem transports manufactured food from the leaves to other parts. (15 marks)

4. Transpiration is the process which involves loss of water by the aerial parts (leaves) by evaporation through the stomata. It ensures the continuous cooling of the plant as the water evaporates and helps in the transportation of mineral salts. (10 marks)

5. The tissue which conducts water from the root to other parts is the xylem, while the phloem transports manufactured food from the leaves to other parts and even to the roots for storage. (10 marks)

6. Growth is a permanent increase in size of an organism as a result of production of new cytoplasm. (5 marks) **Total 100 marks**

ANSWERS TO ASSIGNM ENT

1. (i) Ecosystem (Ecological system) is the basic functional unit of nature and consists of the living and non -living things and the interactions between them (10 marks)

   (ii) Abiotic factor consists of all the non-living aspects of the environment - air, water, temperature. Biotic factors consists of all the living aspects of the environment. (l0 marks).

2. Five abiotic factors include; Temperature, rainfall (water), light, pH (i.e. H^+ concentration) Salinity, and topography.

Three - biotic factors include: Predation, competition; dispersal and pollination. (30 marks)

3. Density - independent factors refer to those factors which affect the population density in an environment irrespective of the what the population of the organisms in that environment is. The natural/man made disasters such as floods, bush fire, hurricane, tornado are examples of density - independent factors. In most cases it may wipe off the entire ecosystem:

   Density - dependent factor:

This deals with all those factors which affect population growth. It may increase or decrease population density. Such factors include temperature, water, if the temperature of a particular environment is favourable, there will be population growth, all other factors being good and if the tempo nature is unfavourable population density will decrease **(50 marks) Total = 100 marks.**

ANSWERS TO ASSIGNMENT

1. Natality simply refers to birth rate. Mortality simply refers to death rate. (15 marks)

2. The activities include:

   (i) Urbanization

   (ii) Pollution

   (iii) Farming (1S marks)

3. The indicator is the ever growing population of man which has gone beyond environmental resistance level. (15 marks)

4. Two ways adopted by humans to prevent limiting of her population include:

   (a) Improvement in the health care delivery

   (b) Increased production of food by applying modern scientific methods of farming (15marks)

5. Three methods of family planning include:

   1. Rhythm method

   2. Withdrawal method

   3. Use of contraceptive pills (15 marks) **Total 75 marks**

ANSWERS TO ASSIGNMENT

I. An ideal (best) association could be that in which both benefit and none loses or is harmed (mutualism). (10 marks).

(2) The host may:

   (a) develop secretions injurious to the parasite

   (b) change the habitat conducive for parasite entry

(c) develop immunity to the attacks/effects of the parasite

(d) destroy the larval stages of the parasite (20 marks)

(3) Man has associations with other groups even though not of his own making/free will

(a) Many parasites live and operate in man - plasmodium (malaria) Hookworm, Jigger (ectoparasite) and lice etc.

(b) Bacteria in the colon

(c) Worms of different types inhabit man. (20 marks) **Total = 50 marks.**

MODULE 4: LIFE AND SURVIVAL I

ANSWERS TO ASSIGNMENT

1. (i) Water

(ii) Fire

(iii) air

(iv) chemical Any 3 x 5 = 15 marks

2. (a) Description should include - location 5 marks

- period 5 marks

- types of change 5 marks

2. (b) Description should include - location 5 marks - period 5 marks

- Types of change 5 marks

3. Problem - How does water cause change in the environment.

Material:- Bowl of water or running tap, uncemented ground/sand heap first gently and later forcefully

Method: - Allow water to run on the uncemented ground/sand heap first gently and later carefully.

Observations:- Water from a deep hole at the point where it strikes the "ground". The hole becomes deeper/under from there.

Inference - Water can cause deep cut in the soil 5 marks

4 destruction of crops, livestock and poultry

- destruction of human life
- lack of arable land
- lack of crops to plant

- starvation
- thirst - drought

ANSWERS TO ASSIGNMENT

1. (a) Three parts of the human body found in the head region are the ears, the eyes and the nose.

   (b) The ear functions as an organ of hearing. The eye functions as an organ of sight. The nose functions as an organ of smell.

2. (a) Two parts of the human body found in the shoulder region are the shoulder and the wrist.

   (b) The shoulder enables one to lift his arm. The wrist acts as a link between the palm, fingers and the rest of the arm.

3. The penis is the male reproductive (sexual) organ. It is found in the lower region of the body. The vulva is the female sexual (reproductive) part as seen externally.

4. Correct diagram fully labelled

ANSWERS TO ASSIGNM ENT

1. a. Tendon.

   b. Cardiac muscles.

   c. Antagonistic pair.

2. i. Skeletal muscle - attached to bones,

   ii. Smooth muscles - digestive system, walls of blood vessels,

   iii. Cardiac muscles - heart,

3, Bending of the lower arm, The biceps muscle contract, the triceps muscles relax, The contraction of the biceps pulls on the lower arm and it bends.

4, Straightening of the lower arms, The triceps contract, the biceps relax, The contraction of the triceps pull on the lower arm thus straightening it,

ANSWERS TO ASSIGNM ENT

1. The term system refers to a group of organs performing the same function. (12 marks)

2. External respiration means the exchange of gases between the atmosphere and the blood. It is sometimes called breathing. Internal (or cell) respiration, on the other hand, means the chemical reactions in which energy is released within the cells for the maintenance of life activities. (12 marks)

3. The organs in sequence that make up the respiratory system of man are the nostrils, trachea (or wind pipe), bronchus, branchioles, air-sacs (or alveoli) and lungs. (12 marks)

4. The excretory organs of the human body are the lungs, the liver, the skin and the kidneys. (12 marks)

5. The lungs excrete carbon (IV) oxide and water vapour produced during respiration. The liver excretes bile pigments formed when red blood cells break down. (20 marks)

6. The organs that make up the central nervous system of man are the brain and spinal cord. (12 marks)

7. A voluntary action is one done consciously and is carried out by the brain. Deciding to study is an example. A reflex action is an unconscious rapid, automatic action that does not involve the brain. It is carried out by the spinal cord. Sneezing is an example. (20 marks)

   Total = 100 marks.

ANSWERS TO ASSIGNMENT

1. a. Science processes are powerful tools for learning the concepts, principles and laws of science.

   b. they are survival skills and can be transferred from one subject area to another (25 marks)

2. a. To observe means:

   i. to take in information about things around us using the senses as appropriate and safe; identifying similarities and differences; noticing details and sequence and ordering observations.

   ii. To predict means:

   to go beyond immediate evidence, and using this to suggest what will happen at some future time. (25 marks)

3. Four indicators of raising questions are:

   i. asking questions which lead to inquiry;

   ii. asking questions for information

   iii. asking questions based on hypothesis

   iv. putting questions into a testable form. (25 marks)

4. a. Testing technique and observation technique.

   In testing, all pupils are given the same examination under the same conditions.

   b. In observation, information can be gathered from a whole range of activities. (25 marks) **(Total = 100 marks)**

MODULE 5: ASSESSMENT IN BASIC SCIENCE

ANSWER TO ASSIGNMENT

1. a. FOOD WEB

    1. Cabbage
    2. flower(nectar)
    3. grasshopper
    4. slug
    5. caterpillars
    6. earthworm
    7. butterflies
    8. humans
    9. praying mantis
    10. frogs
    11. small birds
    12. large birds

As one goes up the trophic level the number of organisms decreases, the type of available organisms are also fewer.

b) 0rganisms compete among themselves for food. Bees and butterflies have to struggle for nectary juices of flowers, There are also predator (lizards frogs and toads) struggling for grasshoppers to eat. When the numbers of grasshoppers is very low, other predators will start to eat one another (praying mantis is eaten up by lizards (50 marks)

2. Producers: grass, mistletoe, orange, mango plant, mealy bug,

   Consumers: tapeworm, camel, fly, tsetse fly, ants

   Decomposers: fly, fungus (20 marks)

3. Food list eaten in last 24 hours

   Pap, milk, sugar, Bean cake, groundnut oil, rice, meat stew, eba, Okro soup with palm oil.

   Producers: Pap from corn, Bean cake from beans, rice, eba from cassava, Okro, palm oil.

Consumer: milk from cow, meat from cow, (primary) man eating Bean cake and Eba. (30 marks) **Total = 100 marks**

MODULE 6: LIFE AND SURVIVAL II

ASWERS TO ASSIGNMENT

1. A body which revolves round another body is a planet of that body. For example the earth is a planet of the sun. A body which rotates round a planet is called a satellite. For example the moon is a satellite of the earth (60 marks)

2. The temperature of the centre of the sun = 15,000.000 K The temperature of the surface of the sun = 6,000 K.

   Temperature difference = (15,000,000 - 6,000) K = 14,994,000 K (20 marks)

3. Because they contain large amounts of the lightest elements ie hydrogen and helium. (20 marks).

MODULE 7: ENERGY

ANSWERS TO ASSIGNMENT

1. motion is the change of position of a body, depending on time. There are four types of motion namely random, linear, rotational and oscillatory motion.(10 marks)

2. Rotational motion, linear motion, Random motion and Oscillatory motion.(10marks)

3. *Speed is the rate of change of distance with time.

   * Velocity is the rate of change' of distance moved with time in specified direction. ,

   * acceleration is the rate of change of velocity with time.(20marks)

4. A scalar quantity is a form of a variable that has only the magnitude while a vector quantity has both magnitude and direction.(10marks) **Total = 50marks**

ANSWERS TO ASSIGNMENT

1. Momentum is an important property of a moving object and it explains the tendency to continue moving in a straight line. By definition, momentum of a body is said to be the product of its mass and its velocity. That is momentum = mv where m= mass, v = velocity.

   The SI unit of momentum is kgm/s (1Smarks)

2. Newton's second law of motion states that the rate of change of momentum of a body is directly proportional to the force applied and takes place in the direction of the force. (15marks)

3. Impulse = Change in momentum

$= mv - mu$, *making m the subject, you have*

$= m(v - u)$

$= 10(80 - 40)$

$= 10 \times 40$

$= 400\ Ns$ (20marks) **Total = 80marks**

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