TRAINING PACKAGE ON

CONTENT AND METHODOLOGY OF TEACHING SCIENCE IN HIGHER PRIMARY SCHOOLS

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Development of Training Package on Content and Methodology of Teaching Mathematics and Science for Teachers/Headmasters of Higher Primary Schools in Karnataka

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A NOTE TO THE READER

Science books of 5th and 6th were reprinted after incorporating corrections in 1999. A new edited and corrected book of 7th standard was introduced recently in 2000. The text books were written according to the instructions by keeping number of pages to limit, which makes the writer to restrict themselves to content only. The methodology component of teaching of science was not incorporated. In order to bring an integration of content and methodology in teachers, need for preparation of module was felt. The Education Department of the Government of Karnataka requested RIE, Mysore to take up the project on the Content and Methodology of Teaching Mathematics and Science at the Higher Primary Levels.

The Project

After frequent visits to schools it was felt that a package that gives sufficient input in terms of objectives, concepts and methodology of teaching and evaluation was required. This package explains the approaches for development of concepts through number of simple classroom as well as outside classroom activities. Most of learning activities are related to day-to-day life experiences of children. A list of evaluatory questions at the end of each topic enables teachers to test the teaching inputs. Sample unit test are also suggested at the end of the units.

Development

A workshop was held at RIE, Mysore for 10 days (22nd to 31st January 2001) with the resource persons form DIET, Higher Primary School Teachers and HMs. It was agreed upon to develop an uniform format to write the activities for each topic. It was also felt that all interlinked topics from 5th, 6th and 7th standards can be clubbed and series of activities to develop lesson were to be suggested. According to the felt needs the teachers can choose relevant activities for a particular class. In first two days science text books were analysed, units and topics from respective units and their relations to previous years as prerequisites were identified. Selecting one unit and one topic at a time the package was developed. All units from three textbooks were not covered, because of shortage of time.

The format followed is as follows:

1. Unit

1.1 Title of topic:

I. Concepts

II. Objectives

III. Introduction

(a) Motivation

(b) Scope in daily life

IV. Teaching Learning activities

V. Student response/outcomes

VI. Evaluation

The learning activities identified also suggest how to conduct the activities in classrooms. The involvement of pupils in various activities is given importance. The learning taking place in pupils is reflected in their responses or learning outcomes. Since science lends itself for some outdoor activities many field activities and visits also are suggested.

How to Use the Training Package

Since large number of teachers of higher primary schools require usage of this package, a ten day workshop cum training for teachers can be arranged to cover both Mathematics and Science. Lectures, discussions, experimentation, performing simple activities can be taken up as suggested in the package. The relevance, suitability and adaptation of such activities can be tested. A flexible ten day schedule is given below.

SUGGESTED PROGRAMME SCHEDULE

Day	I Session	II Session	III Session	IV Session
I	General Discussion	Numbers and Numerals	Science	Science
II	Integers	Science	Exponents	Science
III	Fractional/ Decimal/ Percentage	Science	Problems	Science
IV	Science	Simple Interest	Science	Sets
V	Science	Algebra	Science	Products of Algebraic Expressions
VI	Equations	Science	Problems	Science
VII	Areas	Science	Mensuration	Science
VIII	Construction	Science	Science	Statistics/ Graphs
IX	Coordinate Geometry	Science	Science	Science
X	Problems on all Chapters	Science	Science	Any other Discussions

A few sample unit tests are also suggested at the end, which takes care of whole unit. Similar unit test can be designed on these lines to verify achievements of pupils. This also helps the teacher to identify difficulties of learning if any, and modify or take up remedial teaching. The teachers can try out most of the activities suggested and can also incorporate their own activities according to needs and things available.

We welcome suggestions for further improvement of this training package.

CONTENTS

UNIT I

CHARACTERS OF LIVING THINGS

1.1 Living and Non-living Things

I. Concepts

* Living things perform some activities which nonliving things do not show.

II. Objectives: To enable the students

* to identify living things
* to recognise activities of living things
* to compare living things with nonliving things

III. Introduction

(a) Motivation

* Display of many things both living and nonliving.
* Visit to garden/field to make list of things they see.
* Recalling names of things that are seen around.

(b) Scope in daily life

* The child will be able to identify living things, their characters and classify the things into living and nonliving.

IV. Teaching-learning activities

* Teacher displays many things on table. Things include stone, plants, scale, dry leaf, insect, piece of chalk, cockroach, etc.
* Teacher asks students to observe carefully a stone and grasshopper and list down observations.

* Asks students to compare a potted plant and scale. Asks students to tell what might happen to size of plant and scale after one week.

V. Student response/outcomes

* Students observe movement in insect but not in stone. Asks for reasons.
* Students tell plant grows but not scale. Asks for reasons.
* Summarises that insect and plant are living things and stone and scale are non-living.
* Asks students to classify things kept on table into living and non-living.

VI. Evaluation

* Classify the following into living and non-living things: dogs, rose, plant, brick, housefly, book, scale, cockroach, bench, pencil, bag, bird, cat.
* Make a list of five non-living things found in your house.
* How do you say cat is a living thing ?
* Observe a plant for its growth, measure height daily and record the heights daily.

Day	1	2	3	4	5	6	7
Height in cms							

1.2 Basic Characters of Living Things

I. Concepts

* All living things show basic characters likes respiration, movements, response to stimulus, growth and reproduction.

II. **Objectives**: To enable the students

* to recognise respiration in living things.
* to recognise movements in living things.
* to observe the growth.
* to recognise importance of reproduction.
* to apply the knowledge to reason out the crop production, population growth, etc.

III. **Introduction**

(a) Motivation

* Count the chest movement of a student while sitting and after running.
* Observation of animals moving to collect food.
* Observation of different stages of germination of a seed.
* Observation of photos from childhood to present stage.
* Making a student to do some work.
* Showing a picture of dog and puppies.

(b) Scope in daily life

* Students recognises that living thing do some activities for survival.
* Increase in population is due to reproduction.
* Grains, food stuffs are produced in large quantities to meet demand.

IV. **Teaching-learning activities**

* Teacher asks students to count rate breathing and asks students to run for short distance and count rate of breathing.
* Teacher asks students to blow air in lime water.

* Asks students to place few insects in a bottle and cover the mouth tightly with lid. Observe after one day.
* Teacher calls a student to pick up a chalk from the table.
* Asks student to record growth of a germinating seed.
* Discusses about over population, scarcity of food in our country.

V. Student response/outcomes

* All living thing breath.
* Without air living thing cannot survive.
* Student responds to teacher's stimulus.
* Students observe living things grow.
* Reproduction is important phenomenon of living things.
* Carbon dioxide is produced during breathing.

VI. Evaluation

* Touch with a stick a "Touch me not plant" and observe movements. Take thin and thick sticks are perform activity.
* Observe figure 11.14 on page 97 of VII test book. Record changes in each diagram.
* Take a wooden box, fill with soil, put water. Sow one seed daily for six days. Observe various changes and record.
* Observe the fish in an aquarium for its movements, breathing and count number of breathing.
* Using "lung model", explain how breathing takes place.

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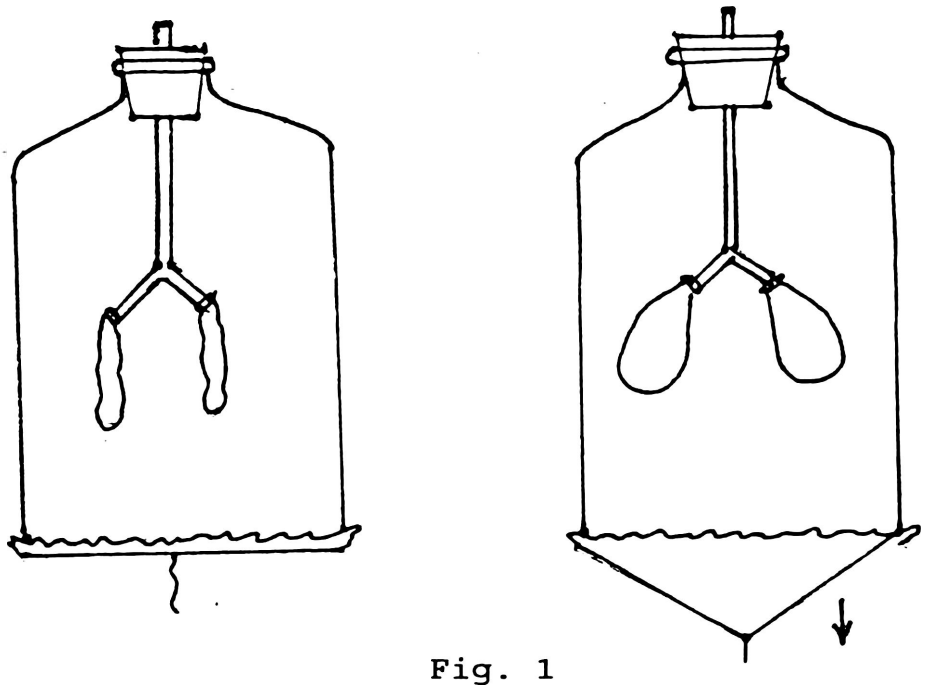


Fig. 1

1.3 Difference between plants and animals

I. Concepts

* Plants and animals have specific body parts.
* Plants differ from that of animals in some aspects.
* Animals can move from one place to another place whereas plants are stationary.
* Plants can prepare their own food and animals cannot prepare their own food.

II. Objectives: To enable the students

* to identify the body parts of living things, i.e. plants and animals.
* to identify the differences between plants and animals.
* to recognise plants as producers and animals as consumer.

III. Introduction

(a) Motivation

* Name the living things around you and group them into plant and animals.

* Observing the parts of the uprooted plant.
* Observing the body parts of animals.
* Prepare the list of all the food items we use and classify them into plant source and animal source.

(b) Scope in daily life

* Child will be able to identify living things, their differences, their uses and classifying them into plants and animals.

IV. Teaching-learning activities

* Teacher mentions the living beings around us and group them into plants and animals. E.g.: Living being includes balsom plant, rose, plant, hibiscus plant, mango tree, rat, bird, dog, etc.
* Teacher asks students to observe carefully a mango tree and a dog and list down their observation.
* Asks students to compare tomato plant and a cow. Asks students to tell how they derive their food.
* Teacher asks students to observe the food of cow, tiger and crow.

V. Student response/outcomes

* Students observe living beings around them and group them into plants and animals.
* Students observe that plant (mango tree) has root, stem, leaves, branches, flower and fruit as its parts and animals (dog) have head, trunk and limbs in their body.
* Plants do not move from one place to another place but animals move from place to place.

* Students observe that cow depends on plant product for their food and plants prepare their own food. Asks for reason.
* Teacher summarises that green plants have chlorophyll pigment plants use sunlight, carbondioxide, water and prepare food and releases oxygen to the atmosphere during the process of photosynthesis.
* Students observe the food of cow, tiger and crow as plant product, flesh of other animals and both plant and animal product respectively.
* Teacher summarises that animals cannot prepare their own food due to the absence of chlorophyll and hence they depend on plant product for their food.

VI. Evaluation

* What are the main difference between plants and animals.
* What is photosynthesis ?
* Why leaves are green in colour ?
* Why animals depends on plants for their food ?
* How animals are useful to plants ?

1.4 Cells

I. Concepts

All organisms are made up of a basic structural and functional unit called cell.

* Cells are microscopic and have nucleus, cytoplasm and a thin delicate membrane called cell membrane.
* Plant cell differs from that of animal cell in some aspects.

* A group of similar cells performing similar function is called as tissues.

II. **Objectives**: To enable the students

* to recognise that all (living) organisms are made up of a basic unit called "cell".
* to identify the parts of the cell.
* to develop the skill of drawing the structure of cell and labelling.
* to list down functions of parts of cell.
* to differentiate between plant and animal cell.

III. **Introduction**

(a) **Motivation**

* Observation of pond water through microscope.
* Mounting check cells and observing through microscopes.
* Mounting onion peel (stained) and observe through microscope.
* Mounting permanent slides of animal and plant cells.

IV. **Teaching-learning activities**

* Observation of a drop of pond water through microscope and identifying the organisms present in it.
* Scrapes off the cells lining the check with the help of tooth pick. Transfer these on to the slide and mount in a drop of water. Put a cover slip and examine under microscope.
* With a mounted needle remove onion peel, stain and mount in water on a slide.

* Teacher mounts the permanent slides of plant and animal cell (like leaf, stem, skin, etc.).

V. Student response/outcomes

* Teacher draws the various types of organisms found in pond water like Amoeba, Euglena, Paramoecium, etc. and label their parts.
* Students observe various types of organisms found in pond water and identify and draw them.
* Students observe centrally located nucleus, cell membrane and cytoplasm in the mounted check cell.
* Students observe nucleus, cytoplasm, cell wall and cell membrane in the mounted onion peel.
* Teacher explains that cells are the basic unit in an organisms.
* Teacher draws both plant cell (onion peel) and animal cell (cheek cell) on blackboard.
* Students will be able to differentiate between plant and animal cell.
* Students observes the mounted permanent slide and will be able to differential them into plant and animal cells.
* Students observe that cells are arranged in groups.
* Teacher explains group of similar cells performs similar functions and are called as tissues.

VI. Evaluation

* What are microscopic organisms ?
* Name the organisms present in pond water.
* What are the differences between plant and animal cell ?

* What is cell ?
* Draw a labelled plant and animal cell.
* What is a tissue ?
* What is the difference between cell and a tissue ?

1.5 Tissues

I. Concepts

* Tissue is a group of cells having a common origin, structure and performing a similar function.
* The structure of cells in a tissue is according to the function they perform.
* Different types of plant and animal tissues are epidermal tissue, meristamatic tissue, vascular tissue, epithelial tissue, muscular tissue, connective tissue and nervous tissue.

II. Objectives: To enable the students to

* recognise that cells of same structure and origin performs same function.
* identify different types of tissues related to their function.
* understand that different tissues operate together to perform a particular function called organ.
* develop the skill of drawing.

III. Introduction

(a) Motivation

* Permanent slides of different parts of the plant like leaf and stem.

* Permanent slides of animal tissues like nerve cell, blood, skin.
* Display the charts of plant and animal tissues.
* Transverse section of Balsom plant (stem) to show the presence of xylem.

(b) Scope in daily life

* Child will be able to identify the importance of tissues in performing specific function of the body.

IV. Teaching-learning activities

* Teacher mounts the permanent slides of leaf, stem, nerve cell and blood, skin and asks students to observe the cells carefully and list down their observations.
* Asks students to draw and compare the permanent slides of leaf and skin. Ask students to observe the difference between the structure of cells.
* Asks students to draw and compare the permanent slides of stem and nerve cell, and to observe the difference between their structure.
* Keep a rooted balsom plant in red coloured water for two hours. Observe red lines inside. Cut section of stem and observe.

V. Student response/outcomes

* Students observe the structure of leaf and stem. Asks for difference.
* Students observe the structure of different tissues in leaf and stem.

* Teacher summarises the function of different plant tissues namely meristamatic tissue, epidermal tissue, parenchyma, sclerenchyma and collenchyma, and draws them.
* Students observe the presence of vascular tissue in plants, i.e. xylem and phloem. Xylem conducts coloured water in the experiment.
* Students observe the structure of blood and nervous tissue.
* Teacher summarises the function of different types of animal tissues namely epithelial tissue, muscular tissue, connective tissue and nervous tissue and draw them.
* Asks students to classify the tissues into plant and animal tissues.

VI. Evaluation

* What is a tissue ?
* What are the different types of plant and animal tissues ?
* Why meristamatic tissue is important in plant growth ?
* What are the important functions of nervous tissue ?
* Name the animal tissue which is responsible for movement ?

UNIT II

LIFE PROCESSES-I: GROWTH, ENERGY

2.1 Growth - Germination of Seed

I. Concepts

* Generally seeds give rise to plants.
* Germination of seed require suitable conditions such as optimum temperature, sunlight, water with mineral salts.
* Plants produce seeds in excess.

II. Objectives: To enable the students

* to acquire knowledge about the conditions that are required for the growth of the plant or germination of seed.
* to reason out for the failure of the sprouting of seed.
* to apply the knowledge acquired to do the activity.
* to develop the skill of performing experiments and observation.

III. Introduction

(a) Motivation

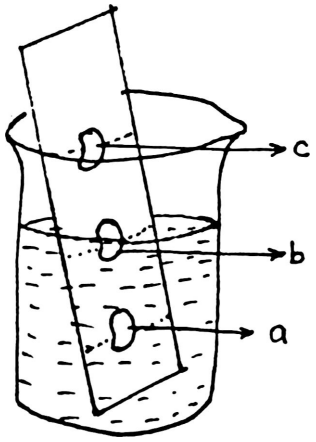
* Observation of _ermination of seed.
* Listing out plants that give seeds and recalling the plants that can reproduce vegetatively.

(b) Scope in daily life

* Student develops the skill of planting trees.
* Student uses scientific method to plant trees.
* Student understands the conditions that are required for the growth of the particular plant.

IV. Teaching-learning activities

* Teacher asks the students to list out plants that give seeds and the plants that do not.
* Teacher makes the students to sow some seeds in a pot with dry mud (without water) and some seeds in a pot with wet mud (with water) and asks them to observe for few days.
* Teacher asks the students to do the activity as follows. Set up the apparatus as shown in the figure and observe for 1-3 days.



a, b, c are seeds

a -> Immersed in water

b -> Just in contact with water

c -> No contact with water

* Teacher asks the students to plant two types of seeds:
  a. young seed
  b. mature seed, in two similar pots and water them.
* Plant 2 or 3 different types of seeds in same pot.

V. Student response/outcomes

* Students list out number of plants that give seeds and those which do not.
* Students conclude that germination of seed require water.
* Students conclude that germination of seed require air as well as water in sufficient amount.

* Students infer that only mature seeds develop.
* Students understand that a particular seed gives rise to a particular plant.

VI. Evaluation

* What are the conditions that are required for the germination of seed ?
* Name some seed giving plants.
* Why do plant produce more seeds ?
* A farmer planted a plant in a pot, watered regular and had kept the pot in a box. The plant did not grow. Why ?
* Sow some green gram and bengal gram seeds and observe the germination of the seeds and record it.

2.2 Energy

I. Concepts

* Energy is ability to do the work.
* There are different forms of energy such as mechanical energy that includes potential and kinetic energy, chemical energy, heat energy, electrical energy, etc.
* One form of energy can be transformed to other forms of energy.
* We can obtain energy from sun, water, wind and biomass.
* Energy can be classified as renewable and non-renewable source of energy.
* In living organisms energy is provided by breaking down of food.

II. Objectives: To enable the students to:

* recall different forms and source of energy.

* compare and contrast the energy obtained from different sources.
* see relationship between the production of energy and utilisation of energy.
* identify different forms of energy and understand the transformation of energy.
* realises the problems of energy crisis and apply his knowledge to solve problem based as energy.

III. Introduction

(a) Motivation

* Taking students to hydroelectric power stations.
* Asking them if they can give example of a type of work that can be done without the utilisation of energy.
* Asking them to observe certain activities like moving of blades of fan, walking, driving vehicle, playing, eating, etc. and asking them, what is the thing that enables them to do all these activities.

(b) Scope in daily life

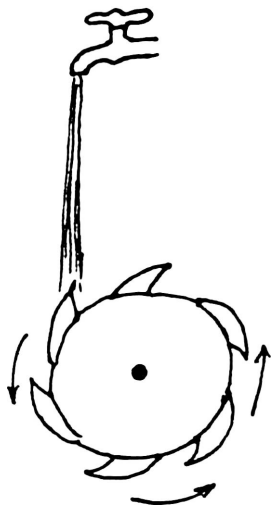
* Students realise that they should not waste energy unnecessarily.
* Students apply the knowledge obtained to solve the day-to-day problems related to energy.
* Students realises that as far as possible they must go for renewable type of energy.
* Students may take steps to conserve energy.

IV. Teaching-learning activities

* List down food items used by students.

* Asks the student to do the following activity:

  Store water in a tank at a certain height fitted with a tap at the bottom. Allow the water to fall on a peddle wheel. The wheel turns.



* Asks the student to take a hard glass test tube. Fill three fourth of it with water. Put a cork tightly on the mouth of the test tube. Heat the bottom of the test tube. Water begins to boil and later the cork flies off with a big sound. Why ? Discuss.
* Make a paper wind mill and asks students to blow air on it. It rotates. Ask them to observe as it rotates.
* Make a list of examples in daily life wherein one form of energy is transformed into another.
* Visit different hydroelectric power stations in Karnataka and know how the electricity is produced.
* Ask students to visit a village and study the method of preparation and use of gobar gas and collect the pictures.

V. Student response/outcomes

* Students observe the way of conservation of energy or conversion of potential energy to kinetic energy and understands the law of conservation of energy.

* Students conclude that energy can be obtained from steam too.
* Students inform that wind mills work drawing energy from wind.
* Students establish relationship between various types of energies and how they are transformed from one form to another.
* Students recognise and recall the method by which electricity is produced.
* Students conclude that instead of burning cow dung cake, gobar gas can be obtained from cow dung which accounts for more energy.

VI. Evaluation

* Give two examples wherein potential energy is converted into kinetic energy.
* Differentiate between renewable and non-renewable sources of energy. Which type of energy should be preferred more and why ?
* What steps would you take to solve the problems of energy crisis ?
* In photography which energy is converted into which energy.
* In an electric fan electrical energy is transformed to which energy ?
* How will you show that moving objects posses mechanical energy ?
* Which is the main source of energy for living plants and animals ? Why ?

2.3 Plant and Animal Organisation

I. Concepts

* Plants and animals have different parts of the body to perform certain functions.
* Structure of parts of plants and animals are suited to their functions.

II. **Objectives**: Students enable to

* recognise different parts plants and animals.
* identify functions of each part.
* relate the structure of organ to its functions.

III. Introduction

(a) Motivation

* Showing a rooted plant and recognising parts of plants.
* Identification of parts of human body.

(b) Scope in daily life

* Students can identify different parts of any plant or animal and their functions. They also identify structural modifications.

IV. Teaching-learning activities

* Teacher bring 4-5 samples of rooted plants and asks students to write down different parts of each plant.
* Asks students to record shape, colour of each part.
* Teacher shows each part like root, stem, etc. their location and explains their functions
* Teacher asks a student to remove plant from a pot.
* Students locate the stem, parts of its.
* Students recognise colour of leaves, flower, etc.

* Students are asked observe a fruit and its parts.
* Teacher asks students identify parts of human body.
* Teacher asks the students to perform some activities with head, hand, leg, etc.

V. Student response/outcomes

* Students recognise that all plants have parts like root, stem, leaves, flower and fruits, etc.
* Students identify location of root, stem and their colour with respect to soil.
* Roots help in fixing of plant into soil, absorption of water, etc.
* Stem is above the soil, carries water, to leaves. Stem also bears branches, leaves, flowers, etc.
* Leaves are green in colour to prepare food, flowers are attractive part to attract insects tfor pollination.
* Fruits store food and produce seeds.
* Recognises parts of human body and list down.
* Students perform activities like walking, lifting boot, eating, seeing with the help of different organs.

VI. Evaluation

* Match the following parts with their functions.

A	B
a. Root	reproduction
b. Seed	conducts water
c. Leaf	fixing into soil
d. Stem	production of food

* Match the following sense of organs with their functions.

A	B
a. Nose	hearing
b. Tongue	touch
c. Eyes	smelling
d. Ears	tasting
e. Skin	seeing

* Which parts of our body performs following functions ?
  a. Walking
  b. Breaking stick
  c. Hearing

2.4 Food Producers and Consumers

I. Concepts

* Most of the plants are called as producers, as they prepare food by photosynthesis.
* All animals are considered as consumers as they directly or indirectly depend upon plants for their food.
* Based on the type of food, consumers are further classified as primary consumers (herbivores), secondary consumers and tertiary consumers (carnivores).

II. Objectives: To enable the students to

* define producers and consumers.
* cite examples for different types of consumers and producers.
* see relationship between the producers and consumers.
* apply the knowledge acquired to link producer to consumer.
* apply the knowledge in citing examples of components of ecosystem.

III. Introduction

(a) Motivation

* Showing the pictures or charts depicting food chain.
* Displaying the samples of many producers (plants) and pictures of different types of consumers and asking them to observe.

(b) Scope in daily life

* Students recognises the tropic level of each producer and consumer.
* Students understands the importance of each of producers and consumers.
* Students relates one organism with other in the concept of food chain and food web.

IV. Teaching-learning activities

* Observation of an acquarium an artificial ecosystem.
* Observation of a pond and lists out the plants and animals that reside in it.
* Asking them to prepare charts depicting food chain.
* Visiting a forest and park.
* Classifies plants as producers with reasons, animals as consumers with reasons. Give examples.

V. Student response/outcomes

* Students observe each individual of acquarium and inform that the water plants like hydrilla are the producers and the fishes are consumers. Students discuss with teacher about the producers and consumers.

* Students recognise the producer and the different consumers in the pond.
* Students prepare charts applying the knowledge that they have acquired.
* Students discusses with the teacher and with their classmates about the various plants and animals of forest. Writes food chain.

VI. Evaluation

* Name the producers in a garden.
* What are herbivores ? Give examples.
* What are producers ? Give one example.
* Prepare a chart depicting food chain.
* What are carnivorous animals ?

2.5 Balance in Nature

I. Concepts

* All living beings are interdependent on each other.
* Animals including man depend on plants and plants in turn depend on animals.
* All living beings are dependent on non-living things in the environment.
* The population of all type of living beings are supposed to be in proportion otherwise the balance in nature is disturbed.

II. Objectives: To enable the students to

* acquire knowledge about the interdependence of various living beings in nature.
* recognise each tropic level in food chain.

* establish relationship between producers and consumers.
* infer that there has to be a balance in the population of each species, otherwise it is going to upset the natural equilibrium.

III. Introduction

(a) Motivation

* Ask the students to list out the food materials got from the plants and animals.
* Showing the chart of food chain.
* Showing the pictures of destructed monuments due to pollution.
* Showing the pictures of endangered and extinct species.

(b) Scope in daily life

* Students reasons out the problems of pollution and its ill effects, ecological imbalance.
* Students recognises the endangered species and tries to protect them.
* Student does not kill animals unnecessarily.
* Students respect every individual's life.

IV. Teaching-learning activities

* Ask the students to list out the food materials that are obtained from plants and animals.
* Ask the students prepare the chart involving the uses of plants and animals.
* Ask the students to list out as many herbivorous and carnivorous animals as they can.

* Ask the students to write a chart to represent food chain in nature.
* Discussion about destruction of parts of food chain.
* Give example of how destruction of frog leads to destruction of plants and crops.

V. Student response/outcomes

* Students make a list of all food materials that are obtained from the plants and animals.
* Students prepare the chart depicting the uses of plants and animals, and collect the materials and arrange an exhibition.
* Students will recognise the useful plants and animals.
* Students list out number of herbivorous and carnivorous animals.
* Students prepare the chart representing food chain.
* Students discuss imbalance in nature caused by human activities.

VI. Evaluation

* How do animals depend on plants ?
* How do plants depend on animals ?
* What will happens if many plants are cut form forest ?
* What steps would you take to maintain balance in nature ?
* Write about Vanamahotsava.

2.6 Food - Photosynthesis in Plants

I. Concepts

* Plant prepare their own food by a process called photosynthesis.

* Plants with chlorophyll use CO_2, H_2O and sunlight to prepare carbohydrates (food) and give out oxygen.
* Plants are called as producers.

II. Objectives: To enable the students to

* define term photosynthesis.
* recognise that all green plants are called as producers.
* explain the whole process of photosynthesis.
* correlate the process of photosynthesis and respiration in animals.

III. Introduction

(a) Motivation

* Asks students to list down food crops and plants that give fruits.
* Asks students to identify colour of leaf of plants.
* Keep two pots with similar plants, one in a dark room and the other one outside exposing to the sun light. Ask the students to observe.
* Observation of food production in a healthy plant and comparing with that of food production.

(b) Scope in daily life

* Students understands the importance of sunlight and its role in photosynthesis.
* He will apply the knowledge in practical life in cultivating crops or plant trees.

IV. Teaching-learning activities

* Teacher asks the students to take two similar potted plants and ask them to keep one potted plant in a dark

room and the other outside exposed to the sunlight for two days. Then the students will be asked to observe the plants.

* Students are asked observe the plant and its yield (fruit or grains) of a healthy plant and so also the plants without leaves or dechlorophyll or yellowed leaves.
* Teacher asks the students to take two similar potted plants and to remove the leaves of one plant and keep both the plants outside.
* Discussion of the process of "photosynthesis".

V. Student response/outcomes

* Students observe that the plant that was kept in dark room drooped but the other plant kept outside looks healthy.
* Students infer that chlorophyll is necessary for the process of photosynthesis.
* Students conclude that leaves are the organs responsible for photosynthesis and chlorophyll is present.
* Students infer that the very important O_2 gas is evolved during the process of photosynthesis.
* They observe that CO_2 is required for the process.

Discussion with students

* Teacher discusses about the raw materials that are required for the process.
* Teacher explains about the products of the process photosynthesis and the role of H_2O in the process.

VI. Evaluation

* What are the raw materials that are required for the process of photosynthesis ?

* What are the products of the photosynthetic process ?
* Enumerate the importance of photosynthesis.
* How will you show that CO_2 is necessary for photosynthesis?
* How will show that H_2O is required for the process of photosynthesis ?

UNIT III

LIFE PROCESSES-II: NUTRITION, DIGESTION

3.1 Nutrition

I. Concepts

* All organisms need food for their survival/to perform various activities.
* Energy is obtained from the food we take.
* Green plants prepare their own food but animals depend on plants either directly or indirectly.
* On the basis of their eating habits, animals are classified into herbivores, carnivores and omnivores.

II. Objectives: To enable the students to

* identify the food items of the organisms.
* identify the animals and their food.
* recognise from where these food items are obtained.
* recall the process of photosynthesis.
* recognise autotrophs, heterotrops and their types in nature.

III. Introduction

(a) Motivation

* Students will be asked to recall how plants get their food.
* Visit to a garden/zoo and to list down the food different animals.
* Students will be asked to list out the food of the following animals - lizard, frog, cow, crow, sheep, birds, lion, tiger, mosquito, elephant.

(b) Scope in daily life

* Students recognise that food is the main source of energy for all living organisms and child will be able to identify autotrophs and heterotrophs.

IV. Teaching-learning activities

* Students will be asked to reason out why organisms need food.
* Students will be taken to the field/zoo and ask them to list down the foot of plants and animals which they see.
* Teacher asks students to observe carefully, the food of tiger, lion and cow and sheep.
* Asks students to compare the food of dog, rabbit, crow, lion, elephant, frog and man.

V. Student response/outcomes

* Students recall that food is the main source of energy for organisms to perform various activities.
* Students tell that plants prepare their own food but animals depends on plants or other animals for their food. Asks for reasons.
* Teacher summarises the process of photosynthesis in plants and introduce the word autotrophs.
* Students observe the food of animals and infer that animals cannot prepare their own food and hence they depend on plants or other animals for their food.
* Teacher summarises and introduce the word heterotrophs for animals.

* Students observe the food of cow, sheep and lion and tiger as plant and animal products respectively.
* Teacher summarises that plant eating animals as herbivores and flesh eating animals as carnivore.
* Students observe the food of dog, crow, cockroach as both plant and animal product.
* Teacher summarises that both plant and flesh eating animals are called as omnivores.
* Asks students to classify the animals based on their food: cockroach, butterfly, frog, elephant, cheetha, giraffe, leopard.
* Different types of teeth help in cutting, tearing and grinding food in animals and man (incisors, canines and molar teeth).

VI. Evaluation

* What is photosynthesis ? Why is it important ?
* Why do animals depends on plants for their food ?
* Classify the following animals into herbivore, carnivore and omnivore: dog, cat, lizard, mosquito, snake, vulture, parrot, deer, elephant.
* Make a list of any five omnivore found in your locality.

3.2 Nutrition in unicellular and multicellular living beings

I. Concepts

* Nutrition is an unique process carried out through specific organs in animals.

* Mode of nutrition varies from unicellular organisms to multicellular organisms.
* In unicellular organisms, digestion takes place within a cell and undigested food is thrown out.
* In multicellular organisms, digestion is performed by specific organs.
* Digestion is a process of breaking down of complex food in simpler forms in presence of enzymes.

II. Objectives: To enable the students to

* identify the importance of nutrition in animals.
* recognise the mode of nutrition in unicellular and multicellular organisms.
* recognise that unicellular organisms have no special organs for digestion.
* recognise the importance of enzymes in the process of digestion.

III. Introduction

(a) Motivation

* Charts showing the process of nutrition in amoeba and hydra.
* Model/chart of human digestive system.

IV. Teaching-learning activities

* Teacher shows slide of amoeba and hydra and display the charts showing the process of nutrition in amoeba and hydra.
* Teacher asks students to observe the chart carefully and identify the differences between amoeba and hydra in their mode of nutrition.

* Teacher displays the chart/model of human digestive system.
* Teacher asks students to compare amoeba and hydra with that of human.

V. Student response/outcomes

* Students observe that in amoeba, there is no special region/organells for food intake and food is captured by pseudopadia. Teacher explains the mechanism.
* In hydra, finger like (tentacles) structures present at the tip helps to capture food. Teacher explains the mechanism.
* Students recognise specific organs and organ system in human digestive system: mouth, oesophagus, stomach, intestine, etc.
* Teacher summarises the role of different parts of the digestive system in higher animals.
* Teacher explains that digestion of food in all animals takes place in presence of enzymes.

VI. Evaluation

* How amoeba differs from that of hydra in the mode of nutrition ?
* Draw figure to show the process of nutrition in amoeba and hydra.
* Draw the human digestive system and explain. What is the role of enzyme ?

3.3 Food and Food Components

I. Concepts

* Food is the main source of energy.
* Food is composed of different types of basic constituents namely carbohydrates, proteins, fats, minerals, vitamins and water.
* Lack of any one of these constituents will impair normal healthy development.

II. Objectives: To enable the students to

* recognise the importance of food for various life activities.
* identify the different constituents of food.
* classify the food based on their function.

III. Introduction

(a) Motivation

* Charts showing various food items.
* Lists out the various types of food items that we eat in morning, during day and at night. Food item includes rice, ragi, wheat, milk, fish, meat, egg, dal, fruits, vegetables.

(b) Scope in daily life

* Child will understand that food gives energy and recognise that food we take should have all the components.

IV. Teaching-learning activities

* Teacher ask students to list out the various types of food that we use everyday.

* Teacher asks students to recognise the importance of rice, wheat, ragi, vegetables, milk, etc. in our every day meal.
* Teacher asks students to reason out why we eat rice/ragi/ wheat/jowar/bajra everyday.
* Teacher asks students to compare rice with that of ghee, butter and oil and their quantity in our diet.
* Teacher tells students why some seeds are germinated before using (i.e. sprouted grams).
* Discusses students to recognise the importance of egg, pulses, milk, green leafy vegetables in our diet.
* Asks students to list down the food items which help us to grow.
* Teacher asks students to find out the importance of fruits and vegetables in our diet.

V. Student response/outcomes

* Students will make a list of different types of food we eat everyday.
* Students can reason out that rice/ragi/chapati (wheat)/ bajra/jowar in the diet provides energy to do work.
* Students list out some of the energy giving food and the importance of sugar, ghee in the diet and are introduced the word carbohydrates and fats.
* Students understand about the body building food and their importance, i.e. for maintenance of our body and to restore the wear and tare of the body and introduce the words proteins.
* Students summarises the protective food and their importance in the diet, i.e. about vitamins and minerals.

* Teacher summarises the food and food components and introduce the word balanced diet and its importance.

VI. Evaluation

* Why do we need energy ?
* What are nutrients ?
* What are the different constituents of food ? Give two examples.
* What are body building food ?
* List out any five food items which contains different constituents.
* Write the importance of the following in our diet: (a) proteins, (b) carbohydrates, (c) vitamins, (d) minerals
* Classify the following food items into carbohydrates, fats, proteins, vitamins or minerals sources.

  cereals, carrot, fish, vegetables, banana, lemon, ghee, palak, pulses, fruits, egg yolk, orange, milk, meat, nuts, guava.

3.4 Digestive System and Process of Digestion

I. Concepts

* Nutrition is an unique phenome on in animals.
* Nutrition in animals involves five steps namely ingestion, digestion, absorption, assimilation and ejection.
* Digestion is a process of breaking down of complex organic molecules into simpler and diffusable form in presence of enzymes.
* Food from mouth passes through a track/system called digestive system or alimentary canal.

* Digestive system includes mouth,buccal cavity, oesophagus, stomach,small intestine, large intestine, rectum and anus.
* Digestive system is associated with certain glands namely salivary gland, gastric gland, intestinal gland, liver, pancreas and they produce some secretion.

II. **Objectives**: To enable the students to

* acquire knowledge about nutrition in animals.
* understand the importance of nutrition in animals and its process (i.e. ingestion,digestion,absorption, assimilation and ejection).
* describe the role of mouth, stomach and intestine in digestion of food.
* develop the skill of drawing.
* apply the knowledge of various process involved in nutrition in other animals.

III. **Introduction**

(a) Motivation

* display the chart/model of human digestive system.
* recall the preliminary steps involved in digestion.

(b) Scope in daily life

* Child will understand that food must be chewed correctly which will help in the process of absorption and assimilation and undigested food is thrown out/eliminated out of the body.

IV. **Teaching-learning activities**

* Teacher asks students to observe the mode of nutrition in different animals and the preliminary steps involved in it.

* Teacher asks students to observe the food before chewing and after chewing. Asks for reason.
* Asks students to observe the function of tongue and its importance.
* Students will be asked about the fate of chewed food.
* Teacher display the chart of human digestive system and asks students to observe the track or path.
* Teacher asks students to keep some beaten rice in mouth for few minutes and taste it.

V. Student response/outcomes

* Students observe that all animals take food through the mouth where it is chewed.
* Teacher introduce the word ingestion for taking food in.
* Students observe that complex solid food is chewed in the mouth with the help of teeth and tongue, and is made soft and easily swallowed.
* Teacher introduce the word mastication and digestion, and summarises the mechanical digestion.
* Students observe the production of saliva from tongue and teacher explains the presence of salivary gland in mouth and the release of enzyme saliva.
* Students recognise that beaten rise tastes sweet.
* Students observe in chart/model that chewed food from mouth enters into stomach through oesophagus. And from stomach to small and large intestine.
* Teacher summarise the absorption and assimilation of food in stomach and small intestine.

* Teacher explains about the role of gastric gland, intestinal gland, liver and pancreas and absorbed food is transported by blood and supplied to different parts of the body, and used for various function.
* Students observe and infer that undigested food material is eliminated out of the body through rectum and anus.
* Students recognise that carbohydrates are converted glucose, facts into fatty acids and proteins in amino acids and are absorbed.

Chart showing different types of glands secret juice, enzymes present limit acts on which component of food and product

Name of the gland	Secretion of juice	Enzymes	Acts on food compounds	Place where it found	End product food components
Salivary gland	Saliva	Amylase	Carbo-hydrates	Mouth	Glucose
Gastric gland	Gastric juice	Rennin Pepsin	Milk protein Proteins	Stomach	Peptones (simple proteins)
Liver	Bile juice		Conrents to alkaline medium	Intestine	-
Pancreatic gland	Pancreatic juice	Amylase Trypsim Lipase	Carbo-hydrates Proteins/ Peptone Lipids (Fats)	Intestine	Glucose, Amino acids Fatty acids & Glycerol
Intestine gland	Intestine juice	Proteo-lytic enzymes Carbo-hydrates	Proteins Carbo-hydrate	Intestine	Amino acids and Glucose

VI. Evaluation

* What is digestion ?
* Explain the steps involved in animal nutrition.
* Draw a neat labelled diagram of human digestive system.
* Prepare a table showing the fate of food in the following regions of alimentary canal: (a) mouth, (b) stomach, (c) small intestine.
* Mention the function of liver and pancreas.

Match the following

Name of gland A	Secretion B
a. Salivary gland	intestinal juice
b. Gastric gland	pancreatic juice
c. Liver	saliva
d. Pancreas	gastric juice
e. Intestine	bile juice

UNIT IV

LIFE PROCESSES-III: RESPIRATION

4.1 Respiration in Lower Animals

I. Concepts

* Respiration is an unique phenomenon among all organisms.
* During respiration energy which is trapped in food is released by oxidation.
* There are two main parts in the process of respiration, i.e. breathing and using oxygen in the cells for releasing energy.
* Respiratory organs vary from organism to organism but lower organisms like Amoeba, Planaria, Euglena have no special respiratory organs.
* Aquatic organisms have gills nad terrestrial organisms have lungs as respiratory organs.
* For some lower organisms, oxygen is not necessary for respiration and such a type of respiration is called as Anaerobic respiration and those organisms which need oxygen for respiration is called as aerobic respiration.

II. Objectives: To enable the students to

* acquire knowledge about respiration in animals.
* understand the importance of oxygen.
* identify the different respiratory organs in different animals.

III. Introduction

(a) Motivation

* Observing aquarium to identify the respiratory organs of aquatic organisms.

* Identifying the respiratory organs of frog, leech and earthworm.
* Disection of frog and cockroach to show their respiratory organs.
* Experiment to demonstrate that carbondioxide is released during aerobic respiration.

(b) Scope in daily life

* The child will be able to understand that life cannot exist without breathing and during respiration oxygen is absorbed and carbondioxide is released by organisms.

IV. Teaching-learning activities

* Teacher asks students to observe fish in the aquarium and to identify the respiratory organ.
* Students touch and feel the nature of skin in leech and earthworm.
* Students perform the experiment by blowing air into a beaker containing lime water.
* Students will be asked to notice the change in conversion of milk into curd and fermentation of grape juice.

V. Student response/outcomes

* Students observe the fish in aquarium and identify gills as the respiratory organs.
* Teacher summarises that fish (aquatic organism) uses the oxygen dissolved in water for respiration through gills.
* Students observe the presence of moist skin in leech and earthworm.

* Teacher summarises the role of skin as a respiratory organ.
* Students blow air into lime water and infer the liberation of carbondioxide during respiration.
* Teacher explains about inspiration and expiration.
* Teacher explains the mechanism of respiration in lower organisms such as amoeba and planaria by simple diffusion of gases.
* Students observe the presence of microbes in curd (through microscope) and grape juice and teacher explains about anaerobic respiration in lower organisms such as bacteria and aerobic respiration in higher organisms.
* Students observe the presence of lungs in disected frog and trachea in cockroach.
* Teacher summarises that as a result of respiration, assimilated food is oxidised/burnt and energy is released for various activities and CO_2 is liberated out of the body.

VI. Evaluation

* What is respiration ?
* Differentiate between aerobic and anaerobic respiration.
* Name the respiratory organs of the following animals.
  (a) Grasshopper
  (b) Cockroaches
  (c) Euglena and Paramoecium
  (d) Fish
* Why respiration is important for organisms ?

4.2 Respiration in Plants

I. Concepts

* Like animals, plants also respire.
* Exchange of gases in plants takes place through stomata and lenticels and body surface in submerged plants.

II. Objectives: To enable the students to

* acquire knowledge of respiration in plants.
* identify stomata in leaves and lenticels in stem.
* understand that plants breath through stomata and lenticels.

III. Introduction

(a) Motivation

* Reasons for plants being called as living things.
* Observing a section of leaves and stem under microscope for stomata and lenticels.

(b) Scope in daily life

* The child will be able to understand that plants respire through stomata, lenticels and body surface.
* In plants both respiration and photosynthesis takes place.

IV. Teaching-learning activities

* Teacher mounts a section of leaf under microscope for stomata.
* Teacher mounts the permanent slides of stem to show the presence of lenticels in stem.

V. Student response/outcomes

* Students observe the presence of stomata as a small pores in leaf with guard cells.

* Teacher summarises that opening and closing of stomata helps in the exchange of gases.
* Students observe the permanent slides showing lenticels as a small opening.
* Teacher summarises the role of lenticels in respiration among plants.
* Teacher through discussion summerises the mechanism of respiration in submerged plants and release of oxygen to the atmosphere.

VI. Evaluation

* How do plants respire ?
* What are stomata ? Where do we find them ?
* What are lenticels ?
* Differentiate between photosynthesis and respiration.

4.3 Human Respiratory System

I. Concepts

* Animals largely exhibit aerobic respiration and hence oxygen is necessary for respiration.
* During respiration air rich in oxygen is taken in and air rich in carbon dioxide is released out, i.e. inspiration and expiration.
* Lungs form the respiratory surface for exchange of gases.
* Human respiratory system includes nostrils, nasal cavity, throat/pharynx, glottis and epiglottis, larynx/voice box, trachea/wind pipe,bronchi, bronchioles, alveoli and lungs.
* Oxygen helps to breakdown the absorbed food and releases energy required for life.

* Blood carries oxygen from lungs to different parts of the body.

II. Objectives: To enable the students to

* acquire knowledge about human respiratory system.
* understand that respiration is a basic life activity.
* recognise the different parts of respiratory system.
* identify the function of each part of the respiratory system.
* develop the skill of drawing.

III. Introduction

(a) Motivation

* Model/chart of human respiratory system.
* Fix up a glass bottle without bottom, with 'Y' shaped glass tube and balloons (simple model Unit-I).

(b) Scope in daily life

* Child will be able to identify the role of different parts of respiratory system.

IV. Teaching-learning activities

* Asks students to close the nose with fingers for two minutes.
* Asks students to reason out why we sneeze ?
* Ask students to observe the chest movement per minute while in rest, at work, after running.

V. Student response/outcomes

* Students observe that they cannot breath if opening of the nose is closed. Ask for reasons.
* Teacher summarises that air enters through the pair of opening at the tip of the nose called nostrils.

* Students observe/infer that when we are exposed to dust, we sneeze. Asks for reason.
* Teacher summarises that hair present in nostrils prevents the entry of unwanted particles into nose/nasal cavity.
* Students infer that food particles may enter into wind pipe if we talk/laugh while having food.
* Teacher explains structure of respiratory system.
* Students observe the two branches of trachea the bronchi and bronchioles and their structure.
* Students observe the presence of sac like structures found at the tip of the bronchioles with network of capillaries within the lungs - alveoli.
* Teacher summarises that gaseous exchange takes place in alveoli by diffusion into the blood and transported to the body and CO_2 diffuses out through the same track.
* Teacher explains about the cellular respiration in organisms.
* Teacher explains role of rib cage during breathing.

VI. Evaluation

* What is breathing ?
* What are the two main process in respiration ?
* What are the organs of respiration in human ?
* Count how many times you breath

  (a) in normal times
  (b) in rest
  (c) after doing exercise

* Mention the changes in chest that are observed during inspiration and expiration.
* Draw a neat labelled diagram of human respiratory system.

UNIT V

LIFE PROCESSES-IV: TRANSPORTATION

5.1 Transport of Materials in Unicellular and Multicellular Organisms

I. Concepts

* Transportation involves the supply of different nutrients and the oxygen that is required for different activities of the study.
* In lower aquatic organisms like amoeba the nutrients enter the body by means of diffusion.
* In higher plants transportation of food materials occurs through phloem cells and the transportation of water occurs through xylem cells.
* In higher animals transportation takes place through a well developed transport system namely circulatory system consisting of heart, arteries, veins and capillaries.

II. Objectives: To enable the students to

* acquire the knowledge about transport system in different organisms.
* understand importance of transport system.
* identify the diffusion mechanism operates in lower organisms for transportation.
* describe the parts of circulatory system of man.

III. Introduction

(a) Motivation

* Performing balsam plant experiment.

* Displaying the model of circulatory system.
* Asking the students to observe the veins present in their hand and checking the pulse rate.

(b) Scope in daily life

* Students understand the importance of stem in plants.
* Students understand that transport system in higher animals in an important system.

IV. Teaching-learning activities

* Teacher perform the students to balsam plant experiment and takes the section of the stem and observes under microscope. Teacher discusses about xylem and phloem.
* Using slides of amoeba or by focussing a drop of pond water consisting of unicellular organisms teacher explains that by diffusion transport of materials occurs in lower unicellular organisms.
* Using chart and model teacher explains the circulatory system and parts of circulatory system.

V. Student response/outcomes

* Students first observe the coloured line in the balsam plant and later observes the cells that are coloured in the section and understands that it is xylem cells that carry water to various plants.
* Students infer that transportation of food and water materials occurs by means of diffusion in lower aquatic organisms (unicellular organisms).
* Students understand about the circulatory system and infer that in other higher animals too transport of materials occurs in a similar way.

* Students conclude that it is phloem cells that carry food materials.

VI. Evaluation

* What are the tissues responsible for transportation of materials in plants ?
* How does the transportation occurs in unicellular organism ?
* What are the organs involved for transportation in higher animals ?
* How will you show that xylem cells are involved for transportation of water in plants ?

5.2 Transport System of Man

I. Concepts

* Blood carries nutrients, oxygen and waste materials to different parts of the body.
* Heart is a muscular pumping organ that sends blood through arteries, veins and capillaries.
* Blood is red in colour because of haemoglobin present in RBCs and WBCs protect our body.
* The blood is classified into four groups based on proteins present.

II. **Objectives**: To enable the students to

* recognise different parts of heart.
* identify arteries, veins and their functions.
* identify functions of RBCs, WBCs.
* describe structure of heart.
* explain functions of heart.
* classify blood in blood groups.

III. Introduction

(a) Motivation

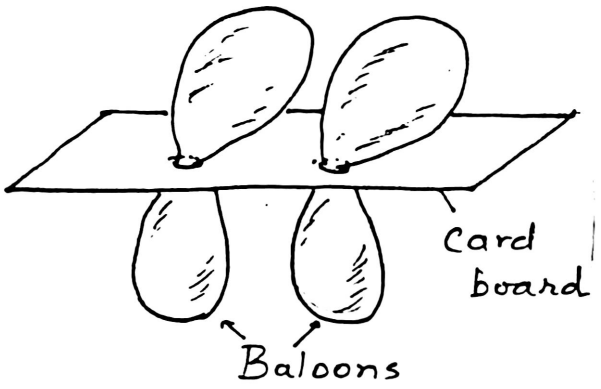
* Teacher asks the students to feel the pulse and count the pulses per minute.
* Uses stethoscope to hear heart beat.
* Show slide of blood smear.

(b) Scope in daily life

* Students understand importance of circulatory system, functions of blood and need for blood grouping.

IV. Teaching-learning activities

* Teacher demonstrates a model of heart to explain parts like auricles (right and left) and ventricles (right and left), aorta, veins, valves, etc.
* Teacher explains how blood is collected into heart through auricles and pumped to different parts by ventricles.
* Explains what is a heart beat.
* Uses an improvised teaching aid to explain how heart functions.



* Shows slide of blood smear under microscope and asks students to identify different cells.
* Discusses about blood groups and importance of blood grouping.

V. Student response/outcomes

* Students know that when heart beats it sends blood through arteries. This is felt on wrist as pulse. Students count number of pulses.
* Students identify right and left auricles and understand that they receive blood from different parts.
* Ventricles are muscular and pump blood through arteries. Aorta sends blood to different parts of body and pulmonary artery to lungs.
* Observe working model and learn how alternatively the auricles and ventricles work.
* See the slide and identify RBCs, WBCs and platelets.
* Learn functions of each like RBCs carry oxygen, WBCs protect from micro-organisms, platelets help in clotting of blood.
* Learn how to classify blood into O, A, B and AB, and need to classify. If a person is in need of blood, how transfusion of blood is done (refer to diagram in VII text book).
* Identify that group O is universal donor and group AB is universal recepient.

VI. Evaluation

* What are different parts of heart ?
* Give functions of RBC, WBC and platelets.
* What are the functions of blood ?
* A boy with 'A' blood group requires blood. Which blood groups can be used for transfusion ?

UNIT VI

LIFE PROCESSES-V: EXCRETION

6.1 Excretion in Lower Animals and Plants

I. Concepts

* Waste products are produced as byproduct of many metabolic activities of animals and plants.
* Excretion is an important life activity which helps in the removal of waste products from the body.
* In aquatic organisms (both plants and small animals) excretion takes place by diffusion.
* In higher plants carbondioxide, oxygen and water are eliminated through stomata and lenticels.
* Some plants excrete minerals and water through glands at the tip of leaves called hydrathodes.
* Some plants store excreta into the bark which is removed.

II. Objectives: To enable the students to

* recognise metabolic activities and products.
* reason out why excretion is important.
* identify process of excretion in aquatic organisms.
* describe the function of flame cells in flat worms.
* explain the function of hydrathode.
* cite examples of resins (excreta) useful to man.

III. Introduction

(a) Motivation

* Discussion of process of respiration and the end products.
* Structure of section of leaf.

* Display of some plant products like rubber, resin, gum, etc.

(b) Scope in daily life

* Significance of elimination of wastes.
* Plant waste products may be useful to man.

IV. Teaching-learning activities

* Recalling names of simple organisms.
* Recalling names of some aquatic plants.
* Discussion of end product of respiration and its diffusion into water medium.
* Showing chart of excretory system of flatworms, highlighting flame cells and their functions.
* Showing a slide of transverse section of leaf to identify stomata and role played by them.
* Demonstration of barks of some plants, rubber, gum, etc. to students.

V. Student response/outcomes

* Students recognise that simple and aquatic organism release their waste products into water by diffusion.
* Higher animals like planaria or flatworms being complex require special excretory cells called flame cells.
* The end products of respiration and photosynthesis are carbondioxide oxygen and water.
* They are eliminated through stomata of leaves by diffusion, lenticells also help in removal of such gaseous wastes.

* Understand that hydrathodes are modified gland that excrete liquid or soluble excreta.
* Solid wastes are deposited into bark and eliminated.
* Cite examples of secretions of plants.
* Classify them into useful material like rubber, gum, resins, etc.

VI. Evaluation

* What is excretion ?
* What are end products of respiration ?
* How aquatic plants excrete ?
* Liquid excreta are sent out through modified glands called _____.
* Name two solid wastes of plants which are useful to man.

6.2 Excretory System in Man

I. Concepts

* Complex excretory organs help in elimination of nitrogenous wastes, water, gases and salts from the body.
* Gaseous excretory products are excreted through lungs, liquids through skin, kidneys and solids through large intestine.
* Kidneys filter out nitrogenous wastes, water and salts from blood and store it in urinary bladder and then excrete.

II. Objectives: To enable the students to

* recall the various waste products.
* recognise the organs involved in excretion of different wastes.
* explain the structure and functions of kidney.

III. Introduction

(a) Motivation

* Teacher asks the students list down end products of respiration, digestion.
* Shows the working model of excretory system of man and explains.
* Taste of sweat.

(b) Scope in daily life

* The role played by excretory organs and need to take care of these organs.

IV. Teaching-learning activities

* Teacher asks students to write down end products of respiration, digestion and asks them to classify them into gases, liquids and solids.
* The teacher asks students to recall how carbon dioxide is eliminated and water also excreted along with it.
* The teacher tells students that liquid wastes like excess of water is thrown out through skin and kidneys.
* Teacher tells that salts also come out through skin.
* Undigested food is thrown out of body by large intestine.
* The teacher displays model of human excretory system and asks students to recognise parts.
* The teacher explains functions of kidney, like it removes wastes - water, salts, urea, uric acid by "filtration" method.
* Asks the students to draw the diagrams of excretory system and prepare chart of excretory products and organs help in elimination.

V. Student response/outcomes

* Students list down waste products, classify and identify organs help in elimination.
* Students recognise that lungs, skin also help in excretion in addition to kidney.
* Excess of salt is also eliminated through skin along with water as sweat.
* Identify that solids are eliminate through large intestine.
* Understand that kidneys are highly specialised organs that help in removing wastes.
* Students describe the process of filtration, storage and elimination.

VI. Evaluation

* Water, salts are eliminated through skin also.(True/False)
* Undigested food is excreted by _____.
* Where are the kidneys located ?
* Draw diagram of excretory system.
* What is filtration ? How is this important ?

UNIT VII

LIFE PROCESSES-VI: MOVEMENTS

7.1 Movement in Plants and Animals

I. Concepts

* Movement is one of the basic/general characteristic feature of living beings.
* Movement may take place in the whole body or any part of the body.
* Movement is caused by various stimuli.
* Mechanism of movement varies in different organisms.
* Movement in higher animals is effected by coordinated action of muscles and bones.
* In animals, movement helps in dispersal or migration and in seeking food and shelter.

II. Objectives: To enable the students to

* acquire knowledge about movement/locomotion among organisms.
* identify the different types of locomotory organs.
* recognise the importance of muscles and bones (in higher animals) in locomotion.
* recognise the importance of dispersal among plants.
* understand that locomotion is essential for the successful survival of organisms in the environment.

III. Introduction

(a) Motivation

* Students will be asked to observe the movement of earthworm, cater pillar, butterfly, fish, frog, snail, snake, birds, man.

* Display seeds of some plants like Tecoma, Calotropis, Castor.
* Observation of pond water through microscope for Amoeba, Euglena and Paramoecium.
* Students will be asked to reason out why stem of the plant always grow upwards and insects fly towards the light.
* Keeping the potted plant in a dark room near the window and asks students to record their observation after a week.

(b) Scope in daily life

* Child will be able to understand the importance of locomotion and to identify the types of locomotory organs.

IV. Teaching-learning activities

* Teacher displays many organisms on the table. Animals includes earthworm, butterfly, fish,bird, cockroach, rat and seeds like Tecoma, Calotropis, Castor, etc.
* Teacher asks the students to observe carefully movement of earthworm and butterfly.
* Teacher asks the students to compare the nature of movement in fish and bird and their locomotory organs.
* Students will be asked to observe the nature of movement/ locomotory organs involved in movement of microscopic organisms like Amoeba, Euglena, Paramoecium through microscope and draw them.

V. Student response/outcomes

* Students observe movement in earthworm and butterfly. Teacher explains about the muscular movement in earthworm and butterfly uses wings as the locomotory organ.

* Through discussion teacher explains about locomotory organs of fish and bird, i.e. about fins and wings.
* Students observe the different types of locomotory organs of microscopic organisms like Amoeba - extension of (protoplasm) body, Euglena - whip like or ribbon like structure, and Paramoecium - numerous hair like structure surrounding the body.
* with the help of figure teacher explains about pseudopodia, flagella and cilia.
* Students observe the growth movement in the potted plant kept in dark near the window, movement of stem towards the source of light and movement of insects towards the source of light during night. Asks for reason.
* Teacher through discussion explains about tropics in plants and taxes in insects which are caused by various stimulus.
* Teacher summerise that in higher animals locomotion is effected by the coordinated action of muscles and bones, i.e. bones support the muscles in movement.
* Through discussion teacher explains about the nature of dispersal of seeds in plants, agents which causes dispersal and the importance of dispersal.

VI. Evaluation

* Mention the locomotory organs of the following animals. Fish, Cow, Amoeba, Butterfly, Man, Earthworm, Birds, Insects, euglena, paramoecium.
* Mention the basic types of movements seen in animals.
* What is the significance of dispersal of seeds in plants ?

UNIT VIII

FOOD, HEALTH AND DISEASES: NEED, PRESERVATION, DISEASES

8.1 Storage

I. Concepts

* Storage and prevention of food is done in order to prevent spoilage of food.
* Food gets spoiled because of the action of microbes.
* If spoiled food is consumed may upset the health and it may also lead to death.
* There are many methods of storage of food such as drying, refrigeration, pickling, adding preservatives, salt drying depending upon the food items.
* Microbes, insects, rats cause damage and spoil the food.

II. Objectives: To enable the students to

* acquire knowledge about the various methods of storage of food.
* select the right method of preservation for a particular food.
* give reasons for methods implement to preserve the food stuffs.
* apply understanding in preserving the food at home.
* select suitable method to avoid actions of microbes insects and rats.

III. Introduction

(a) Motivation

* Displaying pickles, jams, jellies, etc.
* Displaying spoiled food.

* Asking the students how long can you keep the cooked food?

(b) Scope in daily life

* Students use various method to preserve food materials at home.
* Students do not waste the food stuffs and may think of new methods by which they can preserve the food.
* Students learn to protect food items.

IV. Teaching-learning activities

* Teacher display pickles, jams, jellies, soft drinks and ask them if they can use these after three days and put a question why haven't they get spoiled.
* Teacher asks students, in what way do they preserve vegetables and fruits ?
* Teacher then explains various methods of preservation such as drying, salt drying, refrigerating, adding chemicals like sodium-benzoate, etc. as preservative and elicit examples from the students.
* The teacher explains how exposed food gets spoiled by microbes, flies, cockroaches, beetles and rats.

V. Student response/outcomes

* Students infer that it is because of presence of preservatives.
* Students recall from their experience that they can preserve vegetables and fruits by refrigerating.
* Students understand different methods of storage and cite some more example what they know to add to the list.
* Students identify organisms that spoil food items and measures for protecting the food.

VI. Evaluation

* What is the chemical that is added to the food stuff to avoid spoilage called ?
* Name a preservative.
* Give examples of food stuff that are preserved by salting.
* Give examples of food stuff that are stored after sun drying.

8.2 Diseases

I. Concepts

* Diseases are caused by some microorganisms like bacteria, virus or protozoans.
* Some diseases are also caused by the deficiency of some nutrients. These are called deficiency disease.
* Diseases that spread from one person to another is called communicable diseases.
* Communicable diseases spread through contaminated air, water and food.
* Adultration of food may also make a person sick.

II. Objectives: To enable the students to

* acquire knowledge about the various types of diseases.
* recognise the types of disease caused and the symptoms.
* cite examples for communicable, deficiency disease.
* apply the knowledge in their daily life to solve health problems.

III. Introduction

(a) Motivation

* Showing the pictures of diseased persons.
* Sharing the experiences of the children when they had disease, when their family members suffered from disease.

(b) Scope in daily life

* Students will be aware of communicable disease so they take proper care of the patients who suffer from communicable disease.
* Students eat balanced food in order to protect themselves from deficiency disease.

IV. Teaching-learning activities

* Teacher shows photographs of diseased children for example Protein Energy Malnutrition (PEM) diseases.
* Teacher shows photographs of child that is suffering form dehydration.
* Teacher discusses about the communicable diseases like malaria, dysentry, cholera, etc.
* Teacher also discusses about the diseases like cholera, typhoid, etc. and discusses as to what care they should take to prevent the disease.
* Teacher also points out the symptoms of each disease.
* Teacher then discusses or explains about deficiency disease and asks the children to prepare a table containing the name of the disease, the deficient vitamin or mineral responsible for the disease. The source of the vitamins or mineral or any other nutrients.
* Teacher focuses certain slides especially that of protozoan (Entamoeba hystolityca) which causes dysentry and points out how it enters our system.
* Teacher explains about food adultration.
* Classifies disease into communicable and non-communicable.

V. Student response/outcomes

* Students reason out the cause for PEM disease and give some more examples.
* Students understand about various communicable diseases, its agency and learns as to how to prevents these diseases.
* Students adds to the list and give other symptoms which they would have observed.
* Students prepare a table containing all the information of deficiency disease.
* Students observe the organisms and study the structure.
* Students give many examples of food adultration such as Dhara oil that was adultrated two years back by argemone oil.

Name of the disease	Caused by	Transmitted by	Preventive measures to be taken
Cold, cough, sneez	Microbes (virus)	Air	While sneezing or coughing we must coverwith kerchief.
Typhoid, cholera, plague, tuber-culosis	Microbes (bacteria)	Water	Should drink pure water (boiled water) and take clean food, vaccination.
Malaria	Protozoans	Insects (Anaphilis Musquito)	Should keep the house and surroundings clean, use musquito curtain while sleeping.
Eczema	Contact	Direct contact with persons	Should not come in contact with such persons.

VI. Evaluation

* What are communicable disease ?
* Give some examples for deficiency disease.
* Name any two diseases that are caused by bacteria.
* Name any two diseases that are spread through contaminated water.
* What measures would you take to prevent:
  (a) cold and (b) malaria
* What is PEM ?

UNIT IX

SOIL AND CONSERVATION

9.1 Soil

I. Concepts

* Soil is the top most layer of the earth.
* Plants obtain nutrition to some extent form soil and soil is the substratum to plant.
* There are three distinct layers in the soil namely the top soil, subsoil and the rocky layer.
* Weathering of rock leads to the formation of soil.
* Soil is a natural resource.
* Removal of top fertile soil is called as soil erosion.

II. Objectives: To enable the students to

* acquire knowledge about the soil and its importance.
* recognise the different layers of soil and formation of soil.
* recognise the functions of the soil.
* reason out as to why there is less vegetation in desert region.
* apply the knowledge acquired to plant the trees or to raise crops.

III. Introduction

(a) Motivation

* Taking the students out and asking them to observe different types of soil and different layers of soil.
* Displaying the pictures of different types of soil.

* Demonstrating the formation of soil process by rubbing two small pieces of rocks.

(b) Scope in daily life

* Students recognise the fertile soil.
* Use their knowledge in agriculture.
* Understands the importance of the soil.

IV. Teaching-learning activities

* Take two jars and fill it with water, bring two samples of soil one from the garden to other from the play field. Add, stirr and allow the soil to settle in the jar. And ask the students to observe.
* Up root a small plant and ask the students to observe the roots of the plant.
* With the help of the chart explain different layers and constituents of the soil.
* Teacher demonstrates weathering of rock by rubbing two small pieces of rock together.
* Teacher asks the students to collect the rain water directly in one glass and in another glass collect the water flowing in the field after rainfall and the teacher asks to observe.
* Teacher explains characters of top soil, subsoil and rocky scil.

V. Student response/outcomes

* Students observe that in the jar where garden soil is put, more humus is present where as in other jar the water is clear little bit and is having less humus. Then students

will be able to infer that garden soil is more suitable for the plants.

* Students conclude that plant require soil and soil acts as a substratum. Student also infer that soil provides certain nutrients to the plants.
* Students understands the constituents of the soil.
* Students compare the formation of soil in nature with that of the demonstration given by teacher.
* Students understand the concept of soil erosion and conclude that rain water is one of the agency by which soil erosion occurs.
* Student cite few more examples for agencies by which soil erosion occurs.
* Students recognise the top soil containing humus is helpful for growth of plant and is very important.

VI. Evaluation

* What is a fertile soil ?
* What is soil erosion ?
* Draw a diagram illustrating different layers and constituents of soil.
* Why is soil considered as a natural resource ?
* Name any one weathering agent ?

9.2 Soil Conservation

I. Concepts

* Removal of top fertile soil by wind, water is called soil erosion.
* Growing of same type of crop leads to the loss of fertility of the soil.

* Building bunds, teraccess, contour farming help in soil conservation.
* Afforestation, i.e. growing more number of trees also help in soil conservation.
* Rotation of crops retains fertility of soil.

II. **Objectives**: To enable the students to

* know about the methods of conserving soil.
* list out different methods of conserving soil.
* reason out for the failure of crops.
* identify different agencies of soil erosion.
* apply the knowledge acquired in their practical life.

III. **Introduction**

(a) Motivation

* Taking the students to the field and showing the methods that is followed to conserve soil.
* Performing an activity that show that flowing water carry off the soil to large extent.

(b) Scope in daily life

* Students apply the knowledge acquired in practical life when they take up agriculture.
* Students use new and modified methods or techniques to conserve soil.

IV. Teaching-learning activities

* Teacher shows the pictures of terracing on hill side, bunds, etc. to discuss why it has been done.
* Teacher takes the children to field to show and demonstrate the methods followed to conserve the soil.

* Teacher performs an activity by taking two trays: (a) mud, (b) mud wherein grass is grown.
  Teacher pours water with equal force on both the trays and asks the students to observe.
* Teacher perform another activity in one tray teacher put only sandy soil and in another tray teacher puts clay soil and put on the fan and asks the students to observe.
* Teacher takes two trays with soil in it. In one tray teacher builds terrace or make ferrow, or build bunds and puts water and asks students to observe.
* Discusses about loss of soil in open fields, barren land, by wind, rain water, etc.
* Discusses importance of crop rotation.

V. Student response/outcomes

* Students understand the various methods.
* Students learn the techniques to do it practically.
* Students infer that the roots of plant or trees hold the soil and hence planting trees may conserve the soil to large extent.
* Students infer that sandy soil spreads easily with the help of wind and hence some binders have to be planted near the sea-shore or in desert area.
* Students infer that by terracing by contour farming, or by strip farming, or by building bunds, help to check soil erosion.
* Understand that fertility of soil can be retained by crop rotation.

VI. Evaluation

* What is soil erosion ?
* What do you understand by conservation of soil ? What steps do you have to conserve the soil ?
* Why should we conserve soil ?
* What is terracing ?
* Why is strip farming advantageous ?
* Can you suggest your own new method to conserve soil ?

9.3 Agricultural Practices and Implements

I. Concepts

* Agriculture involves a systematic method of managing the crops.
* The food producing plants are called farm crops. They can be divided into four major groups, viz. cereals, pulses, vegetables and fodder crops.
* Agricultural practices include ploughing,sowing, manuring, irrigating, harvesting and storage.
* By growing certain crops alternately, the nutrients used by one plant can be replaced by the other is called rotation of crops.
* Insecticides and pesticides are used to kill insects and pests respectively.
* The crop for which sowing is done for the first season in June-July is called kharif crop.
* The crop for which sowing is done for second season in October-December is called rabi crop.

* Cutting and removing the fully grown crop is known as harvesting.

II. **Objectives**: To enable the students to

* acquire knowledge about the agricultural practices.
* identify the particular method that is used to raise crops.
* understand the procedure used to raise crops.
* apply the knowledge acquired to get good yield and take up the agriculture.

III. Introduction

(a) Motivation

* Taking the students to the field where crops are grown.
* Asking the students to identify the important occupation of India.
* Asking the students work in the field for at least one day.
* Observing the work that is done in the field by a farmer.

(b) Scope in daily life

* Students will be trained or encouraged to take up the agriculture.
* Students understand the importance of modern scientific method to raise crops.

IV. Teaching-learning activities

* Teacher asks the students to make a list of the common crops of India.
* Teacher asks the students to make a list of the horticultural crops and classify them as vegetables, fruits, flowers and decorating plants.

* Teacher takes the children to the field and asks them to observe the work and asks to list out the steps that are followed while or before the farmers sow the seeds.
* Teacher asks the students to collect the pictures or draw the diagrams of agricultural implements that are used in the field.
* Teacher discusses with the students about the methods and steps in farming, manure used, fertilisers, compost, etc.
* Teacher asks the students to find out what type of crops are grown in which particular season. Then teacher explains about kharif and rabi crop.
* Teacher shows the place where grains and crops are stored and discusses about the proper methods of storing the crop, use of insecticides and pesticides and about the buffer stock.
* Teacher explains about the rotation of crops.

V. Student response/outcomes

* Students list out the common crops of India and understand about horticultural crops.
* Students list out the horticultural crops and classify them as vegetables, fruits, flowers and decorating plants.
* Children observe the working that goes on in the fields and recognises the various steps that are followed right from ploughing till irrigation.
* Students observe the implements like seed drill and other implements. Students also watch the way in which tractors work.

* Students discuss about the methods and the manures used.
* Students recall the definition of kharif and rabi crop.
* Students learn the methods and procedure of storing the grains or crop.
* Students cite examples of crops that are used in crop rotation.

VI. Evaluation

* What is crop rotation ? What are its advantage ?
* What is buffer stock ?
* What is seed drill ? How is it used ?
* What are horticultural crops ?
* What steps do you take to control pests and insects that destroy the crops.
* List out the modern agricultural implements that are used in agriculture.

UNIT TEST

I. Choose the correct answer and fill in the blanks 1x4 = 4

1. The example for carnivore is _____

   a. cow b. rabit

   c. lion d. sheep

2. The tissue which helps in control and coordination of the activities is _____.

   a. epithelial tissue b. muscular tissue

   c. nervous tissue d. connective tissue

3. During respiration the gas evolved by the plant is _____.

   a. oxygen b. nitrogen

   c. CO_2 d. hydrogen

4. Cytoplasm and nucleus together to form _____.

   a. cytoplasm b. protoplasm

   c. plasma membrane d. organelles

II. Fill in the blanks with suitable word

1x3 = 3

1. In plants water is conducted through _____.
2. Cell wall found in _____ cells.
3. Leaves are green because of the pigment called _____.

III. Match the following

A	B	1x3 = 3
1. Nucleus	Stimulus to response	
2. Chlorophyll	Controls cell activity	
3. Touch me not	Photosynthesis	

IV. Short answers

2x5 = 10

1. Cite two living things and two non-living things.
2. Mention two basic life activity of living things.
3. Give two examples for unicellular and two multicellular organism.
4. Write two major difference between animal cell and plant cell.
5. Define voluntry and involuntry muscles.

V. Write a neat diagram of plant cell, label the following parts. 5 marks

a. Cell wall
b. Chloroplast
c. Vacuole
d. Nucleous

UNIT TEST

Max. Marks: 25
Time : 45 minutes

I. Write very short answers 2x4 = 8

1. Give two examples for a living being.
2. Mention any two characteristics features of a living being ?
3. What happens when a bean seed is soaked in water ? Why ?
4. Group the following items into animal product and plant product.

   a. Milk b. Ragi

   c. Mustard d. Meat

II. Give reasons for the following 2

   a. Animals cannot prepare their own food.

   b. A plant without root cannot survive.

III. Match the following

a. Parts of a plant Function 3

A	B
i. Root	Preparation of food
ii. Seed	Fixation
iii. Leaf	Reproduction
	Circulation

b. Organs of an animal Function 3

A	B
i. Eye	Smell
ii. Nose	Hear
iii. Ear	Sight
	Movement

IV.

1. Draw a neat figure of a plant and label the following parts. 4

   a. Leaf b. Root

   c. Stem d. Flower

2. Explain with a neat diagram of the set up to show that water, air and temperature are necessary for a seed to germinate. 5

UNIT TEST

Max. Marks: 25
Time : 45 minutes

I. Write short answers 2x6 = 12

1. Which is the source of energy for animals ?
2. Which type of teeth are used in the following cases ?
   a. For tearing b. For cutting
   c. For chewing
3. Name two organisms wherein digestion takes place within the cell.
4. Name the food of the following animals.
   a. Frog b. Sheep
   c. Cow d. Butterfly
5. Give two examples for the following.
   a. Unicellular b. Multicellular
6. Name the major components of the food present in the following.
   a. Rice b. Wheat

II. Match the following

A	B	3
1. Carbohydrates	Fatty acids	
2. Proteins	Glucose	
3. Fats	Amino acids	

III. Match the following

Name of the gland	Secretion	5
A	B	
1. Salivary gland	Intestinal juice	
2. Gastric gland	Pancreatic juice	
3. Liver	Saliva	
4. Pancreatic gland	Sugar juice	
5. Intestinal gland	Gastric juice	
	Bile juice	

IV. Draw a neat diagram of the digestive system of human being and label the following parts. 5

a. Liver b. Rectum

c. Stomach d. Appendix

UNIT TEST

Max. Marks: 25
Time : 45 minutes

I. Write short answers 2x9 = 18

1. Name the two modes of respiration in living beings.
2. Name the process in which energy is liberated.
3. List out any two differences between photosynthesis and respiration.
4. Which is the "power house" of a cell ?
5. Explain the term expiration.
6. How is expiration different from inspiration ?
7. What is the role of diaphragm during respiration ?
8. What is diffusion ? Where does it take place in man ?
9. What are "Alveoli" ?

II. Match the following 2

Living organism	Respiratory organs
A	B
1. Frog	a. Stomata and lenti cells
2. Hydra	b. Gills
3. Fish	c. Lungs
4. Plants	d. Leaf
	e. Body wall

III. Draw a neat diagram of the human respiratory system and label the parts (any five). 5

UNIT TEST

Max. Marks: 25
Time : 45 minutes

I. Write short answers 6x2 = 12

1. Why transportation is needed in living organisms ?
2. Name the means of transportation in lower animals like amoeba and hydra.
3. Why is blood red in colour ?
4. Name the blood groups of the human beings.
5. Who are the "universal donors" ?
6. Who are the "universal acceptors" ?

II. Fill in the blanks 4°

1. Human heart has got _____ chambers.
2. Usually arteries carry _____ blood.
3. In man blood is oxygenated in _____.
4. Heart is present on _____ side of chest cavity.
5. Usually veins carry _____ blood.
6. The lower chamber of the heart are known as _____.
7. 'Aorta' starts from _____.
8. The blood circulation in man includes two stages namely _____ and _____.
9. Heart beat can be counted by using an instrument called _____.

III. Mention the functions of the following: 2

a. Platelets b. W.B.C.

IV. Raju's blood group is O. From whom should he received blood during emergency ? 1°

V. Draw a neat diagram of human heart and label the parts. 5

UNIT TEST

Max. Marks: 25
Time : 45 minutes

I. Write short answers 2x6 = 12

1. List out the four waste products of some plants which are useful to us.
2. Name the waste discharged through skin and kidney.
3. Why do we pass more urine in winter than in summer.
4. During summer our skin will be wet. Why ?
5. Excretion is also an important life activity. Explain.
6. Where are the waste products collected in the plants ?

II. Match the following organisms and excretion. 3

A	B
1. Acquatic organism	Kidneys
2. Higher plants	Diffusion
3. Man	Stomata and Lenti cells
	Muscles

III. Draw diagram of nephron and explain process of filtration. 5

IV. Write a neat diagram of transverse section of kidney and label the parts. 5

UNIT TEST

Max. Marks: 25
Time : 45 minutes

I. Write short answers

1. Ramu has taken only bread for his breakfast today. So which other food do you add to make it a complete food ? 2

2. Name the constituents of food present in the following food material. 3

   a. Wheat b. Milk c. Butter

3. Why should we take balanced diet ? 2

4. How can the following food stuffs be preserved ? 2

   a. Bread b. Cooked food

5. The pond water used by the people for different purposes in a village is unsafe. Why ? 3

6. Name any two diseases spread through water. 2

7. The virus can be seen only through electron microscope. Why ? 1

8. Name the measures that you take to prevent following diseases. 6

   a. Cold b. Cholera c. Malaria

II. Match the following

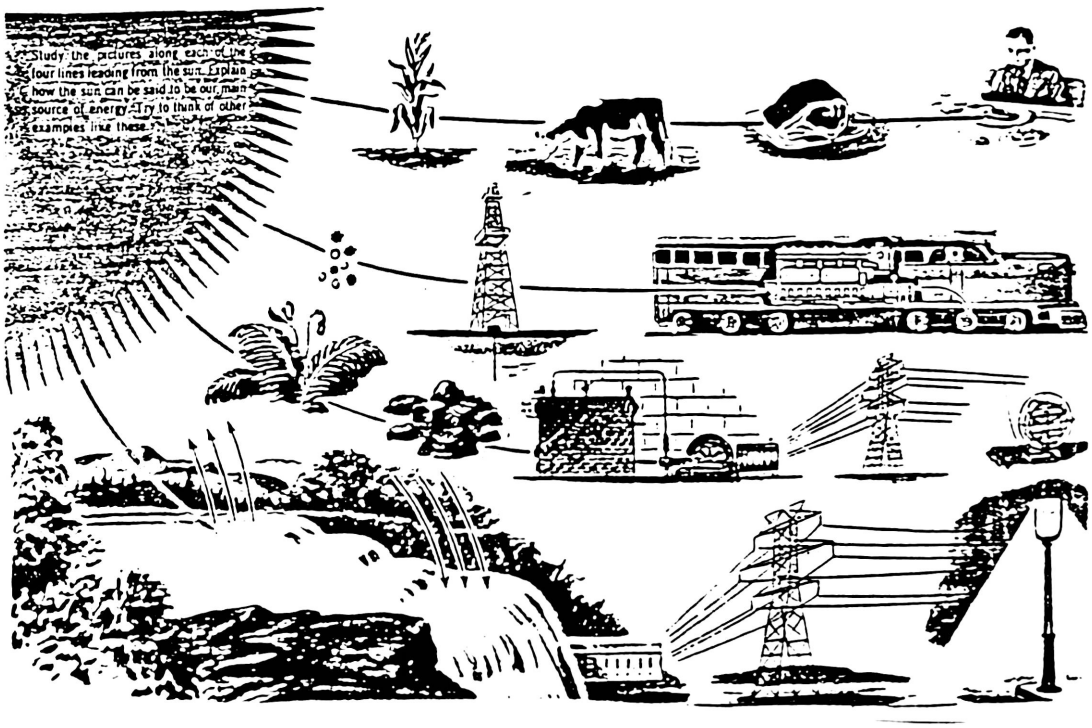
4

A	B
Cholera	Virus
Malaria	Contact
Eczema	Bacteria
Cold	Protozoans

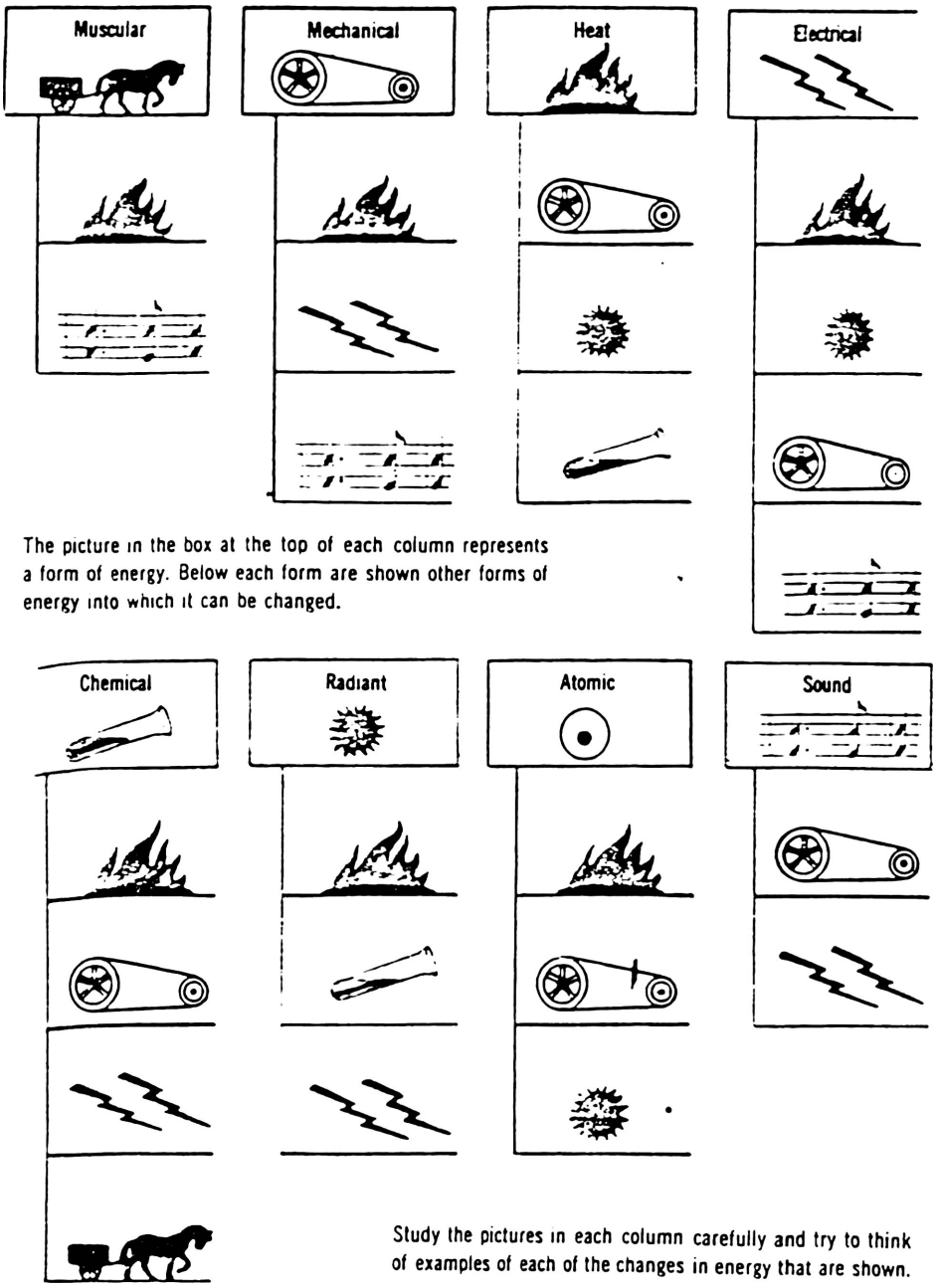
UNIT X

ENERGY

Energy is the ability to do work. Energy and work are closely related. Whenever work is done energy is used to exert force that overcomes resistance. Without energy there would be no force and no work could be done. Sun is the source of energy for all the activity on earth.



Heat, light and sound are some of the forms of energy. The following picture shows that energy is interconvertible, i.e. They can be changed from one form to another.



The picture in the box at the top of each column represents a form of energy. Below each form are shown other forms of energy into which it can be changed.

Study the pictures in each column carefully and try to think of examples of each of the changes in energy that are shown.

Though energy exists in different forms, there are really just two kinds of energy. The energy that matter has because of its motion is kinetic energy. The energy stored in matter because of its position or condition is potential energy.

Teacher should know

Muscular energy is the form of energy used since long time. With the growth of civilisation, the use of tools and machines made work possible with less effort and man started

harnessing other forms of energy with windmills, water wheels, steam engines.

Heat energy cause physical and chemical changes. It makes most material expand and it changes water to steam. This can be converted to mechanical energy and electrical energy. Electricity provides light and heat. Sound is still another form of energy. When sound passes through air it overcomes the inertia of air molecules and sets them in motion and thus does work. Light energy helps green plants to prepare food during photosynthesis and can cause changes in nature.

Energy stored in matter is chemical energy. Coal, gasoline and all other fuels have energy stored in them. When fuel is burnt, this energy is released during the chemical change. Chemical energy stored in the dry cell can be changed to electrical energy. For all the life processes living beings get their energy from the food they eat.

Huge amounts of energy is locked up in the atoms in the form of nuclear energy. This energy can be utilised to produce electricity.

Under proper conditions each form of energy can be transformed into another form. All these transformations of energy are going on around us all the time.

UNIT XI

HEAT

Instructional Objectives

To enable the students to:

1. recall that heat is a form of energy and sun is the main source.
2. recognise that heat is the energy of moving molecules and a substance gets warmer when its molecules move rapidly.
3. recognise that addition of heat or its removal may cause it to change from one form to another.
4. develop an understanding that substance generally expand when heated and contract when cooled.
5. discriminate between heat intensity (temperature) and quality of heat.
6. distinguish between conduction, convection and radiation.
7. recognise that different materials vary in their ability to conduct heat; those that conduct heat slowly are insulators.
8. appreciate scientists and engineers who are trying to trap the abundant energy of the sun for man's use.

Development of Concepts

11 .1 Activity

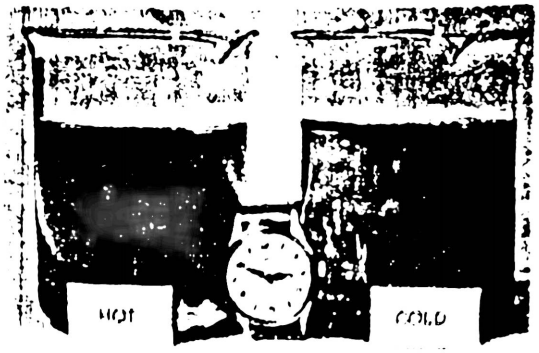
11 .1.1 The teacher may suggest the following activities to be performed by the children.

11 .1.2 Putting water in different place of unequal temperatures to see that heat evaporates water.

11.1.3 Putting clothes in the sun and shade to see that clothes dry faster in the sun than in the shade.

11.1.4 Touching soil, rocks and a pan of water in sun and in the shade to discover that sun heats the things on the earth.

11.2.1 Activity



Materials required

1. two borosil beakers
2. hot and cold water
3. ink
4. a medicine dropper
5. a watch

Note the time when the ink is added. Observe how the ink swirls and begins to mix with water. Ask the students,

1. Are the ink molecules moving ? Why do they move even though water seems to be quite still ?
2. In which of the beakers is the ink spreading fast ? The hot water or the cold water ?
3. Explain the difference in time taken for the ink to spread completely ?

The teacher elicits from the students that hot water has more energy for the ink to spread quickly.

11.2.2 Activity

Let a child wet his hand and fan it briskly. The child will observe that his hand became dry and cool.

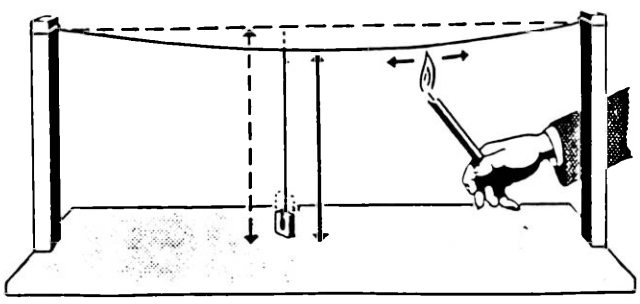
The teacher conclude that the heat to evaporate comes from the skin's surface.

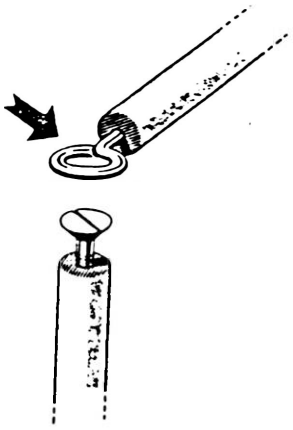
11.3. Activity

Ask the students to observe what happens when we heat 1. ice, 2. wax, 3. wood, 4. a piece of magnesium ribbon, 5. sulphur, 6. phosphorus

The teacher elicits from the observations that heat can bring about physical and chemical changes.

11.3.1 Activity





11.3.2 Activity

Students of class VII can maintain a chart of the temperature changes from day to day for a month.

The students recognise the relationship between the reading on the thermometer and the hotness or coldness of temperature. The intensity of heat is the temperature which is measured in degrees celcius or Farenheit. While the quality of heat is measured in calories.

11.4 Activity: Outdoor setting

The teacher organises to set up a campfire. An iron rod is put into the fire. Ask the students to feel the other end of the rod. In a very short time the other end of the rod (away from the fire) would have become hot. In a tree branch the bird feels the warmth and the people setting around feel the warm glow on their faces.

The teacher introduce to the children the three modes of transmission of heat - conduction, convection and radiation.

Conduction is a method of heat movement in which energy is transferred from molecule to molecule by bombardment.

11.4.1 Activity

Observe

a) the vessels used in kitchen - they made of aluminium, steel, brass, copper, bronze, etc.
b) pressure cooker with bakelite handles.
c) Iron box with wooden or bakelite handles.

The teacher asks the children to heat these vessels for a fixed time with some food in side it and report.

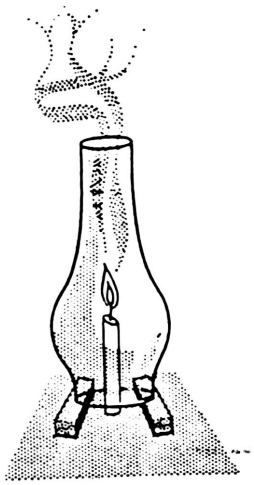
The teacher elicits from their observations that

a) metals like copper, aluminium, brass, bronze and steel heats the food to differnet extent.

b) handles made of wood and bakelite do not become hot. They are insulators.

14.2 Activity

The teacher is suggested to carry out the following activity to reinforce the concept of convection.

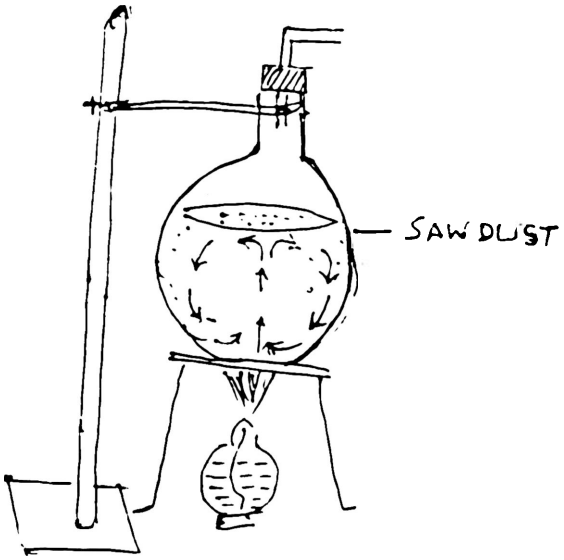


As the flame heats the air, the air becomes lighter, and the cooler heavier air entering at the bottom forces it up through the chimney.

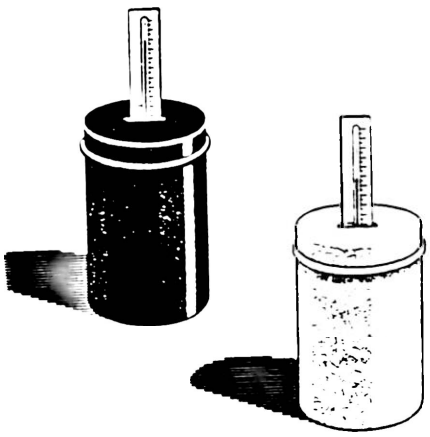
Wind occurs because sun's rays are more direct on the equator than at the poles. The stronger rays in the tropical region warm the air there causing it to rise cooler air from the polar region then flows under the warm air. These create warm currents and circulate round the earth.

11.4.3 Activity

Unequal heating of water causes movement.



11.4.4. Activity



The two cans, one darkened by soot from a candle or black paint, the other painted white, may be set in bright sunlight to show the effect on light and dark objects. The two thermometers fit through slits made in the can covers.

The children reason out as to why we wear light cotton clothing in summer and dark woollen clothing in winter.

Energy from the sun reaches the earth by radiation. Heat and light are the two major forms of energy we receive from the sun. Without which the earth would be a cold dark place with no life.

Scientists and engineers are trying to harness the energy of the sun, wind and water for our use.

Much of the rain that falls on the land flows into rivers. Hydroelectric power stations built to convert the energy of moving water. People use wind energy to power sail boats and wind mills. Large groups of wind mills called wind farms have been set up to generate electricity where wind is steady and strong.

Solar energy is also stored in plants, animals and firewood. Alcohol obtained by fermentation can be used as a fuel. Petroleum gas, oil and coal - called fossil fuels are obtained from the remains of plants that lived millions of years ago.

Solar cookers, solar cells, solar furnaces and solar water heaters capture solar energy directly. They are used to cook food, generate electricity, smelt ores and heat water.

UNIT XII

LIGHT

Introduction

Light is a form of energy that can travel freely through space. The energy of light is called Radiant energy Visible light forms a tiny part of the radiant energy.

Light from the sun heats the earth. Even if we burn all our fuels we may not keep the earth warm for life to exist. Green plants use sunlight to prepare food and grow. The oxygen liberated during photosynthesis is necessary to breathe.

Instructional Objectives

To enable the students to

1. recall that light travels through space with a velocity $3x10^8$ m/s in the form of waves.
2. recognise that we see objects because of the light reflected from them.
3. opaque bodies do not reflect light. Shadows are formed whenever opaque bodies are placed in the path of light.
4. recognise that light emitting bodies are called luminous objects and those which do not emit light are non-luminous bodies.
5. reason out for the occurrence of solar and lunar eclipses.
6. recognise that image of the object is formed by regular reflection of light on a reflecting surface.

Development of Concepts

12.0 The teacher explains that light from the sun falls on the earth at a speed of 3×10^8 m/s and reaches the earth eight and a half minutes later covering a distance of 150 million kilometres.

3.1 Light excites the sense of sight and helps us see the world around us. Objects reflect the light that falls on it and make it possible to see. Light is a form of energy and rules all life on earth.

Luminous and non-luminous bodies

12.1.1 Activity

Ask the children to make a list of sources of light.

They list: sun, electric bulbs, tube lights, candle lights, flash lights, torches, gas lights, etc.

The teacher tells that fireflies emit light. This is called bio-luminence. White phosphorous when exposed to air, it burns. This can be well recognised if the room is darkened. This is called phosphorescence. Those objects which emit light are luminous bodies.

Elicit from the students that objects such as earth, moon, other planets, satellites do not give off light. Such objects are called non-luminous bodies.

We are able to see the moon, other planets and satellites because of the reflected light of the sun.

Shadows

12.2 Activity

The teacher ask the children to do the following activity.

Divide them into groups. The children draw outlines of shadows of themselves at (a) 9.00 am, (b) 12.00 noon, (c) 3.00 pm.

Ask the children

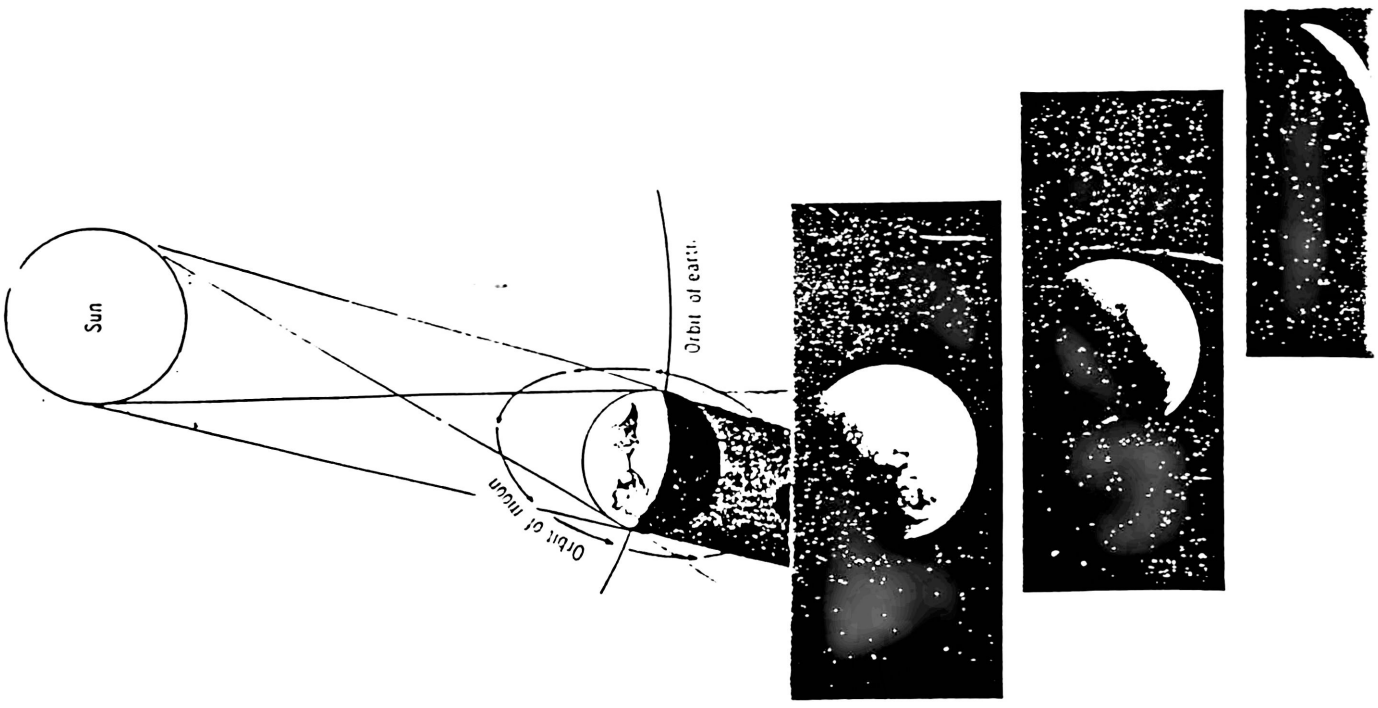
(a) Why shadow is observed ?

(b) What makes the shadow change its length ?

The teacher elicits from the students that there is a relationship between the shadows formed and the position of the sun in the sky.

12.2.1 Activity suggested in the text of class V is to be performed in the classroom to understand the occurrence of eclipses.

12.2.2 Lunar and Solar Eclipses



The photographs show three stages in an eclipse of the moon. The diagram on the left shows what happens when a total eclipse of the moon takes place. During a total eclipse enough light sometimes strikes the moon to make it look dull red.

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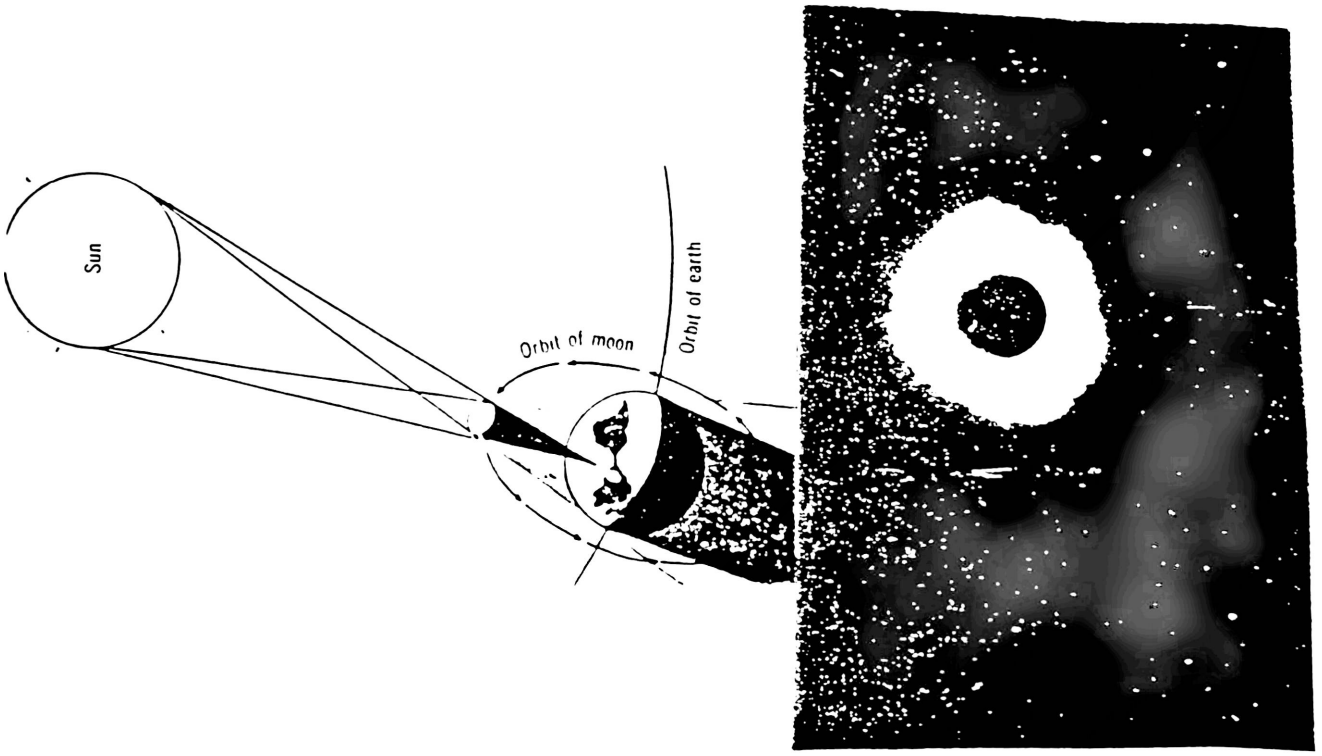


When the sun is completely hidden during a total eclipse, it has a bright ring of light around it. This bright light, called the corona, is shown in the photograph. The diagram shows how a total eclipse of the sun occurs.

The children

(a) appreciate the light and shade game of the heavenly bodies and distinguish between lunar and solar eclipses.

(b) see rela: ionship between full moon day and lunar eclipse and new moon and solar eclipse.

Reflection

12.3. Activity

Take two mirrors. On one mirror sprinkle chalk dust and wipe the other mirror clean. Observe the difference in the image. The students observe that the smooth surface has a sharp image while the other is blurred.

12.3.1 Activity

Take a piece of stiff paper and write 'MIRROR' on it. Place it in front of the mirror. Observe the image formed in the mirror.

The teacher helps the students to recognise that

1) the image of the object placed in front of the mirror is seen as far behind the mirror as the object placed in front of it.
2) the images are laterally inverted.
3) they are upright (virtual) and cannot be caught on a screen and also
4) they are the same size as that of the object.

12.3.2 The activity suggested in the text is performed to study the Laws of Reflection.

12.3.3 Activity

The students are asked to observe the shapes of mirrors in automobiles, microscopes, torches and mirrors used by dentists.

The students report to the teacher that outwardly bulged (convex) mirrors in automobiles help the rider to ge- a rear view of the road. The size of the image increases as the vehicle approaches. The images of vehicles coming at a distance appear small.

Mirrors with inward depression (concave) are used as reflectors in headlights of automobiles, torches and microscopes.

To the Teacher:

Additional information about light

The energy of the sun that shore on the earth million of years ago was stored by plants. These plants died and changed to coal, natural gas and oil. Today we use these fossil fuels to produce electricity and operate machines. Thus the sun is the main source of energy on the earth. By the study of light and its characteristics it is possible to learn much about the universe.

Light can change molecules of silver grains on a photographic film and can produce images. Strong light can fade the colour of fabrics. Light is used for communication. Optical fibres transmit information in the form of light over long distances.

Light is described as a wave, much like the water wave that moves across the lake. Light waves resemble other waves (sound and heat) in some features - wavelength, amplitude and frequency. Amplitude is the height of the wave or maximum displacement from its mean position). A simple relation exists between the wave's frequency and wavelength: the higher the frequency the shorter the wavelength. Wave energy corresponds to its amplitude. The greater the amplitude, more the energy.

The sun is an inexhaustible source of energy. It is because of the release of tremendous amount of energy fuelled by continuous chain of nuclear reactions. Sun will continue to release energy for many more millions of years to come.

UNIT XIII

SOUND

Introduction

We live in a world of sound. Sounds excite, frighten, soothe and inform. We communicate through sound. In nature the songs of birds, barking of dogs, the flutter of wings, the humming and buzzing of insects, etc. are heard daily. In city life, we hear the blare of automobiles and their horns, the loud speakers during festivals, the rumbling of trains, the factory whistles, the voices of street vendors and so on. Man too adds his contribution to the sound by playing the musical instruments.

Instructional Objectives

To enable the students to

1. recognise that sounds are produced by vibrating objects and it travels in all directions from the source.
2. recognise the relationship between the pitch of sound and speed of vibrations.
3. recognise that sound travels in solids, liquids and gases and needs a material medium to propagate.
4. reason out that the reflection of sound causes echo.
5. recognise that too much of unpleasant sound is harmful to health.

Development of Concepts

13.1 Activity

A blade, a rubber band and an empty box.

The teacher holds one end of the blade on the edge of the table and plucks the free end.

The children observe and answer these questions

(a) What does the blade do while the sound is heard ?

(b) Stop vibrating blade with your hand, what happens to the sound ?

(c) Can you make sound without plucking the blade ?

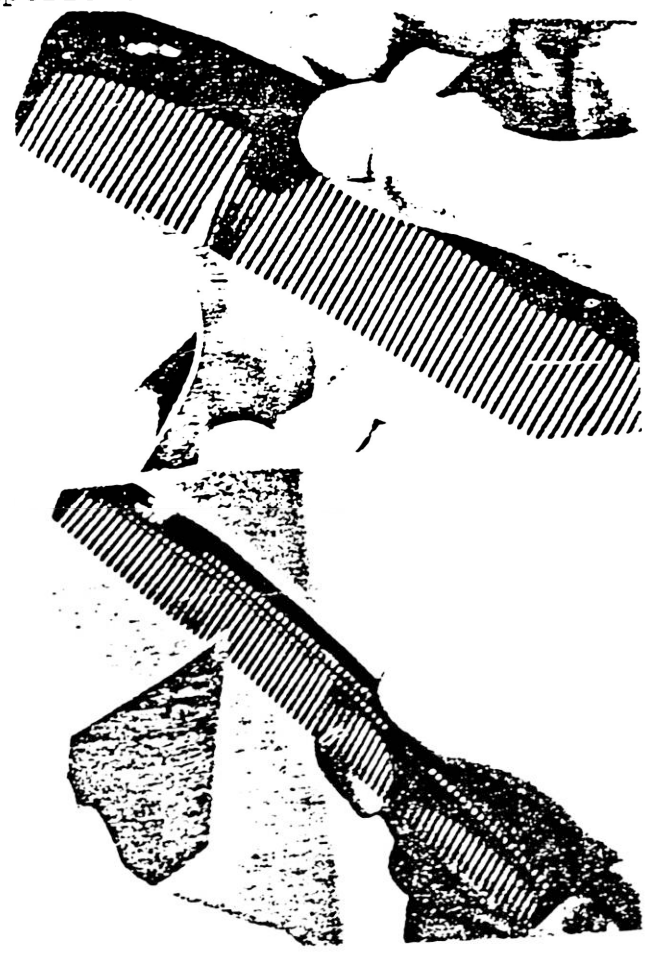
13.1.1 Perform the experiment with empty box with rubber band stretched across it to reinforce the same concept.

Students recognise that sound is produced whenever something is vibrating.

13.1.2 The concept can be reinforced using a tuning fork and bringing it near to a light cork tied to a string. The vibrating tuning fork will cause the cork to oscillate.

13.1.3 We can experience vibrations in our throats when we speak.

13.2 Activity



A comb, a cardboard - one thick and one thin.

Hold the cardboard in one hand and comb in the other as shown in figure. Hold the cardboard lightly but firmly. Pull the cardboard slowly and steadily along the teeth of the comb. Ask the children to listen to the sound.

Now pull the cardboard faster along the teeth.

Teacher asks:

1. What happens to the quality of the sound ?
2. Does it change ? Does it get higher or lower ?

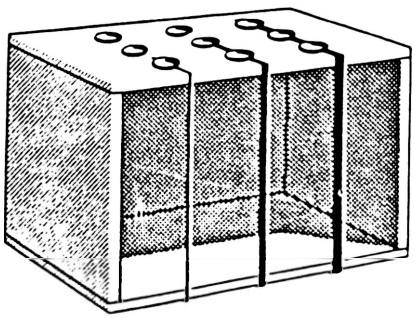
The students recognise that moving a cardboard quickly along the comb makes fast vibrations - moving a cardboard slowly makes slow vibrations.

Teacher asks the children to place their hands on their throat and hum a low note and a high note. The students recognise that at low note vibrations are less and at high note the vibrations are more.

The teacher explains that the sound with more vibrations means high pitch and sound with less vibrations means low pitch.

The teacher asks the students how the sound is produced by the mosquito or the bee. Students recognise that it is due to the vibrating wings.

13.3 Activity



This is performed with rubber bands of varying thicknesses and varying tensions as shown in the figure.

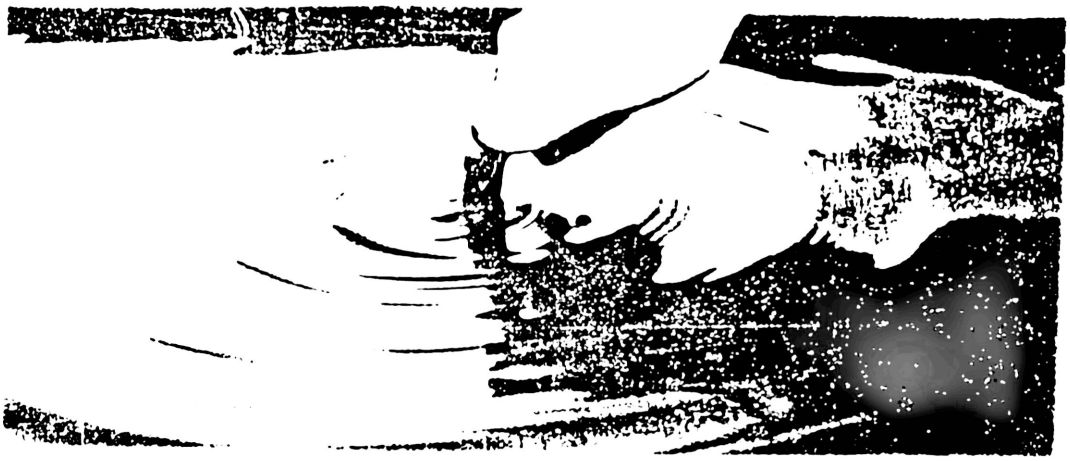
It is observed that tighter it is stretched the higher will be its pitch.

The thinner rubber band vibrates more quickly than a thicker one.

Students can see various musical instruments to understand how they produce different sounds.

13.4 Activity

Ask the students to drop a stone into a pond of water and observe. Water waves in a pond get weaker as they travel away from the source.



13.4.1 Activity

The teacher does the following experiment with the help of a group of students.

In an open area students are placed at various distances around a student. The student at the centre is asked to recite a poem.

Ask

1. How many of you can hear the poem loudly ?
2. How many of them could hear the poem softly ?

3. Ask those students who have heard the poem loudly to move away from person standing at the centre and those who heard the poem faintly to come near the centre. The student standing on the centre should all the while be reciting the poem.

The students experience that sounds get fainter as they move away from the source and stronger as they move towards the source.

The teacher elicits from the students that the loudness of sound decreases as the distance increases between the source and the person.

13.4.2 Activity

The teacher asks children to put their ears to the wall. Have an other student tap the wall from some distance. As the tapping goes on, ask the children move away from the wall so that the sound reaches them by air.

Ask the children

Which sound is louder ?

(a) The one carried through air ? OR

(b) The one carried through the solid wall ?

The children recognise that the wall is solid matter and more compact than in air and sound is heard better through the wall than through air.

13.5 The following activity corresponds to the vacuum pump demonstration described in the text. However an alternative activity is suggested to the teacher as given below.

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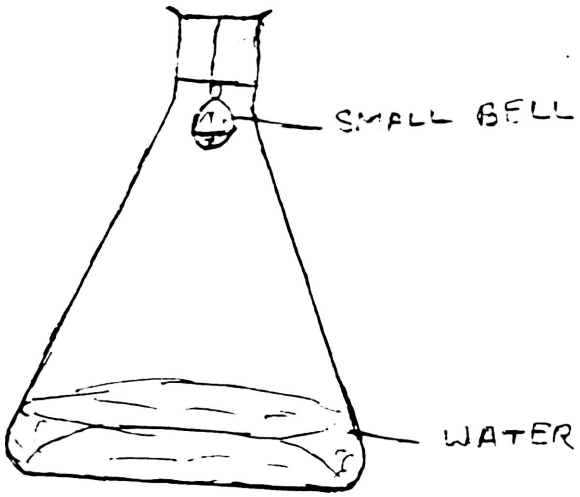


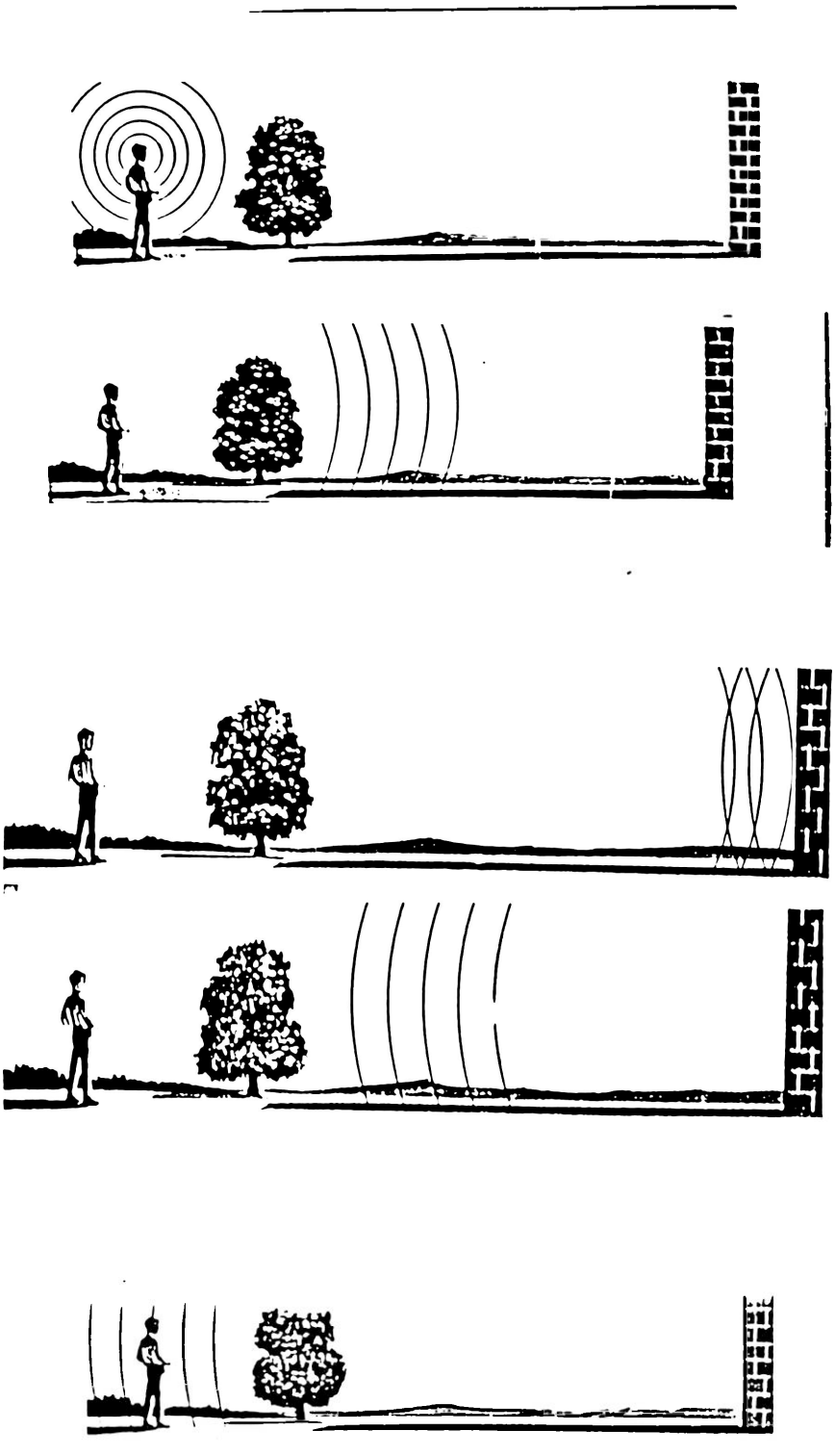
Tie a small bell suspended on a string to the bottom of a airtight stopper or cork for a pyrex flask (lose with the stopper) and shake the flask. The teacher asks the children to observe how loud the sound is.

Remove the stopper and bell. Put about an inch of water in the flask. Boil vigorously for a minute or two. The water vapour will drive out the air from the flask. Remove the flask from heat and insert the bell with stopper. As the flask cools the water vapour in it will condense and form a partial vacuum. The flask will not have much air in it as it had in the beginning.

The teacher asks the children: (a) How does the ringing of the bell sound now ? (b) Is it fainter or louder? Why ?

The teacher helps the students to reason out that air is necessary to make it loud. And less air means there is less sound.

13..6 Activity



Sound waves travel through air in all directions. As shown in figure a boy is standing at some distance away from a brick wall and telling 'hellow'. The sound waves hit the wall. The waves bounce off the wall. Now the waves return. In a short time the returning sound waves reach your ears. You hear 'Hello' softly. It is an echo. Sound waves need a wall, a mountain or a large building to reflect the sound to make an echo.

Sound needs time to travel upto the wall, reflect and return to our ears. It has been calculated that sound travels at the rate of 340 m/s or 1200 kms/hour.

13.6.1 Some unpleasant sound can be categorised as noise. Noisy automobiles, loudspeakers, machineries, aircrafts, bursting of crackers, etc. all produce very unpleasant sound. Sound is measured in decibels. Our ears cannot tolerate sounds beyond 100 decibels. Long term exposure to loud noise can cause permanent deafness, high blood pressure and palpitations in heart. Shocks from loud noises can even cause death.

13.6.2 Hence there is a need:

(a) for designing machinery that produce less sound while running.

(b) to use earplugs while working with noisy machines and preferably such machines to be placed in sound proof enclosures.

(c) to prohibit the use of loud sounding fireworks and loud speakers during festivals.

The Teacher Should Know

Sound waves propagate through compression and rarefactions of molecules in the medium. A medium is required for sound to propagate. As one travels to outerspace, much beyond the atmosphere there is no air. Hence no sound is heard.

Nature of sound can be described in terms of (a) frequency (and pitch), (b) intensity (and loudness).

The more the body vibrates per second the higher will be the frequency. It is measured in Hertz (Hz), i.e., one cycle/second. As the frequency increases the wavelength decreases. Most people can hear sounds with frequencies from 20 Hz to 20,000 Hz. Bats and dogs can hear sounds beyond 20,000 Hz.

You can make a high pitched sound by scratching a nail on a chalkboard. This scratching will cause about 20,000 vibrations/second. The squeak is high pitched, the chip and songs of many birds is high pitched. The mosquito moves its wings so rapidly that they produce a sound of high pitch.

Pitch can be affected by the thickness of a vibrating object. When string instruments are tuned tension is adjusted. The difference between high and low frequency sound waves can be known by the pitch of the sound we hear.

Sound waves travel faster through solids and liquids than through air. Sound travels four times faster in water and fifteen times faster in steel than through air. At $15^{o}C$ at sea level the speed of sound is 340 m/s.

The speed of sound increases as the temperature rises. At 100^{O}C, its speed is 386 m/s in air.

The denser the medium and the more compressible the medium is, the slower the speed of sound is. This property of sound is applied in the manufacture of sound proof materials.

Sound waves travelling through water also produce echoes. A device called SONAR uses under water echoes to measure depths and to locate objects under water.

TEST QUESTIONS

HEAT

1. Name any four forms of energy and give an example for each of them.
2. Identify the kind of energy in these
   a. Sun b. coal
   c. animals d. flowing water
   e. food f. music
3. Classify the following into kinetic energy and potential energy.
   a. A box on a shelf
   b. A wound up spring in a watch
   c. rock rolling down a hill side
   d. paraffin (wax) in a candle
   e. gunpowder in a rifle cartridge
   f. a flying bird
4. Where does the energy of your body come from ? Explain.
5. What form of energy is obtained by the generator ?
6. The nature of heat can best be explained as _____.
7. In the body the chemical energy in the food we eat is _____
   a. completely changed to heat energy
   b. partly changed to heat energy
   c. not changed into energy
   d. none of the above
8. How does the energy of the sun reach us ?
9. How does the wind get its energy ?

10. Transfer of heat to the vessels is due to _____

    a. convection

    b. conduction

    c. radiation

    d. none of the above

LIGHT

1. Classify the following into luminous and non-luminous bodies.

   a. sun, b. earth, c. moon, d. fire fly, e. phosphorus, f. star

2. Sun is a luminous body because

   a. it gives off light

   b. it does not give off light

3. Moon is an example of _____.

   a. luminous body b. non-luminous body

   c. star d. planet

4. Light is a form of _____ energy.

   a. radiant b. heat

   c. chemical d. mechanical

5. Light from the sun travels at a speed of _____ in space.

   a. 3×10^8 m/s b. 340 m/s

   c. 1200 km/h d. 30,000 km/h

6. The part of the eye that is most like a camera is

   a. iris b. lens c. retina d. pupil

7. When light is blocked _____ are formed.

8. When the earth's shadow falls on the moon _____ eclipse is formed.

9. When the sun, moon and the earth are aligned in a straight line we have _____ eclipse.
10. When the sun is high up in the sky the shadow is _____.
11. A lunar eclipse always occurs on a _____ day.
12. A _____ eclipse occurs on a new moon day.

SOUND

1. Whenever there is sound, something is _____.
2. A whistle makes a high sound when you blow into it. Whistle has _____.
3. As the pitch goes lower the vibrations become _____.
4. The thickest and the heaviest string in a guitar produces _____ pitch.
5. When sound waves travel through air, the molecules in the air _____.
6. Is it possible for the astronauts on the moon to hear each others voice ? Explain.
7. Sound travels faster in solid than in gas because the molecules in a solid are _____.
8. To hear the distant horses galloping one would put his ear to the ground. Why ?
9. An echo happens because sound waves _____.
10. During a thunder storm a thunder is heard after we see a flash of lightening. Why ?

UNIT XIV

ELECTROSTATICS

Introduction

Everyone is familiar with the fact that a pen made of plastic material is rubbed on a woollen cloth, it will attract dust and small pieces of paper. If the unrubbed end of the pen is brought near the bits of paper, it will not attract small pieces of paper. This shows that the charge produced at the rubbed end remains stationary or at rest. Hence the charge is called a static charge. Electricity is the flow of charge and since here the charges do not get transmitted from one place to other we call this kind of electricity as static electricity, the study of which is called electrostatics.

Knowledge of static electricity goes back as far as the sixth century B.C. when the Greek philosopher, Thales described the attractive properties of rubbed amber. It was only around 1600 AD that a systematic study of the phenomenon was made by Sir William Gilbert, court physician to Queen Elizabeth.

Concepts to be developed

1. There are two types of electric charges. They are: (i) positive charge, (ii) negative charge.
2. Like charges repel each other, unlike charges attract each other.

3. Lightning is one of the manifestations of static electricity, i.e. the charge at rest.
4. Substances which allow the electric charges to flow through them are called conductors.
5. Substances which do not allow the electric charge to pass through them are insulators.
6. Electroscope is a device for the detection and measurement of charge.
7. Electroscope is used to differentiate between insulators and conductors.

Specific objectives

To enable the students to:

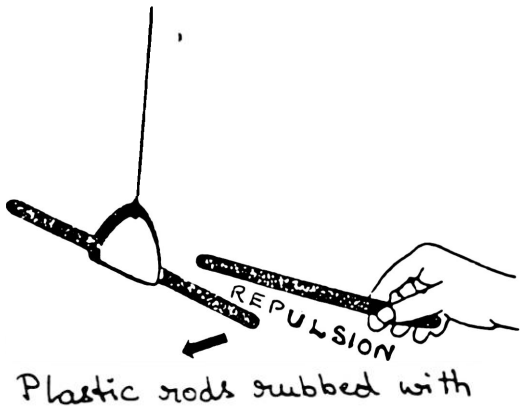
1. define static electricity.
2. recognise that there are two types of charges: positive and negative.
3. recall the law of electrostatics.
4. describe the construction and working of an electroscope.
5. differentiate between insulators and conductors.
6. classify the given materials into insulators and conductors.
7. give reason for lightning and thunder during stormy day.
8. acquire the skill to setup an electroscope using local materials.

Development of the content

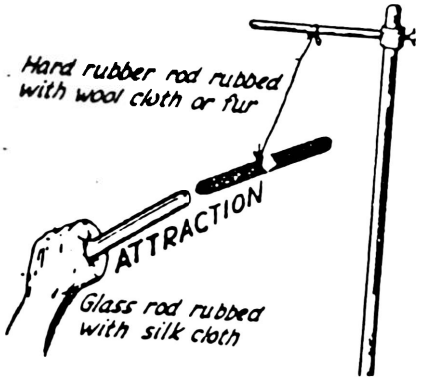
14 .1 Electric charges

All bodies, when charged will not get the same kind of electric charge. This conclusion can be obtained by a simple

experiment. Charge a plastic rod by rubbing it with wool cloth or fur and then suspend it. And then charge other plastic rod in similar manner and bring it close to one end of charged suspended rod we see the suspended rod moving away from this rod, as shown in the figure. This means that the charges on the two rods cause a repulsion between them.



Next, charge a glass rod or a test tube by rubbing it with silk and bring it close to the charged end of the suspended plastic rod. We observe that the plastic rod is attracted towards the glass rod, as in the figure.



So the charges produced by friction on the two rods produce an attraction between them. From this it is clear that the charges acquired by the glass rod and the plastic rod are not the same.

These two kinds of charges are called positive and negative charges. The positive charge is represented by the + sign and the negative by the - sign.

American scientist Benjamin Franklin proposed that electricity acquired by a glass rod rubbed with silk is positive and the charge on plastic rod rubbed with wool cloth is negative.

14.2 Law of Electrostatics

From the above experiments, we see that two negative charges repel each other; and a negative charge and a positive charge attract each other.

In a similar way if you charge two glass rods or test tubes by rubbing them with silk and if one of them is suspended and the other one is brought near it, you would see that the two rods/test tubes repel each other, just as the two plastic rods did.

These experiments verify a fundamental law, called the first law of electrostatics. "Like charges repel each other and unlike charges attract each other".

Teacher should know

14.3 Theory of electrification

It is known that all matter is made up of atoms. An atom has a central nucleus consisting of tightly packed particles called neutrons and protons (nucleons), with electrons moving round it at various distances.

Protons are positively charged and electrons are negatively charged particles along with uncharged particles called neutrons.

In normal atom, the positive charge of the nucleus is equal in magnitude to the total charge of all the electrons. Therefore the atom as a whole, is electrically neutral.

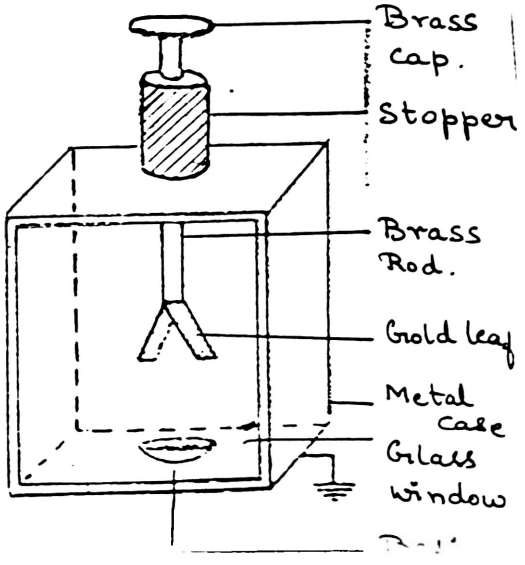
Among the orbiting electrons, some are closer to the nucleus and some are farther away. The electrons farther away are loosely bound to the nucleus. So when a body acquires a surplus of electrons it becomes negatively charged; when it loses some of its electrons, it becomes positively charged.

So when a plastic rod is rubbed with a wool or dry cloth, some of the loosely bound electrons from the wool or cloth move to the plastic rod. Since electrons carry negative charge, the rod becomes negatively charged. As the wool or cloth has lost some electrons. It has excess of positive charge. Hence the wool gets positively charged.

Thus electrification is the separation of the positive and negative charges which are already present on the body and there is no creation of something new.

14.4 Electroscope

Electroscope was invented towards the end of the eighteenth century by a Yorkshire clergyman named Abraham Bennet.



Electroscope in its simplest form consists of two thin gold leaves or aluminium foil fastened to the lower end of a brass rod. The rod passes through a stopper made of a highly insulating material such as alkathene. The upper end of the rod is provided by a brass disc or cap. The leaf is protected form draughts by enclosing it in an earthed metal case with glass windows.

A small basin containing fused calcium chloride is kept inside the case to keep the air dry.

Electroscope can be used to conduct the following experiments:

1. To detect the presence of charge on a body.
2. To test for the sign of the charge on a body.
3. To test the insulating properties of various materials.

Thus an electroscope is simple device for the detection and measurement of charge.

14.5 Insulators and Conductors

The difference between an insulators and a conductors is that, in an insulator, electrons are firmly bound to their atoms and will not move of their own accord. ..hereas in a conductor the electrons are able to move freely from one atom to another.

If one end of a plastic rod is held in the hand and other end is rubbed with wool, a negative charge is developed on its surface. These electrons cannot flow to earth through the hand, since they are unable to move from the rubbed end to the other end of the plastic rod.

When a brass rod is rubbed with fur it becomes charged with electrons in just the same way as the plastic rod. However, the charge cannot be detected, since it is immediately conducted to the earth through the hand. So the insulating or, conversely, the conducting property of a given substance may be tested by holding a sample of the substance in the hand and then bringing it into the contact with the knob of a charged electroscope. If the substance is a good insulator, there will be no leakage of charge through it and the leaf divergence will not alter. If however, the leaf of the charged electroscope collapses instantly it shows that the substance is a good conductor.

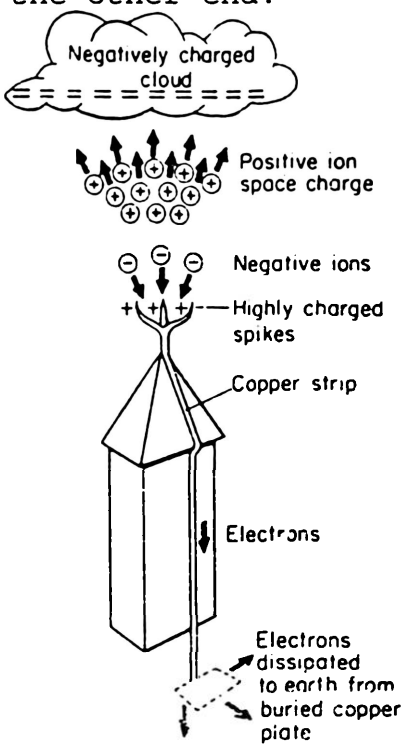
14.6 Phenomena that involve static electricity

1. When a mirror or window pane is polished with a dry cloth in a very day atmosphere, dust and fluff from the cloth stick to the glass and are difficult to remove.
2. A short length of metalic chain is made to trail from the metal frame of lorry and buses in front to conduct the electric charge away to earth built up due to friction of moving vehicle.
3. The basic reason for lightning during rainy season is the formation of static charges in the atmosphere and in particular in clouds. So lightning is an electrical discharge occurring between two charged clouds or between a cloud and the earth.

Thunder is the noise of the moving air which has been heated by the discharge.

Some times when the wind direction changes, the clouds move and charges in the cloud can be discharged into the earth. This may set fire when discharging through a tree or a building or even through the human body.

To avoid damage from lightning, the American scientist Benjamin Franklin suggested that tall buildings should be provided with lightning conductors consisting of thick copper strip running along the height of the building buried in the ground at one end and with a needle like tip pointing at the sky at the other end.



Action of a lightning conductor

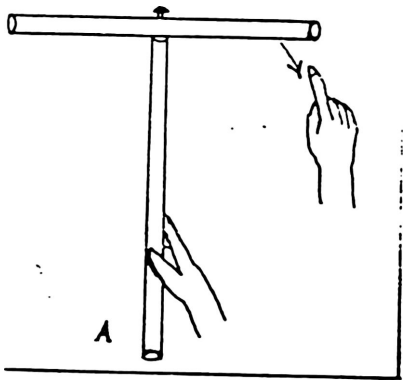
If lightning strikes the building, this metal would discharge it and send it harmlessly to the ground without causing any serious damages to the building, as shown in the figure.

4. Any one who has worn clothing made of certain textiles especially of Terylene or nylon would have experienced small electric sparks with a crackling sound when taken off at the end of a dry day.

14.7 Some more suggested activities

Activity 1

Take a plastic straw (used to drink juice) and pin up a paper pin in the middle of the straw perpendicular to the length of the straw. Keep the pin inside the mouth of the another straw holding it in the hand. Now the two straw will be perpendicular to each other and the straw which is pinned will be able to move freely. Bring your finger near the horizontal straw you will not see any change. Now take out the pinned straw and rub it on a terylene or nylon cloth and keep it again in the same position. And bring your finger near the rubbed end of the straw. The straw gets attracted towards your finger as shown in the figure.



Now take another straw and rub it on a terylene or nylon cloth and now bring it near the charged end of the horizontal straw, now both the straws repel each other as shown in the figure.

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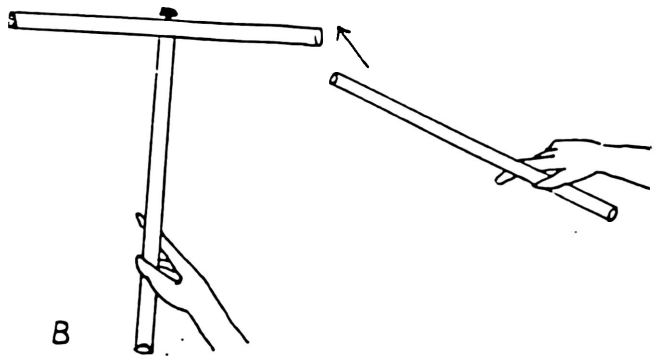
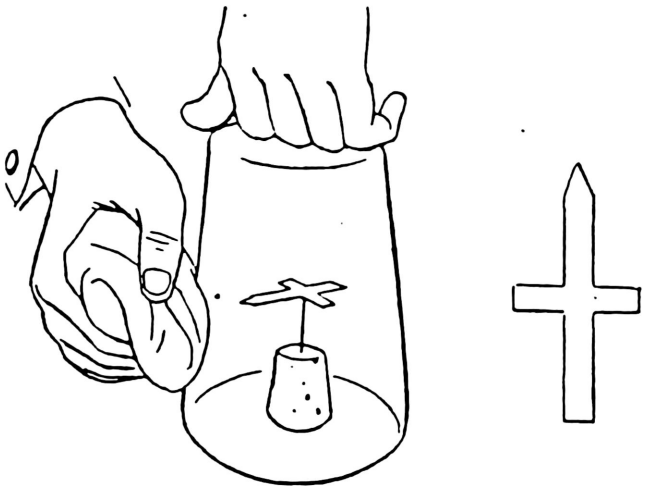


From this experiment we can conclude that when the two straws are rubbed on a nylon cloth they acquire same type of charge, so they repel when brought nearer.

Activity 2

Cut from paper the pointed cross which is shown in the figure.



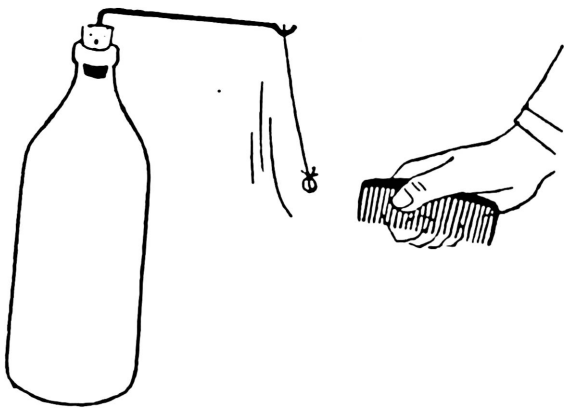
Push a needle into a cork and on the point put the cross. Over both cover a glass tumbler which has been well dried. With the woolen cloth rub a part of the glass and cross will turn round, until the point stands opposite the place where you have rubbed.

Rub slowly with the cloth in the same direction round and round the glass and the cross will rotate.

To make the experiment more attractive you can replace the cross by one with equal arms on which little paper horses can be hung by the thinnest of threads. Then you will have an electrically driven merry go round with horses.

Activity 3

Warm a bottle so that it is completely dry, then push a piece of wire into the cork and bend it over. To the end of the wire fasten a silk thread. At the end of the thread hang dried pith ball or a piece of dried cork. Bring the charged comb upto the pith ball and at first it will be attracted, but after touching the comb and receiving part of the charge from it, it will be repelled and it starts swinging.



If you hang on the wire yet another silk thread and pith ball and then touch both the pitch balls with the charged comb, they both receive the same kind of electric charge and repel each other.

Activity 4

Blow up a balloon and tie it up. Rub the balloon against your dry hair 10-12 times. Now place it gently against the wall. You will see balloon sticking to the wall, because it is charged by rubbing it against your hair. So the charged balloon gets attracted to the wall and holds on to it.

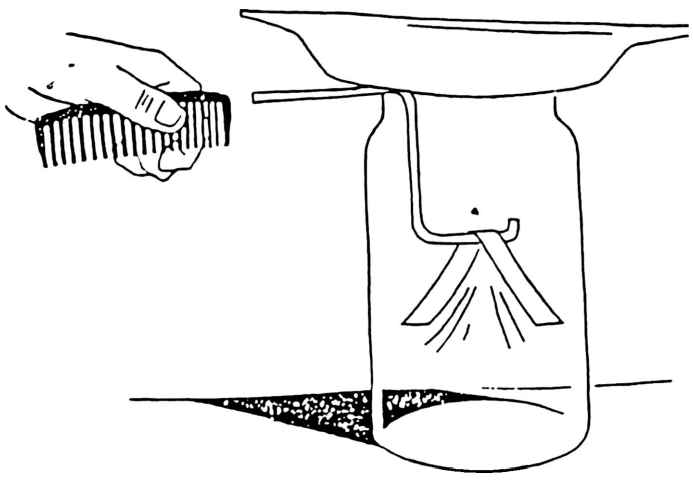
Activity 5

A slender stream of water can be attracted by a charged comb. For this turn the tap on so that a very thin stream of water comes out. Charge the comb by rubbing it with the woollen cloth and then bring the comb up to the thin stream of water. You will then see how the stream bends towards the comb.

This is because water molecules have positive and negative charge ends which are repelled when unlike charge ends come nearer the water is attracted towards the comb.

Instead of tap you can use burette and a fountain pen or plastic rod can be used in the place of the comb.

Activity 6



You can make one of the simplest kinds of electroscope by bending a piece of copper wire in the shape of a z and hanging over the lower horizontal part a strip of thin metal foil as shown in the figure. Place the upper horizontal part of the wire over the rim of a jam bottle. Place an aluminium plate on top as shown in the figure. The electroscope is ready now.

Now bring a charged comb near the end of the copper wire. You will observe the strips of folded metal foils repelling away.

14.8 Teacher should know

1. To carry out the experiments on static electricity the teacher should choose a dry day, since on a humid day electric charge is rapidly dissipated into the moist air.
2. Smoothly rounded materials like glass test tube, etc. hold static charges better than do rough and irregularly shaped objects. If the shape is irregular, the mutual repulsion of electrons causes some to leak into the air from the projecting points.
3. For successful results, all apparatus used in electrical experiments must be thoroughly dry. Glass rods in particular are best warmed before use.

14.9 Evaluation

I. Fill in the blanks with suitable words

1. The Greek equivalent word for amber is _____.
2. _____ carried out systematic study of amber.
3. Like charges _____ each other.
4. Unlike charges _____ each other.

5. _____ is the device used to detect electric charges.

6. _____ are the substances that allow the electric charges to flow through them.

7. _____ are the substances that do not allow the electric charges to flow through them.

8. _____ are good conductors of electric charges.

9. _____ is a bad conductor of electric charge.

10. Lightning is due to _____ electricity.

11. An electric current is the flow of _____.

12. The flow of electrons is called _____.

II. Match the following

A	B
1. Electroscope	a. attract each other
2. William Gilbert	b. device to detect electric charges
3. Static electricity	c. carried out systematic study of amber
4. Electric current	d. charges at rest
5. Like charges	e. flow of charges
6. Unlike charges	f. repel each other
7. Conductors of electricity	g. mica
8. Insulator	h. metals

III. Classify the following into conductors and insulators

1. aluminium	2. silver	3. glass	4. iron
5. silk	6. paper	7. gold	8. amber
9. nickel	10. copper	11. plastic	12. wood

IV. What happens when

1. Two like charges are brought nearer.

2. Two unlike charges are brought nearer.

3. A charged ebonite rod is touched to the knob of an electroscope.
4. A charged ebonite rod is touched to the knob of an electroscope which is positively charged.
5. A charged ebonite rod is touched to the knob of an electroscope which is negatively charged.
6. Two charged clouds come close.

V. Write the answers to the following questions in one sentence

1. How do you charge a glass rod ?
2. Name two types of electrical charges.
3. Write the law of electrostatics.
4. What is an electroscope ?
5. What is a conductor ?
6. What is an insulator ?
7. What is static electricity ?
8. How can you deposit charges on a body ? or How do you electrify an object ?
9. What is electric current ?
10. Name two types of charges.
11. Write the difference between conductor and insulator ?
12. Why is static electricity also called as frictional electricity ?

VI. Answer the following questions

1. How do you find whether a given body is charged or not ?
2. How lightning occurs ?
3. Draw a neat diagram of an electroscope and label the parts.

UNIT XV

WATER

Introduction

There are several things which are very essential for life to exist. All such fundamental elements required by our ancestors as "PANCHAMAHA BHOOTAS". One among these is "WATER". No organism can survive without water.

"Little drops of water makes a mighty ocean"

It is this drop of water which makes everything mobile, active and makes life more meaningful.

Water has many interesting properties that make it a special substance. Water remains in liquid state over a wide range of temperatures. This property makes water "the essence of life" as it provides a medium for biological activities.

Water covers around 3/4th of earth's surface to an average depth of over two miles. It penetrates through the rocks and soil in the earth's crust to considerable depths. Its vapour is always present in the atmosphere.

Concepts

* Water is necessary for both plant and animal life.
* Natural sources of water are oceans, seas, rivers, lakes and ponds.
* Water exists in different forms. It is colourless, odourless, tasteless.
* Water behaves strangely in its density.

* Water expands on cooling from 4°C to 0°C, freezes at 0°C and boils at 100°C at sea level.
* Water is a bad conductor of heat, but has highest heat capacity.
* Water is a universal solvent, possess the properties of liquids.
* Sea water is saline.
* Natural water can be harvested and needs purification.
* Interference of human activities pollute water.
* Maintaining water table is in our present concern.
* Water management is very essential - a need of the hour.

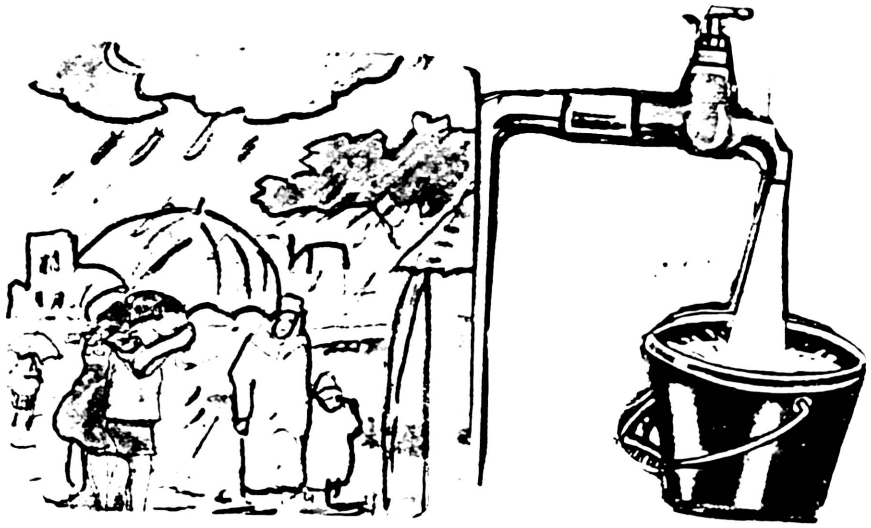
Competency Behavioural Objectives

To enable the pupil to

* list out different sources of water.
* recognise the importance of water in our daily life.
* interpret the meaning of salinity.
* define boiling point, melting point and freezing point.
* identify the physical and chemical properties of water.
* recognise the reaction of water with metals.
* differentiate between hard water and soft water.
* develop the skill to prepare saturated solution.
* design the experiment on melting point of ice and boiling point of water.
* critically examine the process of water harvesting and purification.
* see relationship between human activities and water pollution causes and consequences.
* suggest measures to prevent water pollution.

15.1 Development

15.1.1 Natural Sources of Water



Wells,rivers,ponds, sea, pools, borewells, corporation water, water falls, reservoirs, rain are some of the sources of water. Unfortunately water can be easily polluted and this can be harmful to our health. We must prevent water pollution, as quality of water is of great importance to sustain human life.

15.2 Water is necessary for life as water is required for many activities of life. Water is present in many food substances.

15.2.1 Activity

Displaying the chart showing different human activities carried out everyday.

Explaining the "value of water" as essential requirement of life.

15.2.2 Activity

Teacher displays fruits and vegetables which have water content.

Required materials: Lemon, potato, tomato, grapes, apple and blotting paper. Cut these vegetables. Bring a piece of blotting paper in contact with the vegetable. The blotting paper absorbs water present in them. Conclusion: These food materials contain water.

15.2.3 Water is necessary for the growth of plants.

Required materials: two identical potted plants, water.

Activity

Supply water to one of the plants and ignore the second potted plant. Ask the children to observe the changes in both the plants after a week or so.

Observation: The plant which is watered grows well and remains healthy. The plant not watered becomes dry.

Conclusion: Water is very essential for the survival and growth of plants.

15.3 Physical Properties of Water

15.3.1 Water is Colourless, Odourless

Teacher display distilled water in a beaker. Ask the students to taste a spoon of water and smell it. They recognise that pure water will not have taste, odour and colour.

15 .3.2 Air contains water in the form of vapours

Activity: Children are asked to collect the dew drops, mist, snow.

Formation of mist, dew, clouds and snow is due to the presence of water in the atmosphere.

Weather is said to be humid if water vapour is present in the atmosphere. The content of water vapour in the air is called humidity.

15.3.3 Water exists in three forms

Water is one of the few substances which is found commonly in all the three states, ice as solid, liquid and gas.

Activity: Take ice cubes in a beaker, show that water is in the solid state. Heat it, it melts as liquid, on further heating it changes into vapour as gas.

15.3.4 Exceptional Behaviour of Water

Activity: Solid wax sinks in molton wax. But in case of water it is different. Why ?

Because water has an exceptional behaviour.

Water freezes into ice at $0^{o}C$. Usually things contract by cooling. But in case of water, it shows irregular expansion from $4^{o}C$ to $0^{o}C$. This behaviour is called ANOMALOUS EXPANSION.

During the cooling process, the density of water goes on decreasing upto $4^{o}C$ and then it increases from 4^{o} to $0^{o}C$. Hence the density changes.

Solid water, i.e. ice is less denser than water. Hence ice floats on water.

Activity: Take a disposable plastic container which has pressing type lid, fill it with water up the brim. Close the container and keep it in the freezer. Asking the children to observe the arrangement after sometime.

Observation: The lid comes off as water expands after freezing.

Inference: Because of irregular expansion in water, when it freezes at $0^{o}C$, the density of ice will decrease. Hence ice floats on water.

Fact: The density of water is used as the standard for measuring densities of other substances.

Compare the density of water with the following: alcohol, oil, molasses, stone, chalkpowder. Children are asked to infer.

15.3.5 Water is a bad conductor of heat

Heat flows in water or any other liquid by convection currents. The mode of heat transmission in water takes place by t he actual movement of the particles. Hence water acts as a bad conductor of heat.

15.3.5 Activity

Materials required: Two large jars, two small bottles, ice water, warm water, red and blue ink.

Procedure: Fill one large jar and one small bottle with ice water. Add blue ink to the small bottle. To colour the water fill the other large jar and another small bottle

with warm water. Take the bottle of blue ice water. Hold it just over the jar of warm water slowly tilt the bottle. Let the cold blue water flow out into the warm water. Now ask the children to observe carefully and note the changes in both the jars and bottles.

What happens to the cold water in the warm water ?

Observation: The blue ice water is seen moving down the red warm water.

Conclusion: The blue ice water is denser than red warm water. We can see convectional current.

15.3.6 Composition of water by volume

Volumetric analysis of water reveals that water is a compound of hydrogen and oxygen in the ratio 2:1. This can be shown by electrolysis.

Electrolysis: The process in which decomposition of a substance into its elements by electric current occurs is called electrolysis.

Activity: An improvised apparatus

The electrolysis of water is carried out in an apparatus called voltameter. A simple voltameter consists of a glass

vessel with the opening at the bottom but fitted tightly to a plastic or wooden base and sealed by means of plaster of paris or any such material. The vessel contains two vertical platinum (electrodes) a little distance apart mounted on a conductor wire which are made to pass through the base and joined to the two terminals of a battery by means of copper wire. The vessel is half filled with water, made slightly acidic by adding a few drops of sulphuric acid. Two graduated test tubes filled with the acidified water are inverted over the electrodes. Now electrodes are joined to the poles of a battery.

Observation

On passing electric current, bubbles of gas at once begin to rise from each electrodes and collect in the test tubes. The volume of the gas collected in the cathode will be twice as much as that collected over the anode.

When the test tube containing mere gas is brought near a ligated glowing splinter, the gas burns with a 'pop' sound. Hence the gas collected at the cathode is hydrogen. If a glowing splinter is introduced into the test tube in which the gas collected at the anode the splinter burns brightly confirming that the gas collected is oxygen.

Inference

Water is a compound of O_2 and H_2 in which two volume of hydrogen combine with one volume of oxygen to form water.

$$2H_2 + O_2 \text{ ==== } 2H_2O$$

Molecular formula of water is H_2O.

15.3.7 Water is a Universal Solvent

Water has the ability to dissolve most of the substances. Hence water is called universal solvent.

Activity

Collect some substances like sugar, salt, soda, chalkpowder (lime powder), cocoa flour, etc. Ask the children to dissolve them in water in different containers. Ask them to note their observations. The experiment can be repeated using solvents like alcohol, kerosene, etc.

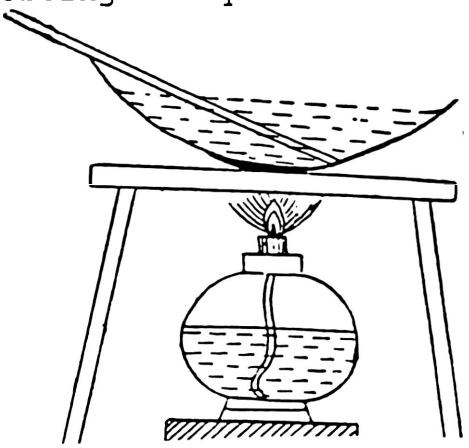
Children can generalise which solvent dissolves most of the substances ?

Activity

Pure water and salt water of same volume are taken in two different beakers. The weights of two beakers are noted. The weight of empty beakers are also determined. The difference in weights shows that water containing salts is heavier.

15.3.8 Water evaporates and condenses

Water can disappear into the air. Water turns into vapour because it absorbs heat and escapes into air. This is a process of converting a liquid into its vapour.



15.3.8 Activity

Take two plates, paint them with black colour. Keep one plate in the sunlight. Place a drop of water on this plate. Keep another plate in the shadow and place a drop of water on this too. After a few minutes observe both the plates.

Observation

The water drop on the plate placed outside, disappears but water drop on the plate in the shadow remains undisturbed.

Inference

The water drop gets evaporated due to heat from the sun.

Suggested Activity

Trying the same activity using different liquids. Note down the time taken for the liquid drop to disappear for each liquid. Then infer.

15.3.9 Water rises up by capillarity

Due to surface tension the water rises up. The same phenomenon is involved when water disappears by using a sponge or butter. The surface tension is due to unbalanced force of attraction replaced water molecules at the surface.

15.3.9 Activity

Introduce a capillary tube in a beaker containing water. Students observe a rise in water level in capillary tube. This rise due to surface tension. Further water

molecules adhere better to glass than to water molecules. This makes the water rise in the capillary.

15.3.10 Water has highest heat capacity

Heat capacity is the amount of heat required to rise the temperature of a mole of a substance by $1^{o}C$.

Water ranks high in its ability to absorb heat, among all other substances.

Fact: The specific heat of water is 4.18 $J/kg^{o}C$.

Activity

Take two test tubes, one is filled with coconut oil and another with water of equal amount using medicine dropper. Heat both the test tubes simultaneously note down the time. Be sure to stir the liquid so that the heating is uniform throughout. With the help of thermometer note down the temperature.

Asking the children to compare the rise in temperature of water with that of oil.

Observation

The temperature of oil rises much more than the water.

Conclusion

Water has high heat capacity.

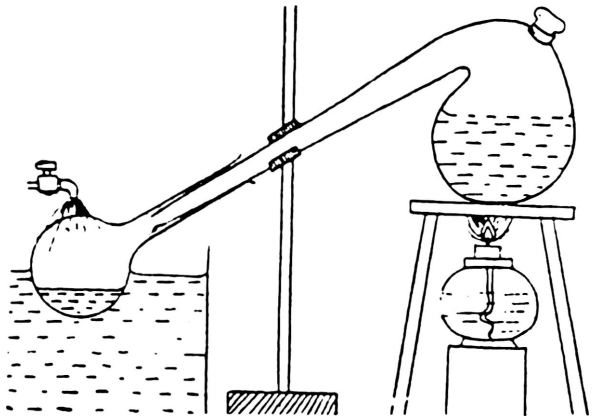
Fact: Unit of heat capacity = Jk^{-1} $mole^{-1}$

15.3.11 Water takes the shape of the container

Activity

Collect transparent bottles of different shapes. Fill water into all the bottles. Ask the children to observe.

15.3.12 Sea water in saline



River water brings salts, minerals into sea. Sea water is continuously evaporated by the sun. This evaporated water forms clouds and brings rain. The rain falling on land dissolves more salts and minerals and brings them into sea, through rivers, thus sea continuously get salts and minerals from different sources. Hence sea water is saline.

Fact: One litre of sea water contains about 35 g of salts.

A solution that contains maximum amount of the dissolved substance at a given temperature is called SATURATED SOLUTION of the substance.

Fact: Sea water is not potable. Drinking of sea water may induce vomiting because of salinity.

Activity

Take two potted plants with similar seedlings. Water one pot with saline water and the other with river water regularly. Ask the children to observe after a week or so.

Observation

One grows wilting another will be healthy.

Saline water is not suitable for agriculture.

15.3.13 Water makes things buoyant

Water has the ability to transport by making things to float on it.

Activity

Make a miniature boats of tin foil by bending up the sides of the sheet or foil. Take a dish pan which is big enough to float a toy boat. Take another smaller pan inside the empty dish pan. Fill the small pan to the brim with water. Float the toy boat. Some water will be displaced and overflow into the dish pan. Collect this water carefully and weigh. Then weigh the boat. The weights should be very close.

Thus a substance which is heavier than water, can float if it is shaped so as to displace water equal to its weight maintaining buoyancy.

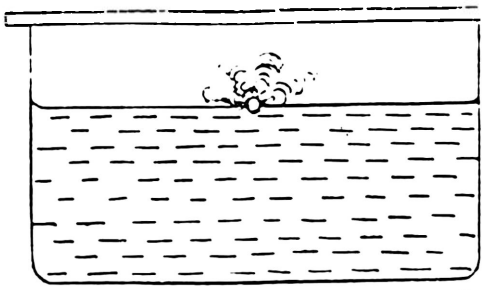
Water is a standard of reference for specific gravity, heat units, specific heat, boiling and melting points, etc. Its heat of fusion and vapourisation are very large. Its vapour pressure and solvent power play important roles in science.

The versatility of water is amazing. It is used for drinking, washing, boating, to generate power and in industries. Thus our ancestors called it as one of the elements of PANCHAMAHABHOOTAS.

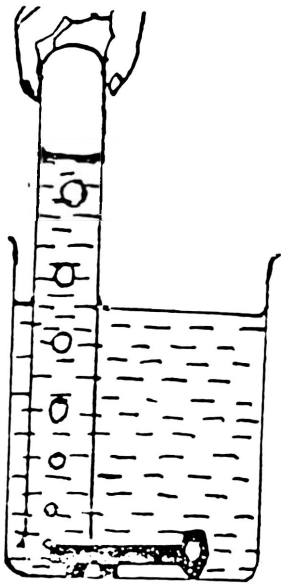
15.4 Chemical Properties

Water reacts with many acids, oxides, bases, metals, etc.

Activity



Sodium in a trough of water



Take a trough half-filled with water and place it on the table. Take a small piece of sodium and drop it into water. At once a vigorous reaction with water starts.

The metal floats, showing that it is lighter than water. It assumes a round shape showing that it has melted due to the heat produced. It rushes about wildly on the surface of water making a creeking noise and getting smaller and smaller until, finally it disappears. As the sodium touches the water, a gas is produced which pushes the sodium to move about on the surface of water. The solution will be soapy to touch due to the formation of sodium hydroxide.

Bases are soapy to touch and bitter to taste.

If a hallow key be filled with sodium by pressing the key into the soft metal and the key then dropped in a beaker of water. It sinks and bubbles of a gas can be seen coming from the metal below. The gas can be collected by inverting a test tube filled with water over it.

If the test tube containing the gas is taken out by closing the mouth of the test tube with the thumb and its open end is held out to a burning splinter. The gas burns with a slight explosion or pop sound. This gas is hydrogen.

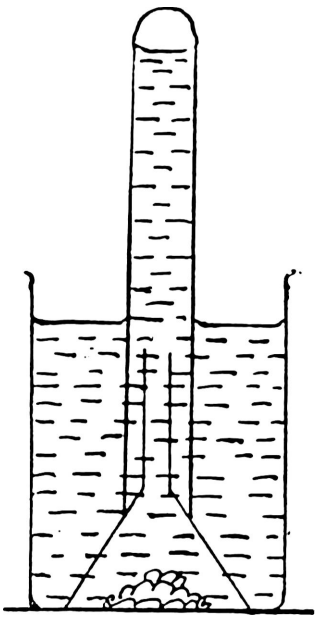
$$2Na + 2H_2O \text{ -----> } 2NaOH + H_2 \uparrow$$

15.4.2 With magnesium

Magnesium is acted upon only very slowly by cold water producing hydrogen and magnesium oxide.

Action of cold water

Activity



Take a piece of magnesium ribbon about 10 cm long. Scrape it by means of sand paper, so that the surface is clean and bright. Bend it into a zig-zag shape and place it in a beaker of water under a small funnel. Invert over the funnel, a test tube filled with water and leave it for a week. It will be observed that bubbles of a gas are rising in the test tube and collect at the top. Further the metal has lost its brightness and gets coated with a white substance.

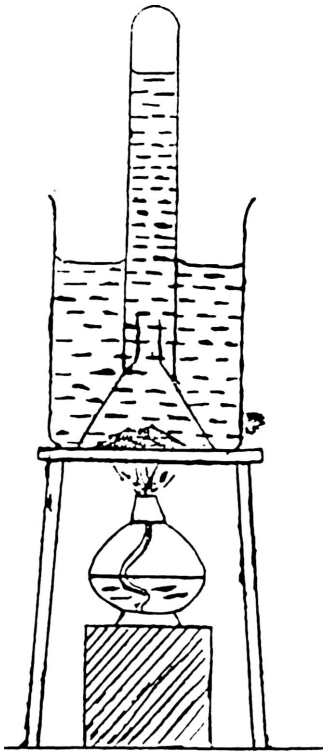
The same procedure is followed to test hydrogen gas.

Extended activity

Action with warm water

Warm water is found to act more readily and if the magnesium is mixed with mercury the reaction proceeds readily.

Activity



Place a tea spoonful of magnesium powder in a mortar and add to it a drop of mercury. Rub them well together. Now place the mixture in a beaker filled with water and invert a funnel with a short stem in such a way as to cover the metal. Invert a test tube filled with water over the end of the funnel.

On warming the beaker, bubbles of gas begin to rise and collect in the test tube. When full, remove the tube from water and the gas is tested.

The mercury remains unaffected by the water at the bottom of the beaker.

15.4.4 With Iron

Pure iron does not react with water but in moist air, it is rapidly corroded with the formation of rust (hydrated ferric oxide). Ordinary iron rusts under water containing dissolved air. Red hot iron decomposes steam, forming iron oxide and hydrogen.

$$3Fe + 4H_2O \text{ ------> } Fe_3O_4 + 4H_2 \uparrow \quad [24H_2OFe_3O_4]$$

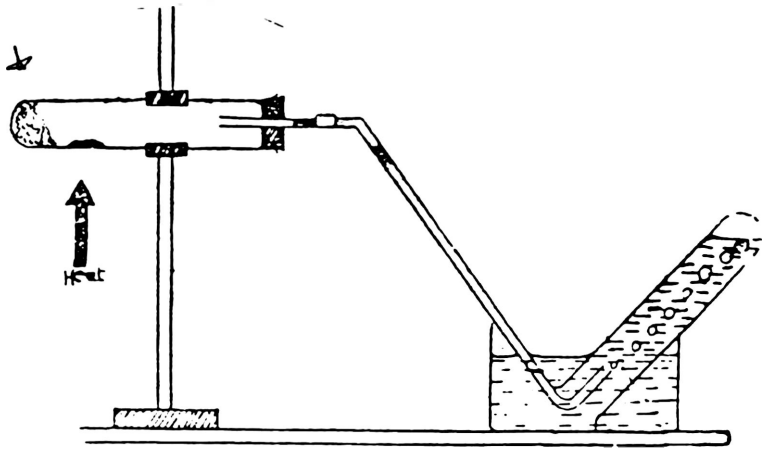
The process of forming rust is called corrosion.

Rusting of iron causes serious problems in building materials. This can be avoided by adopting following methods.

* Application of grease or oil.
* Painting with enamel.
* Coating with metal alloys using tin, etc.
* Electroplating

Fact: Metal hydroxides are basic in nature.

Pack asbestos into the test tube and add water. Holding it horizontal, spread about one spoonful measure of iron filings in the test tube, at a distance of 2 to 3 cm from the asbestos and arrange the apparatus as shown in the figure.



Heat the part of the tube holding the metal by means of a burner gently at first. Do not heat the asbestos directly. By moving on the flame backwards and forwards, boil the water in the asbestos and at the same time keep the metal hot so that a gentle flow of steam is passed over the heated metal.

Observation

The bubbles of a gas starts collecting in the inverted test tube. The collected gas is tested and is found to be hydrogen.

The same activity could be conducted with zinc and aluminium too.

From these activities, we find that water not only contains hydrogen but oxygen too because metals on reaction with water change into oxides and these oxides are identical with the oxides formed by metals when they are burnt in air or oxygen.

15.4.6 Sulphur dioxide reacts with water

Sulphur dioxide reacts with water to form sulphurous acid.

Activity

Take a spoonful of sulphur bring it near the flame. Sulphur burns with bright light forming sulphur dioxide with a pungent smell. Collect the gas into the water containing jar. It dissolves in water forming sulphurous acid.

Extended activity

Take a few pieces of charcoal, heat it. It becomes red hot. Then collect its fumes into water containing jar. The

carbon dioxide gas combines with water giving carbonic acid.

$$CO_2 + H_2O \text{ -----> } H_2CO_3$$

15.5 Types of Water

THe hardness in water is due to presence of dissolved salts and minerals in them. The hard water contains calcium and magnesium salts.

How does water become hard ?

The common mineral that water takes up are limestone or calcium carbonate. This mineral will be used to illustrate the process of hardening water. Rain water, as it leaves the cloud, is the purest form of natural water. As it falls through the air it dissolves various impurities, including carbon dioxide. The rain strikes the earth, soaks through the soil and encounters a bed of limestone. Now pure water will not appreciably dissolve lime stone; but carbon dioxide or carbonic acid attacks the limestone and changes it into a new substances called calcium bicarbonate. This is the chief mineral in hard water and hence is largely responsible for its hardness. Other common minerals in hard water are magnesium bicarbonate and the sulphates of calcium and magnesium.

Experience

What is the result of heating hard water ?

Everybody has seen the white deposits on water heating coil. It needs to be replaced occasionally, because it clogs with time. This leads to wastage of electrical energy if hard water is used.

Where does the 'lime' come from ?

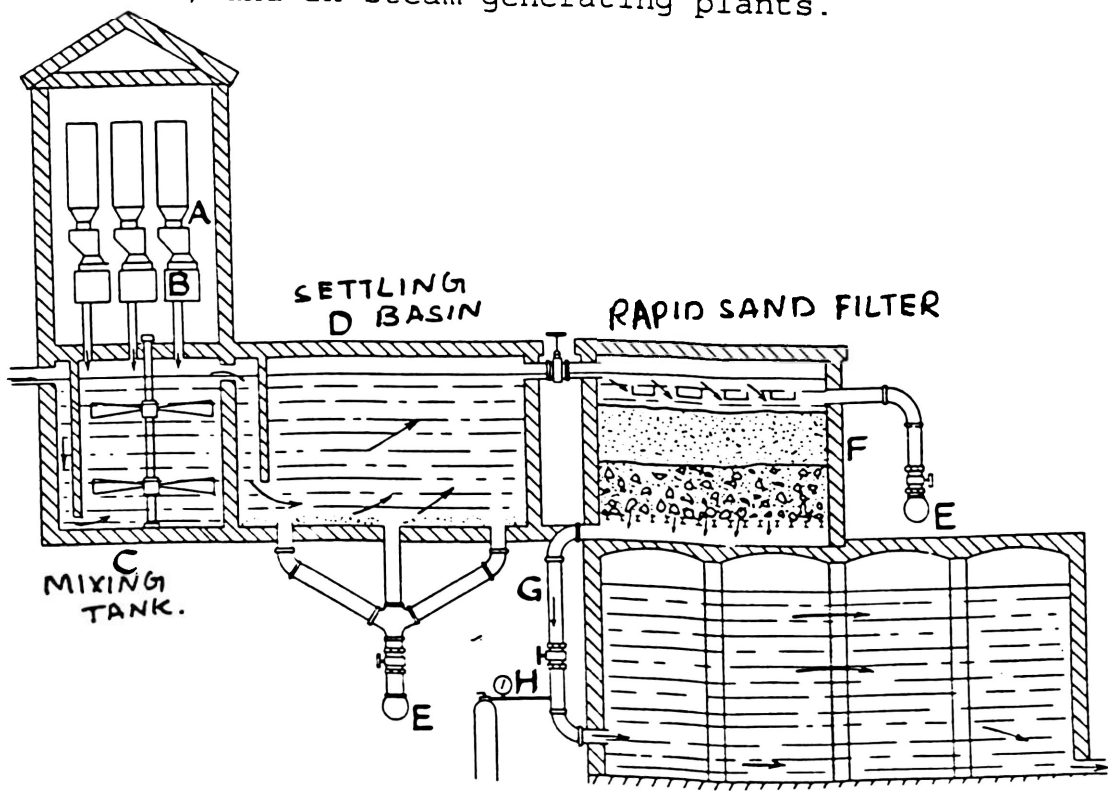
When water is heated almost to boiling, then the compound becomes unstable and decomposes into insoluble calcium carbonate and carbon dioxide. The calcium carbonate coats the tea kettle, clogs the hot water pipes and chokes the steam boiler.

15.5.1 Softening of Hard Water

Removal of hardness in water is called softening.

Activity

There are two major chemical processes for industrial and domestic purposes. The best known process employs soda ash, washing soda and lime soda process. The addition of this mixture to hard water converts the mineral contents into insoluble carbonates and hydroxides. They settle at the bottom and leave the water soft. This treatment is used in the boilers, and in steam-generating plants.



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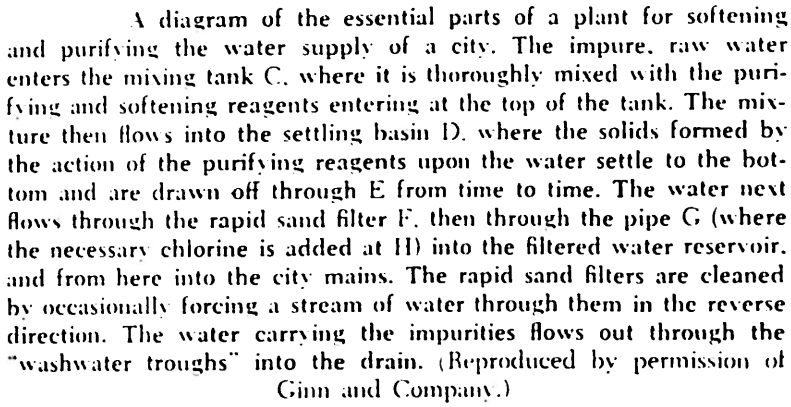

A diagram of the essential parts of a plant for softening and purifying the water supply of a city. The impure, raw water enters the mixing tank C, where it is thoroughly mixed with the purifying and softening reagents entering at the top of the tank. The mixture then flows into the settling basin D, where the solids formed by the action of the purifying reagents upon the water settle to the bottom and are drawn off through E from time to time. The water next flows through the rapid sand filter F, then through the pipe G (where the necessary chlorine is added at H) into the filtered water reservoir, and from here into the city mains. The rapid sand filters are cleaned by occasionally forcing a stream of water through them in the reverse direction. The water carrying the impurities flows out through the "washwater troughs" into the drain. (Reproduced by permission of Ginn and Company.)

Extended activity

A modern method is the zeolite process. The zeolite mineral is also called permutite. Its chemical name is sodium aluminium silicate.

A bed of this chemical is formed on a tin tray. Hard water is taken and passed through this bed.

Calcium and magnesium salts react with permutite and form insoluble calcium and magnesium permutite.

Water is very fundamental for the sustenance of life. Hence water should be used judiciously.

15..6.1 Make sewage water respectable

The public is becoming increasingly conscious of pollution of water. It is used in sanitation, for swimming, boating and fishing. This demand is forcing widespread construction of sewage disposal plants. The objective is not to bury the sewage, but to render it harmless and inoffensive. It is true that if sewage flows far enough in a stream, it will be purified by dilution, green plants (root zone method) sunshine and oxygen.

Sewage disposal, however, aims at purifying it before it reaches the river or lake.

Activity

A model could be prepared and displayed.

This activity has to be conducted as a model to the society under three subtopics:

* Sewage water treatment
* Waste minimisation process
* Best use from work

Sewage is screened to remove rags, paper and other hard materials. It then flows into sedimentation tanks, where the main bulk of solid matter settles down, the liquid portion is sprayed upon the surface of filter beds (large beds of crushed rocks). The rock surfaces are coated with slime which contains bacteria. The settlings of the sedimentation tanks are transferred to other tanks called digesters. This is subjected to bacterial action. It ferments giving out combustible gas and partly liquifies. Here its water content is greatly reduced and the residue may be used as fertiliser. The combustible gas is used for heating. The remaining reduced water can be discharged into the surface water.

Activity

A slow sand filter.

A simple low cost sand filter.

Water trickles through the sand and gravel then penetrates through the walls of the porous charcoal layers. Then the water is collected in purified form. Thus water is made free from impurities. Arrange the apparatus as in figure.

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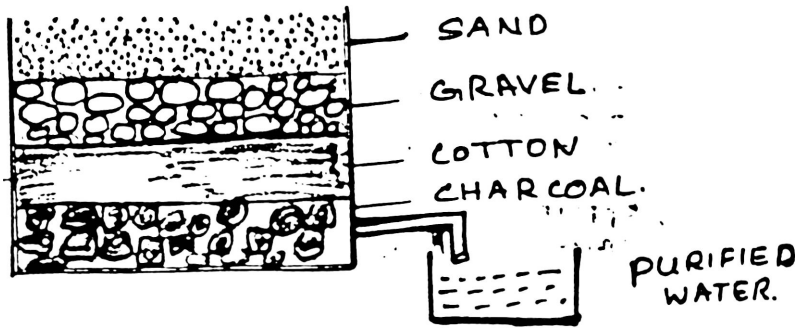


15..7 Water Cycle

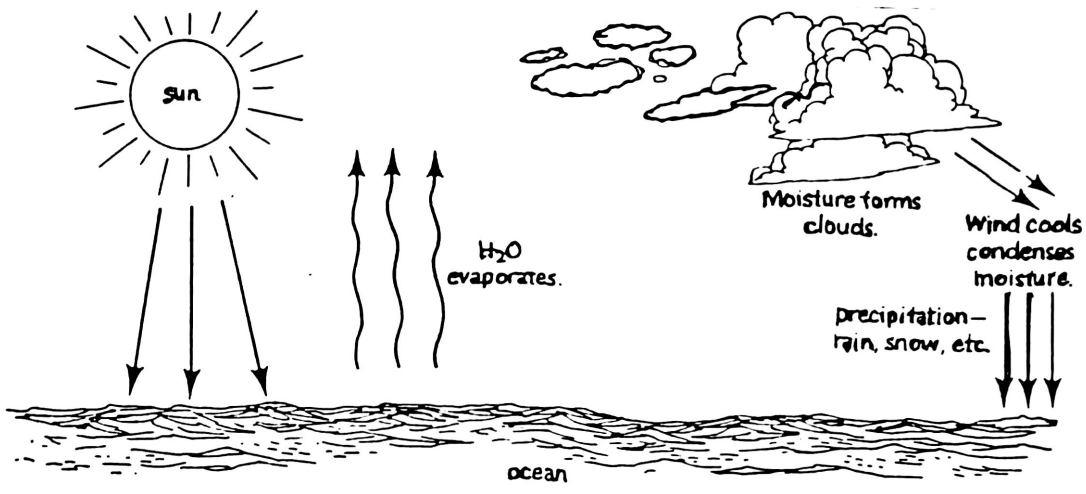
The concept of water cycle can be developed by explaining a continuous condensation and evaporation process.

15 .7.1 Activity

Fill water in a tea kettle. Then boil the water. A jet of steam or water vapour comes out through its spout. Place ice cubes on the plates. Hold the underside of the plate in the steam and ask the children to observe.

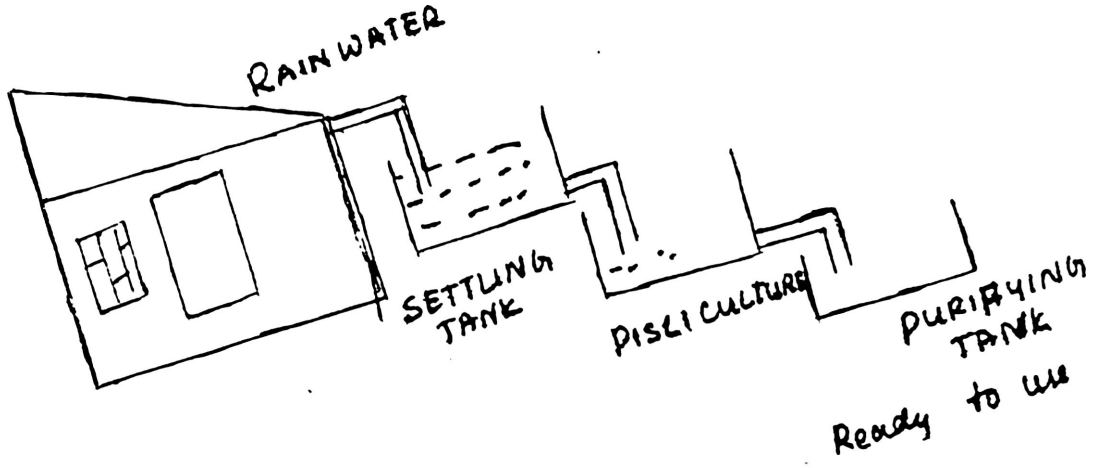
Observation

The bottom of the plate collects water vapour and gets condensed as ice cubes are present on the plate. Then water drips from the bottom of the plate. This forms the artificial rain.



15.8 Natural Water Harvesting

The main source to obtain natural water, is by rain. Here is an advanced technology to harvest water. The phenomenon can be understood with the help of this model. (Blue print of the model shown in figure).



An eco-friendly, slant house is constructed as per the blue print plan. The rain water is collected from the slant roofed house. The collected water is subjected to flow into a settling tank. The heavy insoluble impurities will settle down at the bottom of the tank. Then the water is allowed to flow into the purifying tank, in which there will be rocky bed, and a bed of charcoal. The water collected from this tank can be directly used for the household activities except for drinking and cooking. Thus we can save natural water.

15.9 Let us know something about "water table"

Ground water is the water beneath the earth's solid surface. It has been proven that ground water is derived mainly from rain snow, mist, ice, etc. 84% of surface water sinks into the ground.

The amount of water tha enters the ground is largely determined by the rate of rainfall, porosity of the soil, topography of the surface, temperature and humidity of the atmosphere.

When a well penetrates the ground, it first passes an unsaturated zone where the space between the rock particles of the bedrock are filled with air. This region is called the zone of aeration. The upper surface of the zone of saturation is the WATER TABLE.

Fact: The height of the water table depends on

=> rainfall

=> porosity of rock mantle or bed rock

=> topography of this land

15.10 Evaluation

I. Fill up the blanks

1. Water decomposes to give hydrogen and oxygen in the ratio _____.
2. Freezing point of water is _____.
3. The chemical name of calgon is _____.
4. Sodium and potassium is preserved in _____.
5. A solution in which no further substance dissolves in it is called _____.

6. The colour of rusted iron is _____.
7. The method of using electricity to breakdown the molecule is called _____.
8. The process of rusting of iron is called _____.
9. Water has maximum density at _____.
10. Sodium reacts with water to liberate _____ gas.
11. Water is an oxide of _____.
12. _____ is a device used for electrolysis.
13. Water free from all the impurities is called _____.
14. Water soluble metal oxides are called _____.
15. _____ is called universal solvent.
16. The chemical name of zeolite is _____.
17. Sulphur dioxide reacts with water to give _____.
18. One litre of sea water contains about _____ gm of salts.
19. The specific heat of water is _____.
20. The unit of heat capacity is _____.
21. The attraction between the unlike molecules is called _____.
22. The boiling point of water is _____.
23. The molecular formula of water is _____.
24. Water expands on _____.
25. The content of water vapour in the air is called _____.

II. Answer the following

1. Define the following:

a. oxidation
b. humidity
c. electrolysis
d. heat capacity
e. salinity
f. corrosion
g. hard water
h. soft water
i. water table
j. saturated solution.

2. List different sources of water.
3. Explain with an activity

   "water is necessary for life"
4. What are the physical properties of water ?
5. What is anomalous expansion ?
6. Describe an experiment to show that water is a bad conductor of heat.
7. Explain the process of electrolysis.
8. How does water react with metal ? Give the equation for chemical reaction.
9. Suggest the measures to prevention corrosion.
10. Differentiate between hard water and soft water.
11. How do you remove hardness in water ? Suggest an activity ?
12. How do you make sewage water respectable ?
13. Explain water with the help of a neat diagram.
14. Write a short note on water harvesting.
15. Suggest any five measure to prevent water pollution.

III. Give reason (scientific)

1. Water is called universal solvent.
2. Using hard water is uneconomical.
3. Brown substance is seen on iron nail exposed to moist air.
4. Water is a bad conductor of heat.
5. Distilled water is not suitable for drinking.
6. Ice floats on water.
7. Warm water rises over cold water.

8. Sea water is saline.
9. Sodium and potassium are stored in kerosene.
10. Sodium hydroxide is soapy to touch.
11. Iron articles should be coated with paint.
12. Removal of hardness in water is necessary.
13. Water table should be maintained.
14. Saline water is not suitable for agriculture.

IV. Draw neat diagrams of the following and label the parts

1. Voltameter
2. Water cycle
3. Diagram to explain surface tension
4. Diagram to explain capillarity
5. Diagram to explain water harvesting
6. A sand water filter

UNIT XVI

AIR

16.1 Introduction

No part of the earth is more essential to life than our atmosphere. It is so subtle that we actually live beneath a vast sea of tasteless, odourless and colourless gases. The atmosphere dominates man's activities. What we eat, what we wear and what we produce are determined by climate.

Without air, the earth would be a lifeless rocky world similar to the moon. Without atmosphere the sky would be dark all the time, the stars would not twinkle and the sun would be a blinding fire ball pouring out lethal radiation onto the earth along with heat and light. Without air there would be no clouds, no rain, no running water and no wind. The surface of the earth would be extremely hot during the day.

16.2 Concepts

1. Air occupies space has weight and exerts pressure in all directions.
2. Air is a mixture of gases - oxygen, nitrogen, water vapour, carbondioxide and noble gases.
3. Nitrogen and carbon dioxide are essential for the growth of plants. Oxygen is necessary for combustion.
4. The components of air can be separated by fractional distillation.

5. Human activities has brought about changes in the composition of air.

16 .3 Instructional Objectives

To enable the students to

1. recognise the properties of air
2. recognise the composition of air.
3. recognise that inert gases are used to fill electric bulbs and attain low temperatures.
4. see relationship between human activities and air pollution (changes in the composition of air).
5. identify the causes for air pollution.
6. relate air pollution to various harmful effects on humans, plants, buildings, etc.
7. suggest preventive measures to be undertaken to reduce air pollution.

16 .4 Concept Development

.4.1 Activity

Materials required: a medicine dropper, an empty bottle, a tumbler, a hand kerchief and a trough with water.

Put the tip of the medicine dropper into trough containing water. Squeeze the air out of the medicine dropper. The teacher asks the children to observe as to what happens when the bulb is squeezed. The children observe that the bubbles come out of the tip of the medicine dropper. They recognise that the medicine dropper contained air and that it came out when the bulb was squeezed.

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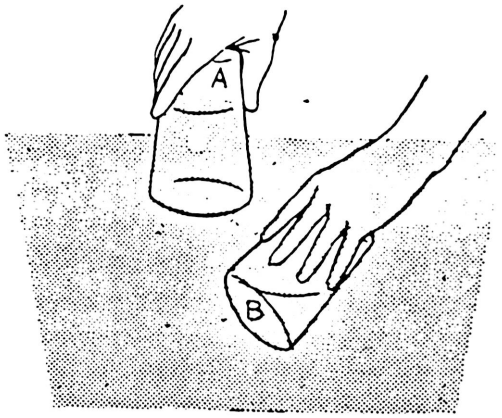


The teacher explains that air and water are substances that occupy space. Two things cannot occupy the same space at the same time. One substance gives way to the other. Here air gives way to the water. When the air is squeezed out water enters the dropper. [This experiment can also be used to demonstrate that air exerts downward pressure]. The same concept can be reinforced with an empty bottle and water.

16.4.2 Activity

An empty tumbler with a hand kerchief firmly pressed to the bottom. Invert the tumbler in the trough with water. Remove the tumbler and ask the children to observe if the hand kerchief has become wet. Children reason out as to why the hand kerchief remains dry in the tumbler. This activity further reinforces the concept that air occupies space.

16.4.3 For the teacher

The atmosphere around the earth extends to several hundred kilometers. It serves as a blanket. Over billions of years the earth formed and as it began to cool, the ocean of air that now surrounds the earth formed. As this atmosphere

cooled, water vapour changed to water, from this water came the first seas.

Air shields the earth from harmful rays from the sun. At the same time air traps much of the heat from the sun. It keeps earth warm enough to support life. Air protects us from meteoric particles, most of which burn up in the atmosphere before they can strike the earth's surface. Clouds that form high up in the air bring us water in the form of snow and rain. All living things require air and water.

We also need air to hear. Sound must travel through air or a medium. Most of the sounds we hear travels through air.

16.4.4 Activity

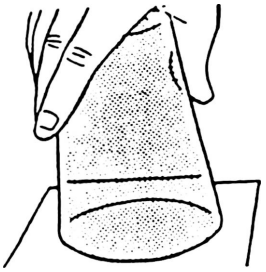
The experiment suggested in the textbook can be performed to show that air has weight.

16.4.5 Activity

Invert a glass tumbler without spilling a drop.

Materials needed

A glass of water, a piece of cardboard or stiff paper.



Fill a drinking glass right upto the brim with water and lay on top a piece of stiff paper or cardboard. Hold the

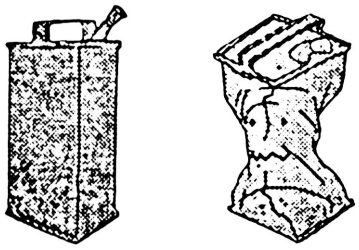
cardboard on and turn the glass upside down. Remove your hand from the cardboard. The water stays in the glass and is not pushed down by the weight of water.

The teacher reason out that the air outside exerts pressure on the cardboard. The force with which the air holds the card against the glass is amply sufficient to support water in the glass.

With a bit of skill it is possible to invert the glass of water without holding the card with your fingers.

16.4.6 Activity

Materials needed: a tin can with screw cap, water and a burner.



The teacher can demonstrate that air has tremendous force.

Wash the tin, pour a cup of water into it. Heat the can to let the water boil for a minute or two. Stop heating and screw the cap quickly. The can is now filled with steam. Most of the air would be driven out of the can. This steam will cool and condense to water. The teacher asks the children to observe the can as it cools. When steam cools and condenses to water, it occupies less space. The teacher explains that the pressure inside the can is less than the

pressure outside. This collapses the can as though a giant hand had crumpled it.

We use air pressure as a force in many ways. For example, when we suck a soft drink through a straw, we do not actually pull the liquid up the straw. Instead, by sucking the straw, we remove some of the air from inside it. As a result the air pressure inside the straw becomes less than the pressure of the air on the liquid outside the straw. Since the outside pressure is more, it pushes the liquid up through the straw. [Refer the medicine dropper experiment]

16.4.7 For the teacher

The balloons filled with a light gas or heated air rise high above the earth since they are lighter than the air around them. Air moving past aeroplanes and birds creates low pressure below the wings which help them to fly.

Air has pressure and weight. At sea level one cubic meter of air weighs 1170 gms. The weight of all the air around the world is more than 5,200,000,000,000,000 metric tons. The weight of air pressing from the top of the atmosphere upon the earth below produced air pressure called atmospheric pressure. The air pressure at sea level is 1.033kgs/sqcm (101.3 K Pascals). The air pressure pressing down on your shoulders weighs about 0.9 metric tons. You do not feel this because you are supported by equal air pressure from all sides.

A barometer is used to measure air pressure. On a barometer, the average atmospheric pressure at sea level is 760 mm of mercury or 1013 millibars.

The upper atmosphere has less pressure than the air near the earth. Simply because there is less air pressing down from above.

Scientific observations of air began in AD 1593, when the Italian scientist Galileo invented a type of gas thermometer. In 1643 Evangelista Toricelli, an Italian Mathematician and Physicist invented the barometer. This invention proved that air has weight and occupied space. In mid 1600's, the Irish chemist Robert Boyle used the barometer to formulate the relationship between the volume of air and air pressure.

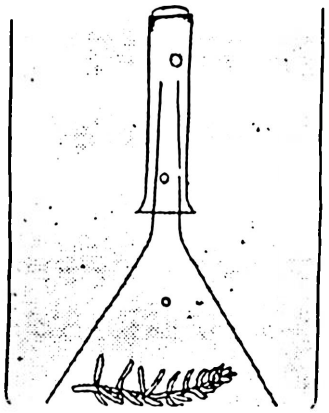
16.4.8 Activities suggested in the textbook with reference to combustion is to be performed to show that air contains a gas that helps burning and forms 20% or $1/5^{th}$ by volume of air.

The teacher may explain that the remaining part is nitrogen with traces of other gases. These gases do not take part in burning.

Oxygen is used up for various activities like breathing, burning of fuels, rusting, bursting of crackers, etc. Carbondioxide is liberated during this process. Nature returns this oxygen to the air by a process called **Photosynthesis.**

16.4.9 Activity suggested in the text to be performed to demonstrate that oxygen is liberated during photosynthesis.

Use a large beaker as shown in the figure.



16.4.10 Activity suggested in the text for the preparation of oxygen to be performed by the teacher to show that oxygen can be obtained from different substances. Substances burn brighter in pure oxygen. Nitrogen in the air actually dilutes the oxygen and reduces the rate of oxidation.

Nitrogen is not an active gas. But it is very important for all life on earth. The important nutrient in food is protein - a nitrogen compound. Proteins form the building blocks of cells and tissues in plants and animals.

Nature has devised ways to enable plants to make use of this nitrogen.

The nitrogen in the atmosphere combines with oxygen to form oxides of nitrogen under high temperatures produced by lightening. These oxides dissolve in water to form acids. These acids react with salts in the soil to form nitrates. These nitrates are soluble in water and hence absorbed by plants for their growth.

Microbes in the soil have the capacity to absorb atmospheric nitrogen and convert them into nitrogen compounds. When they die and decay the plants absorb the nutrients to grow. Certain bacteria (Rhizobium) absorb nitrogen and convert them into nitrogen compounds through a process called nitrogen fixation. The bacteria are present in the root nodules of leguminous plants. There are many microbes which return the used up nitrogen to the atmosphere when plants and animals die and decay.

The other gases in the air are inert gases.

Air also contains solid particles - aerosols. These particles enter the air from active volcanoes, automobile exhausts, forest and bushfires and factory smoke. The wind carries dust and sand into the atmosphere. Pollen from plants, salts from oceans and microbes are the other aerosols.

Rain or snow wash out many aerosol particles, which is why the air is fresher after rains.

16.4.11 Teacher should know

Air becomes a liquid at -190^{o}C. Liquid air is so cold that it boils when poured on ice which is almost 200^{o}C hotter. Liquid air is bluish in colour and looks like water. Liquid air, like air contains 78% nitrogen, 21% oxygen and 1% argon.

Nitrogen and oxygen can be separated by and used in their liquid form by distilling liquid air. When liquid air is heated, the nitrogen turns into a gas before oxygen does

because the boiling point of nitrogen is lower. After nitrogen has been removed, the remaining substance is mostly liquid oxygen.

Liquid nitrogen is used in the manufacture of ammonia. Ammonia is used to manufacture fertilisers, explosives, nitric acid and other chemicals.

In food industry liquid nitrogen is used to quick-freeze food. Liquid nitrogen serves as a refrigerant for food during transport.

Liquid oxygen is used in compact, high energy fuels for rocket engines that power the space craft.

Exposure to liquid air makes metals better conductors of electricity and increases the strength of certain types of magnets.

During the 1700's scientists began to investigate the gases that made up the air.

Oxygen was discovered by Carl Scheele in 1770 and Joseph Priestly in 1774. In 1777 Antoine Lavoisier, a French chemist realised that oxygen enables things to burn. Daniel Rutherford, a Scottish doctor discovered nitrogen in 1772. Argon was discovered in 1894 by Sir William Ramsay and Baron Rayleigh.

By late 1800's scientific studies demonstrated the composition of air is same all over the earth.

16.4.12 Uses of inert gases

Helium is used to obtain low temperature. Liquid helium boils at 4.2^{o} Kelvin. The low temperature properties

of materials can be studied using liquid helium as a cooling agent.

Helium and neon are used to measure the temperature of liquid air because they turn into liquid at a much lower temperature.

16.4.13 Air pollution

Over the years human activities have brought about some changes in the composition of air. For example, carbon dioxide enters the air whenever fuels are burnt. Since 1900s the use of enormous amounts of these fuels has led to 15% increase in the amount of carbon dioxide in the air. However carbon dioxide still makes up a small part of the air.

Human activities influence nitrogen cycle. The oxides of nitrogen pollute the air. These are released by burning fossil fuels and also during lightening. Sunlight causes nitrogen oxides in the atmosphere to react with oxygen to form ozone - an irritating substance in smog. Nitrogen oxides can return to the earth as nitric acid, which causes acid rain.

Nitrogen oxides can promote the decomposition of ozone in the upper atmosphere. Ozone in the upper atmosphere shields living beings from harmful ultra violet rays.

16.4.14 Teacher should know

Air is a mixture of gases that extends from the earth's surface to the outer space. The earth's gravity holds the air in space around the earth. The molecules of air move about freely. As sunlight passes through the

atmosphere it strikes molecules of the gases. The molecules scatter the sunlight (which is a mixture of all colours) in all directions. The sky appears blue because much more blue light is scattered than any other colour.

The principal gases in the air are nitrogen and oxygen. Other gases include argon, krypton, water vapour, carbon dioxide, neon, hydrogen, xenon and ozone. Nitrogen makes up 78% of dry air, oxygen 21% of dry air. The remaining 1% consists chiefly of argon with extremely small amounts of other gases.

Some gases in the air are extremely important. When we breathe we take in oxygen and give out carbon dioxide. Respiration is a kind of combustion. This slow combustion burns food in our body to generate energy for various activities. During photosynthesis plants make use of this carbon dioxide to prepare food and oxygen is liberated as a by-product. Respiration is the reverse of photosynthesis.

Oxygen plays an important part in rusting, combustion and oxidation of materials.

Certain bacteria in the soil turn nitrogen into nitrogen compounds and enrich the soil for the healthy growth of plants.

Carbon dioxide and water vapour help to keep the earth warm. They prevent some of the heat created by the sunlight from escaping back into space. This is known as Green House Effect.

Water vapour is also needed to produce rain and snow. Moisture in the air is known as Humidity. The lower air over the oceans is always filled with water vapour. The air over the desert may be almost dry. The amount of humidity varies with weather. The air is less humid on a clear day than on a cloudy day. If the air becomes cold enough, the water vapour beings to change into tiny droplets or ice-crystals. The process is called Condensation. As air rises up its temperature decreases. Cloud consists of air filled with colourless droplets of water. Rain or snow is produced after these become heavy enough to fall out of the clouds. Fog is simply a cloud near the earth's surface.

Ozone (a form of oxygen) absorbs the harmful ultraviolet rays coming from the sun before reaching the earth.

Origin of the Earth's Atmosphere

The earth's earliest atmosphere did not contain oxygen. But after algae and simple green plants appeared in the oceans about three and a half billion years ago, the amount of oxygen started to increase as a result of photosynthesis. As plants spread on the earth more and more oxygen built up in the atmosphere. By about 400 million years ago there was more oxygen as it does today. The proportion of gases in the air has remained about the same for millions of years.

Since 1900's, great progress has been made in developing equipment for studying the atmosphere. Today rockets, radars, satellites and weather balloons are used to make observations of the air. With these devices scientists

can monitor atmospheric conditions, pollution levels and changes in the composition of air. Computers help meteorologists analyse large amounts of data from various sources and prepare weather maps and weather forecasts.

16.4.15 Suggested Activities for Children

1. Record the temperatures three times a day-morning, noon and night for a week. Later extend it to a month.
2. Record weather conditions for a month regarding

   a. bright sunlight
   b. cloudy
   c. rainy
   d. windy

   Devise symbols to record.

16.5 Evaluation Questions

I. Fill in the blanks

1. An empty bottle contains _____.
2. A common compound of carbon, that is a gas and is found in the air is _____.
3. Air is a _____ of gases.
4. When carbon dioxide is bubbled through lime water, the lime water turns _____.
5. The two major parts o_ the air are _____ and _____.
6. The water rises in the medicine dropper after the air has been squeezed out because of _____ pressure on the outside.
7. _____ in the upper atmosphere shields the earth from harmful ultraviolet rays of the sun.
8. The gases that help the growth of plants are _____ and _____.

9. Oxygen is returned to nature by a process called _____.

10. The components of air can be separated by _____.

II. Choose the appropriate answer

1. Air exerts _____ pressure.

   a. downward b. sideward

   c. upward d. allround

2. An instrument used to measure atmospheric pressure is _____.

   a. thermometer b. hydrometer

   c. barometer d. ammometer

3. The percentage of nitrogen in air is _____.

   a. 20 b. 72 c. 78 d. 21

4. Liquid air is a mixture of _____.

   a. oxygen and carbon dioxide b. nitrogen and inert gases

   c. nitrogen and carbon dioxide d. nitrogen and oxygen

5. The part of the air that helps burning is _____.

   a. nitrogen b. oxygen

   c. carbon dioxide d. argon

III.

a. Arrange the gases in the order of their abundance in air.

   a. carbondioxide b. oxygen

   c. nitrogen d. inert gases

b. Answer the following questions

1. The upper atmosphere has less pressure. Explain.

2. Explain the fact that humidity in air can cause weather changes.

3. Respiration is a kind of combustion. Explain.
4. Mention two uses of oxygen.
5. How is oxygen balance maintained in nature ?
6. How is nitrogen converted to nitrogen compounds ?
7. Make a list of any four uses of nitrogen.
8. Name three kinds of particles present in air.
9. Mention any three uses of inert gases.
10. Why has the composition of air changed over the years ?
11. Mention the causes for air pollution.
12. How can air pollution be controlled ? Suggest any three methods.

UNIT XVII

ACIDS, BASES AND SALTS

Introduction

Chemical compounds can be classified in several ways on the basis of their properties like colour, taste, odour, state, solubility, etc. we group such compounds into different categories and name them accordingly. Oxides are a group of compounds formed by the combination of elements with oxygen. Water is an oxide of hydrogen.

Some of the citrus fruits taste sour because, some organic substance is present in it. We can test, find the chemical substance present in it and can identify the substance present in such fruits called acid. In the same manner, lime stone also forms some compound when combined with water which is called base. In this unit we study acids, bases and salts.

The sour taste in citrus fruits is due to the presence of acid in it. Some substances like lime, limestone, soda, etc. are soapy to touch and bitter to taste. This is due to the presence of some base. In order to make the definitions of acid and base. J.N. Bronsted proposed that an acid is a 'proton donor' and a base is a 'proton acceptor'.

Acid produce H^+ ions.

Bases accept protons.

The word acid comes from the Latin. Word acids meaning sour.

Concepts

* Most of the elements combine with oxygen and form oxides.
* Oxides of non-metals are acidic sour to taste, they dissolve in water to produce acids.
* Acid is called proton donor, the ability to donate proton decide whether it is strong or weak.
* Acids are of two kinds as organic acids and mineral acids.
* Acids react with metals and liberate hydrogen and with carbonates liberate carbondioxide.
* Weak acids exist largely as unionised molecules in solutions.
* Acids react with metal oxides to form salts and water have identical properties and turn blue litmus red.
* Oxides of metals are called basic oxides which dissolve in water form alkalies.
* Bases are soapy to touch, bitter to taste and turns red litmus blue.
* The process of salt formation when acids and bases react is called neutralisation.
* The four main kinds of salts are the acid salts, normal salts, basic salts, double salts.
* The determination of pH value is important in agriculture, industries and medicine.

Competency Behavioural Objectives

To enable the pupil to

* recognise compounds and elements.
* recognise the chemical change that takes place when sulphur and carbon burns in air.

* differentiate between acidic oxides and basic oxides.
* list two kinds of acids - as organic acid and mineral acid and their classification as weak and strong.
* state the physical properties of acids and bases.
* recognise the reaction of acids on metals and litmus paper.
* recognise the different uses of acids and bases.
* explain the process of neutralisation.
* interpret the meaning of basicity.
* appreciate the importance of pH value in agriculture.
* reason out the change in lime water which turns milky when carbon dioxide is blown.
* identify the organic acids present in our daily food items and in human body.
* classify the salts as acidic salts, basic salts, normal salts and double salts.
* reason out that rain water is acidic.
* practice the skill of handling apparatus and laboratory equipments.
* prepare chart on pH values of different substance.

Development

17.1 Elements and Compounds

Elements - An element is a substance that cannot be divided into simpler substance. Eg: oxygen, carbon, iron, etc.

Compound - A compound is a substance produced by the chemical combination of two or more elements in a definite proportion by mass. Eg: water, sugar, salt, etc.

Activity 8.1.1

Displaying some of the elements and compounds, and familiarising the students to recognise.

17.1.2

Most of the elements combine with oxygen and form compounds called oxides. Some oxides dissolve in water to give acids.

Take sulphur powder in a defragrating spoon. Burn it with the help of a spirit lamp. Ask the students to observe the colour of the flame. Then the spoon is introduced into a gas jar and the mouth of the gas jar is closed with a lid.

Ask the students to observe the fumes inside the jar.

Observation

The colour of the flame will be very violet. Recognise the characteristic pungent smell of the gas.

Inference

When sulphur burns in air sulphur dioxide is formed.

$$S + O_2 \text{ -----> } SO_2$$

Collect the gas into a jar. Add a little water into it and shake well. It forms sulphurous acid. Let us call this jar as 1

$$SO_2 + H_2O \text{ -----> } H_2SO_3$$

17.1.3

Take a small pieces of sodium in a deflagering spoon and heat it over the flame.

Observation

It burns in oxygen of the air, brightly in yellow colour and forms a white powder.

Inference

It is an oxide of sodium. A little of this powder is added to jar containing water. It dissolves in water. The solution formed is sodium hydroxide. Name this jar as 2.

17.1.4

Take a pieces of charcoal in a deflagerating spoon and heat it over the flame. Introduce the spoon into a wide mouthed bottle.

Carbon combines with oxygen and form carbondioxide.

$$C + O_2 \text{ -----> } CO_2$$

Remove the spoon from the bottle and add a little water into it. Shake it well. Name this bottle as 3.

$$CO_2 + H_2O \text{ -----> } H_2CO_3$$

The carbonic acid is commonly called soda water.

17.1.5

A small piece of pure magnesium ribbon is held over a flame. Ask the children to observe.

Observation

The ribbon burns brightly.

Caution

Do not look at the flame for too long.

After burning collect the white ash formed on a paper.

$$2Mg + O_2 \text{ -----> } 2MgO$$

Mix this ash with hot water in a beaker and shake well. Name this beaker as 4.

Litmus test

Dip a blue litmus strip in each of the acid one after the other. The paper turns red.

Acids turn blue litmus paper red.

Repeat all the tests including litmus paper test on all solutions obtained in previous activities, i.e. beakers 1 to 4.

(i) Red litmus turn blue

(ii) Soapy to touch

(iii) Bitter to taste

Confirming they are bases. The physical tests on 1 and 3 infer they are sour to taste.

Blue litmus turns red. Confirming they are acids.

Metals like zinc, calcium, magnesium, sodium form respective oxides by reacting with oxygen. They are metallic oxides.

Many of these oxides are soluble in water giving solutions that are called hydroxides. These hydroxides are called bases or commonly called alkalies.

17.2 Properties of Acids

17.2.1

* Lemons and oranges are taken, juice is extracted. Ask the children to identify the tastes of different juices.

Citrus fruits contain citric acid. Tamarind has tartaric acid. Buttermilk has lactic acid. Vinegar has acetic acid. Apple contains malic acid. These are organic acids. Acids are sour to taste.

17.2.2

* Open the bottle of any mineral acid. Take a glass rod and dip it into the acid. Bring it outside and observe white

thick fumes from the stick. Take a drop of the acid and drop it on a piece of paper.

Caution: Handle it carefully.

The paper burns within no time.

Acids are corrosive.

17.2.3

* Take a few pieces of zinc in a test tube. Add a little of dilute hydrochloric acid. [Teacher explains the method of diluting concentrated acid.] The acid reacts with the metal and gas bubbles come out through the liquid. After some time bring a burning paper near the test tube. Ask the students to observe.

Observation

The gas catches fire and burns at the mouth of the test tube making a pop sound.

Zinc + Hydrochloric acid ----> Zinc chloride + Hydrogen

$$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$$

Acids react with certain metals to give salts and hydrogen is liberated.

In above reaction zinc chloride is a salt.

* Acids get neutralised by bases. They lose their acidic properties, because of the formation of salt and water.

$$HCl + NaOH \longrightarrow NaCl + H_2O$$

Hydrochloric acid + Sodium hydroxide -----> Sodium chloride + Water

$$H_2SO_4 + Ca(OH)_2 \longrightarrow CaSO_4 + H_2O$$

Sulphuric acid + Carbon hydroxide -----> Calcium sulphate + Water

The end products of the reaction do not have any acidic property.

17.2.4

* Take a spoon of calcium carbonate in a test tube. Add two or three drops of concentrated hydrochloric acid. A thick white fume is liberated with effervescence. The gas is collected by downward displacement. The gas collected is tested by passing it into lime water. The lime water turns milky.

Calcium carbonate + Hydrochloric acid -----> Calcium chloride + Water + Carbon dioxide

$$CaCO_3 + 2HCl \text{ -----> } CaCl_2 + H_2O + CO_2$$

The mineral acids like sulphuric acid, nitric acid, hydrochloric acid are considered as strong acids. Because they completely dissociate in solutions to give hydrogen ions.

Carbonic acid, sulphurous acid and acetic acid are considered as weak acids. They dissociate in dilute solutions only to a small extent to give hydrogen ion.

17.3 Base

A base is a substance which when dissolved in water dissociates into hydroxyl ion ($-OH^-$) and a positive ion.

A base is a compound which will react with an acid to give a salt and water. Bases are the oxides or hydroxides of metal. When it is dissolved in water it donates hydroxide ions.

17.3.1

Take a trough half-filled with water and place it on the table. Take a small piece of sodium and drop it into water. At once a vigorous reaction with water starts.

The metal floats, showing that it is lighter than water. It assumes a round shape showing that it has melted due to the heat produced. It rushes about wildly on the surface of water making a creeking noise and getting smaller and smaller until, finally it disappears. As the sodium touches the water, a gas is produced which pushes the sodium to move about on the surface of water. The solution will be soapy to touch due to the formation of sodium hydroxide.

Bases are soapy to touch and bitter to taste.

17.3.2 Litmus test

Dip a strip of litmus into the solution. The red litmus turns blue confirming it is base.

Bases turn red litmus blue.

17.3.3

Take potassium hydroxide in a test tube. Add hydrochloric acid slowly from the side of the test tube. It forms potassium chloride and water.

$$KOH + HCl \text{ -----> } KCl + H_2O$$

The hydroxides of the alkali metals are all strong bases. The hydroxides of the alkaline earth metals are strong bases.

An example for weak base is ammonium hydroxide.

17.3.4 Basicity of acids

The number of hydrogen ions H^+ formed by the ionisation of one molecule of an acid is known as its basicity.

If the molecule of an acid can donate only one H^+ to a base, such an acid is called monobasic acid. It can produce only one kind of salt.

Eg: HCl, HNO_3

If the molecule of an acid can donate two H^+ ions such an acid is called dibasic acid.

It can produce two kinds of salts.

Eg: H_2SO_3, H_2SO_4

pH scale

Danish scientist Sorenson designed the scale used to measure acidity or alkalinity is called pH scale.

pH of some common substances.

Milk	-	6.6
Pure water	-	7
Human blood	-	7.3
Sea water	-	8.5

17.4.6 The importance of pH value

The determination of pH value is very important in agriculture, industry and medicine. Each crop has a pH range at which it grows best. The pH of the soil varies usually from 4 to 10. Paddy for example grows best when the pH of the soil is between 5 and 6.5. This is acidic soil. But the sugar cane grows well at pH between 6 and 8. It requires relatively neutral soil.

Determination of the pH using pH indicator strips

The colour of the paper after dipping it in the solution is compared with the colour chart provided with the indicator strips and the corresponding pH value is read off.

17.5 Acids in every day life

Sulphurdioxide and carbon dioxide are both produced by the combustion of fuels such as coal, coke and oil. They react with water vapour in the air to form sulphurous acid and carbonic acid respectively. They can react with monuments and metal structure and damage them. Also they can damage the plants and can cause stunted growth.

17.6 Acids in the body

The stomach wall produces hydrochloric acid, resulting a pH of about 2 in the stomach. This condition help the breakdown of foods, particularly proteins and carbohydrates. Proteins are broken down into smaller molecules like peptides and amino acids. Carbohydrates (starch) are broken down into smaller molecules like glucose.

Acids in the home

Many foods and drinks contain acids. Citrus fruits, oranges, lemons, pineapple grape fruits contain acid. Tomato sauce, brown sauce and mint sauce get their sharp taste from vinegar which contains acetic acid. One of the simplest and cheapest drinks is soda water. This is made by dissolving carbon dioxide in water under pressure.

17.7 Alkalies in industry

The important industrial alkalies are caustic soda (NaOH) and slaked lime ($Ca(OH)_2$). Slaked lime is made by

adding water to lime (CaO). It is used in cement and the manufacture of caustic soda and bleaching powder. Large amounts of caustic soda are used to make soap, paper, rayon and other cellulose fibres. Soap is made by boiling fats and oils with caustic soda or with caustic potash in large vats.

17.8.1 Neutralisation

Take a small quantity of dilute caustic soda (NaOH) solution in a beaker. Add to it two drops of phenolphthalein solution.

Observation

Solution turns pink colour. Add dilute hydrochloric acid solution dropwise with constant stirring till the pink colour just disappears. Now add one more drop of the caustic soda solution and again a drop of acid solution.

Thus when the solution is alkaline it is pink. While it is colourless in acid solution. Addition of caustic soda solution destroys the acidic properties of hydrochloric acid solution.

The reaction of an alkali with an acid or vice versa is called neutralisation.

17.9 Salts

Salts are formed by reaction of acids with metals, metal oxides or metal carbonates.

$$Zn + H_2SO_4 \longrightarrow \underset{\text{Zinc sulphate}}{ZnSO_4} + H_2 \uparrow$$

$$ZnO + H_2SO_4 \longrightarrow ZnSO_4 + H_2O$$

$$ZnCO_3 + H_2SO_4 \longrightarrow ZnSO_4 + H_2O + CO_2$$

17.10 Kinds of salts

The main kinds of salts are the acid salts, basic salts, normal salts and mineral salts.

17.10.1 Acid salts

Salts which are produced from an acid by the replacement of hydrogen atoms of its molecule partially by a metal are called acid salts.

Activity

Take sodium chloride in a test tube. Add two or three drops of concentrated sulphuric acid into it slowly. A white precipitate of sodium bisulphate is formed.

$$NaCl + H_2SO_4 \text{ -----> } NaHSO_4 + HCl$$

All the hydrogen in the sulphuric acid is not replaced. The salt produced in such a reaction is an acid salt.

17.10.2 Basic salts

Bases consists of hydroxyl groups. When this group or the oxygen in the group is partially replaced to form a salt with an acid, we get a basic salt. Bismuth hydroxide and hydrochloric acid react to form bismuth oxychloride and water.

$$Bi(OH)_3 + HCl \text{ -----> } \underset{\text{Bismuth oxychloride}}{BiOCl} + 2H_2O$$

17.10.3 Normal salts

Salts which are produced from an acid by the complete replacement of hydrogen atoms of its molecule by a metal are called normal salts.

When sodium hydroxide reacts with dilute sulphuric acid, sodium sulphate and water are formed.

$$2NaOH + H_2SO_4 \text{ -----> } Na_2SO_4 + 2H_2O$$

Here, all the hydrogen in sulphuric acid is replaced. The salt produced is a normal salt.

17.10.4 Double salts

Double salts are formed by the union of two simple salts. When hot saturated solutions of potassium sulphate and aluminium sulphate are mixed together in equivalent amounts and cooled, potash alum, a double salt crystallises out.

$$K_2SO_4 + Al_2(SO_4)_3 + 24H_2O \text{ -----> } K_2SO_4.Al_2(SO_4)_324H_2O$$

17.11 Suggested Activities

17.11.1

Using pH indicator paper, find out the pH of various samples of the soil collected from different localities around school.

17.11.2

Prepare indicator paper using the colours extracted from flower, clitoria, beetroot, amaranthus, etc. and use them to test various solutions.

17.11.3

Make a list of a variety of food stuff which are acidic. Find out what acids they contain.

17.11.4

Take a small piece of zinc in a test tube. Add a few drops of dilute sulphuric acid into the test tube. Observe.

Show a glowing splinter at the mouth of the test tube. Observe.

17.11.5

Take a small quantity of turmeric powder in a watch glass. Add a small quantity of slaked lime to this. Mix the two. Observe.

17.11.6

Take a small quantity of washing soda in a test tube. Add concentrated hydrochloric acid to the test tube. Pass the gas into a test tube containing lime water.

17.11.7

Take a small quantity of quick lime in a glass tumbler. Add water to it. Shake well. Test with a red litmus paper. To this solution add a few drops of lemon extract. Again test with litmus paper. Observe.

17.12 Evaluation

I. Fill up the blanks

1. An oxide is a compound of an element with _____.
2. Water is an oxide of _____.
3. Quicklime is an oxide of _____.
4. Brown rust is an oxide of _____.
5. Non-metal oxides are _____ oxide.
6. Solutions of acidic oxide turn blue litmus _____.
7. Sulphur combines with oxygen to form _____.
8. Acidic oxides dissolve in water to form _____.
9. Metallic oxides are called _____ oxides.
10. The solutions of basic oxides from red litmus _____.

11. An acid is a compound which contains one or more replaceable _____ atoms.
12. Acids have _____ taste.
13. Lemon juice contains _____ acid.
14. Tamarind contains _____ acid.
15. _____ acid is present in milk.
16. An acid reacts with base to produce water and _____.
17. Acids react with carbonates liberating _____.
18. Water soluble metal hydroxides are called _____.
19. Bases are _____ to taste.
20. Solutions of bases absorb carbon dioxide to form _____.
21. Lime water is a solution of _____.
22. The process of adding acid to an alkali solution is called _____.
23. The indicator phenolphthalein turns pink in an _____ solution.
24. _____ is called king of acids.
25. _____ is an artificial silk.
26. Oxides of metals react with water to produce _____.
27. Carbon burns in air to form _____.
28. Carbon dioxide is an _____ oxide.
29. _____ is present in vinegar.
30. Sodium sulphate is an example for _____ salts.
31. _____ salts are formed by the union of two simple salts.
32. pH value of pure water will be _____.

II. Define acid, base, alkali, antacid. pH value basicity of acid, oxide.

III. Answer the following

1. Write any five properties of acids and bases.
2. What happens when lime water is added to the soil ?
3. What are acidic oxide and basic oxide ? Give example for each.
4. Give any two uses of H_2SO_4, HCl, HNO_3, NaOH, alum. $CuSO_4$, Na_2CO_3, $NaHCO_3$, NH_3, $Ca(OH)_2$.

IV. Give reasons

1. Lemon tastes sour.
2. It is dangerous to taste strong acids and bases.
3. Never add water to the concentrated acid.
4. Sodium hydroxide is called caustic soda.
5. Baking soda is used for cooking.