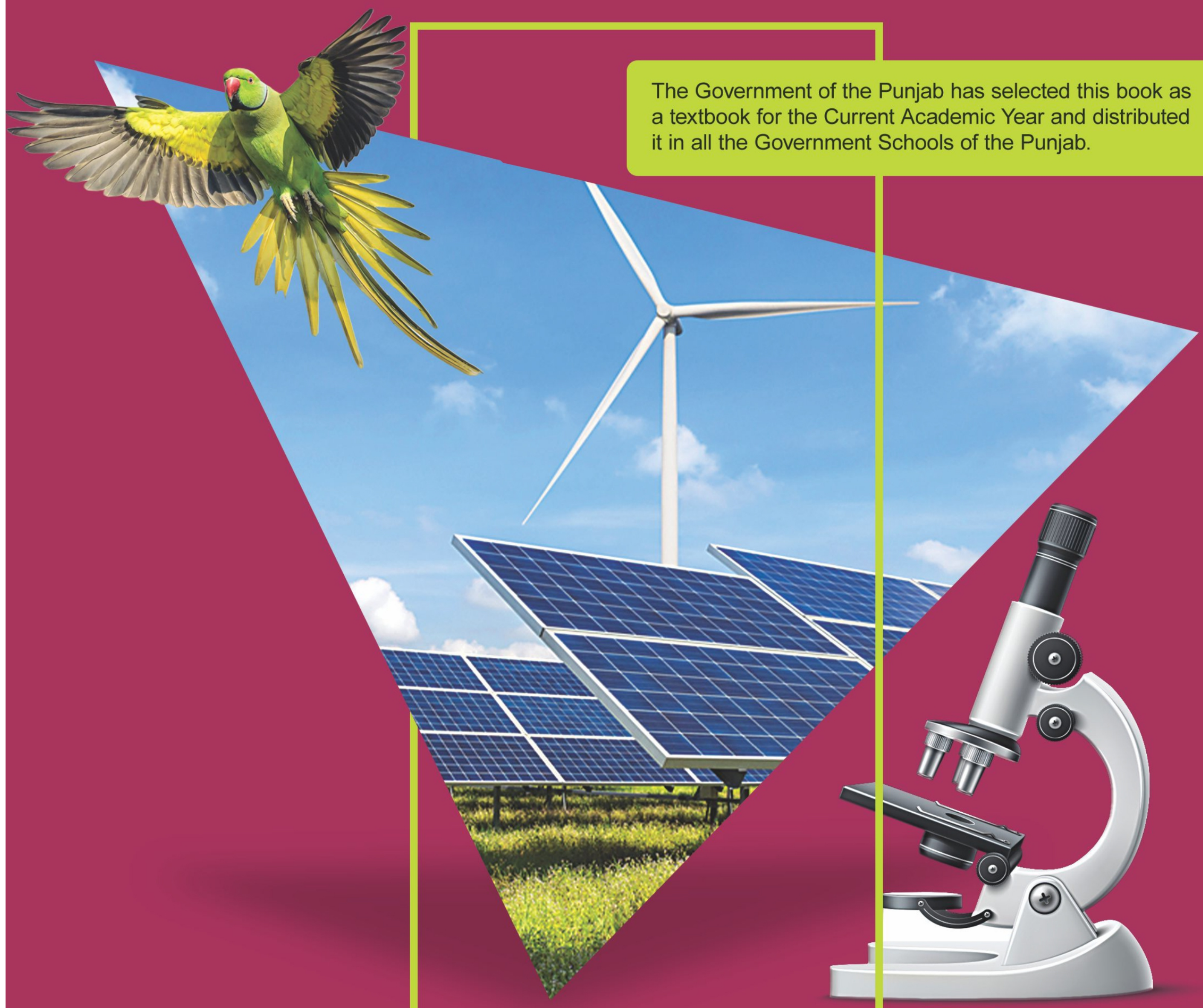

The Government of the Punjab has selected this book as a textbook for the Current Academic Year and distributed it in all the Government Schools of the Punjab.

6

GENERAL SCIENCE

Contents

Members of Review Committee:

- Mr. Aurangzeb Rehman — Joint Educational Adviser, Ministry of CAD, Islamabad
- Dr. Zaheer-ud-Din Khan — Ex-Professor, Department of Zoology, Govt. College University, Lahore
- Mr. Riaz Muhammad — Ex-DEA (Curriculum Wing), Ministry of Education (Defunct), Islamabad
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- Mr. Muhammad Tahir Ch. — Principal, Govt. Higher Secondary School, BamaBala, District Okara
- Malik Muhammad Saeed — SSS, Govt. Higher Secondary School, Maraka Quarters, Lahore
- Mr. Aamir Riaz — Additional Director (Curriculum Wing), Punjab Textbook Board, Lahore / Desk Officer, Punjab Curriculum Authority, Wahdat Colony, Lahore
- Mr. Muhammad Anwar Sajid — Subject Specialist, Punjab Curriculum & Textbook Board, Lahore

Supervised by: Mr. Muhammad Anwar Sajid
(Subject Specialist, Punjab Curriculum & Textbook Board, Lahore.)

Deputy Director Art & Design: Anjum Wasif

Director Manuscript: Farida Sadiq

Printed By: Qudrat-ullah Printers Lahore.

Authors: M. Akram (M.Sc)
Nazeer Ahmad (M.Sc)

Designed by: Aamir Sheikh

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11 Urdu Bazar, Lahore.

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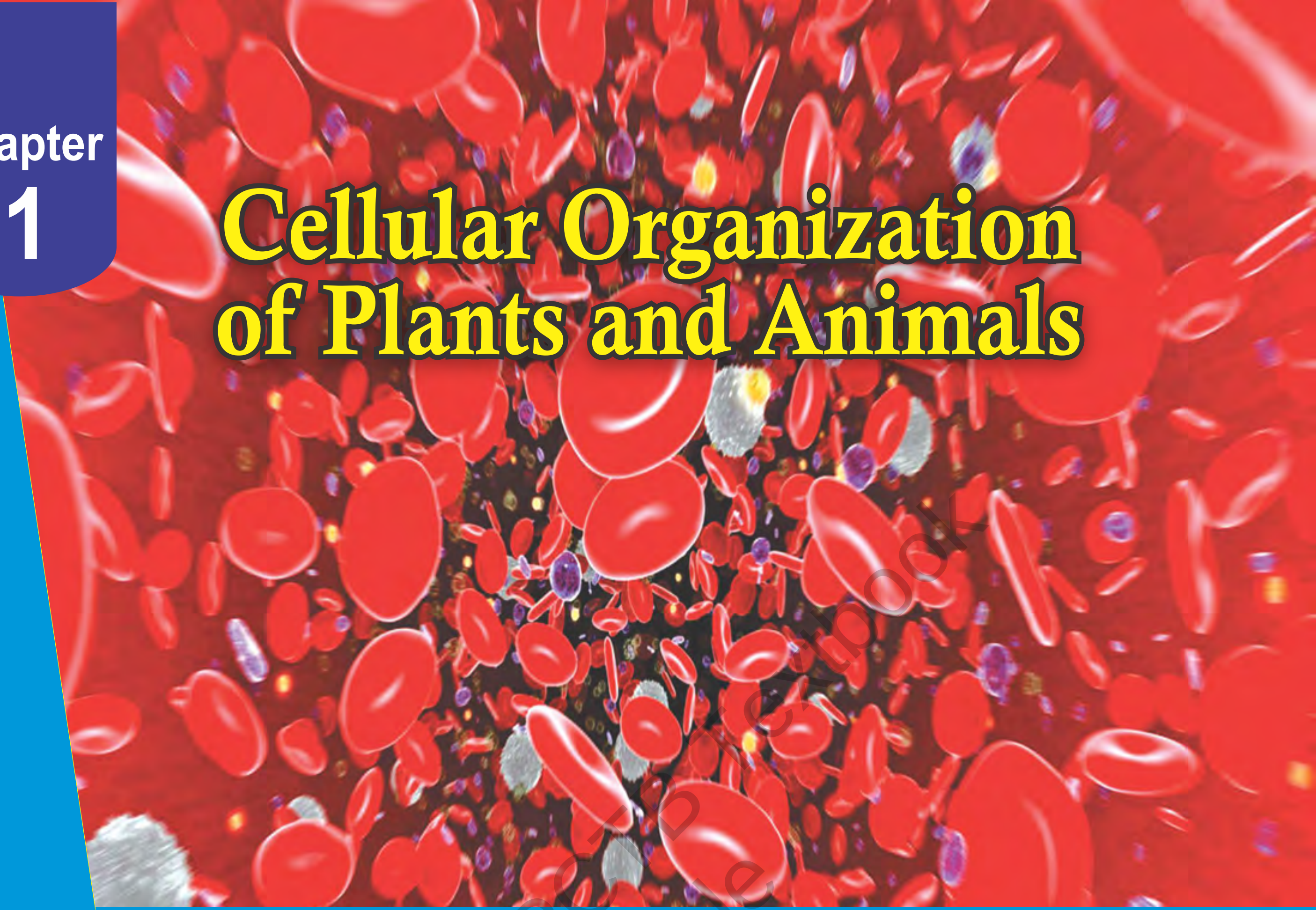
Chapter 1

Cellular Organization of Plants and Animals



Millions of blood cells are running in blood vessels of our body.

Student Learning Outcomes

After completing this chapter, you will be able to:

- Define a cell.
- Describe the different parts of a light microscope and its working.
- Identify different kinds of cells using a microscope.
- Draw, label and describe the basic structure of an animal cell and a plant cell.
- Compare and contrast an animal cell with a plant cell.
- State the function of each part of the cell to indicate how the cell supports life.
- Differentiate between unicellular and multicellular organisms.
- Distinguish between tissues and organs.
- Recognize root and shoot systems in plants.
- State the functions of the major systems of the human body.
- Describe the cellular hierarchy from cell to organ systems in animals and plants.

When we look at a brick house, we can easily see that the bricks are small units in it. Like a brick house, all living things or organisms are made of very small units. In this chapter we shall discuss about these small units of living organisms.

Cells

All living organisms are made of cells. A **cell** is the basic unit of structure and function of all living organisms. Plants and animals are made of trillions of cells. Some living organisms consist of only one cell, e.g. bacteria. Cells are different in sizes, shapes and functions (Fig.1.1).

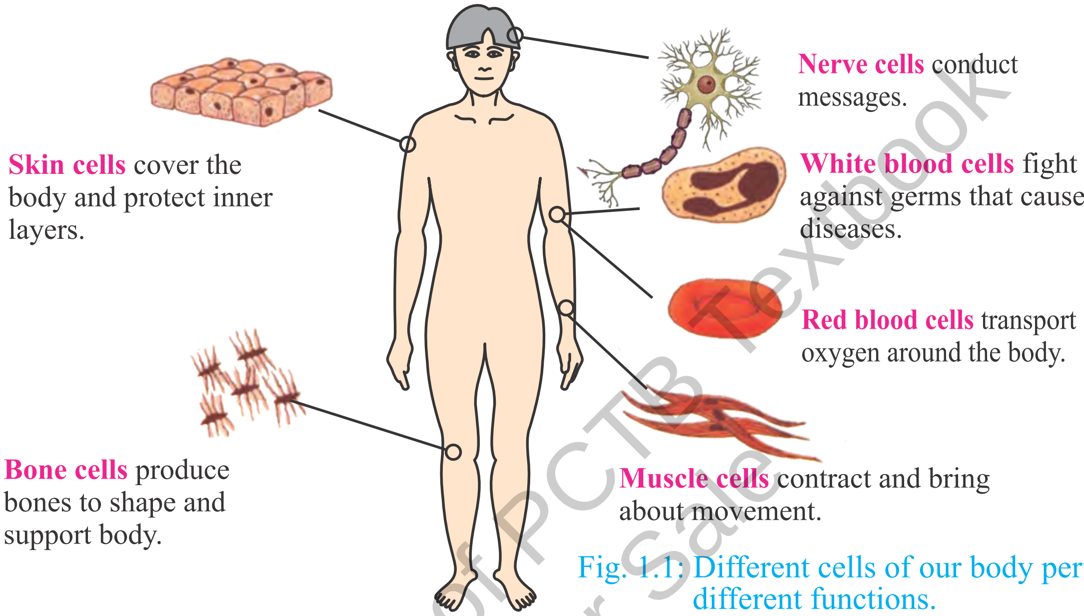
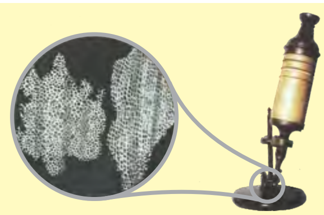


Fig. 1.1: Different cells of our body perform different functions.

Some cells are large enough to be seen with the naked eye, e.g. yolk of an egg. But most cells are too small. We cannot see them with our eyes. We need a special instrument to see the cells.

The term "**cell**" was first used by an English scientist Robert Hooke in 1665. He observed tiny box like structures in a thin slice of a cork under a microscope. He called these structures "cells". Which structure comes to your mind?



Microscope

Microscope is an instrument which is used to see very small things that cannot be seen with naked eye. When we look at something through a microscope, it appears larger. The microscopes we use in our schools are light microscopes. These microscopes use light to show the images.

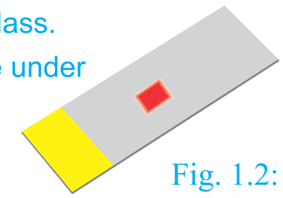
A light microscope has a base, an arm, a tube, a stage and two adjustment screws (Fig.1.2). Two lenses are fitted on the two ends of the tube. The lens at the end of the tube through which we observe an object is called an **eyepiece**.

The lens near the object to be seen is called an **objective lens**. Light is passed through the object from below, using a mirror.

The object to be seen is placed on a glass slide and then on the stage. To focus the object clearly in the microscope, two adjustment screws are used.

We can view an object up to 1500 times bigger than its original size. Most of the cells are too small to be seen without a microscope. What did biologists use to see inside the cell?

The slide is a rectangular piece of glass. The object is placed on it to observe under the microscope.



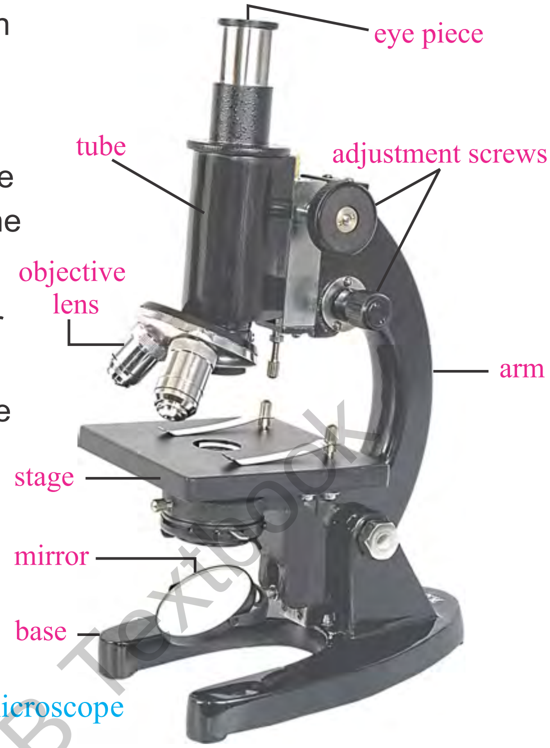


Fig. 1.2:
A light microscope

Activity 1.1

Under the supervision of your science teacher bring a light microscope in the classroom. Identify different parts of the microscope.

Do you know?

Now-a-days scientists use electron microscopes to see very small objects inside the cell. An electron microscope can magnify the image up to 500,000 times. It shows clear images on a television screen. This microscope uses a beam of electrons instead of light.

Animal Cell and Plant Cell

Animal cells and plant cells are similar in many features but a few differences are also present. There are many parts in a cell. A microscopic study of cells shows different parts in animal and plant cells (Fig.1.3 a,b).

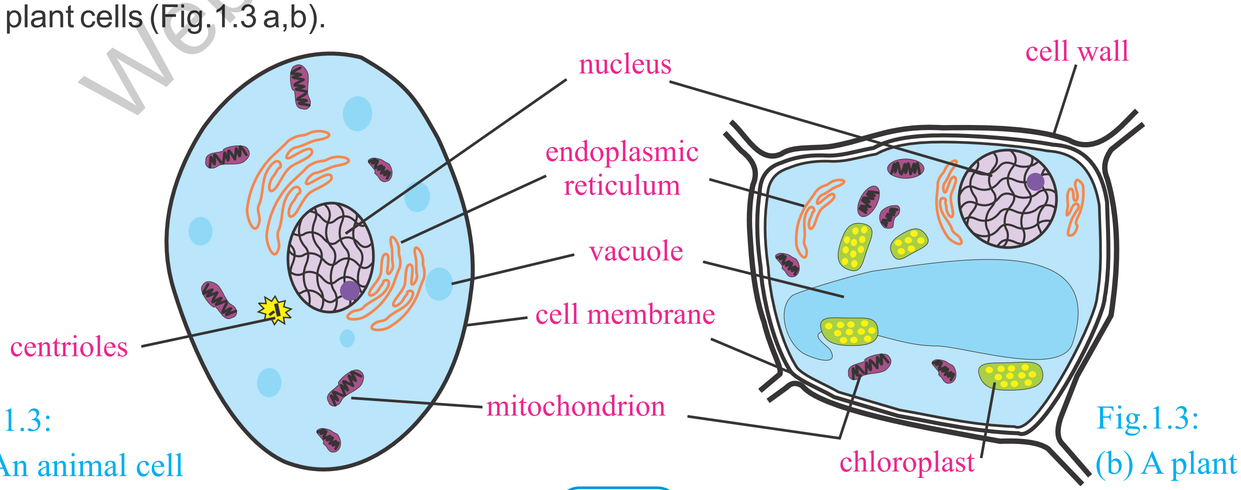


Fig.1.3:
(a) An animal cell

Fig.1.3:
(b) A plant cell

1. Cell Wall

The outermost covering of a plant cell is called the **cell wall** . It is made of a hard material, called cellulose. The cell wall supports the cell and gives it shape. Animal cells do not have a cell wall. Can you explain why a plant body is so hard and animal's body is not?

2. Cell Membrane

The outermost covering of an animal cell is called the **cell membrane.** In plant cells it is present next to the cell wall. The cell membrane controls the movement of materials in and out of the cell.

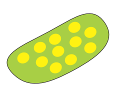
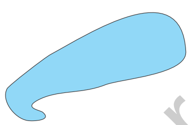
Point to think!

Many tiny holes are present in cell membrane. What is the purpose of these holes?

3. Cytoplasm

Jellylike material present inside the cell membrane is called **cytoplasm.** It contains water and other chemical substances. Many cell organelles (tiny cell structures) are present in it. Most of the cell functions take place in cytoplasm.

CELL ORGANELLES

1. **Endoplasmic reticulum**  It is a network of channels. The movement of materials in the cell takes place through the endoplasmic reticulum.
2. **Mitochondria**  Mitochondria are cell parts that provide energy to the cell.
3. **Chloroplasts**  Chloroplasts are parts of plant cell that contain chlorophyll. They trap energy from the Sun. Plants use the energy to make food.
4. **Vacuoles**  Vacuoles store waste materials, water, air and food particles. In plant cells a single large vacuole is present, but in animal cells many small vacuoles are present.
5. **Centrioles**  Two centrioles are present near the nucleus of an animal cell. They play an important role in animal cell division.

4. Nucleus

The most important part of a cell is its **nucleus**. It controls all the activities of the cell. Therefore, a nucleus is the control centre of the cell. A thin membrane, called nuclear membrane, surrounds the nucleus. Many thread like structures called **chromosomes** are present in the nucleus.

Chromosomes pass on the characteristics of the cell to new cells. The number of chromosomes is fixed in every cell. A human cell has 46 chromosomes.

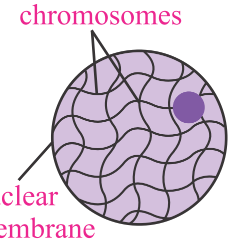


Fig. 1.4: Nucleus of a cell

Point to think!
What would happen to a cell if we remove its nucleus?

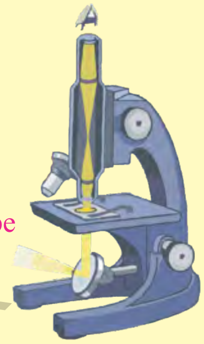
Activity 1.2

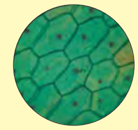
You will need

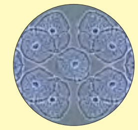
- a light microscope
- prepared slide of human cheek cells
- prepared slide of onion cells

Procedure

1. Observe the slide of onion cells under the microscope. Draw a diagram of one onion cell. Identify and label its parts.
2. Observe the slide of human cheek cells under the microscope. Draw the diagram of one cell and label its parts.
3. Compare the two cells. What difference do you find?

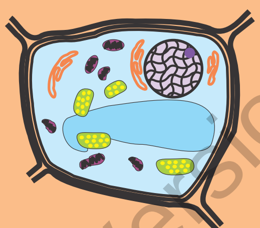

microscope

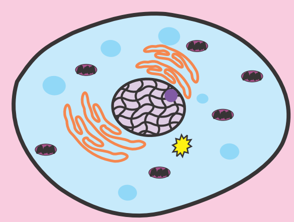

onion cells


cheek cells

Differences Between Plant and Animal Cells

Cell membrane, nucleus, mitochondria and endoplasmic reticulum, etc. are present in both plant and animal cells. But there are some differences too.





Plant cell	Animal Cell
1. **Cell wall** is present.	1. **Cell wall** is absent.
2. **Nucleus** lies near the side of the cell wall because of a large vacuole.	2. **Nucleus** lies in the center of the cell.
3. Single large **vacuole** is present.	3. Many small **vacuoles** are present.
4. **Chloroplasts** are present.	4. **Chloroplasts** are absent.
5. **Centrioles** are absent.	5. **Centrioles** are present.

Activity 1.3

Draw diagrams of an animal cell and a plant cell on a chart and hang it in the classroom. (Whole class activity)

Unicellular and Multicellular Organisms

Some living organisms are made of one cell and some are made of many cells. The living organisms made of only one cell are called **unicellular organisms**. Bacteria, chlamydomonas, amoeba, paramecium, etc. (Fig.1.5) are unicellular organisms.

The living organisms made of more than one cell are called **multicellular organisms**. Plants and animals which we see around us are multicellular organisms (Fig 1.5).

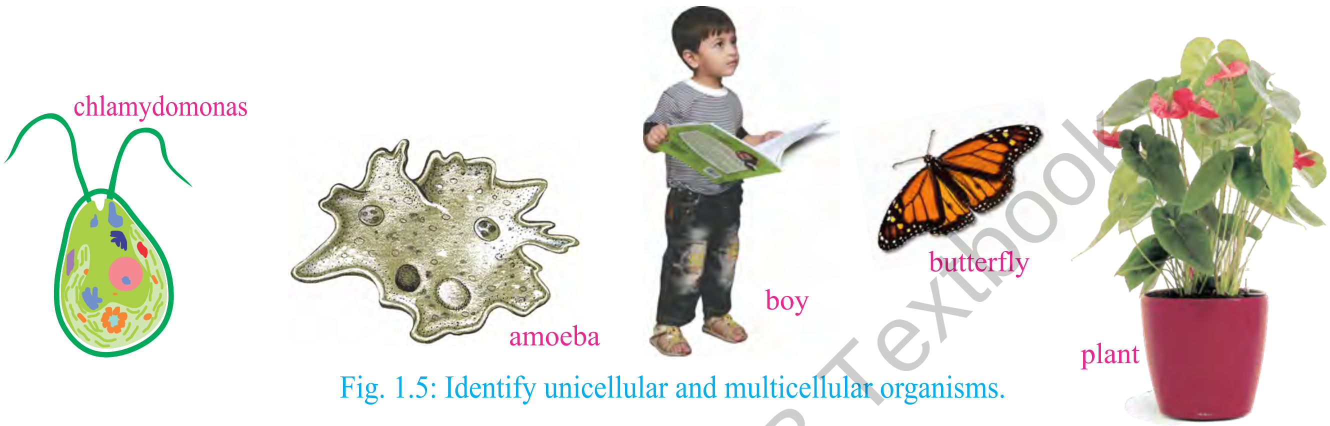


Fig. 1.5: Identify unicellular and multicellular organisms.

Activity 1.4

Under the supervision of your science teacher put a drop of pond water on a glass slide. Observe it under a microscope. You will see many moving unicellular animals and plants. Draw and label the diagrams of amoeba and chlamydomonas.

Cells Form Tissues

In multicellular organisms, cells work in groups. A group of cells performing same function is called a **tissue**. Plants and animals have different tissues in their bodies.

Some Plant Tissues

Following are some plant tissues (Fig. 1.6):

Epidermal tissue

Epidermal tissue covers the roots, stem and leaves of a plant.

Xylem tissue

Xylem tissue conducts water and dissolved salts from roots to the leaves.

Phloem tissue

Phloem tissue arries prepared food from leaves to other parts of plants.

Mesophyll tissue

Mesophyll tissues present in leaves make food for the plant.

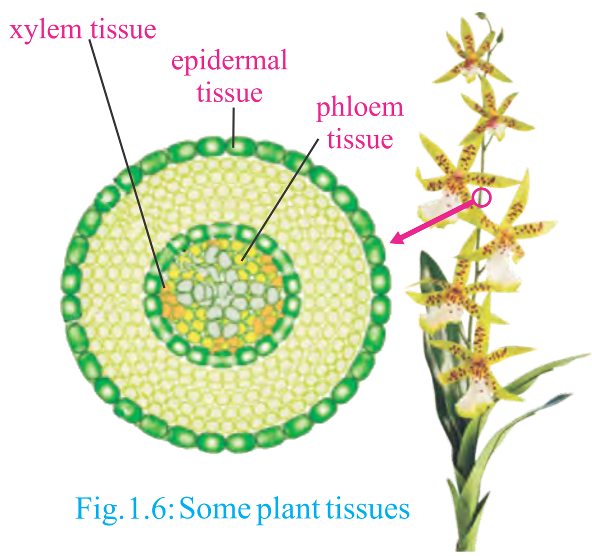


Fig. 1.6: Some plant tissues

Some Animal Tissues

Following are some animal tissues (Fig. 1.7):

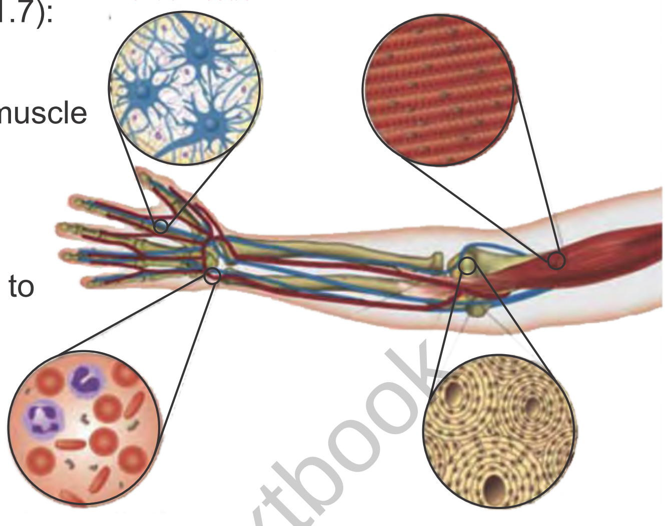


Fig. 1.7: Some animal tissues

Muscle tissue

In an animal's body muscle cells form muscle tissues to help in movement.

Bone tissue

Bone tissue is formed by bone cells. This strong and solid tissue gives shape and support to the body.

Blood tissue

Blood cells form blood tissue. This tissue carries materials from one part of the body to the other.

Point to think!

Fat protects our heart and kidneys from injuries. Isfat also a tissue?

Tissues Form Organs

Different tissues group together to form organs. Our body is made of a number of different organs such as the heart, lungs, eyes, brain, etc. An **organ** is made of different tissues which work together. An organ performs one or more than one functions.

Some Plant Organs

Following are some plant organs (Fig. 1.8):

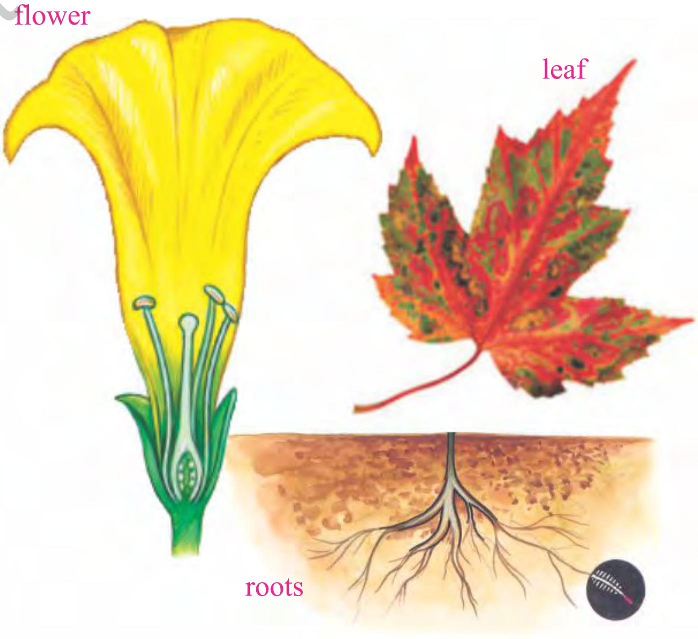


Fig.1.8: Some plant organs

Leaf

Plant leaf is an important organ. Leaves make food. Who use this food?

Flower

A flower is another important organ of the plants. Flowers produce seeds. Seeds grow to produce new plants.

Root

This organ holds the plant in the soil. Root also absorbs water and salts for the plant.

Some Animal Organs

Following are some animal organs (Fig. 1.9):

Heart

The heart pumps the blood in blood vessels which carry it to all parts of the body.

Lungs

Our lungs are very important organs that help in respiration.

Liver

Liver is an organ which helps in digestion of food. It also performs many other important functions.

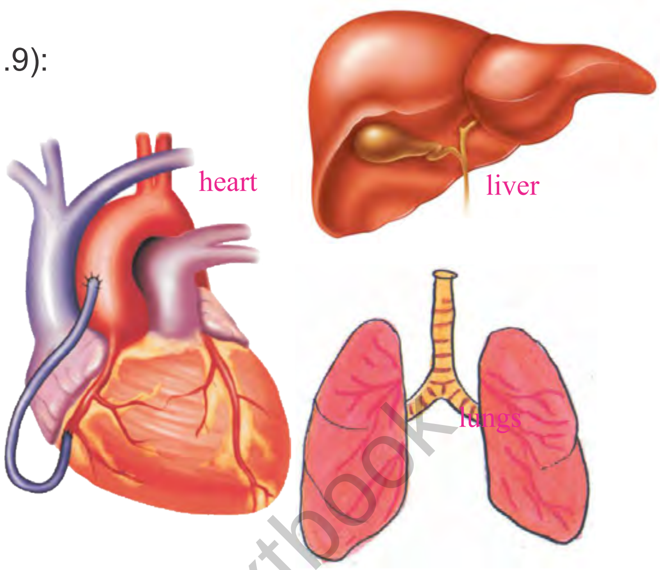


Fig.1.9: Some animal organs

Organs Form Organ Systems

Like cells and tissues, organs also form groups. An **organ system** is a group of organs which work together. Different organ systems do one or more than one special functions .

Major Organ Systems in Plants

Plants have two main organ systems; root system and shoot system (Fig. 1.10):

Root System

The root and its branches form the **root system** of a plant. Roots are present under the soil. Roots hold the plant in the soil. Root system helps the plant to absorb water and salts from the soil.

Shoot System

The part of the plant outside the ground forms **shoot system**. It consists of main stem, leaves, branches and flowers. Shoot system performs many functions such as movement of water, food making and producing seeds, etc.

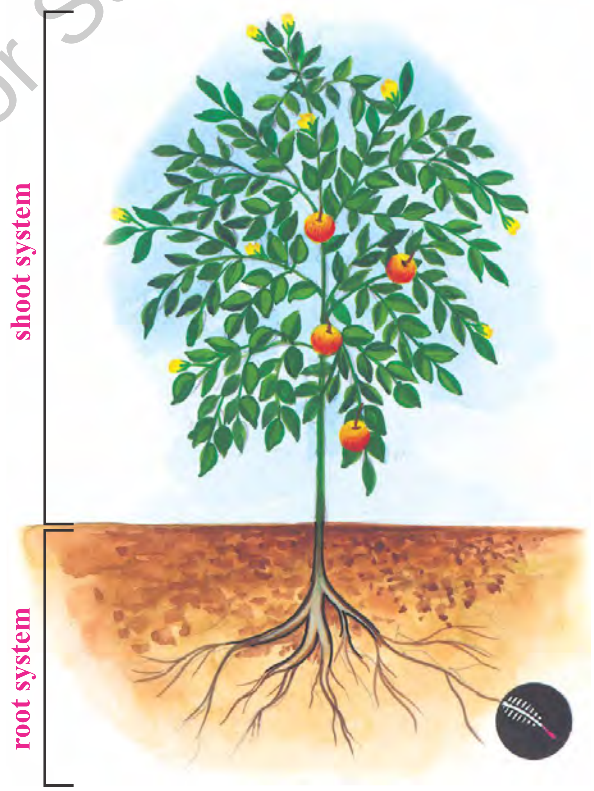


Fig.1.10: Plant systems

Major Human Organ Systems

Many organ systems are present in a human body. These organ systems perform important functions. Some major human organ systems are given below (Fig.1.11).

Digestive System

This organ system consists of mouth, food pipe, stomach, intestines and liver. It helps in digestion of food.

Respiratory System

Respiratory system consists of nose, windpipe and lungs. We breathe through this organ system.

Circulatory System

This organ system consists of heart and blood vessels. It circulates the blood within the body. The blood carries materials with it.

Nervous System

Nervous system consists of brain, spinal cord and nerves. It carries messages from one part of the body to the other.

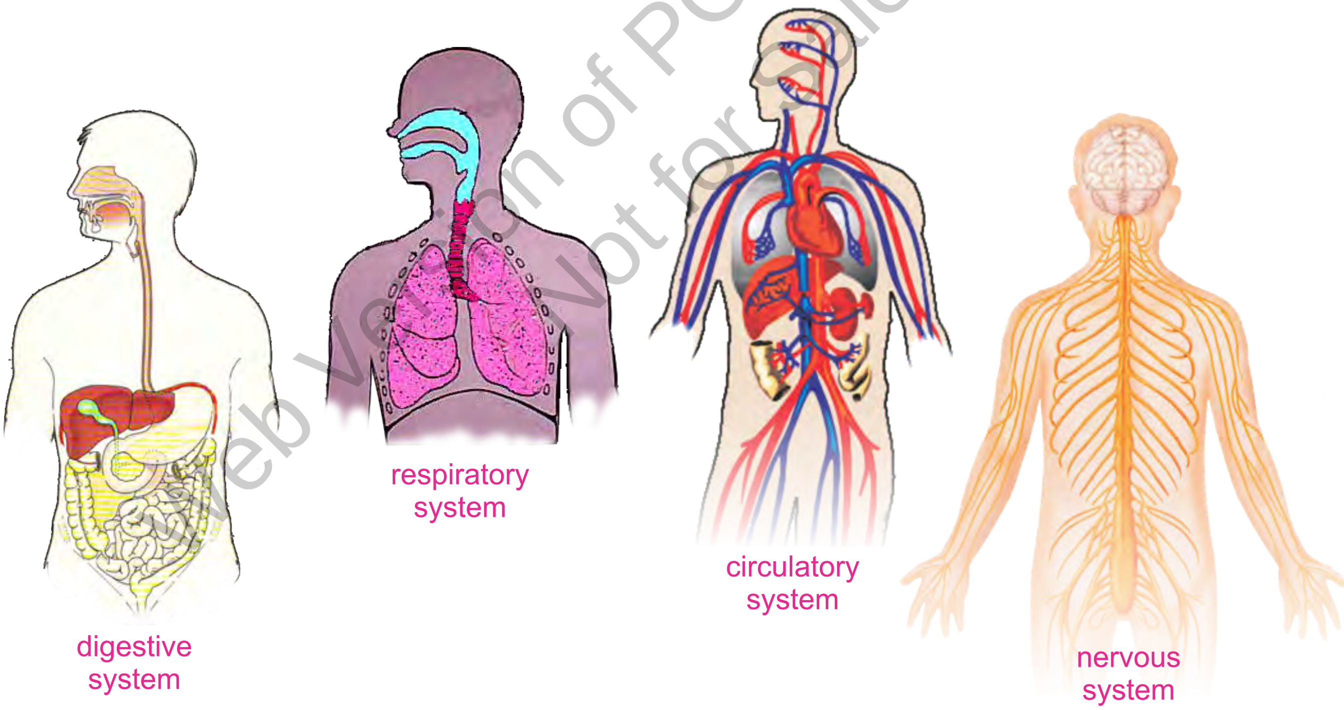


Fig. 1.11: Some major human organ systems

Do you know? Your **heart** is a strange organ. It works the whole life and does not get tired.

Tidbits:

- The human body is made of more than two hundred different types of cells. In flowering plants, nine types of cells are present. The fresh water animal hydra has only seven different types of cells.
- Kidneys are very important organs of our body. They remove wastes from the blood and control the quantity of water in the body.
- Our skin is the largest organ of our body. Its outermost part is made of dead cells. Is it not strange that we make much effort to make our dead cells look nice?

Organisms

The highest level of organization in living things is the organism. An **organism** is a combination of different organs and organ systems which work in coordination.

If any of the body systems fail to work properly, a living organism may die.

Organization of Life

cells → tissues → organs → organ systems → organism

Chapter Review

1. A cell is the basic unit of structure and function of living organisms.
2. Cells are different in their sizes, shapes and functions.
3. A microscope helps in seeing micro-organisms.
4. A cell has different parts like cell wall, cell membrane, cytoplasm and a nucleus.
5. Plant and animal cells are different in some features.
6. One-celled organisms are called unicellular organisms.
7. Organisms consisting of many cells are called multicellular organisms.
8. Cells form tissues, tissues form organs, organs form organ systems, all organs and organ systems form an organism.

Test Preparation

1. Write proper term/word against each statement.

i. A group of different tissues which work together ____________

ii. The brain of the cell which controls its functions ____________

iii. An organism consists of several cells ____________

iv. A group of cells which are similar in structure and function ____________

v. Outer covering of a plant cell ____________

vi. An instrument to see things which are not seen with naked eyes ____________

2. Circle the letter of the best answer.

i. Animal cells do not make their own food because they do not have:
(a) mitochondria (b) vacuoles
(c) chloroplasts (d) centrioles

ii. The "power houses" of the cell are:
(a) chloroplasts (b) mitochondria
(c) vacuoles (d) chromosomes

iii. Aamir was looking at a cell through a microscope and saw mitochondria and cell membrane. What could Aamir say about the cell?
(a) It can only be a plant cell.
(b) It can only be an animal cell.
(c) It is either a plant or an animal cell.
(d) It is neither a plant nor an animal cell

iv. Heart, liver and ears are examples of animal:
(a) organs (b) tissues
(c) cells (d) organ systems

v. Plants make their food in leaves and it is stored in other parts because:
(a) they have xylem tissues. (b) they have roots.
(c) they have stems. (d) they have phloem tissues.

3. Answer the following questions in detail.

i. Describe parts and functioning of a light microscope.
ii. Describe the structure of a plant cell. Also draw its labelled diagram.
iii. Write a note on the nucleus of a cell.
iv. Write about shoot system of a plant.
v. Define a cell, a tissue, an organ, an organ system and an organism.

4. Extend your thinking.

i. A brain cell contains thousands of mitochondria. What can you conclude from this information about the brain's need for energy?

ii. Which cell part is being described?

(a) helps keep cytoplasm inside ____________________

(b) controls all cell activities ____________________

(c) liquid-filled space for storage ____________________

(d) green parts which trap energy ____________________

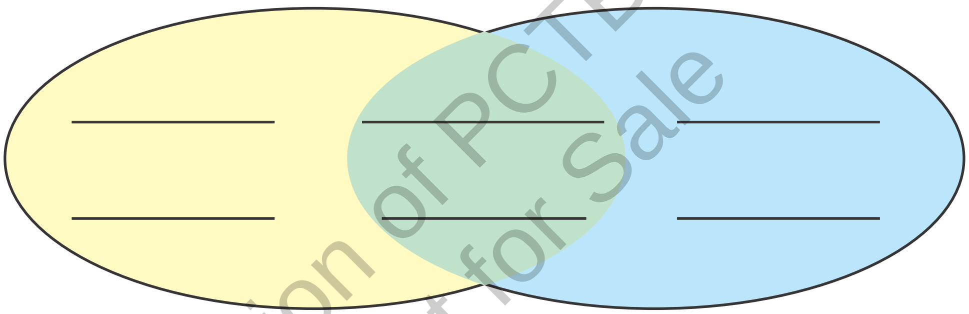
(e) clear, jellylike material ____________________

iii. Suppose you saw a small organism move across your book. Would you conclude that this organism was multicellular or unicellular?

iv. How is a tissue like a team?

5. Complete the Venn diagram.

Complete the Venn diagram to show what parts plant cells have and what parts animal cells have.



Science Projects

1. Under the supervision of your science teacher observe different prepared slides under a light microscope. Draw diagrams of what you see on each slide.
2. Make a model of plant cell and animal cell. You can use Rafhan jelly mix, a round pan (for an animal cell), a rectangular pan (for a plant cell) and some edible materials such as nuts, pieces of slanty, slices of pineapple, etc.

An electron microscope is a very high-powered microscope that uses electrons instead of light. It can show an image more than 500,000 times bigger. Many things that cannot be seen with a light microscope can be seen with an electron microscope. The electron microscope produces a picture similar to the way a television does. The cost of an electron microscope is in lacs. Why do you think the prices of electron microscopes should become low? How can it help in scientific advancement in our country?

Computer Links

- www.biology4kids.com/files/cell-main.html
- http://www.bbc.co.uk/schools/ks3bitesize

Chapter 2

Sense Organs

Our senses tell us about the surrounding world.

Student Learning Outcomes

After completing this chapter, you will be able to:

- Explain the structure and function of eye.
- Explain the structure and function of ear.
- Explain the structure and function of skin.
- Explain the structure and function of nose.
- Explain the structure and function of tongue.

The world around us is very interesting. Allah Almighty has blessed us with five sense organs to enjoy the world. **Sense organs** are special parts of our body that tell us what is going on around us. Our eyes, ears, skin, nose and tongue are our sense organs. All the sense organs are linked to the **brain** by nerves.

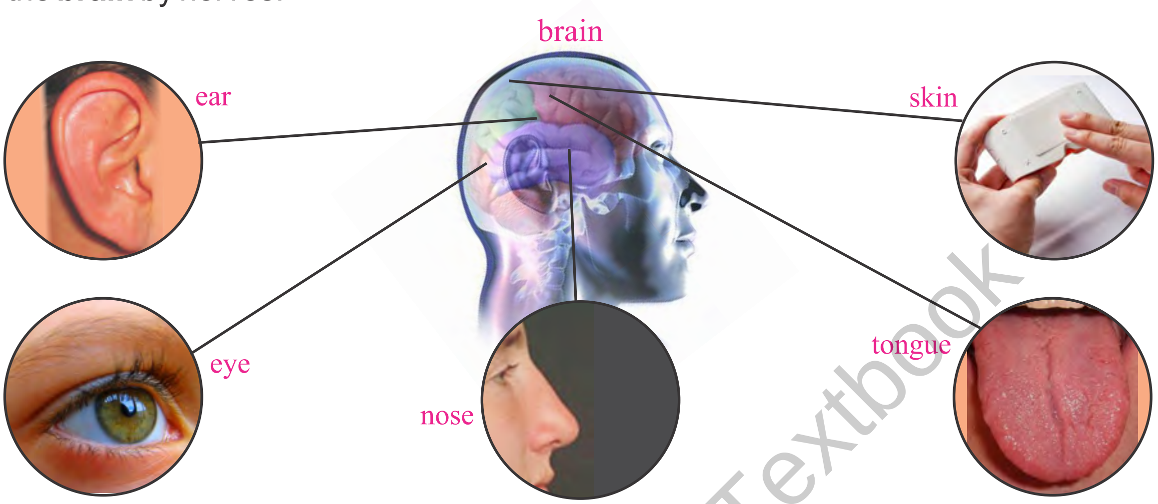


Fig.2.1: Our brain controls every thing that our body does.

The Eye

We see with our eyes. Our eyes tell us about colours, shapes and movements of objects around us. The eye is an organ of sight.

The human eye consists of an eyeball. The eye is covered with eyelids. Eyelashes on the eyelids keep away dust particles. Under the upper eyelids tear glands open.

Main parts of our eye are cornea, iris, pupil, lens, retina and optic nerve (Fig.2.2).

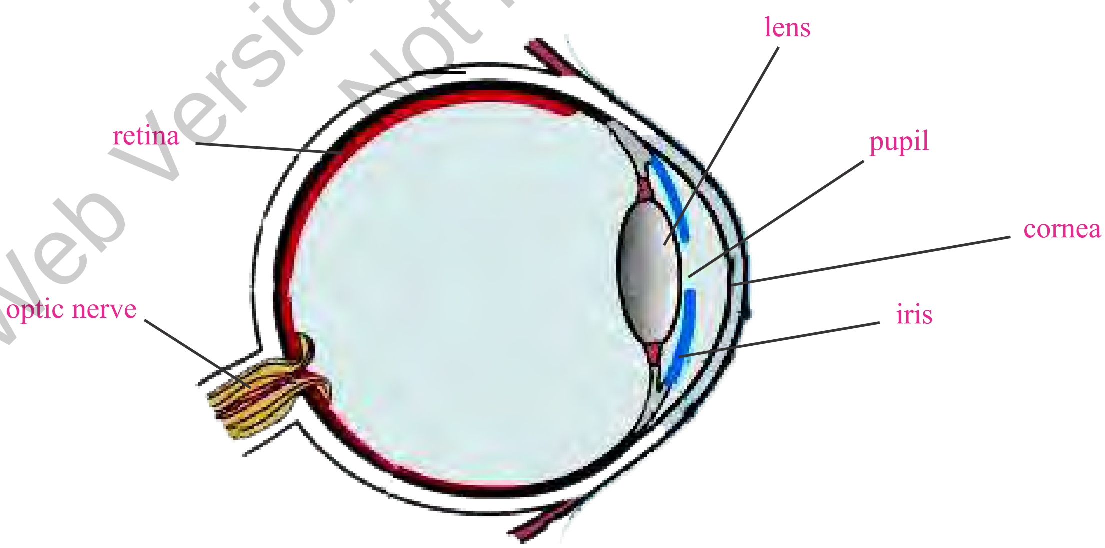


Fig.2.2: Internal structure of human eye

Cornea

In the front of eye, the transparent part is called **cornea.** Light rays enter the eye through the cornea.

Iris

Beneath the cornea the coloured portion of the eye is called **iris.** Have you ever observed brown, blue and hazel eyes of your friends?

There is a hole in the middle of the iris, known as **pupil.** This pupil contracts in bright daylight and expands in dim light.

Lens

Behind the pupil, a flexible **lens** is present. The lens helps the eye to focus light.

> ***Interesting Fact***
>
> The lens in your eye can change its shape to see near and far objects. It becomes thick to see near objects. It becomes thin to see far objects.

Retina

The light sensitive portion of the eyeball is called **retina.** Eye lens forms the image on the retina.

Optic nerve

When light hits the retina, its cells make nerve signals. These signals pass along the **optic nerve** to the brain.

Functioning of Eye

light rays → cornea → pupil → lens —image→ retina —optic nerve→ brain

Do you know? Our eye is similar to a camera. Both have lens. The lens in our eye forms image on the retina but camera lens forms an image on the film.

Activity 2.1

Observe model or chart of structure of eye. Identify different parts of human eye and draw a diagram.

The Ear

We hear sounds through our ears. Ear is an organ of hearing. Human ear consists of three parts; outer ear, middle ear and inner ear (Fig.2.3).

> ***Interesting Fact***
>
> Some animals can twitch their ears to catch sound waves. A horse can move its ears. We cannot move our ears.

Outer Ear

The outer ear consists of a **pinna** and a long narrow tube called **ear canal.** The pinna collects sound waves from the air around. The sound waves then travel along the ear canal.

Middle Ear

The outer ear is connected to the middle ear by a thin membrane called the **eardrum.** The eardrum vibrates when sound waves strike it. On the other side of the eardrum is the middle ear which is filled with air. It has three smallest bones in the body, i.e. **hammer, anvil** and **stirrup.**

Inner Ear

The last part of the ear is the inner ear. The inner ear is filled with a liquid. This part of ear has a coiled structure called **cochlea.** The cochlea is the actual hearing organ. The cochlea sends signals to the brain through a special nerve called **auditory nerve.**

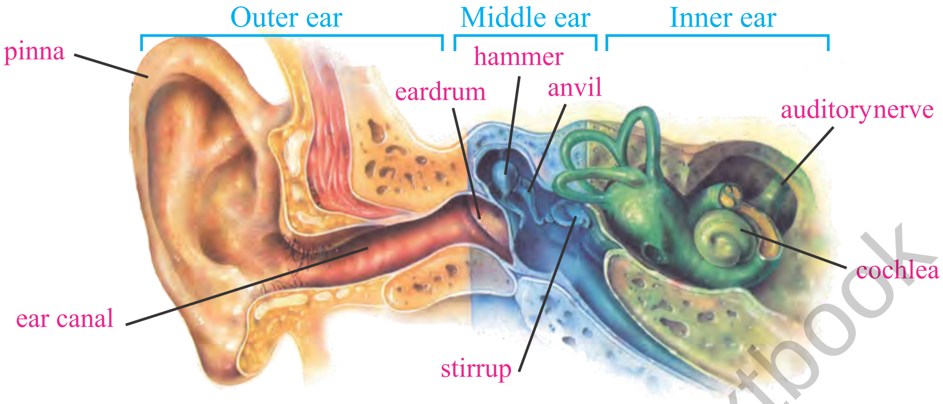


Fig.2.3: Internal structure of human ear

Functioning of Ear

sound waves → pinna → eardrum → three bones → cochlea → (auditory nerve) → brain

Activity 2.2

Observe model/chart of human ear. Identify its different parts. Draw a diagram and label its various parts.

The Skin

The largest sense organ in our body is the skin. Skin is the organ of touch. Skin covers every part of our body. It protects the inner parts of our body. The skin contains several kinds of cells that detect pain, pressure, touch, heat and cold.

Interesting Fact

A blind person can read Braille, by using the sense of touch.

Our skin has an outer layer and an inner layer (Fig.2.4). The **outer layer** has colour pigment and protects the skin from harmful rays of the Sun.

The **inner layer** has blood vessels, nerves, sweat glands and roots of hairs. This layer is the sensitive part of the skin. When we touch something, sensitive cells of the skin receive messages and send them to the brain.

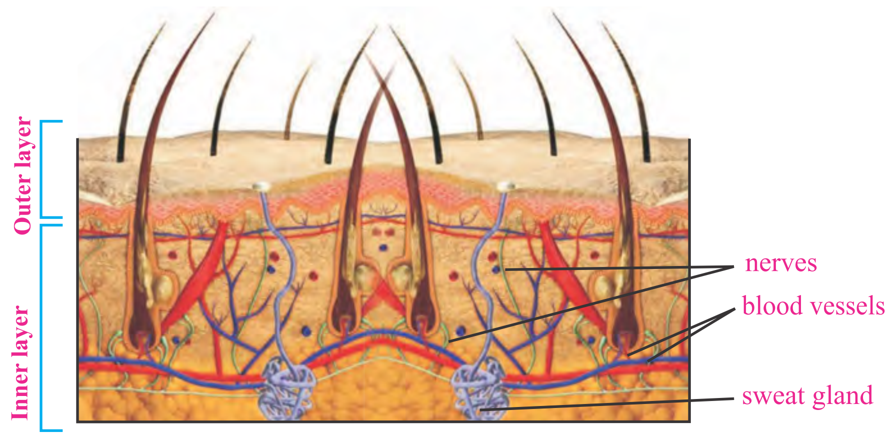


Fig.2.4: Internal structure of human skin

Do you know? The skin at the tips of the fingers is most sensitive. The least sensitive part of our body is our heel.

Activity 2.3

1. Place coins of one, two and five rupees in a small covered shoe box. With your eyes closed, reach into the box and remove the coin of five rupees.
2. Open your eyes to see what coin it actually is.
3. Place back the coin again and repeat your experiment for other coins too.

The Nose

Suppose there is a dead and decaying rat in one of your room's corners. How would you come to know about the dead rat? Of course, you would smell bad odour in the room. The sense organ for smelling is the nose.

Our nose is a hollow air passage. It has two openings called **nostrils.** In each side of the nose is an air chamber (Fig. 2.5).

Interesting Fact

Smells are tiny particles that break off the surface of things and float in the air.

The roof of the nose has lining of nerve cells to sense smell. When certain odour chemicals present in air enter our nose, they touch the nerve cells. Nerve cells pass the message to the brain through the **olfactory nerve.** Our brain tells whether the odour is pleasant or unpleasant.

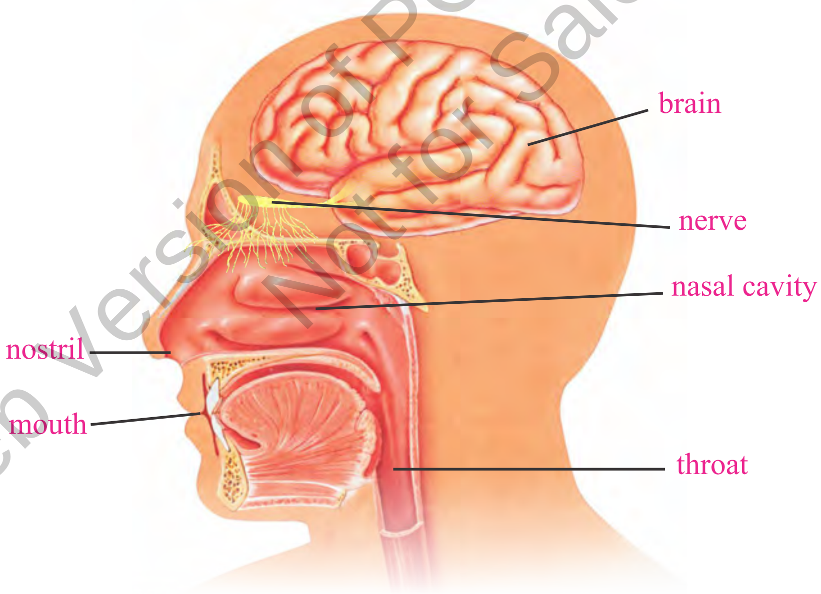


Fig.2.5: Internal structure of human nose

Do you know?

- Dogs have very strong sense of smell. They are often used to trace thieves and drugs.
- Our nose can detect 10,000 different scents and smells.
- Our sense of smell also helps our sense of taste.

The Tongue

Our tongue is the sense organ of taste. It helps to detect the flavour of food. We can detect sweet, salty, sour and bitter tastes with our tongue.

The upper surface of the tongue is covered with many pimple like lumps (Fig.2.6). Between these lumps, **taste buds** are present. Each taste bud has many nerve cells. When particles of a food touch the taste buds, nerves send signals of taste to the brain.

We feel sweet, salty, sour and bitter tastes on different parts of our tongue. The tip of the tongue has taste buds to detect sweet taste. The sides of the tongue are sensitive to salty and sour tastes. The back of the tongue has taste buds to detect bitter taste.

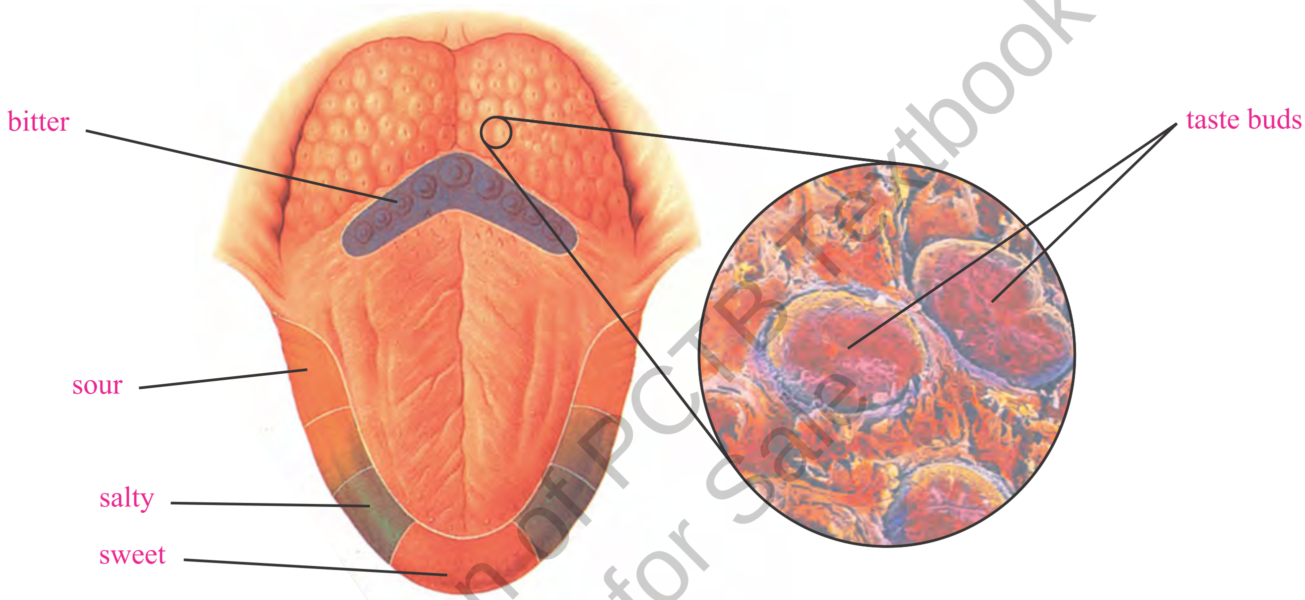


Fig.2.6: Different parts of the tongue detect different tastes.

Activity 2.4

Check the tastes of sugar (sweet), bitter gourd (bitter), lemon (sour) and table salt (salty) on different parts of your tongue.

Chapter Review

1. Our body has five main sense organs.
2. Eye is the sense organ of sight.
3. Our ears are the organs for the sense of hearing.
4. Skin is the organ for the sense of touch.
5. The sense organ for smelling is the nose.
6. The sense organ for taste is the tongue.

Test Preparation

1. Write proper term/word against each statement.

i. It can feel the pressure ____________

ii. The hole in the middle of the iris ____________

iii. Air enters the nose through it ____________

iv. Carries signals from ear to brain ____________

v. Present on our tongue ____________

2. Circle the letter of the best answer.

i. The control room of our body is:
   (a) heart (b) stomach
   (c) brain (d) liver

ii. The most sensitive part of our eye is:
   (a) retina (b) cornea
   (c) pupil (d) lens

iii. A dumb by birth cannot speak. He/She also has no:
   (a) sense of touch (b) sense of taste
   (c) sense of hearing (d) sense of sight

iv. The olfactory nerve links:
   (a) eye and brain (b) nose and brain
   (c) ear and brain (d) tongue and brain

v. Which senses of our body are closely related?
   (a) touch and smell (b) smell and taste
   (c) taste and hearing (d) seeing and touch

vi. Which sense organ also functions as a sense organ for temperature?
   (a) nose (b) tongue
   (c) ear (d) eye

3. Answer the following questions in detail.

I. Describe the structure of human eye.
ii. Describe the structure and function of inner ear.
iii. Write a note on the sense of smell.
iv. What is the importance of our tongue?
v. Write a note on our sense of touch.

4. Extend your thinking.

i. What does happen to pupil of our eyes when we switch the lamp on?
ii. Some times as a result of a cold, the middle ear becomes filled with fluid. Why do you think this can cause a temporary loss of hearing?

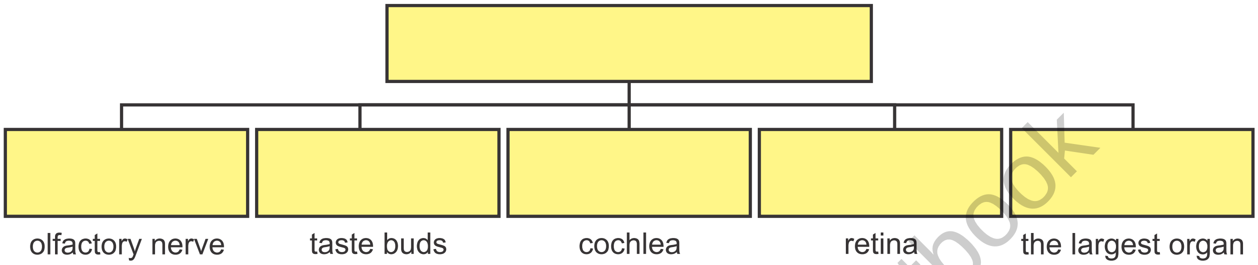
iii. What is the advantage of having a lens in the eye that can change its shape?

iv. Have you ever faced an injury of breaking of your nail? Why is it so painful?

5 Concept Map

Use following terms to complete the concept map.

skin nose ear eyes tongue sense organs



Science Projects

1. Blow up a balloon and see if you can feel sound vibrations. Hold a tube of cardboard against the balloon and make a loud noise into it. Can you feel the vibrations in the skin of the balloon? Your ear drum feels sound vibrations in the same way.

2. Put water in four cups. Add salt to one, lemon juice to another and sugar to another. Leave the fourth. Ask your friends to hold their noses and taste them. See if they can tell the difference. Without smell, should they all taste the same?

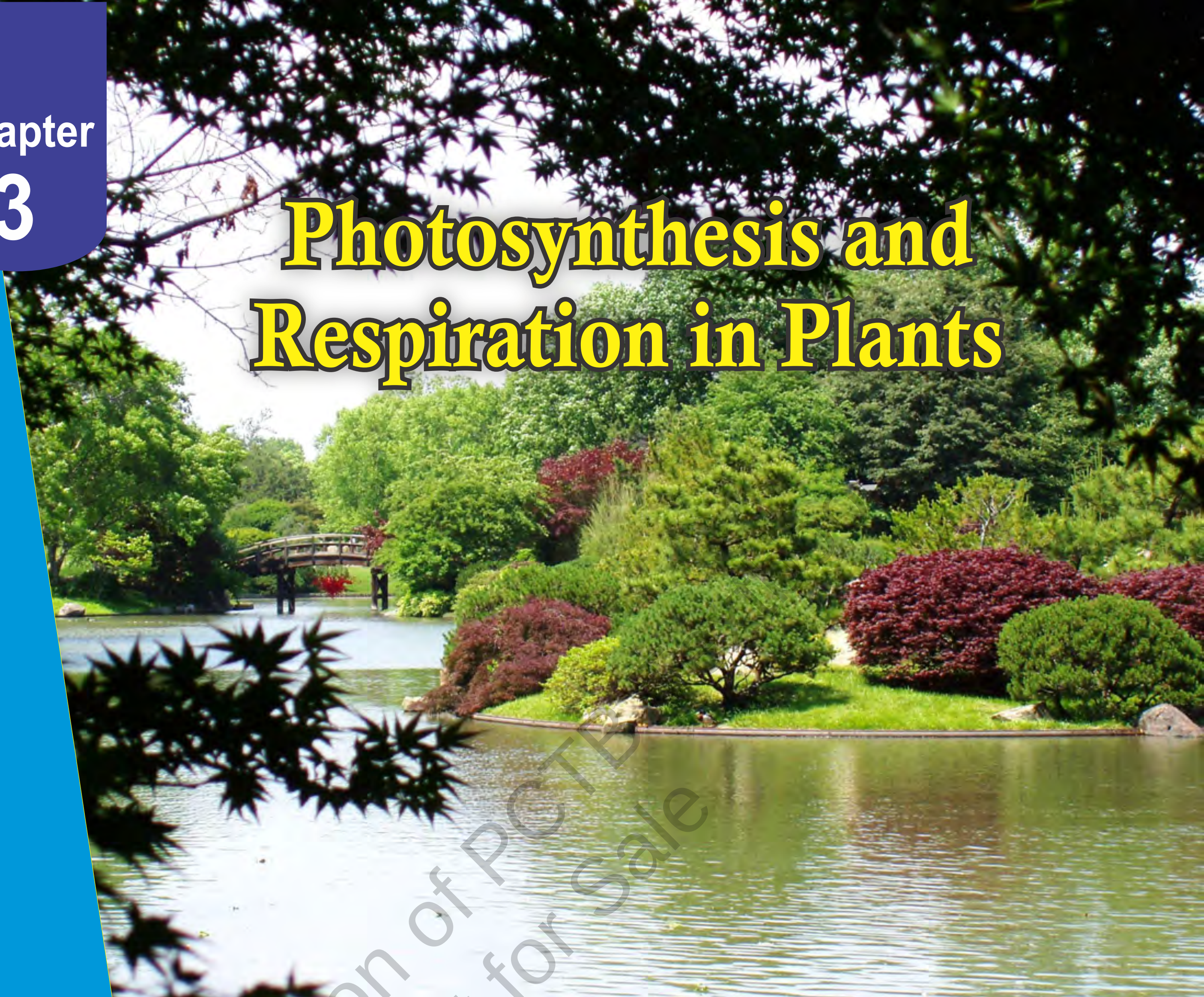
All the sense organs are linked to the brain by nerves. When we hear a bell ring, nerves carry a signal to our brain. Our brain tells us that we are late from school. We must hurry. Our brain is like a big computer. It controls everything that our body does. Why do we think a healthy brain makes our senses better? How can we keep our brain healthy? Can mathematics and computer help us in this regard?

Computer Links

- http://idahoptv.org/dialogue4kids/season10/senses/facts.cfm
- http://faculty.washington.edu/chudler/chsense.html

Chapter 3

Photosynthesis and Respiration in Plants



Plants are living organisms. They also respire like us.

Student Learning Outcomes

After completing this chapter, you will be able to:

- Describe the internal structure of a leaf.
- Define photosynthesis.
- Explain the importance of photosynthesis in plants.
- Describe the effects of different factors on the process of photosynthesis.
- Explain that the structure of leaves facilitates photosynthesis.
- Prove with the help of an experiment that photosynthesis takes place in a leaf.
- Explain the importance and process of respiration in plants.
- Compare and contrast the process of photosynthesis and respiration in plants.

All living things need energy to perform activities of life. You need energy to walk, talk, and play. Plants need energy too. Plants get energy from food which they prepare themselves. Two processes are very important for plants so that they may live alive.

1. Food making process (Photosynthesis)
2. Energy producing process (Respiration)

Before discussing photosynthesis and respiration, it will be very useful to study the internal structure of a leaf.

Internal Structure of a Leaf

Leaves are very important structures. They are plant's food factories. They absorb sunlight energy to make food. Under a powerful microscope, we can see three main internal parts of a leaf, i.e. epidermis, mesophyll and vascular bundle (Fig.3.1).

Epidermis

The upper layer of a leaf is called the **upper epidermis**. The lower layer of the leaf is called the **lower epidermis**. Lower epidermis has many **stomata** (Fig.3.1). Each stoma has an opening and two bean shaped guard cells. Exchange of oxygen, carbon dioxide and water vapours between the leaf cells and the air takes place through stomata.

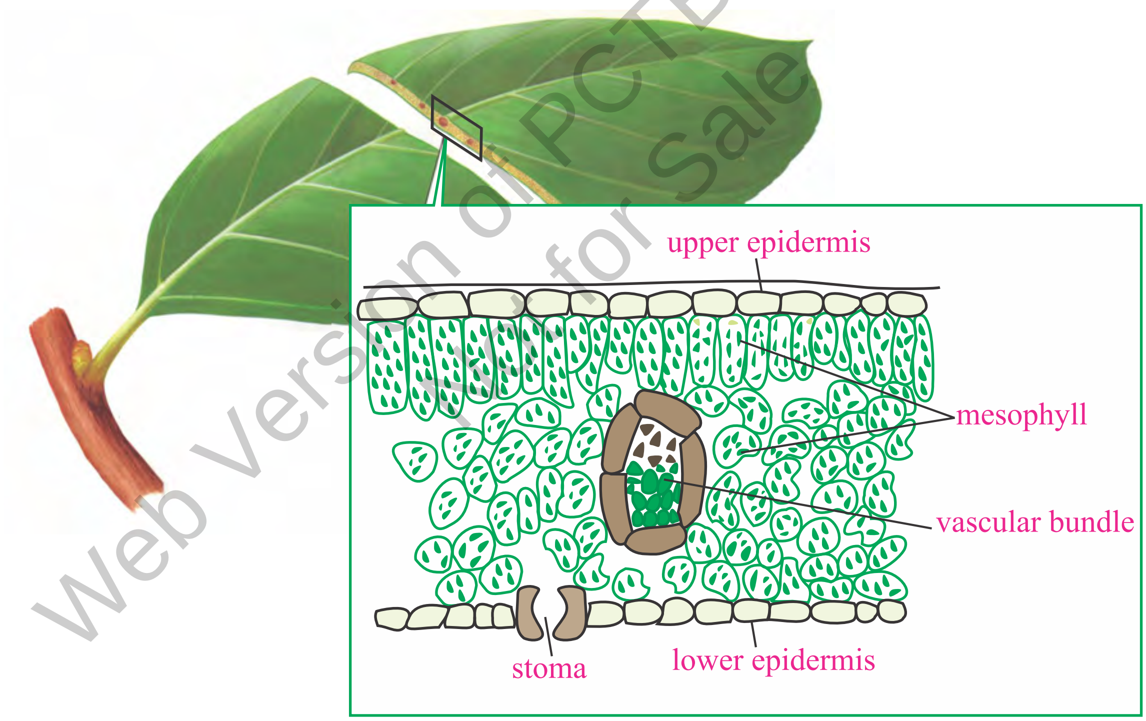


Fig. 3.1: Internal structure of leaf

Mesophyll

Between the upper and lower epidermis is the mesophyll (Fig.3.1). The mesophyll is made of cells that contain **chloroplasts**. A green pigment chlorophyll is present in chloroplasts. Chlorophyll traps light energy which is used in food making process. The mesophyll is the region where food making process called **photosynthesis** takes place.

Vascular Bundle

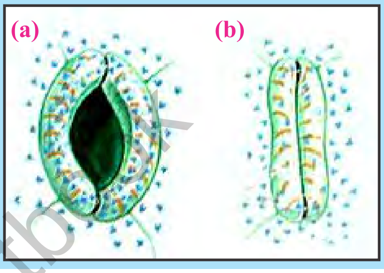
The central part of the mesophyll tissue is made of vascular bundle. Two types of tissues called xylem and phloem are present in vascular bundle (Fig.3.1). **Xylem** carries water from roots to the leaves. **Phloem** carries prepared food to other parts of a plant.

Interesting Fact

Why does a leaf look green?
The leaf looks green because the green colour of the chlorophyll shows through the clear epidermis. This chlorophyll helps to make food.

Do you know?

(a) When the guard cells absorb water, they swell and the stoma opens.
(b) When the guard cells release water, the stoma closes. Usually stomata remain open during the day and closed at night.



Photosynthesis

Plants make their food using carbon dioxide and water in the presence of sunlight and chlorophyll. This process is called **photosynthesis**. Plants also evolve oxygen during photosynthesis. Do you remember that all organisms use oxygen during respiration?

A word equation can explain the process of photosynthesis.

$$\text{Carbon dioxide + Water} \xrightarrow[\text{chlorophyll}]{\text{sunlight}} \text{Glucose + Oxygen}$$

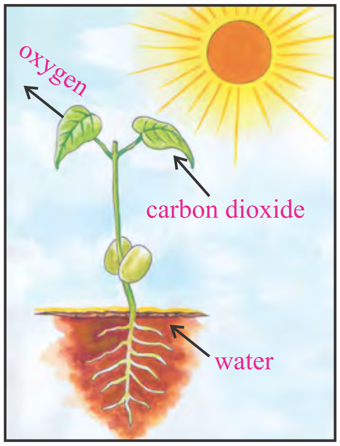


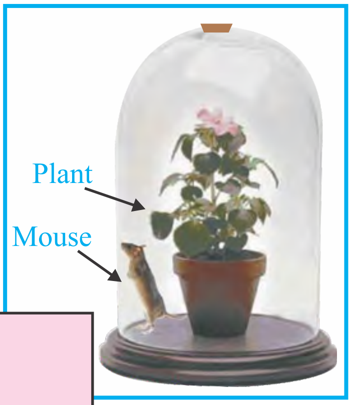
Fig.3.2: Photosynthesis in plants

The word "Photosynthesis"
The word "photosynthesis" is a combination of two Greek words : photo and synthesis. "Photo" means light, and "synthesis" means to make.

Importance of Photosynthesis

Photosynthesis is one of the most important chemical changes that take place in our world. If photosynthesis does not take place, nearly all living things will die.

Glucose and oxygen are the products of photosynthesis. All living things use these two products in respiration to produce energy. This energy is used to perform different activities of life.



POINT TO PONDER
It has been thought that plants and animals could live in a sealed environment such as a glass globe. Do you think it is possible? If yes, how?

Effects of Different Factors on Photosynthesis

Light, temperature, carbon dioxide, water and chlorophyll are necessary factors for photosynthesis. If any of these factors falls to a low level, photosynthesis slows down or stops.

Light

Plants trap sunlight to make food by photosynthesis. Photosynthesis increases as the light intensity increases. Recall! Which structure of leaf traps light? Of the seven colours of light, chlorophyll absorbs blue, orange and red light.

Carbon dioxide

Carbon dioxide which plants absorb from air is an essential component for photosynthesis. The rate of photosynthesis increases with increasing carbon dioxide level. The level of carbon dioxide in the air is about 0.03 to 0.04 percent.

> ***Interesting Fact***
>
> Plants in the world are sometimes called the "lungs of the nature". They produce oxygen and decrease carbon dioxide in the air.

Temperature

The higher the temperature, the faster the process of photosynthesis. Normally plants grow well at 25-35°C. Temperatures below 0°C and above 40°C are not suitable for plant growth.

Water

Water is also one of the raw materials for photosynthesis and it is required in limited amounts.

Chlorophyll

Chlorophyll is the green material in plants that traps sunlight for photosynthesis. It gives green colour to the leaves. Without chlorophyll the photosynthesis is impossible.

Structure of Leaf is Well Suited to Photosynthesis

Mostly photosynthesis occurs in green leaves because their structure is suitable for this process (Fig.3.3).

1. Most leaves have a flat blade to absorb maximum light.
2. Leaves are thin, so carbon dioxide and light can reach to inner cells easily.
3. Leaves have large number of stomata in the lower epidermis. Carbon dioxide can enter and oxygen and water vapours leave through these stomata.
4. Thick layer of mesophyll cells makes enough food for the plant.
5. Vascular bundle in the leaf spreads its veins in a network to carry water to photosynthesizing cells and glucose away from them.

All these characteristics prove that the structure of a leaf is fit for the process of photosynthesis.

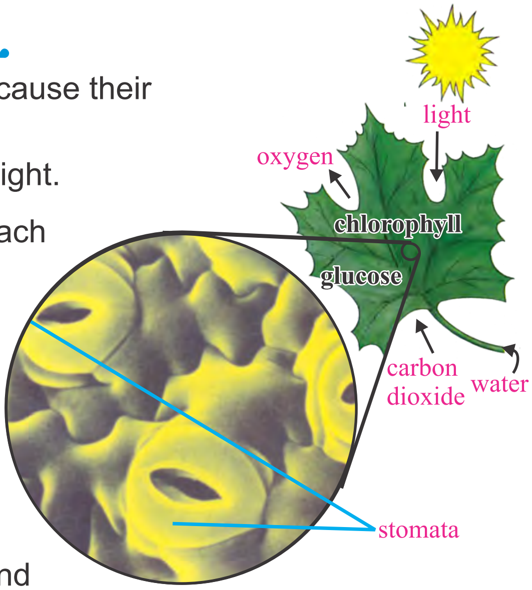


Fig.3.3: Stomata are important for the gas-exchange process during photosynthesis!

Activity

You will need: ◈ a plant ◈ black paper ◈ scissor and tape ◈ water

Procedure

1. Cut 2 squares of black paper. Each square should be big enough to cover completely one side of a leaf.
2. Place one square on one side of a leaf and another square on the other side. Tape the squares together.
3. Place the plant in a sunny place. Water it every other day for a week.
4. Remove the squares. Record your observations of the covered and uncovered leaves.

Things to think: Why does the colour of some leaves become different?

Point to think!

What would happen (especially to the amount of oxygen in the air) if photosynthesis stopped?

Respiration In Plants

Respiration is the energy producing process in living things. In this process plants use oxygen to break down glucose into water, carbon dioxide and energy. Here the word equation shows the process of respiration:

$$\text{Glucose} + \text{Oxygen} \longrightarrow \text{Carbon dioxide} + \text{Water} + \text{Energy}$$

Exchange of gases in plants takes place through stomata present in leaves (Fig.3.4). This exchange of gases takes place in two different steps. These steps are respiration and photosynthesis.

During daytime plants photosynthesize and produce glucose and oxygen. They use glucose and oxygen in respiration, while carbon dioxide and water are produced. These products are used in photosynthesis. At night the process of photosynthesis stops but respiration is a continuous process. Plants take in oxygen from the air and give out carbon dioxide and water in respiration.

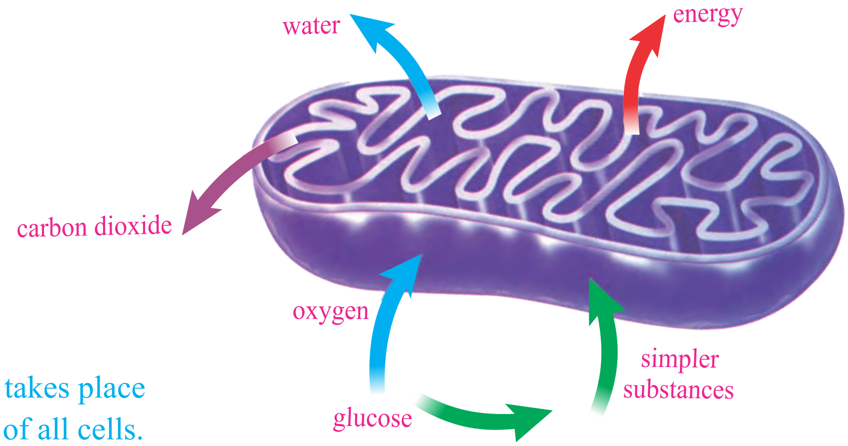


Fig.3.4: Respiration takes place in the mitochondria of all cells.

Do you know? It is advised not to sleep under a tree during night, because of high amount of carbon dioxide and less oxygen in the air.

Comparison Of Photosynthesis and Respiration

Photosynthesis and respiration are two different processes. They are reverse to each other.

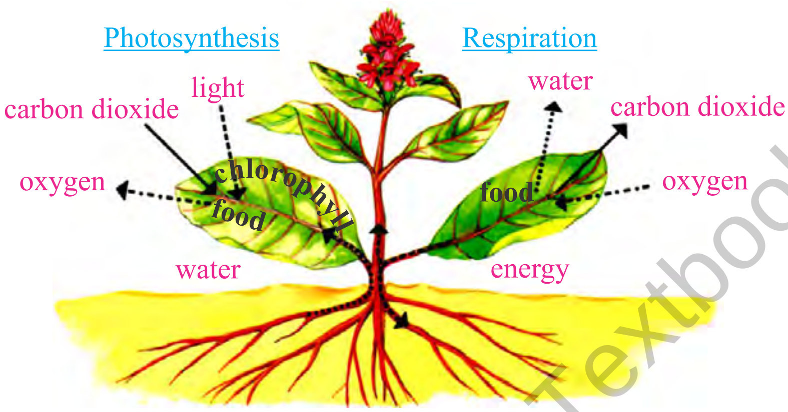


Fig. 3.5: Comparison of photosynthesis and respiration

Table: Comparing Photosynthesis and Respiration

Photosynthesis	Respiration
Occurs in plants	Occurs in all living organisms
Food-making process	Food-using process
Traps energy to produce glucose	Breaks glucose to release energy
Carbon dioxide+Water $\xrightarrow[\text{chlorophyll}]{\text{light energy}}$ Glucose+Oxygen	Glucose+Oxygen $\longrightarrow$ Carbon dioxide+Water+Energy

Do you know? Photosynthesis occurs in chloroplasts of plant cells while respiration occurs in mitochondria of every animal and plant cell.

Chapter Review

1. Food is prepared in the mesophyll tissues of a leaf.
2. Plants make their food by the process of photosynthesis.
3. Structure of leaf is well suited to the process of photosynthesis.
4. Light, temperature, carbon dioxide, water and chlorophyll are necessary factors for photosynthesis.
5. Respiration is the energy producing process in living things.

Test Preparation

1. Write proper term/word against each statement.

i. Process of producing energy by the use of glucose and oxygen ________________

ii. The outer protective layer of the leaf ________________

iii. Process of making food by the use of water and carbon dioxide ________________

iv. Green pigment in plants ________________

v. Openings in a leaf ________________

2. Circle the letter of the best answer.

i. Stomata open to allow__________the plant.

(a) sugar into (b) sugar out of

(c) carbon dioxide into (d) light into

ii. Products of photosynthesis are:

(a) carbon dioxide and water (b) hydrogen and water

(c) glucose and carbon dioxide (d) glucose and oxygen

iii. How does chlorophyll help a plant?

(a) It absorbs light energy in photosynthesis.

(b) It moves water and minerals through the plant.

(c) It moves sugar and water through the plant.

(d) It absorbs water.

iv. Which is correct for leaves to make food?

(a) flat surface (b) presence of large number of stomata

(c) thick layer of mesophyll cells (d) a,b,c

v. Respiration takes place in__________of cells.

(a) chloroplasts (b) mitochondria

(c) nucleus (d) cell membrane

3. Answer the following questions in detail.

i. Describe the internal structure of leaf.

ii. Which factors are necessary for photosynthesis?

iii. Prove that the structure of a leaf facilitates the process of photosynthesis.

iv. How does respiration occur in plants?

4. Extend your thinking.

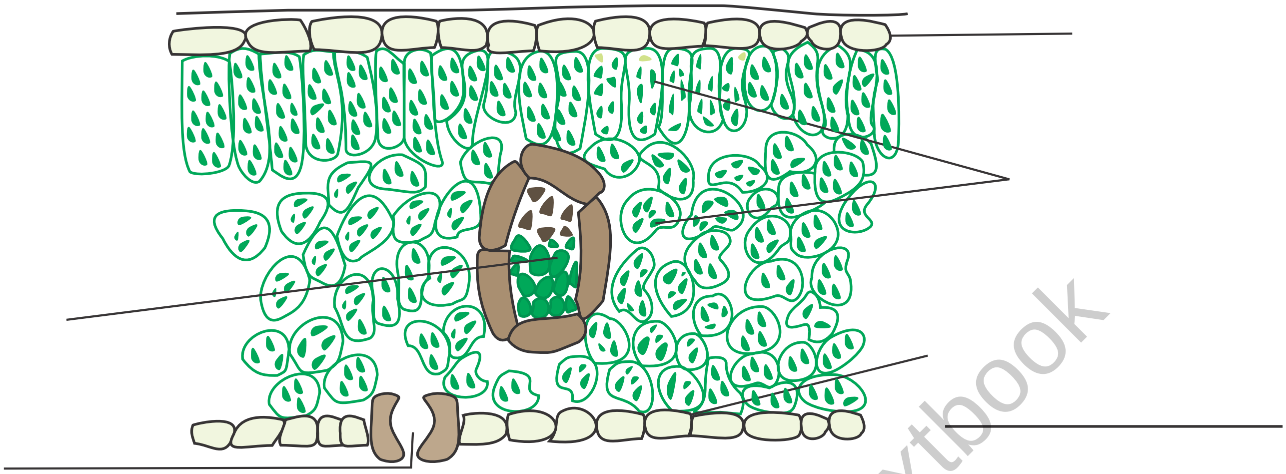
i. Which part of the leaf can best be compared to your skin?

ii. What is one cause of oxygen being found in the atmosphere?

iii. What would happen if there were no carbon dioxide in the air?

iv. Why is it important that the leaves on a stem are arranged so they do not overlap too much?

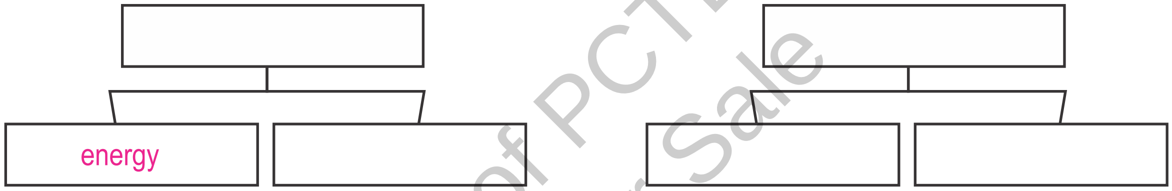
5. Identify and label the following diagram.



6. Concept Map

Complete the concept map using following words:

glucose, photosynthesis, carbon dioxide, respiration, oxygen



Science Projects

1. Grow two potted plants from seeds. Keep one plant in the dark and the other in the sunlight. Which plant has more chlorophyll? What does this show about chlorophyll in leaves?
2. If a microscope is available, look at a piece of epidermis peeled from an onion leaf. Find the stomata and guard cells.
3. Look at different kinds of green plants to see how their leaves are placed to catch sunlight. What do you discover?

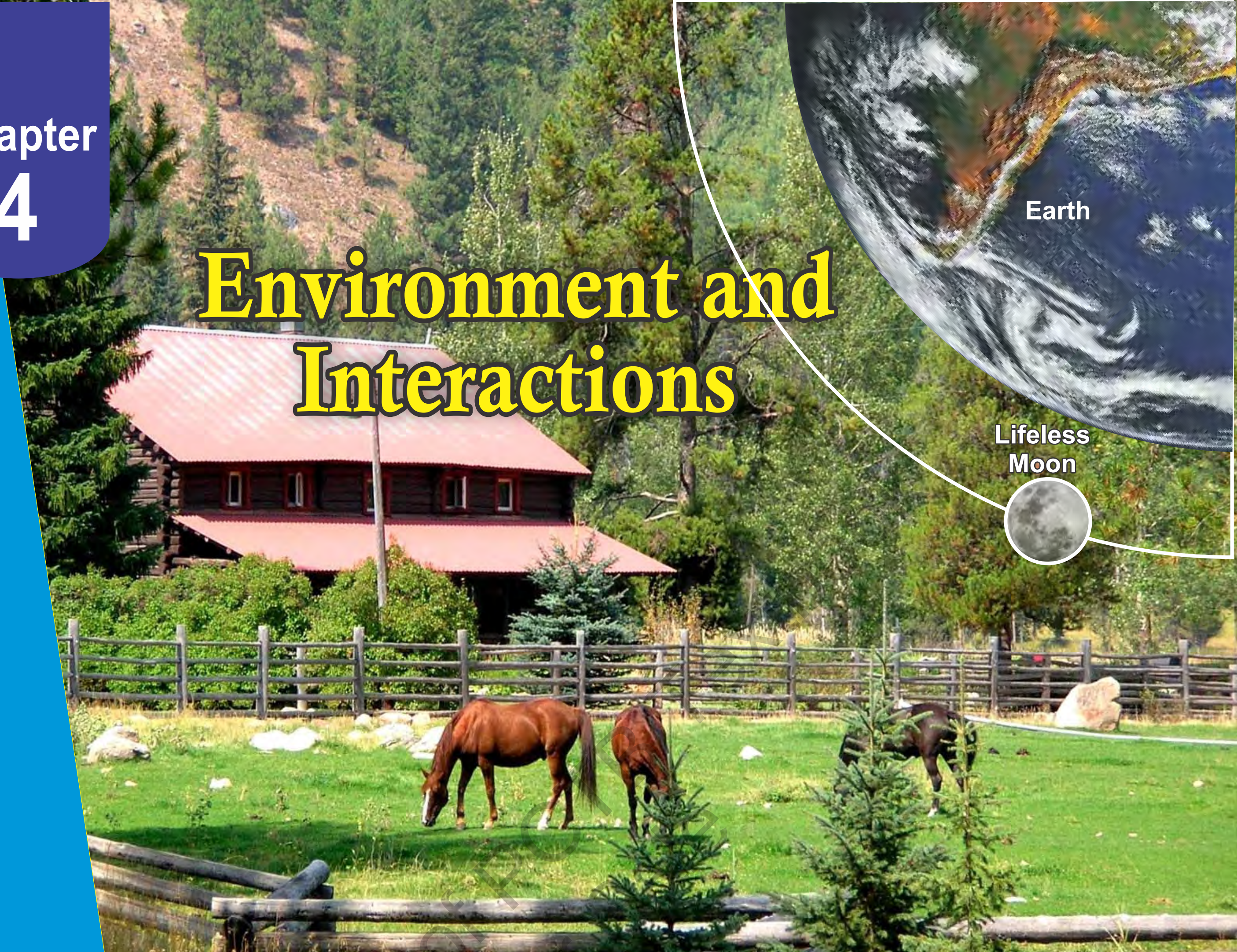
Nearly all the living organisms in every community depend on green plants for food. To make food, green plants take carbon dioxide, water and minerals from the air and the soil. Cutting the trees is a common practice in our country. Why do you think this practice can create a great problem of food shortage? What would you suggest to avoid this problem?

Computer Links

- http://www.worsleyschool.net/science/files/photosynthesis/page.html
- www.biology4kids.com/files/plants_main.html

Chapter
4

Environment and Interactions



The Earth is full of life.

Student Learning Outcomes

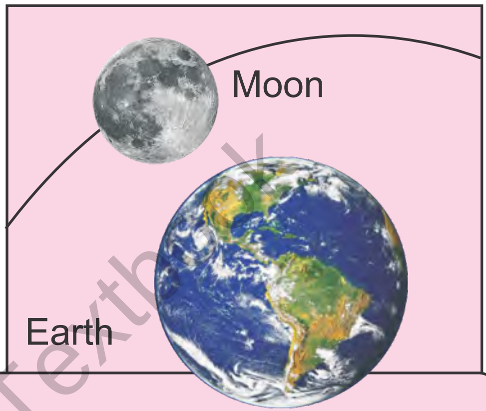
After completing this chapter, you will be able to:

- Identify the components of environment.
- Compare the physical factors, which make up the environment of a desert and a rain forest.
- Describe the relationship between biotic and abiotic components of the environment.
- Explain how abiotic factors affect the ability of plants to create their own food.
- Describe that living things depend on one another for food, shelter and protection.
- Explain the different relationships between organisms.
- Give examples of how organisms interact with each other and with non-living parts of their environment.

Environment

Everything around an organism that affects its life is called its **environment**. Life is not same on every part of the Earth. Conditions are different at different places. That is why, we find a variety of plants and animals on Earth. Living organisms do not live alone. All living things interact with one another all the time. They also interact with the non-living things around them.

Components of Environment



Environment has two components:

All plants, animals and micro-organisms are called living or **biotic components** of an environment.

Air, water, light, temperature and soil constitute non-living or **abiotic components** of an environment. What are some biotic and abiotic factors in your classroom environment?

Point to think!

The Moon is the natural satellite of our Earth. Both receive light energy from the Sun, but they present different pictures. Our Earth is full of life, but the Moon is lifeless. Which are the necessary factors absent on the Moon and present on the Earth?

Biotic Components

Biotic components of an environment consist of plants, animals and micro-organisms. Most of the interactions among organisms involve food. Plants and animals are often linked together because only green plants can make food.

Producers

Plants are able to make their own food by photosynthesis and are known as **producers.** They also release oxygen in which all organisms respire.

Consumers

All the organisms which do not make their own food and feed on plants directly or indirectly are called **consumers.** There are different types of consumers (Fig.4.1).

Animals that eat only plants are called **herbivores.** Horses, goats, squirrels and butterflies are herbivores. Can you name a few more herbivores?

Animals that eat flesh of the herbivores or other animals are called **carnivores.** Some carnivores are tigers, lions, cats, dogs, frogs and snakes.

Fig.4.1: A consumer may be a herbivore, a carnivore or an omnivore.

Some animals eat both plants and animals. They are called **omnivores.** Chickens, crows, bears and humans are omnivores.

Decomposers

When plants and animals die, their bodies are broken down or decomposed by bacteria and fungi. These bacteria and fungi are called **decomposers.**

Decomposers play a very important role in the environment. They break down complex substances into simple ones. Plants and animals reuse these simple substances. This is a natural way of "recycling" of materials.

Point to think!
What would happen if there were no decomposers in our environment?

Dependence of Organisms Upon One Another

Fig.4.2: An owl in a tree hole

All organisms (plants and animals) interact with each other. Animals depend upon plants:

1. For food

All animals depend directly or indirectly on green plants for their food. From where do we get fruit , vegetables and cereals?

2. For shelter

Fig.4.3: A parrot is not easily seen in green leaves.

Some animals such as owls make their homes in the holes of trees (Fig. 4.2). Some birds like sparrows, crows, eagles and kites build their nests in trees. A few insects like the ants, grasshoppers, moths and beetles live in trees. Plants provide animals shade and also make the surroundings cool.

3. For protection

Some animals take help from plants to protect themselves from enemies. For example, a parrot hides in the green leaves due to its colour (Fig. 4.3), a grasshopper hides in grass due to the same colour.

Plants also depend upon animals:

1. For carbon dioxide

Fig.4.4: The bird helps the plant in pollination.

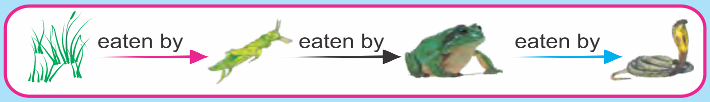
Plants cannot make their food without carbon dioxide gas. All animals release carbon dioxide during respiration. Plants absorb this gas from air.

2. For pollination

Animals also help some plants in their pollination (Fig. 4.4).

Do you know?

All living organisms need food to live. Green plants make food and animals consume this food. There is a food link among organisms and is called **food chain.**



Activity 4.1

Visit a nearby pond under the supervision of your teacher.

- Do you see any animal or plant floating on the surface of pond water?
- Do some animals and plants live under water?

How do these animals and plants depend upon each other?

Abiotic Components

Abiotic components means non-living components. Light, temperature, soil, air and water are abiotic components in an environment.

Interesting Fact

Some animals like earthworms, woodlice and cockroaches avoid sunlight and live in dark places.

Light

Light is a very important abiotic factor of the environment. The ultimate source of light energy is the Sun. Plants need sunlight for photosynthesis. All animals use the food prepared by plants. Most animals including human beings need sunlight for most of their activities.

Fig.4.5: The camel, known as the ship of the desert, can tolerate high temperature.

Temperature

The heat of the Sun greatly influences the temperature of a place. Some places on the Earth like deserts are too hot and others like glaciers are too cold for animals and plants to survive. There is a great difference of temperature between day and night of a desert. Days are hot and nights are cold. Most organisms are active at temperatures between 0°C and 45°C. Temperature affects the activities of plants and animals.

Air

Air is an important abiotic factor. Air is a mixture of gases. Air contains gases which are very important for the lives of animals and plants. Animals and plants respire in the oxygen of air. Respiration is a necessary process to live. Plants in addition to oxygen, also need carbon dioxide from air to make their food.

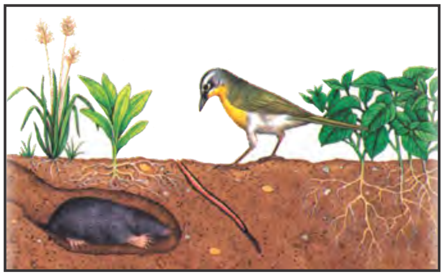


Fig.4.6: Soil provides necessary minerals and water to the organisms.

Soil

Soil is very important for plant growth. It is an important factor of environment. Without soil, most of the plants would not exist. Plants get water and necessary minerals from soil. Bacteria present in soil provide important compounds to the plants. Man provides fertilizers to crops through soil.

Activity 4.2

Arrange a soil study program under the supervision of your science teacher. Select a shady patch of land in the school lawn or nearby park. Observe the soil.

- Do you see some small animals and plants on the ground? Dig the soil to some depth.
- Do you see some animals in the soil? Can you name these animals? Uproot a small plant from the soil. Place it for some time and then observe it.
- Will the plant remain alive after being uprooted?

Based on this study, discuss the importance of soil for living things.

Water

Water is essential for life. It is present in the environment of every plant and animal. The amount of rainfall throughout the year determines the amount of water available at any place.

Fig.4.7: Tropical rainforests cover 10% of the land, but more than 50% of the total kinds of plants and animals are found here.

A large number of plants and animals is found in tropical rainforests because of heavy rainfall. Very few plants and animals are found in deserts because of less rainfall. Many plants, such as water lily and hydrilla are found in water. Can you name a few animals that are found in water?

Organisms living in deserts have developed special features to store water in their bodies. The cactus is a desert plant. Its fleshy body and spines help it to store water in its body. Have you ever heard that camels can go without water for weeks?

Warning: Living animals are involved in your activity. Carefully handle them, and when you finish, put them back outside.

Activity 4.3

You will need:
- about 10 ants in a small transparent bottle with a lid
- a plastic container (may be ice-cream container)

Procedure

1. Observe the way the ants move about at normal room temperature.
2. Now fill the plastic container with cold water and place the jar of ants into it.
   After 10 minutes, again observe the way the ants move about at low temperature. Compare
   the movements of ants with their movements at normal temperature.
3. Replace cold water with 'hand hot' warm water.
4. Place the jar of ants in the warm water.
5. Observe the movements of ants at higher temperature. Compare the three movements.
   Now try to answer this simple question.

Why are more insects found buzzing around light bulbs on a summer evening than in winter?

Relationships Among Organisms

Organisms in an environment interact with other organisms in order to obtain food, shelter, etc. There are many different types of relationships among organisms. Some of these are described below:

Fig.4.8: Identify the predator and prey.

Predator-Prey Relationship

An animal that kills and eats another animal is called a **predator.** The **prey** is the animal the predator kills and eats. The relationship between predator and prey is called **predation.**

For example a lion hunts and eats deer (Fig.4.8). The lion is a predator. The deer is its prey. Predation is a temporary relationship. It only lasts as long as the time a predator takes to kill and feed its prey.

Parasitism

Parasitism is a relationship between two living organisms in which one is harmed and other helped. A **parasite** is a living organism that feeds on another living organism. The living organism on which the parasite feeds is called the **host.**

Many plants and animals are parasites. A mosquito is a parasite. The mosquito uses our blood or the blood of another animal for food. We are the host and mosquito is a parasite.

Cuscuta is a parasitic plant. Its weak and yellowish stem twines around the stem of the host plant. It sucks water and food from the stem. Leech, ascaris (malap), etc. are also parasites.

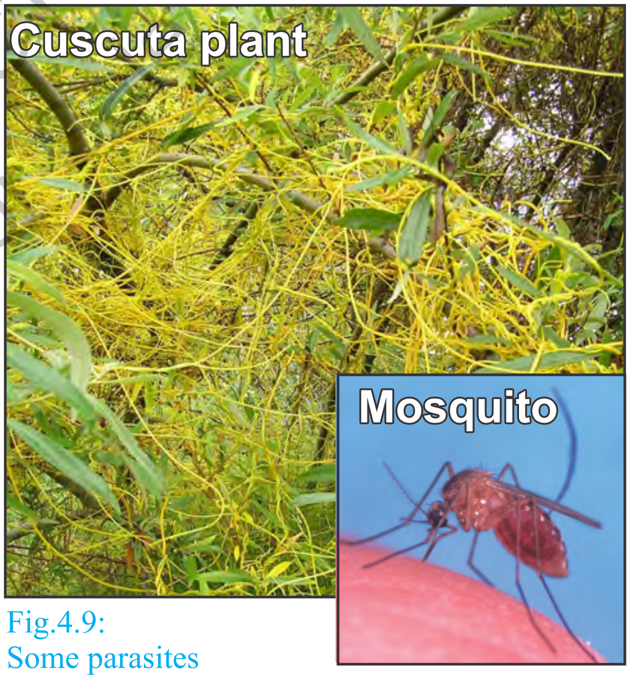


Fig.4.9:
Some parasites

Do you know?

Some types of wasps have parasitic larvae. The adult wasp lays its eggs inside the body of a caterpillar. After hatching of the larvae, they eat up all the body of caterpillar from inside and adult wasps come out.

Mutualism

Mutualism is a relationship in which two living organisms live together and depend on each other. It is a friendly relationship. Mutualism occurs among some plants and animals.

Algae and fungi form lichen (Fig. 4.10) . The lichen shows mutualism between the two. Green alga makes food for itself and for the fungus. Fungus protects the alga from drying up. The fungus also gives carbon dioxide to alga to make food.

A dead log contains termites. Termites eat wood (Fig. 4 .10). However, they are not able to digest the wood . There is a kind of a unicellular organism that lives inside the termites. This unicellular organism is able to digest the wood. After the unicellular organisms digest the wood, the termites can use it.

Fig.4.10: Some examples of mutualism

Point to think!

Explain how a frog can be both predator and prey.

Chapter Review

1. Life is not uniformly distributed on Earth.
2. An environment has two components, i.e. biotic and abiotic.
3. Animals, plants and micro-organisms are included in biotic components of an environment.
4. Living things depend upon one another in an environment.
5. Abiotic or physical environment means non-living environment.
6. Light, water, air and soil are included in abiotic components of an environment.
7. There is a system of give and take between biotic and abiotic components of environment.

Test Preparation

1. Write proper term/word against each statement.

i. Plants, animals and micro-organisms in an environment ______________

ii. The animals that can eat both plants and animals ______________

iii. Bacteria and fungi are examples of ______________

iv. A living thing that lives on or in another living thing and harms it ______________

v. A relationship between two kinds of organisms in which both benefits ______________

vi. An animal that is killed by a predator ______________

2. Circle the letter of the best answer.

i. An abiotic component of the environment is:

(a) a plant (b) an animal

(c) water (d) a micro-organism

ii. A pine tree is a:

(a) predator (c) consumer

(b) producer (d) parasite

iii. Organisms that feed on plants directly or indirectly are called:

(a) producers (b) predators

(c) prey (d) consumers

iv. What kind of organisms help clean a place of waste and dead remains?

(a) decomposers (b) carnivores

(c) herbivores (d) omnivores

v. Which is an example of parasitism?

(a) two species of insects that feed on the same rare plant

(b) a lake near a forest in northern areas

(c) an African lioness feeding her cubs

(d) a tick living on a dog

3. Answer the following questions in detail.

i. How do plants depend upon animals for their needs?

ii. Explain the abiotic factors of the environment.

iii. Explain the following with examples:

(I) Parasitism

(ii) Mutualism

(iii) Types of consumers

4. Extend your thinking.

I. What would be the effect of destroying most or all of the plants on the other biotic factors in an environment?

ii. There were many deer in a forest. Hunters killed the mountain lions, wolves,and other enemies of the deer. What changes do you think took place because of what the hunters did?

iii. Think of three things you like to eat. What type of consumer are you?

iv. Why are animals said to be consumers instead of producers?

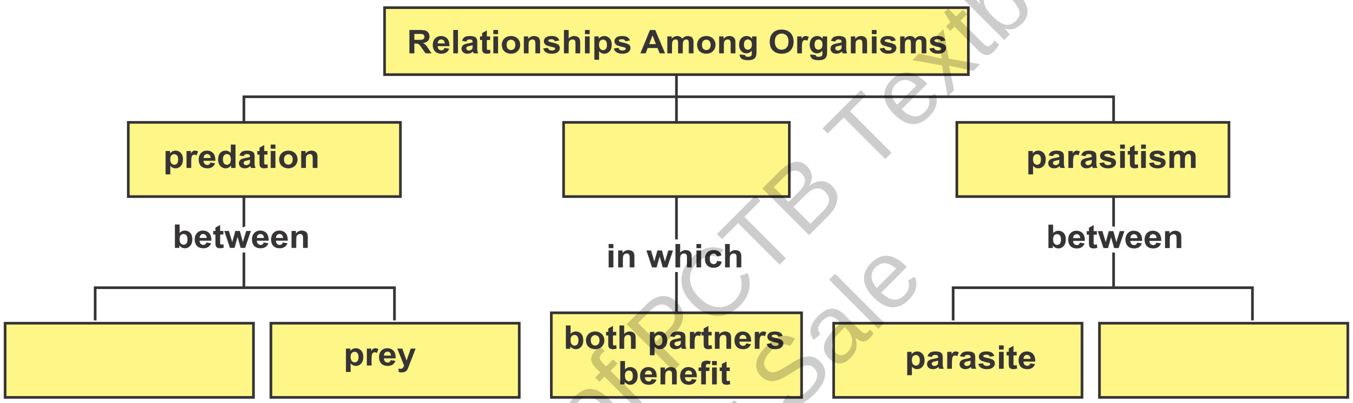
v. Why is it better for a parasite to leave its host alive?

vi. Where does the main source of energy come from in an environment?

vii. What are two ways a mosquito may harm its host?

5. Concept Map

Complete the concept map.



Science Projects

1. Find out which plants and animals provide our most important foods. Then make a report to your class. Collect pictures of those plants and animals and prepare a chart to illustrate your report.
2. Find out what are lichens and what type of relationship they show.

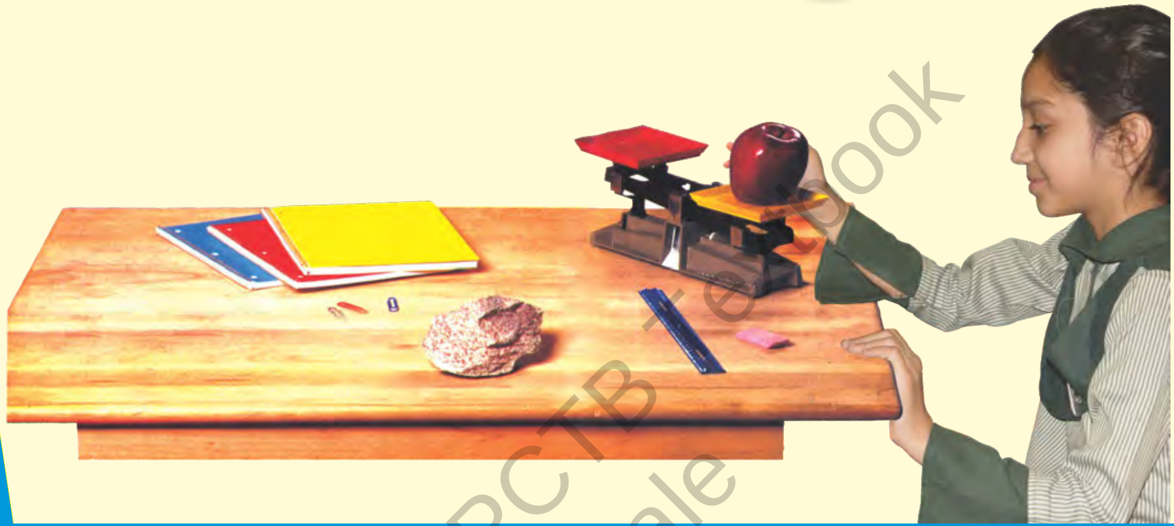
Water, soil, air and light are abiotic components of an environment. Water is needed by all living things in the environment. Without water, plants would not be able to make food. Soil in an environment not only holds plants but it also provides many nutrients to plants. Air is also needed in the environment. Plants use carbon dioxide in photosynthesis. All living things use oxygen during respiration. Rapid development in science and technology has created a great problem of pollution. Investigate how water pollution, air pollution and land pollution affect living organisms in an environment.

Computer Links

- http://www.slideshare.net/schumaiers/13-interactions-among-living-things
- http://dnr.wi.gov/org/caer/ce/eek/earth/index.htm

Chapter
5

Atoms, Molecules, Mixtures and Compounds



All of these objects are made of matter.

Student Learning Outcomes
After completing this chapter, you will be able to:

- Differentiate between an atom and a molecule.
- Recognize the symbols of some common elements.
- Classify elements into metals and non-metals.
- Relate the physical properties of elements to their uses.
- Differentiate between elements and compounds, compounds and mixtures.
- Identify examples of compounds and mixtures from their surroundings.
- Explain uses of common mixtures in daily life.
- Explain why air is considered as a mixture of gases.
- Identify the sources of carbon dioxide and how its level can be maintained in nature.
- Separate mixtures using a variety of techniques.
- Choose a technique to separate and identify different components in dyes.
- Demonstrate with an experiment to separate soluble solids from mixtures.
- Use safety measures to conduct science experiments.

Atoms and Molecules

We see many things around us. Some are big and some are small. All things are made of **matter**.

Matter is made of atoms. **Atom** is the smallest particle of matter which takes part in a chemical reaction. We cannot see atoms because they are so small. Atoms except noble gases cannot exist independently.

Two or more atoms can join together to form larger particles of matter called **molecules**. Molecules can exist independently. Sometimes a molecule has the same kind of atoms but, sometimes, different atoms combine to form a molecule. For example, one molecule of oxygen gas is made of two similar oxygen atoms (Fig. 5.1). A water molecule has three atoms, i.e. one oxygen atom and two hydrogen atoms (Fig.5.2).

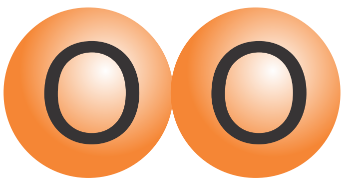


Fig.5.1: Oxygen molecule (O_2)

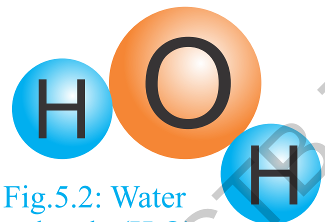
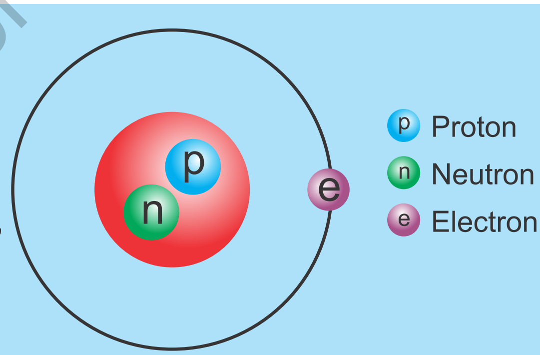


Fig.5.2: Water molecule (H_2O)

Fig.5.3: Graphite used in lead pencils is made of carbon atoms.

Do you know?

The word 'atom' means 'indivisible'. But now the scientists have discovered that an atom is divisible. Atoms are made of the fundamental particles called electrons, protons and neutrons. These particles are even smaller than the atoms.



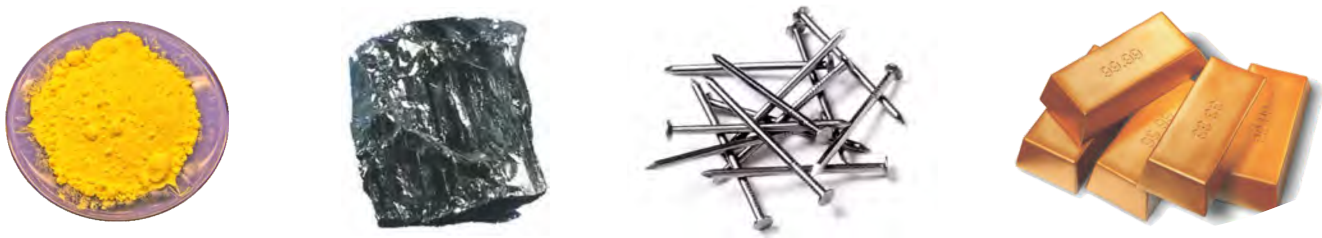
Activity 5.1

Take plasticine or clay of different colours. Make balls of different sizes. Use these balls to make models of oxygen and water molecules.

Elements

The matter consisting of only one kind of atoms is called an **element.** Gold, silver and copper are the examples of elements .

If we take a piece of coal which is carbon and break it into very small pieces, we will find that its very small piece is also coal (carbon). Elements cannot be broken down into further simpler forms by ordinary chemical processes.



sulfur powder | carbon (coal) | iron | gold

Fig.5.4: Every element consists of one kind of atoms.

There are 109 elements known to scientists. Around 92 elements are naturally found. Other elements are made by scientists. Elements exist in all three states of matter. For example iron is a solid element. Mercury is a liquid element and oxygen is an element in gaseous state.

Some Common Elements and their Symbols

In the beginning, each element was written in its full name. A short way to write the names of elements was developed. Each element is given a symbol. A **symbol** is the abbreviated name of an element. The symbol consists of one or two letters taken from the English or Latin name of the element.

'H' is the symbol of hydrogen. 'Na' is the symbol of sodium whose Latin name is *natrium.*

Table 5.1: Some common elements and their symbols

Element	Symbol	Element	Symbol
Aluminium	Al	Iron (Ferrum)	Fe
Calcium	Ca	Mercury (Hydrargyrum)	Hg
Carbon	C	Nitrogen	N
Chlorine	Cl	Oxygen	O
Copper (Cuprum)	Cu	Phosphorous	P
Gold (Aurum)	Au	Silver (Argentum)	Ag
Hydrogen	H	Sulphur	S
Iodine	I	Sodium (Natrium)	Na

Classification of Elements

Scientists classify elements into two main groups, i.e. metals and non-metals.

Metals

About 70 percent elements are metals. All metals have almost similar physical properties. Most of the metals are shiny or gray solids and they can be moulded or shaped by heating and pressing.

Metals are also good conductors of heat and electricity as they allow them to pass through. Some common metals are given in the table 5.2.

Table 5.2: Common Metals

Aluminium (Al)	Iron (Fe)	Silver (Ag)
Calcium (Ca)	Lead (Pb)	Sodium (Na)
Copper (Cu)	Mercury (Hg)	Zinc (Zn)

Fig.5.5: Metal are used to make many objects.

Non-metals

The elements other than metals are called non-metals. They have different properties from metals. Non-metals can be solids, liquids or gases. Solid non metals are brittle and you cannot mould or shape them. Most of the non-metals do not allow electricity and heat to pass through them. They are non-conductors.

A few non-metals are given in the table 5.3.

Table 5.3: Common Non-metals

Carbon (C)	Hydrogen (H)	Oxygen (O)
Chlorine (Cl)	Nitrogen (N)	Sulphur (S)

Uses of Some Common Elements

We can relate the physical properties of elements to their uses.

Physical Properties and uses of Metals

Metals are widely used in our everyday life due to their physical properties.

i. State

Most metals are found in solid state. However, mercury (Hg) is found in liquid state. Mercury is filled in thermometers to measure temperature.

ii. Hardness

Most metals are hard solids. For example, iron is used to make steel. The steel is then used for making rails, bridges, ships, girders, surgical instruments and utensils.

iii. Lustre

Freshly cut metals have brilliant shine, called lustre. For example, aluminium is used for making utensils and picture frames due to its lustre. Gold and silver are used to make ornaments because of their shine.

iv. Melting and Boiling Points

Metals have high melting and boiling points. Due to this property iron, copper and aluminium are used to make kitchen utensils.

v. Strength and Malleability

Metals are used to make sheets, wires and springs due to their property of strength and malleability.

vi. Conductivity

Metals like copper and aluminum are used in electrical wiring. They have the property to allow the electricity to pass through them. This property is called conductivity.

Alloys

An interesting property of metals is the ability to form alloys. An alloy contains more than one metals. German silver is an alloy of copper, zinc and nickel. It is used in jewellery. Brass is the alloy of copper and zinc that is used to make pipes, hose nozzles and jewellery.

Physical Properties and Uses of Common Non-metals

Non-metals are found in solid, liquid and gaseous states. Most non-metals are not hard. Most non-metals have no shine or luster. They have low melting and boiling points. Most non-metals are bad conductors of electricity. However, graphite is a good conductor of electricity. Non-metals are widely used in our daily life.

1. Air contains several gases, which are non- metal elements.
2. Welders use flame of oxy-fuel for cutting and welding metals.
3. Hydrogen and nitrogen gases are used in the manufacture of urea (fertilizer).
4. Banaspati ghee is manufactured by the use of hydrogen and vegetable oil.
5. Phosphorus is used in match industry.
6. Oxygen gas is used in hospitals.
7. Carbon as diamond is used in jewellery.
8 Graphite (carbon) is used by mixing with clay in pencils.

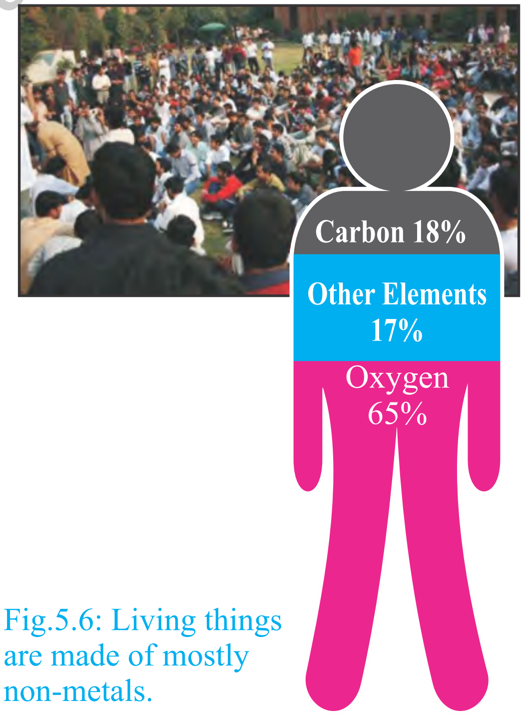


Fig.5.6: Living things are made of mostly non-metals.

Do you know?

Diamond (carbon) is a non-metal, but it is the hardest matter on the Earth. It is shiny and is used in jewellery. It is also used to cut glass.

Activity 5.2

Take different objects, such as metal wire, a metal key, a ruler, a glass slide, an eraser, etc. Make a circuit with a battery, switch and bulb. Pick up the objects one at a time, attach them in the circuit. If the bulb lights up then it is a metal, if it doesn't then the object is a non-metal.

Compounds and Mixtures

Many things on the Earth are not elements. Some of them are compounds and some are mixtures.

Compounds

When two or more elements combine chemically in a fixed ratio, a **compound** is formed. For example, water is the compound made of the elements hydrogen and oxygen .

$$\text{Hydrogen} + \text{Oxygen} \longrightarrow \text{Water}$$

There are 109 known elements but there are thousands of compounds. Elements in a compound cannot be separated easily. Properties of elements change when they are combined as compounds.

In case of water, hydrogen and oxygen are colourless gases. They have no smell or taste. Hydrogen will burn very quickly in oxygen. Both of these gases combine to form water which is a compound. We can see and taste it.

Fig. 5.7: Some common compounds of everyday use

Mixtures

When two or more substances are mixed in such a way that no chemical change takes place, the combination is called a **mixture.**

Parts of a mixture can be separated easily because they are not chemically combined . All the parts in a mixture keep their own properties. For example, salad in the bowl is a mixture of different fruits and vegetables. You can taste them. How could you separate iron buttons from a mixture of different buttons?

A mixture may be homogenous or heterogeneous. A **homogenous** mixture has uniform appearance throughout. For example, a mixture of sugar or salt dissolved in water.

A **heterogenous** mixture does not have uniform appearance throughout. This mixture is made of different parts. For example, a mixture of oil and water.

Fig.5.8: Some examples of mixtures

Activity 5.3

Take a glass of water, add some amount of table salt in it and stir it well. Where does the salt go? Salt is mixed in the water. Can you separate the salt and water again?

Activity 5.4

- Take a mixture of sulphur and iron filings in a china dish.
- Move a bar magnet in this mixture. What did you observe?
- Now heat the mixture of sulphur and iron filings. It will change into a black mass.
- Move the bar magnet in this black mass. What did you observe? Is the black mass a compound or a mixture?

Uses of Compounds and Mixtures

We use a number of compounds and mixtures in our everyday life.

Water is used in homes, in industries and in agriculture. Without water life is impossible.

Carbon dioxide is a compound of carbon and oxygen. Plants use it to make food. It is used to manufacture urea (fertilizer) and the bread. It is also filled in soda bottles.

Sodium chloride is commonly known as table salt. It is the compound of sodium and chlorine elements. People use it to preserve fish and pickles. We add it to our food to make it salty. It is also used to manufacture caustic soda and washing soda.

Fig.5.9: Fire extinguisher uses carbon dioxide to put out the fire.

Sherbat is a mixture of sugar, water, table salt and lemon, etc. We use it in hot summer days. **Salad** is a mixture of different vegetables as onion, carrot, radish, beet, cucumber, tomato and cabbage, etc. **Ice cream** is a mixture of milk, sugar and flavour.

Milk is also a mixture of water, fats, proteins and carbohydrates. **Tincture of iodine** is a mixture of iodine and alcohol. We apply it on a cut to kill the germs.

Fig.5.10: Ice cream is a mixture.

Do you know? The sea is the world's largest mixture. It covers about 70 percent of the Earth's surface. Water, sodium chloride (table salt) and many other salts are present in the sea water.

Air as a Mixture of Gases

Air is a mixture of gases. The largest component of air is nitrogen gas which is about 78 percent. The 21 percent of air is the oxygen gas. Many other gases like carbon dioxide, helium, etc. form remaining one percent of air. Each gas in the air keeps its individual identity and can be separated.

Besides gases, air also contains water vapours, particles of dust, smoke and pollen grains. Which components of air are elements and which are compounds?

Level of Carbon dioxide in Air

The amount of carbon dioxide ($C0_2$) in the air is 0.03 to 0.04 percent. All green plants use this carbon dioxide to make their food during photosynthesis . Is it not strange that its level in the air is maintained at the above given ratio all the time? Nature has managed the level of carbon dioxide by different methods. All organisms evolve this gas during respiration. By the burning of wood , coal and oil, carbon dioxide is produced.

Separating Mixtures

We have learnt that the components of a mixture can be easily separated. This separation has important applications in our everyday life.

1. Filtration

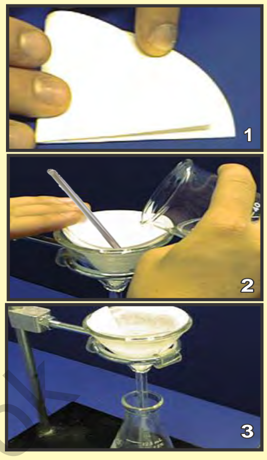
Filtration is a method in which we use a filter paper or filter cloth to separate insoluble solids of a mixture from a liquid.

We use strainer for separating tea leaves from tea. This is also a process of filtration. In a water filtration plant, filtration is used to separate solid impurities from dirty water.

Do you know?

- The hair and mucus in our nose help in the filtration of air before entering the lungs.
- Our kidneys filter the blood and separate waste materials in the form of urine.
- Water filters use the process of filtration to clean the tap water.

Activity 5.5



You will need: filter paper glass funnel glass rod iron stand beakers muddy water

Procedure

1. Take a filter paper and fold it as shown in the figure 1.
2. Fit the filter paper in a wet glass funnel.
3. Now take some muddy water in a beaker and pour it on the glass rod in the funnel.
4. The water passes through the filter paper into the beaker. The mud is kept back by the filter paper. The process is called **filtration.**

2. Sublimation

The process in which a solid on heating, directly changes into gas or vapour state is called **sublimation.** We can use this process to separate the two components of a mixture if one component has the property to sublime.

Put a few balls of naphthalene in your cupboard with clothes. You will not find these balls after some months. Where do the balls go? It is also interesting that on cooling, the vapours again return to solid.

$$\text{Solid} \underset{\text{cooling}}{\overset{\text{heating}}{\rightleftharpoons}} \text{Vapours}$$

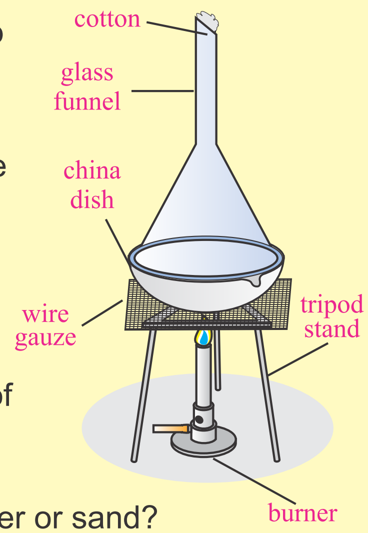
Iodine, ammonium chloride (noshader), camphor (kafoor) and naphthalene have the property to sublime.

Activity 5.6

You will need: a china dish a glass funnel cotton a tripod stand a burner or spirit lamp mixture of ammonium chloride (noshader) and sand

Procedure

1. Take a china dish and put some mixture of ammonium chloride and sand in it.
2. Invert a glass funnel over the china dish and close the end of the funnel with a cotton swab.
3. Set the apparatus as shown in the figure.
4. Heat the mixture.
   After some time you will see white powder on the inner walls of the funnel.
   Sand remains in the china dish.



Things to think: Which one has the property to sublime, noshader or sand?

3. Distillation

Fig.5.11: The process of distillation is used in an oil refinery to get petrol.

Mixtures can be separated with another method called distillation if the components of the mixture have different boiling points. **Distillation** is the method by which two or more liquids in solution are separated by boiling off the liquid with the lower boiling point and condensing it in another container.

Doctors use distilled water for injections. In some countries like Kuwait and Saudi Arabia, sea water is passed through the process of distillation to get drinking water.

Crude oil is a mixture of different chemicals such as petrol, tar, oil, dissolved gases and kerosene. In an oil refinery the method of distillation is used to separate components of crude oil.

Activity 5.7

You will need: large bowl, small glass, tape, plastic sheet, small stone, water, salt

Procedure

1. Take some mixture of salt and water in a large bowl.
2. Take an empty small glass and put it in the bowl. The top of the glass should be higher than the saltwater.
3. Cover the top of the bowl with a plastic sheet (use tape).
4. Put a small stone right in the centre of the plastic sheet, over the glass. The stone will weigh the plastic down and help you to collect the distilled water.
5. Put the apparatus in bright sunshine for a few hours to distill water from the solution.
6. Take the plastic sheet off and taste the water that's collected in the glass. Do you think it's salty or fresh?

Can you explain the process of separating water from the mixture of salt and water?

4. Paper Chromatography

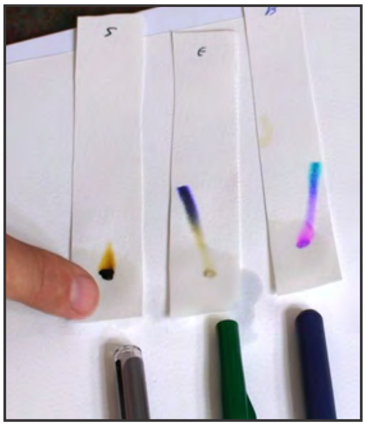


Fig.5.12: Chromatography works to separate different dyes in inks.

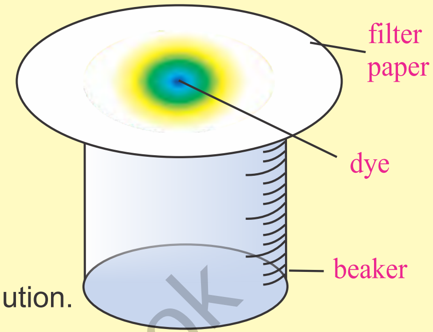
Dyes and inks are mixed to make the colours for food, clothes and pens. We can use a method called chromatography to find if the colour in the ink of a pen is a pure dye or a mixture of dyes.

Chromatography is the separation of coloured chemicals. It works because some components of a mixture are more soluble than others.

In paper chromatography special paper is used to separate the coloured components in a mixture. Chromatography only works for soluble dyes, like that in food and pen, not the dyes in clothes. The most soluble dyes move faster on a filter paper than less soluble dyes (Fig. 5.12).

Activity 5.8

You will need: a beaker; a medicine dropper; a filter paper; solution of a dye or ink



Procedure

1. Place a filter paper on the beaker.
2. Put a drop of ink in the middle of the filter paper.

Soon you will see different bands of colour on the filter paper.

Each band shows the presence of a different component of the solution.

Things to think: Why do bands of colours appear on the filter paper?

Safety in Science

You need to be careful when doing science activities. Here are some safety tips to remember:

- Listen to your teacher's instructions carefully.
- Read each activity carefully.
- Never taste or smell materials unless your teacher tells you to do.
- Handle scissors and other sharp things carefully.
- Keep your work place neat and clean.
- Tell your teacher at once if you see something that looks unsafe.
- Wash your hands well after each activity.

Chapter Review

1. Atoms are the building blocks of matter.
2. The simplest form of matter is called element.
3. Symbols are used to represent elements.
4. Elements are classified into: i. metals ii. non-metals
5. We use metals and non-metals according to their physical properties.
6. Elements combine chemically to form compounds .
7. When substances mix without showing chemical change, a mixture is formed.
8. Air is a mixture of gases.
9. Filtration, sublimation, distillation and paper chromatography are the methods of separating components of mixtures.

Test Preparation

1. Write proper term/word against each statement.

i. Building blocks of matter ______________

ii. The matter consisting of only one kind of atoms ______________

iii. The process of separating components of a mixture having different boiling points ______________

iv. The separation of coloured chemicals ______________

v. A solid changes into vapours without becoming a liquid ______________

2. Encircle the letter of the best answer.

i. When elements are joined chemically in a compound, they:
   (a) loose their original properties
   (b) keep their original properties
   (c) become a mixture
   (d) become another element

ii. Which of the following does not describe elements?
   (a) all the particles are alike
   (b) canjoin together to form compounds
   (c) can be broken down into simpler substances
   (d) have particular properties

iii. Which substance is a compound?
   (a) carbon
   (b) chlorine
   (c) sodium chloride
   (d) sodium

iv. Which process can be used to separate salt from the mixture of salt and water?
   (a) filtration
   (b) sublimation
   (c) paper chromatography
   (d) distillation

v. How can you see the colours of chemicals present in bright-coloured chocolate beans?
   (a) by distillation
   (b) by sublimation
   (c) by paper chromatography
   (d) by filtration

3. Answer the following questions in detail.

i. Relate physical properties of metal elements with their uses.

ii. Define and explain compounds.

iii. What do you know about sublimation and distillation?

iv. Define paper chromatography and explain it with the help of an activity.

v. Write symbols of the following elements:
   potassium, nitrogen, sodium, gold, mercury, silver

4. Extend your thinking.

i. Why is water said to be a compound instead of an element?

ii. Explain why salt cannot be removed from a saltwater mixture by pouring the mixture through a filter paper.

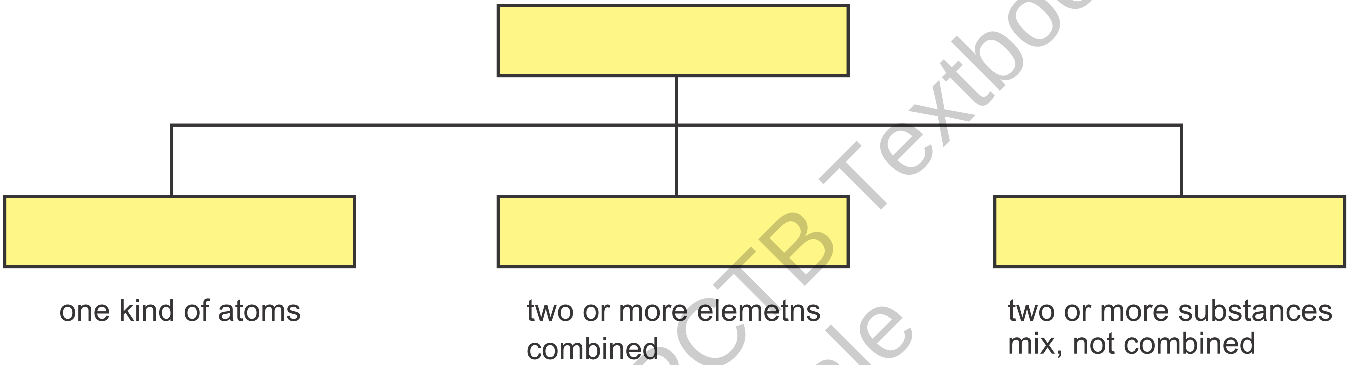
iii. Describe a procedure to separate a mixture of salt, finely ground pepper and pebbles.

iv. If we try to separate the parts of a material and cannot, does this means that the material is an element? Explain why.

5. Concept Map

Complete the concept map using following words.

element, substance, mixture, compound



Science Projects

1. Cut a strip of paper from a filter paper. Use tape to wrap one end around a pencil so that the other end will just touch the bottom of a clear plastic cup. Using a water soluble black marker, make a small dot in the centre of the strip. Pour water in the cup. Keep the pencil with filter paper strip carefully on the cup so that the strip end just dip in the water. What happened as the filter paper absorbed the water? What colours were mixed to make black ink?

2. Can you identify baking soda and powdered sugar? Put some amount of each compound in two clear plastic cups. Pour some amount of vinegar to each cup. Baking soda reacts with vinegar, while powdered sugar does not. Which of these compounds is baking soda and which is sugar?

Alloy formation is an interesting property of metals. An alloy is a solid solution of metals or non-metals dissolved in metals. Brass is an alloy of the metal zinc dissolved in copper. Steel is an alloy made of the non-metal carbon and other elements dissolved in iron. Some people use this property of metals to earn unlawful money. Investigate the people who use this property of metals illegally.

Computer Links

- http://www.docbrown.info/page01/ElCpdMix/EleCmdMix.htm
- http://www.hometrainingtools.com/mixtures-compounds-science-explorations-newsletter/a/1214/

Chapter
6

Air

Air is a matter that has mass and occupies space.

Student Learning Outcomes

After completing this chapter, you will be able to:

- Recognize the importance of air.
- Identify the composition of air.
- Relate the properties and uses of gases in air with the composition of air.

Air and its Importance

Air is a mixture of gases. Air is present everywhere. Even in water and soil, air is present. Air covers the Earth like a thick blanket. This blanket of air is called the **atmosphere.**

Many layers of air are present in the atmosphere. Scientists have divided the atmosphere into four layers (Fig.6.1). These are troposphere, stratosphere, mesosphere and thermosphere.

Each layer of the atmosphere mixes with the layer above. Only the lowest layer of the atmosphere has enough air to support the life. Troposphere starts at Earth's surface and goes up about 8 kilometres to 16 kilometres above the surface. Most weather conditions happen in this layer.

As we go up through the layers of the atmosphere , temperature and air pressure change. Air pressure decreases as we go up.

Air is very important to us:

- We breathe in the air. We can't live without it.
- Air is needed for burning.
- We pump air into footballs, balloons and tyres of our vehicles.
- In our homes, we use air pressure to draw dust into the bag of vacuum cleaner.
- Fish and other animals in water use the air dissolved in water for respiration.
- Plants use air (carbon dioxide) to make their food.

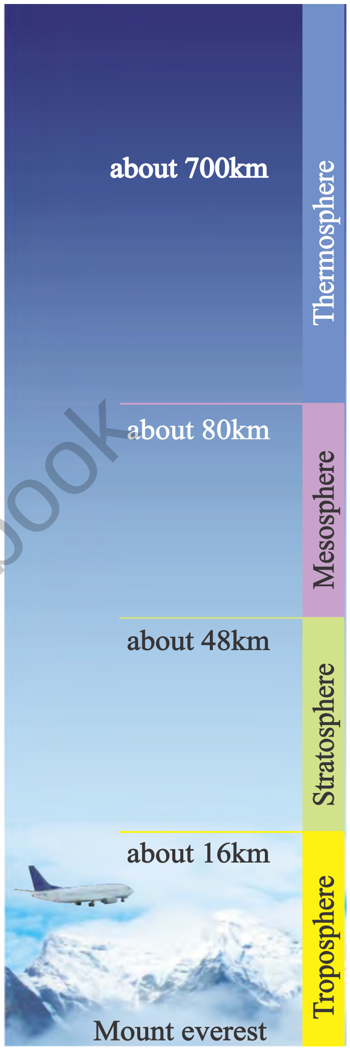


Fig.6.1: Layers of atmosphere

> Moving air is called **wind.** Differences in air temperature create winds. Winds can move slow or fast. Wind comes from different directions. A **wind vane** shows wind direction. Scientists make forecasting about weather with the help of a wind vane.

Composition of Air

We know that air is a mixture of different gases. Major gases in the air are:

- About 78 percent of the air is **nitrogen** gas.
- About 21 percent of the air is **oxygen** gas.
- About 0.03 to 0.04 percent of the air is **carbon dioxide** gas.
- Remaining air contains **rare gases** like helium and argon.

Some amount of water vapours, ozone, smoke and dust particles are also present in air.

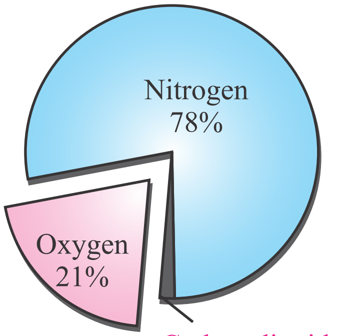


Fig.6.2: Air is a mixture of gases.

Properties and Uses of Gases in the Air

Nitrogen

Nitrogen is the major part of the air. It is a colourless gas. It has no taste or smell. It is slightly soluble in water. Nitrogen does not burn and does not support the process of burning. Actually, it is not a very active gas.

Fig.6.3: Nitrogen is present in some medicines.

Uses of Nitrogen

1. Nitrogen is used to preserve freshness offoods.
2. As nitrogen does not burn, it is used in explosive storage tanks.
3. Nitrogen is used in light bulbs to prevent the filament from burning up.
4. Fertilizers like ammonia, urea, ammonium sulphate, contain nitrogen. These fertilizers increase the fertility of land.
5. Nitrogen is used in dyes, medicines and explosives.
6. Presence of nitrogen in the air reduces the process of rusting of iron.
7. Liquid nitrogen is used as a coolant for freezing of blood and large computer systems.

Do you know? Presence of nitrogen slows down the process of burning. If there was be mostly oxygen in the air, even small fires would have caused great damage.

Oxygen

Second major gas of the air is oxygen. It is a colourless gas. It has no smell. Oxygen is slightly soluble in water. It is very active gas. Oxygen does not burn. But it helps in burning and rusting of iron.

Uses of Oxygen

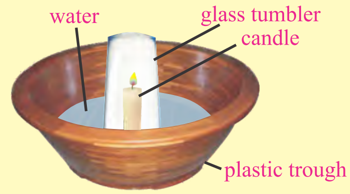
Fig.6.4: Oxygen is used in the flame of welding.

1. All the living organisms use oxygen for respiration.
2. It is essential for burning of wood, coal and natural gas.
3. It dissolves in water. Due to this property animals and plants breathe in the water.
4. Some patients of lungs and heart diseases need oxygen in hospitals.
5. It is used in welding and cutting of metals.
6. Rockets use liquid oxygen during their space journeys.
7. Mountain climbers, sea divers and astronauts carry oxygen in cylinders for breathing.

Do you know? One tree produces as much oxygen which can fulfil the needs of 36 children.

Activity 6.1

You will need: plastic trough a candle a glass tumbler matchbox water



Procedure: 1. Fix a candle in a plastic trough.
2. Pour some water in the trough. 3. Light the candle.
4. Invert a glass tumbler over the candle.

You will see that the candle continues burning for sometime and then puts out. The water rises in the glass to some extent.

Things to think: Why does the flame go off ? Why has water risen in the glass tumbler?

Carbon Dioxide

The amount of carbon dioxide in air is less than one percent. It is a colourless gas. It has no smell but a sour taste. It is slightly soluble in water but its solubility increases under high pressure. It is heavier than air. It can turn lime water milky. Carbon dioxide does not burn. It also does not support the burning process.

Fig.6.5: Carbon dioxide makes the cake fluffy.

Uses of Carbon dioxide

1. All green plants absorb carbon dioxide from the air to make food.
2. Carbon dioxide is filled in soda water bottles under some pressure.
3. A fire extinguisher releases carbon dioxide to put out fires.
4. When the cake is baked, bubbles of carbon dioxide are given out. These bubbles cause the cake to rise and become fluffy.
5. Carbon dioxide is easily frozen into its solid form which is called dry ice. The dry ice is used to preserve the food.

Do you know?

Dry ice is crushed into powder. This powder is carried high up in the clouds by an aeroplane. The dry ice is sprinkled on the clouds which fall as rain. This process is done in an Australian desert.

Activity 6.2

You will need: lime stone a basket a brush water

Procedure

1. Take some lime stone in the basket. Pour as much water in the basket, so that all the lime stone sinks in it.
2. After one hour apply the lime water on a wall with the help of brush.

What colour do you see on the wall? After some time the lime water absorbs carbon dioxide from the air. What colour do you see now?

Rare Gases

Rare gases include argon, neon, helium, etc. They do not react with other elements. They do not cause burning. They are present in rare amounts in air.

Uses of Rare Gases

1. Argon is used in electric bulbs and fluorescent lamps.
2. Neon is used in colourful advertisement lights.
3. Helium is a very light gas. It is filled in weather balloons.

Water Vapours

Very small amount of water vapours is also present in air. But the amount of water vapours in the air changes with changing weather. Heavy amount of water vapours in the air causes rain. Water vapours in the air control the rate of evaporation from plants and animals. The presence of water vapours in air sometimes produces **smog** which is a combination of smoke and fog.

Activity 6.3

You will need: a glass tumbler pieces of ice

Procedure

1. Wipe the outer surface of the glass tumbler with a dry cloth.
2. Fill the tumbler with pieces of ice.

What do you see on the outer surface of the tumbler?

Things to think: From where does the water come on the outer surface of the tumbler?

Dust Particles

Smoke and dust particles are also present in the air. We can see dust particles in the air.

Close all the doors and windows of your room during a sunny day. Let the sunlight enter the room through a small hole and see the dust particles.

Chapter Review

1. Air is present everywhere.
2. Atmosphere is the blanket of air around the Earth. It has four layers.
3. All organisms respire in air.
4. Air is a mixture of different gases.
5. Nitrogen and oxygen are major constituents of air.
6. Nitrogen is not a very active gas.
7. Oxygen is a very active gas.
8. Carbon dioxide is used in photosynthesis.

Test Preparation

1. Write proper term/word against each statement.

i. The layer of the atmosphere that supports all life ________________

ii. The gas that makes up the largest part of air ________________

iii. The gas that makes up about 21% of air ________________

iv. A gas which is filled in soda water bottles ________________

2. Encircle the letter of the best answer.

i. Thick blanket of air around the Earth is:
(a) Earth cover (b) atmosphere
(c) wind (d) Earth's coat

ii. We can produce a lot of urea fertilizer because:
(a) There is oxygen in the air.
(b) There is a lot of nitrogen in the air.
(c) There is carbon dioxide in the air.
(d) There is water in the air.

iii. During their space journeys , rockets use:
(a) liquid oxygen (b) liquid nitrogen
(c) liquid hydrogen (d) liquid carbon dioxide

iv. We want our bun to be fluffy. Which gas can help us?
(a) nitrogen (b) oxygen
(c) carbon dioxide (d) helium

v. Percentage of $C0_2$ in air is about:
(a) 0.01 -0.02% (b) 0.03 -0.04%
(c) 0.02 -0.04% (d) 0.06 -0.08%

vi. Which gas is considered as life supporting?
(a) argon (b) nitrogen
(c) hydrogen (d) oxygen

3. Answer the following questions in detail.

i. What is the atmosphere? How is air important for us?
ii. Write some uses of oxygen in our daily life.
iii. Write some properties of carbon dioxide .

4. Extend your thinking.

i. How would air composition change if there were no plants?
ii. When an empty glass is inverted vertically into a tub of water, the water does not enter the inverted glass. Why do you think this is so?

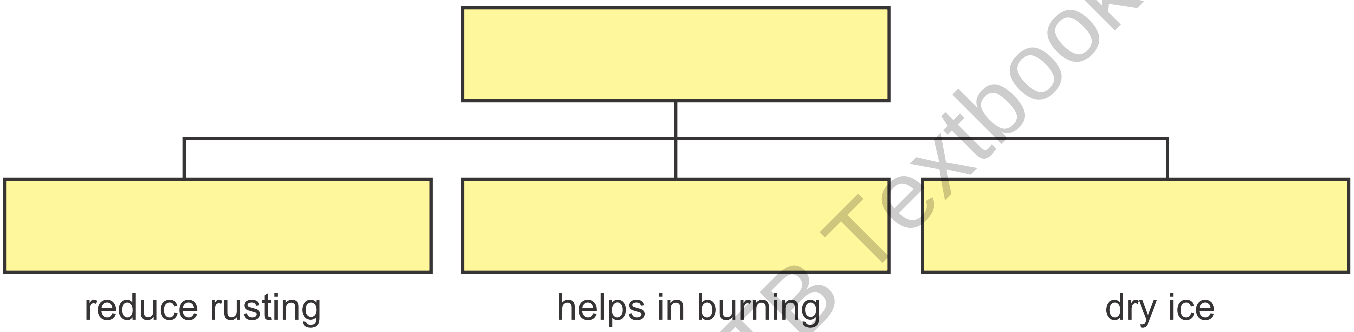
iii. Why is carbon dioxide important for survival of life on Earth? Name one other gas in Earth's atmosphere and explain its importance to living things.

iv. Based on what you have learnt, can you give three ways in which oxygen and nitrogen are the same and two ways in which they are different?

5. Concept Map

Fill the concept map using following words:

carbon dioxide oxygen air nitrogen



Science Projects

1. A pile of books can be lifted with air. Place a plastic bag (fitted with a valve) on the table. Place four books on it. Blow the air in the plastic bag. Observe what happens.

2. Tape four equal lengths of string to the corners of a square polythene sheet. Tie the strings to a small doll. Drop the parachute from a height. The parachute floats down smoothly. It comes down due to the force of gravitational attraction. Why does it come down slowly?

When percentage of carbon dioxide increases in the atmosphere, it increases the temperature of the Earth. This behaviour of carbon dioxide is called **greenhouse effect.** The greenhouse effect is important. Without the greenhouse effect, the Earth would not be warm enough for humans to live. But if the greenhouse effect becomes stronger, it could make the Earth warmer than usual. Even a little extra warming may cause problems for humans, plants, and animals. How can we decrease the greenhouse effect?

Computer Links

- http://www.docbrown.info/page01/ElCpdMix/EleCmdMix.htm
- http://www.hometrainingtools.com/mixtures-compounds-science-explorations-newsletter/a/1214/

Chapter 7

Solutions and Suspensions

Ink in your pen and printing inks are solutions.

Student Learning Outcomes

After completing this chapter, you will be able to:

- Differentiate between solute, solvent and solution.
- Identify solute and solvent in a solution.
- Explain the formation of solution by the particle model.
- Distinguish between aqueous, dilute and concentrated solutions.
- Demonstrate the use of water as a universal solvent.
- Prepare saturated and unsaturated solutions.
- Define solubility.
- Investigate the effect of temperature on solubility using a variety of compounds.
- Differentiate between solutions and suspensions.
- Identify uses of solutions and suspensions in daily life.

When dirt and water make a mixture, the dirt will slowly settle to the bottom. When solid sugar dissolves in a glass of water to make a mixture, the sugar will not settle to the bottom. The sugar and the water mix so completely that the solid sugar seems to disappear. Every part of this mixture is exactly the same as every other part. This is a special kind of mixture. We will discuss it in this chapter.

Solution and its Components

We know that many solids dissolve when they are put into liquids. When something dissolves, it forms a solution. A **solution** is a homogenous mixture of two or more components. The mixture of salt and water is a solution. We use many solutions everyday.

All solutions are the mixture of two or more substances. The substance in less amount is called **solute.** The substance in which solute is dissolved is called **solvent.** The solvent is always more in quantity than a solute. Can you explain solute and solvent in a solution of salt and water?

Fig.7.1: When salt mixes in the water, a solution is formed.

Solvent + Solute ⟶ Solution

Types of Solutions

The most common types of solutions are those in which a solid, liquid or gas dissolves in a liquid. However, other types of solutions are also found.

Table 7.1: DIFFERENT TYPES OF SOLUTIONS

State of Solute	State of Solvent	Examples of Solutions
Solid	Liquid	Salt solution, lemonade, tea
Liquid	Liquid	Ink in water, alcohol in water
Gas	Liquid	Carbonated drinks (carbon dioxide dissolved in water) River water (oxygen dissolved in water)
Gas	Gas	Air (mixture of many gases)
Solid	Solid	Brass (mixture of zinc and copper), bronze (mixture of copper and tin)

Do you know? The sea is the world's largest solution. Many salts are dissolved in sea water.

Aqueous Solution

Water is the most common solvent in the world . It can dissolve many things in it and forms solutions. However, grease, paint and fats do not dissolve in water. A solution in which water is the solvent is known as an **aqueous solution** (aqua means water). Can you name a few aqueous solutions?

Particle Model of Solution

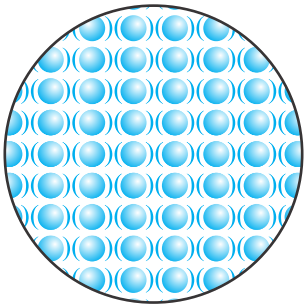


Fig.7.2: The particles of matter are in motion all the time.

We know that matter consists of tiny particles. These particles show special behaviour. A particle model explains the behaviour of particles of matter.

The matter is made of tiny particles.

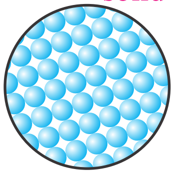
Particles of matter are in constant motion.

There are forces of attraction between particles.

There are spaces between the particles. On heating, the particles start moving faster.

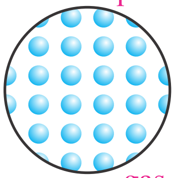
Matter exists in three states, i.e. solid, liquid and gas. We can explain states of matter inthe light of particle model.

1. Solid



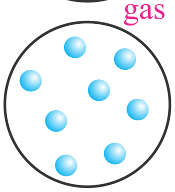
Particles in a solid are held together strongly. There are very little spaces among them. Particles do not move freely. They only vibrate in their fixed position. That is why, a solid has a fixed shape and fixed volume.

2. Liquid



Particles of a liquid are less close to each other than a solid. Spaces among the particles are greater than solids. Particles move freely and collide each other. But, particles do not leave the liquid. That is why, a liquid has fixed volume but no fixed shape.

3. Gas



There are large spaces among the particles of a gas. Particles move freely in the space they have. Particles may leave the gas, if it is not enclosed in a container. That is why, a gas has no fixed shape or volume.

We can explain the formation of solution in the light of particle model of matter. When we dissolve salt in water, forces of attraction between salt particles become weak. These particles of the salt spread among the spaces between water molecules. It is because of the constant motion of particles of water. Every part of the solution becomes same.

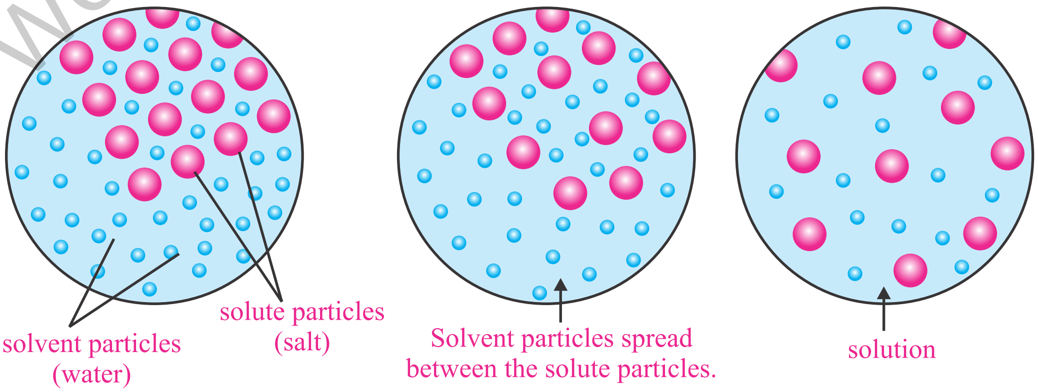


Fig. 7.3: Particles of the solute spread evenly throughout the solvent and form solution.

Liquid-liquid solution can also be explained in the light of particle model. When two liquids are mixed, their particles spread among the spaces between particles of each other. In this way a homogenous solution is formed. For example, lemon juice makes solution with water. Some liquids do not make solution. Their particles do not spread among the spaces between particles of each other. For example, oil does not make solution with water.

The temperature affects the movement of molecules . The greater the temperature, the faster the particles move.

Water as a Universal Solvent

Most of the things dissolve in water easily. We can say that water is a very good solvent.

Fig.7.4: Aquatic animals use oxygen dissolved in water.

- Sugar, rock salt and sodium bicarbonate (meetha soda), etc. dissolve in water.
- Milk, alcohol, lemon juice, vinegar and apple juice dissolve in water.
- The food we eat forms a solution in the body and then absorbs in the blood.
- Many harmful substances are produced in our body. These substances dissolve in water and excrete as urine and perspiration .
- Plants absorb minerals from the soil that are dissolved in water.
- Oxygen gas dissolves in water. It keeps aquatic animals alive (Fig.7.4).
- Carbon dioxide gas also dissolves in water. Aquatic plants use this dissolved carbon dioxide to make food.

Therefore, we can say that water is not just a solvent but a **universal solvent.**

Point to think!
Why are more impurities dissolved in water?

Activity 7.1

You will need: ✲ 6 glass tumblers ✲ water ✲ table salt ✲ sugar ✲ sodium bicarbonate (meetha soda) ✲ lemon juice ✲ carrot juice ✲ milk

Procedure

1. Take water in all the six glass tumblers.
2. Dissolve the above given things, one in each glass tumbler.

All the given things dissolve in water.

What would you conclude about the water as a solvent?

Dilute and Concentrated Solution

A solution with less quantity of a solute is called a **dilute solution.** A solution with more quantity of solute is called a **concentrated solution.**

Dilute ⟷ Concentrated

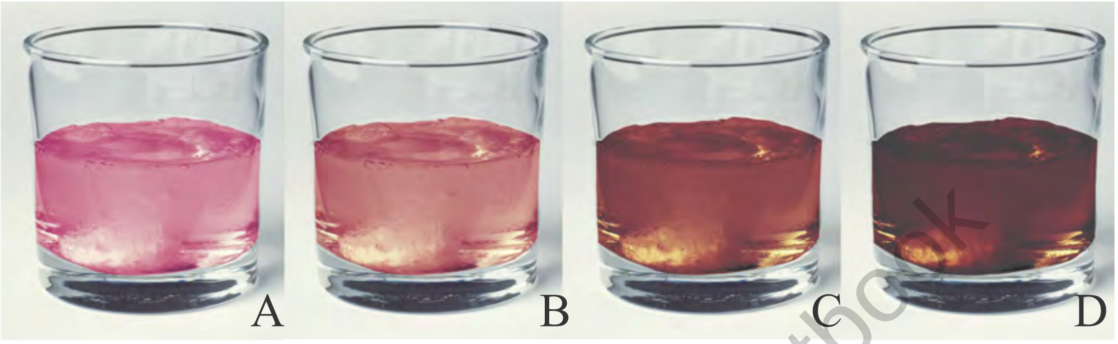


Fig.7.5: The solution with light colour (A) is a dilute solution as it contains less amount of solute. What about the solution with dark colour (D)?

Activity 7.2

You will need: ✲ 2 glass tumblers ✲ sugar ✲ a spoon ✲ water

Procedure

1. Take equal amount of water in two tumblers.
2. Add one spoon full of sugar in one tumbler and three spoons full of sugar in second tumbler. Mix the sugar well in the water.
3. Taste the solutions of both the tumblers.

Things to think: Why is the solution of second tumbler sweeter than the solution of the first tumbler? Which solution is dilute and which one is concentrated?

Saturated and Unsaturated Solutions

A solution in which the solvent cannot dissolve any more solute at a particular temperature is called a **saturated solution.**

We know that sugar dissolves in water to form a solution. If you keep on dissolving sugar in a glass of water, a stage will come when no more solute is dissolved in the solution, but settles down. You have made a **saturated solution.** But remember, do not change the temperature. Can you give the name **unsaturated solution** to that solution in which you can dissolve some more amount of solute?

Do you know?

The Dead Sea is highly saturated with salts. These salts become crystals at slight decrease in temperature. Due to this property of The Dead Sea, things do not sink in it.

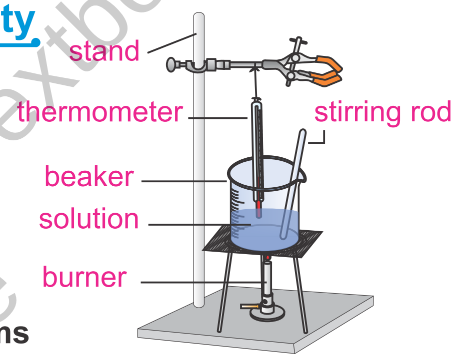
Activity 7.3

You will need: ✲ a glass tumbler ✲ table salt ✲ a spoon ✲ water

Procedure

1. Take some amount of water in a tumbler.
2. Add half spoon full of table salt to the water and mix it well.
3. Keep on adding table salt to the solution until the table salt starts settling down at the bottom of the tumbler. This is the saturated solution of table salt at room temperature.
   Can you dissolve any more table salt to the solution at this temperature?
4. Prepare a saturated solution of table salt at room temperature. Also illustrate that more solute dissolves in hot water than in cold water to make a saturated solution.

Solubility and Effect of Temperature on Solubility



We can dissolve 24 grams of crystals of blue copper sulphate in 100 grams of water at room temperature to make saturated solution. But we have to dissolve 36 grams of table salt in 100 grams of water at room temperature to make it saturated solution. The difference is due to the different solubilities of these salts.

The amount of solute in grams dissolved in 100 grams of the solvent at a given temperature is called its solubility at that temperature.

Take 100 grams of water in a beaker and make a saturated solution of sodium chloride (table salt) at room temperature (Fig.7.6). Start heating the solution on a spirit lamp. Now add some more salt in the solution and stir it. You will see that more amount of salt is dissolved in this hot solution. It means the solubility of a solute increases with increase in temperature.

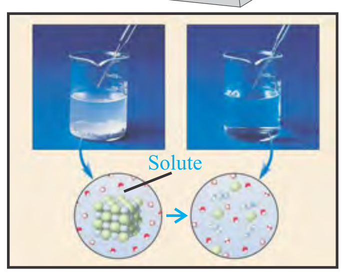


Fig.7.6: Mixing and heating increase solubility of copper sulphate in water.

We have learnt that 24 grams of copper sulphate dissolve in 100 grams of water at room temperature (25°C). At 60°C, 60 grams of copper sulphate will dissolve to make saturated solution. You can say that the solubility of copper sulphate is 24 grams at 25°C and 60 grams at 60°C.

It is interesting that the solubility of gases in liquid solvents decreases with increasing temperatures.

Activity 7.4

Take a 100 grams of water in a glass tumbler or beaker. Take 100 grams of table salt and start it dissolving in the water bit by bit and stir the solution constantly. After some time no more salt will be dissolved. A saturated solution at room temperature is prepared. Now weigh the remaining amount of salt to calculate the solubility of the table salt at room temperature.

Some Uses of Solutions

When sugar and water are mixed in such a way that sugar is dissolved evenly through the water, a **solution** is produced. We use many kinds of solutions.

1. Carbonated water is a solution of carbon dioxide gas and other substances dissolved in water. When we shake a can of carbonated water, the gas separates quickly from the water. In a closed can, the bubbling gas has no place to go. It builds up pressure. When you open the can, the gas escapes.
2. We use lemonade and tea in our homes. These are solutions too.
3. The air is a solution of different gases. We breathe in this solution.
4. The steel used for buildings and cars is a solution. A solution of two or more metals is called **alloy.** During the process of making steel, carbon and iron are melted into liquid form. Then the carbon is dissolved in the iron.
5. In the ocean, salt and other minerals are dissolved in water. Ocean water is a solution.


Fig.7.7: Lemonade and stainless steel are solutions.

Point to think!
Your gold is an alloy made from equal parts of copper and silver combined with a greater amount of gold. Identify each component of yellow gold as a solute or solvent.

Suspensions and Their Uses

When powdered chalk and water are mixed, a suspension is produced. The chalk spreads evenly through the water on shaking. When you stop shaking, the chalk settles down. This suspension has milky appearance because the chalk particles are visible.

A mixture in which the solute particles are too large to move freely with solvent particles and the particles settle down after some time, is called a suspension.

A suspension can be separated by passing it through a filter. The liquid or gas passes through, but the filter paper traps the large solid particles.

Here are some examples of suspensions:

Mixing soil in water forms a suspension.

Fig.7.8: Some medicines are available in the suspension form.

Lassi is a form of suspension.

Fruit squashes are examples of suspensions.

Lassi is a form of suspension.

Fruit squashes are examples of suspensions.

Stirring up the bottom of a river or a lake produces a suspension. After some time, the sand or soil again settles down.

Blood is a suspension. Red blood cells, white blood cells and platelets are suspended in a solution called plasma.

A suspension which contains a large amount of insoluble solid solute is called **slurry.** The runny paste of cement mixed with water is an example of slurry.

Fig.7.9: Algae in water is an example of suspension.

Table 7.2: Properties of Solutions and Suspensions

Solutions	Suspensions
1. Particles of solute do not settle out.	1. Particles of solute settle down on standing.
2. Particles pass through ordinary filter paper.	2. Particles can be separated by ordinary filter paper.
3. Light rays do not scatter on passing through the solution.	3. Light rays scatter on passing through the suspension.

Chapter Review

1. A solution is a homogenous mixture of two or more components.
2. Aqueous solution is the solution inwhich water is the solvent.
3. Water is a universal solvent because many things dissolve in it.
4. A concentrated solution contains relatively more quantity of solute.
5. No more solute is dissolved in a saturated solution at particular temperature.
6. Solubility is the amount of solute in grams dissolved in 100 grams of the solvent at a given temperature.
7. When particles of solute remain suspended in the mixture, the mixture is called suspension.

Test Preparation

1. Write proper term/word against each statement.

i. A substance in a solution that is dissolved ____________________

ii. A solution in which no more solute is dissolved ____________________

iii. A substance that takes in, or dissolves the other substance ____________________

iv. A solution with less quantity of solute ____________________

2. Circle the letter of the best answer.

i. A solution that contains a large amount of solute is best described as:
   (a) unsaturated (b) dilute
   (c) concentrated (d) weak

ii. We make a solution when we mix:
   (a) salt and water (b) sugar and cinnamon
   (c) vegetables in a salad (d) cheese sauce and macaroni

iii. Which of the following increases the solubility of a gas in a liquid?
   (a) increasing the temperature (b) stirring
   (c) decreasing the temperature (d) decreasing the amount of liquid

iv. Particles settle down in a:
   (a) solution (b) suspension
   (c) solute (d) solvent

v. Which one is a universal solvent?
   (a) milk (b) cooking oil
   (c) petrol (d) water

3. Answer the following questions in detail.

i. Describe the particle model of solution.
ii. Prove that water is a universal solvent.
iii. What is solubility? How does temperature affect the solubility?
iv. Compare the properties of solutions and suspensions.
v. Define the solvent, solute and saturated solution.

4. Extend your thinking.

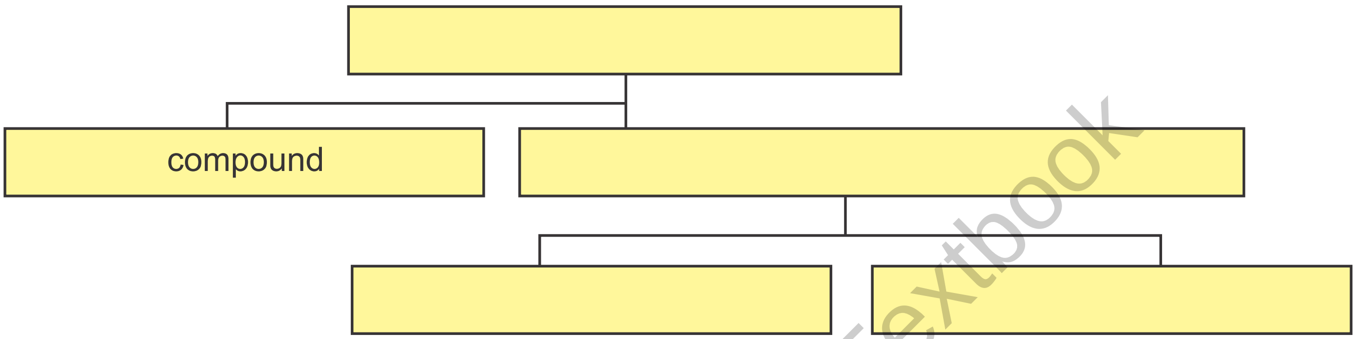
i. What makes ocean water a solution?
ii. How can you cause more solid solute to be dissolved in a liquid?
iii. Why do the words "Shake well before use" on a bottle of medicine indicate that the medicine is a suspension?
iv. Identify the solute and solvent in a solution made from 15 grams of oxygen and 5 grams of helium.
v. Even after a glass is filled to the brim with water, you can add a considerable amount of salt without making the water run over. How is this possible?

vi. Suppose you were given a bottle that had a solid and a liquid mixed in it. How could you tell whether the mixture was solution or a suspension?

5. Concept Map

Use the following terms to complete the concept map.

suspension   matter   solution   mixture



Science Projects

1. Make some lemon soda water. Get a clean bottle with a screw top. Put one teaspoonful of baking soda in the bottle and fill it half with cold water. Now pour in four teaspoonfuls of lemon juice and fasten the top quickly. Watch what happens. When the action in the bottle has stopped, pour some of the water into a glass tumbler and see what happens. What type of solution did you make?
2. Get nine pieces of cloth of the same kind and divide them into sets of three. On one piece of each set, crush green grass or leaves and rub them hard. On the second piece of each set, rub in motor oil and then soot or dirt. Rub in wet paint on the third piece of each set. Then try to get the spots out of one set by washing it in clear water, out of the second set with soap and water, and out of the third with the turpentine–a solvent. Explain what happens.

Many mixtures appear to be solutions but do not have their characteristics. Milk is not a solution, even though it looks like one. If ordinary milk stands for a long enough, the cream in it rises to the top. Many medicines, such as remedies for upset stomach, are suspensions. The directions on the label tell you to shake the bottle well before use. Why must you shake the bottle? What problem could arise if you don't?

Computer Links
- http://www.800mainstreet.com/9/0009-001-mix-solut.html
- http://www.lcc.ukf.net/KS3Chem/mixtures.htm

Chapter 8

Energy and Its Forms

The Sun is the ultimate source of energy on Earth.

Student Learning Outcomes

After completing this chapter, you will be able to:

- Explain that energy provides the ability to do work and can exist in different forms.
- Identify different forms of energy with examples.
- Differentiate between kinetic and potential energy.
- Demonstrate how one form of energy can be converted into other form of energy.
- Identify that energy is dissipated in atmosphere.
- Explain that energy is conserved during conversion of different forms of energy.
- Explain the importance of energy in improving the quality of life.
- Identify energy converters in your surroundings.
- Illustrate energy conversion to other forms using an energy converter.
- Explain the term renewable.
- Describe the advantages of using renewable energy sources.
- Describe the form of energy stored in the human body.
- Identify energy transfer in an environment.

Energy

Energy makes change possible. We use it while doing things. It moves cars along the road and boats over the water. It cooks our food and keeps ice frozen in the freezer. It plays our favourite songs on the radio and lights our homes. Energy is needed for our bodies to grow. Scientists define energy as:

Energy is the ability to do work.

Fig.8.1: The horse uses energy to run.

Forms of Energy

Energy is found in different forms such as light, heat, chemical energy, etc. We can put all the forms of energy into two categories: potential and kinetic.

1. Potential Energy

Potential energy is the energy that is stored in an object due to its position. It is written as P.E.

When we stretch a rubber band or lift a stone to some height, energy is stored in these objects. This energy is called potential energy (Fig.8.2).

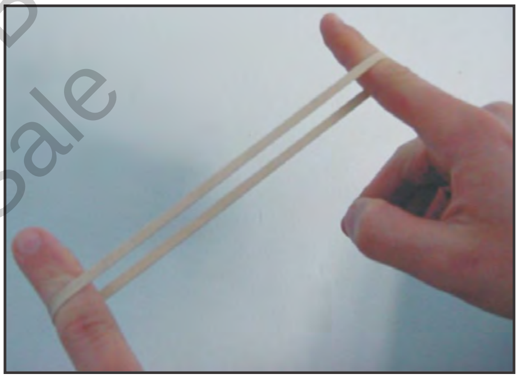


Fig.8.2: A stretched rubber band possesses potential energy.

A brick on the ground cannot do any work. But when we raise the same brick, energy is stored in it. The brick can do work due to the potential energy.

The energy in the wound up spring of a toy car is potential energy. This energy can cause the toy car to move.

When we put a stone in the sling of a catapult and stretch its rubber, potential energy stores in it. This energy can throw away the stone (Fig.8.3).

The hands of a mechanical watch move due to the potential energy stored in its spring.

There are several different forms of potential energy.

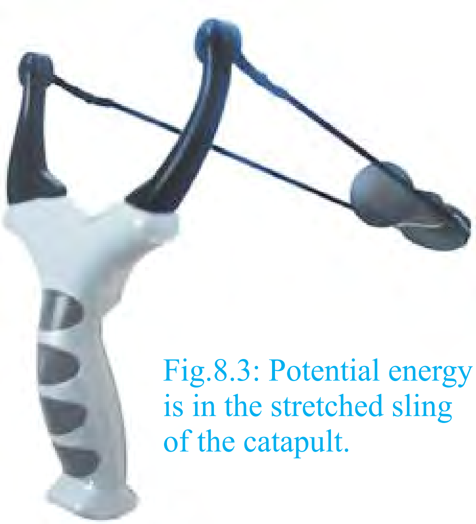


Fig.8.3: Potential energy is in the stretched sling of the catapult.

Chemical Energy

Chemical energy is a form of potential energy. It is stored in food, batteries and fuels such as coal, petrol and natural gas.

Food, fuels and batteries release chemical energy as a result of chemical reactions.

Stored Mechanical Energy

Mechanical energy is the energy stored in the objects by the application of force. Compressed springs and stretched rubber bands possess stored mechanical energy.

Gravitational Energy

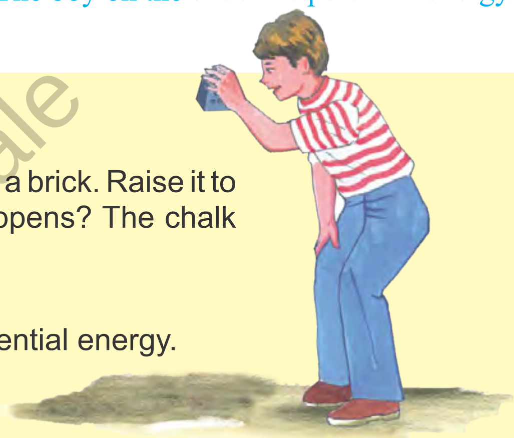
Gravitational energy is the energy stored in an object due to its height. When we raise a brick up to some height, it possesses gravitational energy.

Nuclear Energy

Nuclear energy is the energy stored in the nucleus of an atom. Very large amount of energy can be released when a nucleus of an atom splits.

Fig.8.4: The boy on the slide has potential energy.

Activity 8.1



Take a few pieces of chalk and put them on the ground. Take a brick. Raise it to a certain height and drop it on the chalk pieces. What happens? The chalk pieces break into smaller pieces.

What do you learn from this experiment?

A raised brick is able to do work because it possesses potential energy.

2. Kinetic Energy

Energy in a body due to its motion is called **kinetic energy.** A moving bus and running tap water possess kinetic energy. It is written as K.E.

The amount of kinetic energy depends on the mass of the object and its speed. A train has more kinetic energy than a car moving at the same speed.

The world is full of movement. Moving objects have kinetic energy. The moving air or wind has kinetic energy. It can move leaves and twigs of trees.

Flowing water in a river can move things in it. It has kinetic energy. There are several other forms of energy.

Fig.8.5: The flowing water causes the boat to move.

Heat Energy

Heat is a form of energy. It is the movement of particles within the substance. When we heat up an object, its particles move and collide faster. Heat can move from one place to the other. Heat cooks our food. It changes solids into liquids and liquids into vapours. The Sun is a major source of heat for us.

Light Energy

Light is a form of energy. The Sun is the major source of light for us. Light helps plants to make food. Some calculators use light energy to work. The light passing through the lens of a camera makes an image on the film.

Fig.8.6: The fan uses electrical energy.

Electrical Energy

Electrical Energy is the movement of electrical charges. Electrical charges moving through a wire is called electricity. We use many appliances at homes which use electricity. Can you name such appliances? Lightning is another example of electrical energy.

Fig.8.7: Sound is a form of energy.

Sound Energy

Sound is also a form of energy. Sound energy is produced by the vibrating body. Place small pieces of paper on the surface of a stereo deck. The sound energy causes the pieces of paper to move. When you speak, your sound vibrates the eardrums of the listener. The energy in sound is far less than other forms of energy.

Activity 8.2

Place four empty plastic bottles on the floor in a row. Roll a tennis ball towards them. What will happen? Your rolling ball can do a work. It knocks down the plastic bottles. What form of energy is present in the rolling ball?

Conversion of Different Forms of Energy

Conversion of energy means energy changes. One form of energy can be changed into another form. Let us discuss some energy changes.

1. When we lift a toy car to the top of the ramp, potential energy is stored in it (Fig.8.8). When we let it go down the ramp, it moves and gains kinetic energy.
2. Wood, natural gas, petrol, etc. all fuels have chemical energy (potential energy). When we burn these fuels, their energy changes to light and heat energy.
3. When we switch on a bulb, the electrical energy changes into light energy.
4. We eat food. When we run, the chemical energy (potential energy) of food changes to mechanical energy.
5. Switch on the radio. Can you explain the inter-conversion of energies?

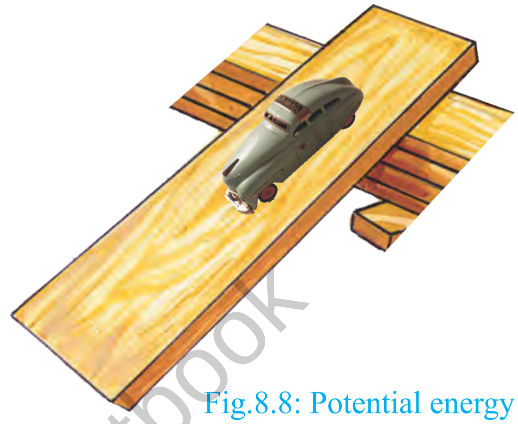


Fig.8.8: Potential energy of the toy car changes into kinetic energy.

In a kitchen

potential energy → heat and light energy

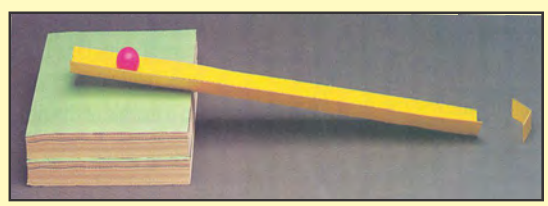
In a bus

stored energy (potential energy) —petrol→ moving energy (kinetic energy)

For a diver

stored energy (potential energy) → moving energy (kinetic energy)

Activity 8.3



You will need: ✼ a long bent piece of cardboard
✼ 3 identical books ✼ a small metal or golf ball
✼ a small piece of cardboard

Procedure

1. Raise the bent piece of cardboard by placing a book under its one end.
2. Put the ball at the top. The ball has potential energy.
3. Let the ball roll down the long cardboard to strike the small piece of cardboard. The rolling ball has kinetic energy which displaces the piece of cardboard.
4. Set the apparatus again and repeat your experiment with two books and then three books under the long cardboard.

Observe the energy of the ball when lying on the high place.

Things to think: Which type of energy has changed into the other?

Conservation of Energy

About a hundred years ago, a few scientists performed some experiments. They concluded that:

Energy cannot be made nor it can be destroyed but energy can be changed from one form to another. This fact is known as the **law of conservation of energy.**

Consider a pendulum (a hanging ball) swinging back and forth (Fig.8.9). When the ball stops for a moment at the highest point in its swing, it has no kinetic energy. The energy is all potential. When it comes down at the lowest point on its swing, its speed is greatest. Here the pendulum has no potential energy.

The energy is all kinetic. The pendulum keeps swinging, changing the forms of energy. But the total amount of energy remains constant.

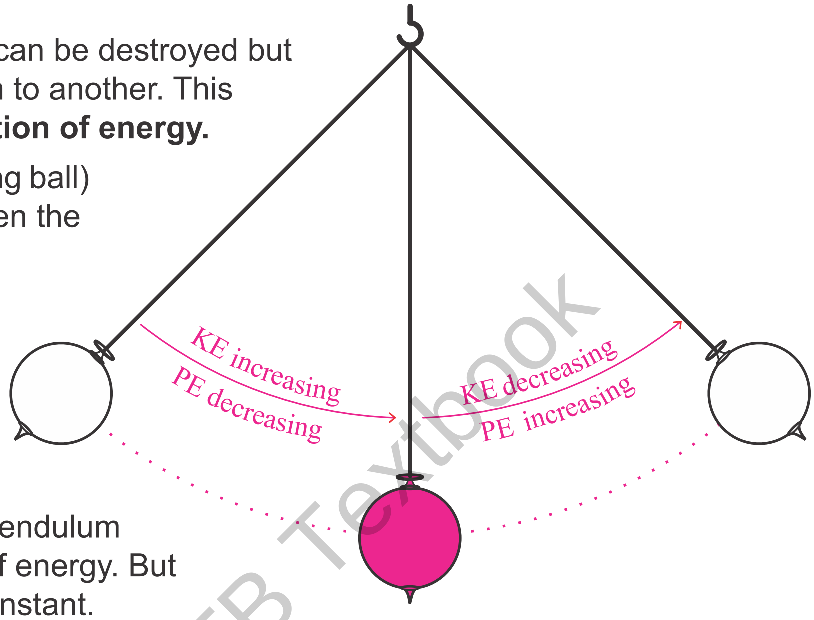


Fig.8.9: Conservation of energy in a moving pendulum

When after a long time the pendulum stops its swinging, what happens to its energy? Is this energy lost? No, according to the law of conservation of energy, the energy cannot be made or destroyed. It simply changes its form.

In case of pendulum in each swing, very small amount of its energy changes to heat energy which increases the temperature of the string and the ball. Heat dissipates in the atmosphere.

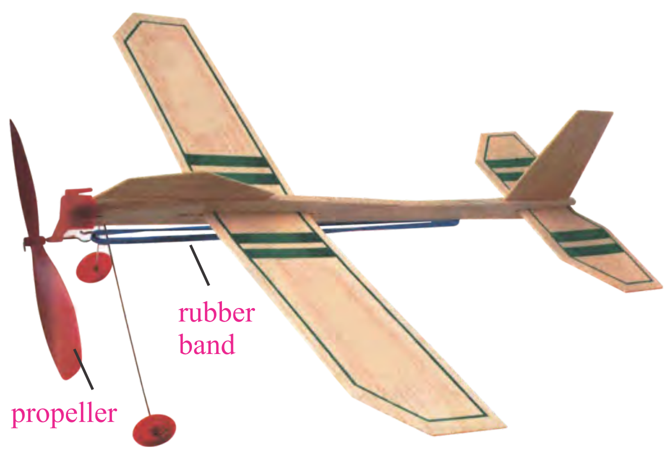


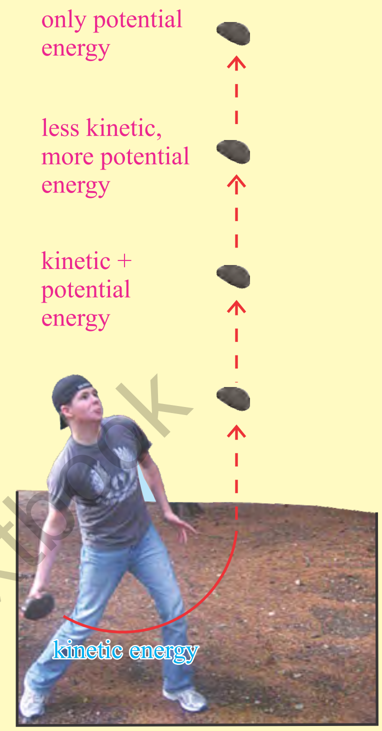
Fig.8.10: When we twist the propeller of this plane, it stretches the rubber band. The rubber band stores potential energy in it. How will this energy be transformed?

Don't be afraid. When you remove the lid of the box given to you by your friend, you are terrified when the jack-in the-box springs up. In fact a jack-in-the-box has potential energy stored in it.

Activity 8.4

- Lift a stone to throw it up.
- The stone has very little potential energy in your hand.
- Your arm gives energy to the stone which is now moving. The stone has kinetic energy.
- The stone is going higher and higher. The higher the body, the more potential energy it has. The stone also has kinetic energy during its flight.
- At a certain height the stone stops. Here, it has no kinetic energy, while its potential energy is maximum.
- All its kinetic energy has transformed into potential energy.
- On the way back, gradually the stone loses its potential energy and gains kinetic energy.
- On reaching the ground its potential energy becomes zero and all the potential energy is transformed into kinetic energy, just like at the start of throw.

Conclusion: Energy can change from one form to another, but total amount of energy does not change.



Energy Converters

Energy can change its form. Scientists have developed such devices which change the form of energy. These devices are called **energy converters** or **energy changers.** We use many energy converters in our everyday life (Fig.8.11).

i. A **lamp** is an energy converter. It changes electrical energy to light energy.

ii. A **television** converts electrical energy to light energy (picture) and sound energy.

iii. **A radio** is a good example of energy converter. It changes electrical energy to sound energy.

iv. An **electric drill** is used to make holes in wood and metal. A drill converts electrical energy to mechanical energy (kinetic energy).

v. **Washing machine** is a common energy converter which is used in our homes. It changes electrical energy to mechanical energy.

Fig.8.11: A few energy converters

vi. A **calculator** with a cell converts electrical energy to light energy. Some calculators convert solar energy (from the Sun) to electrical energy and then to light energy.

Fig. 8.12: A calculator

Do you know? Plants are energy converters too. They change solar energy to potential energy (food).

Activity 8.5

Take a wind-up toy. It works by means of a spring. Do you know that it is also an energy converter?

Wind up the key of this toy.

Put the toy on the ground. It can run along the ground. What energy changes have taken place?

You provide energy to the spring that stores in the spring in the form of potential energy. When put on the ground, the movement of the toy shows that potential energy of the spring becomes kinetic energy.

Energy Conservation

Think! Has the energy lost in the above experiment. No! If you play with the toy for a long time, you will notice that the toy heats up. It also produces sound during movement. The energy in the toy is converted into heat and sound energy which are dissipated in atmosphere. The energy is not lost but conserved during the experiment.

Renewable Energy Sources

There are many sources of energy such as coal, oil and natural gas. These fuels are called **fossil fuels.** These fuels would not last for ever. They are not recoverable. These sources are called **non-renewable energy sources.**

The shortage of fossil fuels will create serious energy problems. We must look for alternative sources of energy that can be recovered . These sources are called **renewable energy sources.**

Renewable sources of energy include wood, water, wind, animal wastes, sunlight and tides of sea.

Hydro-electric Energy

The kinetic energy of flowing water is transformed into electrical energy. This energy is called as hydro-electric energy. Dams are built to obtain this energy.

The water required for producing hydro-electric energy is available free of cost.

Hydal power stations do not add pollution to atmosphere.

Wind Energy

Fig.8.13: A wind farm

Wind has kinetic energy in it. A windmill is amachine which has blades. These blades move by the energy of wind. In recent years, a wind mill is being used to produce electricity. A wind farm (consists of about 100 windmills) is used to generate electricity in greater amount.

Wind energy is available without any cost.

Wind energy does not cause any pollution.

Biogas

Biagas is a mixture of gases. These gases are formed by the decay of animal wastes and water. A biogas plant is used to produce this gas. Biagas can be used as a fuel in homes. We can use the remaining material as a fertilizer. The plant for biogas is also called gobar gas plant.

Biogas is cheaper than any other fuel.

It produces less pollution as compared to coal and petroleum.

Solar Energy

Fig.8.14: This house uses solar energy.

The Sun is the ultimate source of energy on Earth. The energy coming from the Sun is called solar energy. Solar energy can be changed into electricity with the help of solar cells. Solar energy can be an effective renewable energy source in our country.

Solar energy comes on the Earth free of cost.

This energy is also pollution free.

There is a lot of solar energy coming on the Earth.

Tidal Energy

The winds when blow over the surface of the sea, cause tides in it. In some countries, these tides are used to make electricity.

Energy from sea tides is also free of cost.

This energy does not cause any type of pollution.

Energy in Our Lives

Our body uses energy all the time; even when we sleep, our body requires energy. Our body needs energy to grow, to move and to keep warm.

Our body gets energy from food. The food has stored energy. Our body changes this energy to the kinds of energy it needs, like heat energy and kinetic energy.

Energy Transfer in an Environment

Green plants use sunlight to grow and make food. This solar energy is stored in the form of chemical energy of food. Animals and human beings eat the food prepared by the plants. The chemical energy of food transfers to their bodies. The bodies of animals and human beings change the chemical energy of food to the kinds of energy they need. Heat energy and kinetic energy then dissipate in atmosphere. Similarly, solar energy causes wind energy, sea tides energy and many other forms of energy. All these energies change their form and at the end dissipate in atmosphere.

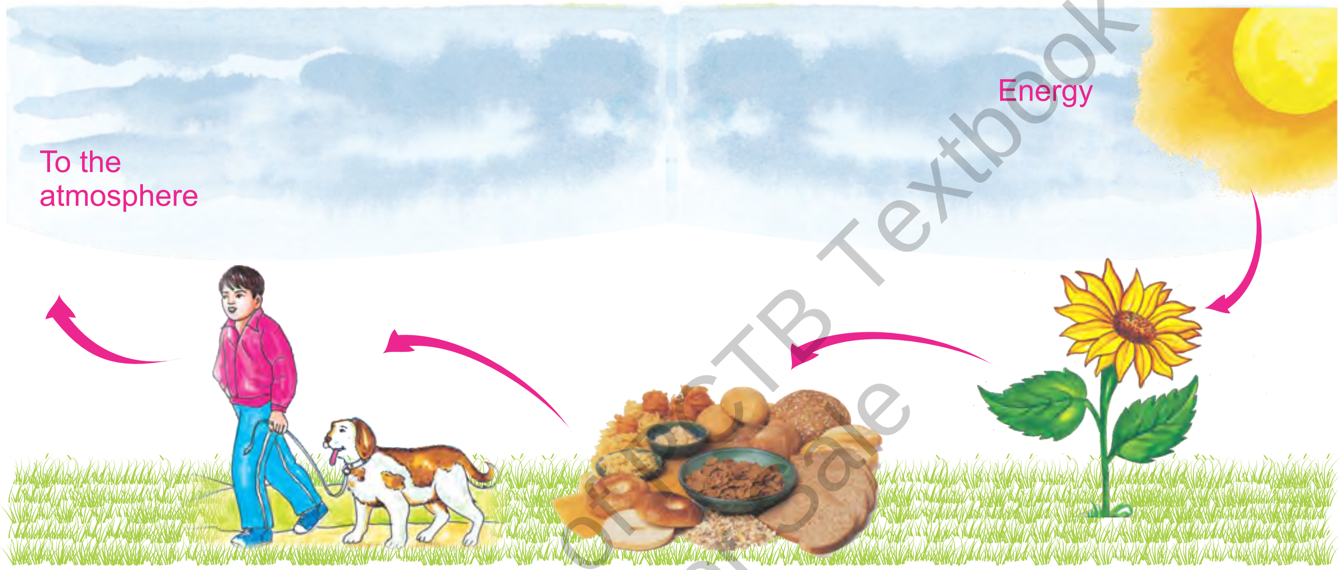


Fig.8.15: The heat energy comes from the Sun, passes through different organisms and in the end dissipate in atmosphere.

Point to think!
Going up the stairs or climbing a hill is always tiring. Why?

Chapter Review

1. Energy is the ability of a body to do work. Energy comes in many forms.
2. The energy due to the position of a body is called potential energy.
3. A moving body possesses kinetic energy.
4. One form of energy can be changed into another form . At the end energy dissipates in atmosphere.
5. The total energy in the universe is constant.
6. Energy converters are the devices which can change the form of energy.
7. Wind, water, Sun, biogas and sea tides are renewable sources of energy.

Test Preparation

1. Write proper term/word against each statement.

i. The fact that energy cannot be created or destroyed ____________

ii. Kinetic energy of flowing water that is transformed into electricity ____________

iii. A mixture of gases formed by the decay of animal wastes and water ____________

iv. The energy possessed by a stretched rubber band ____________

v. Energy coming from the Sun ____________

2. Circle the letter of the best answer.

i. All the planets which are orbiting around the Sun possess:
   (a) potential energy
   (b) kinetic energy
   (c) sound energy
   (d) electrical energy

ii. A diver getting ready to dive has:
   (a) hydal energy
   (b) chemical energy
   (c) kinetic energy
   (d) potential energy

iii. A drill converts:
   (a) kinetic energy to electrical energy
   (b) electrical energy to potential energy
   (c) electrical energy to heat energy
   (d) electrical energy to mechanical energy

iv. A car engine gets hot after a long ride because:
   (a) it contains lot of electrical energy
   (b) the Sun heats the engine
   (c) the energy of motion produces waste heat
   (d) the battery keeps it warm

v. When we come down the stairs, we lose:
   (a) kinetic energy
   (c) sound energy
   (b) potential energy
   (d) heat energy

3. Answer the following questions in detail.

i. What is the difference between potential and kinetic energy? Give two examples.

ii. Define and explain the "law of conservation of energy".

iii. Describe at least three renewable sources of energy.

iv. Write a note on "energy transfer in an environment".

4. Extend your thinking.

i. How can the kinetic energy of truck be increased without increasing its speed?

ii. What energy does a skier has at the top of a hill and coming down a hill?

iii. How can solar energy be helpful to Pakistan in overcoming electricity shortage?

iv. What energy changes take place as a tube light is turned on?

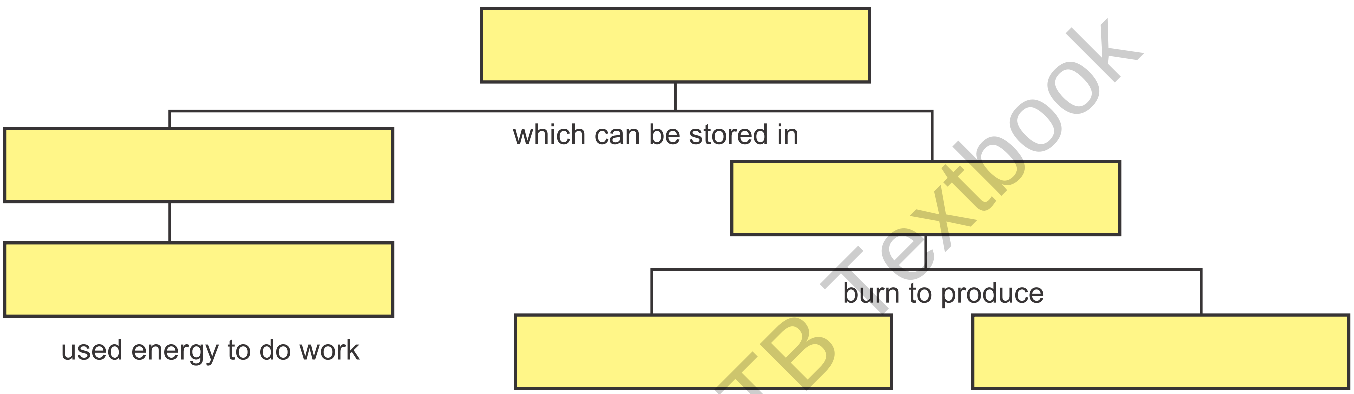
v. You turn on an electric fan to cool off. Describe the energy conversion involved.

vi. Imagine that you drop a ball. It bounces a few times, but then it stops. Your friend says that the ball has lost all of its energy. Using what you know about the law of conservation of energy, respond to your friend's statement.

5. Concept Map

Complete the concept map using the following words.

food sunlight fuel animals heat light



Science Projects

1. Take five marbles and place them in a row. Pick up the marble closest to you and roll it towards the end of the row of marbles. The impact of the marble you rolled causes a transfer of energy between the marbles in the row. As a result the marble at the other end is moved forward. This happens without the other marbles moving. From where did the last marble get this energy?

The demand for oil and gas is increasing day by day due to the rapid increase in the population of our country. We have to spend a lot of money on petroleum products. The increased use of petroleum products also produces a lot of pollution. Why do you think it is necessary for our country to adopt alternating energy sources, such as wind energy, solar energy, hydro-electric energy and biogas energy?

Computer Links

- http://38.96.246.204/kids/energy.cfm?page=1
- http://www.ftexploring.com/energy/enrg-types.htm

Chapter
9

Forces and Machines

We are stuck with machines. Machines make our lives easier.

Student Learning Outcomes

After completing this chapter, you will be able to:

- Recognize wheel and axle and identify their uses.
- Describe pulleys and their kinds.
- Identify the uses of pulleys in daily life.
- Describe the functions of pulley systems and gear systems.
- Describe how motion in a system of pulleys of different sizes is transferred to motion in another system of various gears in the same structure.
- Investigate with the help of an experiment the effort required by different gear systems to lift the same load.
- Find out how the action of a pulley system is altered by changing the tension of the band connecting two pulleys.
- Design and make a system of pulleys and/or gears for a structure that moves in a prescribed and controlled way and performs a specific function.
- Identify and make modifications to your own pulley and gear systems to improve the way you move a load.
- Describe how a bicycle functions.
- Identify common devices and systems that incorporate pulleys and/or gears.

We know that a machine is anything that makes our work simpler and easier. A **simple machine** is a simple tool used to make our work easier. Lever, wheel and axle, pulley, inclined plane, wedge and screw are simple machines. All the complex machines like tractors, cars and fans are made of simple machines. We have learnt about lever, inclined plane and wedge in class five. Here we shall discuss wheel and axle, pulley and gears.

Wheel And Axle

The most important invention of the human history is the "invention of the wheel". Wheels can move heavy objects easily.

Wheels are used in a simple machine called wheel and axle.

A **wheel and axle** consists of a large wheel fixed to a smaller wheel called the axle.

When the wheel turns, the axle also turns. A wheel has bigger diameter than that of the axle (Fig. 9.1).

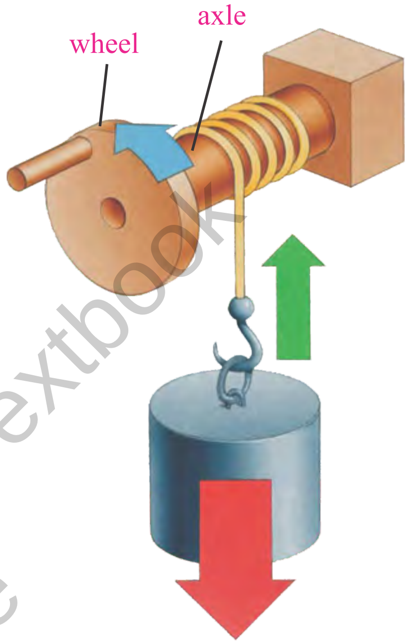


Fig.9.1: A wheel has bigger diameter than that of the axle.

We use wheel and axle in two ways.

1. To lift a heavy load ,we apply force on the wheel to turn the axle.
2. To increase the speed, we apply force on the axle to turn the wheel.

A screwdriver is an example of wheel and axle. The broad part of the screwdriver works as a wheel. The narrow part of it acts as the axle. A small force on wheel provides a bigger force at the axle to push the screw into the wood.

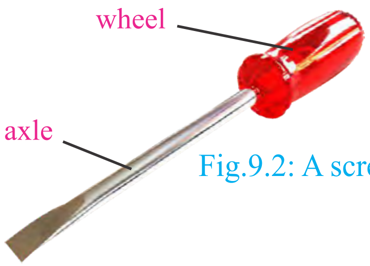


Fig.9.2: A screwdriver

The steering wheel of motor vehicles is also an example of wheel and axle (Fig.9.3). A small force on steering wheel provides a big force to the axle that easily turns the wheels of the vehicle.

A mincing machine, a tap handle, a hand drill and crank on a well are examples of wheel and axle. Buses, cars and bicycles also contain wheels and axles.

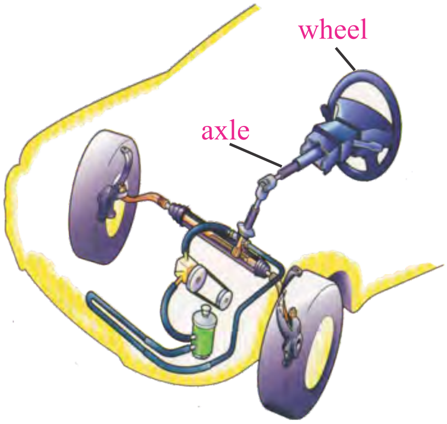


Fig.9.3: Steering wheel

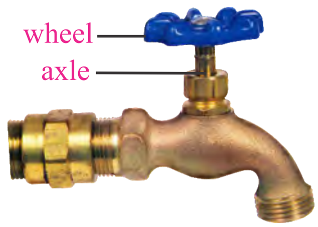


Fig.9.4: A tap handle is a wheel.

Fig.9.5: The wheel and axle in this tricycle means it can roll smoothly along the ground.

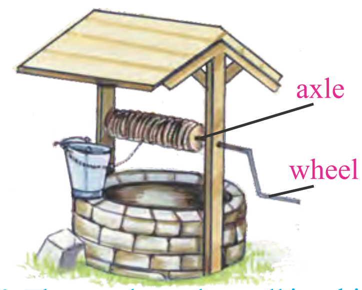
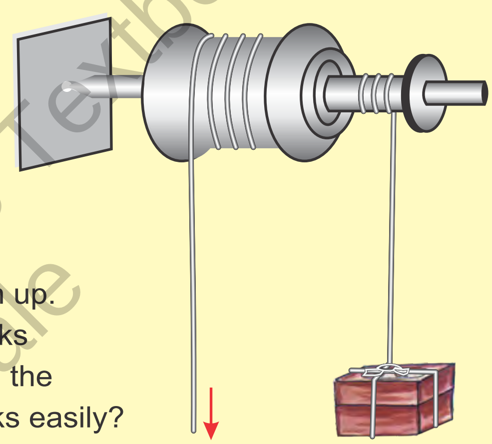


Fig.9.6: The crank on the well is a kind of wheel and axle. It reduces the force needed to raise the bucket.

Activity 9.1



To make a simple wheel and axle take one thread reel of large diameter and one of small diameter. Now fix them together firmly. Pass a thin and strong stick through the reels. Take two strings, tie one end of each string to each reel and roll them around the reels as shown in the figure. In this case the big reel will act as a wheel and small reel as an axle.
Take some books and tie them together and try to lift them up. Estimate the effort needed to lift them up. Now tie the books to the free end of axle string. Rotate the big reel by pulling the free end of the string rolled around it. Can you lift the books easily?

Pulley

Instead of axle, the wheel could also rotate a rope or cord. This variation of the wheel and axle is the pulley.

A **pulley** is the wheel with a groove in its edge through which a cord is passed. The pulley turns around an axle.

We can use pulleys to raise and lower objects. A pulley changes the direction of force and makes our work easier.

- Pulley is used to lift construction material to upper stories on a construction site.
- Motor mechanics and engineers use pulleys to lift and place heavy engines in the cars.
- The pulley on a flag-pole changes the direction of applied force. We pull down one end of the rope that passes over the pulley, the flag attached to the other end goes up (Fig.9.8).
- A crane uses a pulley system in which fixed and moveable pulleys are used to lift very heavy loads (Fig.9.9).

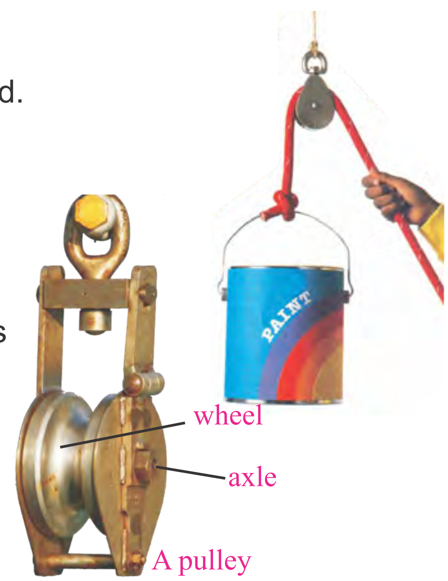


Fig.9.7: Pulley is a simple machine which can be used to lift loads easily.

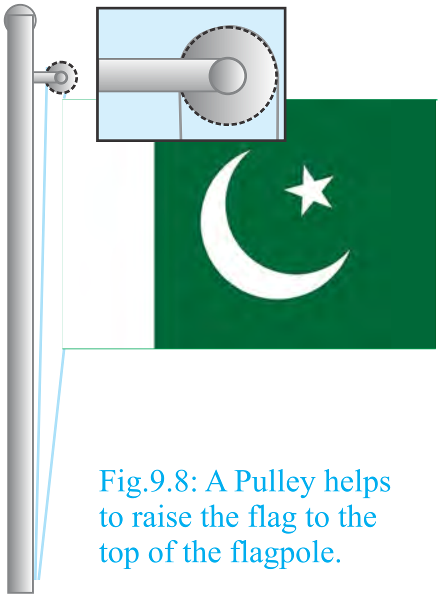
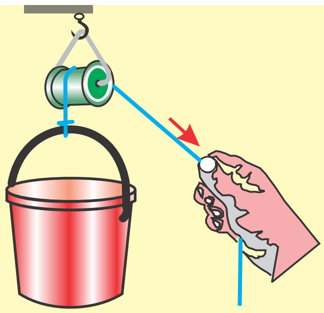


Fig.9.8: A Pulley helps to raise the flag to the top of the flagpole.

Fig.9.9: The crane uses pulleys to work.

Activity 9.2



Fill a small bucket half with water. Try to lift the bucket. Is it very easy? Ask an adult to bend a wire into a triangle. Push the ends of wire into a thread reel. Hang your pulley with some support. Tie the bucket with the end of a string.

Pass the string over the pulley. Pull the string downward to lift the bucket. Is it easier now? In some areas of our country people use pulley to draw water from a well.

Types of Pulley

There are two kinds of pulleys, i.e. fixed pulley and moveable pulley.

i. Fixed Pulley

The axle of this pulley is fixed with some support. The load is tied on one end of the rope which is passing over the pulley. The force is applied on the other end of the rope to lift the load (Fig.9.10). A fixed pulley is used to change the direction of applied force.

Fig.9.10: Fixed pulley

ii. Moveable Pulley

This kind of pulley has a hook to tie the load. The moveable pulley moves together with the load. In this kind, the rope is attached to some support while pulley moves. A moveable pulley does not change the direction of a force. The applied force and the load move in the same direction (Fig.9.11).

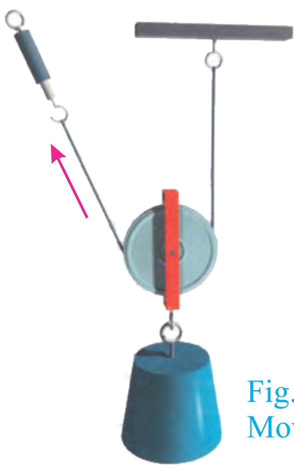


Fig.9.11: Moveable pulley

Pulley System

To make our work more easier, we can use pulley system. It consists of a fixed pulley and a moveable pulley. It is also called "block and tackle". The load is attached to the moveable pulley (Fig.9.12). Can you suggest a way in which we might apply force in downward direction in a pulley system?

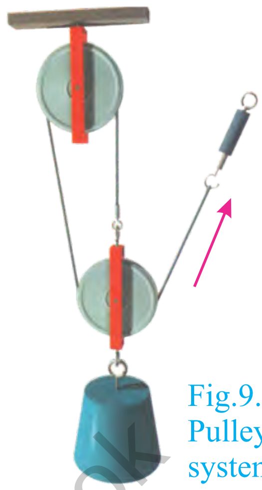
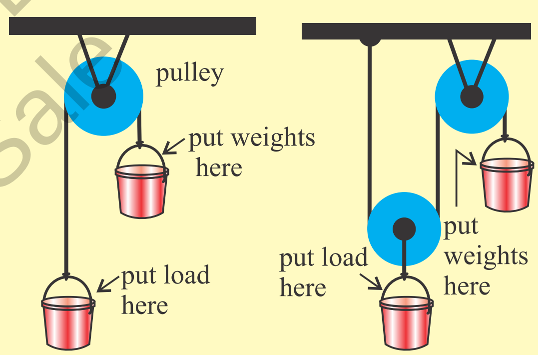


Fig.9.12: Pulley system

Do you know? Some times two pulleys work in such a way that they are connected with a belt. One pulley moves and causes the other pulley to move. For example in a water pump, a small pulley is attached to a motor. When motor runs the small pulley moves and causes the large pulley to move.

Activity 9.3

You will need: ✻ 1 fixed pulley and 1 moveable pulley ✻ 15 weights ✻ 1 rope ✻ 2 small buckets ✻ some amount of sand as a load



Procedure:

1. Hang the fixed pulley to some support.
2. Tie the rope to 1 small bucket and put the load in it.
3. Pass the rope over the pulley and tie the second bucket to its free end. Make the rope short enough so that the second bucket is near the fixed pulley.
4. Gently put the weights into the second bucket one at a time until the load just lifts off the ground. Record the number of weights you needed.
5. Repeat this experiment with one moveable pulley and one fixed pulley as shown in the figure. In this case the load is attached to the moveable pulley. Record the number of weights you needed.

What did you conclude about the lifting of load using one pulley and using two pulleys?

Gears

A gear is also a modification of the wheel and axle. Gear wheel has teeth around it. The teeth of one gear usually fit into the teeth of another gear. Gears are used to transfer the force from one wheel to another. They can also increase or reduce the speed.

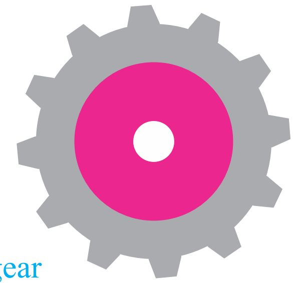


Fig.9.13: A gear

The Gear Train

Gears work in teams. When two or more gears work together, it is called a **gear train** or gear system. One gear is called driving gear to which force is applied. The other gear is called driven gear which turns due to the movement of the first gear.

We can use a gear system in two ways .

1. When the driving wheel is larger and the driven wheel is smaller, the gear system is used **to increase the speed.**
2. When the driving wheel is smaller and the driven wheel is larger, the gear system is **used to increase the force.**

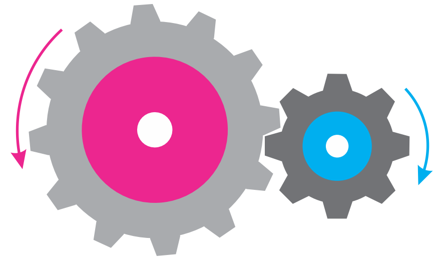
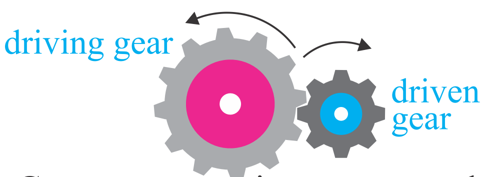
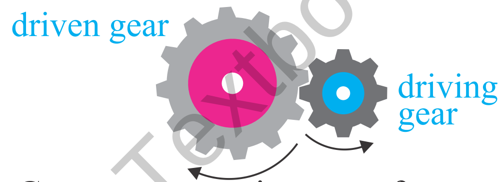


Fig.9.14: Gear train



Gear system to increase speed



Gear system to increase force

Activity 9.4

You will need: ❇ 1 set of gears ❇ 2 labels (stickers)

Procedure:

1. Put one axle in each of the four small gears.
2. Make a mark on one tooth on each gear.
3. Use the stickers to label one gear as the driving gear "D" and one as the driven gear "d".
4. Put these two gears on the base board with the marked teeth touching as shown in the figure 1.
5. Turn the driving gear one complete time around in a clockwise direction. Watch the driven gear as you do. Record how many times the driven gear turns and in what direction.
6. Now put another gear between the driving and the driven gears as in figure 2. Turn the driving gear as in step 5 and record what happen to the driven gear.
7. Finally, repeat this procedure with two gears between the driving and driven gears. See figure 3.

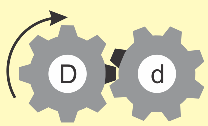


Fig. 1

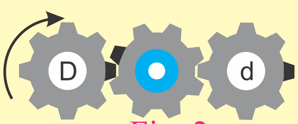


Fig. 2

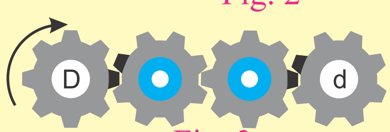


Fig. 3

No. of gears in between	Turns	Direction
0		
1		
2		

Uses of Gears In Everyday Life

Gears usually make part of a more complicated machine. They transfer energy from one wheel to the other to change the direction of force.

A hand-drill consists of two mutually perpendicular gears. When its larger gear is rotated in a vertical plane, the smaller gear linked with it rotates very fast in the horizontal plane. A hand-drill is used to make holes in wood.

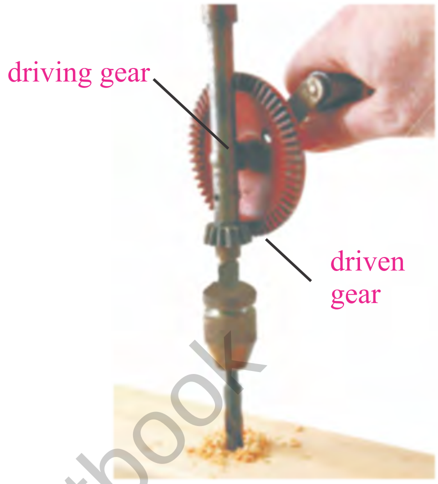


Fig.9.15: A hand-drill

Your bicycle moves with the help of gears. Two gears are linked with each other by a chain. The chain makes it possible for the small gear to move in the same direction as that of the big gear. The front gear is a large wheel with teeth in which pedal is fitted. The rear gear is a small toothed wheel which is present in the rear wheel of the bicycle. When you pedal the bicycle, you turn the big gear. The big gear turns the chain, which turns the rear small gear. When this small gear turns, the bicycle moves forward.

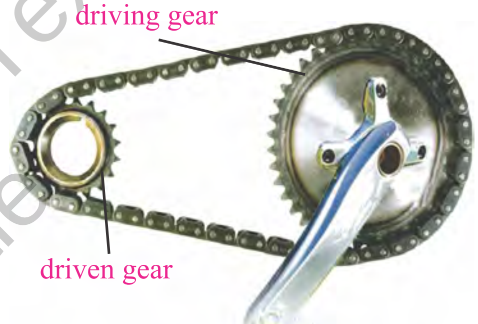


Fig.9.16: Gear system in a bicycle

In a racing bicycle, more than two wheels work in the gear system.

A wind-up clock consists of many gears. The minute wheel is a smaller gear with a few teeth, while the hour wheel is a bigger gear with many teeth. The minute wheel rotates the minute hand and hour wheel rotates the hour hand.

Fig.9.17: Gear system in a wind-up clock

Gears are also used in motor vehicles, factory machines and many other instruments.

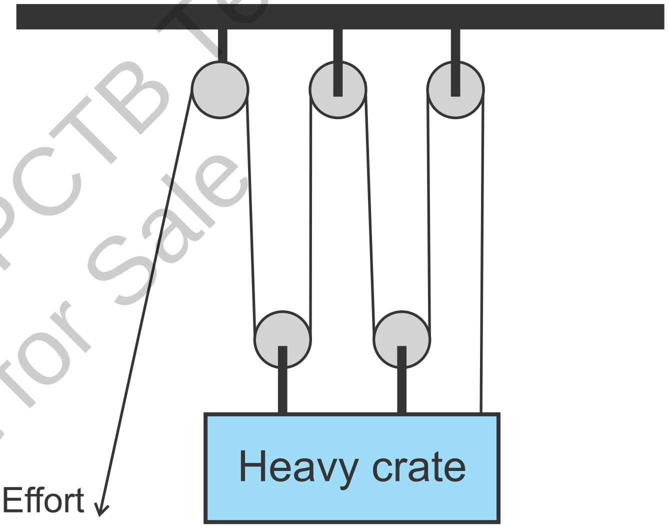
Point to think!
Which parts of a bicycle are wheel and axle, pulleys and gears?

Do you know?

Have you ever seen a racing-bicycle? When a racer wants to increase the speed of a bicycle, he/she changes the gears or pulleys in such a way that the pedal gear is a larger wheel and the rear gear becomes the smallest wheel.

Design of a system to lift heavy objects

A common way to lift heavy objects is shown in a schematic diagram. You can also design your own system to lift heavy objects. Also tell your teacher how can you reduce the effort even more to lift this heavy crate.



Chapter Review

1. A wheel and axle is made up of a large wheel that is connected to a circular rod called axle.
2. Pulley is also a wheel with a groove in its edge. A rope passes over a pulley.
3. There are two kinds of pulleys: fixed pulley, moveable pulley.
4. Gear is a toothed wheel. Gear system is a kind of wheel and axle.
5. Pulleys and gears can change the direction of force.
6. We use pulley systems and gear systems in a number of ways .
7. A hand-drill, a bicycle, a wind-up clock and many other machines use gears.

Test Preparation

1. Write proper term/word against each statement.

i. Wheel and axle, pulley, gear ____________

ii. Two or more gears working together ____________

iii. A grooved wheel which moves around an axle ____________

iv. Helps to rotate object faster and easily ____________

v. A wheel of a smaller diameter in wheel and axle ____________

2. Circle the letter of the best answer.

i. Which of the following is not a simple machine?
(a) a tap handle (b) a jar lid
(c) a screwdriver (d) a gear

ii. Which simple machine can help us to move a sail on a sailboat?
(a) a lever (b) a wheel and axle
(c) a gear (d) a pulley

iii. Gear system is a kind of:
(a) lever (b) wheel and axle
(c) compound machine (d) wedge

iv. The chain of your bicycle is a:
(a) pulley (b) lever
(c) screw (d) wheel and axle

v. Which pulley system can make our work easier?
(a) a pulley system with 2 pulleys (b) a pulley system with 3 pulleys
(c) a pulley system with 4 pulleys (d) a pulley system with 5 pulleys

3. Answer the following questions in detail.

i. Write some uses of a wheel and axle in our daily life.
ii. Describe two kinds of pulleys and their working.
iii. Define a gear and write its characteristics .
iv. Write briefly about the working of a hand drill and a bicycle.

4. Extend your thinking.

i. A doorknob is a wheel and axle. How does it work?
ii. What type of simple machine would be used to lower an empty bucket into a well and then lift the bucket full of water?

iii. When you let water into a bathtub, what kind of machine helps you open the tap?

iv. If the driving wheel and the driven wheel of a gear system are of the same size, which gear will move faster?

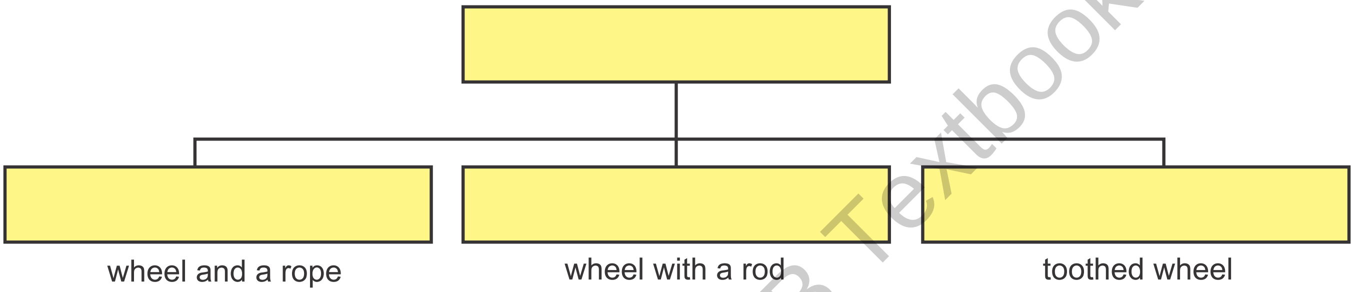
v. How are compound machines different from simple machines?

vi. How are wheel and axle, pulley and gear alike?

5. Concept Map

Fill the concept map using the following words:

gear wheel and axle simple machines pulley



Science Projects

1. Visit a machine shop. Report the types of simple machines you see. Paste pictures of all the six simple machines in your science copy.
2. Visit a nearby mechanical workshop. Observe the machines which use wheel and axle, pulley system and gear system . How do these simple machines make the work of a mechanic easier?
3. Observe a gear system in an egg-beater and a mincing machine. How does gear system make your work easier?

Computer Links

- www.mikids.com
- http://www.handworx.com.au/gearworx/mechanics/gears.html

Chapter 10

Properties of Light

Light can transmit, absorb and reflect.

Student Learning Outcomes

After completing this chapter, you will be able to:

- Differentiate between transmission, absorption and reflection of light.
- Demonstrate the laws of reflection.
- Demonstrate the difference between smooth, shiny, and rough surfaces.
- Compare the regular and diffused reflection.
- Identify everyday applications, which involve regular reflection and diffused reflection.
- Draw ray diagrams for light reflected from a plane mirror at different angles of incidence.
- Describe image formation by a plane mirror.
- Compare characteristics of the images formed by a plane mirror and a pinhole camera.
- Explain the use of reflecting surfaces in different devices.
- Design an experiment to make an optical instrument using mirrors.
- Explain the principle of reflection in a kaleidoscope.
- Describe the relationship of angles between two mirrors and the number of images you can see in a kaleidoscope.
- Explain types of mirror and their uses in our daily life.
- Investigate the image formation by convex and concave mirrors.

Light is a form of energy which is given out by **luminous objects.** The Sun, bulb, candle, etc. are luminous objects. Other objects which do not give out light are called **non-luminous.**

Light can pass through **transparent** materials. Glass, water, clear plastic and air are transparent materials. Light cannot pass through **translucent** materials. A tracing paper, frosted glass and waxed paper are translucent materials.

Transmission, Absorption and Reflection of Light

Light behaves differently when it falls on different objects. When light falls on the surface of a non-luminous object, it can behave in three ways (Fig.10.1):

1. When light falls on transparent objects, it is **transmitted** to the other side. That is why, we can see across transparent objects.
2. When light falls on rough opaque objects, most part of this light is **absorbed** and changed into heat energy. A black surface absorbs most of the light.
3. When light falls on a smooth shiny surface, it bounces off in one particular direction. This bouncing of light is called **reflection** of light.

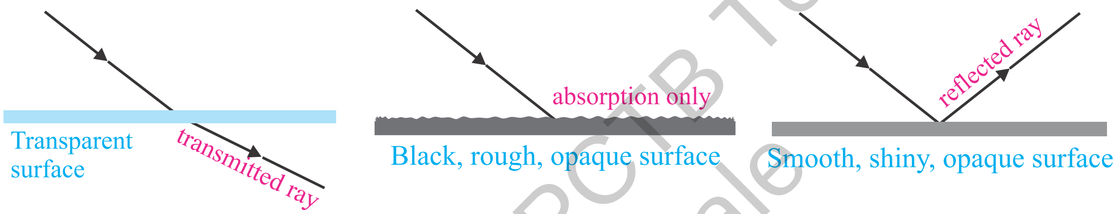


Fig.10.1: Behaviour of light on different surfaces

A part of light passes through a surface (windscreen of a car), some part is reflected and rest of light is absorbed in the surface. it means transmission, reflection and absorption occur at the same time.

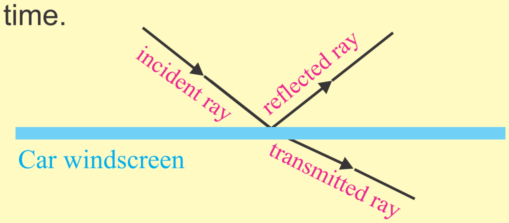


Fig.10.2: Identify transmission, absorption and reflection of light in the picture.

How Reflection Occurs

Reflection occurs when a light ray strikes a shiny surface (mirror) and bounces off (Fig. 10.3). The ray that strikes the shiny surface is called **incident ray.** The ray that bounces off is called **reflected ray.** The point at which incident ray strikes is called **point of incidence.** The line perpendicular on the point of incidence is called **normal.** Incident ray forms **angle of incidence** with the normal. It is denoted by 'i'. The angle that reflected ray forms with the normal is called **angle of reflection.** It is denoted by 'r'.

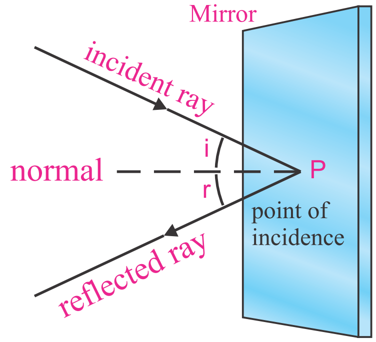


Fig.10.3: Reflection of light

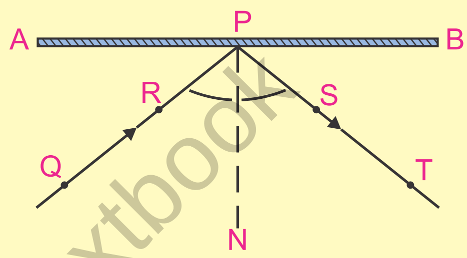
Laws of Reflection

It has been found experimentally that reflection of light obeys certain laws as:

1. The **angle of incidence** is equal to the **angle of reflection.**
2. The **incident ray,** the reflected ray and the **normal** at the point of incidence all lie on the same plane.

These are called the **laws of reflection.**

Activity 10.1



1. Fix a white paper on a drawing board using the drawing pins.
2. Place a mirror strip AB (fixed in a stand) on the paper.
3. Fix two common pins Q and R obliquely in front of the mirror in a line.
4. See the image of the pins in the mirror and fix two more common pins S and
   T in such a way that image of pins Q and R and pins S and T lie on the same straight line.
5. Join the points Q, R, S, and T with the AB (strip) on point P. Draw a perpendicular line on P. It is normal.

Observe the **angle of incidence** QPN that incident ray QR forms with the normal and the **angle of reflection** NPT that reflected ray ST forms with the normal. We will observe that:

The angle of incidence is equal to the angle of reflection.

The incident ray, the reflected ray and the normal on the point of incidence all lie on the same plane.

Types of Reflecting Surfaces

Some surfaces reflect more light than the others. A reflecting surface may be smooth or rough.

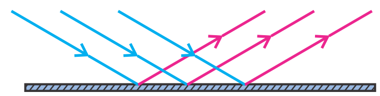


Fig. 10.4: Regular reflection of light from a smooth shiny surface

Smooth Surface

A plane surface is called a smooth surface. When parallel light rays hit a smooth shiny surface, all the rays are reflected at the same angle. It is called **regular reflection** of light (Fig.10.4).

Rough Surface

An uneven surface is called a rough surface. When parallel light rays hit a rough surface, all the rays are reflected at different angles. It is called **diffused reflection** of light (Fig.10.5).

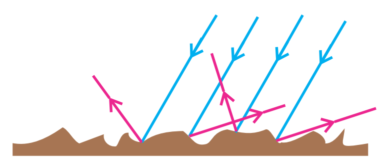


Fig. 10.5: Diffused reflection of light from a rough surface

Applications of Regular and Diffused Reflection in Everyday Life

Regular and diffused reflections of light have many applications in our everyday life:

Due to the regular reflection of light we look our image in the plane mirror.

We can turn the sunlight towards dark places by the regular reflection of light with the help of a shiny surface.

Sunlight does not reach directly in our rooms, but we can see things in our rooms. This is because of diffused reflection of light. The light scatters in different directions when it shines on dust particles.

We can see things just before the sunrise and just after the sunset due to the diffused reflection of light.

Images Formed By a Plane Mirror

A shiny surface is called a **mirror.** A plane mirror has a smooth and flat surface. We see images in a **plane mirror** when light reflected by the mirror enters our eyes. We use a plane mirror to see our faces. We observe that;

1. The image formed by a plane mirror is **upright** (straight upward).
2. The image is **equal in size** to the object.
3. The image is **laterally inverted.** It means your right becomes left in the image.
4. The image in the plane mirror is **virtual.** It means the image disappears on removing the object.
5. The image is as far behind the mirror as the object is in front of it.

Fig.10.6: Reflection in a plane mirror

Ray Diagram For Light Reflected From a Plane Mirror

Take a sheet of white paper and fix it on a drawing board. Draw a line MR on the sheet and put a plane mirror vertically along the line. Now fix a pin O, serving as the object before the mirror (Fig.10.7).

View the image I of pin O from left side of the object pin and fix two pins P and Q in such a way that both of these pins and image I lie in the straight line. Now view the image from the right of the pin O and fix two pins S and T in the same way.

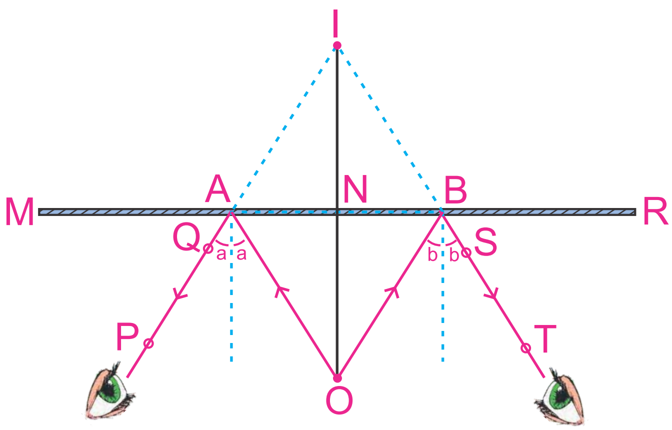
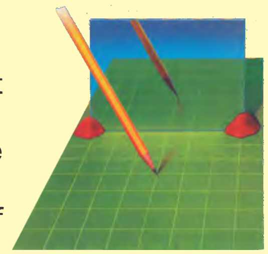


Fig.10.7: Ray diagram for plane mirror

Remove all the pins and put cross (x) to mark each pin hole. Draw lines PQ and ST beyond the mirror line MR till both lines intersect each other. Draw a vertical line from O to I which meets MR at N. Also join O to the points A and B where lines PQ and ST meet the line MR. Measure ON and IN. ON is the distance of the object from the mirror and IN is the distance of the image from the mirror. Both will be equal.

Draw perpendiculars on A and B to prove the laws of reflection. At each point of incidence, the angle of incidence should be equal to the angle of reflection.

Activity 10.2



To prove that a plane mirror forms the image as far behind as the object is in front of it.

1. Take a piece of graph paper and spread it on a table. Mark over one of the horizontal lines on this piece.
2. Put a mirror along the marked line in vertical position with the help of modeling clay.
3. Put your pencil in front of the mirror and observe its image.
4. Now place the pencil six squares far in front of the mirror. The image in the mirror will also be six squares behind the mirror.
5. Repeat the image formation by placing the pencil 8 squares far in front of the mirror. How many squares behind the mirror is the image now?

The word 'Ambulance' is often written laterally inverted on the front of ambulances. Why? In fact, such writing can be easily read by drivers ahead from their side mirrors.

A Pin-hole Camera

We know that light travels in straight lines. A device which makes use of this fact is called a **pin-hole camera.** A Muslim scientist Al-Haithem invented the pin-hole camera.

A pin-hole camera simply consists of a cardboard or a metal box with a very small pin-hole in the middle of its one of the faces. All inside the camera is made black so that light can not enter the camera. A white screen is placed along the opposite face of the pin-hole (Fig.10.8).

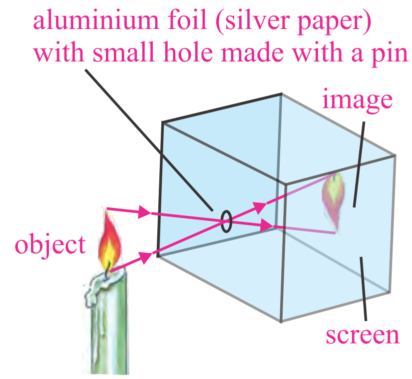


Fig.10.8: A pin hole camera

Image Formation by the Pin-Hole Camera

When a brightly lit object is placed in front of the hole of a pin-hole camera, an inverted (upside down) image of small or large size and of same colour as that of the object is obtained on the white screen of the camera. This image is real as it can be made on a screen.

We can obtain good pictures with our pin hole camera by pasting some photographic film instead of a white screen.

Comparison of Images Formed by a Plane Mirror and a Pin-hole Camera

A plane mirror forms a virtual image while a pin-hole camera forms a real image.

A plane mirror forms the image of equal size as of the object. A pin-hole camera mostly forms smaller or diminished images.

The image formed by a plane mirror is upright. A pin-hole camera forms an inverted image.

Do you know? An image which we can obtain on a screen is called a **real image.**
An image which we cannot obtain on a screen is called a **virtual image.**

Uses of Reflecting Surfaces

Reflecting surfaces help to change the direction of light in many optical instruments like periscope, telescope and microscope.

Periscope

A **periscope** helps us to see on the other side of the wall. We can make a periscope.

A simple periscope consists of a long tube which bends at right angle on both ends. A plane mirror is fitted on either end in such a way that the mirror makes an angle of 45° with the walls of the tube (Fig.10.9).

The top mirror reflects the light to the bottom mirror which then reflects it to our eyes.

Periscopes are used in submarines. People in a submarine can watch the objects above the water surface.

Battle tanks are also fitted with periscopes.

The crew inside the tank can see every thing outside of the tank.

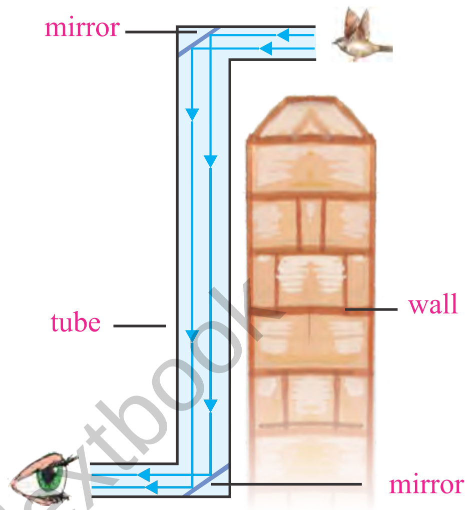


Fig.10.9: A periscope

Reflecting Telescope

A reflecting telescope produces images of distant objects like the Moon, stars and planets.

A plane mirror is used to reflect light into the **reflecting telescope** (Fig.10.10).

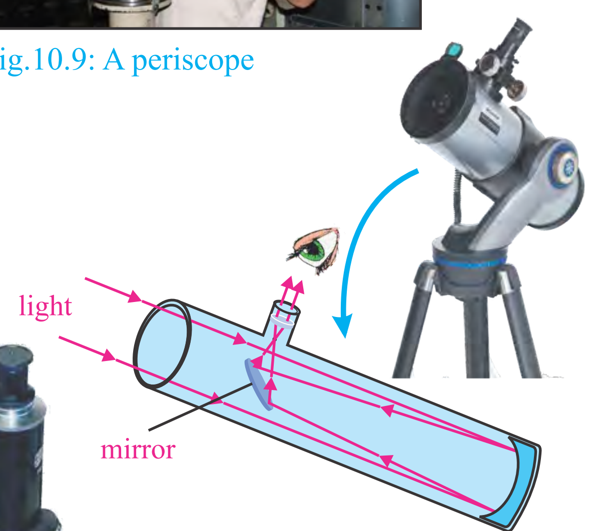


Fig.10.10: A reflecting telescope

Microscope

A **microscope** is used to see tiny objects like bacteria. A lens system works in it. However, a mirror is also used to reflect light into the microscope, otherwise you will be unable to view the image in it (Fig.10.11).

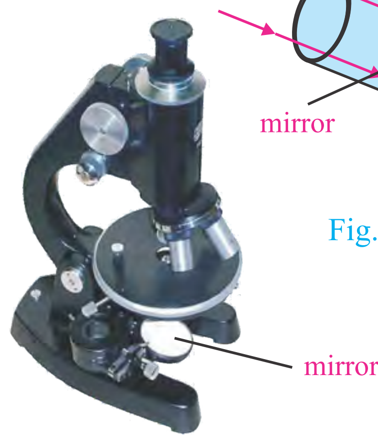


Fig.10.11: A microscope

Multiple Reflections

A **kaleidoscope** is an optical instrument in which we can see changing patterns of a simple design.

A kaleidoscope is a hollow tube containing two or more rectangular plane mirrors (Fig.10.12). The mirrors are fixed at an angle of 60° or 45° with each other. At the far ends of the kaleidoscope are two more plates, one made of clear glass and the other of ground glass.The clear glass is closer to the eye hole. Small pieces of coloured objects are placed between the plates and are reflected in the mirrors.

The plate of ground glass throws the reflections in different directions. It makes a beautiful design. When the viewer turns the kaleidoscope, the coloured pieces shift position and the reflected patterns change. The constantly changing patterns are formed by the multiple reflections of the loose coloured pieces through mirrors.

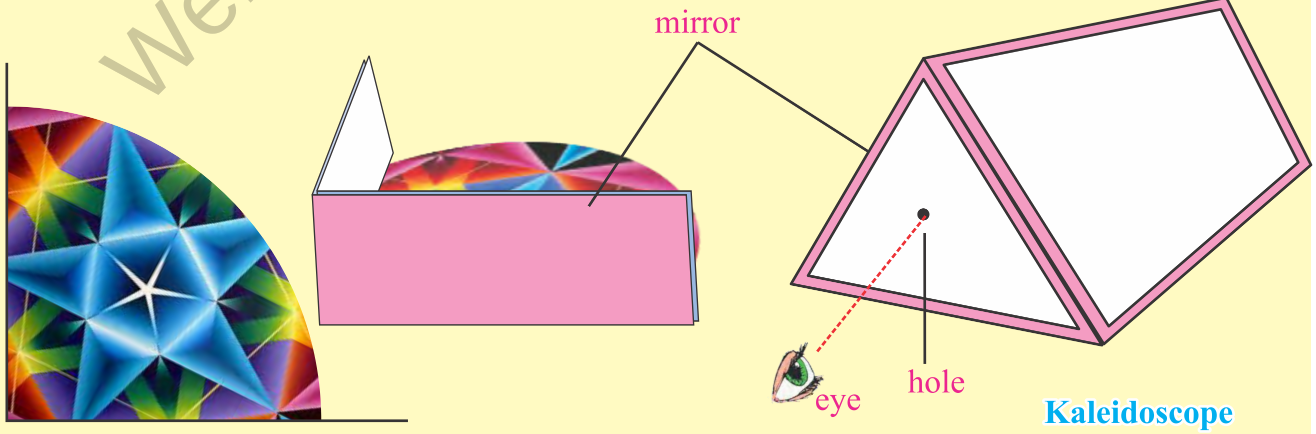
Experiments have proved that the angles between the two mirrors of a kaleidoscope affect the number of images seen.

Fig.10.12: A kaleidoscope

Activity 10.3

Draw two mutually perpendicular lines on a sheet of white paper. Draw some design with colour pencils between these lines. Place two mirror strips vertically on these lines with the help of modeling clay. Observe the images of the design in one of the mirrors. The number of images seen is 3. Now change the angle between the two mirrors, for example 60°. The number of images now seen is 5.

It proves that when angle between mirrors of a kaleidoscope changes, the number of images seen is also changed.



Types of Mirrors

All the reflecting surfaces are not flat like the plane mirror. Some are curved in shape. Mirrors are of two types, i.e. **plane mirror and curved mirror.**

The plane mirror has been discussed in the early part of this chapter. A curved mirror is a part of a hollow sphere.

Curved mirrors are of two types, i.e. concave mirror and convex mirror.

Fig.10.13: Image in the spoon bowl

Concave Mirror

A curved mirror whose inner curved surface is reflecting is called a concave mirror. It is like the inside of the bowl of a spoon.

Convex Mirror

A curved mirror whose outer curved surface is reflecting is called a convex mirror. It is like the outside of the bowl of a spoon.

Fig.10.14: Image in a plane mirror

Uses of Mirrors

Plane, concave and convex mirrors form different images.

A **plane mirror** forms an upright virtual image which is same in size as that of the object.

It is used as a looking glass. It is also used in periscopes, telescopes and microscopes to reflect light.

A **convex mirror** forms an upright virtual image which is smaller in size.

Convex mirrors are used as; security mirrors in shops, car wing mirrors and blind corner mirrors on roads especially on mountains.

A **concave mirror** forms a real upside down image on a screen. It forms an upright virtual and very big image if the object is very close to the mirror.

Concave mirrors are used as; a dentist's mirror, a cosmetic mirror, a headlight mirror, a torch and search light mirror.

Fig.10.15: Image in a curved mirror

Point to think!

Have you ever visited Sozo Water Park, Lahore? You can observe your amusing images in strange mirrors here. Can you explain these mirrors?

Terms Related to Curved Mirrors

A curved mirror is a part of a sphere. The centre of the curve is called as the centre of curvature and is denoted by 'C'. The centre of the mirror is called the pole and is denoted by 'P'. The line joining the 'C' to 'P' is called the principal axis.

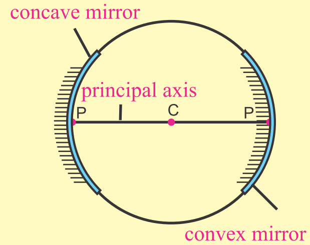


Image Formation in Concave and Convex Mirrors

A concave mirror can form real as well as virtual image, but a convex mirror only forms a virtual image.

Images with a Concave Mirror

When light rays strike a concave mirror parallel to its principal axis, after reflection they pass through a common point in front of the mirror. This common point is called the **principal focus.** It is denoted by 'F' (Fig.10.16). A concave mirror has an original principal focus 'F'. That is why it can form real images on a screen.

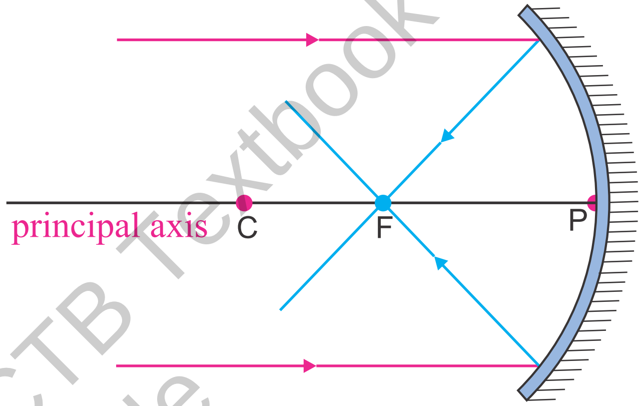
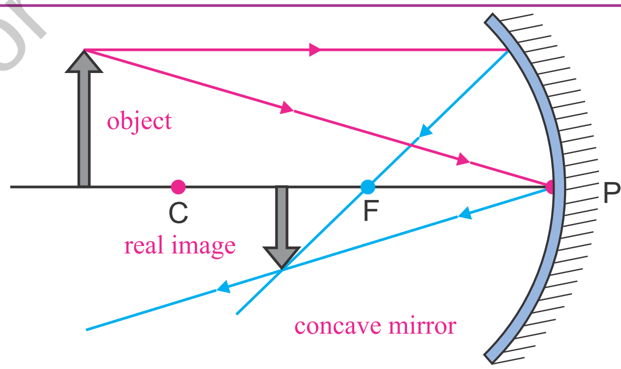


Fig.10.16: Reflection of light from a concave mirror

The characteristics of an image depend upon the distance between the object and the mirror.

1. If the object is beyond the principal focus (F), the image formed is real and upside down.



1. If the object is very near to the concave mirror, the image forms behind the mirror. It is virtual, upright and bigger in size.

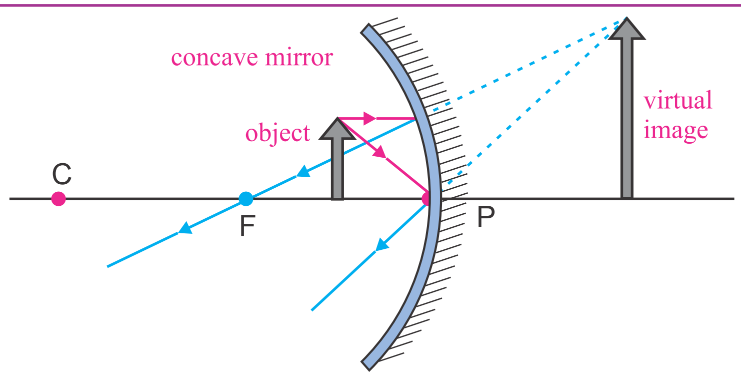


Image With a Convex Mirror

Convex mirror always spreads light rays. When light rays parallel to the principal axis strike a convex mirror, after reflection they spread in such a way that they appear to come from a point behind the mirror. This common point is called the **principal focus** 'F' of the convex mirror (Fig.10.17).

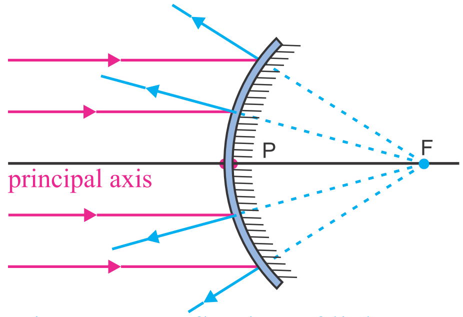
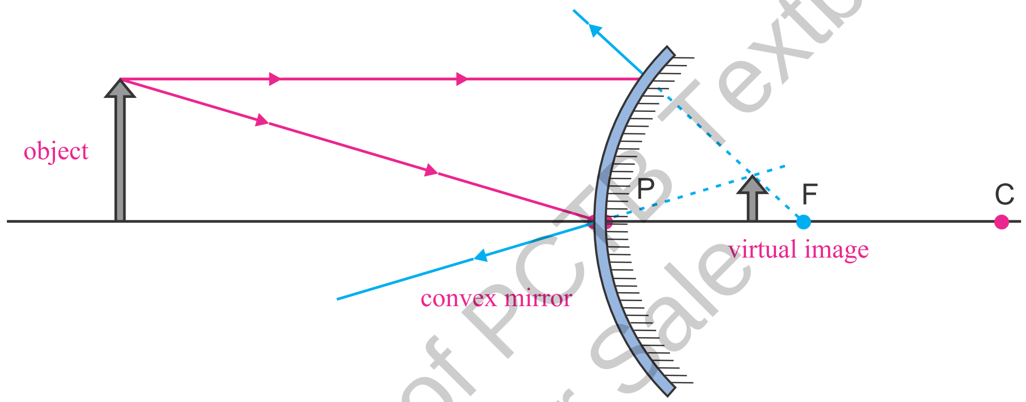


Fig.10.17: Reflection of light from a convex mirror

A convex mirror always produces a **virtual, upright** and **smaller** image of the object at any distance in front of it. The image is located behind the mirror.



Chapter Review

1. Light behaves differently when it falls on different objects.
2. Whenever light reflects, it obeys 'Laws of Reflection'.
3. Transparent objects transmit, rough opaque objects absorb and shiny surfaces reflect the light.
4. Smooth surfaces reflect all rays of light in a regular pattern and rough surfaces reflect light rays in different directions.
5. A plane mirror has a smooth and flat surface to reflect the light regularly.
6. A periscope, a telescope, a microscope and a kaleidoscope are devices which use reflection for their working.
7. We can view different designs in a kaleidoscope.
8. A curved mirror is a part of a hollow sphere . Curved mirrors are of two types: concave mirror, convex mirror.
9. A convex mirror forms a virtual image while a concave mirror mostly forms real images.

Test Preparation

1. Write proper term/word against each statement.

i. Helps see things before the sunrise and after sunset ________________

ii. Used to see very small things ________________

iii. A mirror that forms mostly real images ________________

iv. The angle of incidence is equal to the angle of reflection ________________

2. Circle the letter of the best answer.

i. When light rays bounce off from a shiny surface:
(a) reflection occurs (b) absorption occurs
(c) bending of light occurs (d) nothing happens

ii. Light reflects regularly from a surface which is:
(a) opaque and rough (b) rough
(c) black (d) smooth and shiny

iii. We can see things around us even on cloudy days due to:
(a) regular reflection of light (b) irregular absorption of light
(c) regular transmission of light (d) diffused reflection of light

iv. One statement is not correct for the plane mirror:
(a) the image formed is upright (b) the image is equal in size to the object
(c) the image is real (d) the image is laterally inverted

v. Your friend wants to see over a wall. What would you suggest him to use?
(a) telescope (b) kaleidoscope
(c) periscope (d) microscope

vi. Which device uses the fact that light travels in straight lines?
(a) telescope (b) kaleidoscope
(c) pin-hole camera (d) microscope

3. Answer the following questions in detail.

i. Define the transmission, absorption and reflection of light.
ii. Prove the laws of reflection through an activity.
iii. Draw a ray diagram for light reflected from a plane mirror.
iv. How does multiple reflection occur in a kaleidoscope?
v. Describe in detail the image formation in a concave mirror.

4. Extend your thinking.

i. Is a shiny metal plate also said to be a mirror?
ii. How does the surface of a still pond or puddle behave when light falls on it?
iii. How can a scientist see the details of the Moon?
iv. White surfaces reflect most of the light that strikes on them. Why are people used to wear dark coloured dresses in winter?
v. Can you obtain a virtual and upright image from a concave mirror? Draw a ray diagram.

vi. Can a plane mirror ever produce a real image? Explain.
vii. If you look directly at a highway it looks black. If, however, you look at it at an angle, it looks shiny. Why does it look so?

Science Projects

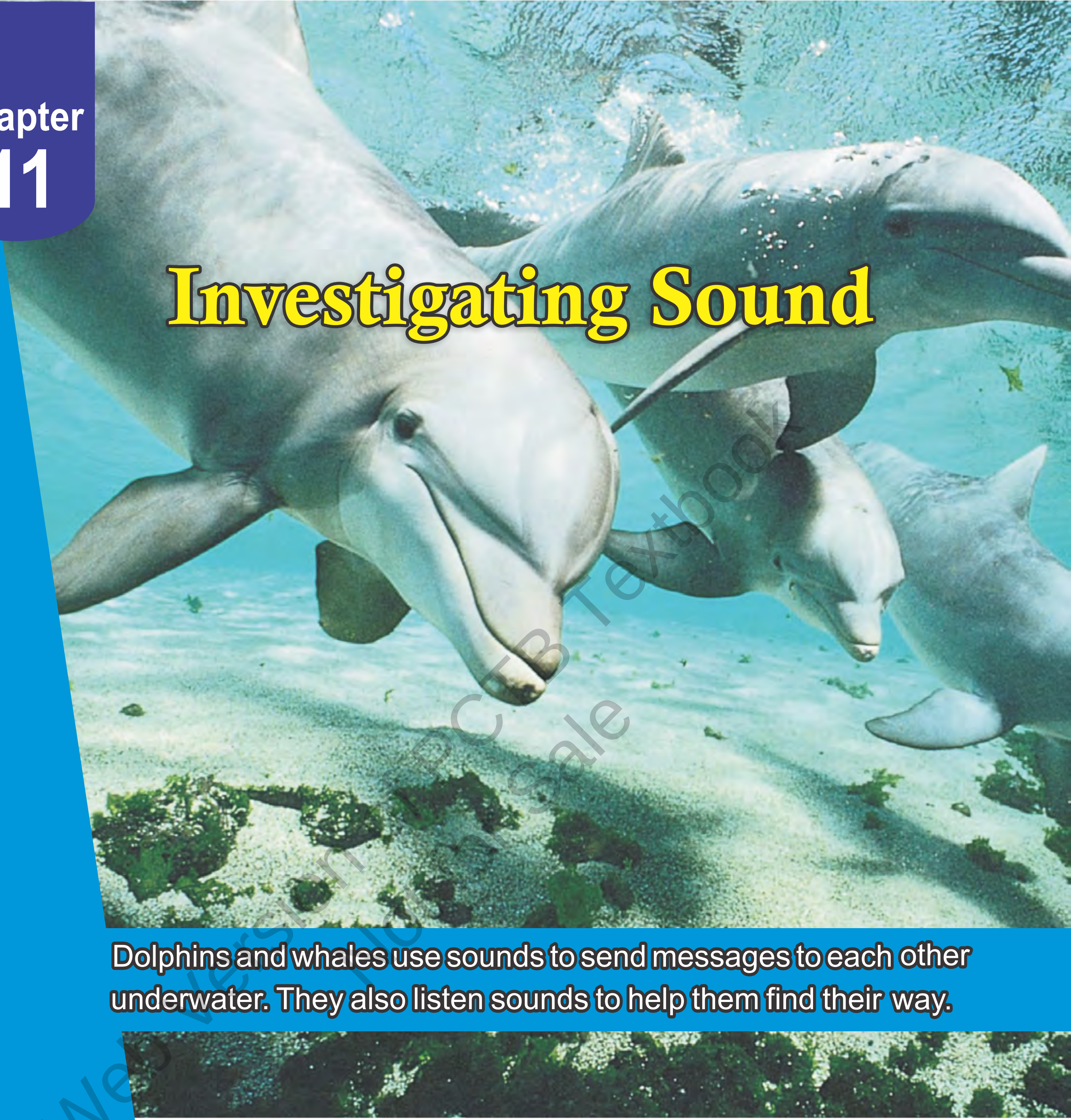
1. Look at the back of a shiny spoon. What kind of image do you see? How does changing the distance between your eyes and the spoon affect what you see? What kind of mirror does the back of the spoon represent? Now look at the front of the spoon. What kind of mirror is the front of the spoon? What kind of image do you see?
2. Take two 1-litre milk or juice cartons, two small square mirrors, scissors and tape . Cut around the top of each carton and remove the roof. Cut a window in the front at the bottom of each carton. Fix a mirror in the window of each carton at 45° angle. Tape the open parts of both the cartons in such a way that one window faces you and other on the opposite side. Use your periscope to see over an obstacle or wall.
3. Take three long mirrors, tape them along the length with their coated sides outside. Insert these mirrors in a tightly rolled cardboard tube. Cover one end of the tube with clear plastic. Put some pieces of broken bangles, silver glitter and coloured paper over the plastic sheet. Cover them with another layer of plastic. Tape a circular piece of card with a hole in the centre on the other end of the tube. Look through the hole and rotate the tube to see beautiful patterns made by multiple reflections.

The Sun has produced energy for billions of years . Solar energy is the Sun's light rays that reach the Earth. This energy can be converted into other forms of energy, such as heat and electricity. Why do you think solar energy can help us overcome the severe problem of electricity shortage?

Computer Links
- http://www.physchem.co.za/OB12-mat/transmission.htm
- http://www.physicsclassroom.com/class/refln/u13l4a.cfm

Chapter 11

Investigating Sound



Dolphins and whales use sounds to send messages to each other underwater. They also listen sounds to help them find their way.

Student Learning Outcomes

After completing this chapter, you will be able to:

- Describe sound as a form of energy.
- Compare the speed of sound in solids, liquids and gaseous mediums.
- Identify a variety of materials through which sound can travel.
- Explain how does a human ear receive sound waves.

We are surrounded by sound. There is a great variety of sounds. Sound is all around us like air. Have you not listened to these sounds?

Fig.11.1: The bird is chirping.

- the call of your sweet mother to awake you
- the sound of water running in the sink
- the chirping of birds outside the window
- the voices of hawkers in the street
- the ringing of the school bell

Some sounds are **loud** and some are **soft.** Some sounds are **pleasant** to hear, but loud noise is an **unpleasant** sound. Which sound do you like, singing of a bird in a tree or noise of running traffic on the road?

How does sound produce?

Sound is produced when matter moves back and forth very quickly. A back and forth movement is called a **vibration.** Sound is produced only when something vibrates.

Fig.11.2: The boy is playing a flute.

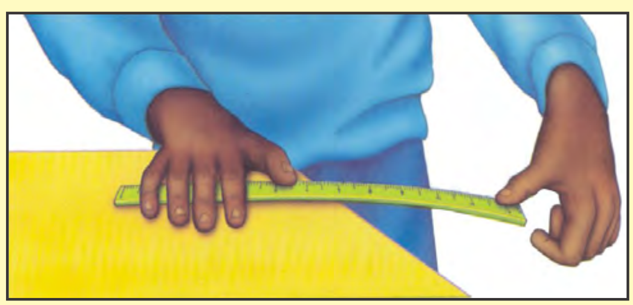
Sounds are produced in solids, liquids and gases.

If we touch our throat while we are talking, we can feel the vibrations in our voice box. Strike a spoon on the side of the cup and see the vibrations. Mosquitoes produce buzzing sound due to the vibration of their wings. When someone speaks, vibrations are produced in the air and we hear the sound.

A flute (bansuri) produces sound due to the vibrations of air particles.

Activity 11.1

Hold one end of your wooden ruler firmly on the edge of a table. Now press the free end of the ruler and release. You will hear the sound when the ruler vibrates.



Do you know?

Loons are very interesting birds by their voice. When they produce sound, it hears as they are laughing.

Sound as a Form of Energy

We know that energy can do work and work is done when something is moved. We have also learnt that sound is a kind of energy.

When we strike a drum, sound is produced. The sound is produced because the drum skin vibrates. This sound vibrates our eardrum and we hear it. Larger amounts of energy can produce louder sounds. If a drummer beats the drum with a lot of force, it will make a loud sound. We can conclude that:

Fig.11.3: A drum can produce loud sounds.

Much energy = Loud sound

Less energy = Soft sound

Vibrations affect the volume of sounds. We can observe it on the surface of a deck speaker. When the volume is high, more vibrations can be seen by putting pieces of paper or empty capsules on the surface of the speaker. Loud volume sounds can be produced by strong vibrations. It shows that loud sound possesses more energy than the soft sound.

Activity 11.2

Fix one end of the meter rod on the edge of the table with the help of screw.

- Press the free end of the meter rod gently. It will vibrate slowly and will produce a soft sound.

- Now push the ruler farther down and release. A louder sound is produced with a higher number of vibrations.

Whenever work is done on an object, energy is given to it. In this case the energy of your hand produces vibrations in the ruler. The ruler produces sound energy in exchange of your energy.

Energy must always be added to an object to produce sound.

How Does Sound Travel?

When someone calls us from a distance, we hear the sound. It means sound travels. But sound needs a medium to travel all the time. The medium may be gas (air), liquid (water) or solid (metal).

Fig.11.4: Sound from the radio can travel through solids, liquids and gases.

Sound is a form of energy that spreads from its source in all directions. It is only possible when the vibrating particles hit each other and pass on the vibrations as sound. That is why sound energy needs a medium for its propagation. Sound energy cannot travel in vacuum due to the absence of any particles.

Sound also loses energy as it travels from one place to the other. Have you ever observed that a loud sound dies

of after travelling for some distance? Have you ever observed that when your friend goes away from you, sometimes your call does not reach him? why?

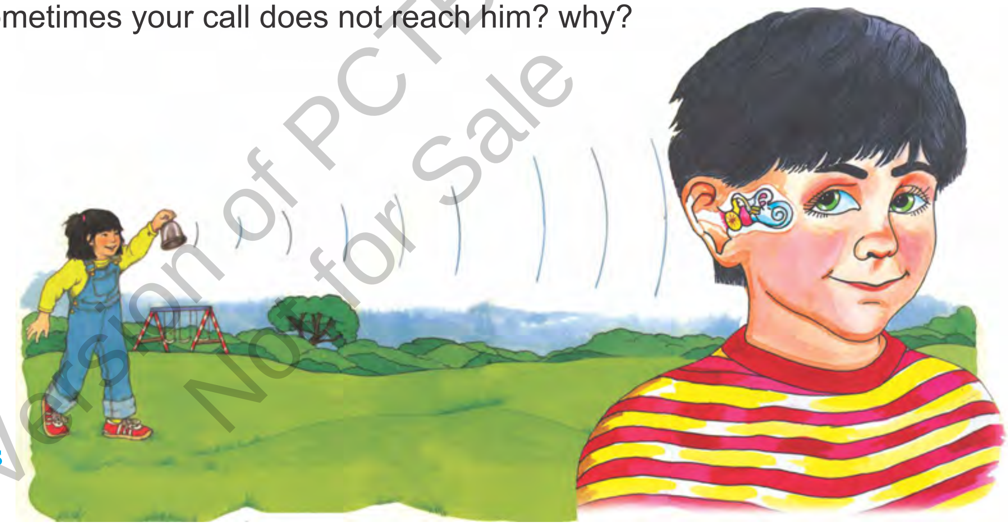
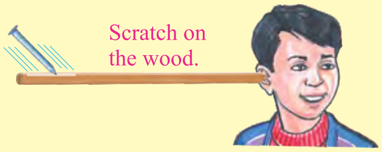
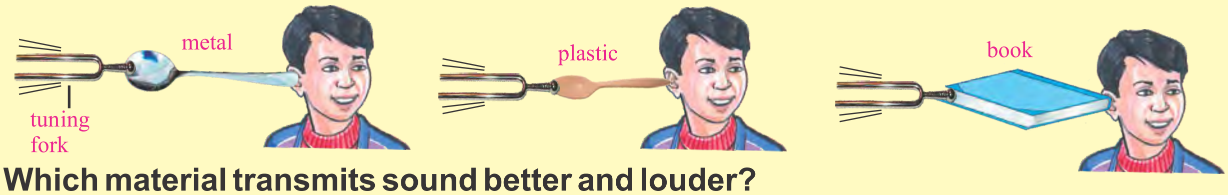


Fig.11.5: Sound vibrations travel in air.

Activity 11.3

Is sound transmitted through wood, plastic, metal and cardboard? Can you hear a scratch through wood that you cannot hear through air? Use a tuning fork with different materials.





Which material transmits sound better and louder?

Activity 11.4

You can hear better through your bones. Try it!

Do some huming. Plug your ears with fingers during huming. The sound of hum hears better, when you plug your ears. Your bones are solid through which sound travels faster.

Speed of Sound in Different Materials

We know that sound travels by passing on its vibrations to the particles of some medium. The speed of a sound depends on what kind of matter it is travelling through.

Air is made of gases. The particles in gases are farther apart than in liquids and solids. It takes longer for one gas particle to hit another and move the sound energy along. Particles in liquid are closer together. Water is a liquid. Sound travels more quickly in water than it does in air. Particles in solids are very closer together than in liquids, so obviously sound travels the quickest in solids.

Fig. 11.6: The particles of solids are very close to each other. You can use a tin-can telephone to talk to your friend because sound travels the quickest in solids.

Table 11.1: Speed of Sound in Gas, Liquid and Solid

Medium	Speed (metre per second)
Gas (air)	350
Liquid (water)	1,500
Solid (steel)	6,000

Activity 11.5

Hit two spoons together in air and then in water. Listen to the sounds carefully in each case. Which transmits sound more efficiently, air or water?

Activity 11.6

You will need: ✲ sealable plastic bag ✲ pencil with eraser ✲ water wooden block

Procedure: 1. Fill the bag with air by blowing into the bag. Seal the bag closed.

2. Hold the bag next to your ear. Cover your other ear with your hand. Listen while your partner taps the bag lightly with the pencil eraser. Record whether the sounds are loud or quiet.
3. **Fill** the bag with water. Seal the bag. Repeat the step 2. Record whether the sounds are louder or quieter than before.
4. Hold the block next to your ear, and cover the other ear. Ask your partner to tap lightly on the block. Record whether the sounds are louder or quieter than before.

Things to think: Does sound travel most easily through solids, liquids, or gases? Explain your answer.

The flash of light in lightning is seen earlier than the sound of thunder. It is because light travels much faster than sound.

Some whales make sound that can be heard up to 160 kilometres away!

Activity 11.7

Observe the sky through your window during the rainy season when it is raining with thunder at night. Will you see the flash of lightning and also hear the sound of thunder at the same time? Which one travels faster light or sound?

Do you know?

A rabbit has very long ears that can move around. These ears can catch many sound waves. If another animal tries to catch a rabbit, the rabbit can hear the sounds from far away distance. Then the rabbit has time to run away.

How does Human Ear Receive Sound?

We have studied the structure of human ear (Fig.11.7) in chapter 2. Here we shall see how it works.

The outer part (pinna) of the human ear directs sounds into the ear canal. Inside the ear canal, the sound waves hit the eardrum. The sound waves make the eardrum vibrate. The eardrum causes three tiny bones in the middle ear to vibrate. Because of their shapes, the bones are named the hammer, the stirrup, and the anvil. Then the vibrations move into the cochlea in the inner ear.

The cochlea is a snail-shaped organ which is filled with a liquid. When the liquid in the cochlea starts to vibrate, tiny hairs in the cochlea move. They convert the vibrations into signals. These signals of sound travel along the auditory nerve to the brain.

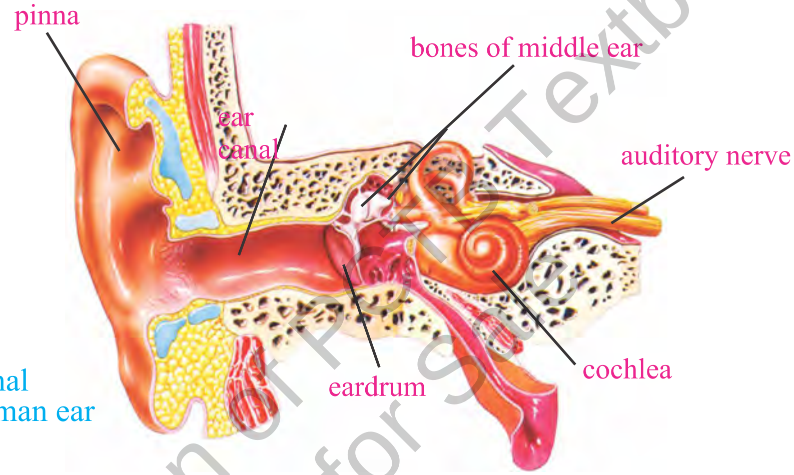


Fig.11.7: Internal structure of human ear

Ear protectors

Protect Your Ears

The ear drum of your ear is very delicate and sensitive. It can easily be damaged. If there is an injury in the ear drum of your ear, you may become deaf.

- Don't enter any object into the ear. It may be dangerous.
- Listening to noise over and over for a long time can cause hearing loss.
- Wear ear protectors at noisy places.

Chapter Review

1. All sounds are produced by vibrating bodies.
2. Sound is a form of energy.
3. Larger amount of energy can produce louder sounds.
4. Sound needs a material medium to travel.
5. Sound travels fastest through solids followed by liquids and gases.
6. Ears receive sound waves, convert them into signals and send them to the brain.
7. Very loud sound or any injury in the ear can make you deaf.

Test Preparation

1. Write proper term/word against each statement.

i. Sound moves the quickest through it ____________________

ii. Speed of sound in it is 350 metres per second ____________________

iii. Carries signals of sound to the brain ____________________

iv. Back and forth movement ____________________

2. Circle the letter of the best answer.

i. Sound waves travel most quickly through:
   (a) solids (b) gases
   (c) air (d) liquids

ii. When does our body use more energy?
   (a) when we speak gently (b) when we talk to our friend
   (c) when we shout over others (d) when we talk to our mother

iii. The speed of sound in steel is:
   (a) 350 metre per second (b) 1,500 metre per second
   (c) 2, 100 metre per second (d) 6,000 metre per second

iv. Sound travels the slowest in:
   (a) water (b) steel
   (c) copper (d) air

v. Which group of people is unable to hear one another?
   (a) a group of mountaineers on K-2 (b) a group of tourists in a desert
   (c) a group of astronauts on the Moon (d) a group of people in a closed room

3. Answer the following questions in detail.

i. Prove that sound is a form of energy.
ii. How does sound travel?
iii. How do we hear sound?

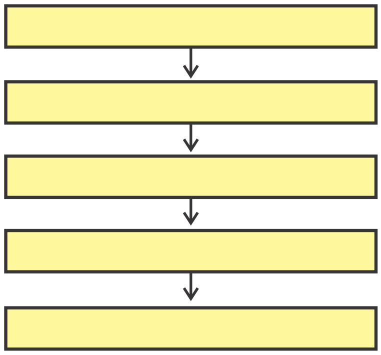
4. Extend your thinking.

i. What happens if you sprinkle paper pieces on a drumhead and then hit the drumstick?
ii. Could sound from a radio travel through a room with no air? Explain.
iii. Does sound move faster through the ear canal or through the tiny bones in the middle ear?
iv. Explain how covering the ears can prevent a person from hearing a sound?
v. How can sounds be harmful and helpful?
vi. Why is there no sound heard in vacuum?
vii. A bird sitting in a tree hears the chirping of another bird. A whale hears the songlike sound made by another whale swimming near it. Which sound travels faster, the bird's chirping or the whale's singing? Explain.

5. Concept Map

Write following words in order of how you hear sound:

hammer, cochlea, brain, eardrum, ear canal



Science Projects

1. Mark a round hole on top of a shoe box and cut it. Place two wooden wedges at the ends of the hole to make the bridges of the stringed musical instrument like zither. Stretch rubber bands of different widths around the box. Pluck the strings to hear a musical note which can be changed by tightening the bands with a drawing pin.
2. Tie a metal object, such as a wire hanger or a spoon, to the center of a piece of string. Wrap each of the two ends of the string around one finger on each hand. Gently place the fingers holding the string in your ears. Let the object swing until it strikes against the edge of a chair or table and listen to the sound. Listen to the sound made by the collisions when your fingers are not in your ears. Does sound travel better through air or through the string?

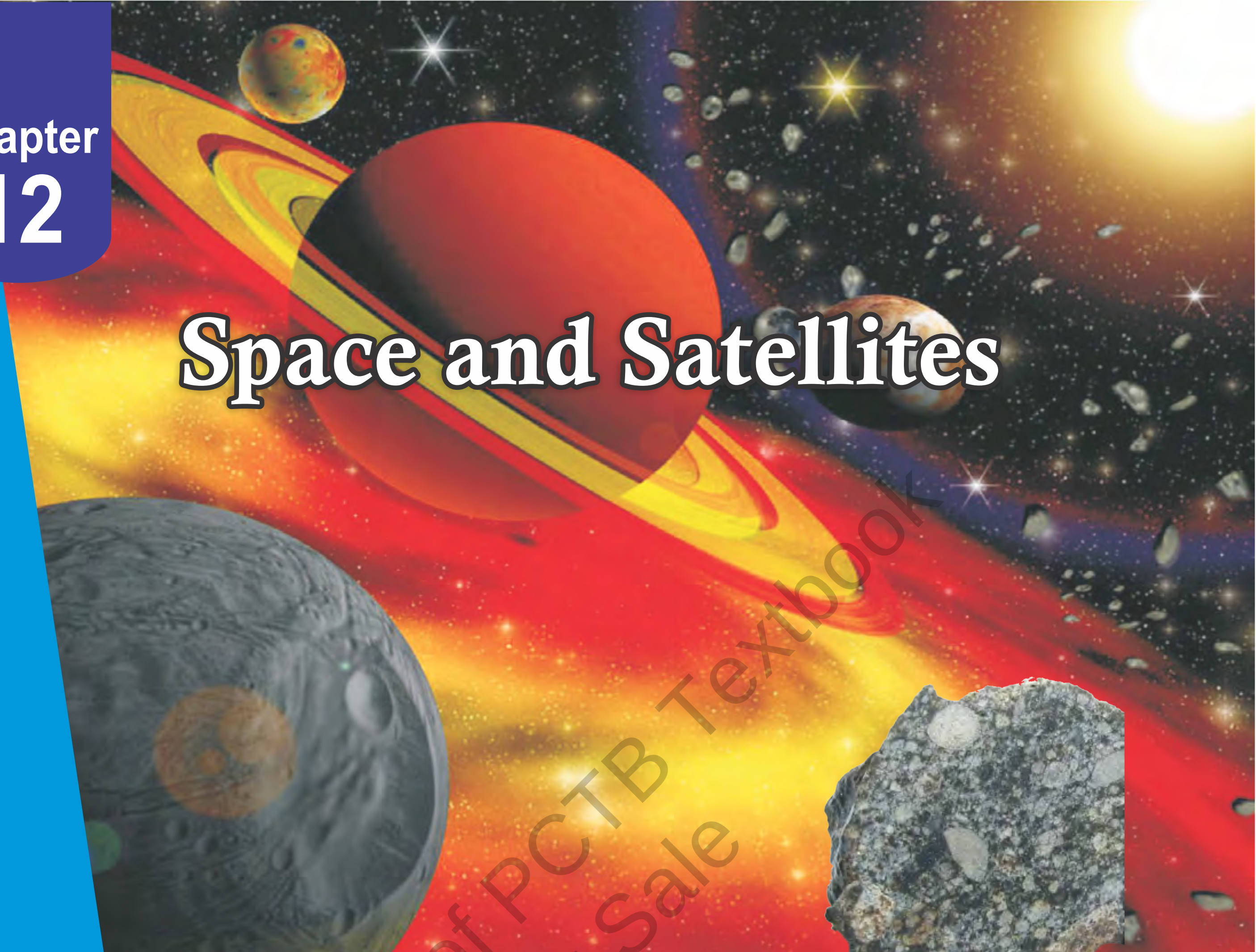
Many more people want to fly in and out of Lahore Airport. The airport needs to build another runway to handle more airplanes. This would bring money and jobs to the local people. Neighbours of the airport object. The added noise might break their windows and damage their hearing. The airport manager agrees that there will be more noise. But he says it will only last a few hours each day. He has to think about the whole city, not just those who live near the airport. The city government will buy the homes of people who want to move away. What are the arguments for a new runway? What are the arguments against the runway?

Computer Links

- www.historyforkids.org/scienceforkids/physics/sound/
- http://scifiles.larc.nasa.gov/text/kids/D_Lab/acts_sound.html

Chapter 12

Space and Satellites



Stars, planets and innumerable rock pieces are wandering in space.

Student Learning Outcomes

After completing this chapter, you will be able to:

- Define the term satellite.
- Compare the physical characteristics of comets, asteroids and meteors.
- Describe different kinds of meteors.
- Inquire into the sighting of Halley's Comet; describe what would you feel if you saw it.
- Define the terms artificial satellites and geostationary satellites.
- Explain the key milestones in space technology.
- Describe the uses of various satellites in space.
- Investigate how artificial satellites have improved our knowledge about space and how they are used for space research.
- Explain how do satellites tell us where we are.

Do you know that all stars, the Sun, the Moon, the Earth, all planets and satellites are called **heavenly bodies?** The heavenly bodies are moving in unimaginable vast space - **universe.**

The Sun, the planets, and their moons are the largest objects in the solar system. But asteroids and comets are the smaller parts of the solar system. We have already studied about the solar system and planets. In this chapter, we shall study other members of the solar system.

Satellites

Any heavenly body that moves around a planet is called a **satellite.** The Moon is a natural satellite of the Earth that orbits the Earth (Fig.12.1). Mars, Jupiter, Saturn, Uranus and Neptune have their own satellites too.

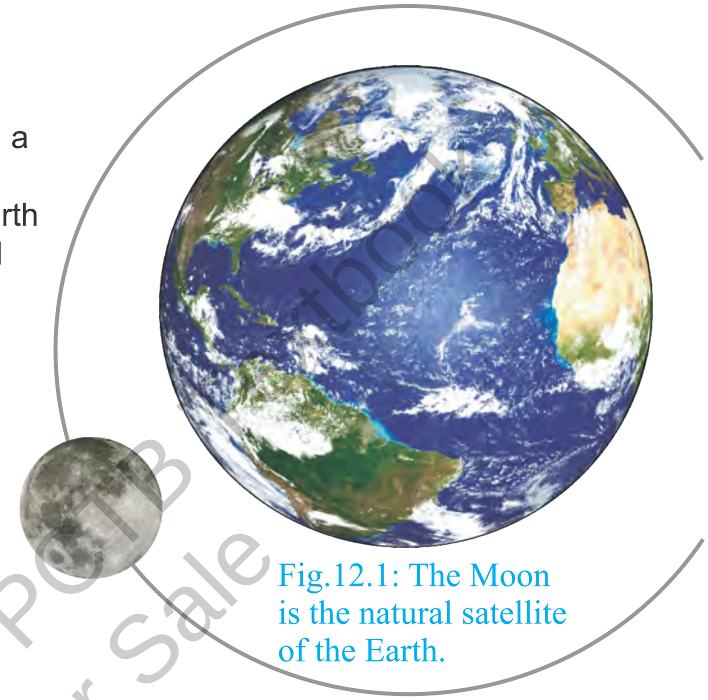


Fig.12.1: The Moon is the natural satellite of the Earth.

Natural Satellites

Beside moons of the planets, some other natural satellites are also moving around the Sun. These are asteroids, comets and meteoroids. Some of them can be seen from the Earth.

Asteroids

An **asteroid** is a piece of rock that orbits the Sun between Mars and Jupiter. The astronomers have discovered thousands of asteroids. Asteroids are made of rock, metals or minerals.

Most of the asteroids orbit the Sun between Mars and Jupiter in a wide band (Fig.12.2). This band is called the **asteroid belt.** The asteroid belt is about 15 hundred thousand kilometres wide. Asteroids come in all shapes and sizes.

Some asteroids have diameter up to 1,000 kilometres but some are very small in diameter.

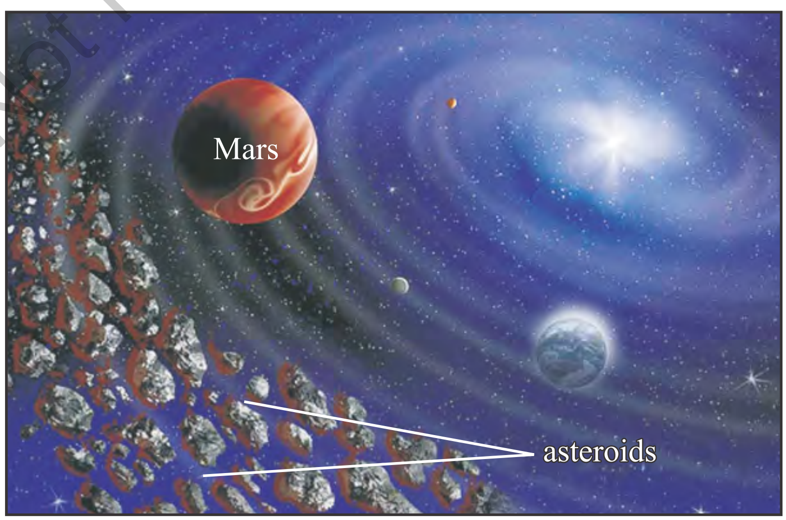


Fig.12.2: Asteroid belt between Mars and Jupiter

Two asteroids are seen from the Earth without the help of a telescope.

These are **Ceres** and **Vesta.** Ceres is the largest asteroid ever discovered (Fig.12.3). Its diameter is about 933 kilometres. Vesta is half the size of Ceres.

A question may arise in our minds, "How were asteroids formed?" Some astronomers suggest that the asteroids are leftover matter from the time the planets were being formed. We can say that asteroids may be the pieces of our solar system that never formed a planet.

Fig.12.3: Ceres is the largest known asteroid. It measures about 933 kilometres.

Do you know?

- Most asteroids complete their one orbit around the Sun in about five Earth years.
- A scientist who studies the stars, planets and other objects in space is called an **astronomer**.

Comets

Besides planets and asteroids some other objects also orbit the Sun. These are comets. A **comet** is a large ball of ice and dust that orbits the Sun. Comets move around the Sun in an elliptical path. They take a very long time to complete their one orbit around the Sun.

Comets probably come from the far, outer edges of the solar system.

They are only seen when they come close to the Sun (Fig.12.5).

A comet has three parts: a **head, coma** and a **tail** (Fig.12.4). The head is made of ice, particles of rocks and gases. The heads of most comets are only a few kilometres wide.

When a comet comes near the Sun, gases escape from its head due to the heat of the Sun. A large, fuzzy, circular cloud around the head of a comet is called the coma.

During orbiting near the Sun, a long tail of gases and dust particles is formed behind the comet. This tail can be millions of kilometres long. The tail of a comet points away from the Sun.

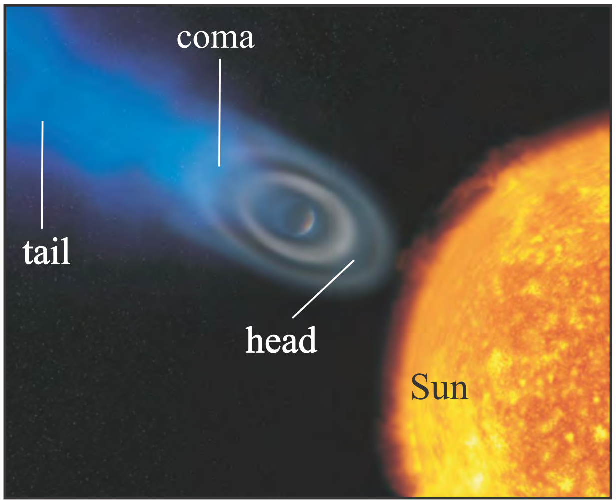


Fig.12.4: The three parts of a comet

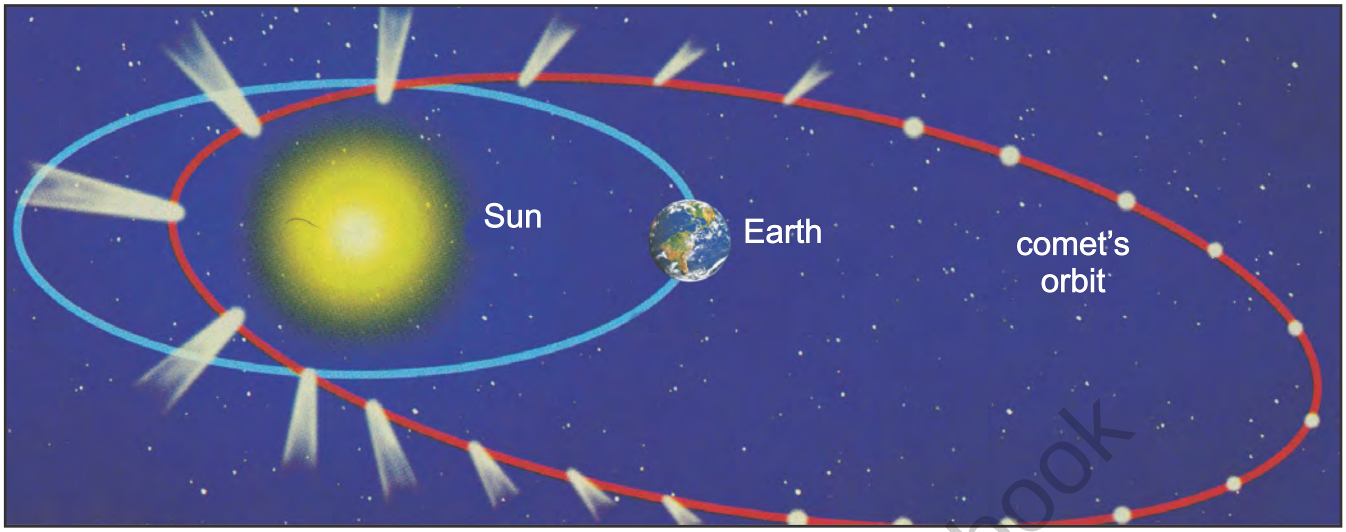


Fig. 12.5: During orbiting near the Sun a comet bears a long tail of gases.

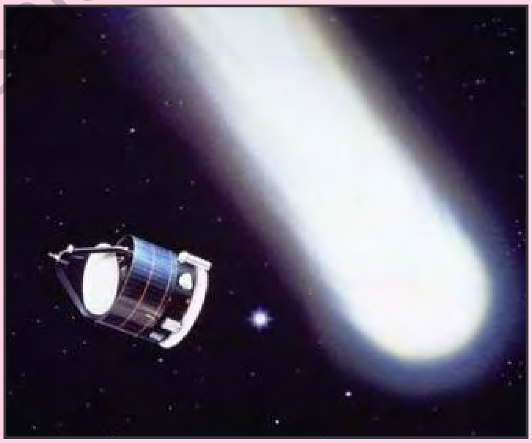
Comets far away from the Sun bear no tail. Most of the time comets remain far away from the Sun.

A comet known as **Comet Halley** has appeared in the sky many times. It appears after every 76 years. It was seen in 1986 for the last time.

When can we expect to see Comet Halley again?

People in the past had been sighting the **Comet Halley** in different ways. Some people sighted it as a long-haired star. Some sighted it as having a tail streaming like smoke up to nearly half the sky. Some sighted it as having a tail like a broom or like the blade of sword. To some people it looked like a dragon with multiple tails. Many people were also afraid of this comet.

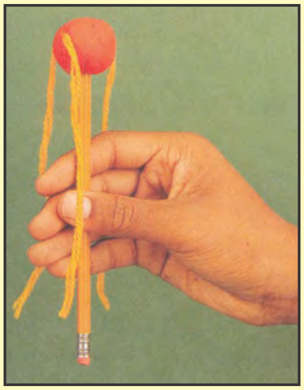
European scientists sent a space probe **Giotto** to meet Comet Halley in 1985-86. Giotto sent many pictures of the Comet Halley back to the Earth. Its head was black in colour. As the Giotto moved through the coma of the comet, itwas struck by the particles of ice and dust.



Activity 12.1

1. Form a small ball out of modeling clay to represent a comet.
2. Using a pencil point, push three 10cm lengths of string into the ball. The string represent the comet's tail. Stick the ball onto the pencil point, as shown in the picture.
3. Hold the ball about 1 metre in front of a fan. The air from the fan represents the solar wind. Move the ball toward the fan, away from the fan, and from side to side.

Things to think: How does moving of the ball affect the direction in which the strings point? Which way the tail of a comet points?



Meteors

Uncountable number of small heavenly bodies also orbit the Sun. These are called meteoroids. A **meteoroid** is a piece of rock or metal that orbits the Sun. Meteoroids are scattered in different orbits in space. Most of them are too small to be seen from the Earth.

Have you ever seen a shooting star or fireball in the sky? In fact, it is not a star but a meteoroid entering the atmosphere of the Earth. Due to the friction of air, it gets fire (Fig.12.6).

A meteoroid when enters the atmosphere of our Earth, it is called a meteor. A **meteor** is a stray particle which comes from the asteroid belt and enters the atmosphere of the Earth. Due to the friction of air, the meteor gets fire and a trail of light is seen. Some people call them falling stars, shooting stars, or fireballs . We can view 20 to 30 meteors on a clear night. But we have to move away from the glare of city lights.

Most meteors entering our atmosphere burn up 50 to 100 kilometres above the surface of the Earth. It adds tons of dust into our atmosphere everyday.

Sometimes a few big enough meteoroids do strike Earth's surface. These are called meteorites. A **meteorite** is a meteor that strikes Earth's surface.

Fig.12.6: Meteoroids make streaks of light as they burn up in the atmosphere.

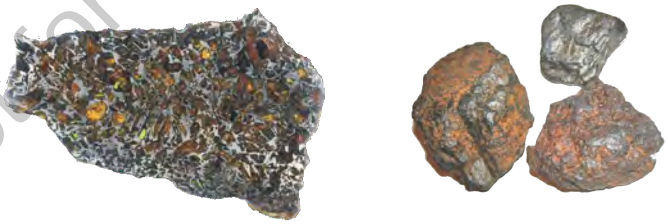
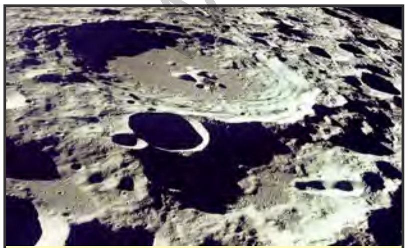


Fig.12.7: A few big meteorites



The spots on the Moon are meteoroid craters on its surface. Can you explain how were these craters formed?

In 1920, a very big meteorite named **Hoba** struck the Earth in Namibia (Africa). It weighs 60 tons.

Very long ago a huge meteorite made a crater 180 metres deep and 1,200 metres wide. It is located in Arizona (America).

Activity 12.2

1. Place a magnet inside a clear plastic bag. Then move the bag-covered magnet through the rainwater your teacher has collected.
2. Use a hand lens to look carefully at the outside of the bag. If you find any small spheres, or round objects, use a stick to scrape them onto a microscope slide.
3. Observe the objects through a microscope. If they still look like round objects, what you probably have are meteorites–pieces of space dust that came to Earth as falling stars!

Things to think: What might cause most meteorites to be rounded in shape?

Artificial Satellites

There are many man-made satellites orbiting the Earth. These are called **artificial satellites**. Artificial satellites are very important for mankind. The first artificial satellite was sent by Russia in 1957. It was named **Sputnik-1** (Fig.12 .8). Launching of this satellite opened new horizons for the scientists. After a few years of launching Sputnik-1, Russia sent **Yuri Gagarin,** the first man into space. Since then, thousands of satellites have been sent into space.

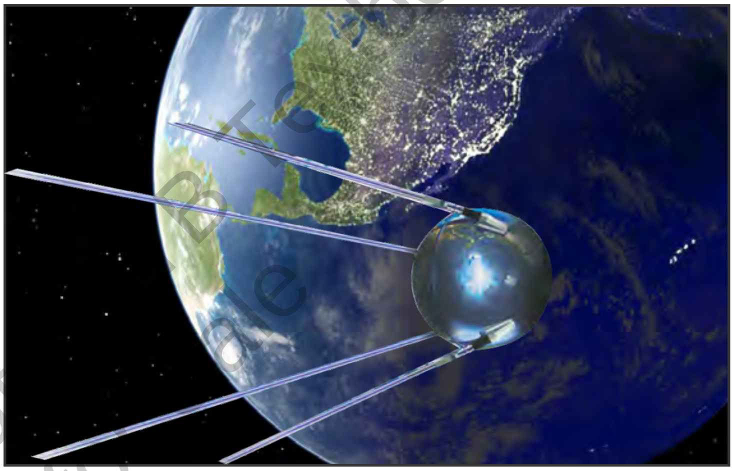


Fig.12.8: Sputnik-1 was the first small step of man in space.

Orbits of Artificial Satellites: Artificial satellites move around the Earth in different orbits. Some orbits are given here:

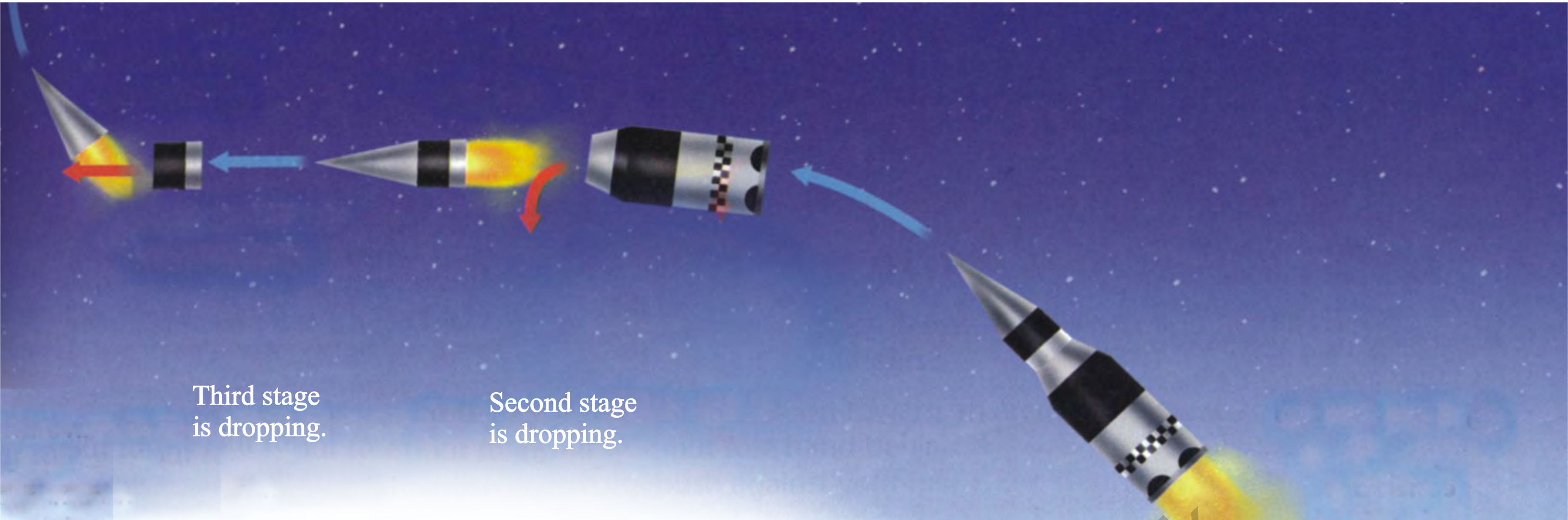
Geostationary Orbit: The orbit in which an artificial satellite completes its one orbit in the same time that the Earth takes to complete one spin, i.e. 24 hours, is called *geostationary orbit*. A satellite in this orbit looks stationary from the Earth.

Polar Orbit: *Polar orbit* passes over the north and south poles of the Earth. So, satellites moving in this orbit can scan the whole Earth during their motion.

Eccentric Orbit: The scientific satellites move in *eccentric orbit* to measure magnetism and electric fields of the Earth.

Low Earth Orbit: This orbit is very close to the Earth. *Low Earth orbit* is used by space shuttles, space stations and the Hubble Telescope. These satellites may orbit the Earth every 90 minutes.

Satellite Receiving Station: A station on the Earth that receives messages from the satellites is called a *satellite receiving station*.



Launching of a Satellite into Space

Launching of an artificial satellite into space is not very easy. This project requires a lot of money. The satellite is mounted on the top of a very high speed **rocket**. A rocket has many parts (Fig.12.9). Each part of the rocket falls off after pushing the satellite through the atmosphere into space. After a certain period of time all the artificial satellites will burn up like meteors.

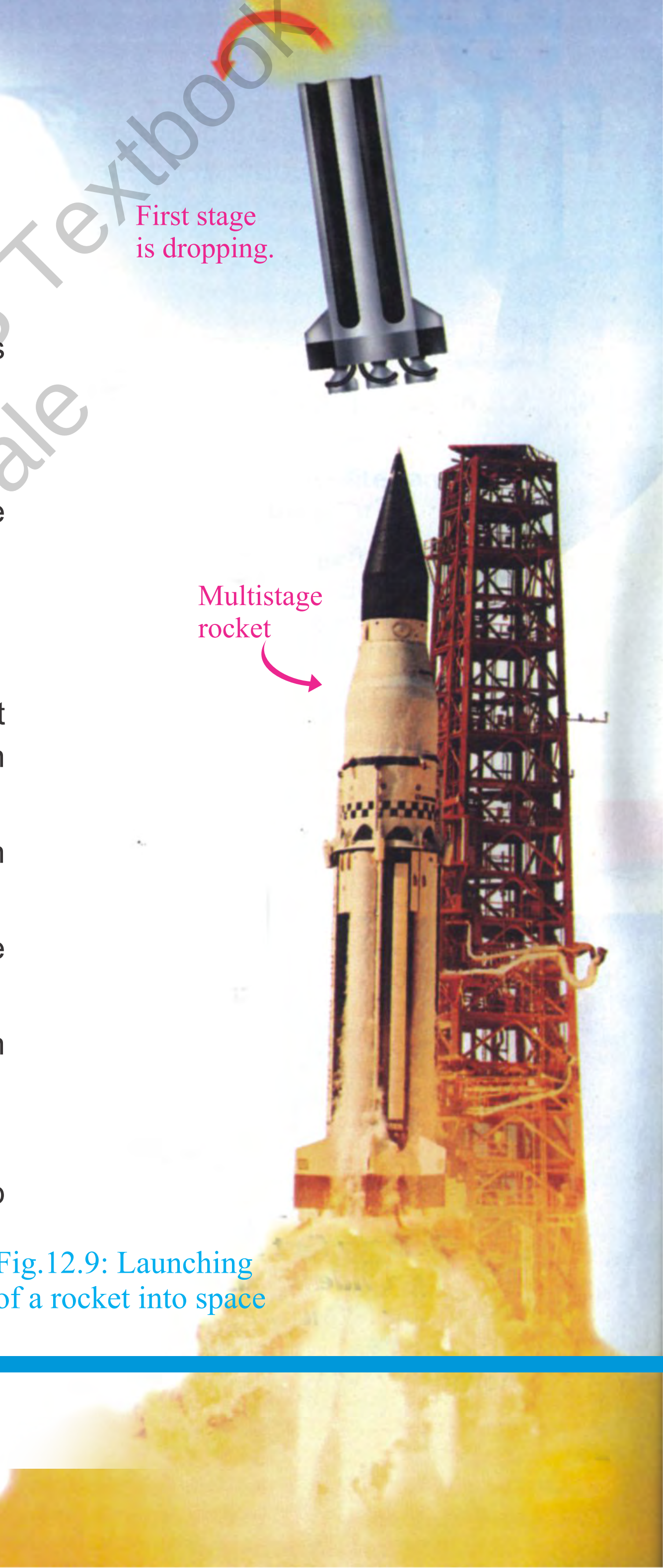


Fig.12.9: Launching of a rocket into space

Key Milestones in Space Technology

Here is a look at some of the key milestones in space technology:

October 4, 1957: Soviet Union launches Sputnik-1.

January31,1958: United States launches Explorer 1.

April 12,1961: Yuri Gagarin becomes the first human to enter space and return safely.

July 16, 1969: Launch of Apollo 11. It puts first man on the Moon.

May 14, 1973: United States launches its first space station, the Skylab.

June 18, 1983: Sally Ride becomes first American woman in space.

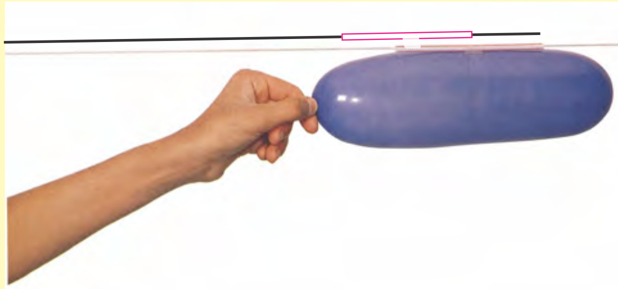
February 19, 1986: Mir space station launches.

September 30, 2003: First privately owned spaceship launches.

August 4, 2007: Phoenix lander lands on Mars.

Activity 12.3

Pass a length of strong thread through a drinking straw. Tie the ends of the thread to window grills on opposite sides of a room. Inflate a long balloon and pinch its end with your fingers. Fix the balloon to the straw with the tape. Remove your finger to see the balloon rocket fly across the room.



Kinds of Artificial Satellites

Scientists have sent many satellites which move around the Earth. These satellites help scientists to learn about weather and many more things on the Earth.

Sputnik-I

On October 4, 1957, Russia sent the world's first artificial satellite, Sputnik-1 into space. The name comes from a Russian word for "travelling companion of the world." It weighed just 83 kg. It carried a thermometer and two radio transmitters which sent information about the atmosphere to the Earth. Its two transmitters functioned only for 21 days. After 57 days in orbit, it was destroyed .

Explorer 1

Explorer 1 was the first satellite launched by the United States of America. It was sent into space on January 31, 1958. It weighed only 14kg. Explorer 1 sent information about the radiation environment in Earth orbit.

Geostationary Satellites

Geostationary satellites move at a height of about 36,000 km above the Earth. At this height they move around the Earth at the same speed as the Earth moves around its axis. This satellite seems to be stationary. They are used as communication satellites. Pakistan launched its first geostationary satellite, PAKSAT-1R on August 11, 2011.

Landsat Satellites

The Landsat satellites are a series of satellite missions. Since 1972, Landsat satellites have collected information about Earth from space. Landsat satellites have taken photographs of Earth's continents and surrounding coastal regions.

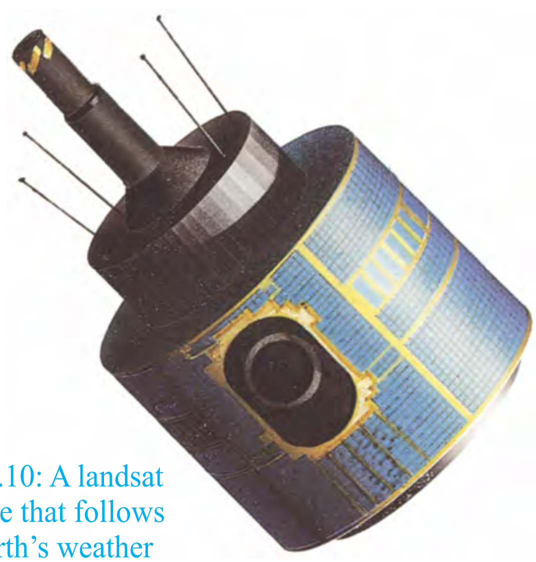


Fig.12.10: A landsat satellite that follows the Earth's weather

Communication Satellites

Communication satellites have a great effect on our daily life. They link remote areas of the Earth with telephone and television. Newspapers are typed and transmitted to printing machines via satellite in some countries.

Fig.12.11: This telecom satellite passes telephone messages from one side of the world to the other.

Polar Satellite

Polar satellite was launched on February 24, 1996 by America. Polar satellite studies atmosphere of the Earth in polar orbit after every 18 hours. Polar satellite will help scientists to protect future satellites from atmospheric dangers.

Global Positioning System

Satellites have improved our knowledge about space and even about our Earth. Using satellites, you can find your position anywhere in the world accurate to 1Om or less. Locating the position of objects with the help of a satellite is called the **Global Positioning System or GPS**. It is freely accessible by anyone with a GPS receiver.

Visiting The Space

- In 1969, two Americans were the first men to step on the Moon. They were **Neil Armstrong** and **Edwin Aldrin**.
- India sent her first satellite **Aryabhatta** into space in 1975.
- Pakistan sent her satellite **Badr-I** in 1990s.

Chapter Review

1. Any heavenly body that moves around a planet is called a satellite.
2. Asteroids are discovered moving between Mars and Jupiter.
3. A comet is a heavenly body made of ice and dust particles. It has three parts; a head, coma and a tail.
4. Meteoroids are pieces of rock or metal. They also orbit the Sun.
5. Man-made satellites orbiting the Earth are called artificial satellites. Sputnik, Explorer 1, Communication and Polar satellites are different kinds of artificial satellites.
6. Artificial satellites move around the Earth in different orbits.
7. A rocket is used to launch a satellite into space.

Test Preparation

1. Write proper term/word against each statement.

i. First artificial satellite in space ____________

ii. A system which helps us find our position anywhere in the world ____________

iii. The largest asteroid ever discovered ____________

iv. A small body made of ice and dust that orbits the Sun ____________

2. Circle the letter of the best answer.

i. The asteroid belt is located between:
(a) Jupiter and Saturn
(b) Earth and Mars
(c) Mars and Jupiter
(d) Venus and Mars

ii. The Comet Halley appears after:
(a) 35 years
(b) 50 years
(c) 60 years
(d) 76 years

iii. The first human in space was:
(a) Edwin Aldrin
(b) Neil Armstrong
(c) Dr. Sally Ride
(d) Yuri Gagarin

iv. Locating the position of objects with the help of a satellite is called:
(a) GRS
(b) GMS
(c) GPS
(d) PGS

v. The tail of a comet points:
(a) towards the Sun
(c) towards the Earth
(b) away from the Sun
(d) away from the Earth

vi. The first artificial satellite was sent into space in:
(a) 1939
(b) 1952
(c) 1957
(d) 1969

3. Answer the following questions in detail.

i. Write a detailed note on comets.
ii. What do you know about asteroids and meteors?
iii. What are the key milestones in space technology?
iv. Write a note on any three artificial satellites.

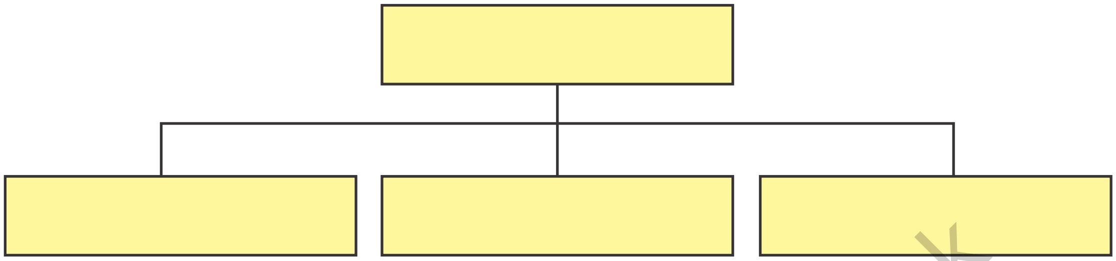
4. Extend your thinking.

i. How are asteroids and meteorites alike? How are they different?
ii. Why does a comet's tail always stream away from the Sun?
iii. Is it not a good idea to make the space station an international project?

5. Concept map

Complete the concept map using following words:

asteroids, solar system, comets, meteors



sometimes enter Earth's atmosphere

space objects made of ice and dust

move between Mars and Jupiter

Science Projects

1. Fill a tray with flour. From a height, drop a small stone into it. Carefully remove the stone to see the crater it has made. How are craters formed on the surface of the Moon?
2. On a table next to a window place a shaving mirror facing the Moon. Place another mirror opposite the first one facing inwards. Take a magnifying glass in your hand and stand at an angle from where you can see the Moon in the mirror facing inwards. Raise the magnifying glass and through it see a magnified (larger) view of the Moon in the mirror facing inwards.

Caution: Do not try to observe the Sun using this experiment. It can damage your eyesight.

Today there is a large telescope in orbit around the Earth. Its name is the Hubble Space Telescope. Even though the mirror in the Hubble Space Telescope is smaller than that of many telescopes on the Earth, it can see more clearly. Why does the Hubble Telescope takes clearer pictures than telescopes on Earth? Why is there a need of such telescopes in space?

Computer Links

- http://www.space.com/
- http://www.nasa.gov/worldbook/asteroid_worldbook.html

GLOSSARY

Abiotic component: anything in an ecosystem that is not living.
Asteroids: a space object that orbits the Sun between Mars and Jupiter.
Atmosphere: thick blanket of air around the Earth.
Atom: a small particle that makes up matter.
Auditory nerve: a nerve that carries signals of sound from ear to brain.

Biotic components: all the living things found in an environment.
Brain: the body's nerve centre which controls everything that the body does.

Cell organelles: parts inside a cell that allow it to function.
Cell: basic unit of structure and function of living bodies.
Chlorophyll: green material in plants that captures energy from sunlight for photosynthesis.
Chromatography: the process of separating components of coloured chemicals.
Cochlea: a coiled tube in internal ear that is filled with fluid and tiny hairs.
Comet: a small body of ice and rock that gives off gas and dust in the form of a tail as it passes close to the Sun
Community: all the populations living in the same place.
Compound machine: a machine made of two or more simple machines.
Compound: a material made up of two or more elements combined chemically.
Concave mirror: a mirror with a surface that curves inward.
Concentrated solution: a solution with greater amount of solute.
Conversion of energy: change of energy from one form into another.
Convex mirror: a mirror with a surface that curves outward.

Deaf: a person who cannot hear.
Decomposers: organisms that feed on dead plant and animal matter.
Diffused reflection: reflection that occurs when parallel rays of light hit a rough surface and reflect at different angles.
Dilute solution: a solution with lesser amount of solute.
Distillation: the process by which vapour of a heated liquid is condensed and turned into a substance free of impurities.
Driven wheel: a wheel of gear system which turns due to the movement of the driving wheel.
Driving Wheel: a wheel of gear system on which force is applied.

Eardrum: thin skin that covers the middle ear.
Ears: the sense organs with which we hear.
Ecosystem: all the living and non-living things that interact in an area.
Element: a material made up of only one kind of atoms.
Energy converters: devices which change the form of energy.
Energy: the capacity of a body to do work.
Environment: everything that surrounds a living thing.
Epidermis: the outer, protective layer of the leaf.
Eyes: the sense organs with which we see.

Fixed pulley: a kind of pulley whose axle is fixed with some support and does not move.

Gear: a wheel with jagged edges like teeth.
Global Positioning: locating the position of objects with the help of a satellite.
Green house effect: increase in the temperature of Earth due to the presence of higher amounts of carbon dioxide in air.

Incident ray: the ray which strikes the mirror.
Iris: the coloured part of the eye.

Kaleidoscope: a device in which constantly changing patterns of simple designs can be viewed.
Kinetic energy: energy of matter in motion.

Law of Conservation of Energy: a law which states that energy cannot be created or destroyed.
Law of Reflection: the angle of incidence is equal to the angle of reflection.
Limiting factors: the factors necessary for the process of photosynthesis

Meteor: a stray piece of metal or rock from space that enters Earth's atmosphere and glows.
Meteorite: a meteor that strikes Earth's surface.
Meteoroid: a piece of metal or rock that orbits the Sun.
Microscope: a device used to see invisible things.
Mixture: a material made of two or more substances mixed together physically.
Molecule: a combination of two or more atoms.
Moveable pulley: a kind of pulley which moves together with the load.
Multicellular organism: an organism which consists of several cells.

Non-renewable Energy Sources: energy sources which are not recoverable.
Nose: the sense organ with which we smell.
Nucleus: the control cent reof a cell.
Nuclear energy: the energy present in the nucleus of an atom.

Organ: a group of different tissues that work together.
Organ system: a group of organs which work together to do one or more than one special functions.

Periscope: a device which is used to see beyond obstacles.
Phloem: tubes responsible for the conduction of prepared food in plants.
Photosynthesis: the process by which plants make their food using carbon dioxide, water and sunlight.
Pin-hole camera: a device which makes use of the fact that light travels in straight lines.
Pitch: how high or low a sound is.
Plane mirror: a flat mirror that produces an upright, virtual image of the same size as the object.
Potential energy: the energy an object has because of its position.
Predator: an animal that hunts and eats other animals.
Pulley: a simple machine made of a wheel which turns round an axle.

Rare gases: gases present in very small amounts in air.
Real image: an image which can be obtained on a screen.
Reflection: the bouncing back of a light ray when it hits a surface through which it cannot pass.
Regular reflection: reflection that occurs when parallel rays of light hit a smooth surface and all reflect at the same angle.
Renewable Sources of Energy: energy sources that can be replaced in nature at a rate close to the rate at which it is used.
Respiration: energy producing process in organisms.
Rough: a material with bumpy or uneven surface.

Satellite: A natural or artificial body that revolves around a planet.
Saturated solution: a solution in which no more solute is dissolved at a given temperature.
Sense organs: organs that help us know what is happening around us.
Simple machine: a tool which makes our work simpler and easier. Lever, wheel and axle, pulley, inclined plane, wedge and screw are simple machines.
Skin: the sense organ with which we feel.
Smog: combination of smoke and fog.
Solubility: ability of one substance to dissolve in another.
Solute: the substance that is dissolved in a solution.
Solution: a homogenous mixture of two or more components.
Solvent: the substance that dissolves another substance in a solution.
Speed: rate of motion.
Stomata: pores in leaves that help exchange of gases.
Sublimation: the change of state from a solid directly into a gas.
Suspension: a mixture in which particles of solute are suspended through out a liquid or gas and are large enough to settle down.

Telescope: a device that forms enlarged images of distant objects and makes them appear closer.
Tissue: a group of cells that perform similar function.
Tongue: the sense organ with which we taste.
Translucent: a material that scatters light as it passes through.
Transparent: a material that transmits light.
Troposphere: the layer of the atmosphere closest to the Earth's surface.

Unicellular organism: an organism which consists of only one cell.

Vascular bundle: a collective name given to xylem and phloem.
Vibration: a very quick back-and-forth movement.
Virtual image: an image which cannot be obtained on a screen.
Volume: loudness of a sound.

Wheel and Axle: a simple machine with a centre rod attached to a wheel.
Wind: moving air

Xylem: tubes responsible for the conduction of water from roots to the leaves.

Index

This index lists the pages on which topics appear in this book.

ACKNOWLEDGEMENTS

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