Class-VII

The LIVING WORLD

(A Book of Science & Technology)

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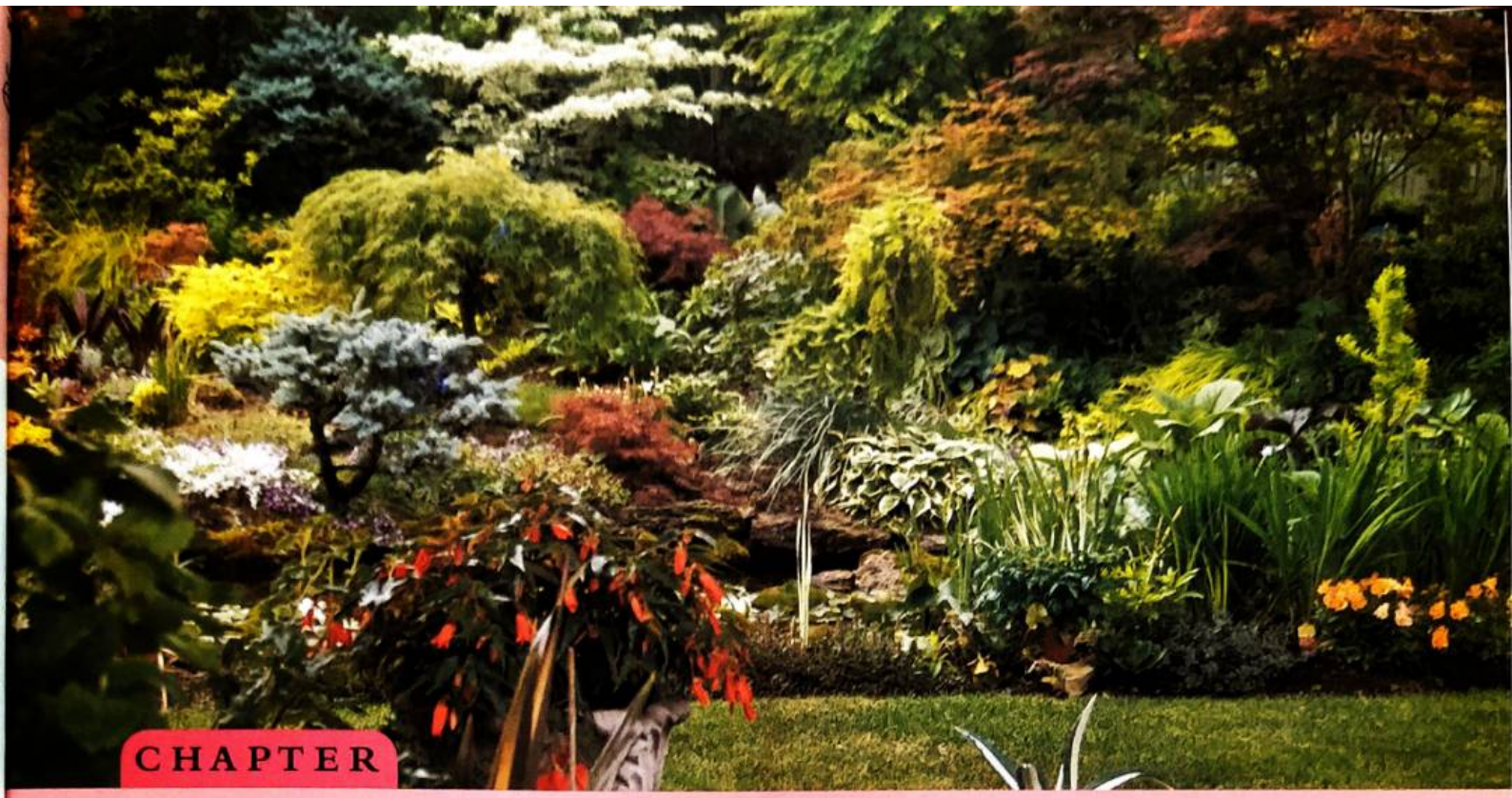


CHAPTER

1 Nutrition in Living Organisms—Plants

In Class-VI, we have already learnt that food is essential for all living organisms. We also learnt that carbohydrates, proteins, fats, vitamins and minerals are all important components of our food. These components of food are necessary for our body and are called **nutrients**. The nutrients enable living organisms to build their bodies, to grow, to repair damaged parts of their bodies and to provide the energy to carry out life processes.

Nutrients are 'taken in' through their food by living organisms and are utilised in their bodies. This process of obtaining, and utilising food by an organism, is known as **nutrition**. The process of obtaining food is not the same in all organisms. On the basis of food habits, the modes of obtaining the required nutrition, by the body, have been divided into the following two categories:

- **Autotrophic Nutrition**

  It is the mode of nutrition in which organisms can make their own food from simple raw materials. All green plants and some bacteria are **autotrophs.** (In Greek, *auto* = self, *trophe* = nutrition).

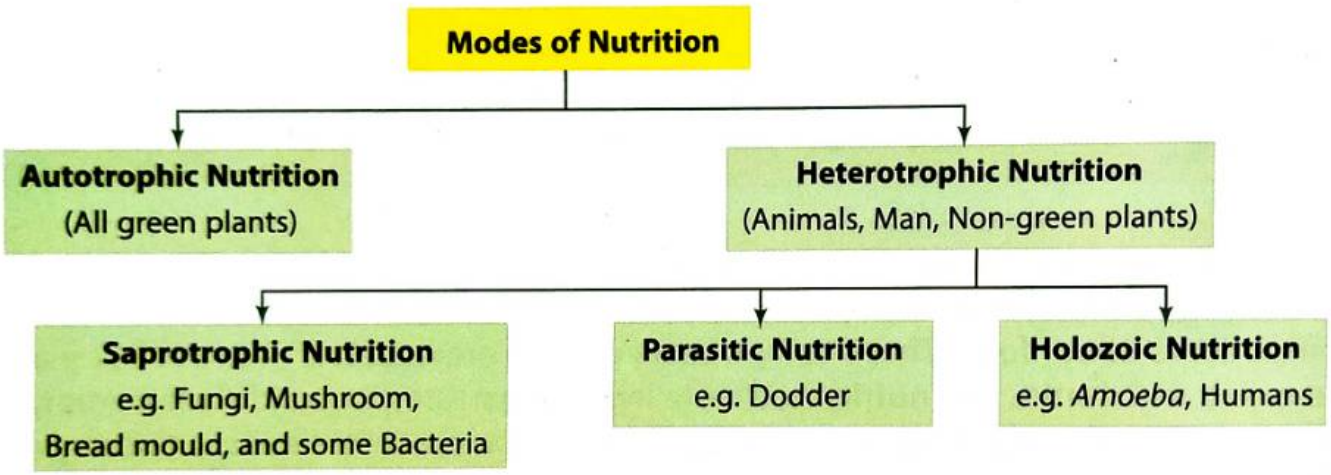
- **Heterotrophic Nutrition**

  It is the mode of nutrition in which organisms cannot prepare their food on their own and depend on others for it. All animals, and a few plants, are **heterotrophs.** (In Greek, *heterone* = (an) other)

I can prepare my own food by using water and carbon dioxide in the presence of sunlight that is captured by chlorophyll.

I cannot prepare food on my own. I depend on plants for food.

Let us study the following flow chart.



Do You Know ?

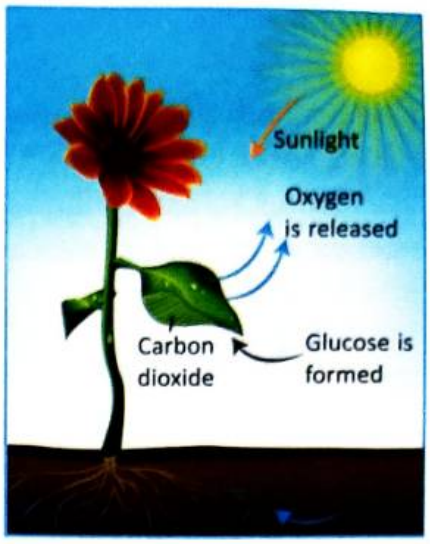
Euglena is an organism that shows both autotrophic and heterotrophic modes of nutrition. It has both plant and animal-like features.

Photosynthesis–Food Making Process in Plants

The synthesis of food in plants occurs in their leaves. Hence, leaves are called the **food factories** of the plants. The leaves have a green pigment called **chlorophyll**. It helps leaves to capture the energy of the sunlight. This energy is used by the plants to synthesise their food using carbon dioxide and water. This process is called **photosynthesis**

(**photo** = light, **synthesis** = to combine) as it takes place in the presence of sunlight. This process can be written in the form of the following equation:

carbon dioxide + water $\xrightarrow[\text{chlorophyll}]{\text{sunlight}}$ carbohydrate + oxygen (glucose)



Photosynthesis

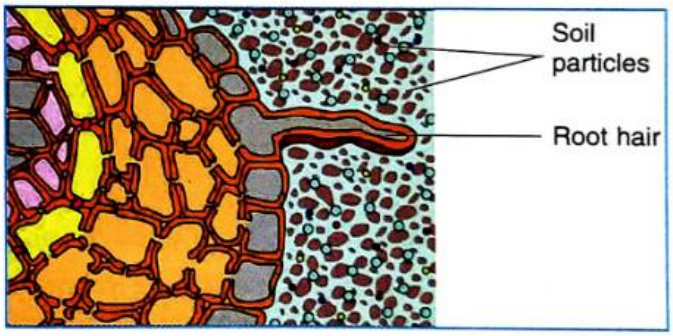
Raw Materials for Photosynthesis

From the above equation, it is clear that carbon dioxide and water are the raw materials for photosynthesis. For this process, chlorophyll and presence of sunlight/light are also necessary. Since food is synthesised in leaves, all the raw materials need to reach there.

Water and minerals (From soil) → **Raw materials for photosynthesis** ← Carbon dioxide (From air)

Water and Minerals

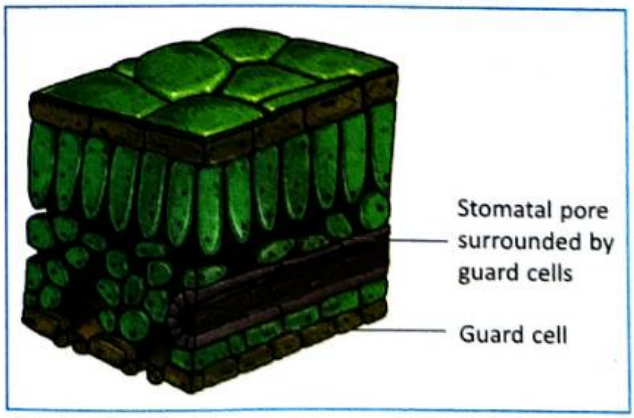
These are absorbed by the roots from the soil. From here, water and minerals are transported to other parts of the plant by the 'vessels'. **Vessels** are tubes that run throughout the root, the stem, the branches and the leaves. You will learn more about this in Chapter 8.



Roots absorb water and minerals from soil

Carbon dioxide

Plants take carbon dioxide from the atmosphere. Carbon dioxide enters the leaves through tiny pores present on the surface of leaves. Such pores are called **stomata**. The stomata are surrounded by special cells called **guard cells**.



Enlarged portion of leaf epidermis showing stomata

Activity 1

Take a potted plant. Apply a thin coat of vaseline on both sides of a leaf. Observe the plant for a few days. While all the other leaves remain green, the one, coated with vaseline, becomes yellow and falls off. This happens because the stomata of such a leaf get blocked. Such a leaf, cannot, therefore, take gases (like carbon dioxide and oxygen) from the atmosphere.

- ### Sunlight

  Sunlight is the light and energy that comes from the Sun. During photosynthesis the plants use the energy of sunlight to prepare food. That is why the food making process, in plants, is called **photosynthesis**. (Photo = light, synthesis = to combine)

- ### Chlorophyll

  The leaves are green due to the presence of a pigment—chlorophyll. It helps the leaves to capture solar energy. This energy is used to prepare food from carbon dioxide and water.

Do You Know ?

Some plants have leaves that are not green in colour. Such leaves contain chlorophyll but the green colour is masked due to the presence of other coloured pigments. The presence of additional pigments causes other leaf colours, such as red in coleus and purple in red cabbage. However, such leaves can still perform photosynthesis.

However, some variegated leaves have yellow patches. Such yellow areas on the leaf do not contain any chlorophyll and hence, cannot perform photosynthesis.

Photosynthesis is a unique process. It is this process that supplies food, directly or indirectly, for all living organisms. The energy of the sun, thus, gets passed on to all organisms through plants. Plants also provide oxygen, needed by all living organisms, for respiration. Can you imagine life on earth in the absence of photosynthesis?

Do You Know ?

Both deer and lion depend on plants. If there were no plants, deer would not survive and if there were no animals, like deer, the lions, too, would die. Plants, in turn, depend on solar energy. Hence, solar energy is the ultimate source of energy for all living organisms.

Products of Photosynthesis

The initial product of photosynthesis is a carbohydrate—glucose. It next gets converted to starch whose presence, in the leaves, indicates the occurrence of photosynthesis. Carbohydrates contain carbon, hydrogen and oxygen. Some carbohydrates are also converted to proteins and fats. Besides carbon, hydrogen and oxygen, proteins also contain nitrogen. Now where does this nitrogen come from? Nitrogen is present in the air but plants cannot use this nitrogen directly. Some bacteria, present in the soil, convert gaseous nitrogen into its usable form which is soluble and is, therefore, absorbed by roots along with water. Roots are also able to absorb nitrogenous compounds, present in fertilisers, that are added to the soil.

Other Modes of Nutrition in Plants

Some plants cannot synthesise their own food because they do not contain chlorophyll. Such plants depend on food produced by other plants. Their mode of nutrition is, therefore, **heterotrophic**. One such plant is *Cuscuta* (*amarbel*, dodder). It can be observed as a yellowish thread-like structure, without leaves, growing on other plants. *Cuscuta* is a **parasite** since it derives its nutrition from some other living organism and causes harm to that organism. The plant, on which it grows, is known as 'the **host**.'

Cuscuta-Dodder growing on a bush

Pitcher plant

Have you heard of insect-eating plants? There are plants that feed on insects for their nitrogen requirements. Some parts of such plants get modified to trap insects. For example, the leaf, of the pitcher plant, gets modified to form a pitcher with a lid. The lid is able to open and close the mouth of the pitcher. The pitcher is lined with downward-pointing hairs. When an insect enters, it cannot climb back out against the hairs and ultimately falls to the bottom of the leaf, and gets digested by the juices present there. Such insect-eating plants are called **insectivorous plants**.

Modes of Nutrition for Other Organisms

Saprotrophic Mode of Nutrition

'*Sapros*' means rotten and 'trophic' means food. **Saprotrophic nutrition** is the process in which the organisms feed on dead and decaying matter. The food gets digested outside the cells, or sometimes, even outside the body of the organism. This type of digestion is called **extracellular digestion**. The organism secretes digestive juices directly onto the food. These digestive juices make the food soluble; the organism then directly absorbs it. Some organisms, which have saprotrophic nutrition, are *Rhizopus* (bread mould), *Mucor* (pin mould), Yeast, *Agaricus* (mushroom) and many bacteria.

Do You Know ?

You must have observed (i) a white cottony growth on leather articles in humid weather (ii) mushrooms growing on rotting wood and (iii) greenish-blue patches on rotting fruits. A cottony growth, developing into coloured patches, is a common occurrence on stale bread. These organisms belong to the group of fungi and bacteria, and they exhibit the saprotrohic mode of nutrition.

Symbiotic Relationship

Sometimes two organisms live in close association and develop a relationship that is beneficial to both. This is called **symbiotic relationship**. (In Greek, *symbion* = "to live together"). Some algae and fungi live in the roots of trees. They receive shelter and nutrition from the tree; in return, they help the trees to absorb water and minerals more efficiently.

Lichen is a living partnership between a fungus and an alga. The fungus absorbs water and provides shelter. The alga prepares food by photosynthesis.

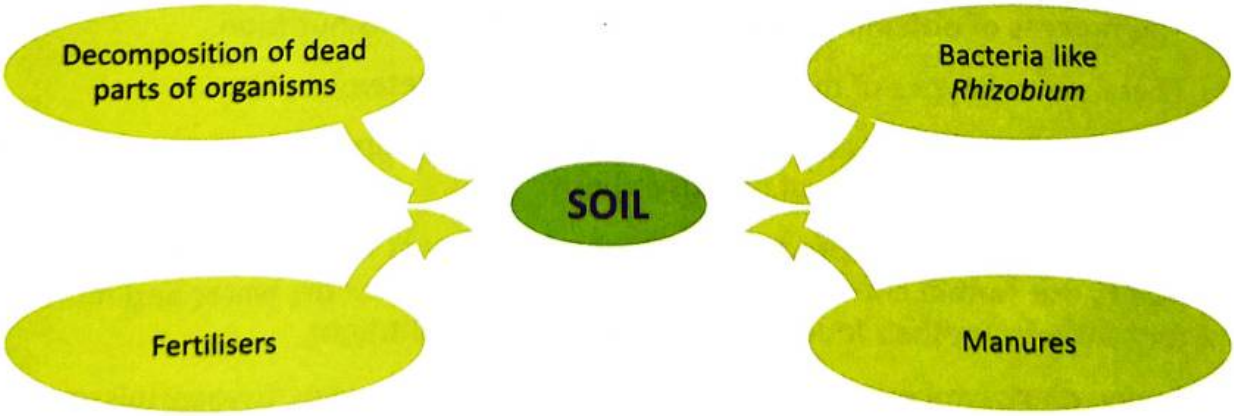
Lichens growing on rock

Rhizobium is a bacterium that lives in the roots of leguminous plants. It converts nitrogen, from the atmosphere, into a usable form that can be utilised by the plants. The plants, in turn, provide food and shelter to the bacterium.

Leguminous plant showing root nodules

How are Nutrients Replenished in the Soil?

Plants remove nutrients from the soil as they grow. These nutrients need to be reintroduced into the soil so that the soil remains productive. Farmers usually enrich the soil by adding manures and fertilisers; these are materials that contain one or more of the nutrients that plants need. In a forest, where no one goes to add fertilisers, the decomposition of dead leaves, and other plant and animal matter enriches the soil with nutrients. As we discussed just above, bacterium like *Rhizobium*, also help in making the soil rich in nitrogen.



Keywords

autotrophic nutrition	mode of nutrition in which organisms prepare their own food.
chlorophyll	green pigment present in the leaves of plants.
heterotrophic nutrition	mode of nutrition in which organisms do not prepare their own food; they derive their food from plants, or animals, or both.
host	the living organisms from which a parasite derives its food.
insectivorous plants	insect-eating plants.
nutrition	the process, of obtaining, and utilising, food by a living organism.
parasitic nutrition	mode of nutrition in which non-green plants live on other living organisms and obtain their food from them.
photosynthesis	the process through which green plants prepare their own food.
saprotrophic nutrition	mode of nutrition in which some plants feed on dead and decaying matter.
stomata	tiny pores that are present on the surfaces of leaves; useful for exchange of gases.
vessels	channels, to transport water and minerals, to different parts of the plant.

You Must Know

1. The process of obtaining, and utilising, food is known as nutrition.
2. There are two types of nutrition—autotrophic and heterotrophic.
3. Autotrophic nutrition is the mode of nutrition in which green plants synthesise their own food by the process of photosynthesis.
4. Photosynthesis is the process by which green plants make their own food. The plants use simple chemical substances, like carbon dioxide, water and minerals, for synthesising their food, in the presence of sunlight/light.
5. During photosynthesis plants take in carbon dioxide and release oxygen; this released oxygen is utilised by living organisms for their survival.

6. Heterotrophic nutrition is the mode of nutrition used by some plants and practically all animals. It is used by all organisms that cannot synthesise their own food and depend on other sources for their food.
7. Heterotrophic nutrition has been sub-divided into three categories: saprotrophic, parasitic and holozoic nutrition.
8. Organisms, which derive nutrition from the body of other living organisms (host), are called parasites; for example, *cuscuta* (*amarbel*) and insect-eating plants.
9. Insect-eating plants are called insectivorous plants. Pitcher plant is an example of an insectivorous plant.
10. Saprotrophic nutrition is the process by which the organisms feed on dead and decaying matter.
11. In symbiotic relationship two organisms live in close association and develop a relationship that is beneficial to both.
12. The soil needs to be continuously replenished to remain productive. This is because the plants growing on it, and the small organisms living in it, keep on depriving it, of the nutrients present in it.

Something To Know

A. Fill in the blanks.

1. Animals are _____ as they cannot synthesise their own food.
2. The _____, of a plant, absorb water and minerals from the soil.
3. During photosynthesis plants take in _____ and release _____.
4. _____ are the tiny pores through which leaves exchange gases.
5. Insect eating plants are called _____ plants.
6. An essential raw material needed for the process of photosynthesis, and
   (a) available in the soil is _____.
   (b) available in the air is _____.

B. Match the following:

1. Chlorophyll	(a) Autotrophs
2. Lichens	(b) Saprotrophs
3. Fungi	(c) Symbiotic relationship
4. *Amarbel*	(d) Leaf
5. Plants	(e) Parasite

C. Tick (✓) the correct option.

1. Green plants, that can synthesise their own food, are known as—

   ☐ heterotrophs ☐ parasites

   ☐ autotrophs ☐ saprotrophs

2. The food factory, of the plant, is its—

   ☐ root ☐ flower

   ☐ stem ☐ leaf

3. Which of the following is an insectivorous plant?

- ☐ pitcher plant
- ☐ leguminous plant
- ☐ green plant
- ☐ *amarbel*

4. Mushroom is an example of a/an—

- ☐ saprotroph
- ☐ parasite
- ☐ autotroph
- ☐ insectivorous

5. An organism, that fixes nitrogen in the soil, is—

- ☐ mushroom
- ☐ *mucor*
- ☐ *rhizobium*
- ☐ *cuscuta*

D. Answer the following questions in brief.

1. Why is nutrition important for a living organism?
2. How do green plants synthesise their food?
3. State the role of 'vessels' present in a plant.
4. Define the following terms:
   (a) Symbiotic relationship
   (b) Nutrients
   (c) Saprotrophic mode of nutrition
   (d) Photosynthesis
5. When some wheat dough was left in the open for a few days, it started emitting a foul smell. State, why?

E. Answer the following questions.

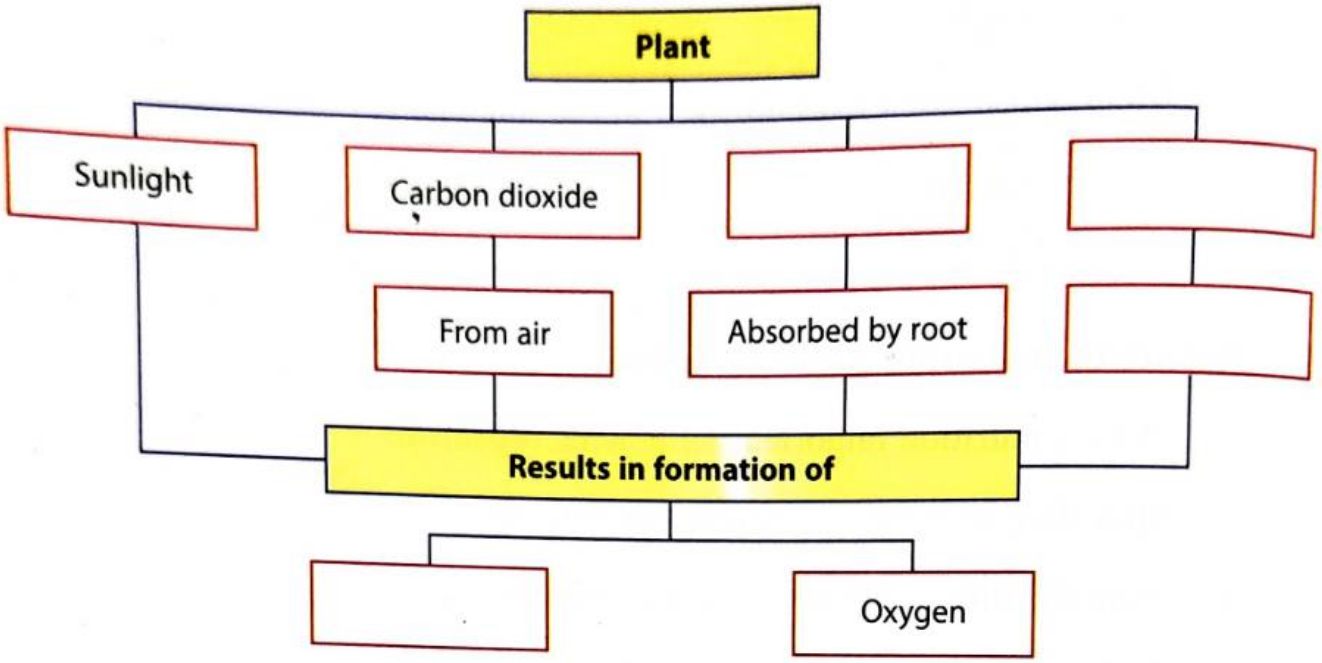
1. Why would life not be possible on the earth in the absence of photosynthesis?
2. Give reasons for the following:
   (a) Mushroom is a saprotroph.
   (b) Sun is the ultimate source of energy for all living organisms.
   (c) The leaf of a plant 'dies out' if its stomata are blocked.
   (d) Leaf is known as the food factory of the plant.

(e) Lichen is a 'living partnership' between a fungus and an alga and this 'partnership' is beneficial to both.

3. Why do some plants feed on insects? How does a pitcher plant catch insects?

4. How do *rhizobium* bacteria and leguminous plants help each other in their survival?

5. Complete the web chart.



Value Based Question

The teacher told her students the story of the film *Dost*. She told them that, in that film, the friendship, between a visually challenged boy and a lame boy, helps them both to face, and overcome, the very many challenges of their day-to-day life. She went on to compare their friendship with the 'symbiotic relationship' between two organisms.

1. Suggest any two 'values' that, according to you, must have been there in the two friends of the film *Dost*.

2. In what way is the friendship, between the two boys, similar to the 'symbiotic relationship' between two organisms?

3. Give one example of a 'symbioitic relationship' between two organisms.

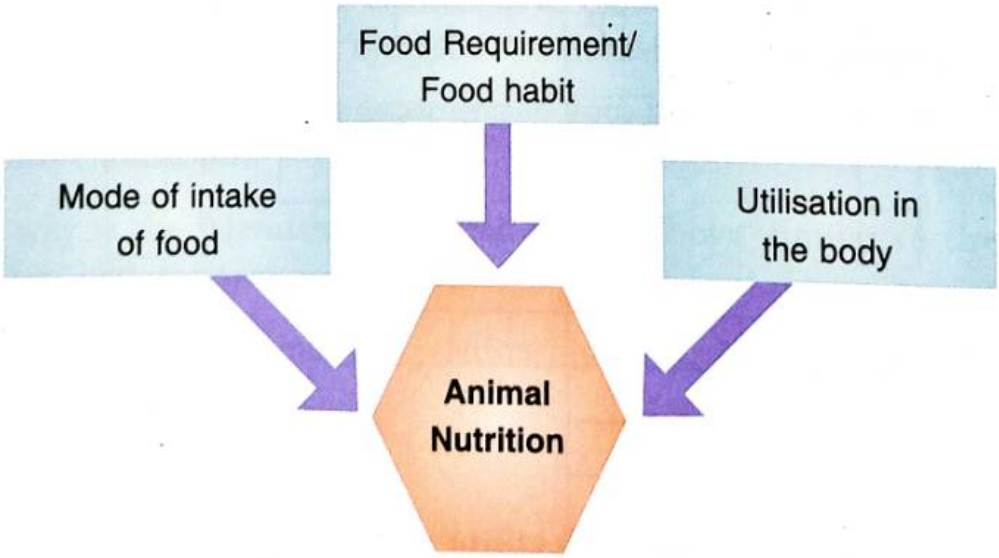
Something To Do

1. **Compose a few lines/poem on the 'utility of plants'.**

CHAPTER

2 Nutrition in Living Organisms—Animals and Man

You have already learnt in Chapter 1 that plants can prepare their own food and are called **autotrophs**. Animals cannot prepare their own food and are called **heterotrophs**. Animals eat complex food materials but break it down into simpler forms in their bodies. Their body gets the required nutrition through the three main steps shown below—



Three main steps in Animal Nutrition

Modes of Intake of Food

The method of taking in food is different in different organisms. The relevant parts of their body get modified in a manner that makes it easy for them to eat their food. A sparrow has a short beak to pick up seeds and worms. The long, tubular beak, of the humming bird, helps it to suck nectar from the flowers. The cow has sharp incisors and flat molar teeth that help it to cut and grind plant materials. The jaws of many snakes enable them to swallow animals that may be much larger than the size of their head.

Sparrow

Humming bird

Cow

Snake

Mode of intake of food differs in different organisms

Food Habits of Animals

On the basis of their food habits, animals have been categorised into three different categories.

The animals, like cow and deer, that eat only plant materials, are called **herbivores**.

The animals, like lion and tiger, that eat only other animals, are called **carnivores**.

Animals, like bear and human beings, that eat both animals and plant materials, are called **omnivores**.

Modes of Nutrition

It is their food that provides animals their required nutrition. As we have mentioned in the previous chapter, the nutrition requirements of heterotrophs, i.e. heterotrophic nutrition, are met by them in three different ways. These three modes of nutrition are:

- Saprotrophic nutrition
- Parasitic nutrition
- Holozoic nutrition

■ Saprotrophic Nutrition

We have already learnt in the previous chapter that, the mode of nutrition, in which an organism obtains its (required) nutrients, from dead and decaying plant and animal matter, is known as **saprotrophic nutrition**. Such an organism secretes enzymes outside, digests the organic food and absorbs the soluble organic compounds.

Most fungi and some bacteria are saprotrophs.

■ Parasitic Nutrition

The mode of nutrition, in which an organism (known as a parasite) obtains food from some other living organism (known as the host), of a different group, is known as **parasitic nutrition**. Parasites may live on, or in, the body of another living organism. In this mode of nutrition the parasite is benefitted while the host gets harmed.

Roundworms, head louse, body louse and tapeworm are parasites.

■ Holozoic Nutrition

This is a mode of nutrition, in which organisms, like *Amoeba* and human beings, eat food that may be in solid or in liquid state. This food is taken into the body (or eaten), and then it is broken down (or digested) to provide the required nutrition to the body.

Having understood the three different modes of nutrition, used by heterotrophs, let us now talk, in detail, how the human body gets its required nutritions.

▶ Nutrition in Humans

The food that we eat passes though a long muscular tube (called the alimentary canal) present inside our body. This canal begins at the mouth and ends at the anus. The food is broken down into tiny molecules that are carried, by blood, to all parts of the body. The sequence of steps, involved in this process, are as follows:

- Ingestion

  The act of getting, and eating, food is called **ingestion**. In humans, it takes place through the mouth where the teeth help in chewing the food.

- ## Digestion

The process of breakdown, of complex molecules into simple soluble ones, is called **digestion**. This digestion of food gets done, with the help of certain chemicals, called the **enzymes**. The process of digestion starts in the buccal cavity and gets completed in the small intestine.

- ## Absorption

The digested food is absorbed by the walls of the small intestine from where it gets passed on to the blood.

- ## Assimilation

The absorbed food is utilised by the body, for growth and formation, of body parts. This process is known as **assimilation**.

- ## Egestion

The elimination, of undigested food, from the alimentary canal, is known as **egestion**.

The alimentary canal is made up of the following (body) parts:

(a) Buccal cavity

(b) Food pipe (or Oesophagus)

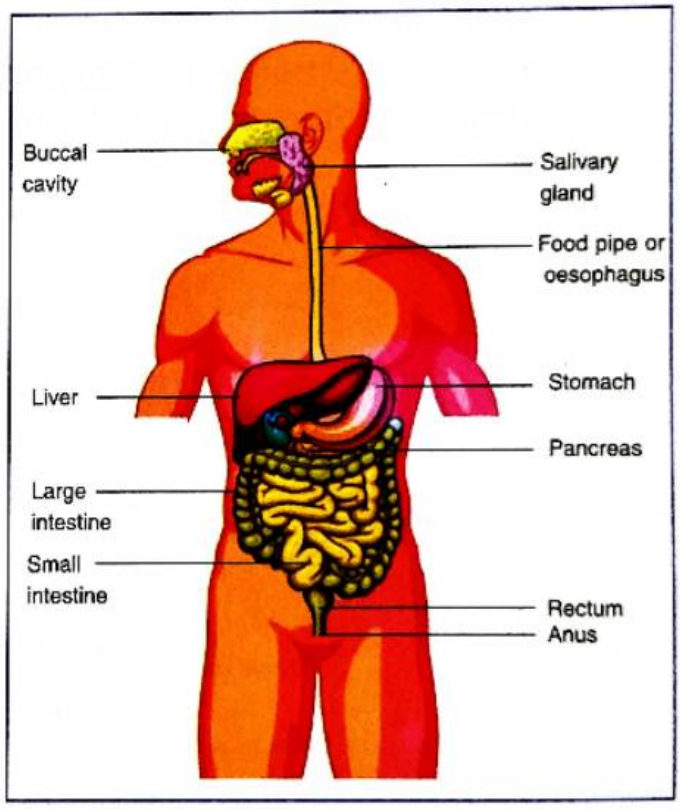
(c) Stomach

(d) Small Intestine

(e) Large Intestine

(f) Rectum

(g) Anus



Human Digestive System

Besides these parts, there are a number of glands, associated with the alimentary canal, which play their roles in the process of digestion of food. The salivary glands, pancreas and the liver, are the three main such glands.

The Alimentary canal, along with these associated glands, form the overall **digestive system**. We now look at the specific function/role of the different parts of the digestive system.

Mouth and Buccal Cavity

In humans, the food is taken in through the mouth from where it goes into the buccal cavity. Our buccal cavaity contains the teeth and the tongue. The Salivary glands, present here, release saliva into the buccal cavity.

Activity 1

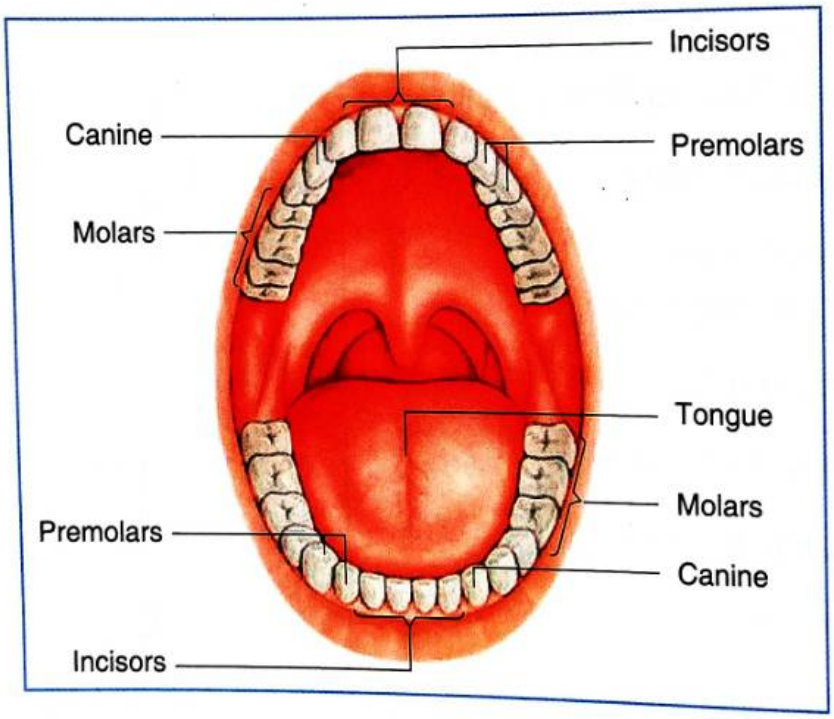
Chew a piece of bread for 3-4 minutes. Note the change in taste as you chew it.

Describe the observed change in taste. Why is there a change in taste?

The saliva contains digestive juices that break down starch to form sugar. Hence, a starchy substance (that is tasteless), when chewed for sometime, tastes sweet.

The Teeth

Teeth, are rooted in the sockets of the bones of the jaw. These are covered by a white, strong, shining, protective material, called the **enamel**. Teeth help in cutting, tearing and grinding of food.



A view of buccal cavity

Adult humans typically have 32 teeth—16 in upper jaw and 16 in the lower jaw—that fit together and help them to chew food. Humans develop two sets of teeth during their life. The first set of teeth are 20 small teeth, also known as **baby teeth** or **milk teeth**. They start appearing, above the gumline, when a baby is six, or seven, months old. By the time a child is (around) six years

old, a second set of 32 larger teeth, called **permanent teeth,** 'come out' from the gums and (eventually) replace the milk teeth.

Humans have four different types of teeth that perform different functions.

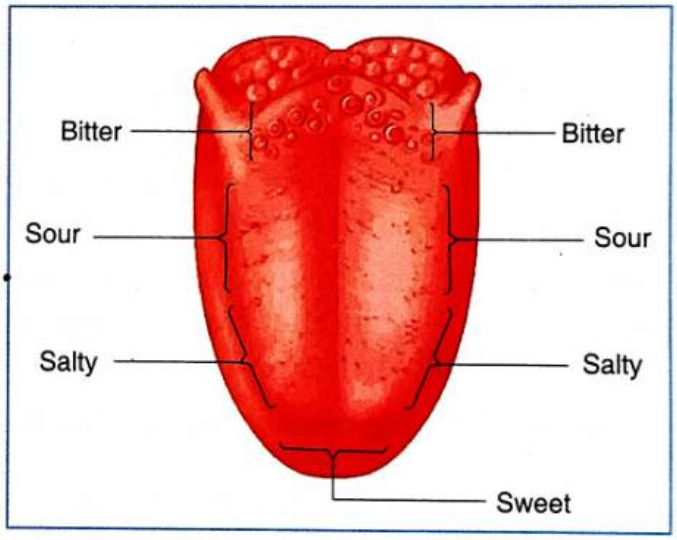
- **Incisors** are used for cutting of food.
- **Canines** are used for tearing of food.
- **Premolars** are used for grinding of food.
- **Molars** are also used for grinding of food.

Do You Know ?

Enamel is the hardest substance in the human body and covers the outer portion of the teeth. It is made up of mineral salts (of calcium and magnesium) and keratin (a protein). It can withstand quite high pressures.

The Tongue

Tongue is a muscular organ attached to the floor of the buccal cavity. It is free to move at its front end where it can move in all directions. The tongue helps in mixing up of saliva with food; it also helps in swallowing food. It has four types of taste buds which help us to know about the sweet, sour, bitter and salty tastes, associated with different types of items, in our food.



Taste buds on tongue

Do You Know ?

Tongue is a busy organ. The tongue serves as an organ of taste, with taste buds scattered over its surface. During chewing, the tongue holds the food against the teeth; in swallowing, it moves the food back into the buccal cavity, and then into the oesophagus (when the pressure of the tongue closes the opening of the trachea, or windpipe).

Activity 2

Take some water that has been obtained after boiling rice. This water has some starch dissolved in it. Add 2-3 drops of this water to four glass bowls (or small transparent *katories*, or glasses), and label them as A, B, C and D. Add a teaspoon of plain water to each glass bowl. Now add a teaspoon of your saliva to bowl B. Heat another teaspoon of your saliva, over a flame, for about 20 seconds and add this to bowl C. After about 10 minutes, add 4-5 drops of iodine in each bowl, except bowl D. Tabulate your observations in the following table.

Glass Bowl	Quantity of water with starch	Quantity of saliva	Colour change observed after 10 minutes
A			
B			
C			
D			

Presence of blue-black colour, after the addition of iodine drops, shows the presence of starch. What happened to the starch in bowl B? Why did the blue-black colour not appear in bowl B and bowl D?

For the Teacher

The blue-black colour does not appear in bowl B because the saliva 'breaks' the starch into simpler sugars which do not undergo a colour change with iodine.

There is, however, a colour change in bowl C. This is because the saliva loses it property of 'breaking' starch after heating. The starch, therefore, stays as such. Hence, the addition of iodine causes a colour change.

Note: While doing this activity, teacher must ensure hygiene.

The Food Pipe (or Oesophagus)

The **food pipe** is a long, narrow and muscular tube that connects the buccal cavity to the stomach. Food, that has been chewed in the mouth, is pushed downward into the oesophagus. From here, the onward movement of the food is due to the movement of the muscles, present in the wall of the oesophagus.

Do You Know ?

Epiglottis is a flap-like structure present at the top of the wind pipe. It closes the wind pipe when we swallow food and prevents the food from entering our lungs.

The Stomach

The **stomach** is the widest part of the alimentary canal. It is a thick-walled, sac-like muscular organ. It receives food, from the oesophagus, and passes it into the small intestine. The inner lining of the stomach secretes gastric juices, which have mucus, hydrochloric acid and enzymes present in them.

Mucus protects the inner lining of the stomach. Hydrochloric acid kills bacteria. It also provides the acidic medium, needed for digestion of food, by the enzymes in the stomach. The enzymes, in the stomach, break down proteins to simpler substances, like amino acids.

Do You Know ?

Stomach with a hole

On June 6, 1822, a person named Alexis St. Martin, was accidentally shot in the stomach. Dr. Beaumont treated his wound. Despite his best efforts, Dr. Beaumont could not close the hole in his stomach that never fully healed.

Dr. Beaumont recognised that he had, in St. Martin, the unique opportunity to observe digestive processes. He began to perform experiments, on digestion, in the stomach of St. Martin. Most of these experiments were conducted by tying a piece of food to a string, and inserting it, through the hole, into St. Martin's stomach. Every few hours, Dr. Beaumont would remove the food and observe how well it had been digested. Dr. Beaumont also extracted a sample of gastric acid (digestive juice) from St. Martin's stomach for analysis. He also used samples of this stomach acid to "digest" bits of food in cups. This led to the important discovery that the stomach acids help to digest the food (into simple and soluble) nutrients, that the stomach can use. It was, thus, realised that digestion is primarily a chemical process, and not a mechanical one.

The Small Intestine

The small intestine is not all that small. It is about 6–7 metres long. It helps in digestion by using three types of secretions.

1. Secretions from liver—The Liver is the largest gland in the human body. It is present slightly below the stomach, on the right side. It secretes bile juice, that is stored in a bag-like structure, called the **gall bladder**. This bile juice plays an important role in digestion of fats.

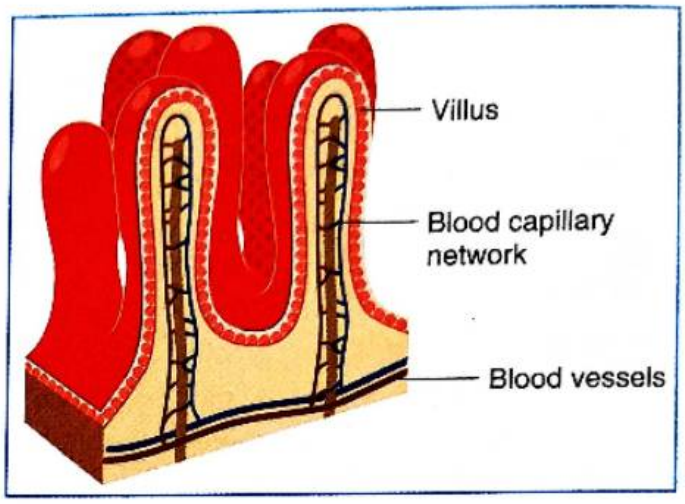
2. Secretions from pancreas—**Pancreas** is a yellow, leaf-shaped, gland, located just below the stomach. It secretes pancreatic juice; this juice acts on carbohydrates, proteins and fats and breaks them into simpler forms.

3. Secretions from the small intestine—The inner wall, of the small intestine, itself secretes the intestinal juice. This juice digests carbohydrates, proteins and fats.

The small intestine, uses the bile, pancreatic and intestinal juices to complete the process of digestion of food in itself. Here (i) carbohydrates are digested to simple sugars like glucose (ii) proteins are broken down to amino acids and (iii) fats are broken down into fatty acids and glycerol.

- ### Absorption of digested food in the small intestine

The inner wall, of the small intestine, absorbs the digested food. It has a large number of finger-like projections, called **villi**. The villi increase the effective surface area for absorption of digested food. This absorbed food is passed to blood vessels, present in the villi. The 'food', thus, get transported to all parts of the body via the blood. It is used to produce energy and to build complex substances required by the body. This whole process is called **assimilation**.



Parts of small intestine showing villi

The Large Intestine

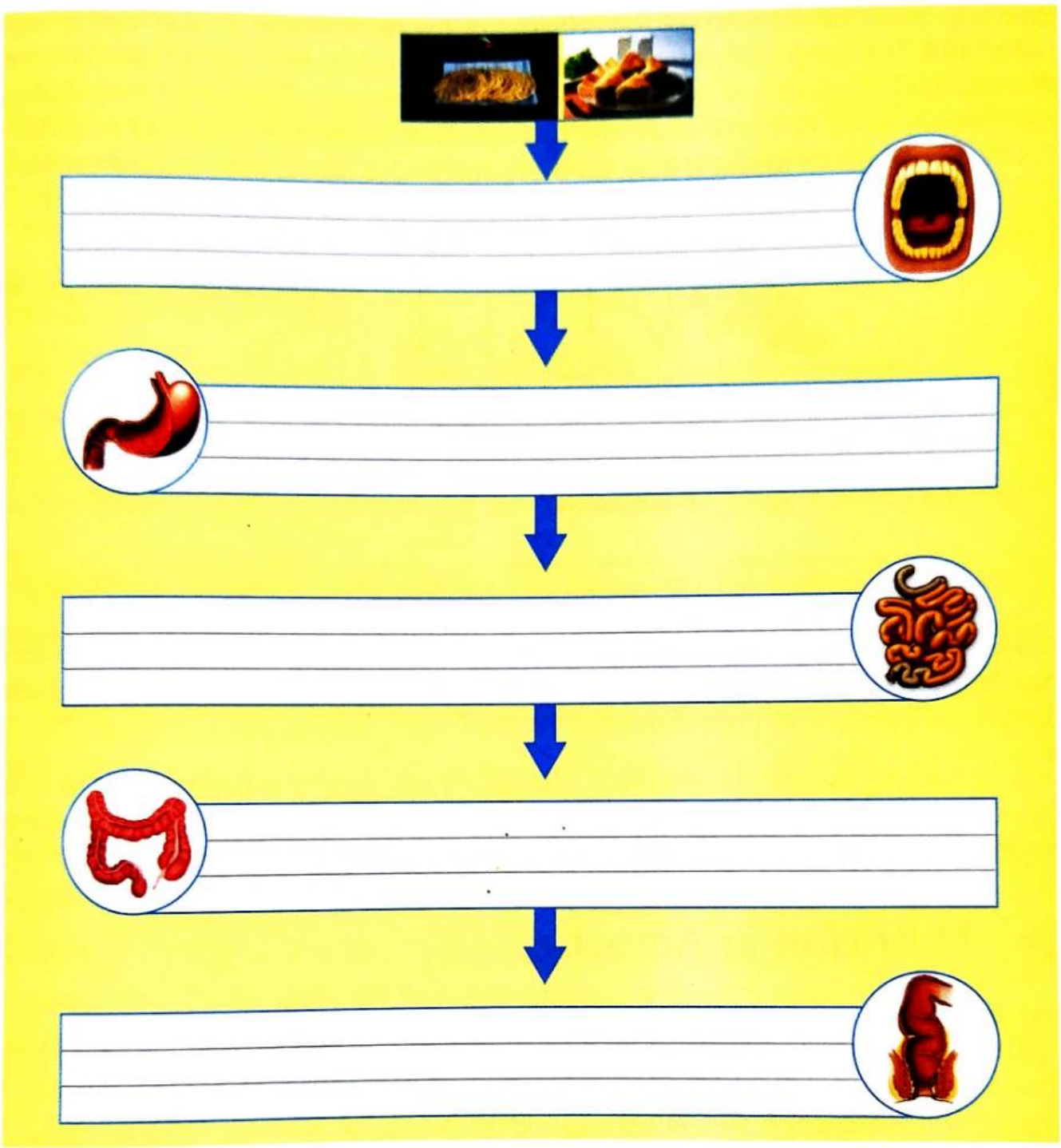
Large intestine is wider and shorter than the small intestine. It is about 1.5 metres in length. The undigested, and unabsorbed, food enters the large intestine. Here, the excess of water and some minerals are absorbed from the undigested food. The left over waste part of food passes to the rectum and is stored there as faecal matter. The faeces are eliminated through the anus. This process is called **egestion**.

Activity 3

Tracing the journey of a *chappati*/sandwich.

We all eat a *chappati*, or a sandwich, quite often. Our digestive system 'breaks down' this food item into simpler forms. It, thus, helps it to provide the energy and nutrients our body needs for its maintainence and growth.

Use the flow chart, given on the next page, to trace the journey of a *chappati*/sandwich to show how it goes from just being a 'food item on your plate' to 'energy for life'. Write just one/two sentence/s, in the space provided, to highlight the role of, each of the indicated parts, in this eventful journey.

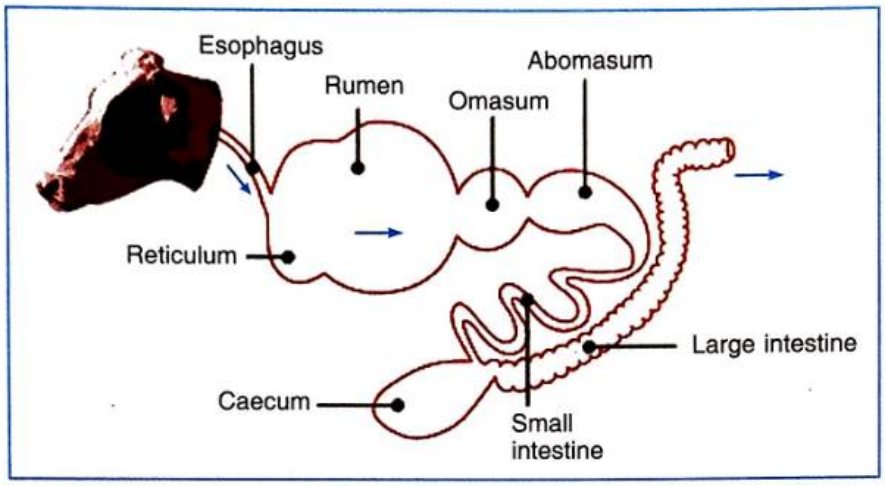


Nutrition in Cud Chewing Herbivore Animals

Cud chewing herbivore animals are called **ruminants.** Cow, deer, camel, buffalo, sheep and giraffe are some of the well-known **ruminants.** They have a special four-chambered stomach.

The first chamber is the largest and is called **rumen**. These animals first swallow the food quickly and store it in their rumen. The rumen has some micro-organisms

that help in partial digestion of the cellulose of the plant materials. This food is now called **cud**. The ruminants, later on, bring this cud back to their mouth and chew it thoroughly. This process is called **rumination**. The thorough chewing of food during rumination, helps to break down the rich cellulose content of the plant materials. This 'breaking down' makes it easy, for these animals, to digest the cellulose content.



Digestive system of a cow

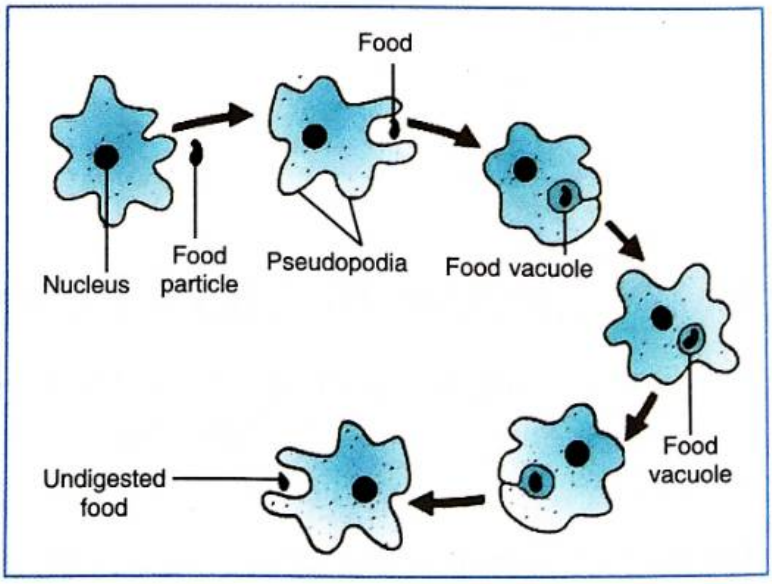
Ruminants also have a spacious bag-like structure, between their small intestine and the large intestine. This is called **caecum**. The bacteria, present in the caecum, help in further digestion of the cellulose of the food.

It is interesting to note here that such bacteria are not present in the human digestive system. Human beings cannot, therefore, digest the cellulose, which goes on to form roughage. Roughage helps in the bowel movement in the human body.

Nutrition in Amoeba

Amoeba is a microscopic, unicellular, organism found in moist soil, ponds and lakes. It is surrounded by a cell membrane. It constantly changes its shape and moves with the help of pseudopodia (*pseudo* = false, *podia* = feet). Pseudopodia also help it in capturing food.

Amoeba feeds on small microscopic organisms like bacteria and algae. When *Amoeba* comes in contact with food, it produces pseudopodia



Nutrition in Amoeba

around the food particle. As the cell membranes of the pseudopodia fuse, the food gets trapped in a food vacuole.

Digestive juices are secreted into this vacuole to digest the food. The digested food is absorbed and used for production of energy, movement and maintenance of the organism. The undigested food, present in the food vacuole, is expelled, from the *Amoeba*, by the process of **egestion**.

Keywords

absorption	process by which digested food passes into the blood.
alimentary canal	the long muscular tube in the human body through which food passes after its ingestion.
assimilation	process of using the absorbed food for growth and for producing energy.
buccal cavity	oral cavity located at the upper end of the alimentary canal.
caecum	bag-shaped part, at the beginning of the large intestine, present in ruminants.
canines	pointed teeth used for tearing of food.
digestion	breaking down of complex food into simple soluble forms with the help of digestive juices.
enamel	white substance that covers the teeth.
egestion	process of elimination of undigested food.
ingestion	process of 'taking in' of food.
incisors	front teeth used for cutting and biting.
molars	last teeth, that are larger and flat, and are used for crushing and grinding food.
oesophagus	food pipe.
premolars	teeth situated next to canines, and used for crushing and grinding food.
pseudopodia	false feet of amoeba which it uses to (i) trap its food and (ii) for its movement.
ruminants	cud chewing herbivore animals.
villi	small projections, in the inner walls of the small intestine of human beings; these help in absorption of the digested food.

You Must Know

1. Animal nutrition includes nutrient requirement, mode of intake of food and its utilisation in the body.
2. Heterotrophic nutrition is of three types—saprotrophic nutrition, parasitic nutrition and holozoic nutrition.
3. The process of nutrition in animals involves ingestion, digestion, absorption, assimilation and egestion.
4. The human digestive system consists of the mouth, oesophagus, stomach, small intestine and large intestine; ending in the rectum and anus.
5. The main digestive glands, which secrete digestive juices, are the salivary glands, the liver and the pancreas. The stomach wall and the wall of the small intestine also secrete digestive juices.
6. The different types of teeth, in humans, are—incisors, canines, premolars and molars.
7. Digestion begins in the buccal cavity and continues in the stomach and small intestine. The digested food gets absorbed, in the blood vessels, from the small intestine.
8. The absorbed substances are transported to different parts of the body. Water, and some salts, are absorbed from the undigested food in the large intestine.
9. The undigested, and unabsorbed residue, are expelled out of the body as faecal matter through the anus.
10. Cud chewing herbivore animals are called ruminants. They first, quickly swallow food and store it in their rumen. Later on, the food returns to the mouth and the animals chew it on thoroughly.
11. Amoeba ingests its food, with the help of its false feet, called pseudopodia. The food is digested in the food vacuole.

Something To Know

A. Fill in the blanks.

1. The digestion of food in humans starts in the _____ and is completed in the _____.
2. _____, present in the stomach, kills bacteria.
3. The largest gland in the human body is the _____.
4. Partially digested food, that is chewed again by grass eating animals, is called the _____.
5. *Amoeba* uses _____ for locomotion and for capturing its food.

B. Match the following:

1.	Gall bladder	(a)	Bile Juice
2.	Proteins	(b)	Cow
3.	Intestinal wall	(c)	Absorption
4.	Rumen	(d)	False feet
5.	Pseudopodia	(e)	Amino acids

C. Tick (✓) the correct option.

1. Organisms, that can synthesise their own food, are called—

☐ heterotrophs ☐ parasites

☐ autotrophs ☐ saprotrophs

2. Cow is a/an—

☐ saprotroph ☐ parasite

☐ autotroph ☐ heterotroph

3. Animals, that eat both plant materials and animals, are called—

- ☐ herbivores
- ☐ omnivores
- ☐ carnivores
- ☐ ruminants

4. Which one of these is not a part of the alimentary canal?

- ☐ stomach
- ☐ anus
- ☐ liver
- ☐ large intestine

5. Bile juice is released by the—

- ☐ salivary glands
- ☐ pancreas
- ☐ liver
- ☐ large intestine

D. Answer the following questions in brief.

1. Define the following terms:

   (a) Holozoic nutrition

   (b) Alimentary canal

2. Give the meaning of the terms:

   (a) Assimilation

   (b) Rumination

3. Name the organs that make up the human alimentary canal.

4. State two differences between milk teeth and permanent teeth.

5. Name the four types of teeth in the human mouth.

6. State the function of the (a) incisor teeth (b) premolar teeth.

7. State the role of acid in the human stomach.

8. State the function of (a) bile juice and (b) pancreatic juice in the human digestive system.

E. Answer the following questions.

1. Draw a neat, well labelled diagram of the human digestive system.
2. Justify the following statements:
   (a) Crow is an omnivore.
   (b) It is said that the mode of nutrition, in human beings and *Amoeba*, is quite similar.
3. Give reasons for the following:
   (a) Ingestion of food is difficult without teeth.
   (b) If we chew rice, or bread, for a few minutes, it starts tasting sweet.
   (c) Bacteria are present in the caecum of ruminants.
4. Explain how digested food gets absorbed into the blood.
5. State, in one/two sentence/s each, the various processes involved in nutrition in ruminant animals.
6. Explain ingestion of food, in *amoeba*, through a diagram.

Value Based Question

The biology teacher, who was also the coach of the school cricket team, would often compare his team members with the different 'organs' of their digestive system. He would tell them to concentrate on their respective roles and to work as a team in a selfless and dedicated way. This, he would say, would enable them to succeed in winning matches in the same way as the 'team', of the organs of the digestive system, 'succeeds' in digesting, and using, the 'ingested food'.

1. State two of the values that the teacher wanted his students to 'have in them'.
2. Try to make a list of 'eleven names' that are a part of the 'team' that makes up the human digestive system.
3. Have a group discussion on the importance of 'Team work' in day-to-day life.

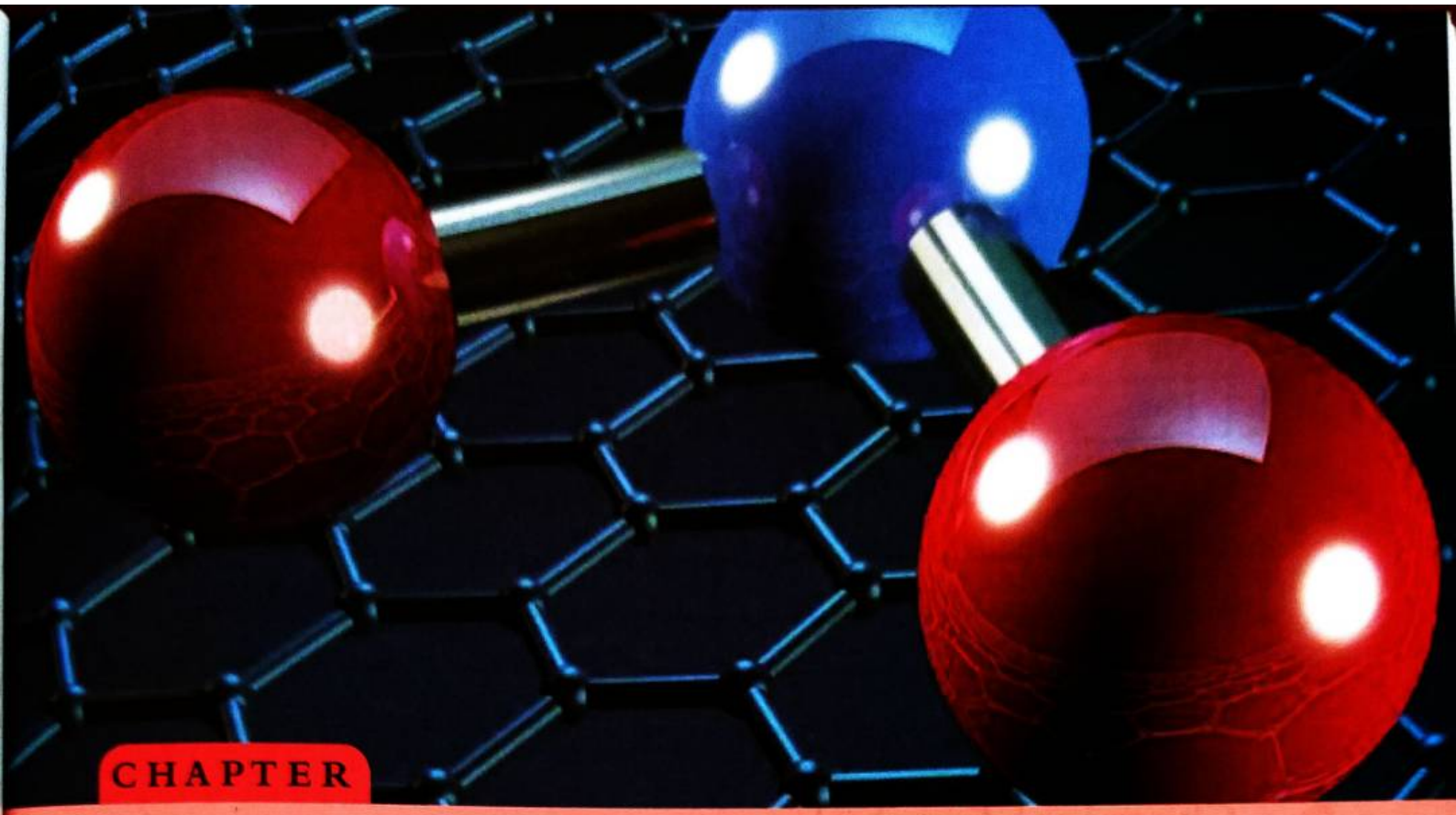
Something To Do

1. Make a PowerPoint presentation on the various ways in which animals ingest their food. For example—
[Herbivores–Cow; Carnivores–Lion; Blood suckers–Leech; Fruit eating–birds; Fluid feeders–Butterflies, moth, earthworm; Insectivore–Frog]
2. Collect data, from the parents of your five classmates, about their milk teeth. Tabulate your data as given below.

S.No.	Name	Age at which first tooth fell	Age at which last tooth fell	No. of teeth lost	No. of teeth replaced

Use the collected data, to estimate the average age at which children lose their milk teeth.

3. Make a model of the digestive system (using clay/plasticine to make the organs) and rubber pipes/ribbons to make the food pipe and small intestine.
4. Activity—Assign a particular organ of the digestive system to each student and ask them to enact the role of it. The students need to follow the given guidelines. They should introduce themselves as a particular organ, explain its structure and function, its importance and significance in the human body and name some diseases, associated with the 'organs', represented by them.
The teacher can judge their role play by considering their presentation, content, visual aid used, clarity of the concepts, etc.



CHAPTER

3 Chemical Substances and Processes

In the previous class, we learnt some basic facts about matter and its nature. Matter exists in three states—**solid, liquid** and **gas**. All matter is made up of small particles called **atoms**. Atoms combine to form **molecules**. Materials, which are made up of same kind of particles, that is, has same atoms or molecules, are called **pure substances**. Pure substances can be further classified as 'elements' and 'compounds'.

An **element** is a pure substance which is made up of atoms of the same kind. For example, iron is an element which is made up of iron atoms.

A **compound** is a pure substance which is made up of molecules of the same kind. A molecule of a compound consists of atoms of two, or more, different elements that have combined in a fixed ratio. For example, water is a compound made up of water molecules. Each molecule of water contains two atoms of hydrogen and one atom of oxygen combined together.

In addition to elements and compounds, we also have mixtures. A **mixture** contains two or more substances mixed in any proportion. The components of a mixture are not chemically combined with each other. A mixture is, therefore, not a pure substance.

Activity 1

Classify the following materials into pure substances and mixtures.

Material	Pure Substance/Mixture
Air	
Iron	
Water	
Soil	
Lemonade	
Gold	
Oxygen	

Chemical Symbols

Chemical substances are often represented by symbols. Earlier chemists (Alchemists) used pictorial symbols to represent different elements. However, the symbols of different elements are now represented by the letters of the English alphabet.

The present day chemical symbols of some common elements are given below:

Name of the element	Symbol
Hydrogen	H
Sodium	Na
Magnesium	Mg
Aluminium	Al
Calcium	Ca
Potassium	K
Iron	Fe

Name of the element	Symbol
Copper	Cu
Gold	Au
Silver	Ag
Carbon	C
Oxygen	O
Sulphur	S
Nitrogen	N
Phosphorus	P
Chlorine	Cl
Bromine	Br
Iodine	I

Chemical Formula

The **chemical formula** of a substance is based on the composition of that substance. It indicates the type and number of atoms of each kind present in that substance.

For example, the chemical formula of water is written as H_2O. This means that a water molecule is formed by the combination of two atoms of hydrogen and one atom of oxygen.

Similarly, the formula of carbon dioxide is CO_2. This means that a carbon dioxide molecule is formed by the combination of one atom of carbon and two atoms of oxygen.

How to Write the Chemical Formula?

To write the chemical formula of a substance, the chemical symbols of all the elements are written and the number of atoms of each element is written as

a subscript to the right side of its symbol. For example, nitric acid contains one atom of hydrogen, one atom of nitrogen and three atoms of oxygen. The chemical formula of nitric acid is, therefore, written as HNO_3 (one is not written as a subscript). Similarly, glucose contains six atoms of carbon, twelve atoms of hydrogen and six atoms of oxygen. Its chemical formula is, therefore, written as $C_6H_{12}O_6$.

Many substances are made up of positively and negatively charged particles, called **ions**. Let us learn to write the chemical formula of such substances. For this, we need to know the symbols and charges of the different ions present in a given substance.

For the Teacher

Tell the students that they will learn the details of this concept in higher classes. At present they only have to learn the names of some common positive and negative ions.

The names and symbols of some common ions, along with their charge, are given below:

Name of the ion	Symbol
Sodium	Na^+
Magnesium	Mg^{2+}
Aluminium	Al^{3+}
Calcium	Ca^{2+}
Hydrogen	H^+
Copper	Cu^{2+}
Iron	Fe^{2+}
Zinc	Zn^{2+}
Ammonium	NH_4^+

Name of the ion	Symbol
Chloride	Cl^-
Oxide	O^{2-}
Hydroxide	OH^-
Carbonate	CO_3^{2-}
Sulphate	SO_4^{2-}
Nitrate	NO_3^-
Acetate	CH_3COO^-
Phosphate	PO_4^{3-}

In the name of a chemical substance, made up of a positive and a negative ion, generally, the name of the positive ion is mentioned first followed by the name of the negative ion. For example, the chemical name of common salt is sodium chloride. Here, the name of the positive ion (Sodium, Na^+) is mentioned first and the name of the negative ion (Chloride, Cl^-) is mentioned afterwards. In the chemical formula also, the symbol for the positive ion is written first followed by the symbol for the negative ion. Hence, the chemical formula of sodium chloride is written as NaCl (and not as ClNa).

We summarise below the procedure followed for writing the chemical formula of a substance:

1. Symbols of positive and negative ions are written and their charge is written on the top-right corner of the symbol.
2. Common factor, if any, is removed (from the numbers) in the charges of the two ions.
3. Charges of two ions are 'criss-crossed'; these (criss-crossed) numbers are now written at the bottom-right of the symbols of the two ions. This gives us the chemical formula of the substance.

Let us take some examples to understand this.

Example 1: To write the formula of sodium oxide, we write the symbol for sodium and oxide ions along with their charges.

$$Na^{+1} \quad O^{2-}$$

There is no common factor in the numbers corresponding to their charges. We now 'criss-cross' their charges.

$$Na^{+1} \times O^{2-} \longrightarrow Na_2O_1 = \boxed{Na_2O}$$

Hence, the chemical formula of sodium oxide is Na_2O.

(**Note:** The subscript (1) is not written as a subscript in the chemical formula.)

Example 2: To write the formula of aluminium sulphate, we first write the symbols for aluminium and sulphate ions along with their charges.

$$Al^{3+} \quad (SO_4)^{2-}$$

There is no common factor in the numbers corresponding to their charges. We now criss-cross their charges and write the criss-crossed numbers as subscripts against the two symbols.

$$Al^{3+} \times (SO_4)^{2-} \longrightarrow Al_2(SO_4)_3$$

Hence, the chemical formula of aluminium sulphate is $Al_2(SO_4)_3$.

Example 3. To write the formula of calcium carbonate, we first write the symbols for calcium and carbonate ions along with their charges.

$$Ca^{2+} \quad (CO_3)^{2-}$$

Here, the common factor between the numbers corresponding to the two charges is 2. When we remove this common factor, we are left with the number 1 with both the symbols. Since the subscript 1 is not to be written, the formula for calcium carbonate would be just $CaCO_3$.

▶ Chemical Changes

In the previous class, we have learnt that substances can undergo different types of changes. We have also learnt that these changes may be slow or fast; reversible or irreversible; physical or chemical.

Activity 2

Classify the changes given below into suitable categories.

Name of the Change	Physical/ Chemical	Slow/Fast	Reversible/ Irreversible
1. Melting of ice			
2. Burning of candle			
3. Curdling of milk			
4. Breaking of a glass			

We have already learnt that in a physical change, the substance may undergo a change in its physical state, shape, size or colour but it does not change into another substance.

During a chemical change, a substance changes into another substance. When suitable substances are mixed in appropriate amounts, they may undergo chemical interaction resulting in the formation of a new substance.

For example, when iron comes in contact with moisture and air, it gets rusted. Copper articles get coated with a green substance when exposed to moist air. Similarly, burning of wood in air converts it into ash and carbon dioxide. The process, in which a chemical change causes one substance to change into another, is called a **chemical reaction**.

Substances which undergo a chemical change in a reaction are called the **reactants** whereas the new substances which are formed are called the **products.**

Chemical Equation

We have learnt above that chemical substances can be represented by appropriate symbols. A chemical reaction, occurring between different substances, can also be represented by using appropriate symbols and formulae. The represention of a chemical reaction, using symbols and formulae of substances, involved in the reaction, is called a **chemical equation**.

When we write a chemical equation, we put the symbols of the reactants on the left-hand side and those of the products on the right-hand side. An arrow is put between them as shown below:

Reactants ⟶ Products

The physical state of the reactants and products is written in bracket along with their symbols. The letter 's' is used to denote solid state, 'l' for liquid, 'g' for gas and 'aq' for an aqueous solution (solution of a substance in water). For example, when carbon and oxygen react with each other, carbon dioxide is formed as a product. This reaction is represented as a chemical equation as follows:

$$\underset{\text{carbon}}{C(s)} + \underset{\text{oxygen}}{O_2(g)} \longrightarrow \underset{\text{carbon dioxide}}{CO_2(g)}$$

Balancing of Chemical Equations

A chemical equation should be balanced. A **balanced chemical equation** is that in which the number of atoms of each element are the same on both sides of the equation. In order to balance the number of atoms of various elements, on either side of the equation, the chemical formula of a substance is **not** changed. Instead, a suitable coefficient (number) is written before the formula of that substance. For example, reaction between hydrogen and oxygen gas gives water. This is written as a chemical equation as follows:

$$\underset{\text{hydrogen}}{H_2(g)} + \underset{\text{oxygen}}{O_2(g)} \longrightarrow \underset{\text{water}}{H_2O(g)}$$

Here, the number of oxygen atoms is not same on both sides of the equation. To make their number the same, the coefficient '2' is written, with the formula of water, on the right-hand side of the equation.

$$H_2(g) + O_2(g) \longrightarrow 2H_2O(g)$$

Now, we need to balance the number of hydrogen atoms. For this, the coefficient '2' is written, with the formula of hydrogen, on the left-hand side of the equation. We now get

$$2H_2(g) + O_2(g) \longrightarrow 2H_2O(g)$$

This is now the required balanced chemical equation for the reaction.

For the Teacher

Give more examples of balancing of simple equations like

- $2Na + Cl_2 \longrightarrow 2NaCl$
- $H_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + 2H_2O$

Types of Chemical Reactions

Chemical reactions can be classified into different types, depending upon the type of chemical change, occurring during the reaction. Let us study the different types of reactions one by one.

1. **Combination reaction:** A chemical reaction, in which two or more substances (reactants) combine to form a new substance (product), is called a **combination reaction**.

Combination reactions are very useful in synthesising various chemicals. For example:

(i) Combination of hydrogen and oxygen gas yields water.

$$2H_2(g) + O_2(g) \longrightarrow 2H_2O(g)$$

(ii) Combination of nitrogen and hydrogen gas yields ammonia gas.

$$\underset{\text{nitrogen}}{N_2(g)} + \underset{\text{hydrogen}}{3H_2(g)} \longrightarrow \underset{\text{ammonia}}{2NH_3(g)}$$

2. **Decomposition reaction:** A chemical reaction, in which more than one product is obtained from a single reactant, is called a **decomposition reaction**.

For example:

(i) Breaking up of water, into hydrogen and oxygen gases, on passing an electric current, is an example of a decomposition reaction.

$$2H_2O(l) \xrightarrow{\text{electric current}} 2H_2(g) + O_2(g)$$

(ii) On strong heating, limestone (calcium carbonate) decomposes into quick lime (calcium oxide) and carbon dioxide gas.

$$\underset{\text{limestone}}{CaCO_3(s)} \xrightarrow{\text{heat}} \underset{\text{quick lime}}{CaO(s)} + \underset{\text{carbon dioxide}}{CO_2(g)}$$

3. **Displacment reaction:** A chemical reaction, in which one element displaces another in a compound, is called a **displacement reaction**.

To understand this, let us perform the following activity.

Activity 3

Take some crystals of copper sulphate in a beaker. Dissolve them in 50 ml of water. A blue-coloured solution is obtained. Put an iron nail in the solution and keep it there for 5-10 minutes.

What do you observe?

The blue colour of the solution changes into light green and a brown coating appears on the iron nail. This happens because iron displaces copper from copper sulphate and forms iron sulphate which is green in colour. Copper deposits as a brown coating on the iron nail.

The chemical equation for this reaction is given below:

$$\underset{\text{iron}}{Fe(s)} + \underset{\text{copper sulphate solution (blue)}}{CuSO_4(aq)} \longrightarrow \underset{\text{iron sulphate solution (green)}}{FeSO_4(aq)} + \underset{\text{copper}}{Cu(s)}$$

4. **Neutralisation reaction:** A chemical reaction, between an **acid** and a **base**, is called a **neutralisation reaction**. A neutralisation reaction always leads to the formation of a salt and water.

$$\text{Acid} + \text{Base} \longrightarrow \text{Salt} + \text{Water}$$

For example:

(i) the reaction between hydrochloric acid and sodium hydroxide (a base) yields sodium chloride (a salt) and water.

$$\underset{\substack{\text{sodium}\\\text{hydroxide}}}{NaOH(aq)} + \underset{\substack{\text{hydrochloric}\\\text{acid}}}{HCl(aq)} \longrightarrow \underset{\substack{\text{sodium}\\\text{chloride}}}{NaCl(aq)} + \underset{\text{water}}{H_2O(l)}$$

(ii) the reaction between magnesium hydroxide (a base) and sulphuric acid yields magnesium sulphate (a salt) and water.

$$\underset{\substack{\text{magnesium}\\\text{hydroxide}}}{Mg(OH)_2(aq)} + \underset{\substack{\text{sulphuric}\\\text{acid}}}{H_2SO_4(aq)} \longrightarrow \underset{\substack{\text{magnesium}\\\text{sulphate}}}{MgSO_4(aq)} + \underset{\text{water}}{2H_2O(l)}$$

Keywords

balanced chemical equation	equation having same number of atoms of each element on both sides.
chemical equation	representation of a chemical reaction using symbols and formulae of substances involved in the reaction.
chemical formula	representation of chemical composition of a substance.
chemical reaction	the process which leads to a chemical change of one substance to another.
combination reaction	chemical reaction in which two or more substances combine to form a new substance.
compound	a pure substance which is made up of molecules of the same kind.
displacement reaction	a chemical reaction in which one element displaces another in a compound.
element	a pure substance which is made up of atoms of the same kind.
mixture	is made up of two or more substances, which are mixed together in any ratio but are not chemically combined.
neutralisation reaction	a chemical reaction between an acid and a base leading to the formation of salt and water.
products	the new substances formed after a chemical reaction.
pure substances	materials which are made up of same kind of particles, that may be, atoms or molecules.
reactants	substances which undergo a chemical change in a reaction.

You Must Know

1. Materials, which are made up of same kind of particles, are called pure substances.
2. Pure substances are classified as elements and compounds.
3. An element is made up of atoms of same kind.
4. A compound is made up of molecules of the same kind.
5. Mixtures are not pure substances.

6. Chemical substances are often represented by 'symbols'; the symbols are usually derived from the name of the element itself.
7. The chemical formula of a substance represents the chemical composition of that substance.
8. In the chemical formula of a substance, the number of atoms of each element is written as a subscript with the symbol of that element.
9. Many substances are made up of positively and negatively charged particles, called ions.
10. While naming a chemical substance, made up of ions, the name of the positive ion is written first followed by the name of the negative ion.
11. To write the chemical formula of a substance (made up of ions), the charges of two ions are criss-crossed and are written as subscripts with the symbols of the ions. Common factor, if any, in the charges of the two ions, is removed.
12. During a chemical change, a substance changes into another substance.
13. The process which leads to a chemical change is called a chemical reaction.
14. Substances, undergoing change in a chemical reaction, are called reactants. The new substances, which are formed, are called the products of that chemical reaction.
15. The representation of a chemical reaction using symbols and formulae of substances involved in the reaction is called a chemical equation.
16. A balanced chemical equation has equal number of atoms of each element on both sides of the equation.
17. Chemical reactions can be classified into different types depending upon the type of chemical change occurring during the reaction. For example,
    (i) Combination reaction: in which two or more substances combine to form a new substance.
    (ii) Decomposition reaction: in which more than one product is obtained from a single reactant.
    (iii) Displacement reaction: in which one element displaces another element in a compound.
    (iv) Neutralisation reaction: in which an acid reacts with a base to form salt and water.

Something To Know

A. Fill in the blanks.

1. Materials made up of same kind of particles are called _____.
2. The type and number of particles of each kind present in a substance is given by its _____.
3. The chemical formula of water is _____.
4. Iron gets rusted on coming in contact with _____ and _____.
5. The process that leads to a chemical change is called a _____.
6. In a neutralisation reaction, _____ and _____ are formed.

B. Write True or False for the following statements.

1. All matter is made up of atoms. ☐
2. Compounds are substances consisting of two or more elements chemically combined in a fixed ratio. ☐
3. The symbol of element copper is Cu. ☐
4. Formula of sodium chloride is written as ClNa. ☐
5. The chemical formula of aluminium sulphate Al_2SO_4 is. ☐
6. New substance formed in a chemical reaction is called product. ☐
7. Magnesium hydroxide is an acid. ☐

C. Tick (✓) the correct option.

1. The chemical symbol Ag represents the element—

☐ sodium ☐ aluminium

☐ silver ☐ sulphur

2. One molecule of nitric acid is made up of—

- ☐ two atoms of hydrogen, two atoms of nitrogen and two atoms of oxygen.
- ☐ one atom of hydrogen, one atom of nitrogen and three atoms of oxygen.
- ☐ one atom of hydrogen, one atom of nitrogen and two atoms of oxygen.
- ☐ one atom of hydrogen, two atoms of nitrogen and three atoms of oxygen.

3. The chemical formula of magnesium phosphate is—

- ☐ $Mg(PO_4)_2$
- ☐ $Mg_2(PO_4)_3$
- ☐ $Mg_3(PO_4)_2$
- ☐ $Mg(PO_4)_3$

4. The following reaction is an example of a—

$$Fe(s) + CuSO_4(aq) \longrightarrow FeSO_4(aq) + Cu(s)$$

- ☐ combination reaction
- ☐ displacement reaction
- ☐ decomposition reaction
- ☐ neutralisation reaction

5. The chemical formula of quicklime is—

- ☐ CaO
- ☐ $CaCO_3$
- ☐ $Ca(OH)_2$
- ☐ $CaCl_2$

D. Answer the following questions in brief.

1. What are elements?
2. Give the chemical symbol of iron and chlorine.
3. Write the chemical formulae of the following compounds:

   (a) Aluminium oxide (b) Zinc acetate

4. Balance the following equation:

$$Ca(OH)_2 + HCl \longrightarrow CaCl_2 + H_2O$$

5. What does a chemical equation represent?
6. What are reactants and products in a chemical equation?
7. Give one example of a combination reaction.

E. Answer the following questions.

1. Write the steps involved in writing the chemical formula of calcium phosphate.
2. How is a chemical change different from a physical change?
3. 'Neutralisation reaction is a chemical change.' Justify this statement with the help of an example.
4. Define a decomposition reaction and give an example of the same.
5. Classify the following reactions into different types, giving reason.

   (a) $CaO(s) + SiO_2(g) \longrightarrow CaSiO_3(s)$

   (b) $KOH(aq) + HCl(aq) \longrightarrow KCl(aq) + H_2O(l)$

   (c) $Cu(s) + 2AgNO_3(aq) \longrightarrow Cu(NO_3)_2(aq) + 2Ag(s)$

   (d) $BaCO_3(s) \xrightarrow{heat} BaO(s) + CO_2(g)$

Value Based Question

The school principal told her students that she would like them to follow a 'special practice' of the Japanese schools. Their schools do not keep staff members for cleaning as such. The students, themselves, work as a team and take pride in maintaing the cleanliness of their school. She went on to say that she would like them to replace their old habits by new, better habits in a way similar to a 'displacement reaction' in which one element replaces another in a compound.

1. State two values displayed by the students of Japanese schools.
2. Why did the principal tell her students that the suggested ideas, in a way, similar to what happens in a displacement reaction?
3. Give one example of a displacement reaction.

Something To Do

1. **List any five physical and chemical changes that you see around you.**
2. **Think of a small activity to show that rusting of iron requires both oxygen and water.**

CHAPTER

4 Acids, Bases and Salts

We all know that there are wide varieties of materials around us. They differ from one another in their colour, odour, taste, physical state and other properties. We often use such properties to classify substances and materials into different categories.

Some materials, like lemon, vinegar and tamarind have a sour taste. These materials taste sour due to the presence of chemicals called **acids**. Other materials, like baking soda and soap, have a bitter taste. It is due to the presence of chemicals called **bases**.

Caution: It is dangerous to taste any unknown substance, either at home, or in school.

The term acid has been derived from the Latin word '*acidus*', which means 'sour'. All sour-tasting materials contain acids. Acids are classified into two categories:

- Mineral Acids

  Acids, which are prepared from the minerals present in the earth, are called **mineral acids**. Hydrochloric acid (HCl), sulphuric acid (H_2SO_4), nitric acid (HNO_3), sulphurous acid (H_2SO_3) and phosphoric acid (H_3PO_4) are some of the well-known mineral acids.

Do You Know ?

Sulphuric acid is often known as the 'King of Chemicals.' It is used in the manufacture of a wide variety of materials.

• Organic Acids

Acids, which are naturally occurring and are found in plants and animals, are called **organic acids**. Many fruits and vegetables contain organic acids. For example, guava contains oxalic acid. Orange, lemon and *amla* contain citric acid. Grapes, tamarind and gooseberries contain tartaric acid. Sour milk contains lactic acid. Vinegar contains acetic acid (CH_3COOH).

These contain citric acid

These contain tartaric acid

Sting of bees, red ants, wasps and stinging nettle contain formic acid (HCOOH) which causes a shooting pain.

Acids, like hydrochloric acid, nitric acid, sulphuric acid and phosphoric acid, are strong acids. Acids, like citric acid, acetic acid, carbonic acid and formic acid, are weak acids. We will learn more about strong and weak acids in higher classes.

Acids, manufactured in the factories, are highly concentrated, that is, the water content in them is very low. Their concentration can be decreased by adding water to them. Acids, having a low concentration, are called **dilute acids**.

For the Teacher

Explain to the students that concentrated acid must always be diluted by adding acid to water slowly and not by adding water to acid directly.

Do You Know ?

Gases, like carbon dioxide, sulphur dioxide, nitrogen dioxide, etc., are released in the air by factories, power houses and automobile exhausts. These gases mix with rain water and form acids. Rain water, thus, becomes acidic. When this 'acid rain' falls on buildings, made of marble (which is calcium carbonate), the acid reacts with marble. Acid rain is the main cause of yellowing of Taj Mahal. Buildings and monuments, made of marble, (like Taj Mahal), thus, get affected by the action of 'acid rain'.

Bases and Alkalies

Bases are substances which react with acids to form water and salt. Bases are bitter in taste and have a soapy feel.

Some bases are soluble in water. Such bases are called **alkalies**. For example, sodium hydroxide and aluminium hydroxide are both bases. However, sodium hydroxide is also termed as an alkali because it is soluble in water.

Some bases, like sodium hydroxide (NaOH) and potassium hydroxide (KOH) are strong bases. Others, like ammonium hydroxide (NH_4OH), aluminium hydroxide ($Al(OH)_3$) and copper hydroxide ($Cu(OH)_2$), are weak bases.

Indicators

Acids and bases can be identified not only through their taste but also with the help of substances called **indicators**. An **indicator** is a substance which shows different colours in an acidic and a basic medium. The colour of the indicator can, thus, help in identifying acids and bases.

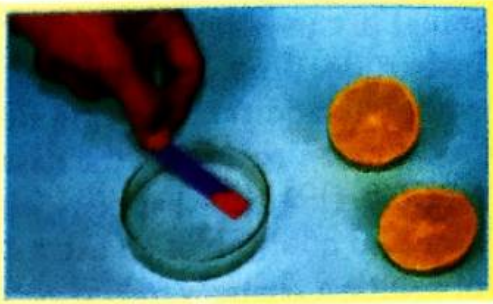
An indicator, used very often, is litmus. It is obtained from lichens and is purple in colour. Its colour changes to red in an acidic medium and to blue in a basic medium.

Litmus can be used as an indicator in the form of a solution. In practice, it is more common to use a paper strip that has been dipped in litmus solution and allowed to dry. Such a paper strip is called **litmus paper**.

Let us now perform two activities to understand how litmus can be used to identify an acid and a base.

Activity 1

Take some lemon juice in a petridish and dip a strip of blue litmus paper in it. The colour of the litmus paper changes to red due to the presence of an acid in the lemon juice.



Activity 2

Take some soap solution in a petridish and dip a strip of red litmus paper in it. The colour of litmus changes to blue. This happens due to the presence of a base in the soap solution.

Turmeric can also act as an indicator. It turns red in a basic medium and remains yellow in an acidic medium. Have you ever noticed what happens when soap is rubbed on a turmeric stain on your handkerchief or shirt?

Juice of China rose (Hibiscus) petals can also be used as a natural indicator. It turns dark pink (magenta) when added to an acid and turns green when added to a base.

Another commonly used indicator is phenolphthalein. It is colourless in an acidic medium and turns pink in a basic medium.

Neutralisation and Formation of Salts

A chemical reaction between an acid and a base is known as a **neutralisation reaction**. When such a reaction takes place, water and salt are formed. During neutralisation, the acid and the base 'cancel' the effect of each other.

Let us perform an activity to understand the process of neutralisation.

Activity 3

Take 10 ml of dilute hydrochloric acid in a conical flask and add two drops of (blue) litmus solution to it. It turns red [see Fig. (i)]. Now, add a solution of sodium hydroxide, drop by drop, to the flask and keep on swirling the solution constantly while the addition is being done. At some point, addition of another drop of base (sodium hydroxide) to the flask, would change the colour of solution from red to blue (see Fig. (ii)). This happens when all the acid in the flask has been neutralised by the base and addition of an extra drop of base make the solution basic. Hence, the colour of solution changes to blue.

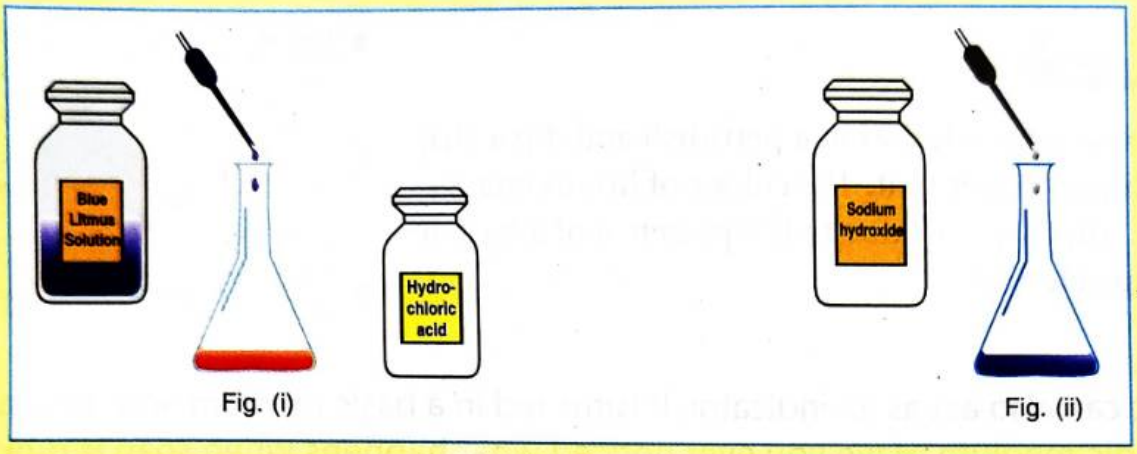


Fig. (i) Fig. (ii)

Do You Know ?

Hydrochloric acid, present in small quantities in our stomach, helps in digestion of food. However, when an excess of this acid gets secreted in the stomach, it causes uneasiness, nausea and pain. To cure this problem, we have to take medicines, called **antacids.** These contain a mild base which 'neutralises' the excess acid present in the stomach.

Some examples of neutralisation reactions are given below in the form of chemical equations:

$$\underset{\text{Sodium hydroxide (Base)}}{NaOH} + \underset{\text{Hydrochloric acid (Acid)}}{HCl} \longrightarrow \underset{\text{Sodium chloride (Salt)}}{NaCl} + \underset{\text{Water}}{H_2O}$$

$$\underset{\text{Potassium hydroxide (Base)}}{2KOH} + \underset{\text{Sulphuric acid (Acid)}}{H_2SO_4} \longrightarrow \underset{\text{Potassium sulphate (Salt)}}{K_2SO_4} + \underset{\text{Water}}{2H_2O}$$

$$\underset{\text{Magnesium hydroxide (Base)}}{Mg(OH)_2} + \underset{\text{Nitric acid (Acid)}}{2HNO_3} \longrightarrow \underset{\text{Magnesium nitrate (Salt)}}{Mg(NO_3)_2} + \underset{\text{Water}}{2H_2O}$$

Naming of Salts

The salts of different acids are named as follows:

- Salts of sulphuric acid (H_2SO_4) are named as **sulphates**.
- Salts of hydrochloric acid (HCl) are named as **chlorides**.
- Salts of nitric acid (HNO_3) are named as **nitrates**.
- Salts of sulphurous acid (H_2SO_3) are named as **sulphites**.
- Salts of carbonic acid (H_2CO_3) are named as **carbonates**.
- Salts of acetic acid (CH_3COOH) are named as **acetates**.

For example, $CaSO_4$ is a salt formed from calcium hydroxide and sulphuric acid. It is named as calcium sulphate. Similarly, $NaNO_3$ is named as sodium nitrate; NaCl is named as sodium chloride; Na_2SO_3 is named as sodium sulphite; Na_2CO_3 is named as sodium carbonate and CH_3COONa is named as sodium acetate.

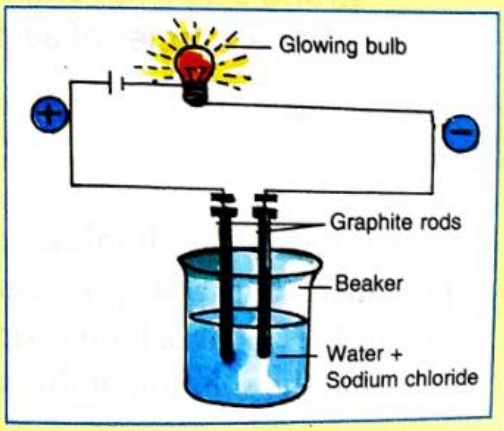
Properties of Salts

1. Salts are formed through reactions between acids and bases.
2. Most of the salts are readily soluble in water.
3. Salts do not conduct electricity in their solid state. However, molten salts and solution of salts in water conduct electricity.

Let us now perform an activity to show that solutions of salts, in water, can conduct electricity.

Activity 4

Take a beaker and fill it half with water. Dissolve some common salt (sodium chloride) in this water. Connect two graphite rods with the two terminals of a battery, with a zero watt LED bulb in between, as shown in the figure. Now dip these graphite rods in the solution of sodium chloride. The bulb starts glowing indicating the flow of electric current. This shows that a solution of sodium chloride can conduct electricity.



Classification of Salts

Salts are classified as neutral, acidic and basic.

• Neutral Salts

Salts, formed by the reaction of a strong acid with a strong base, are **neutral salts**. Solution of a neutral salt in water is neutral, that is, it is neither acidic nor basic. Hence, such a salt solution does not change the colour of the litmus paper.

Sodium chloride (NaCl) is a neutral salt as it is formed by the reaction of a strong acid (HCl) and a strong base (NaOH). KCl, KNO_3, Na_2SO_4 are some other examples of neutral salts.

Activity 5

Take a solution of sodium chloride in water in a petridish. Dip a strip of blue litmus paper in the solution. What do you observe? The colour of litmus paper does not change. Next, dip a strip of red litmus paper in this solution. The colour of litmus paper again does not change. This shows that the solution is neither acidic nor basic, that is, it is neutral.

• Acidic Salts

Salts, formed by the reaction of a strong acid and a weak base, are **acidic salts**. Solution of an acidic salt in water is acidic, that is, it would changes the colour of blue litmus paper to red.

Aluminium chloride ($AlCl_3$) is an acidic salt as it is formed by the reaction of a strong acid (HCl) and a weak base ($Al(OH)_3$). NH_4NO_3, $ZnSO_4$, $CuCl_2$ are some other examples of acidic salts.

Activity 6

Take a solution of aluminium chloride in water in a petridish. Dip a strip of blue litmus paper in the solution. The colour of litmus paper changes to red. This shows that the solution of this salt is acidic in nature.

• Basic Salts

Salts, formed by the reaction of a weak acid and a strong base, are **basic salts**. Solution of a basic salt in water is basic, that is, it changes the colour of red litmus paper to blue.

Sodium acetate (CH_3COONa) is a basic salt as it is formed by the reaction of a weak acid (CH_3COOH) and a strong base (NaOH). CH_3COOK, HCOONa, Na_2CO_3 are some other examples of basic salts.

Activity 7

Take a solution of sodium acetate in water in a petridish. Dip a strip of red litmus paper in the solution. The colour of litmus paper changes to blue. This shows that the solution of this salt is basic in nature.

Keywords

acids	chemicals which are sour in taste.
alkalies	bases which are soluble in water.
acidic salts	salts formed by the reaction of a strong acid and a weak base.
bases	chemicals which have a bitter taste and a soapy feel.
basic salts	salts formed by the reaction of a weak acid and a strong base.
indicator	a substance which shows different colours in an acidic and a basic medium.
mineral acids	acids which are formed from the minerals present in the earth.
neutralisation reaction	a reaction, between an acid and a base, resulting in the formation of salt and water.
neutral salts	salts formed by the reaction of a strong acid with a strong base.
organic acids	naturally occuring acids that are found in plants and animals.

You Must Know

1. Materials around us differ from one another in their colour, taste, physical state and other properties.
2. Some materials taste sour due to the presence of chemicals called acids. Some other materials have a bitter taste and a soapy feel, and are called bases.
3. Acids are classified as mineral acids and organic acids.
4. Mineral acids are formed from the minerals present in the earth. Acids, like hydrochloric acid, sulphuric acid, etc., are mineral acids.
5. Naturally occurring acids are called organic acids. Acids, like acetic acid, lactic acid, citric acid, etc., are organic acids.
6. Acids may be strong (like hydrochloric acid), or they may be weak (like acetic acid).
7. Acids, manufactured in factories, are highly concentrated. They are mixed with water to lower their concentration. Acids of low concentration are called dilute acids.
8. Bases, which are soluble in water, are called alkalies.
9. Some bases (like sodium hydroxide) are strong bases. Some other bases (like ammonium hydroxide) are weak bases.
10. Acids and bases can be identified with the help of substances called indicators.
11. The indicators show different colours in an acidic and a basic medium.
12. Litmus (paper or solution), turmeric, China rose and phenolphthalein are some of the indicators that are used very often.
13. A chemical reaction, between an acid and a base, is known as a neutralisation reaction.
14. During neutralisation reaction, salt and water are produced.
15. Most of the salts are readily soluble in water. Salts do not conduct electricity in their solid state. Salts conduct electricity in their molten state and in the form of their solution in water.
16. Salts are classified as neutral, acidic and basic.
    - Neutral salts are formed by reaction of a strong acid and a strong base.
    - Acidic salts are formed by the reaction of a strong acid and a weak base.
    - Basic salts are formed by the reaction of a weak acid and a strong base.

Something To Know

A. Fill in the blanks.

1. Acids which are present in plants and animals are called _____.
2. Bases taste _____ and have a _____ feel.
3. Acids turns the colour of blue litmus paper to _____.
4. The products of neutralisation reaction are _____ and _____.
5. Salts of nitric acid (HNO_3) are named as _____.
6. Sodium acetate (CH_3COONa) is a basic salt formed by the reaction of _____ and _____.

B. Match the following:

1. Lemon juice	(a) Oxalic acid
2. Tamarind	(b) Lactic acid
3. Vinegar	(c) Citric acid
4. Red ants	(d) Acetic acid
5. Sour milk	(e) Tartaric acid
6. Guava	(f) Formic acid

C. Tick (✓) the correct option.

1. Bases have a—

☐ bitter taste and a rough feel ☐ sour taste and a rough feel

☐ bitter taste and a soapy feel ☐ sour taste and a soapy feel

2. An example of a natural indicator is—

☐ methyl orange ☐ ink

☐ phenolphthalein ☐ litmus

3. An acid, that contributes to the sour taste of some fruits, is—

- ☐ hydrochloric acid
- ☐ sulphuric acid
- ☐ citric acid
- ☐ nitric acid

4. Which of the following is a strong acid?

- ☐ acetic acid
- ☐ citric acid
- ☐ nitric acid
- ☐ carbonic acid

5. Substances, produced through a chemical reaction between acids and bases, are known as—

- ☐ salts
- ☐ indicators
- ☐ antacids
- ☐ alkalies

6. An indicator, that turns red in a basic medium, is—

- ☐ turmeric
- ☐ phenolphthalein
- ☐ blue litmus
- ☐ hibiscus

7. The general taste, of acids and bases, is respectively—

- ☐ sweet and salty
- ☐ sour and salty
- ☐ sour and sweet
- ☐ sour and bitter

D. Answer the following questions in brief.

1. What are mineral acids?
2. Give two examples each of mineral acids and organic acids.
3. Name any two substances that can be used as indicators.
4. Write the meaning of the term 'neutralisation reaction.'
5. Give any two properties of salts.
6. Classify the following salts as neutral, acidic or basic. Also, write their names.

   (a) Na_3PO_4

(b) K_2CO_3

(c) NH_4NO_3

E. Answer the following questions.

1. 'All alkalies are bases but all bases are not alkalies'. Justify this statement.
2. Suggest an activity that can help one to decide whether a given solution is acidic or basic in nature.
3. Write chemical equations for the following reactions:
   (a) Calcium hydroxide reacts with nitric acid.
   (b) Acetic acid reacts with calcium hydroxide.
   (c) Hydrochloric acid reacts with sodium hydroxide.
   (d) Ammonium hydroxide reacts with sulphuric acid.
4. State the difference between neutral, acidic and basic salts. Give one example of each.
5. Describe an activity to show that solutions of salts, in water, can conduct electricity.

Value Based Question

The Physical Training (PT) teacher noticed that two of her students were having very heated arguments with each other. She immediately went to them, calmed them down and made them sit together. She listened patiently to both of them and then explained to them the merits, of the 'other point of view' and the importance of 'team work'. The students agreed to follow her advice and instructions.
The chemistry teacher, who was watching all this, remarked that she sees a lot of similarity between the role of the PT teacher and the 'neutralisation reactions' between acids and bases.

1. State the values displayed by the PT teacher.
2. Do you agree with the remarks of the chemistry teacher? Give reason.
3. Write the chemical equations for two neutralisation reactions, giving names of all the compounds relevant to the reaction.

Something To Do

1. **Common names of some substances are given below. Find out the chemical formulae, chemical names and the uses of these substances, and write them in the table given below:**

Common Name	Formula	Chemical Name	Use
Caustic soda			
Caustic potash			
Baking soda			
Washing soda			
Limestone			
Quicklime			
Lime water			
Plaster of paris			
Blue vitriol (*neela thotha*)			

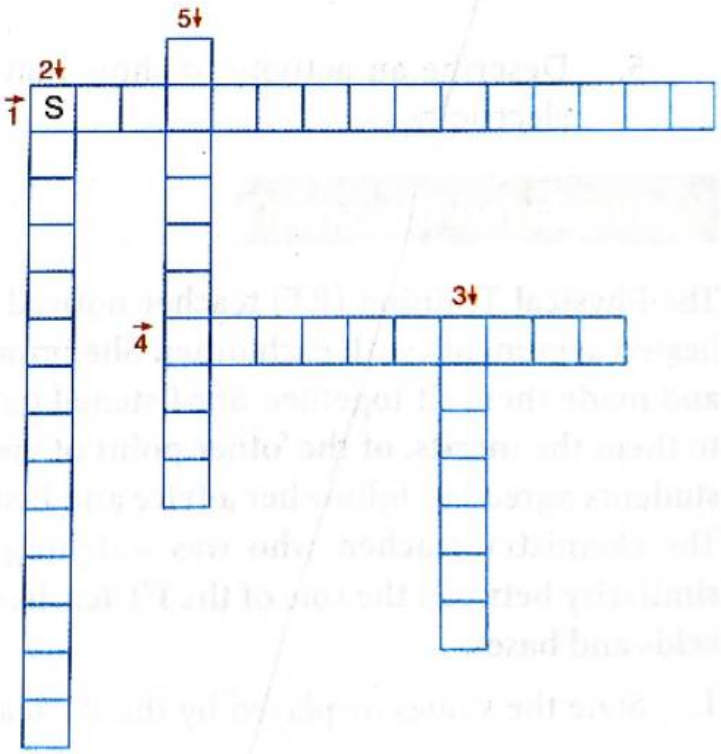
2. **Solve the crossword puzzle with the help of the clues given below:**

Across →

1. A basic salt present in washing powders.
4. A weak acid present in vinegar.

Down ↓

2. An acid whose salts are called sulphites.
3. A substance used to reduce acidity in our stomach.
5. An acid present in oranges and lemons.



3. **Some acids, bases and salts are commonly used in our daily life. Find out the names of such substances, specify whether they are acids, bases or salts and write their uses.**

5 | Heat

We are all familiar with the sensations of 'hot' and 'cold'. On a hot summer day, we find it uncomfortable to walk barefoot on a cemented floor, as it is too 'hot'. During winter months, we will find that very floor as being too 'cold'.

We express the degree of hotness of a body through its **temperature**. The more is the temperature of a body, the hotter it is and vice-versa.

▶ Heat as Energy

We know from our daily experience, that a bottle of ice-cold milk, left on a table on a hot summer day, soon warms up. A glass tumbler, of boiling-hot milk, kept on the same table, cools down after a while. It shows that when the temperatures of a body and its surroundings are different, there is a transfer of energy between the body and its surroundings. This transfer continues till the body and its surroundings attain the same temperature. In the case of ice-cold milk bottle, heat flows from the surroundings to the bottle; in the case of boiling-hot milk tumbler, it flows from the glass tumbler to the surroundings. Based on such experiences, we say that:

1. Heat is a form of energy (heat energy/thermal energy), that is transferred from one body to another, due to the existence of a temperature difference between them.

2. Transfer of heat energy/thermal energy always takes place from the body at a higher temperature to that at a lower temperature.

Let us now perform an activity which shows that heat is a form of energy and it can be converted into other forms of energy.

Activity 1

To show that we can get other forms of energy from heat.

Take a vessel half filled with water. Cover it with a light aluminium lid and heat it over a flame. We will see that the water starts boiling after a while. The lid then 'rises up', and 'falls down', again and again. Here, the steam (formed by the heated water) could raise the lid. It, therefore, does mechanical work. This shows that heat is a form of energy and it can be used to do mechanical work.

Do You Know ?

In early days, heat was considered as a fluid (liquid) that flowed from a hotter body to a colder body. This (weightless and colourless) fluid was called the '**calorific**'. This theory was shown to be incorrect by the experiments of physicists, like Davy, Count Rumford and Joule, who showed that heat is just a form of energy.

Heat and Temperature

We often observe that when we heat a body, its temperature rises. This indicates that heat and temperature are related to each other. Heat is the **energy** of a body that is due to the motion of its constituents particles (molecules). Temperature, on the other hand, is just an **indicator** of this energy. Even a cold object possesses **heat energy** due to the motion of its particles (molecules). When we add, (or remove) heat (from) a body, motion of its molecules becomes **faster** (or **slower**).

Effects of Heat

When a body is heated, various types of physical and chemical changes are observed to take place. We list below some of the main effects of heat.

Physical changes

(a) **Change in temperature:** We all know that addition, or removal, of heat to, or from, a body brings about a change in its temperature. Addition of heat to a body (usually) raises its temperature, whereas, removal of heat, from a body (usually), lowers its temperature.

(b) **Change of state:** Under appropriate conditions, addition, or removal, of heat to, or from, a body, can also bring about a change in its state. For example, on putting a tray of water (liquid form) in the freezer compartment of a refrigerator, the water freezes to form ice. Ice, as we know, is the solid form of water. Similarly, when water is heated over a flame, it starts boiling and gets converted into steam. Steam, as we know, is the gaseous or vapour form of water.

(c) **Thermal exapansion:** Most of solids, liquids and gases, are known to expand on heating. This phenomenon is called **thermal expansion**. For example, the metal rim, to be put on a cart wheel, is designed to have a (slightly) smaller diameter than that of the wheel. When this rim is heated, it becomes 'red-hot', expands, and slips on to the wheel easily. When it is cooled, it contracts and grips the wheel firmly.

Chemical changes

Many chemical changes take place only when the reactants are heated up. For example, we can prepare oxygen, in the laboratory, by heating potassium chlorate (along with manganese oxide as a catalyst) over a flame.

Do You Know ?

It is interesting to note that ice and cast iron are two of the few solids that contract on heating. Cold water, at 4°C, is known to expand on cooling. This special property of water helps us to understand (i) why water pipes sometimes burst at very cold places and (ii) a soft drink glass bottle often cracks when left in the freezer compartment for a long time. It is also linked with the survival of aquatic animals even at places where the (surrounding) atmospheric temperature goes down well below 0°C.

Measurement of Temperature

We now know that heat is a form of energy and temperature is an indicator of that energy. We often feel that we can get 'an estimate' of the temperature of a body by just touching it. However, though our senses do give us an idea of temperature, they are often unreliable and misleading. For example, if we remove an ice tray, and a packet of frozen vegetables, from the freezer compartment, the ice tray may appear colder to our hand even though both are at the same temperature.

We, therefore, need a more reliable method to know the relative hotness or coldness, i.e. the temperature of a given body. We use special instruments for this purpose. All such instruments, or devices, are known as **thermometers**.

Activity 2

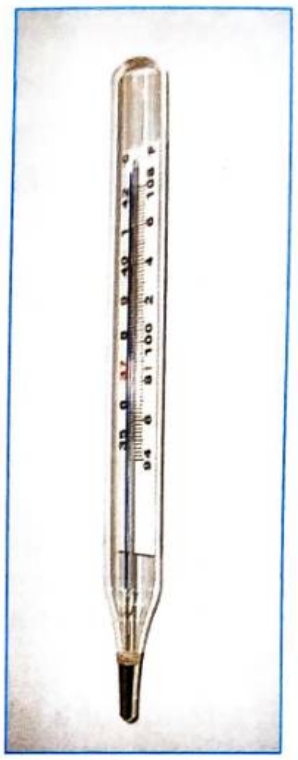
To get an idea about the importance of determining temperature accurately.

List your ideas, about the 'needs' of different persons, to know the temperature of different objects accurately. Jot down your ideas in a tabular form as shown below.

Person who needs to know temperature	The likely purpose
1. A Parent	
2. A Child	
3. A Doctor	
4. A Farmer	
5. A Mechanic	
6. A Pilot	
7. A Weather Reporter	
8. A Cook/Chef	
9. A Cricket Official	
10. A Tourist	

The Thermometer

We find that many of the physical properties, (like thermal expansion, pressure, volume) of different materials, change with temperature in a regular and systematic manner. We can, therefore, use these properties as a way of measuring temperature. The simplest thermometer, with which we all are familiar, is the **mercury in glass thermometer**. It is based on the thermal expansion of mercury. This thermometer is shown in the figure here.



Glass Thermometer

It consists of a narrow capillary tube of glass that is closed at its upper end and has a bulb at its lower end. The bulb is filled with mercury. Inside the capillary tube we can see a small shining thread of mercury. The mercury, present in the bulb of the thermometer, expands when heated. The extent of its expansion, and, therefore, the length of mercury thread in the capillary tube, depends on the extent of heating of the thermometer. This, in turn, depends on the temperature of the object with which the thermometer bulb has been put in contact. The length of the mercury thread (in the thermometer) can, thus, give us a measure of the temperature of the object.

Do You Know ?

Mercury expands in a uniform way, and also remains in its liquid state, over a wide temperature range. It also does not stick to the walls of the glass capillary tube and is a shining silvery liquid. It is because of these reasons that mercury is often used in ordinary thermometers.

Reading a thermometer

For measurement purpose, the temperarture scale is calibrated to assign a numerical value to a given temperature. Depending on the purpose, and use, of a thermometer, two fixed reference points (lowest temperature and highest temperature) are choosen. The difference, in the temperature of the two fixed reference points, is called the **range** of the thermometer. The interval, between these fixed points, is divided into an equal (fixed) number of divisions.

Two scales, that have been in common use, are the **Fahrenheit** and the **Celsius scales**. Most of the countries now use the Celsius scale to measure

the temperature of an object. Our school laborartory thermometer is one such thermometer.

Do You Know ?

The temperature 'T' in degrees celsius (°C) is equal to the temperature 'T' in degrees Fahrenheit (°F) minus 32, times 5/9. T (°C) = [T (°F) – 32] × 5/9.

Comparison of Fahrenheit (°F) and Celsius (°C) scale readings

Normal room temperature	23°C	72°F
Normal human body temperature	36.9°C	98.4°F
Water boils at	100°C	212°F
Water freezes at	0°C	32°F

The range of a laboratory thermometer can be from –10°C to 110°C.

Thermometers, in the range 0°C to 100°C, are found more often in school laboratories.

Activity 3

To find the range and least count of different thermometers.

Record your observations in a tabular form as shown below:

Thermometer	Range (°C)	Least Count (°C)
1.		
2.		
3.		
4.		

Least count of measuring instrument is the smallest quantity that can be measured as per the calibration of that instrument.

$$\text{Least Count of an instrument} = \frac{\text{difference between two marked readings}}{\text{total number of division between them}}$$

Clinical Thermometer

We use a specially designed, and calibrated, (mercury in glass) thermometer to measure our body temperature. Such a thermometer is known as the **clinical,** or **doctor's, thermometer**.

The clinical thermometer differs, from an ordinary (mercury in glass) laboratory thermometer, in two respects:

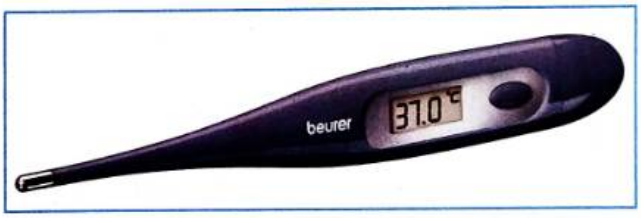
(i) It is calibrated from 35°C to 42°C only. This is so because this is the range over which the temperature of the normal human body can vary.

(ii) It has a slight 'bend', or kink, in its capillary tube. This kink is given the name **constriction**. .

The constriction ensures that mercury thread does not fall back, by itself, after this thermometer has been used to measure the temperature of a person. The reading can, therefore, be taken conveniently. This would not be the case if an ordinary laboratory thermometer was used for this purpose.

Do You Know ?

- The normal human body temperature is the average body temperature of a large number of healthy persons. It is quite close to 36.9°C (or 98.4°F). A body temperature close to 40°C (or 104°F) indicates a condition of 'high fever.'
- Now a days Digital (electronic) thermometers are preferred over the conventional mercury thermometers. These thermometers are easy to read as they give a 'LCD display' of the temperature of the person. They are also mercury free.



Activity 4

To measure the human body temperature using a clinical thermometer.

Before measuring the body temperature, wash the thermometer with an antiseptic solution. Hold it firmly and give it a few jerks. The jerks will bring the level of mercury below 35°C. Now place the thermometer gently under the tongue of the person being observed. Let it remain there for about one minute. Now take out the thermometer and note its reading. While reading, keep the line of sight along the convex meniscus of the level of mercury in the thermometer. This is the body temperature of the person under observation.

Caution: The person, under observation, must close her/his mouth, around the thermometer bulb, very gently. The bulb should not break as any amount of mercury, going inside the body, can prove quite dangerous. Also, NEVER put the thermometer in the mouth of a child.

Repeat these steps for several persons.

Record your observations in a tabular form.

S.No.	Name	Body Temperature (°C)
1.		
2.		
3.		
4.		
5.		
6.		

Transfer of Heat

We often observe the transfer of heat from a hot body to a cold body. Simple situations, like the ones given below, indicate such a heat transfer.

(i) When one end of a metal rod is put in a flame, its other end also soon becomes very hot.

(ii) When a glass of hot water is left on a table, it becomes lukewarm after some time.

(iii) When a metal chair is left out in the sun, on a hot summer day, it becomes too hot to sit on.

In all these cases, transfer of heat takes place, with the hot object losing some of its heat, and the cold object gaining the 'heat'. We, therefore, say that there is a (net) transfer of heat from the hot object to the cold object.

In nature, there are three different methods of transfer of heat. They are known as **conduction**, **convection** and **radiation**. Let us understand them one by one.

Conduction

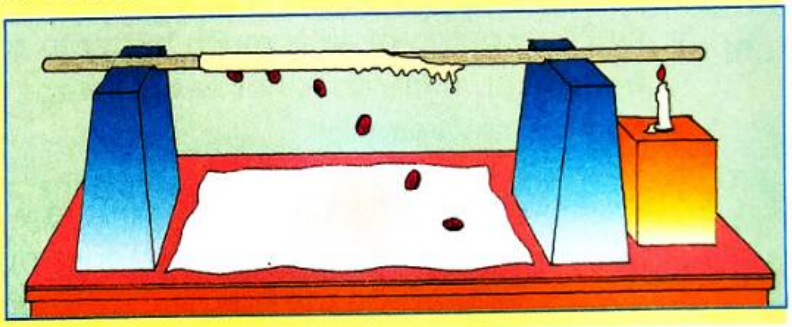
This is the most significant method of transfer of heat in solids. In this method, heat is transferred from one particle (molecule), of the object, to the next, and then to the next, and so on, without the particles leaving their places. The particles just vibrate about their mean positions, and keep on passing heat energy, to their 'next-in-line' neighbours.

We can perform a simple activity to observe this method of heat transfer.

Activity 5

Take a metal rod. Coat it with a thick layer of (softened melted) wax. [Do the coating carefully without letting the (hot) melted wax to cause any burns (A suitable spatula/ rod may be used for this purpose)]. Fix some small buttons, on the wax, at regular intervals of, say, 5 cm each. Allow the wax to solidify and harden up.

Fix the rod on two metal stands and heat the rod at one of its two ends. After sometime, we will observe that the buttons start falling down, one by one, from the side being heated up. This happens because of the transfer of heat, through the metal, and subsequent (sequential) melting of the wax.



Let us now see whether heat energy is able to 'go along' easily through all solids. We know that when we put one end of a metal rod in a flame, its other end also soon becomes too hot to touch. This shows that heat 'goes through' quickly along a metal rod. Metals are, thus, good **conductors** of heat.

On doing the same experiment, with a wooden rod, we find that the end of the wooden rod held by us, does not become hot even after a long time while the (other) end may well have burnt out by then. This shows that heat cannot easily 'go along' a wooden stick. Wood is, thus, a **bad conductor** of heat. Bad conductors of heat are also known as (heat) **insulators**.

All metals are good conductors of heat with some of them better than the others. Wood, ebonite, cotton, plastic, cork, thermocole, air and water are all bad, or poor, conductors of heat, i.e. they are 'heat insulators.'

We put both good and bad conductors to many uses in our daily life. For example,

1. We use metals to make cooking utensils. Metals, being good conductors, quickly transfer the heat of the flame to the food items kept inside. The food items then get heated up and cooked. Metals are also used for making kettles, boilers and boiler tubes, for the same reason.

2. We use wooden, or plastic, handles for holding tea kettles, or cooking utensils. These handles help us to hold them even when the objects themselves are quite hot. This is because, being insulators, they do not let the heat to get transferred to our hands.

3. Use of bricks and mud, for making houses, helps to shield us from the heat of the sun during summer. These materials are bad conductors of heat and hence, do not let the outside heat to reach easily inside the house. We can now also understand why rooms, with tin roofs, often become very hot during summer.

4. Air is known to be a bad conductor of heat. Blankets, woolen clothes, and quilts, help us to stay warm in winter. They all make use of the bad conductivity of air. They trap a layer of air between themselves and our body. (Such trapping of air is much better in a new quilt than in an old one). Our body heat, then, does not easily escape out, through this trapped air layer, and we stay warm.

5. Ice boxes are often made as double walled containers. The layer of air, trapped between the two walls, does not easily let the outside heat reach the ice, kept inside the box. The ice, therefore, does not melt quickly.

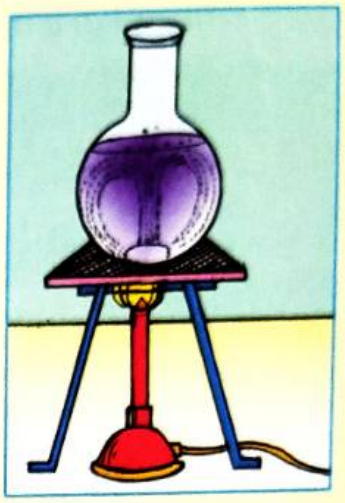
Convection

We have noted above that water is a poor conductor of heat. How does then, the water, put in a kettle, get heated up when it is put over a flame?

The molecule in liquids (and gases) are quite free to move. This is unlike solids whose molecules are quite rigidly fixed. It is this ability of liquid molecules (to move around) that causes a liquid to get heated up. We call this method of heat transfer, in liquids (and gases), as **convection**. To see how heat is transferred, by convection, let us look at a simple activity.

Activity 6

Take a round bottom flask and fit it in a stand. Now, take a tripod stand with a wire gauge on top of it. Keep the flask over the wire gauge, kept on top of the tripod stand. Half fill the flask with water and put some crystals of potassium permanganate into it. Now put a burner below the tripod stand, light it up and start heating the flask.



We will soon observe streaks of colour, moving up, and then coming down. This cyclic movement, of coloured streaks, will continue for a while. Soon the whole water acquires colour; it also get heated up.

How do we understand this cyclic movement of the coloured streaks in water? The water at the bottom of the flask, gets heated up first. As a result, it becomes lighter. As the water molecules are free to move, these heated up (lighter) molecules (coloured by contact with the potassium permanganate crystals) move up. The colder, and heavier, molecules at the top, then move down to take the place vacated by these molecules. It is these movements that we see in the form of the coloured streaks 'going up and down.' Because of these movements, the whole water soon gets heated up.

Liquids, and gases too, are, thus, seen to transfer heat throughout their volume, by the (actual) movement of their molecules. We call this method of heat transfer as **convection**. We often refer to these cyclic movements of molecules, in liquids and gases, as **convection currents**.

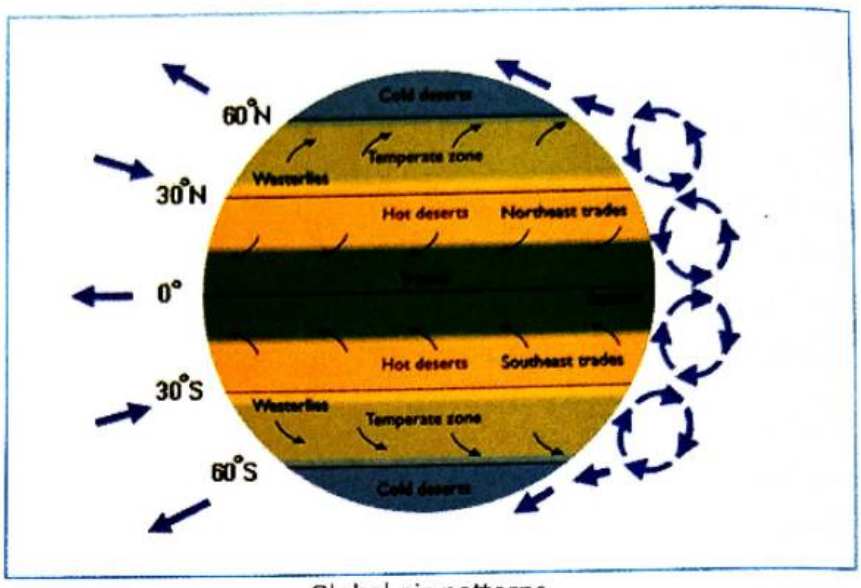
We make considerable use of convection currents in our daily life. The use of windows and ventilators in rooms, use of chimneys in factories, and the radiators, in cars, are some common applications that are based on convection currents.

Convection currents also have a significant effect on weather and climate. When the air, at a place, gets heated up, it expands and occupies more space. It, therefore, becomes lighter and moves up. The air pressure, at that place, then gets lowered. Hence, air from surrounding places, rushes in to take the vacated place. This sets up convection currents in air leading to **winds** and **storms**.

- ### Global wind patterns

  It is easy to realise that there would always be an uneven heating of the earth. It is this uneven heating that results in **global wind patterns**.

The places, near to the equator, receive maximum heat energy from the sun. The air, at these places, gets heated up, rises, and, thus, leaves a low pressure area behind it. The cooler air, mainly from places between 0 to 30 degree latitude, and the equator, then moves in towards the equator. The greater the difference in pressure, the faster does the air move in. These winds (moving air) blow, from north and south, towards the equator.



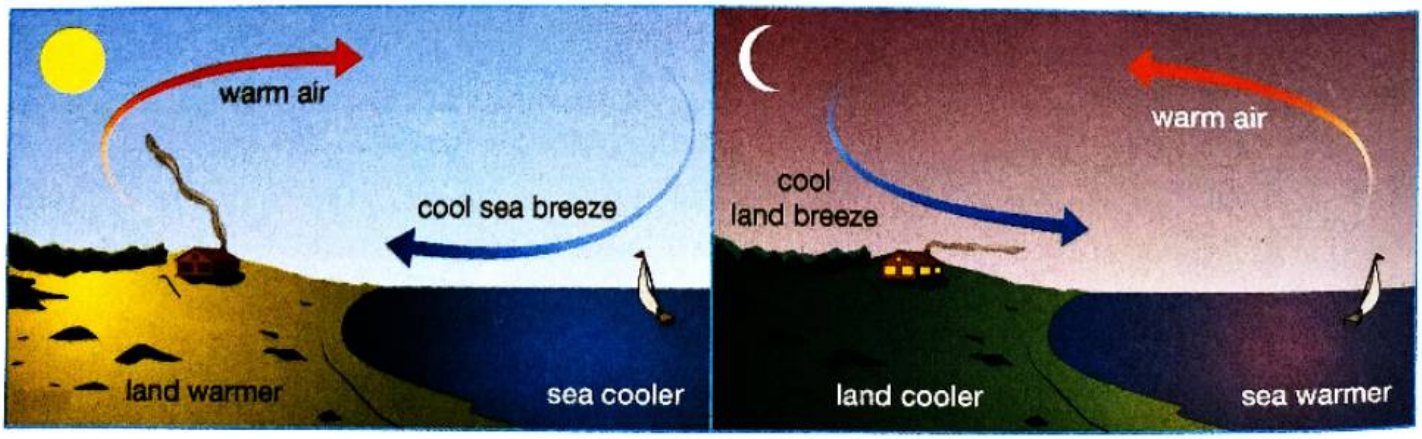
Global air patterns

At the poles, the air is colder than that at latitudes of say, about 60 degrees. Hence, the wind currents here are set up from the poles towards the warmer latitudes.

- ## Land and Sea Breezes

Water gets heated up slowly than land during day time. Hence, the air above the land gets heated up more quickly and rises up. Cooler air, from above the sea, then rushes in to take its place. We call this movement of air as a **Sea breeze**.

During night, water cools more slowly than land. The air, above the water, therefore, becomes warmer and rises up. Its place is taken up by the cooler air above the land. This movement of air is called as **Land breeze**.



Day time

Night time

These land, and sea, breezes help in maintaining the temperature of air at a more or less uniform value through the day and the night. We, therefore, have an equitable climate on places near the sea.

Do You Know ?

The wind speed, wind direction, temperature and humidity, of a place, all contribute to the development, of the atmospheric convection currents, into storms and cyclones. The strong wind sometimes forms a cloud and grows into a thunderstorm (having speed of 80–150 km/hr). Cyclone is a huge storm, having strong spiralling winds, going inwards and upwards, at a speed of around 150 km/hr over warm ocean regions. Cyclones rotate in anticlockwise/clockwise (northern hemisphere/southern hemisphere) direction around the centre of the storm (eye) which is the calmest, and low pressure, region. The difference, in the pressure, determines the intensity of the cyclone and the strength of the winds. Once a mature cyclone forms, it can last up to a week, depending upon the atmospheric and oceanic conditions. When cyclones come on to the land, the accompanying heavy rain, strong winds and large waves, can damage buildings, trees and cars.

Do You Know ?

In summer, at places near the equator, the land warms up faster. Hence, most of the time, the land temperature is higher than that of water in the oceans. The air over the land gets heated up and rises. This casues the wind to flow from the oceans towards the land. These winds carry water and bring rain. We call these winds as **monsoon winds.**

Radiation

We feel hot when we stand out in the sun or when we are near a fire place. How does the heat of the sun, or the fire place, reach us?

The heat of the sun does not reach us either by conduction or by convection. This is because there is (mostly) empty space (vacuum) between the sun and the earth. Conduction and convection, both require a material medium for the transfer of heat.

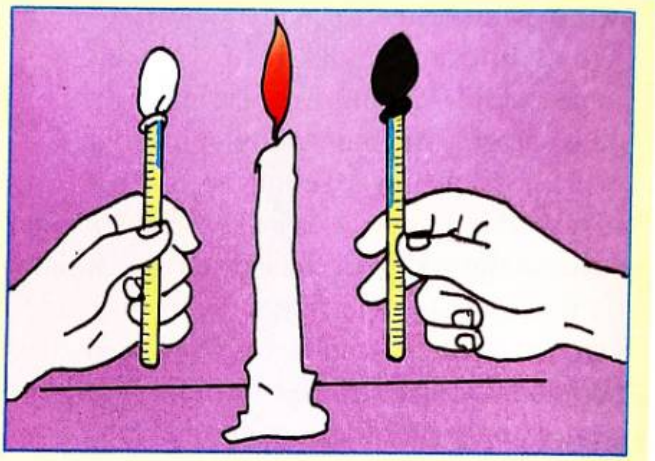
It follows then that, there must be a third method of heat transfer. We call this method of heat transfer as **radiation**. It may be defined as a method of heat transfer in which no material medium is required.

The heat energy, received by an object through radiation, is called **radiant energy**. We say that all hot objects give out, or radiate, heat energy.

When radiant energy falls on any matter, a part of it is reflected back and a part of it is absorbed by the matter. It is the absorbed part of radiant energy that heats up the object. We find, through practical experience, that black objects are very good absorbers of radiant energy. Highly polished, or white objects, on the other hand, absorb very little amount of the radiant energy falling on them. The following activity will help us to verify this fact.

Activity 7

Take two identical thermometers and keep them side by side. Wrap a piece of black paper on the bulb of one of the thermometers and a piece of white paper on the bulb of the other thermometer. Now keep both of them at equal distance, from a fire place, or a 'lighted up' candle.



We observe that the temperature of the thermometer, having black paper on its bulb, rises (a little) faster than that of the other thermometer. This shows that black objects absorb heat better than white objects.

The difference between the absorption, and emission, properties of black and polished surfaces has many practical uses. We list below some of these:

1. The bottom of cooking utensils is often kept black. This enables the utensils to better absorb the heat of the flame.
2. We prefer white, or light coloured, clothes in summer, they absorb less heat from the surroundings.
3. Tea, or coffee, pots are often made shining bright. They, therefore, radiate out less heat. The tea, or coffee, kept in the them, therefore, stays hot for a longer time.
4. Fire brigade men often use shining brass caps. These caps absorb very little heat and therefore, help the firemen while they are putting off the fire.
5. Houses generally have light colours on their outer walls. These absorb, and radiate, less heat. This helps to keep the houses cool in summer and warm in winter.

6. Many buildings, in the cities, have coated shining glass as their 'outer walls.' These absorb and radiate, very little heat. This helps to improve the efficiency of the 'air conditioning systems' in the building.

7. The thermos flask is used to carry, in it, hot or cold drinks. It makes use of the property of shining, or polished, surfaces of absorbing, as well as radiating, very little heat. (It also makes use of the bad conductivity of air/vacuum through its 'double walled' structure).

Keywords

clinical thermometer	a device used to measure the temperature of human body.
conduction	mode of transfer of heat in solids in which heat moves from molecule to molecule without any movement of the molecules themselves.
conductor of heat	material which allow heat to flow through it with ease.
convection	mode of transfer of heat, in liquids and gases, in which molecules themselves move to carry heat.
degree celsius	a unit for measurement of temperature.
heat	energy in transit.
insulator of heat	material which does not allow heat to flow through it.
laboratory thermometer	a device used to measure temperature in laboratory.
land breeze	the breeze that flows, from land surface to sea surface, during night.
least count	the minimum reading that an instrument can measure.
radiation	mode of transfer of heat which does not require any material medium.
thermal expansion	expansion of matter on heating.
thermometer	a device used to measure the temperature.
temperature	an indicator of the degree of hotness or coldness of an object or a substance.
sea breeze	the breeze that flows, from sea surface to land surface, during day time.

You Must Know

1. Heat is a form of energy that gets transferred from a body at a higher temperature to a body at a lower temperature.
2. Heat can be converted into other forms of energy.
3. Temperature is an indicator of the degree of hotness or coldness of an object.
4. When a body is heated, various type of physical and chemical changes are observed.
5. Thermometer is a device used to measure temperature.
6. Clinical thermometer is used to measure the temperature of the human body.
7. The range of the clinical thermometer is from 35°C to 42°C. While that of the ordinary laboratory thermometer from –10°C to 110°C.
8. The ordinary laboratory glass thermometer is based on the principle of thermal expansion of mercury on heating.
9. There are three modes of transfer of heat—conduction, convection and radiation.
10. In solids, heat is generally, transferred by conduction.
11. In liquids and gases, heat also gets transferred by convection.
12. No material medium is required for transfer of heat by radiation.
13. The materials, which allow heat to pass through them with ease, are called conductors of heat.
14. The materials, which do not allow heat to pass through them, are called bad conductors of heat or (heat) insulators.
15. The cyclic movements of molecules, in liquids and gases, are known as convection currents.
16. Convection currents have significant effect on weather and climate.
17. Land and sea breeze, in coastal areas, occur due to convection currents.
18. When heat falls over an object, some of it is absorbed by the object and some of it gets reflected back.
19. The temperature of an object increases because of absorption of heat.
20. Dark coloured objects absorb (heat) radiations better than the light coloured objects.

Something To Know

A. Fill in the blanks.

1. Heat is a form of _____.
2. The range of clinical thermometer is from _____ °C to _____ °C.
3. Water is a _____ conductor of heat.
4. Land and sea breezes help to maintain the _____ of air.
5. Transfer of heat, from the sun to the earth, takes place mainly through the process of _____.

B. Write True or False for the following statements.

1. Heat cannot be produced by doing work. ☐
2. No gaps are left between the rails of railway tracks. ☐
3. Poor conductors of heat are also good insulators of heat. ☐
4. Ventilators, when provided in rooms, are located near their roofs. ☐
5. A material medium is required for transfer of heat by the process of radiation. ☐

C. Tick (✓) the correct option.

1. A copper ball at 30°C is put in a container, containing water at 30°C. In this case—

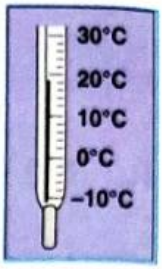
   ☐ heat will get transferred from water to the copper ball.

   ☐ heat will get transferred from the copper ball to water.

   ☐ heat would flow first from copper ball to water and then from water to copper ball.

   ☐ there would be no transfer of heat between the copper ball and water.

2. The reading of the laboratory thermometer, in the figure shown here, is—



- ☐ 10.2°C
- ☐ –10°C
- ☐ 10.8°C
- ☐ 18°C

3. It is not convenient to use the laboratory thermometer to measure our body temperature. This is so because—

- ☐ its range is small.
- ☐ as the thermometer is taken out from the mouth, the level of mercury, in it, immediately starts falling.
- ☐ our body does not transfer heat to its bulb.
- ☐ it takes a very long time to acquire the temperature of the body.

4. When we hold our hands close to the side of a flame, they get warmed up mainly due to—

- ☐ conduction as well as convection
- ☐ conduction
- ☐ radiation
- ☐ convection

5. The freezer compartment in a refrigerator is usually put near its top. This provides good cooling throughout the refrigerator through—

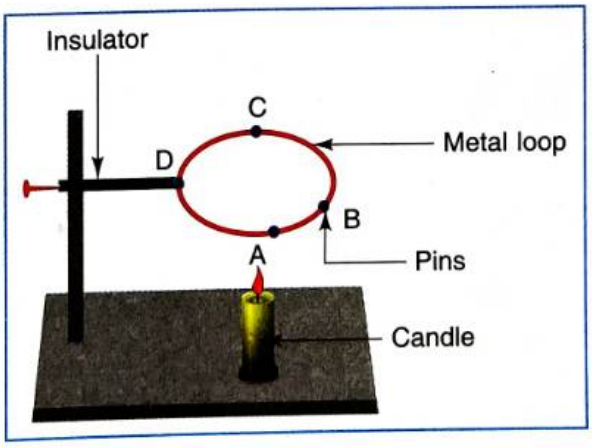
- ☐ the good conductivity of air.
- ☐ the radiation of heat by the food items kept inside the refrigerator.
- ☐ the setting up of 'convection currents', in the air inside the refrigerator.
- ☐ transfer of heat by conduction and radiation.

D. Answer the following questions in brief.

1. In which direction does the transfer of heat normally take place?
2. What is the cause of heat generation in the following situations:
   (a) We apply brakes on our fast moving car.
   (b) People often jump up and down to feel warmer in cold weather.
3. State two types of physical changes that may take place when a substance is heated.
4. In what way(s) does a clinical thermometer differ from an ordinary thermometer?
5. State the mode/different modes, of heat transfer, in the following situations.
   (a) A paper cup, full of hot soup, lying on a table.
   (b) Cooking vegetables in a pan.
   (c) Melting of a chocolate bar, in the school bag, on a hot day.
   (d) Cooking food in a microwave oven.
6. What is meant by sea breeze? When does it occur?

E. Answer the following questions.

1. In the arrangement shown in the figure, pins A, B, C, and D are fixed to a circular metal loop with the help of wax.



The circular metal loop is heated at the point A with the help of a candle flame.

In which order would the pins fall if AB < AD? Justify your answer.

2. Give reasons for the following:

   (a) Iron rims are heated red hot before 'fixing' them on cart wheels.

   (b) A clinical thermometer has a slight bend, or kink, in its capillary tube.

   (c) A new quilt is warmer than an old one.

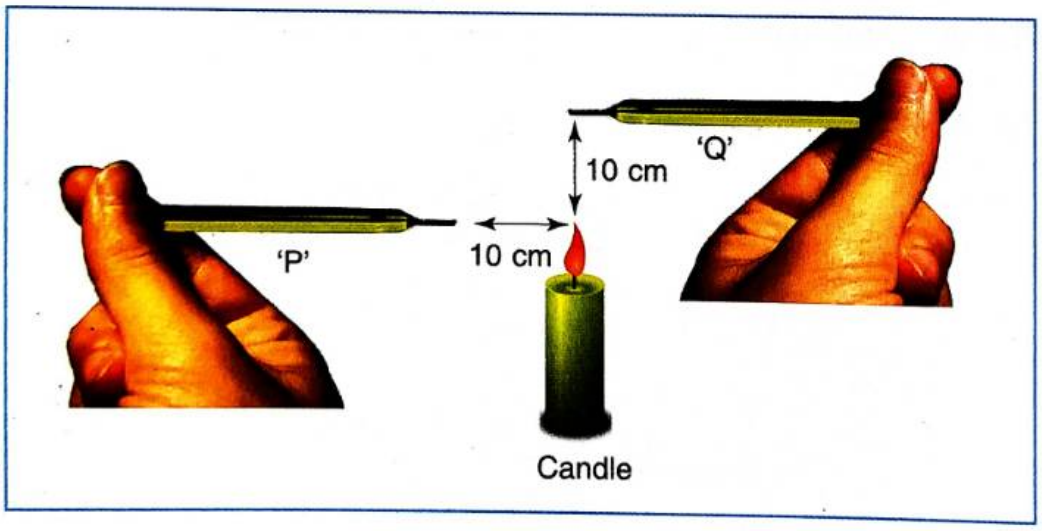
   (d) A brass tumbler feels much cooler than a wooden tray on a chilly day.

   (e) The bottoms of cooking utensils are often kept black.

3. Akshit visited Rishikesh for river rafting during summer holidays. At a campsite, there were two tents, one made with a black fabric and the other with a white fabric. Which one should Akshit prefer? Give reason for the choice. Should Akshit prefer the same tent during winters?

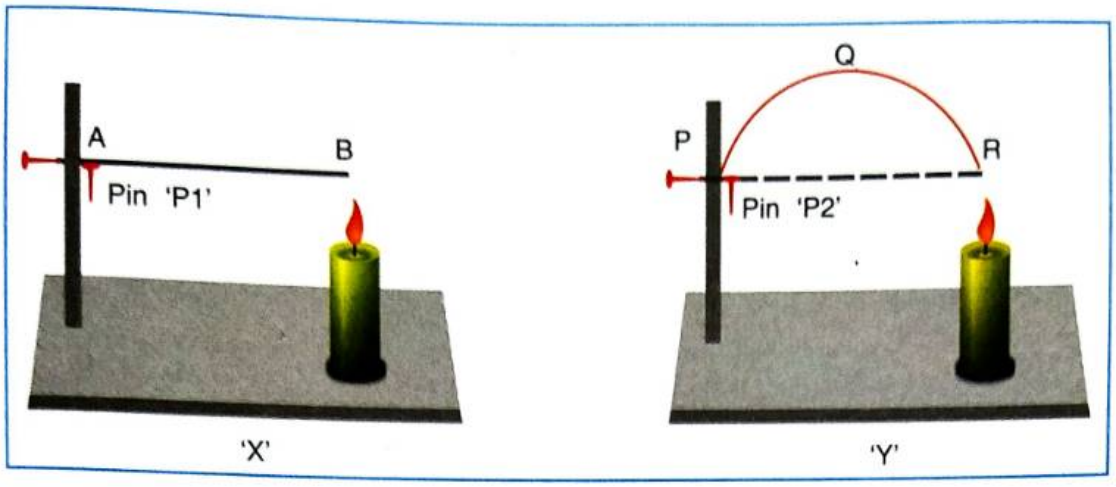
4. Explain briefly how winds are caused.

5. Supriya, while doing an experiment in the Science Laboratory, kept a laboratory thermometer 'P' 10 cm away on one side of the flame of a candle. Her friend Riya kept a similar thermometer 'Q' 10 cm above the flame of the candle as shown in the figure.



   In which of the thermometers, 'P' or 'Q', the rise in temperature will be faster? Give reason for your answer

6. In the two 'set-ups' X and Y, shown on the next page, the wires AB and PQR are made of the same material and have equal 'thickness'. The length of the wire AB, (in the set-up 'X') is equal to the diameter (= PR) of the semi-circle, formed by the wire PQR, (in the set-up 'Y'). Pins, P1 and P2, are attached, to wires AB and PQR respectively, with the help of wax. Which of the two pins, P1 or P2, will fall off later? Give reason for your answer.



Value Based Question

During the summer holidays, Hridyika went to visit her grandparents in their village. During her morning walks there, she observed that a girl in the village would play very good music on her home-made musical instrument. Hridyika was very much impressed by her skill and wanted to learn playing that instrument from her. She, however, felt hesitant to ask her to teach her. When she discussed her problem with her mother, she advised her to politely and keenly request that girl to teach her that skill. She told Hridiyika that just as heat always flows from a hot object to a cold object, knowledge and skill always 'flow' to a pupil from her/his mentor.

1. State the values displayed by Hridiyika's mother.
2. Name the three different modes of transfer of heat and give one example of each.
3. Have a group talk in which students talk about how they learnt some skill from a mentor.

Something To Do

1. **Boil some water in vessel. Cover it with a plate. Remove the plate after sometime. Allow it to cool. We will see droplets of water on the surface of plate. Try to find out why, and how, these water droplets are formed.**
2. **Describe the various ways in which heat energy can enter/escape from our houses. Learn about the measures that are now being taken to reduce such heat transfers.**
3. **Take a cup of hot water/tea. Measure its temperature accurately with a thermometer. What will happen to the hot water/tea if it is left in a room for, say, one hour? Measure the temperature at fixed intervals of five minutes and**

record (your observations) in the given table. Using these readings, try to draw a temperature-time graph.

S.No.	Time (minutes)	Temperature (°C)

4. Take some (moderately) hot water in a tumbler. Dip one end of a steel spoon, a plastic spoon, a glass rod, a wooden stick and a copper rod in the hot water. After waiting for few minutes (say 2-3 minutes) (carefully) touch the other end of each item. Observe which ones become hot and which ones do not. Hence, categorise them as 'Heat conductors' or as 'Heat insulators'.

Heat conductors	Heat insulators

CHAPTER

6 Motion and Time

Motion

We all often observe that objects, like motor vehicles, aeroplanes, animals, birds and human beings are having different types of motion. We also know that different heavenly objects, like the galaxies, stars, sun, planets and the moon, are all in motion. It is also known that our earth is moving around the sun. When we are sitting at one place, the blood in our bodies is flowing through the arteries and veins; also and air is flowing into, and out of, our lungs. We thus, realise that motion is an integral part of our life.

When do we say that an object is in motion?

An object is said to be in **'motion'** if its position, with respect to its immediate surroundings, changes with time.

When the position of an object, with respect to its immediate surroundings, does not change with time, it is said to be at **'rest'** with respect to its surroundings.

All Motion is Relative

It is, important to realise that all motion is **relative**. A given object may be regarded as 'being at rest' by one observer and as 'being in motion' by another observer. For example, two persons, sitting next to each other in a moving train, are at rest with respect to each other. However, they are both in motion with respect to a person standing outside on the platform.

Have you ever experienced that while sitting in a train, standing on the platform, you suddenly 'feel' that your train has started moving. This happens, when another train, on a neighbouring track crosses your train. Thus, the decision about a given object's state of 'rest', or 'motion', depends very much on the observer and the surroundings chosen.

Do You Know ?

We often think of motion when the position of an object changes with time. However, there are certain situations in which we interpret motion through some indirect evidence. Thus, the motion of air is visualised through movement, or rustling, of leaves and motion of earth is interpreted through observation like the regularity of sunrise and sunset.

We have already discussed, in Class-VI, that objects may move in a straight line or may follow a circular or curved path. They may also rotate, oscillate or vibrate.

Activity 1

Let us recall different kinds of motions. Complete the table below by giving some examples of each type of motions.

Kind of Motion	Examples
1. Linear motion	
2. Circular motion	
3. Periodic motion	
4. Oscillatory motion	
5. Rotational motion	

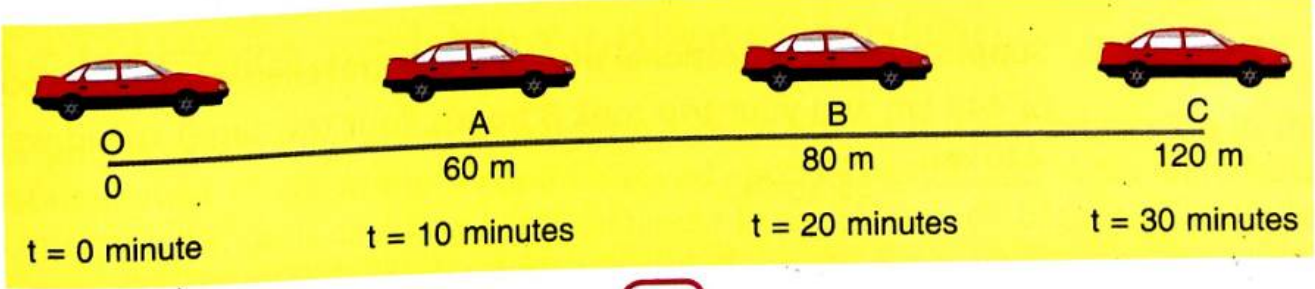
Motion along a Straight Line

The simplest type of motion is motion along a straight line (linear motion). For example, motion of a train on a straight track, of an apple falling from a tree, of hailstones falling to the ground, or the straight march-past of soldiers in a parade, can all be thought of as examples of 'motion in a straight line.'

We realise that in all these cases, the objects concerned are moving along a (nearly) straight path. We call all such motions as **'rectilinear'** or simply as **'linear motion'**.

Describing Straight Line Motion

We need to specify the position of an object, at different times, to describe its motion along a straight path. Consider the motion of a car along a straight level road. Choose point 'O' as the point from where the car starts moving. This means that the car is at 'O' at 't' = 0. Let A, B, C represent the 'position of the car' at different instants of time.



In the first 10 minutes, the car moves from O to A. The distance covered is 60 m in these first 10 minutes. In the next 10 minutes, the car moves from A to B. Hence, the distance covered by it is 20 m in these (next) 10 minutes. We can, therefore, say that the car 'speeded up' in the time interval 0-10 minutes and 'slowed down' in the time interval 10–20 minutes.

We, thus, realise that the change, in the positions of an object, helps us to decide how 'fast' or 'slow' its motion is.

Speed

Speed is a measure of how 'fast' an object is moving. We, therefore, regard speed as an **indicator** of the **rate/rapidity** of a given motion.

In our daily life, we come across two common situations—(i) Different objects may take different times to cover the same distance. We then call that object as the 'fastest' which takes the least time. (ii) Different objects may cover different distances in the same time. Here, we call that object as the 'fastest' which covers the maximum distance in the (same) given time.

The most convenient way to find out which of the two or more objects is moving 'faster', is to compare the distances covered by them in unit time. For example, when we say that **Car A** and **Car B** are moving at a speed of **30 km/h** and **50 km/h**, respectively, we mean that the distances covered by Cars. A and B, in a time of **one hour**, are **30 km** and **50 km**, respectively. We can then say that Car B is moving with a **'higher speed'** as compared to Car A.

We state the relationship between these physical quantities as—

$$\text{speed} = \text{distance per unit time}$$

or

$$\text{speed} = \frac{\text{distance}}{\text{time}}$$

The basic unit (SI unit) of speed is **metre per second (m/s)**. It is also often expressed in other units, such as metre per minute (m/min) or kilometre per hour (km/h).

Example 1: Suppose, on an educational trip, you have travelled a total distance of 440 km and your trip took 8 hours. Your (average) speed was $\frac{440\,\text{km}}{8\,\text{h}} = 55$ km/h.

This is your average (effective) speed as you might have stopped on the road for one or another reason. It implies that on an average, you have covered a distance of 55 km in one hour.

We now understand that as an object moves, its speed can go on changing. We, therefore, often describe the motion of an object in terms of its average speed.

$$\text{Average speed} = \frac{\text{Total distance covered}}{\text{Total time taken}}$$

Comparison of 'Speed'	
1.	Speed of light in air $\simeq 3 \times 10^8$ m/s
2.	Speed of sound in air $\simeq$ 340 m/s at room temperature
3.	Speed of earth's rotation $\simeq$ 440 m/s at the equator
4.	Speed of earth's revolution $\simeq$ 30 km/s
5.	Speed of launching of satellites/rockets $\simeq$ 8 km/s
6.	Fastest bird (Pregrine falcon) $\simeq$ 200 km/h
7.	Fastest animal (Cheetah) $\simeq$ 115 km/h

Do You Know ?

The speedometers, of vehicles, directly record the speed at a given time (instantaneous speed) in km/h. The vehicle is in uniform motion (along a straight path), if its average speed is same as its instantaneous speed.

Uniform and Non-uniform Motion

Consider a car moving along a straight narrow road. Let it travel first 30 km in the first hour, next 30 km in the second hour and another next 30 km in the third hour. In this case, the car is covering equal distances in equal intervals of time of one hour

each. Its speed, therefore, remains constant over these one-hour time intervals. We can, therefore, call the motion of this car as a **uniform motion**, over these one-hour time intervals. To be more precise, however, we say that:

An object is said to be in **uniform motion** when it moves along a straight path, and covers equal distances in equal intervals of time, howsoever small these intervals of time may be.

Now suppose the same car is travelling on another straight narrow road with lots of traffic on it. It continues to travel along a straight path but its speed, during its journey, keeps on changing. We call such a motion as a **non-uniform motion**.

The motion of the car is also regarded as **non-uniform** if it does not move along a straight path. It is only motion with a constant speed, along a straight path, that is regarded as a uniform motion.

Activity 2

Given below is the data about the positions of (i) a car and (ii) a bus (moving along a straight path) at different times. Examine this data carefully and decide whether the motion is (i) uniform or (ii) non-uniform.

Time	Position from starting point (Car)	Position from starting point (Bus)
9.00 am	0 km	0 km
9.05 am	5 km	4 km
9.10 am	10 km	6 km
9.15 am	15 km	9 km
9.20 am	20 km	11 km

Time

Time plays an important role in our life. Any change, or movement, which takes place, is understood in terms of a physical dimension called **'time'**. Time and change are often linked together. Some natural events (like the solar or the lunar eclipse) happen

once in a while. Other natural events repeat themselves over a regular (fixed) interval of time. We refer to such regular repeating events as **periodic** events.

In ancient times, people used such natural events, repeating themselves at regular intervals of time (e.g. sunrise and sunset, seasons in a year, changes in the appearance of moon, etc.) to count and define the intervals of time. The time interval between one sunrise and the next was called a '**day**'. Similarly, a month was measured from one new moon to the next. A year was fixed as the time taken by the earth to complete one revolution of the sun.

Measurement of Time

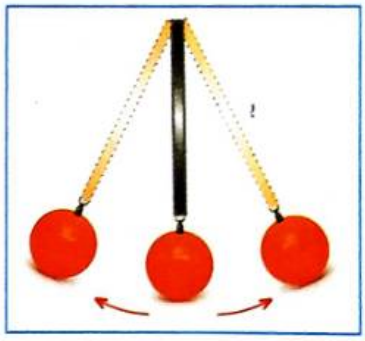
The early scientists developed many devices to measure time intervals that are much smaller than a day. Devices, like the sundial, the hour glass and water clock, were used to measure time.

Now a days we depend on clocks and watches to measure intervals of time (in seconds, minutes and hours). Clocks, and watches are the 'time measuring devices' that we now use most often.

Most of the clocks make use of some periodic motion. An oscillating simple pendulum is an example of a periodic motion.

The Simple Pendulum

A simple pendulum is made up of a metal ball (bob) attached to a taut light string, or thread, that is fixed rigidly at one end.

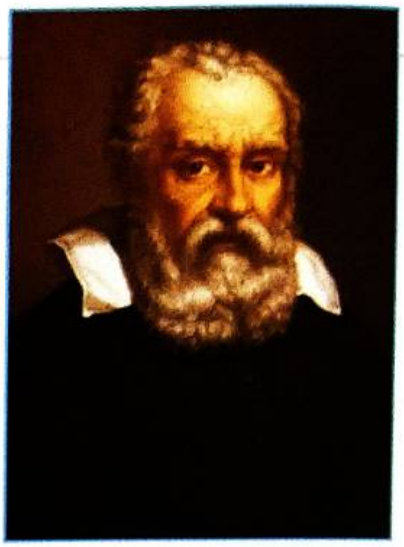


The bob of the pendulum is free to oscillate. When the pendulum is at rest, it is in its mean (equilibrium) position. When the bob of the pendulum is slightly displaced from its mean position, the bob undergoes a regular 'to and fro' motion. One such complete 'to and fro' motion is equivalent to 'one oscillation' of the pendulum. One oscillation gets completed when the pendulum goes from one extreme (initial) position, to its mean position, then to the other extreme position, again to its mean position, and then finally back to the initial (extreme) position.

The time taken for one complete oscillation, by the pendulum, is known as the **'time period'** of the pendulum.

Do You Know ?

The discovery of the oscillatory motion of pendulum, and its properties, are generally attributed to 'Galileo'. The story goes that one day, during his visit to a church, he noticed that the gaseous lamps, hanging from the ceiling, were swinging due to the breeze. Galileo noticed that the swinging was periodic in nature. He measured their time period by counting of the beats on his wrist. He also observed that all lamps having the same length, were swinging with the same time period. These observations helped him to understand and formulate the basic ideas about the simple pendulum.



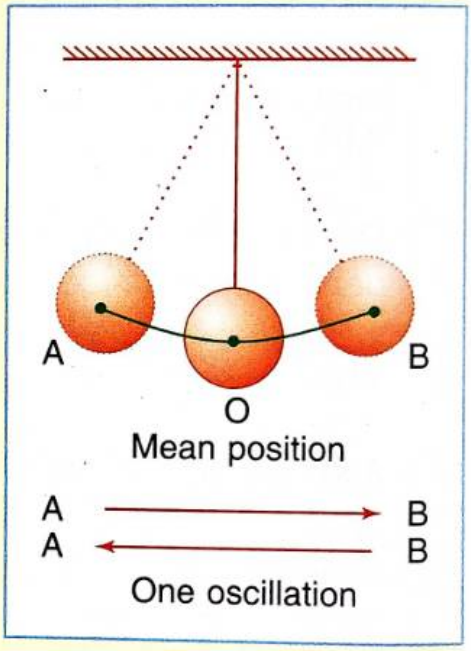
Galileo

Activity 3

To measure the time period of a simple pendulum.

Set up a simple pendulum as shown in the figure. Use a definite (suspension) length (say 1 m) of the thread that has a metal bob attached at its free end.

Let the bob of the pendulum come to rest at its mean position 0. (switch off nearby fans, if any). Displace the bob of the pendulum (by about 5 cm) to one side and release it gently. Let the pendulum oscillate for some time. Start a stop watch when the bob is at one of its extreme positions. Let the bob complete, say, 10 oscillations. Stop the watch/clock at this instant and record the time taken to complete these 10 oscillations.



The time period is this time (measured in seconds) divided by '10'. Repeat the above activity a few times and record your observations in a tabular form.

Length of thread = _____ cm

S.No.	Time taken for 10 oscillations (in seconds)	Time period (seconds) = $\frac{\text{Time taken for 10 oscillations}}{10}$
1.		
2.		
3.		
4.		
5.		

Is the time period nearly same is each case? We will find that (i) a slight change in initial displacement does not affect the time period of the pendulum; (ii) a pendulum of given length takes a definite time to complete one oscillation.

It follows then that if two pendulums, of the same length, are taken, they will take same time to complete one oscillation. This observation led to the design of the pendulum clocks. In pendulum clocks, time is measured in terms of the time taken by a standard pendulum to complete one oscillation.

A clock, or a wrist watch, runs continuously and can be used to know time. However, they cannot be used to measure accurately short time intervals, such as time taken by an athelete to run 100 m. For such measurements, we need a watch that can be started, and stopped, at precise moments. We use a 'stop watch' in such cases.

Now a days we use digital and quartz crystal clocks having suitable circuits in them. These clocks are much more precise than the pendulum clocks.

Do You Know ?

Automobiles are fitted with devices that directly (i) measure the distance covered in km and (ii) show their speeds at different times. These devices are known as **'odometers'** and **'speedometers' respectively.**

Measuring Speed

The speed of an object can be determined through distance and time measurements.

Example 2: The odometer of a car reads 12000 km at the start of a trip and 12400 km at the end of the trip. If the trip took 8 hours, find the average speed of the car.

Distance covered by the car = 12400 km – 12000 km = 400 km
Time taken = 8 hours.

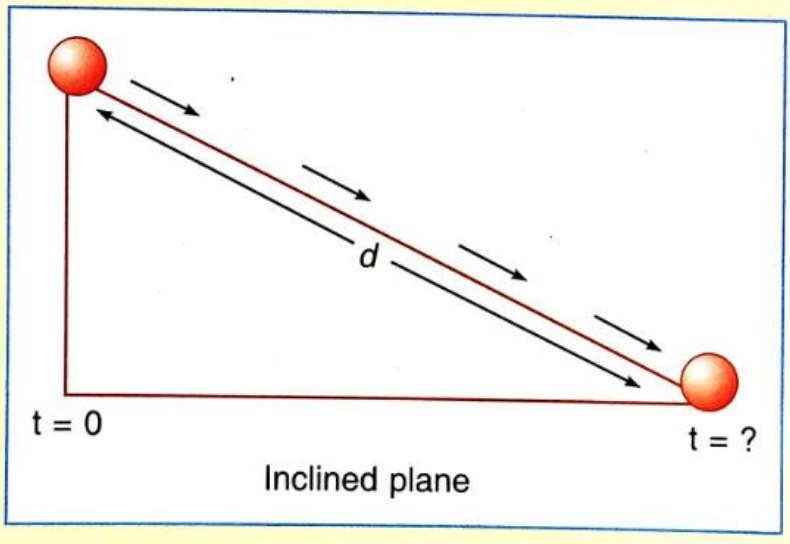
$$\text{Average speed} = \frac{\text{Distance covered by the car}}{\text{Time taken}}$$

$$\therefore \quad \text{Average speed} = \frac{400\text{ km}}{8\text{ hour}} = 50\text{ km/h}$$

Activity 3

To measure the speed of various objects.

Take a long flat ordinary wooden board/surface that can be kept inclined at different angles. Also take various objects, like a pencil, a toy car, a plastic ball, a glass ball and a tennis ball, which can roll/slide down the inclined plane.



Measure, and record, the distance covered along the inclined plane using a metre scale.

Measure, and record, the time taken to travel the entire length of the inclined plane using a stop watch.

Calculate the average speed of each object which moved down the inclined plane.

Object	Distance covered (m)	Time taken (s)	Average speed (m/s)

Next calculate the average speed when the object starts rolling from 'half way down' the inclined plane. Is the average speed during its full length roll equal to the average speed when it rolls from 'half way down' the inclined plane?

What happens to the average speed, if angle of inclination of the plane is changed?

[**Note:** We can also use a flat narrow long straight (horizontal) track, over which we can slide objects by giving them an initial push.]

Some Simple Calculations

Once we know the speed of an object we can find out the distance covered in a given time.

We have

$$\text{distance covered} = \text{speed} \times \text{time}$$

Example 3: The Shatabdi Express takes 6 hours to travel from New Delhi to Lucknow at an average speed of 80 km/h. Find the distance from New Delhi to Lucknow.

We have

$$\text{distance} = \text{speed} \times \text{time}$$

$$= \frac{80\ \text{km}}{\text{h}} \times 6\ \text{h}$$

$$= 480\ \text{km}$$

We can also find out the time taken by an object to cover a given distance while moving with a given speed.

We have

$$\text{time taken} = \frac{\text{distance covered}}{\text{speed}}$$

Example 4: The distance from Delhi to Chandigarh is 250 km. A bus travels at an average speed of 50 km/h. How much time would it take to travel from Delhi to Chandigarh?

$$\text{time taken} = \frac{\text{distance covered}}{\text{speed}}$$

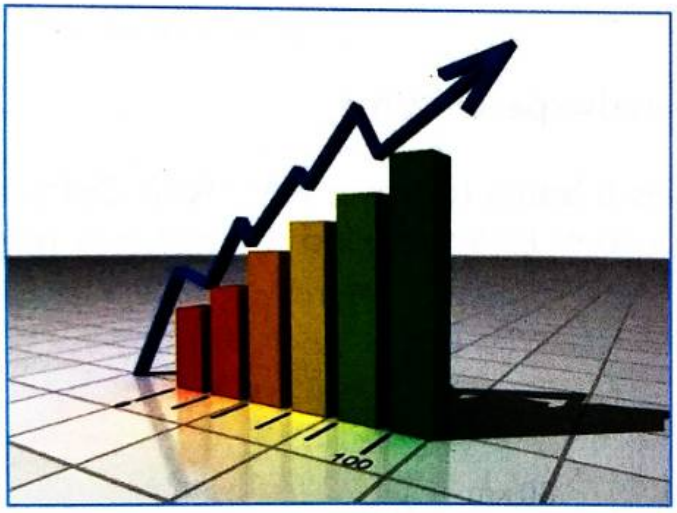
$$= \frac{250\ \text{km}}{50\ \text{km/h}}$$

$$= 5\ \text{h}$$

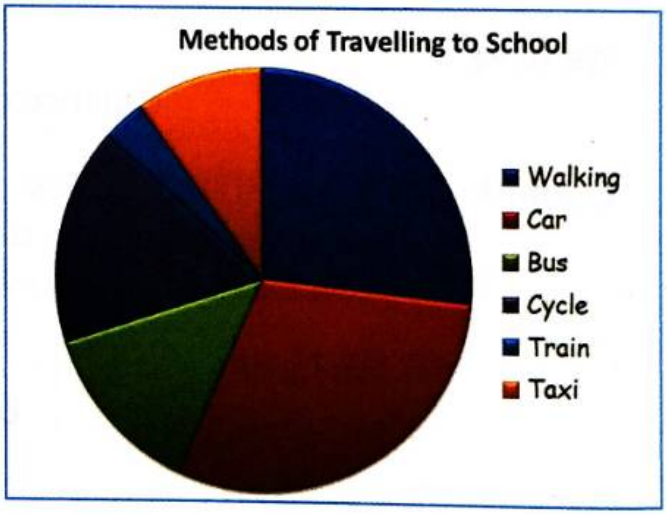
Graphs

We all know that a given 'idea', or 'concept', becomes easier to understand if we can give it a pictorial form. The 'idea' or 'concept' then 'appears to come alive', as it was.

'Graphs', very often used in Science, Mathematics and other fields of study, help us in having such a 'pictorial' and 'alive' representation. They enable us to communicate information in an interesting and visual manner. Depending on the information to be conveyed, and its specific use, we often draw many types of graphs. The bar graphs, the pie graphs and linear or straight line graphs are some of these different types of graphs. Of these, the straight line, or linear graphs, are used most often in Science.



Bar graph



Pie graph

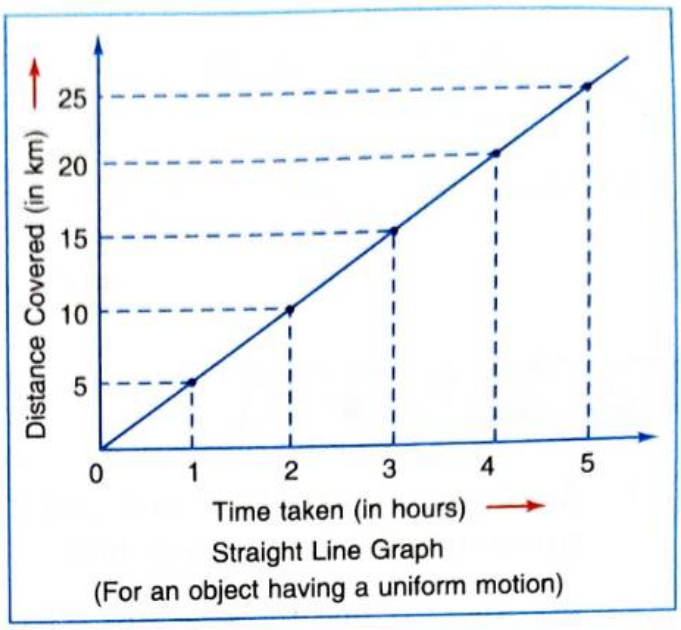
Using Graphs to Describe Motion: Distance-Time Graphs

We often use linear graphs to describe the motion of an object. On such a (linear) graph, we generally choose the x-axis as the 'time axis' (independent variable) and the y-axis as 'distance-axis' (dependent variable).

We plot the distance-time graph by following the steps given below:

(i) We choose appropriate scales to represent values of distance and time on the graph. The scale should not be too large or too small. It should be such that it enables us to utilise the maximum part of the graph.

(ii) Mark the values for the distance and time, on their respective axis, according to the choosen scale.



Straight Line Graph
(For an object having a uniform motion)

(iii) Next mark the points on the graph according to the given set of their values.

(iv) Join all the points on the graph.

For an object having a uniform motion, the distance-time graph would be a straight line, inclined to the time axis.

Keywords

average speed	the average speed of an object equals the total distance moved divided by the total time taken to cover that distance.
non-uniform motion	when an object, (i) moving along a straight path, covers unequal distances in equal intervals of time or (ii) does not move along a straight path, its motion, is called a non-uniform motion.
periodic event	an event, that repeats itself over a regular interval of time, is known as a periodic event.
rectilinear motion	motion of an object along a straight line.
simple pendulum	a simple pendulum consists of a point mass, attached to a massless string, suspended from a rigid frictionless support.
speed	speed is a measure of 'how fast' an object is moving, or speed can be regarded as an indicator of the rate/rapidity of a given motion.

time period of a pendulum	time taken to complete one oscillation by the pendulum.
uniform motion	when an object, moving along a straight path, covers equal distances in equal intervals of time, (howsoever small these time intervals may be) its motion is called a uniform motion.

You Must Know

1. An object is said to be in motion if its position, with respect to its immediate surroundings, changes with time.
2. An object is said to be at rest if its position, with respect to its immediate surroundings, does not change with time.
3. Motion and rest are relative terms. An object at rest, with respect to one observer, may be in motion for another observer and vice-versa.
4. Motion of an object along a straight line is called rectilinear motion.
5. Speed determines how fast an object is moving. It equals distance covered in a unit time. Its SI unit is metre per second.
6. The average speed of an object is the total distance moved divided by the total time taken to cover that distance.
7. An object is said to be in uniform motion if it moves along a straight path and covers equal distances in equal intervals of time, (howsoever small these time intervals may be).
8. An object is said to be in non-uniform motion if it covers unequal distances in equal intervals of time and vice-versa. Its motion is necessarily non-uniform if it does not move along a straight path.
9. Periodic events are used for measurement of time.
10. The time taken to complete one oscillation by a pendulum is known as the time period of that pendulum.
11. Motion of objects can be represented in pictorial form by their distance-time graphs.
12. The distance-time graph, for the motion of an object moving with a constant speed, is a straight line, inclined to the time axis.

Something To Know

A. Fill in the blanks.

1. An object is said to be at rest if it _____ change its position with time.
2. The SI unit of time is _____.
3. A child, sitting in a revolving giant wheel, is an example of a _____ motion.
4. A car, moving on a busy straight road, is an example of _____ motion.
5. The speedometer of a motorbike measures its speed in _____ .

B. Write True or False for the following statements.

1. The speed of a fast moving train is usually measured in metre per hour. ☐
2. The average speed remains constant for an object having a uniform motion. ☐
3. A man walks for 1 minute, at a speed of 1 m/s, along a straight track. The total distance covered by him is 1 m. ☐
4. An object, moving along a straight line, is said to be in uniform motion if it covers regularly increasing distances in equal intervals of time. ☐
5. The time period of a simple pendulum, that takes 42 seconds to complete 20 oscillations, equals 2.1 seconds. ☐
6. The distance-time graph, for a car kept parked on a side road, is a straight line parallel to the time axis. ☐

C. Tick (✓) the correct option.

1. Out of the following, the only correct formula is—

☐ distance × time = speed

☐ distance = speed × time

☐ time = $\frac{\text{speed}}{\text{distance}}$

☐ speed = $\frac{\text{time}}{\text{distance}}$

2. A man walks on a straight road from his home to a market 3 km away with a speed of 6 km/h. The time, taken by the man to go from his home to market, equals—

☐ 18 minutes

☐ 30 minutes

☐ 40 minutes

☐ 50 minutes

3. The odometer of a car reads 57321.0 km when the clock shows the time as 8.30 a.m. The odometer reading changes to 57336.0 km at time 8.50 a.m. The distance, moved by the car, in these 20 minutes, equals—

☐ 15 km

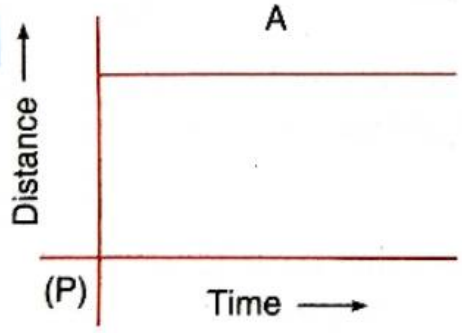
☐ 21 km

☐ 26 km

☐ 36 km

4. Out of the following distance-time graphs, the graph that represents a truck at rest, is the graph labelled—

☐



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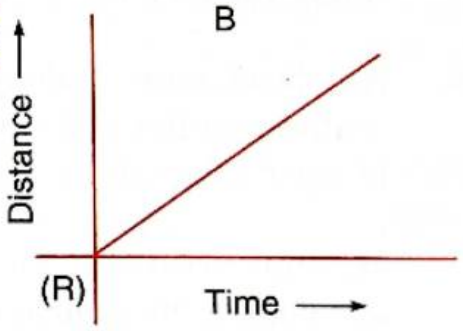

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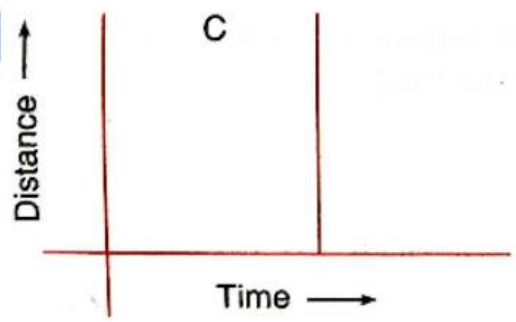

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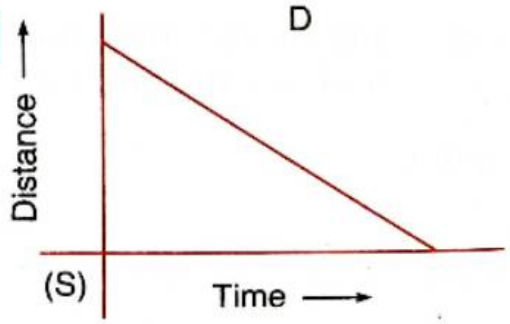
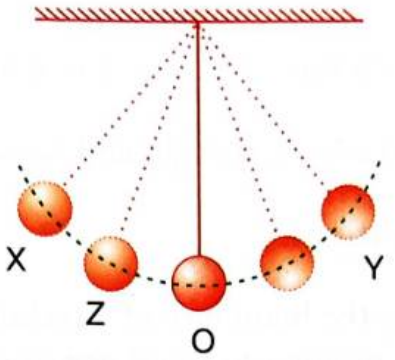


5. In the given diagram of a simple pendulum, the time taken by the bob to move from X to Z is 't_1' and from Z to O is 't_2'. The time period of this simple pendulum is—



☐ $(t_1 + t_2)$

☐ $2\,(t_1 + t_2)$

☐ $\left[\frac{(t_1 + t_2)}{2}\right]$

☐ $4\,(t_1 + t_2)$

6. The S.I. unit of speed is—

☐ km/minute

☐ m/minute

☐ km/hour

☐ m/second

D. Answer the following questions in brief.

1. A boy walks to his school with a constant speed of 4 km/h and reaches there in 30 minutes. Find the distance of the school from his house.

2. The distance between two stations is 216 km. A bus takes 4 hours to cover this distance. Calculate the average speed of the bus in km/hour.

3. Two Cars, A and B, (starting, at the same time, from the same point) are moving with average speeds of 40 km/h and 50 km/h, respectively, in the same direction. Find how far will Car B be from Car A after 3 hours.

4. A car moves with a speed of 40 km/h for 15 minutes and then with a speed of 60 km/h for the next 15 minutes. Find the total distance covered by the car in these 30 minutes.

5. Define the term 'Periodic motion'. Give two examples of periodic motions that can be used to measure time.

6. Distinguish between uniform and non-uniform motion. Give one example of each.

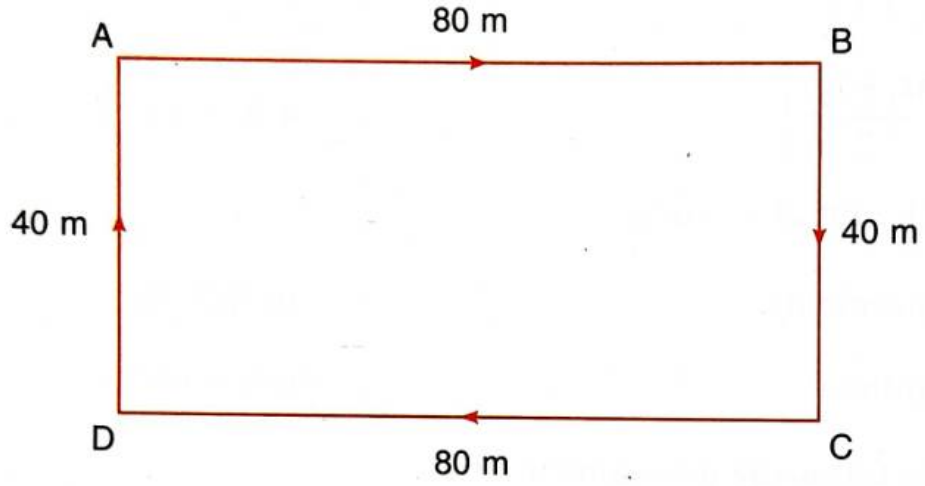
7. Draw the shape of distance-time graph for:

   (a) a man, waiting for a bus, standing at one point, on a bus-stand.

   (b) a man, walking on a level, straight and narrow road, with a constant speed.

E. Answer the following questions.

1. A farmer moves along the boundary of a rectangular field ABCD as shown in the figure. He takes 4 minutes to travel across each side.



   Is the motion of this farmer uniform or non-uniform? Find his average speed over one complete round of the field.

2. During rainy season, Shivam noted that the thundering sound of clouds was heard 6 seconds after the lightening was seen by him. If speed of sound in air is 340 m/s, find the distance of the point where the thundering sound was produced.

3. (a) How can we make a simple pendulum?

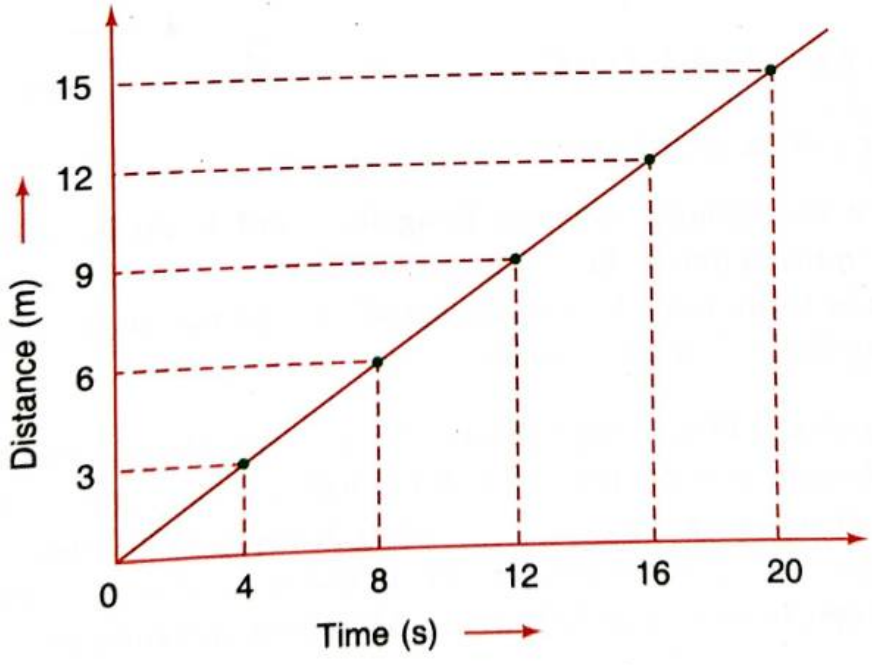
   (b) A simple pendulum takes 10 seconds to complete 5 oscillations. Find the time period of this pendulum.

4. Carefully examine the data given below for motion of two different objects A and B. State whether the motion of these two objects is uniform or non-uniform.

Time →	7.00 a.m.	7.30 a.m.	7.45 a.m.	8.00 a.m.	8.15 a.m.	8.30 a.m.
Total distance covered by A (in metres at the given time) →	0	20	30	40	50	60
Distance covered by B (in metres at the given time) →	0	10	24	35	38	43

5. Observe the graph given here. From the graph, find (i) the values of distances 'P' and 'Q' in 'm' and (ii) the value of time 'R' in 'seconds'.

Distance (m) →	0	'P'	6	9	'Q'	15
Time (s) →	0	4	8	'R'	16	20



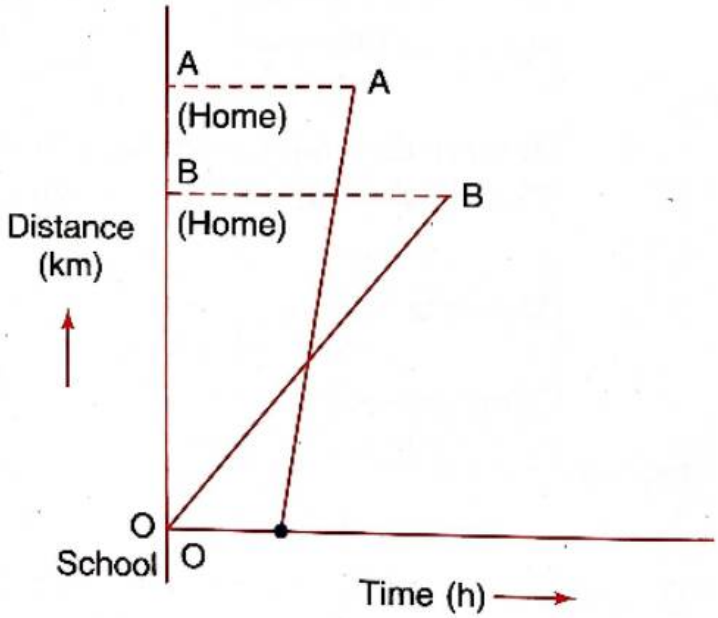
Value Based Question

In the science class, Drishti observed a video showing the working of a pendulum wall clock. She noted that a slight change in the initial displacement of the (bob) did not affect the time-period of the pendulum. When she discussed her observation with her grandfather, he told her that we must also not let the effects of small disturbances to change the daily routine and the values of our life.

1. State any four values that we should maintain in our life.
2. Design an activity to show that a slight change, in the initial displacement of the bob, does not affect the time period of a simple pendulum.

Something To Do

1. **The following figure shows the distance-time graph for two students A and B who start from their school and reach their respective homes. Examine it carefully and answer the following questions:**



   (a) Who starts first from the school?

   (b) Who reaches home first?

   (c) Who covers more distance?

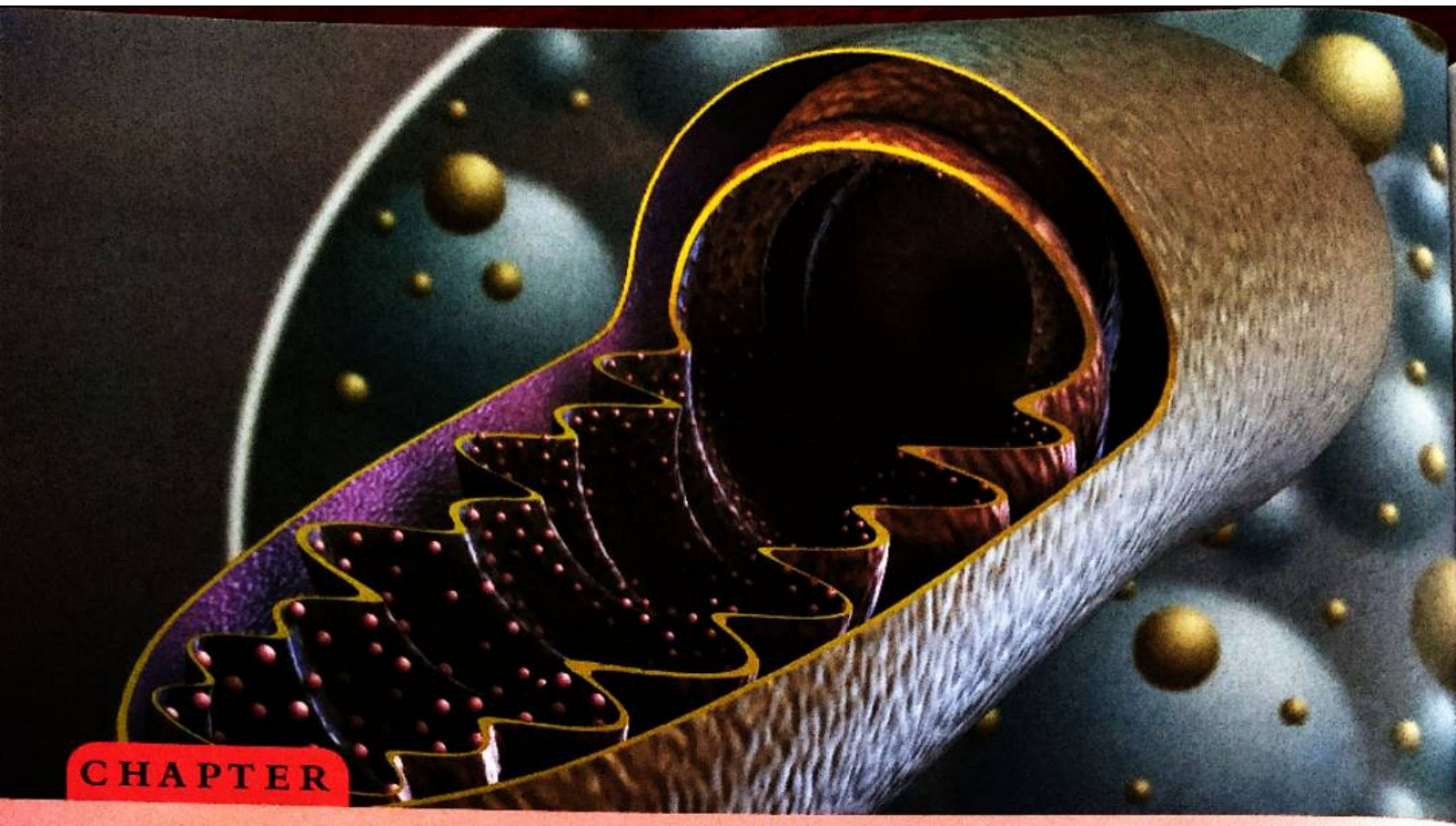
   (d) Whose average speed is more?

2. **Assume that the distance between Bengaluru and Delhi is 1200 km by air and 1500 km by train. A person takes 2 hours to reach there by air but needs 25 hours to reach there by train. Find the average speed in both the cases. Repeat this exercise by collecting data for different cities.**

3. **Draw a long straight line on the ground. Mark points at distances 10 m, 20 m, 30 m and so on. Compare your speed of walking with that of your friends. Measure the time taken to cover a known distance using a stop watch. Find out who amongst you is the fastest. Represent your results in the form of a table. Draw a bar-graph to show the speeds of different students. Also draw 'distance-time' graphs for each student.**

4. Collect information about the time of starting from the home and the time of arrival at school for your classmates. Record it in the following table.
Use this data to calculate the average speed of each student. (For distance covered use the shortest distance from your classmates' home to school as measured on an accurate local map.

Name	Distance moved	Time of Departure	Time of Arrival	Time Taken	Average Speed



CHAPTER

7 Respiration in Organisms

You already know that all living organisms require energy to perform different biological activities. This energy is obtained from the food that is consumed by an organism. A process, called **respiration**, releases this energy from the food and helps the organism to perform its biological activities.

Respiration is the name of the general process in which organisms convert sugars into biochemical energy using oxygen. The process occurs in all organisms including animals, plants, fungi and bacteria. During respiration, energy is produced. This energy is then used in different processes, necessary to support life. In addition to producing energy, respiration also produces carbon dioxide and water as waste products.

Respiration involves an exchange of gases–Oxygen is used in the body and carbon dioxide is released from the lungs. In plants, the processes of respiration, as well as photosynthesis, occur simultaneously during the day. Plants take in oxygen and carbon dioxide, respectively, for these two processes. However, photosynthesis does not occur in the absence of light. At night, only respiration takes place in the plants. This means that, during night, oxygen is taken in and carbon dioxide is released by plants.

Oxygen reaches all the cells of the body when we breathe. In the body cells, oxygen combines with the absorbed food with the help of enzymes. As a result, energy and carbon dioxide are produced. This process, that releases energy in the cells, is known as cellular respiration.

Cellular respiration is the process in which cells produce the energy they need to stay alive. During cellular respiration, cells (usually) use oxygen to break down the sugar (glucose) to produce energy.

The body gets its usable energy, for various life processes, through the processes of breathing and cellular respiration.

Do You Know ?

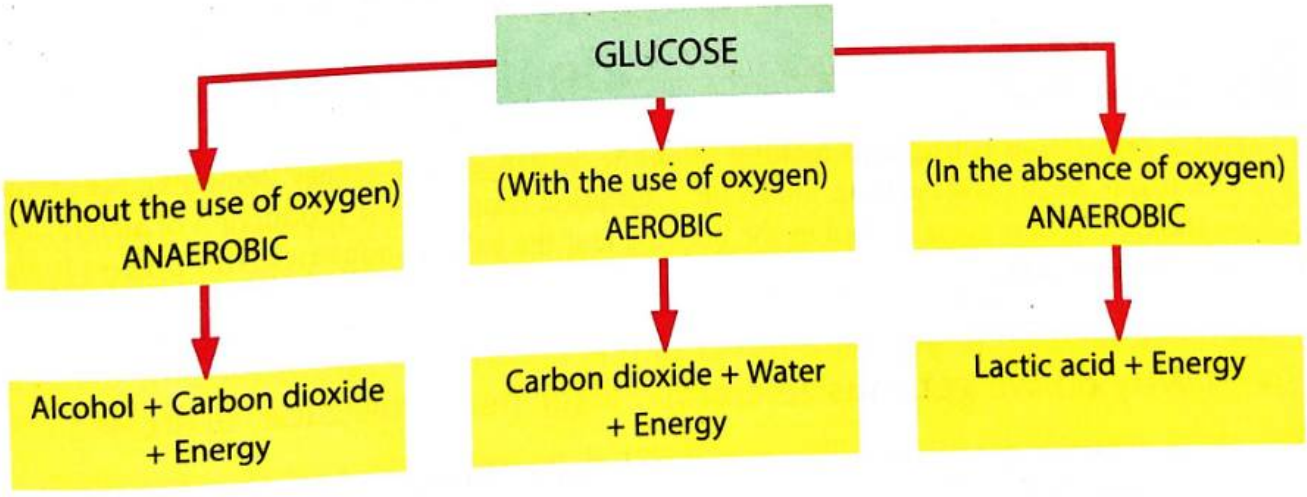
We breathe about 5000 times every day. The lung, on the left side of our body, is slightly smaller than the lung on the right side. The extra space, on the left side, leaves space for the heart to work efficiently without being obstructed by the surrounding organs.

Types of Respiration

There are two types of respiration: **aerobic respiration** and **anaerobic respiration**.

Aerobic respiration is the release of energy, from glucose, in the presence of oxygen. Strictly speaking, aerobic means 'in air.' However, it is the oxygen, in the air, which is necessary for aerobic respiration. An organism is described as aerobic if it requires oxygen in order to survive.

Types of Respiration
(Based on the use of oxygen)



Anaerobic respiration takes place in the 'absence of air.' Here, oxygen is not used for the release of energy from food molecules, such as glucose. An organism is described as an anaerobic organism when it does not require oxygen to produce energy.

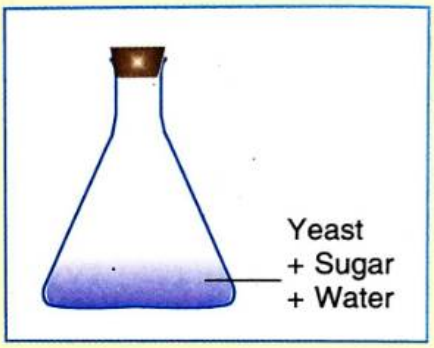
Anaerobic respiration, that takes place in yeast, is put to commercial use for the production of alcoholic beverages. It is also useful for making breads and for fermenting the *idli* and *dosa* batter. This type of anaerobic respiration is also called fermentation.

Another type of anaerobic respiration can take place in human muscle cells when enough oxygen is not available.

Activity 1

To show anaerobic respiration in yeast.

Take a conical flask. Add some lukewarm water in which a teaspoon of sugar has been dissolved. Add a few granules of dry yeast to this solution. (Dry yeast is available in bakery shops.) Seal the conical flask with a cork, keep it at room temperature and observe this set up after 3–4 days.



What do you observe? Bubbles are observed in the solution that move up to the surface to form a froth. An alcoholic smell comes from the flask when you remove the cork. If a lighted matchstick is brought close to the mouth of the flask, it will get extinguished showing that the gas present in the flask is carbon dioxide. The yeast spores, introduced in the flask, have multiplied and are respiring anaerobically.

(Remember: The flask is sealed and oxygen content in it is limited.)

Do You Know ?

Anaerobic respiration is useful in making alcoholic beverages and bakery items like bread and cakes. In plants, yeasts and bacteria, anaerobic respiration results in the production of alcohol and carbon dioxide. This process is used in the brewing and the baking industries. This process is also known as **fermentation**.

- Why do we get muscle cramps after heavy physical exercise?

  Human muscles can respire anaerobically. However, lactic acid is produced during this process and accumulates in the muscles. Because of this, the

muscles cannot continue working for long. They get fatigued after some time causing muscle cramps. Anaerobic respiration, in humans, is less efficient than aerobic respiration for releasing energy. This explains why humans can run faster in a short distance race (sprint) than over long distances. When an athlete stops after a sprint, he/she has to breathe faster, and deeper, for some time to 'feel normal' once again. This is to take in 'extra' oxygen, in order to break down the accumulated lactic acid, on top of the 'normal' break down of sugar, that is a part of aerobic respiration. The body, thus, pays back the oxygen debt built up during the sprint.

An athlete experiencing muscle cramps after a sprint

Activity 2

To show that respiration produces heat energy.

Soak some gram seeds in water overnight. Allow them to germinate on moist cotton for 3–4 days. Deactivate half of the seeds by placing them in boiling water for 2–3 minutes. Place the live germinating seeds in one flask (experimental), and the 'dead seeds' in another (control) flask. Insert a thermometer into each flask. Record the temperature and seal the flasks with cotton wool. Record the temperature daily over the next five days. You will observe that there is no temperature change in the flask containing boiled, dead seeds. However, in the other flask, there is a steady rise in temperature each day.

We, thus, find that only the living, and respiring, seeds cause a rise in temperature. We can, therefore, conclude that respiration produces heat.

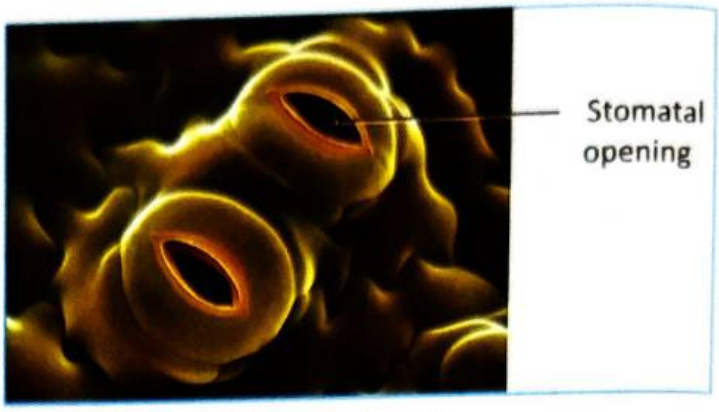
Respiration in Plants

Plants, as we know, are also made up of cells. Like animals, they respire in order to release energy. They also have cellular respiration. Plants synthesise sugar (glucose) which is used during respiration to produce energy. The glucose molecules break down, in the presence of oxygen, to release energy through a step-wise reaction. The net result of cellular respiration is that carbon dioxide and water are formed, accompanied by the release of energy. The process can be represented as follows:

Glucose + Oxygen ⟶ Carbon dioxide + Water + Energy

It is interesting to note that the equation for respiration is the reverse of the equation for photosynthesis.

We know that plants do not have any specific organs for breathing. They utilise the simple process of diffusion for exchanging the gases oxygen and carbon dioxide. They do so with the help of small openings on the surface of their leaves. These openings are called **stomata**. The stomata generally open up during the day time and remain closed at night. They help in the exchange of carbon dioxide and oxygen.



Leaf surface showing stomata

In addition to doing this exchange of gases, the (open) stomata also help the plants in the process of transpiration. Transpiration is an important part of the water cycle in nature. It is by this process that plants lose their excess water through their open stomata.

The following table summarises the details of the gases, released by plants, at different times of the day:

Conditions	Photosynthesis/Respiration	Overall result
Dark	Respiration No photosynthesis	Oxygen taken in Carbon dioxide given out
(Appropriately) Dim light	Photosynthesis rate equals respiration rate	There is no net intake or release of either oxygen or carbon dioxide
Bright light	Photosynthesis rate is greater than the respiration rate	Carbon dioxide taken in and oxygen given out

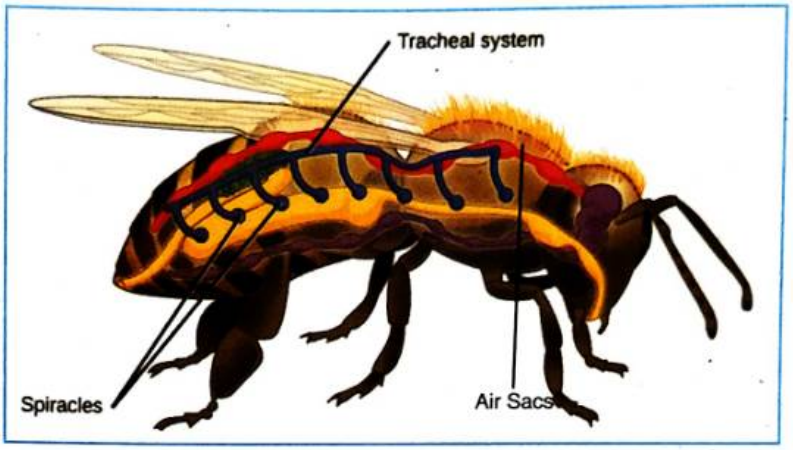
Besides stomata, some other parts of the plants, (like woody branches, that are made of dead cells on the surface and have pores known as **lenticels**) also help the underlying living cells to exchange gases during respiration.

The cells, in the roots of the plants, also need oxygen to survive. They take in air from the air spaces present between the soil particles. A plant can, therefore, die if over-watered. This happens because air spaces, in the soil, then get occupied by water and this prevents the plant roots from taking in air (oxygen) that they need.

Respiration in Animals

In small animals, the exchange of gases takes place by diffusion through their overall body surface. In large animals, there are organs which help in bringing oxygen, from the air, inside the body so that cellular respiration can take place easily.

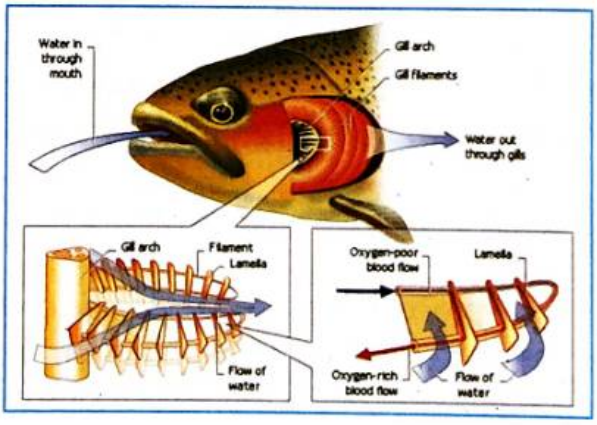
- In small organisms like *Amoeba* and *Hydra*, oxygen enters, and carbon dioxide goes out, through the simple process of diffusion.
- In earthworms and leech, skin is the organ for exchange of gases. It is smooth, moist and richly supplied with blood.



An insect showing a network of tracheae

- In fish, prawns and crabs, the respiratory organs are the gills. Oxygen-rich water enters through the mouth and oxygen-deficient water leaves through the gills.
- Insects have a network of branched tubes, called **tracheae**, for respiration. These tracheae open on the surface of their bodies through pores.
- Some animals have very well developed spongy organs, called **lungs**, for respiration. In mammals, structures, like diaphragm and rib-cage, support the process of breathing. Many of you might have observed the movement of ribs in cows, dogs and small babies, while they are sleeping.

Do You Know ?



Fishes breathe by 'drinking water'. A pressurised gulp of water flows from the mouth into the gill chamber on each side of the head. Gills, located in gill clefts within the gill chambers, consist of fleshy, sheet like filaments, transected by extensions called **lamellae**.

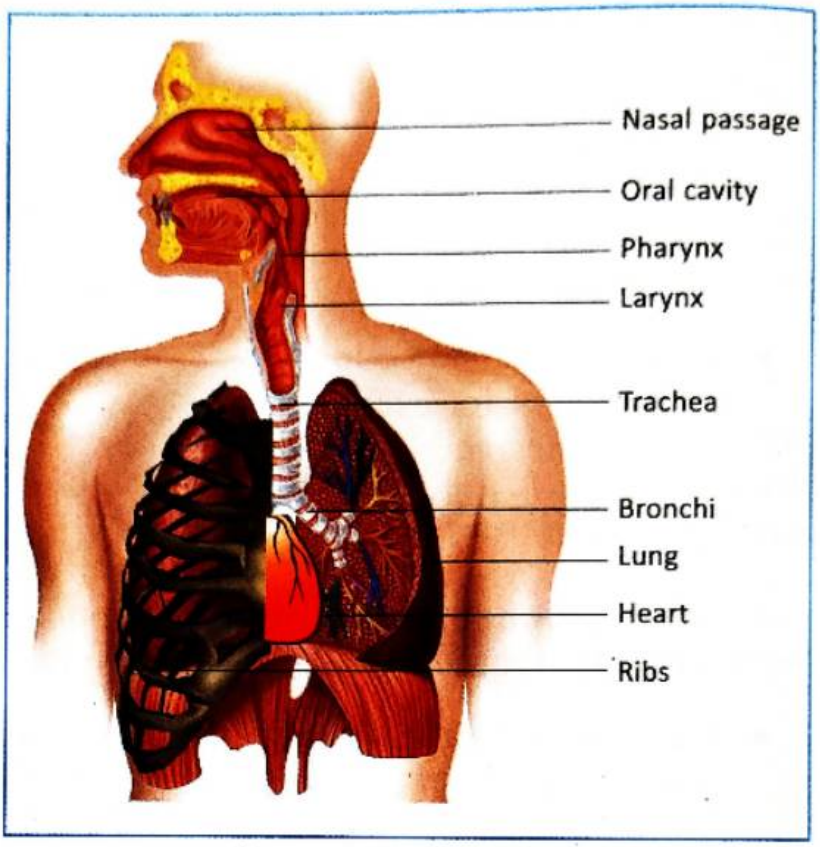
As water flows across the gills, the oxygen contained in it, diffuses into the blood that is circulating through vessels in the filaments and lamellae. Simultaneously, carbon dioxide, in the fish's blood stream, diffuses into the water and is carried out of the body. A fish can close the opercula, or flaps of tissue covering the gill openings, to prevent water from escaping.

Respiration in Humans

We all breathe air that contains oxygen required for respiration. Respiration is both external and internal. The taking in, and giving out, of air is called **external respiration** or **breathing**. Breathing consists of inhalation and exhalation. It continues throughout the life of an individual.

Taking in of air, rich in oxygen, is called **inhalation**. Giving out of air, rich in carbon dioxide, is called **exhalation**. These processes take place with the help of the muscular diaphragm and the rib cage.

The **diaphragm** is a muscular partition which separates the chest cavity from the lower abdominal cavity. The chest cavity is surrounded by the rib cage. The lungs are located in the chest cavity.



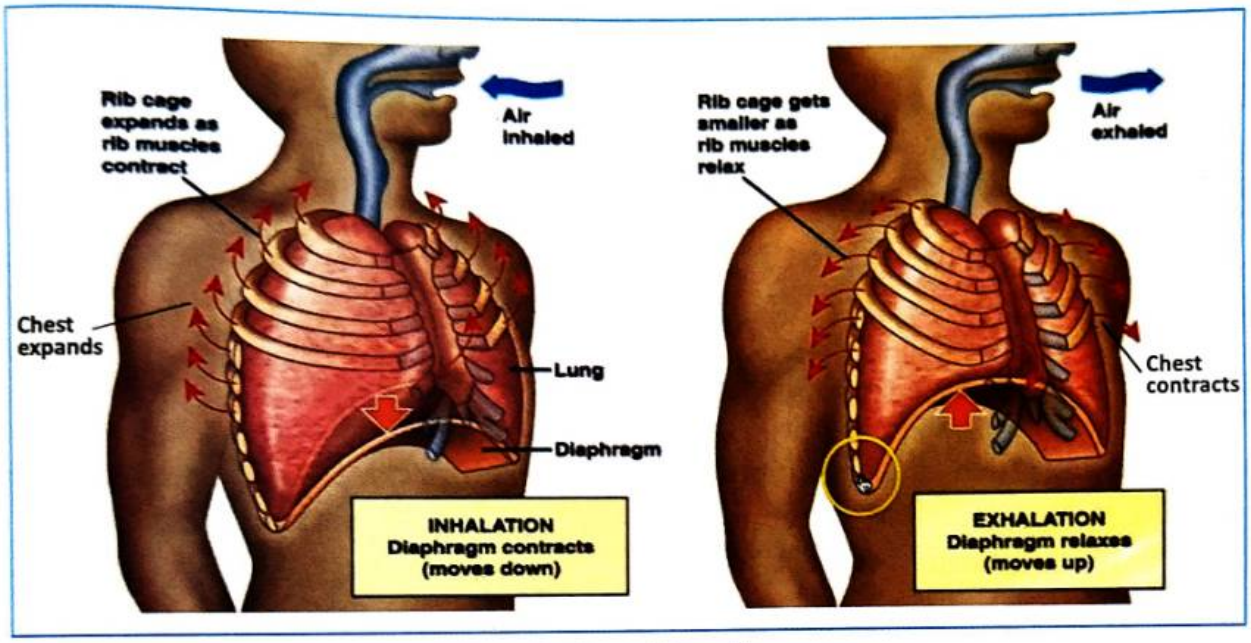
Human Respiratory System

The number of times a person breathes per minute is termed as the '**breathing rate**.' One breath is one inhalation plus one exhalation. An adult normally breathes from 14 to 20 times per minute, but vigorous exercise can raise the rate to up to 80 breaths per minute. A child's rate of breathing, at rest, is faster than that of an adult at rest. A new born baby has a rate of about 40 breaths per minute. In general, smaller animals have faster breathing rates than larger animals. For example, A rat breathes about 60 times per minute while a horse breathes only about 12 times per minute.

Mechanism of Breathing

The process of breathing can be divided into two phases—inspiration or inhalation and expiration or exhalation. In **inspiration**, air moves into the lungs while in **expiration**, air is forced out of the lungs. The lungs themselves have no muscle tissues. Their movement is controlled by the rib cage and the diaphragm. During inspiration, the muscles, around the rib cage, contract, lifting the ribs upward and outward, and lowering the dome of the diaphragm until it forms a nearly flat

sheet. As a result of these changes, the chest cavity expands. Because the lungs are attached to the chest cavity, they also expand. Due to this enlargement of the lungs, air pressure inside the lungs falls below the pressure of the air outside the body. This creates a partial vacuum and so the air, from outside the body, rushes into the lungs. During expiration, the muscles, that lift the rib cage and lower the diaphragm, relax. As a result, the rib cage and the diaphragm, return to their original positions and the lungs contract. With each such contraction of the lungs, the air, inside them, gets forced out.



Mechanism of breathing

Do You Know ?

Why do you yawn?

When you are sleepy or drowsy, the lungs do not take enough oxygen from the air. This causes an increase of carbon dioxide in your body. The brain senses this increase and sends a message that causes you to take a deep long breath–a Yawn. It brings in oxygen and decreases carbon dioxide content in the blood.

Now find out why you cough and sneeze?

Do You Know ?

Smoking affects lungs

When one smokes cigarettes, many chemicals enter one's body through the lungs. Burning of tobacco produces more than 4000 chemicals.

Nicotine, carbon monoxide and tar are some of these substances. Smoking damages the lungs and airways to a great extent. Smokers generally suffer from a variety of problems related to breathing. These problems can range from an annoying cough, to grave illness like emphysema and cancer.

- **How is oxygen transported from lungs to other parts of the body?**

  The blood, while passing through the lungs, picks up oxygen with the help of a (red) pigment called **haemoglobin**. Blood is red due to the presence of haemoglobin in it. Haemoglobin transports oxygen to different parts of the body. It also picks up some of the carbon dioxide, produced by the cells, during cellular respiration, and transports it to the lungs for expiration. Haemoglobin, thus, acts as a 'respiratory carrier' in our body.

- **Why do we need to breathe out carbon dioxide?**

  High levels of carbon dioxide in the body can be toxic and hence, carbon dioxide needs to be removed. It is brought to the lungs by blood and then removed when we exhale.

Activity 3

To show that exhaled air contains carbon dioxide.

Take a drinking straw and a test tube containing freshly prepared lime water. Place one end of the straw in the lime water and blow the exhaled air gently at the other end of the straw. What do you observe?

Lime water turns milky due to the presence of carbon dioxide in the exhaled air.

Keywords

aerobic respiration	release of energy from food (glucose) in the presence of oxygen.
anaerobic respiration	release of energy from food (glucose) in the absence of oxygen.
breathing rate	number of times a person breathes per minute.
cellular respiration	break down of glucose, to produce energy in cells.
expiration	'giving out' of air rich in carbon dioxide.
haemoglobin	pigment, present in blood, which transports oxygen to different parts of the body.
inspiration	'taking in' of air rich in oxygen.
lenticels	pores on the surface of woody branches that help in exchange of gases.

respiration	conversion of sugars into biochemical energy.
stomata	small openings, on the surface of leaves, which help in exchange of gases.
transpiration	loss of excess water from plants through open stomata.

You Must Know

1. All living organisms require energy to perform various biological activities.
2. Energy is released through the break down of sugars, in foods, by a process called respiration.
3. Respiration involves exchange of gases, i.e. oxygen is used in the body and carbon dioxide is released from the lungs.
4. Respiration that takes place in the (i) presence of oxygen is called as aerobic respiration and (ii) absence of air is called anaerobic respiration.
5. Anaerobic respiration can take place in human muscles but it accumulates lactic acid in them which cause muscle cramps.
6. Plants also respire in order to release energy. They do so by exchange of gases through the stomata in their leaves.
7. Loss of excess water also takes place through open stomata and is called transpiration.
8. In small animals, the exchange of gases takes place by diffusion through their overall body surface.
9. In mammals, the organs of respiration are the lungs. Humans take in oxygen from air for respiration. Breathing, a process of external respiration, involves 'inhalation' and 'exhalation.'
10. In humans, breathing takes place with the help of the rib cage and the diaphragm.
11. The number of times an animal breathes per minute is called its breathing rate.
12. Oxygen-rich air is breathed in during inhalation. This oxygen is, then, carried to different parts of the body by haemoglobin, which is the red colouring pigment in blood.
13. Carbon dioxide, produced through cellular respiration, is transported back to lungs from where it is exhaled.
14. High levels of carbon dioxide in the body can be toxic, hence, it needs to be removed.

Something To Know

A. Fill in the blanks.

1. Lactic acid is produced during _____ respiration.
2. Insects have organs, called _____, for respiration.
3. Taking in of air, rich in oxygen, is called _____.
4. An adult human being normally breathes from _____ to _____ times per minute.
5. The movement of lungs is controlled by the _____ and the _____.
6. _____ acts as the respiratory carrier in our body.

B. Match the following:

1.	Lactic acid	(a)	Transpiration
2.	Stomata	(b)	Pores on branches
3.	Respiratory carrier	(c)	Muscle cramps
4.	Lenticles	(d)	Fermentation of yeast
5.	Alcohol	(e)	Haemoglobin

C. Tick (✓) the correct option.

1. Respiration helps in—

☐ locomotion ☐ digestion

☐ absorption ☐ obtaining energy

2. Stomata perform the function of—

☐ absorption of water ☐ absorption of minerals

☐ exchange of gases ☐ movement of food

3. The process represented by the following equation,
(glucose + oxygen ⟶ carbon dioxide + water + energy)

- ☐ is photosynthesis
- ☐ is transpiration
- ☐ is fermentation
- ☐ is aerobic respiration

4. To survive, plant roots need—

- ☐ carbon dioxide
- ☐ oxygen
- ☐ chlorophyll
- ☐ sunlight

5. Earthworms and leeches respire through their—

- ☐ lungs
- ☐ gills
- ☐ trachea
- ☐ skin

D. Answer the following questions in brief.

1. Define respiration. Name the two types of respiration.
2. Name the respiratory organ of the following:

   (a) crab (b) man (c) leech (d) an insect
3. Define transpiration.
4. Define the term 'breathing rate'.
5. Name the body organs which help lungs during the process of breathing.
6. Why do we need to breathe out carbon dioxide?

E. Answer the following questions.

1. Why do we get muscle cramps after heavy excercise?
2. Why does a potted plant die when over watered?
3. Where are stomata found in a plant? State their function.
4. How is oxygen transported from lungs to the other parts of the body?
5. Draw a neat, well-labelled diagram of the human respiratory system.

6. Describe an activity to show that exhaled air contains carbon dioxide.

7. Describe the changes that take place (i) around the rib cage (ii) diaphragm (iii) chest cavity, during inspiration. State the effect of these changes.

Value Based Question

It was time for the 400 m race in the annual athletic meet of the school. Shweta, who was tipped to win the race, maintained a clear lead over others till about 30 m from the finishing line. She then felt cramps in her legs but did not give up. She quickly took some deep and fast breaths and continued running. Her presence of mind, determination, courage and positive attitude, helped her to just manage to win the race. Rita and Neetu, who finished second and third, respectively, were the first to congratulate her on her success.

1. State the values displayed by Shweta.

2. Write about some situation in which you, or one of your friends, displayed a behaviour similar to that of Rita and Neetu.

3. State the likely reason due to which Shweta felt cramps in her legs.

Something To Do

1. **Observe the changes in a leaf when both of its surfaces are coated with oil/ vaseline? Perform this activity and give a simple explanation of your observations.**

2. **Find out about two diseases related to the respiratory system. List their causes, their effect on respiration and their cure.**

3. **Record the breathing rates, of your friends and their family members (i) when at rest and (ii) after performing the activities given in the following table. Let the person rest for 15 minutes after performing each activity. Enter your results in the table given below:**

Breathing Rates

S.No.	Name of the person	At rest	After brisk walk for 10 minutes	After skipping 100 times

CHAPTER

8 Transportation in Plants and Animals

You know that organisms need food, water and oxygen for their survival. These substances are transported to various parts of the body. The wastes, that are produced by the organisms, are removed from the body. These wastes are transported and collected in an area from where they are removed.

The process of movement of substances, from one location to another, in an organism, is known as **transportation**.

In unicellular organisms, transportation is easy. Here, simple processes, like diffusion and osmosis, help in the movement of different substances.

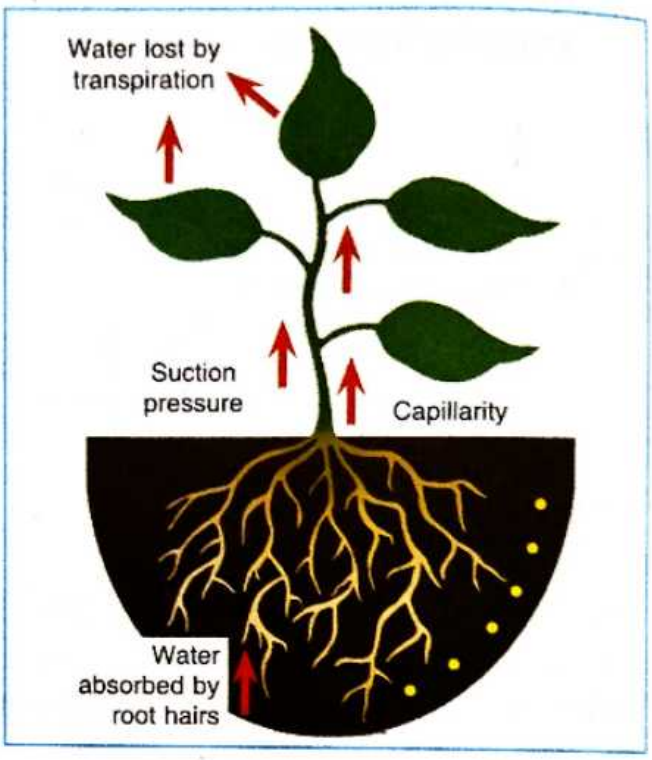
In multicellular organisms, different parts of the body perform different functions in the process of transporation. However, they stay connected so that each part receives its required substances while the unwanted materials are eliminated from the body. Simple processes, like diffusion and osmosis, are not sufficient here for transportation as a lot of time would be needed in such a case.

Transpiration in Plants

Transpiration is the evaporation of water molecules, in the form of water vapours, from the plant surface, especially from the stomata on its leaves. You may wonder why a plant loses water that it has absorbed from the soil. The plant absorbs water and mineral nutrients from the soil. While most of the minerals are utilised, the water is not fully used up. It is this excess (unused water) that needs to be 'evaporated out'.

Transpiration is beneficial to the plants. It creates a suction pull which helps water to be transported to great heights in tall trees.

It also helps to lower the plant's body temperature in summers. It may be called a necessary evil.



Transpiration in a plant

Do You Know?

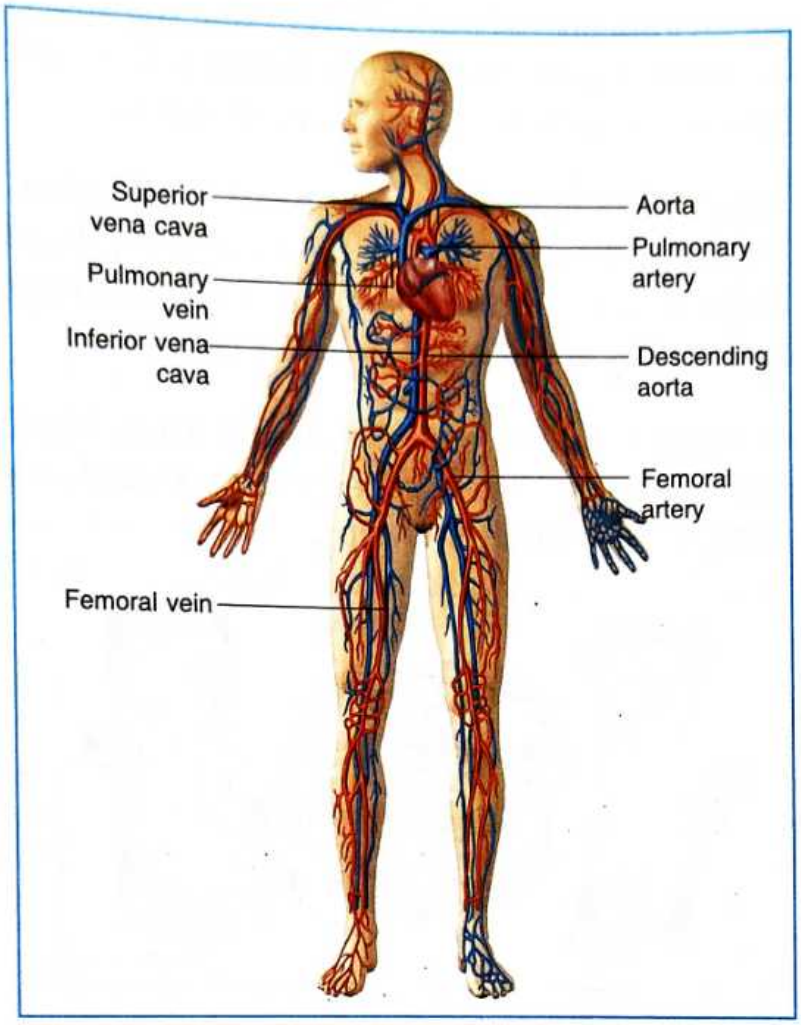
A single maize plant loses about 245 litres of water through transpiration in one growing season.

Transportation in Animals

In higher animals, including human beings, there is a circulatory system for transportation of different substances. These include—

- digested food
- oxygen
- carbon dioxide
- excretory waste, etc.

The circulatory system, in the higher animals, consists of the heart, blood vessels and blood. Let us discuss them in detail now.



Circulatory system in humans

Heart

The **heart** is a hollow muscle, in the middle left of the chest, that pumps blood to different parts of the body. A muscular wall, called **septum**, divides the heart length-wise into its left and right sides. A valve divides each side into two chambers: an **upper atrium** and a **lower ventricle**.

When the heart muscles contract, they squeeze the blood through the atria and then through the ventricles. Oxygenated blood, from the lungs, flows into left atrium and then to all parts of the body. Deoxygenated blood, returning from the body, flows into the right atrium and then to lungs for oxygenation.

Do You Know ?

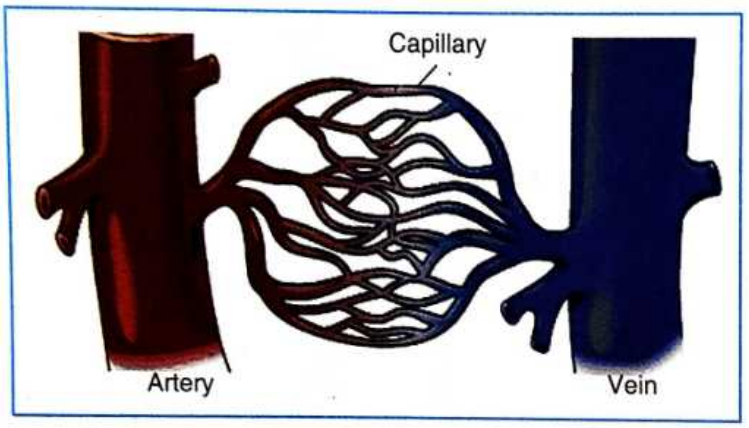
If all blood vessels in your body were to be arranged along a straight line, the line would be almost 1,00,000 km long.

Blood Vessels

Blood vessels are an intricate network of tubes that transport blood to the entire body. Blood moves to all parts of the body through these blood vessels. Blood vessels are of three types: arteries, veins and capillaries.

Arteries carry oxygen-rich blood, from the heart, to all other parts of the body. As blood flows through the arteries at a high pressure, they have thick, elastic walls. The arteries branch out into smaller tubes, known as **capillaries**, when they enter the different organs of the body.

These capillaries come together and form **veins**. Thus, blood enters an organ through the arteries; gets distributed; collects various substances from that organ and then moves out of it through the veins.



Veins carry the oxygen-deficient, and carbon dioxide-rich, blood back to the heart. Veins have thinner walls than the arteries as the blood flows through them at a lower pressure. Veins have valves that stop the backflow of blood. Hence, blood flows in one direction only, that is, towards the heart.

Blood

Blood is a fluid medium that helps in transport of different materials throughout the body. It is made up of two components: (i) the cell component that includes the **RBC** (Red Blood Cells), **WBC** (White Blood Cells) and **blood platelets**; and (ii) the liquid component, called the **blood plasma**. Let us know a little more about these different components of the blood.

• RBCs

RBCs are cells containing the protein molecule **haemoglobin**. You already know that haemoglobin transports oxygen to different parts of the body and

is, therefore, known as the **respiratory carrier**. Blood is red in colour due to the presence of haemoglobin.

- WBCs

  These are the defence forces of the body. White blood cells destroy harmful bacteria and dead cells. They protect our body against infections.

- Platelets

  Platelets help in clotting of blood. They are there to prevent excessive loss of blood if any part of the body gets injured.

- Blood Plasma

  It is a straw-coloured liquid component of blood, that normally holds the blood cells. It makes up about 55 per cent of the body's total blood volume.

Do You Know ?

The membrane, or outer layer, of the red blood cell is flexible like a soap bubble. It can bend itself in many directions without breaking. This is important because the red blood cells must be able to pass through the tiniest blood vessels, (the capillaries) to deliver oxygen wherever it is needed.

Functions of the Blood

The main functions of the blood can be summarised as follows:

- Blood helps to distribute the digested food to all parts of the body.
- Circulation of blood (resulting in its distribution in the body) also helps to maintain the body temperature.
- Blood cells, especially the WBCs, help fight infections.
- Clotting of blood is needed to prevent any excessive bleeding. Blood platelets help in clotting of blood.
- Blood transports oxygen, from the lungs to the tissues.
- Blood also transports carbon dioxide, from the tissues to the lungs.

Heart Beat and Pulse Rate

The heart beats as long as one stays alive. A 'heart beat' consists of a contraction and relaxation of its muscles. The contraction of the heart is called **systole** and

its relaxation is termed **diastole**. The rhythmic contraction of the heart and its main arteries, is felt as regular jerks and is referred to as the **pulse.** The pulse rate is the same as the rate of heart beat.

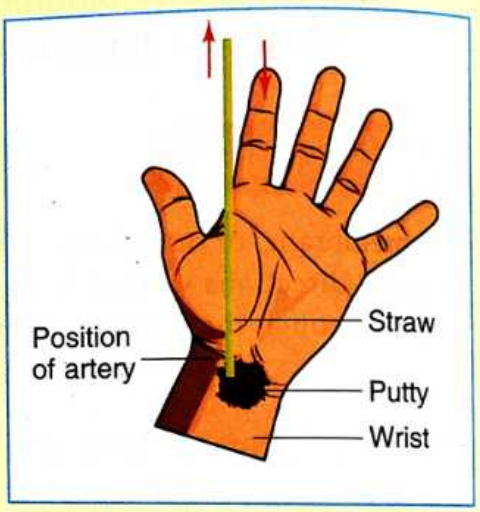
At rest, the (human) heart beats 60 to 80 times per minute. During exercise, or excitement, the rate can increase up to 200 beats per minute.

Activity 2

Visual counting of pulse by 'pulse meter'.

You will need: A stopwatch, a drinking straw (or a piece of broomstick), some plastic putty (or modelling clay).

Hold the inside of your left wrist towards you. Place the index and middle fingers of your right hand on the inner side of your left wrist (on the thumb side). Feel the pulse. Now, place a small piece of putty/modelling clay, on the wrist, where you feel the pulse. Press a straw (or a broomstick) into the putty so that it sticks upright from your wrist. Lay the back of your left hand on the table and observe.



Every time the pulse passes, the straw rocks slightly. Count the number of times the straw moves in one minute. This is your pulse rate.

What happens to the pulse rate after some vigorous physical exercise?

Do You Know ?

English physician William Harvey's discovery of 'what the heart does and how the blood circulates' is widely regarded as the single greatest medical discovery of all times. It established the importance and significance of doing experiments (in medicine) to learn how the organs of the body, and their tissues, function.

Through a series of brilliant experiments, on animals and humans, Harvey demonstrated how blood circulates in the body. He also showed that the valves in veins allow blood to flow only in the direction, that is, towards the heart. All these discoveries, taken together, proved that blood moves in a circle in the body—that is, there is a "circulation".

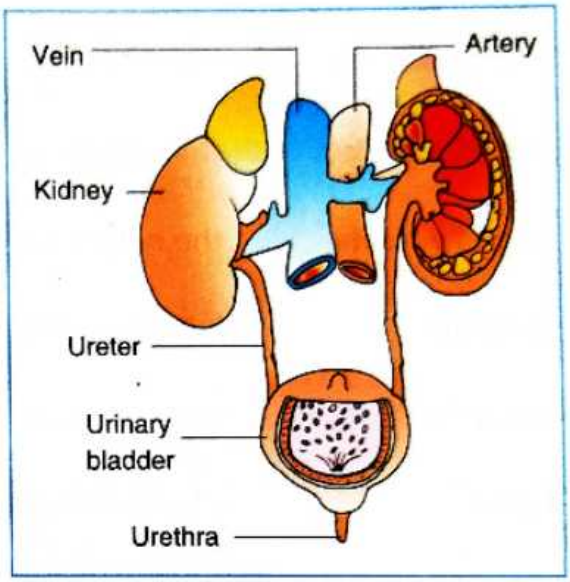
Excretion in Animals

The process of removal of wastes, produced by living organisms, is called **excretion**. Excretion, in unicellular plants and animals, takes place through diffusion. In multicellular organisms, the process is more complex. There are specific areas of the body that perform this function.

Some organs of excretion (in higher animals) are:

The Kidneys

In higher animals, the cells generate wastes, such as urea, when nutrients are broken down within them. These wastes are toxic and, therefore, have to be removed from the body. These wastes are transported by the blood to the kidneys. The kidneys process the waste and produce urine. This is passed through the ureters to the urinary bladder and finally removed from the body through the urethra.



Human Excretory System

The undigested food is eliminated, during egestion, from the anus, as **faeces**. This should not be confused with excretion.

Do You Know ?

The two kidneys in the body receive between 1100-2000 litres of blood per day. Because the body has only about 5.6 litres of blood, the blood runs through the kidneys, to be purified, once about every four minutes.

The Lungs

Carbon dioxide produced by cells during respiration is removed through lungs by exhalation.

The Skin

The skin offers a large surface area, for losing body heat. Skin is supplied with a large number of blood capillaries and sweat glands. When there is a rise in

temperature, sweat glands get activated and produce sweat. Sweating leads to cooling of the skin due to the evaporation of sweat. Small amounts of urea, salts and other metabolic wastes are also eliminated through sweating.

Keywords

arteries	blood vessels which carry oxygen-rich blood, from the heart, to all parts of the body.
blood plasma	liquid component of blood.
blood platelets	the cell components, in the blood, which help in clotting of blood.
blood vessels	the network of tubes that transport blood to the entire body.
diastole	relaxation of heart muscles.
excretion	the process of removal of wastes produced by living organisms.
heart	a hollow muscle in the middle of the chest that pumps blood to different parts of the body.
phloem	plant tissue which transports food in plants.
systole	contraction of heart muscles.
transportation	movement of substances in an organism.
transpiration	evaporation of water from the plant surface, especially from the stomata on leaves.
veins	blood vessels which carry the oxygen-deficient, and carbon dioxide-rich, blood back to the heart.
xylem	plant tissue which transports water and minerals in plants.

You Must Know

1. All organisms need food, water and oxygen for their survival. These substances need to be transported to various parts of the body.
2. In unicellular organisms, processes like diffusion and osmosis can cause the required movement of substances.
3. In multicellular organisms, different parts of the body perform different functions in the process of transportation.
4. Plants obtain water and minerals, from the soil, with the help of roots.
5. Water and minerals, and food are transported to the other parts of the plants by the conducting tissues of a plant, known as the xylem and the phloem.
6. Water is lost from the plant surface by a process known as transpiration.
7. There is a circulatory system, for transportation of different substances, in human beings.
8. The circulatory system is made up of the heart, blood vessels and blood.
9. The heart pumps the oxygenated blood, coming from lungs, to all the parts of the body through the arteries.
10. Deoxygenated blood is carried back to heart by the veins.
11. Blood has two components—the cell component [that includes RBC (Red Blood Cell), WBC (White Blood Cells) and blood platelets] and the liquid component, called the blood plasma.
12. Blood helps to distribute the digested food to body parts; this helps to maintain the body temperature, fights infections, transport oxygen from the lungs to tissues and carbon dioxide from the tissues to the lungs.
13. A complete heart beat consists of a contraction (systole) and a relaxation (diastole) of its muscles.
14. The number of times the heart beats in one minute is called the pulse rate.
15. The removal of wastes, produced by the living organisms, takes place by the process of excretion.
16. Kidneys, lungs and skin are the main organs of excretion in higher animals.
17. Kidneys remove the waste in the form of urine.
18. Lungs remove the carbon dioxide, produced during respiration.
19. Skin removes a small amount of waste in the form of sweat.

Something To Know

A. Fill in the blanks.

1. Water and minerals are transported, to various parts of a plant, by a network of tubes, called the _____
2. _____ is the respiratory carrier in blood.
3. The upper chambers of heart are known as _____ while the lower chambers are known as _____
4. _____ is the muscular wall that divides the heart length-wise.
5. Excretion, in unicellular plants and animals, takes place through _____

B. Write True or False for the following statements.

1. Phloem transports food, from the leaves, to the other parts of the plant. ☐
2. Transpiration is harmful for the plants. ☐
3. Oxygenated blood, from the lungs, flows into the left atrium and then to all other parts of the body. ☐
4. Arteries carry the oxygen-deficient blood, back to the heart. ☐
5. Platelets help in the clotting of blood. ☐
6. The red colour of the blood is due to the presence of plasma. ☐
7. Urine is passed out of the body through the urethra. ☐

C. Tick (✓) the correct option.

1. A process, that helps in transportation, in unicellular organisms is—

☐ locomotion ☐ absorption

☐ diffusion ☐ respiration

2. In plants, water is transported by the—

- ☐ stomata
- ☐ root hair
- ☐ phloem
- ☐ xylem

3. The blood vessels, having thick, elastic walls, are called—

- ☐ arteries
- ☐ capillaries
- ☐ veins
- ☐ atria

4. Which part of the blood has haemoglobin?

- ☐ WBCs
- ☐ RBCs
- ☐ blood platelets
- ☐ plasma

5. Urine gets collected in the—

- ☐ ureter
- ☐ urethra
- ☐ kidney
- ☐ urinary bladder

D. Answer the following questions in brief.

1. What will happen if the xylem tissue gets damaged in a branch of a tree?
2. Define transpiration.
3. Name the three types of blood vessels.
4. State any two functions of the blood.
5. Define the term 'pulse rate'.

E. Answer the following questions.

1. Briefly explain the transport of water and minerals in plants.
2. Describe, in brief, the function of heart.
3. State the functions of the three types of blood vessels.
4. Give one function each of RBC, WBC and platelets.
5. Draw a neat and well labelled diagram of the human excretory system.

Value Based Question

Mr. Vidhwan, a very dedicated, disciplined and devoted teacher, decided to spend his post retirement life in his village. He spent his time there in helping the village children to acquire the basic skills of the three R's. The village elders would often say: "Mr. Vidhwan spends all his time in transporting his knowledge and skills to our children. He is as important to us as the roots are to the plants."

1. State the values displayed by Mr. Vidhwan.

2. Name the substance and its source which is transported to other parts of the plant by (a) roots (b) leaves.

3. Try to read the 'life story' of any person who 'transported' her/his knowledge/skill/ wealth to the 'society at large'. Share your story with the other students in the class.

Something To Do

1. **Find out about two human diseases related to the circulatory system. Try to find out their causes and their cure.**

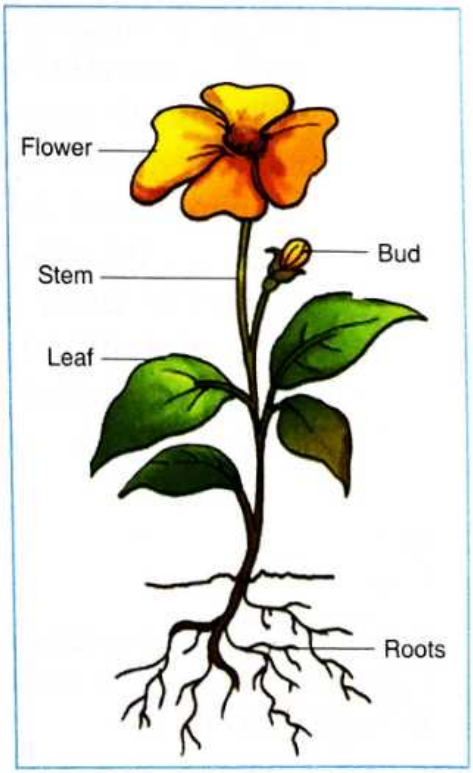
2. **Make an improvised Stethoscope using a plastic funnel, a rubber tube, a balloon and a rubber band. Measure, and compare, the heart beat of all the members of your family using this.**

3. **Have you ever thought of the excretory products of plants and their importance to us? Try to find out the basic details related to these products and give their uses.**

9 Reproduction in Plants

All living organisms have a life span after which they die. No organism lives forever. However, all living organisms are able to produce more of their own kind before they die. This ability to reproduce is a common characteristic of all living organisms. The process, by which living organisms can produce more of their own kind, is known as **reproduction**. The detailed mechanism of reproduction is, however, different for different types of living organisms.

Let us first try to familiarise ourselves with the details of this process for plants. How do plants reproduce? Before we study this, let us find out more about the parts of a flowering plant. Roots, stem and leaves are known as the **vegetative parts** of a plant. It is the flowers that are the **reproductive parts** of a plant. Flowers change into fruits which contain seeds. When seeds germinate, they form new plants.



Parts of a plant

Types of Reproduction in Plants

The methods of reproduction, in plants, are generally grouped into two main types: **asexual reproduction** and **sexual reproduction**.

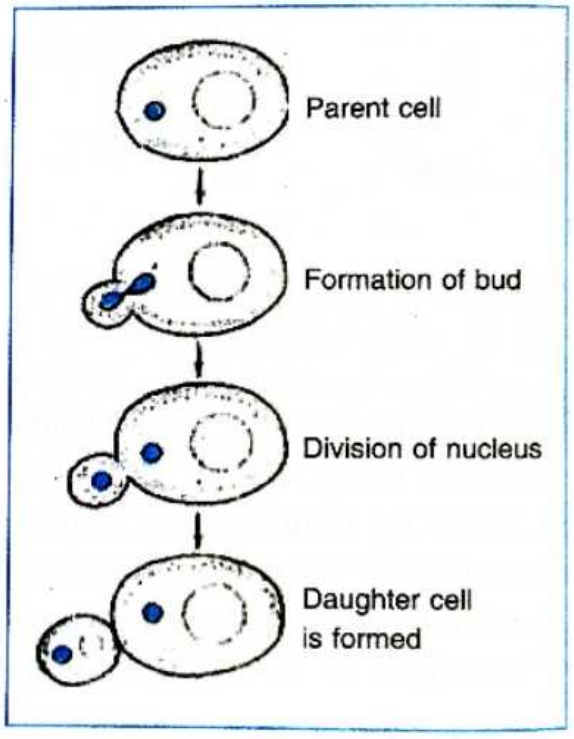
Asexual Reproduction

In **asexual reproduction**, an individual can reproduce on its own without the involvement of another individual of the same species. The division of a bacterial cell, into two daughter cells, is an example of asexual reproduction. Asexual reproduction is not, however, limited to single-celled organisms. Most plants have the ability to reproduce asexually.

How does asexual reproduction take place in different organisms? Let us find out.

Budding

Some organisms, like yeast, reproduce asexually through budding. You know that yeast is a unicellular organism. To reproduce asexually, it produces an outgrowth called a **bud**. The nucleus, in the yeast cell, also divides into two daughter nuclei. Out of these, one nucleus remains in the parent cell while the other moves to the bud. The bud may grow and get detached from the parent cell. Sometimes, another bud arises from the first bud and soon a chain of buds gets formed. This process results in the production of a number of yeast cells in a short period of time.



Budding in Yeast

Do You Know ?

Probiotics are dietary supplements containing potentially beneficial bacteria or yeast. Some probioitc supplements use the yeast 'saccharomyces bouldardii' to maintain, and restore, the natural flora in the human intestine.

Activity 1

To grow yeast in a beaker.

Take about 100 ml of lukewarm water in a beaker and dissolve one teaspoon of cane sugar in it.

Add a few grains of dry yeast (available at the bakery shop, or a chemist). Yeast cakes, available at some bakery shops, can also be used.

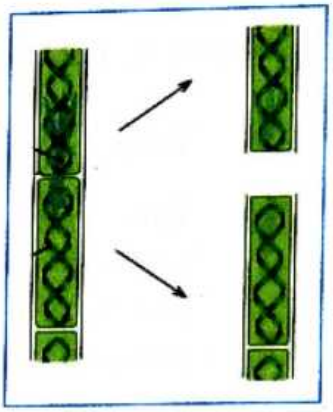
Mix well and cover the mouth of the beaker with a lid or aluminium foil. Leave it undisturbed for about 24 hours.

You will observe bubbles rising in the solution and froth forming at its surface.

Take a drop of this solution on a clean glass slide. You may use methylene blue to stain the yeast cells. Cover it with a glass cover slip. Observe the yeast cells on the glass slide, under the microscope, to see the different stages of budding.

- ### Fragmentation

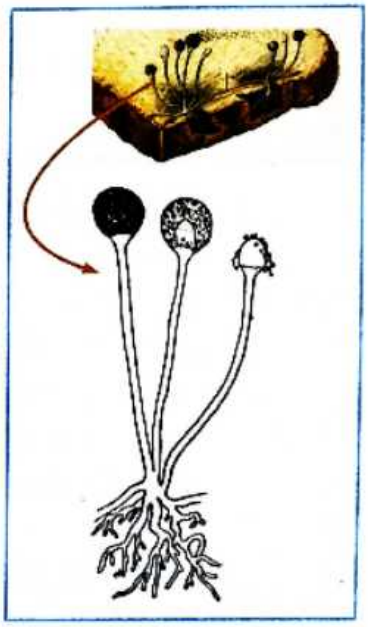
You may have observed slimy green patches on the ground, near ponds and other water bodies having stagnant water. If you try to lift them with a stick, you will see long, fine, green thread-like structures. These are the **algae**. One such alga is *Spirogyra*. It reproduces asexually by fragmentation. A *Spirogyra* filament breaks up into two or more fragments. These fragments grow and develop into new individuals. As this process continues, the whole pond may get covered by a green scum.



Fragmentation in *Spirogyra*

- ### Spore formation

You may have observed a cottony growth on stale bread, or some spoilt food stuffs. It does not take long for this cottony growth to turn into minute pin-head like structures of bread mould. These are called **sporangia** (singular-sporangium) as they have spores in them. The spores are thick-walled, microscopic, asexually reproducing bodies. They are carried by wind and keep floating in air. They germinate when they find a suitable medium to grow. Mosses and



Bread mould

ferns also reproduce through production of spores. These are examples of non-flowering plants that do not produce seeds.

Activity 2

To make your own microbe garden!

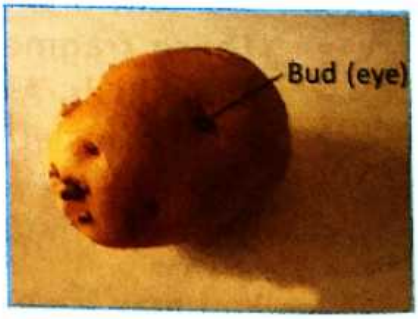
Take a piece of bread and moisten it slightly with water. Place it in a deep glass dish and cover it with a lid. Keep it in a warm, moist place for about 48 hours. Observe the piece of bread occasionally. You will see a cottony growth appearing on the bread. If you keep this bread for a few more days, you will observe that the cottony growth seems to be developing coloured patches that are due to formation of tiny, pin-head like structures. These tiny pin-heads are sporangia that contain the spores. Just like a garden has many different types of flowers, your microbe garden will contain different varieties of fungi, collectively called **bread moulds**.

Caution: Perform this activity under adult supervision. Do not bring your face too close to the bread piece. Use a hand lens to observe. This 'garden' will have to be (carefully and properly)disposed off in about a week's time.

• Vegetative propagation

This type of asexual reproduction is seen in some higher plants. In this method new plants are produced from the vegetative parts, like root, stem or leaves, of the plant. It is for this reason that this method is called **vegetative propagation**.

Vegetation propagation from stem: You must have observed potato tubers. Potatoes are the swollen ends of the underground stem of the potato plant. They store food in the form of starch. Each potato tuber has 'eye' like structures, called **buds**. These buds grow into new plants.



Potato tuber

Modified stems of ginger and turmeric can also produce new plants. Vegetative propagation, in plants, like onion, takes place through special structures, called **bulbs**. These bulbs are composed of reduced stem, with layered fleshy scale leaves.


Onion bulb

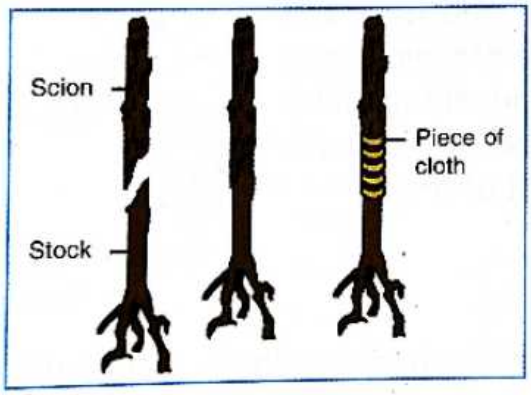
Corms in plants, like gladiolus and colocasia (*arbi*), also help in vegetative propagation. A **corm** is a short, vertical, swollen underground stem that

serves as the storage organ and is used by some plants to survive in winter or other adverse conditions, such as drought and extreme heat.

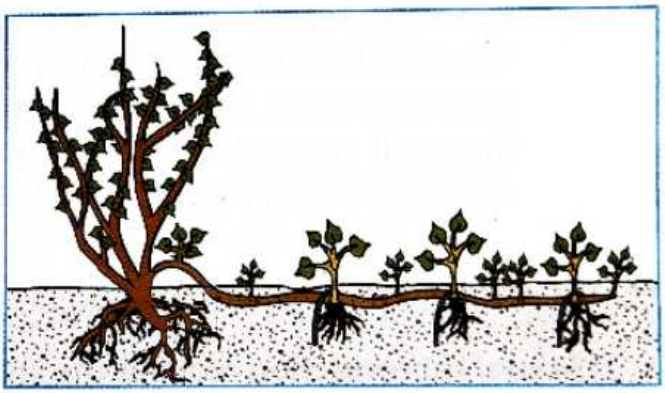
Cacti (singular-cactus) can be multiplied by breaking a part from the old stem and growing it in the soil. You must have observed grass growing in the gardens like a thick green carpet. The gardener puts a few grass plants and soon the whole garden is covered with a green grass cover. This is because the stem of grass grows horizontally and produces leaves and roots at regular intervals.

Cactus

Commercially important plants are often propagated by asexual means in order to sustain and maintain their desirable traits like flower colour, flavour, resistance to disease, etc. Cuttings may be taken from the parent plant and rooted. This is done in plants like rose, guava and *bougainvillea*. Other artificial methods, like grafting (as in mango and citrus plants) and layering (as in jasmine), are also used for vegetative propagation of plants.



Grafting in Rose



Layering in Jasmine

Vegetative propagation from leaves: Leaves of *Bryophyllum* have leaf buds in the notches of leaves. The buds develop into tiny plantlets; these can grow into new plants when these plantlets come in contact with moist soil.

Vegetative propagation in *Bryophyllum* from leaves

Do You Know?

Bryophyllum has the unique ability of growing small plantlets on the fringes of the leaves; these eventually drop off and form roots. Due to this, it has been given names like Mother of Thousands, Mother of Millions, Devil's Backbone, Pregnant Plant, Miracle Leaf, Sprouting Leaf, Sprout Leaf Plant, Leaf of Life, Resurrection Plant, Life Plant and Good Luck Leaf.

Vegetative propagation from roots: Some plants like sweet potato and dahlia use their roots for asexual reproduction. Trees, such as the poplar, send up new stems from their roots. In time, an entire grove of trees may form from the original tree.

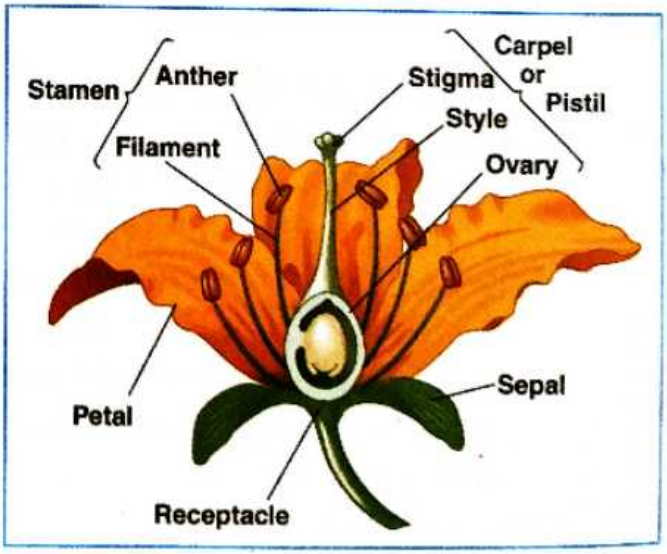
Sweet potato

Vegetative propagation has a number of advantages over sexual reproduction. The plants, produced by this method, take less time to grow. They also bear flowers and fruits earlier than the plants produced from seeds. The new plants are exact copies of the parent plant and have the same desirable characters as those of their parent plant. However, this can be a disadvantage also. Since all such plants are identical, if a disease spreads, it can infect the whole lot of them.

Dahlia tuber

Sexual Reproduction

Sexual reproduction requires the involvement of two individuals, typically one of each sex. Normal human reproduction is a common example of sexual reproduction. In flowering plants, the reproductive parts are located in the flower.



Parts of a flower

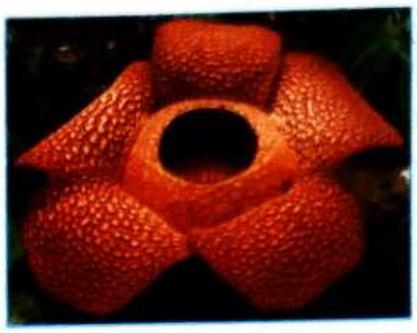
Let us study the parts of a flower.

Most flowers have sepals, petals, stamens and pistils.

Sepals form the outermost whorl of green leaf-like structures. They protect

protect the inner parts of the flower during the bud stage. Petals are usually brightly coloured and may also produce fragrance. Petals help to attract insects for pollination. Stamen is the male reproductive part. It consists of an anther and a filament. Pollen grains are produced in the anther. Pistil is the female reproductive part which consists of the ovary and ovules.

Do You Know ?



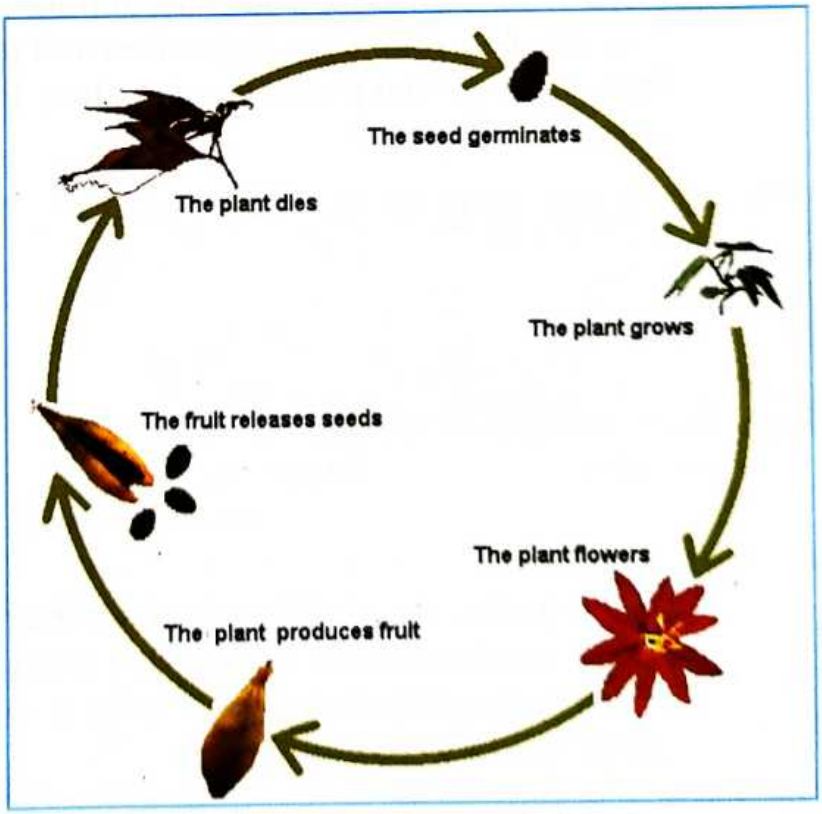
Rafflesia belongs to a group of parasitic, stemless, leafless plants with a distinctive, putrid, odour. The plants are native to Malay Arhchipelago and Indonesia and live on the stems and roots of certain woody vines. The large, pink, five-lobed flowers are pollinated by carrion flies. The blossom of one species, the corpse lily, is recognised as the largest flower in the world. It grows up to 91 cm (36 inch) in width, with petals 3 cm (1 inch) thick and 46 cm (18 inch) long, and weighs as much as 7 kg.

• Unisexual and Bisexual Flowers

Flowers may contain either only pistils, or only stamens, or both. Flowers of some plants, like papaya and corn, have either only pistils or only stamens. Such flowers are called **unisexual flowers**. A unisexual flower may be a male flower (with stamens) or a female flower (with pistils).

Flowers of some plants, like tomato, brinjal and mustard, have both stamens and pistils in every flower. Such flowers are called **bisexual flowers**.

Sexual reproduction, in flowering plants, follows the life cycle, shown in the figure given here.

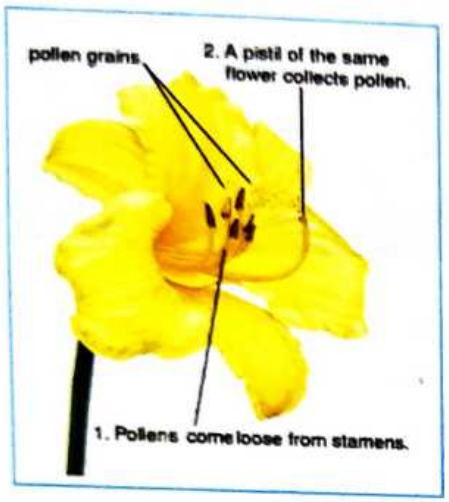


Life cycle of a flowering plant

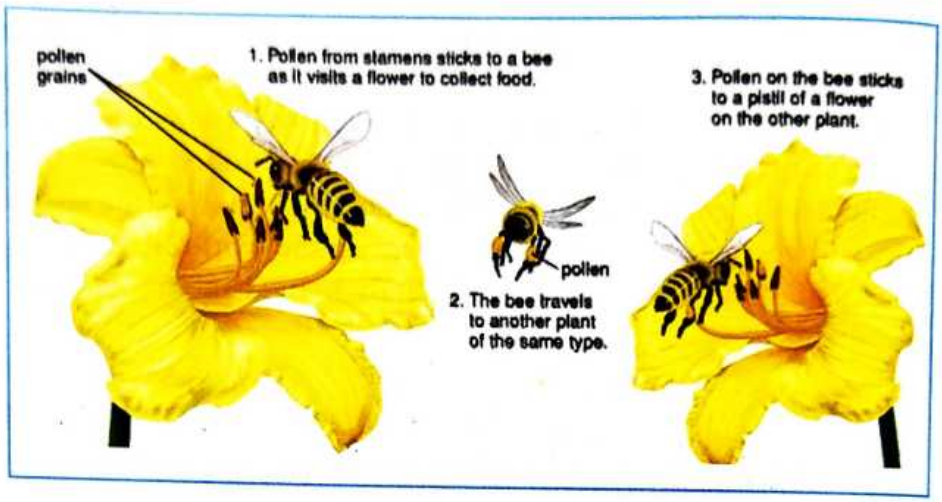
Let us discuss the main processes involved in this life cycle:

Pollination

The transfer of pollen grains, from the anther to the stigma in flowers, is known as **pollination**. Pollen grains are transferred, either from anther to stigma of the same flower (self pollination), or to a flower on a different plant of the same kind (cross pollination).



Self pollination



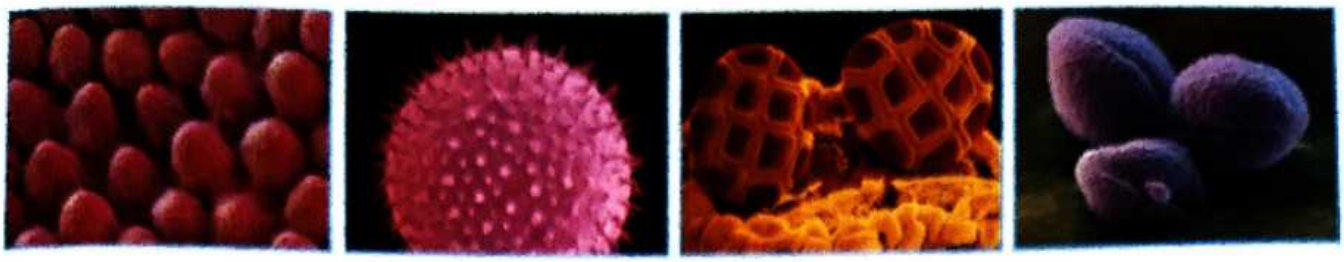
Cross pollination

Pollinators in nature: The process of pollination requires pollinators. **Pollinators** are agents that carry, or transfer, the pollen grains from an anther to a stigma. Wind, bees, butterflies and many other insects, birds, rats and bats, are the main pollinators in nature. In some aquatic plants, water is an agent of pollination.

Honey bee | Butterfly | Bird | Bat

Pollinators in nature

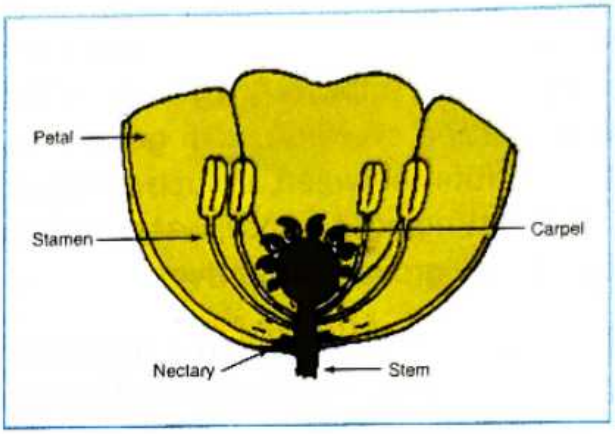
Pollen grains are very light and are microscopic in size; they contain the male reproductive cell. Each pollen grain has a distinctive outer wall that is tough and resistant to decay. The patterns, present on this outer wall, are distinctive of a species of plant.



Pollen Grains of some flowering plants (magnified)

The wind pollinated flowers have their anthers situated at a higher level than the petals. This lets the pollen grains to get blown away by wind. The insect pollinated flowers are brightly coloured and have nectar glands; these release a sweet liquid (nectar) that attracts insects.

Wind pollinated flower



Insect pollinated flower

Fertilisation

Pollen grains germinate when they fall on the stigma of a flower of the same species. A pollen tube is produced that reaches the ovule. The male and female reproductive cells, called **gametes**, fuse to form a zygote. This process of fusion, of the male and female gametes, is called **fertilisation**. The zygote then divides inside the ovule to form a baby plant called the **embryo**.

Fate of the flower after fertilisation: After fertilisation, the sepals, petals, stamens and stigma usually dry up and fall off.

Development of seed: The ovules form seeds. A seed has cotyledons to store food and the future plant, i.e. the embryo.

Development of fruit: After fertilisation, the ovary begins to grow and forms the fruit. The fruits may be sweet and juicy (like mango and orange), or they may be hard and woody (like almond and walnut). The fruit is, thus, actually a ripened ovary.

Do You Know?

Some fruits, like apples, are termed as **false fruits**. Apple is known as a false fruit as the juicy edible portion does not develop from the ovaries but from the receptacle present just above the stalk of the flower.

Germination of seed: Under suitable conditions, the seed germinates to form a seedling that grows into a new plant.

Seed Dispersal

Most higher plants reproduce by producing seeds. The seeds also help the plants to spread out and grow in new places, sometimes a long distance away from the parent plant. This is important because, if the seeds are not dispersed, a large number of germinating seedlings can grow very close to the parent plant. This will result in competition between all such seedlings, as well as the parent plant. The 'competition' is for getting light, space, water and nutrients; all of these are important for plants to be able to grow and survive.

Seeds can be dispersed in a number of different ways, depending on the nature of the seeds. They may be carried by wind, water or animals. Some plants even shoot out the seeds explosively.

Dispersal by Wind

Seeds, that are very light, get carried to a new place by wind. The seeds of the orchid are almost as fine as dust. Many others, like the seed of madar (*aak*), have hairy growths which act like little parachutes and carry the seeds far away from the parent plant. The seeds of drumstick, maple and fruits of sunflower, are also carried by wind.

Seed of Madar (*aak*)

Do You Know?

The sea bean has the largest seed pod in the world. It can travel more than 3 kilometres through rivers before it flows into the sea. Here, it can float around for up to a year before it is washed ashore. Coconuts are also dispersed in this manner.

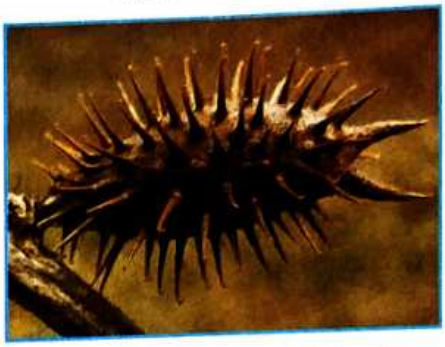
Dispersal by Water

Fruits which float, such as those of the lotus, water lily and the coconut palm, are carried away by water. Coconuts can travel for thousands of kilometres across seas and oceans.

Fruit of coconut

Dispersal by Animals

Some plants have juicy fruits that animals like to eat. The animal eats the fruit but only the juicy part is digested. The seeds pass through the animal's digestive system as such; they are deposited on land where they form new plants. This land can be far away from where the parent plant was. Cherry and apple seeds are dispersed in this way. Birds also like to eat some fruits. They help to disperse their seeds, to other areas, through their droppings. Some seeds, like those of *Xanthium* and *Urena*, have spiny seeds with hooks. These seeds get attached to the fur of animals and are carried away.



Spiny seed of *Urena* with hooks

Dispersal by Explosion of Fruit

Some plants have pods, that explode when ripe and shoot out the seeds. The seeds can, thus, get scattered far away from the parent plant. This process is seen in plants like castor and balsam. Seeds of pea and bean plant are formed in pods. When the seeds are ripe, and the pod has dried, the pod bursts open and their seeds get scattered.

Balsam seed-pods explode and shoot out the seeds

Do You Know?

Animals as pollinators

The African elephant eats the Acacia plant and helps to disperse the seeds by shaking the trees. When the elephant eats the seeds, the seeds find a fertile home in the elephant's droppings.

The Alpine Nut Cracker eats pine cone seeds; it also usually buries the seeds that it does not eat. When it forgets where it has buried them, the seeds there get a chance to grow.

The Durian is a plant that is really smelly. Animals of all sorts, like the Orangutan, come to eat it. When it breaks open, all the seeds just tumble out.

Keywords

asexual reproduction	reproduction in which an individual can reproduce on its own without the involvement of another individual of the same species.
bisexual flowers	flowers having both stamen and pistil.
budding	asexual reproduction by producing an outgrowth called the bud.
fertilisation	fusion of male and female gametes to form a zygote.
fragmentation	breaking of an organism into fragments which develop into new individuals.
pistil	female reproductive part consisting of ovary and ovules.
pollination	transfer of pollen grains, from anther to stigma, in flowers.
pollinators	agents that carry, or transfer, the pollen grains from an anther to a stigma.
reproduction	process by which organisms produce more of their own kind.
sexual reproduction	reproduction involving two individuals, typically one of each sex.
stamen	male reproductive part consisting of an anther and a filament.
unisexual flower	flowers having either only stamens or only the pistils.
vegetative reprodctuion	asexual reproduction through use of the vegetative parts (like root, stem or leaves) of the plant.

You Must Know

1. All living organisms have the ability to produce more of their kind.
2. There are two methods of reproduction: asexual and sexual.
3. In asexual reproduction, an individual can reproduce on its own without the involvement of another individual of the same species.
4. Different ways of asexual reproduction are budding, fragmentation, spore formation and vegetative propagation.
5. In vegetative propagation new plants are produced from the vegetative parts (like roots, stem or leaves) of the plant.
6. Sexual reproduction requires the involvement of two individuals, typically one of each sex.
7. The reproductive parts of the plant are located in the flower.
8. Stamen, the male reproductive part, consists of an anther and a filament.
9. Pistil, the female reproductive part, consists of the ovary and the ovules.
10. A flower having either only stamen or only pistil, in it, is a unisexual flower whereas a flower, having both stamen and pistil, in it, is a bisexual flower.
11. Sexual reproduction in flowering plants involves the processes of pollination, fertilisation, seed formation and development of the fruit.
12. Pollen grains transfer from anther to stigma of the same flower (self pollination), or to the flower on the different plant of the same kind (cross pollination).
13. Seed dispersal helps each plant to get sufficient light, water and nutrients to grow.
14. Dispersal of seeds can occur through the wind, or by water, or animals, or by explosion of fruit.

Something To Know

A. Fill in the blanks.

1. _____ reproduce through the process of budding.
2. Pollen grains are produced by _____.
3. The agents, that carry the pollen grains from anther to a stigma, are called _____.
4. The fusion of a male gamete with a female gamete is called _____.
5. Seeds of orchids get dispersed by _____.

B. Write True or False for the following statements.

1. Yeast reproduces asexually through fragmentation. ☐
2. Sweet potato and dahlia use their roots for asexual reproduction. ☐
3. A unisexual flower has both stamen and pistil in it. ☐
4. Water can be an agent of pollination. ☐
5. Male and female gametes fuse to form the zygote. ☐
6. Seeds of pea and bean plant are formed in pods. ☐

C. Tick (✓) the correct option.

1. Spirogyra reproduces asexually by—

☐ fragmentation ☐ budding

☐ spore formation ☐ vegetative propagation

2. Bryophyllum reproduces through its—

☐ roots ☐ leaves

☐ stem ☐ flowers

3. The reproductive part of the plant, for sexual reproduction, is its—

- ☐ flower
- ☐ root
- ☐ stem
- ☐ leaf

4. Pollen grains contain the—

- ☐ future flower
- ☐ future seed
- ☐ male reproductive cell
- ☐ female reproductive cell

5. Fruit develops from the—

- ☐ ovary
- ☐ leaves
- ☐ ovule
- ☐ petals

D. Answer the following questions in brief.

1. Name the two types of reproduction in plants.
2. Define vegetative reproduction.
3. Give two examples of plants which reproduce through spore formation.
4. Name two artificial methods of vegetative propagation from stem.
5. When is a flower said to be a bisexual flower?
6. Name any three ways by which seeds are dispersed.

E. Answer the following questions.

1. In what ways is vegetative propagation better than sexual reproduction?
2. Draw a well labelled diagram to describe the parts of a flower.
3. How is self pollination different from cross pollination?
4. How are fruits formed?
5. Why is dispersal of seeds necessary for growth of plants?

Value Based Question

Madam Anshita, a highly respected teacher, in a school for differently abled students, is a very hardworking, dedicated and disciplined teacher. She has a lot of empathy for her students. She uses different teaching methods as per the needs and requirements of her many, differently abled students. She often says that her approach is guided by nature which also uses different methods for dispersal of seeds of different types of plants.

1. State the 'values' that have made Madam Anshita a highly respected teacher.

2. Name the different methods that nature uses for dispersal of seeds. Give one example each of any two of these methods.

Something To Do

1. **Make a terrarium**

   Take a large glass bottle with a narrow mouth (wide enough to place plants inside the bottle). Fill the lower 1/6 part of the bottle with pebbles. Add a layer of sand, followed by leaf manure, and finally moss. Place plants, like aloe vera, money plant, cacti, in this terrarium. Keep the mouth of the bottle covered. You may open it for about an hour a day. Sprinkle some water once in 4–5 days. Your terrarium is ready. Decorate a sunny corner of your house with this terrarium.

2. **Keep a few potatoes in a warm moist place for a few days. Observe the 'eye' portion that soon starts forming leaf like structures. Cut each potato into 3–4 pieces. Ensure that each piece has about 1–2 'eyes'. Bury these pieces in the soil. They will produce new potato plants within two weeks!**

3. **Visit a vegetable market. Make a list of the fruits and vegetables that you find there. Try to find out which of these vegetables are actually fruits (ripened ovaries).**

   List your observation in the following tabular format:

Name of the fruit/ vegetable	Is it a ripened ovary? (true fruit)	If no, which part of the plant is it?
Spinach	No	Leaves
Cucumber	Yes	—

CHAPTER

10 | Soil

Soil is important to us. It is one of the most important natural resources on earth. Most of the life forms on earth depend on soil as it is a direct, or indirect, source of food for them. Plants obtain their nutrients from the soil and animals are dependent on them. Soil is the home to many different forms of life. Soil is also known as **earth**. It is the substance from which our planet takes its name. Soil has been formed by weathering, erosion and decay of living plant and animal matter. However, valuable top soil is formed so slowly that it should be protected and valued because it cannot get replaced in the average lifespan of human beings.

Soil can be defined as the naturally occurring, loose covering of broken rock particles and decaying organic matter (humus) on the surface of the Earth. It is capable of supporting life.

Do You Know?

It takes 500 years to produce just less than an inch of top soil, which is the most productive layer of soil.

Soil Formation

Soil formation is the combined effect of physical, chemical and biological processes on its parent material, the rocks. This process is termed as **weathering**. There are two different types of weathering—**physical weathering** and **chemical weathering**.

There are several causes, or agents, of **physical weathering**. The main ones are listed below.

1. **Temperature:** The expansion and contraction of minerals in the rocks, due to variations in temperature, form weaker zones. This gradually breaks them apart.

2. **Water:** Torrential rains, and flowing waters, dislocate the soluble and solid particles on the rocks and expose the inner portions to the agents of weathering. The dislodged particles are carried down and deposited elsewhere as alluvium. Similarly, the sea-waves wear off the rocks on the shore. The glaciers, in the high mountains, exert an erosive and transporting influence, on the rocks and their fragments.

3. **Wind:** Wind exerts abrasive action, detaches the particles from the rocks and acts as a carrying agent. Sand-storms in the deserts, and high winds on the sea shore, have both erosive and transporting action.

4. **Plants and animals:** Lichens and mosses, growing on bare rocks, can cause their gradual disintegration. Grasses, shrubs and trees, growing in crevices of rocks, help to extend the cracks through the growth of their roots.

Let us now talk about **Chemical weathering**. This type of weathering takes place due to the following factors:

1. Organic acids, released during the decomposition of organic matter.

2. The solvent action of water, that dissolves the soluble salts and forms solutions, further hastens the process of weathering.

Do You Know ?

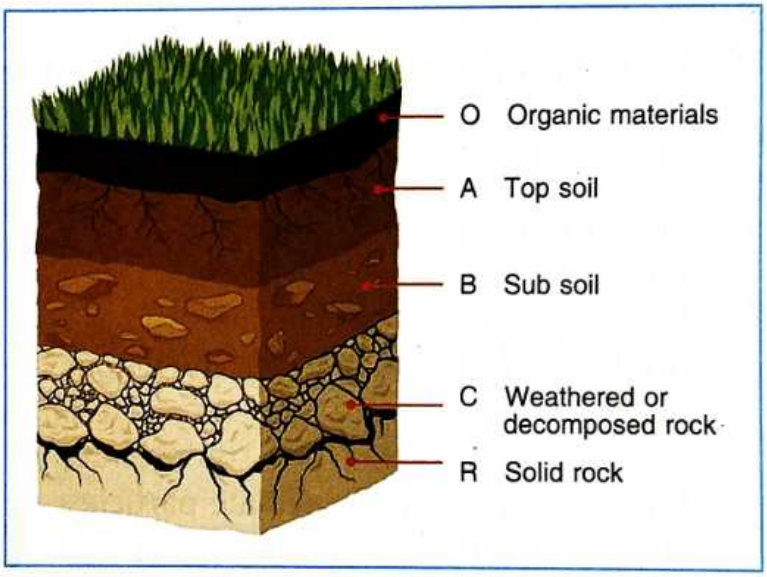
One of the more pleasant rain smells, the one we often notice in the woods, is actually caused by bacteria. Actinomycetes, a type of filamentous bacteria, grow in soil when conditions are damp and warm. When the soil dries out, the bacteria produce spores in the soil. The wetness, and force of rainfall, kick these tiny spores up into the air where the moisture, after a rain, acts as an aerosol (just like an air freshener). The moist air easily carries the spores to us and we breathe them in. These spores have a distinctive, earthy smell we often associate with rainfall. These bacteria are extremely common, and are found all over the world. This accounts for the universality of this sweet "after-the-rain" smell.

Soil Profile

If you visit a site, where earth has been dug for building a house, or look in a soil pit, or on a roadside cut, you will see various layers in the soil. These layers are called **soil horizons**. The arrangement of these horizons, in a soil, is known as a **soil profile**.

Soil Horizons

Each soil horizon is different from the other in texture, colour, chemical composition and depth.



Soil profile

O Horizon

It is the top, organic layer of soil, made up mostly of leaf litter and humus (decomposed organic matter).

A Horizon

This layer, also called **top soil,** is found below the O horizon. Seeds germinate and plants grow in this dark-coloured layer. It is made up of humus (decomposed organic matter) mixed with mineral particles.

Sometimes, leaching of minerals and clay content takes place in the lower part of A-horizon as water drips through this region. This process of leaching is called **eluviation**.

B Horizon

It is also called the **sub soil**. This layer is beneath the A Horizon and above the C Horizon. It contains clay and mineral deposits, like iron, aluminium oxide and calcium carbonate. It receives them, from layers above it, when mineralised water drips from the top soil.

C Horizon

It is the layer beneath the B Horizon and above the R Horizon. It consists of slightly broken-up bedrocks. Plant roots do not penetrate this layer and very little organic material is found in this layer.

R Horizon

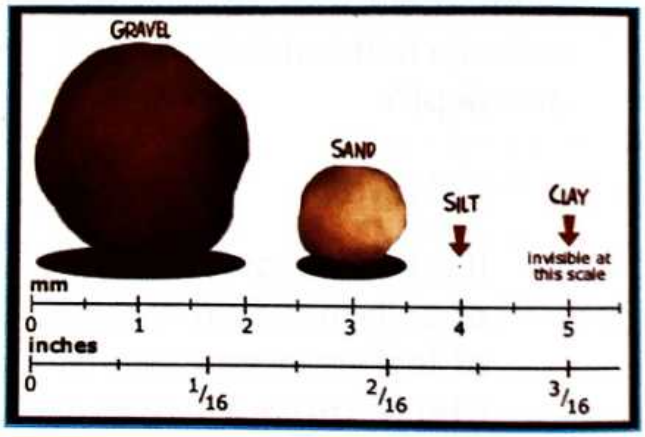
This consists of the unweathered rock layer, called the **bed rock.** It exists beneath all the other layers.

Properties of Soil

Let us now discuss, in some detail, about some of the properties of soil.

Soil texture

Soil texture depends mainly on the relative size of the soil particles. You now know that soil particles are produced as a result of weathering of rocks. The bigger, coarse soil particles are termed **sand**. The smaller particles, that are smooth, are termed **clay**. The intermediate particles, that are neither very rough, nor too smooth, are termed **silt**.



Relative soil particle sizes

A mixture of soil particles and humus forms the soil. The soil also has living organisms, like bacteria, roots of plants, insects and earthworms.

On the basis of **soil texture**, soil is classified into three categories—sandy soil, clayey soil and loamy soil. Let us discuss them one by one.

1. **Sandy soils** have soil particles that are bigger in size; the large spaces between them are filled with air. They are, therefore, said to be well aerated. Such soils cannot retain water as water can drain out quickly through the

spaces between the sand particles. Sandy soil needs more frequent irrigation for successful crop growth.

2. **Clayey soils** have a higher proportion of fine and smooth soil particles. There is very little space between the soil particles. Such soils cannot retain air. However, clayey soils can retain more water than sandy soils. This high water-holding capacity can cause problems, like water-logging, in the fields.

3. **Loamy soil** is a mixture of sand, silt and clay particles. It can hold both air and water. Loamy soil has humus also. It is considered to be the best soil for growing most of the crops.

• Soil colour

It gives an indication of soil conditions and some of its important properties. Soil colours differ due to mineral content of their parent rock and the amount of organic matter in them. Red, yellow or brown colours are usually related to the different types of iron oxides in the soil. Dark colours of a soil are associated with presence of certain minerals and the type of organic matter (humus) in it.

Soils of different colours

• Soil structure

Anyone, who has ever made a mud ball, knows that soil particles have a tendency to stick together. It would be difficult to make mud balls with sand because sand paticles do not adhere (stick together) in the same way as the finer clay particles do. A sandy soil may be structureless because sand grains behave independently of each other. Clayey soils, on the other hand, have the tendency to stick together.

Plasticity and cohesion

Plasticity is the property that enables moist soil to change its shape, on application of force, and retain this shape even when the force is withdrawn. On this basis, sandy soils may be considered to be non-plastic and clayey soils to be plastic. The tendency of similar particles to stick to one another is known as **cohesion**. Plastic soils are cohesive. Plasticity and cohesion, reflect the consistency and workability of the soils. This property is utilised, in practice, for making clay pots and terracotta toys.

Soil density

Soils, having larger particles, usually have a higher weight, per unit volume, than those having smaller particles.

Infiltration rate and percolation rate

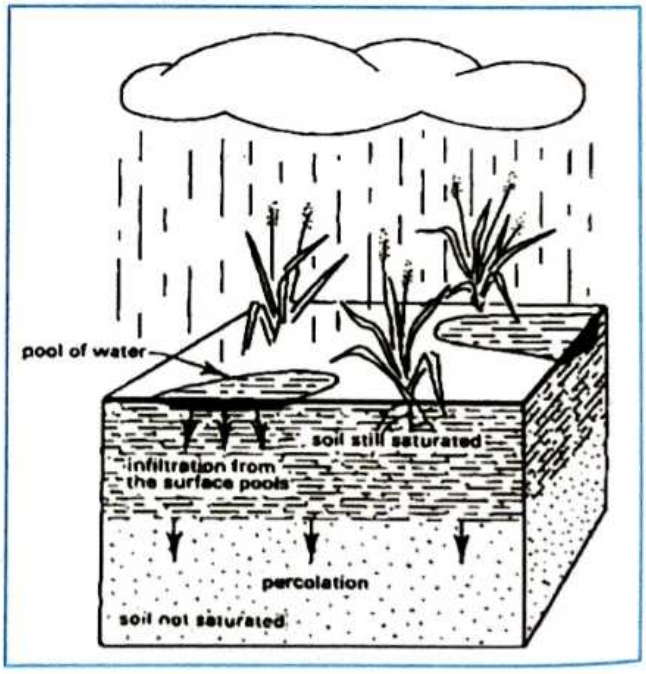
Absorption of water, by the soil, depends on its infiltration and percolation rate. **Infiltration** is the rate at which water enters a soil while **percolation** is the rate at which water moves through a soil. These are key factors in determining the suitability of a soil for growing crops. These two factors also influence the formation of natural wildlife habitats.

Cemented and concrete floors cannot absorb water. Water cannot enter or move through such areas.

Soil type is very important in under-standing the rate of absorption and retention of water in the soil.

Some soils, such as clayey soils, take up water very slowly, and also hold it well (they do not drain well).

Sandy soils absorb water well but do not hold it well. They allow water to drain out quickly. Soils with high humus content, (like peat), hold the water well and do not let it drain out very fast because of their high organic content.



Soil percolation

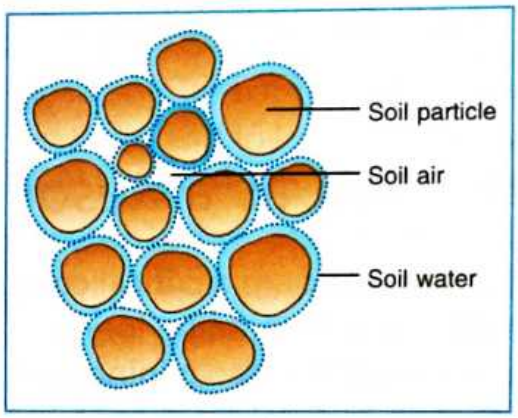
Composition of Soil

Composition of soil depends on the nature of parent rock and the quantity and type of organic materials present in it. The following components are generally found in a soil:

1. **Inorganic substances:** Most of the inorganic substances, present in the soil, are derived from the parent rock. Addition of fertilisers also affects the inorganic content of a soil.

2. **Organic material (Humus):** This includes dead and decaying parts of plants and animals, animal excreta and residues of soil organisms. Humus increases the productivity and water holding capacity of the soil.

3. **Soil water:** It is generally present in the spaces between the soil particles. The water content of a soil has a significant effect on plant productivity. Different crops, however, differ in their irrigation requirements.



4. **Soil air:** Spaces, between the soil particles, contain air. Well aerated soils are associated with healthy roots that increase crop productivity. Soil air is important for the respiration of roots. Soil air content decreases due to water logging which can result in poor plant growth, and even death, of the plants.

5. **Living organisms:** A variety of organisms are found in soil. They include micro-organisms like bacteria, fungi and algae.

Do You Know ?

There are 5000 to 7000 different species of bacteria in one gram of soil.

Insects, and earthworms, are also present in the soil. Earthworms are known as **nature's ploughmen**. They burrow deep below the surface, consuming organic matter and soil along the way. Coiled soil masses, known as **casts,** are

Earthworm–Nature's ploughman

excreted from the worm's digestive system, making the soil more fertile. The earthworm's burrowing action continually moves mineral-rich soil to the surface, which improves plant growth. The burrowing action also aerates the soil, enhancing drainage.

Do You Know?

Vermicompost (also called worm compost, vermicast, worm castings, worm humus or worm manure) is the end-product of the breakdown of organic matter by some species of earthworm. Vermicompost is a nutrient-rich, natural fertiliser and soil conditioner. The process, of producing vermicompost, is called **vermicomposting**. The earthworm species (or composting worms) most often used are red wrigglers (*Eisenia foetida*) or red earthworms (*Lumbricus rubellus*).

Soil as a Resource

Soil materials are a critical component in the mining and construction industries. Soil serves as a foundation for most construction projects. Massive volumes of soil can be involved in surface mining, road building and dam construction. **Earth sheltering** is the architectural practice of using soil as external thermal mass against building walls.

Soil resources are critical to the environment, as well as to food and fibre production. Soil provides minerals and water to plants. Soil absorbs rainwater and releases it later, thus, preventing floods and drought. Soil cleans the water as it percolates. Soil is the habitat of many organisms.

Do You Know?

Soil is often present at the bottom of the food chain. Plants and some lower animals take nutrients from the soil and animals obtain nutrients from the plants.

Soil Pollution

Soil pollution is defined as the build-up of persistent toxic compounds, chemicals, salts, radioactive materials, or disease causing agents in soils. This has adverse effect on plant growth and animal health.

Soil pollution is caused by factors like use of chemical pesticides, excessive use of fertilisers, percolation of contaminated surface water to the layers below the surface, oil and fuel dumping, leaching of wastes from landfills or direct discharge of industrial wastes into the soil.

Soil and Crops

The soils, in different parts of India, are different due to the type of parent rock present there and the amount of humus present in that soil. Other factors, that affect the nature of the soil are, climatic factors like temperature, light, wind, rainfall and humidity. These factors affect the soil profile and also bring changes in the soil structure.

The type of crop, that may be grown in a particular field, depends on the type of soil, the soil components, the humus content and the climatic factors in that region. Cereal crops, like wheat; and legumes, like gram, grow well in clayey and loamy soils. Such soils have good water retaining capacity. Paddy grows well in soils that are clayey and rich in organic matter and are, therefore, able to retain water. Loamy soils, that drain water easily, are ideal for growing pulses. Cotton grows well in well-aerated soils that also drain water easily. Hence, sandy-loam or loam soils are preferred for growing cotton. Coconut trees, that grow well in sandy soils, are found in large numbers in the coastal regions.

Soil Erosion

Soil erosion implies the removal of the top soil by agents, such as wind and water. Without human activities, losses of soil, through erosion, in most areas, would probably be balanced by the formation of new soil. In forests and grasslands, vegetation protects the soil. When rain falls on the surface of grass, or on the leaves of trees, some of the moisture evaporates before it can reach the ground. Trees and grass serve as 'wind breakers,' and the network of plant roots helps to hold the soil in place against the action of both rain and wind.

Agriculture and deforestation, along with housing, industrial development and highway construction, destroy the protective canopy of vegetation and greatly speed up erosion of soil. Overgrazing can change grassland into deserts. Careless cultivation, which involves leaving the field fallow for some time, can also cause soil erosion.

Preventing Soil Erosion

Soil erosion can be prevented by extensive afforestation practices. This involves planting of trees on bare lands and nearby fields. Avoiding overgrazing, and overuse of land, also help in preventing soil erosion.

We need to remember that soil is a precious natural resource. In order to sustain life on earth, destruction and misuse, of such a precious natural resource, needs to be avoided at all costs.

Keywords

clayey soil	soil, having fine, smooth particles, with very little space between them.
cohesion	the tendency, of similar particles, to stick to one another.
humus	dead and decaying plant/animal organic matter.
infilteration rate	the rate at which water enters a soil.
loamy soil	a soil made up of a mixture of sand, silt and clay particles.
percolation rate	the rate at which water flows, or trickles, through porous soil.
plasticity	the property, that enables moist soil to change shape, on the application of force, and retain its changed shape when the force is withdrawn.
sandy soil	soil, with bigger particles, having large spaces, filled with air, between them.
soil erosion	the removal of top soil by agents, such as wind and water.
soil horizons	different layers present in the soil.
soil pollution	the build-up of toxic compounds and chemicals, etc., in the soil.
soil profile	the arrangement of soil horizons in a soil.
weathering	the process of breaking down of rocks by the combined effect of physical, chemical and biological processes.

You Must Know

1. Soil is the naturally occurring, loose covering of broken rock particles and decaying organic matter on the surface of the earth.
2. Soil is formed by the process of weathering. There are two types of weathering—physical and chemical.
3. Temperature, water, wind, plants and animals are the main agents of physical weathering.
4. Decomposition of organic matter and solvation action of water results in chemical weathering.
5. There are various layers in the soil called horizons. Different soil horizon are: O horizon, A horizon, B horizon, C horizon and R horizon.
6. The arrangement of the horizons, in a soil, is known as 'soil profile.'
7. Soil texture depends on the relative size of the soil particles.
8. On the basis of soil texture, soil is classified into three categories: sandy soil, clayey soil and loamy soil.
9. The properties, of plasticity and cohesion, decide the consistency of the soil and its workability.
10. Absorption of water, by the soil depends upon the rate at which water enters a soil (infilteration) and the rate at which water moves through that soil (percolation).
11. Composition of soil depends on the nature of its parent rock and the quantity and type of organic materials present in it.
12. Soil water affects plant productivity.
13. Soil air is important for the respiration of roots.
14. A variety of micro-organisms like bacteria, fungi and algae, are found in soil. Insects and earthworms are also present in it.
15. Soil materials are the main components in construction projects.
16. Soil provides minerals and water to plants and prevents floods and drought and cleans water as it percolates.
17. Presence of toxic compounds, chemicals salts, radioactive materials, or disease causing agents, results in soil pollution.
18. The removal of top soil by agents, such as wind and water, cause soil erosion. Agriculture, deforestation, overgrazing and careless cultivation speed up erosion.
19. Soil erosion can be prevented by extensive afforestation, avoiding overgrazing and overuse of land.

Something To Know

A. Fill in the blanks.

1. Various layers in the soil are called _____.
2. The intermediate particles, that are neither very rough, nor too smooth, are termed as _____.
3. _____ is the tendency of similar particles to stick to one another.
4. Soil air is important for roots to carry out _____.
5. _____ and _____ cause soil pollution.

B. Match the following:

1.	Potter's soil	(a)	No percolation
2.	Organic material	(b)	Clay
3.	Vermicompost	(c)	Well aerated
4.	Sandy soil	(d)	Humus
5.	Concrete floor	(e)	Earthworms

C. Tick (✓) the correct option.

1. Which of the following is not an agent of physical weathering?

☐ wind ☐ temperature

☐ water ☐ organic acids

2. Which of these is the lowest horizon of soil profile?

☐ subsoil ☐ bed rock

☐ gravel ☐ humus

3. Which organism is known as nature's ploughman?

- ☐ honeybee
- ☐ bird
- ☐ rat
- ☐ earthworm

4. Which soil can retain more water?

- ☐ sandy soil
- ☐ loamy soil
- ☐ clayey soil
- ☐ polluted soil

5. Coconut trees thrive in coastal regions where the soil present is mainly—

- ☐ clayey soil
- ☐ sandy soil
- ☐ loamy soil
- ☐ sandy loam

D. Answer the following questions in brief.

1. State the meaning of the term 'soil'.
2. List the four main agents of physical weathering.
3. Write one difference between sand, clay and silt.
4. Name the types of soil classified on the basis of soil texture.
5. Give the meaning of the term 'Cohesion'.
6. List any three causes of soil pollution.

E. Answer the following questions.

1. Classify, and explain, the categories of soil on the basis of 'texture of the soil'.
2. Differentiate between infilteration rate and percolation rate.
3. Write a short note on 'composition of soil'.
4. 'The type of crop that may be grown in a particular field depends on the type of soil.' Give three examples in support of this statement.
5. What is soil erosion? How can it be avoided?
6. Why is it said that 'plasticity' and 'cohesion', play an important role in the workability of a soil?

Value Based Question

On the 'opening day', the school principal, and teachers, welcomed the parents and guardians of their 'new students'. The principal went on to say that the parents and the teachers, both have a crucial role to play, in the growth and development of the children. She compared their roles with the role of the physical and chemical agents that cause the weathering of the soil and make it suitable for supporting, and sustaining, the growth of all forms of life.

1. State any two of the values that parents/teachers generally display during the growth of their children.

2. Write, in brief, the role of (i) Plants and animals (ii) Solvent action of water in the 'weathering' of the soil.

Something To Do

1. **Visit a potter: Potters are difficult to find in cities. Try finding such a place, and visit it with your teacher and classmates. Observe the texture of the soil used by the potter. Can he make pots using sand? How does the property of plasticity differ in sand and clay?**

2. **Take three pots and fill them with sand, clay and loamy soil. Sow similar wheat grains, or seeds of green gram, in each of these pots. Water them regularly, using the same amount of water, for each pot. Record your observation about the growth of the plants. What do you infer?**

3. **Make a group of six. Find out the main crops grown in any three states of India. Also find out the types of soil they are grown in. Make a PowerPoint presentation on your report.**

CHAPTER

11 Electric Charges at Rest

All of us might have had the experience of some one or the other saying: 'Oh not again! What shall we do without electricity? It is again going to be an uncomfortable summer day!'

Remarks like this indicate the importance of electricity in our day to day life. If we look around us, we find that electricity plays a very vital role in our life. The electric bulbs, tubelights and LEDs that light up our homes and streets at night, the fans that cool us during hot summer days, the refrigerator that cools our food items and keeps them fresh, radio and television that educate and entertain us, and the metro

trains that help people commute from one place to another, all these, and so many other devices and appliances, need electricity for their working. One of the major 'revolutions' of the previous century—the computer—also needs UPS (Uninterrupted Power Supply). The electric motors and pumps, that help the farmers, to water their fields, again work on electricity. And so do all the factories that are producing clothes, food items, confectionery, stationery, utensils, glass, water, and so on, for all of us.

If we look into the history of the discovery and development of electricity, we find that, it was in the sixteenth century that an interesting phenomenon was discovered. It was found that when amber was rubbed against a piece of flannel, it acquired the property of attracting light objects—like dry grass leaves, tiny pieces of paper or small pith balls. This property was not shown by amber when it was not rubbed against flannel. The rubbed piece of amber was referred to as having 'got electrified' or having acquired an electric charge. (The Greek name for amber is *elektron* and it was this name that was used for coining the term 'electric'.)

Following the discovery of this property of amber, a lot of experiments were done to find whether other substances also show this property. A very significant part of such work was done by an English physician and physicist William Gilbert (1540–1603). He discovered that this property was also shown by substances like diamond, sapphire, opal and rock salt. There were, however, some other substances which did not show this property.

Uncharged and Charged Objects

An object is said to be **electrically charged**, or simply **charged**, if it has acquired the property of attracting light objects. Most of the substances, usually, do not have this property, i.e. they are 'uncharged'. Let us now do some simple activities to see how objects can be charged and what are their special properties when they are 'charged up'.

Activity 1

Take a dry plastic comb and rub it vigorously through dry hair. Now bring this comb near tiny bits of paper. You will find that the paper bits get attracted towards the dry comb. This shows that a dry plastic comb gets electrically charged when (properly) rubbed.

Activity 2

Take a dry metal comb and bring it near tiny bits of paper after vigorously rubbing it through dry hair. Do the paper bits 'fly off' towards this comb? We find that they do not do so. This shows that a dry metal comb does not get 'charged up' even after vigorous rubbing.

The results, of a similar activity, for some other objects, are summarised in the table below:

Material	Metallic/Non-metallic	Electrical property
Plastic comb	Non-metallic	Gets charged up on rubbing
Metal comb	Metallic	Does not get charged up on rubbing
Drinking (plastic) straw	Non-metallic	Gets charged up on rubbing
Ebonite rod	Non-metallic	Gets charged up on rubbing
Glass rod	Non-metallic	Gets charged up on rubbing
Metal pen	Metallic	Does not get charged up on rubbing

Conductors and Insulators

From the results of the Activity 2, we find that metallic objects do not (normally) get charged up on rubbing. Non-metallic objects, however, (normally) get charged up on rubbing. We can, therefore, think of two different types of materials in nature: (i) that 'get charged up' on rubbing and (ii) that 'do not get charged up' on rubbing.

Metallic materials (that normally do not get charged up on rubbing (because they allow an electric charge to flow through them with ease)) are known as **conductors.** Non-metallic materials (that normally get charged up (because they do not allow an electric charge to flow through them easily))are known as **insulators**. Both conductors and insulators find a wide variety of practical applications in our daily life.

Do You Know ?

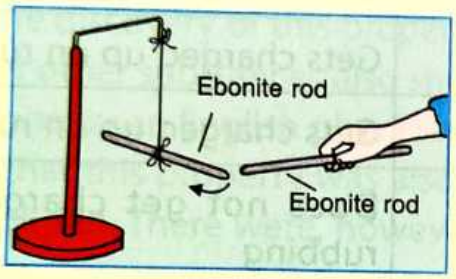
Metals are also known to let heat flow through them with ease. We may, thus, say that good conductors of heat are also good conductors of electricity and vice-versa.

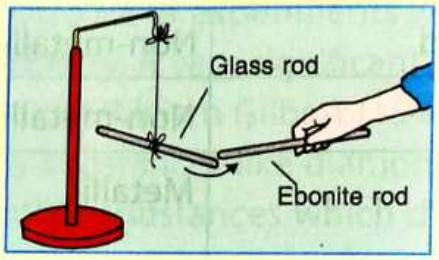
Kinds of Charges in Nature

Most of the early experiments, on study of properties of charged up objects, were done by using ebonite rods (rubbed against flannel) and glass rods (rubbed against silk). These gave us very useful and interesting information about their properties. Let us perform some activities to learn about these properties.

Activity 3

Take two ebonite rods and two glass rods along with two stands and some thread. Suspend one of the ebonite rods, and one of the glass rods, from each of two stands. Charge up each of the two suspended rods by rubbing them vigorously against flannel and silk, respectively. Now take the other ebonite rod and charge it up also by vigorous rubbing against flannel. Bring this charged ebonite rod near the suspended (and charged) ebonite rod. You will find the suspended (charged) ebonite rod moving away from (i.e. getting repelled by) the charged ebonite rod.





Now take the charged ebonite rod towards the suspended (and charged) glass rod. You will find the glass rod moving towards (i.e. getting attracted by) the charged ebonite rod.

Repeat these observations by charging up the other glass rod. When you bring it, in turn, near the suspended (and charged) ebonite and glass rods, you find that—

(i) the suspended charged glass rod moves away from (i.e. gets repelled by) the charged glass rod held in the hand.

(ii) the suspended charged ebonite rod moves towards (i.e. gets attracted by) the charged glass rod held in the hand.

Like and Unlike Charges

From the above observations, we can conclude that:

- a charged object exerts a force not only on uncharged objects (like small dry pieces of paper) but also on other charged objects.

The force exerted by a charged object on another charged object is a force of—

(i) **repulsion** when the two charged up objects are similar in nature.

(ii) **attraction** when the two charged up objects are different in nature.

Because of this difference in their behaviour, we can say that there are two (opposite) kinds of charges in nature. We can also say that:

Like charges **repel** each other while unlike charges **attract** each other.

Positive and Negative Charges

Early experiments, of the kind described above, showed that there are two kinds of (opposite to each other) charges in nature. They were referred to as positive charge (+) and negative charge (–). It was, Benjamin Franklin who named the charge produced on a glass rod (on rubbing against silk) as a positive charge and that produced on an ebonite rod (on rubbing against flannel) as a negative charge.

We now use this classification, along with the basic rule: **Like charges repel and unlike charges attract each other,** to decide the nature of an unknown charge. The unknown charge is **positive** if it is repelled by a charged up glass rod (or attracted by a charged up ebonite rod). It is **negative** if it is attracted by a charged up glass rod (or repelled by a charged up ebonite rod).

Charges are Produced in Pairs

As we already know that an ebonite rod is known to get (negatively) charged up when it is rubbed against flannel. A piece of thermocole, or a drinking straw, gets charged up when it is rubbed against paper. A plastic scale gets charged up when it is rubbed against a piece of woolen cloth or flannel. We can test the 'charged up' nature of all these objects by using them to 'pick up' small pieces of paper or dry grass.

But what about the rubbing objects (the piece of flannel, paper, or woolen cloth) in all these cases? We find that they also get charged up. Thus, (rubbing) the piece of flannel, paper or woolen cloth can also attract tiny pieces of paper or dry grass. We can, therefore, say that when two objects are rubbed against each other, they both get charged up.

There is, however, an interesting feature of these two 'charged up' objects. If they are simultaneously brought near tiny pieces of paper, 'the combination' does not attract

them. The combination, therefore, behaves like an uncharged object. Why? This can happen if the two objects carry equal but opposite charges. We can, therefore, say that when two objects are rubbed against each other, they both get charged up with equal and opposite amounts of charges. In other words, **charges are always produced in pairs**.

Earthing

Suppose a negatively charged object is put 'in contact with the earth'. This contact can be brought about either by a metallic wire or even by touching it (**Warning:** Touch a charged object only if it is safe to do so). The extra charge, present on the object, can then move on into the earth. The object, on losing the extra charge, becomes an uncharged object.

We, thus, observe that putting a charged object, in contact with the earth, causes it to lose its charge. We call this process as the **Earthing** of the given object. 'Earthing' (putting in contact with the earth) thus, causes a charged object to lose its charge. This fact has many useful practical applications in our daily life. We always earth the metallic body of all electrical appliances and devices, that we use in practice. This helps to keep their bodies uncharged and saves us from possible 'electric shocks'.

Methods of Charging up

There are three methods by which a given object can be charged. These are charging by (i) rubbing or friction, (ii) contact or conduction and (iii) induction. Let us now discuss them.

Charging by Rubbing or Friction

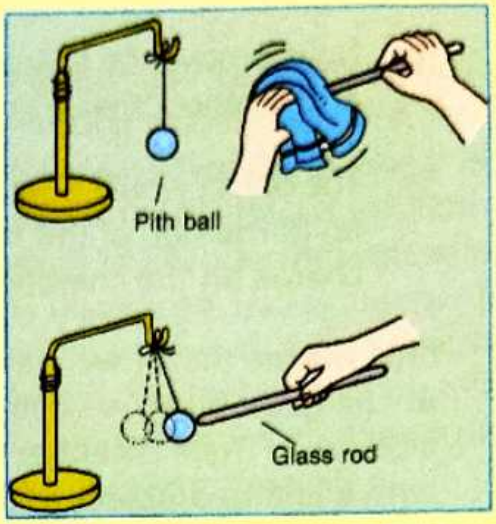
We have already learnt about this method in the previous pages. Here, different (insulator type) objects get charged by rubbing them against some other suitable object.

Charging by Contact or Conduction

In this method, a given uncharged object is 'charged up' by bringing it in direct physical contact with another charged object. The charge (on the original charged object) then gets 'shared' between the two objects. Hence, the (originally) uncharged object also gets charged up.

Activity 4

Take a small pith ball or a thermocole ball. (A pith ball is made from dried elder pith–a kind of wood that is extremely light). Take a wooden stand and suspend the pith ball (or the thermocole ball) with a cotton or silk thread. Now take a glass rod and charge it up by rubbing it against a silk cloth. Bring the charged glass rod near the suspended ball and observe what happens.



The suspended ball first gets attracted towards the charged rod. After coming in contact with it, it shares its charge, gets charged up and gets repelled away from it. Thus, the suspended ball acquires a charge by coming in contact with a charged rod. This is, thus, a simple illustration of charging by **contact** or **conduction**.

The charge, thus, accquired (by contact) by the uncharged object, depends on the size of the two objects and the materials they are made of. If both, the uncharged object and the charged object, are identical then they accquire equal charges.

Electrical Induction

Before we explain the third method, i.e. charging by induction, let us first understand what Electrical Induction is?

Suppose a charged object is brought near an uncharged one. The two kinds of charges (already present) in the uncharged object, then get 'separated out'. The 'opposite' kind of charges move to the 'nearer end' and the like charges move to the 'farther end' of the uncharged object. We call this phenomenon, of separation of charges of an uncharged object (due to the presence of a charged object in its neighbourhood), as the phenomenon of **electrical induction**.

Charging by Induction

We can charge a given object by induction by following the given steps:

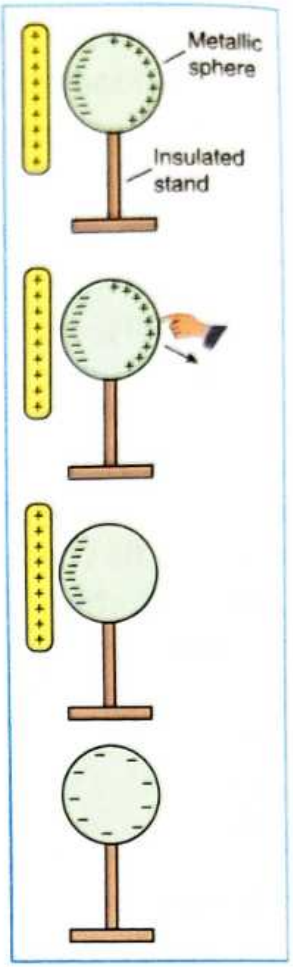
1. Bring a charged object near (but without touching it) the object to be charged. This would cause the charges in this (uncharged) object to get 'separated out'.

2. Keeping the charged object in its nearby position, touch the uncharged object with the hand (if permitted; otherwise use a shielded metallic wire) to connect it to the earth. Thus, the uncharged object is 'earthed'.

3. Still keeping the charged object in its position, remove the hand (or the earth contact).

4. Now remove the charged object from the neighbourhood of the object that was to be charged.

5. The object would now be seen to have an electrical charge on it. The sign of this charge is opposite to the sign of the charge on the charged object used for charging it up.

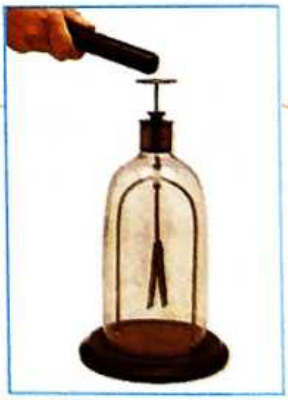


This means that if we want to give a positive charge to an uncharged object, we need a negatively charged object and vice-versa. There is neither any rubbing nor any direct contact with a charged object in the above steps for 'charging up' a given object. We, therefore, have a new method for charging up a given object. It is this method that we call as the method of 'Charging by Induction'.

A close look, at the steps followed (for charging by induction), shows that the uncharged object gives up its 'far-end' charge to the earth. It is, therefore, the earth that is losing or gaining the charge. We can, therefore, say that the earth acts as the source (or sink) that is responsible for charging an object by induction.

Do You Know ?

A simple device, to detect charge on a body, is the gold leaf electroscope. It consists of a vertical metal rod housed in a box. There are two thin gold leaves attached to the bottom end of this rod. When a charged object touches the metal knob, at the top of rod, charges flow on to the leaves and they diverge. The degree of divergence indicates the amount of charge on the body.

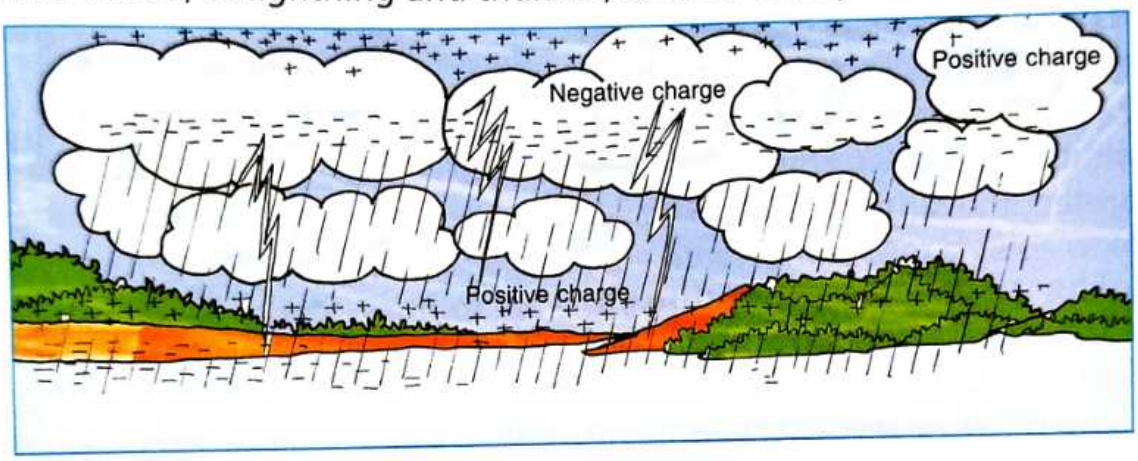


Charges in Nature

We now know that lightning (and thunder) are due to the production of very large amounts of charges on the clouds. It is not quite clear as to how these charges get produced. However, it is found that the bigger and heavier droplets in the clouds tend to acquire a negative charge while the smaller and lighter droplets tend to have a positive charge on them. Air currents then push the (lighter) positively charged

droplets upwards while the (heavier) negatively charged droplets stay downwards. (There may, however, be some positive charges also in the lower part of the clouds).

The positive and negative charges, in the clouds, exert a strong force of attraction on each other. The air (known to be a bad conductor of electricity) 'present between them' does not let these charges move towards each other. However, when the charge build up goes beyond a certain limit, the air 'breaks down' and loses its normal insulating nature. There is, then, a sudden flow of very large amount of charges through some parts of the air. We call this phenomenon as an **electric discharge**. Such a 'discharge' heats up the air very much and its starts glowing and flashing. It is such a flash that we see as **lightning**. Lightning is also accompanied by a cracking loud sound that we hear as **thunder**. Both lightning and thunder, therefore, occur together or simultaneously. A particular 'event', of lightning and thunder, lasts for a very short time only.



At certain times, the charges present in the lower parts of clouds are strong enough to induce an opposite charge on the ground below them. When the air, between these charged clouds and the ground, 'breaks down' (i.e. loses its normal insulation properties), an electric discharge occurs through it. This results in **lightning**. The resulting flow, of huge amount of electric charges, may take place through tall, (or multi-storeyed) buildings, TV (or radio) towers, or tall trees. This can heat up the objects so much that they are likely to get 'burnt out'. Lightning can, thus, cause much damage.

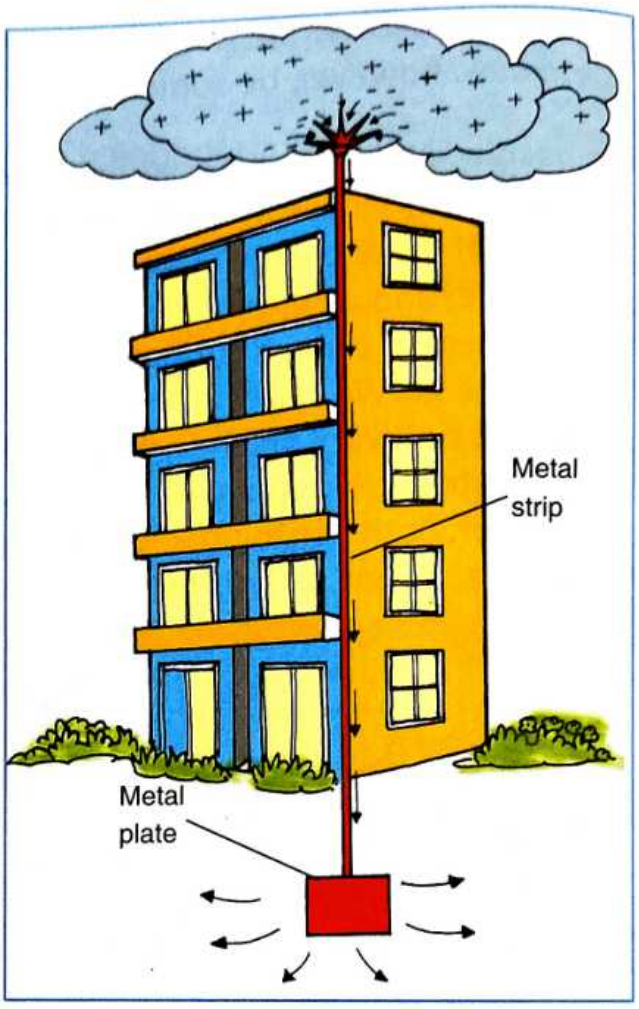
Do You Know ?

Lightning strikes somewhere on the surface of earth about 100 times every second.

Lightning Conductor

A **lightning conductor** is a device that is designed to minimise, or avoid, the loss of life and property during lightning. It was Benjamin Franklin who suggested

the idea of such a device and it is now used in all tall or multi-storeyed buildings and other tall structures.



A lightning conductor is simply a long flat thick strip of metal. It goes all the way from a point well above the highest point of the structure (a tall building, a TV tower, a high rising monument, etc.) to be protected, to a point well inside the earth. It is arranged along the outer periphery of the structure and its lower end is joined to a metal plate that lies buried deep inside the earth. At its upper end, it has a spike-like (or pointed) structure. A lightning conductor helps to protect the structure in two ways:

1. The spike-like (or pointed) structure, at its upper end, helps to reduce the chance of a build up of very large amounts of charges on the clouds in its 'neighbourhood'. This reduces the chance of a lightning-strike occurring there.

2. The flat thick metal structure of the lightning conductor provides a safe and easy passage, to the flowing electric charges, as and when lightning does strike. The lightning charges, therefore, flow down, through it, deep down into the earth and not through the structure. The structure is, therefore, saved from the damaging effects of lightning.

Safety Precautions during Lightning

- For a person caught outside in the open:
  - On observing the signs of lightning and thunder, go to a safe place immediately.
  - A house, or a building, is a safer place.
  - One is safer inside a car, or bus, provided the windows and doors are shut.

- Avoid sheds and open areas.
- Stay away from trees.

- For a person present inside a house or a building:
  - Avoid contact with water.
  - Do not use electric equipments, like T.V., computers, etc. Electrical lights can remain on.
  - Do not use corded phones. As lightning may strike exterior phone lines, it is safer to use cordless or mobile phones.

Advantages of Lightning

Lightning converts nitrogen into its oxide which get dissolved in water and come down with rain. This helps plants to get their much needed nitrogenous compounds. Lightning can also result in the formation of ozone from oxygen. Ozone provides a protective blanket in the atmosphere that shields us from the harmful ultraviolet radiations of the sun.

The huge flow of charges during lightning also helps the earth to maintain a 'balance' in the total electric charges contained in it.

Keywords

charging by conduction	process of charging an uncharged object by direct physical contact with a charged object.
conductors	substances/materials which allow electric charges to pass through them with ease.
charging up	making an object acquire some 'special properties' through rubbing, contact or induction.
earthing	the process of transfer of charge to the earth.
induction	process of charging an uncharged object without actually touching it with a charged object.

insulators	substances/materials which do not allow electric charges to pass through them.
lightning	a sudden electric discharge between a (charged up) cloud and some other object.
lightning conductor	a device used to protect tall buildings from lightning.

You Must Know

1. An object is said to be electrically charged if it has acquired the property of attracting light objects.
2. Non-metallic materials/objects can be charged up by rubbing with other objects. Metals, or metallic objects, do not get charged up through rubbing.
3. There are two kinds of charges in nature—positive charge and negative charge.
4. Like charges repel each other while unlike charges attract each other.
5. Charges are always produced in pairs.
6. There are three ways of charging an object—(i) charging by rubbing (ii) charging by conduction and (iii) charging by induction.
7. When an uncharged body is brought in direct physical contact with a charged body, it gets a charge similar to that of the charged body. This is called charging by conduction.
8. Charging by induction neither involves any rubbing nor any direct contact with a charged object.
9. The process of electric discharge, between clouds and the earth, or between different clouds, causes a phenomenon, called lightning.
10. Lighting strike can destroy life and property. Hence, precautions need to be taken when lightning takes place.

Something To Know

A. Fill in the blanks.

1. There are _____ types of charges in nature.
2. _____ charges repel each other and unlike charges _____ each other.
3. The materials, that normally do not get _____ on rubbing, and allow electric current to flow through them with ease, are known as _____.
4. Lightning and _____ occur together.
5. The scientist, who proved that lightning is electrical in nature, was _____.

B. Write True or False for the following statements.

1. The charges acquired by a glass rod, and the silk cloth with which it is rubbed, are equal and of the same sign. ☐
2. During charging by conduction, the charged object shares its charge with the uncharged object. ☐
3. A charged body loses its charge if we touch it with our hand. ☐
4. Lightning is a natural electrical discharge phenomenon. ☐
5. We do not need any special device to protect tall buildings from lightning. ☐

C. Tick (✓) the correct option.

1. A charged plastic comb (comb B) is brought near another similarly charged, and suspended, plastic comb (comb A). Then comb A would—

☐ remain unaffected ☐ move towards comb B

☐ move away from comb B ☐ start oscillating

2. A student is provided with four objects:

A: A plastic comb

B: A copper rod

B: A rubber balloon

D: A woolen cloth

The object, that cannot be easily charged by rubbing, is the object labelled as—

☐ A

☐ B

☐ C

☐ D

3. Two charged objects, are brought close to each other. The two objects would—

☐ always repel each other.

☐ always attract each other.

☐ either attract or repel each other.

☐ neither attract nor repel each other.

4. During charging, by induction, it is—

☐ the charged object, as well as the earth, that share their charges with the object to be charged.

☐ only the charged object that shares its charges, with the object to be charged.

☐ only the earth that 'shares its charges', with the object to be charged.

☐ the uncharged object that is able to produce charges on itself.

5. During charging (i) by conduction, and (ii) by induction, the charge on the charging object—

☐ decreases in both the cases.

☐ decreases in the first case but remains unchanged in the second case.

☐ decreases in the second case but remains unchanged in the first case.

☐ remains unchanged in both the cases.

6. During lightning, we can have an electric discharge—

- ☐ only between two opposite charged clouds.
- ☐ only between a charged cloud and the ground.
- ☐ either between two opposite charged clouds or between a charged cloud and the ground.
- ☐ neither between two opposite charged clouds nor between a charged cloud and the ground.

D. Answer the following questions in brief.

1. A glass rod is rubbed against a silk cloth. Which object/s gets/get charged in this process?
2. Name two objects (a) that can be charged by rubbing (b) that do not get charged on rubbing.
3. State the main difference between a conductor and an insulator.
4. Name the device used for protecting tall buildings from lightning strikes.
5. Give the meaning of the term 'earthing'.
6. List down two precautions that a person can take if he is caught outside in the open during a lightning strike.

E. Answer the following questions.

1. A charged drinking plastic straw is brought near another suspended plastic straw, that is (a) similarly charged (b) uncharged. Explain what we would observe in each case and why.
2. Why do we say that 'charges are always produced in pairs'?
3. Describe a simple experiment to show that the total charge on a pair of objects, that have been rubbed together, is zero.
4. Why does a charged object lose its charge when touched?
5. Can we say that a charged object attracts an uncharged object by first charging it through induction? Explain your answer.

6. State the sign of the charge acquired by an object when it is charged, by a positively charged rod, through (a) conduction (b) induction. Give the reason for your statement.

7. Is it important to have a very good contact between the lower end of a lightning conductor and the earth? If so, why?

Value Based Question

Tavish was driving back home from his office when it started raining heavily. The rain poured along with a thundering sound and lightning. On the way he saw an old man walking along the street. Tavish stopped the car and requested him to immediately get inside the car. Later on, he dropped the old man at his place.

1. State two values displayed by Tavish.

2. Did Tavish do the right thing by asking the old man to get inside his car? Give reason for your answer.

Something To Do

1. To design a simple metal leaf electroscope.

We can design a simple version of a gold leaf electroscope by using—

(i) an aluminium leaf

(ii) a wooden stand

(iii) a metal wire and

(iv) a 'box' made from thermocole sheets with transparent paper walls.

We can use it for applications similar to that of a gold leaf electroscope.

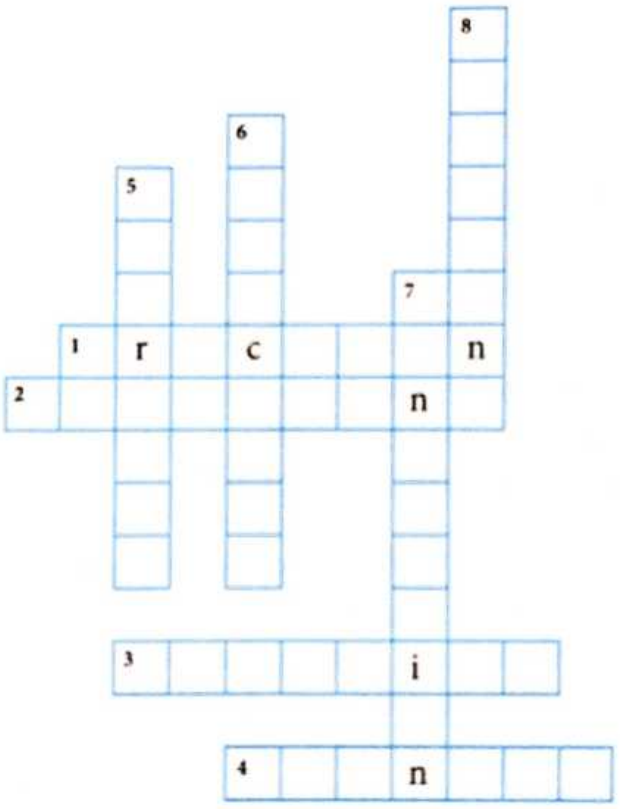
2. Solve the crossword with the help of given clues.

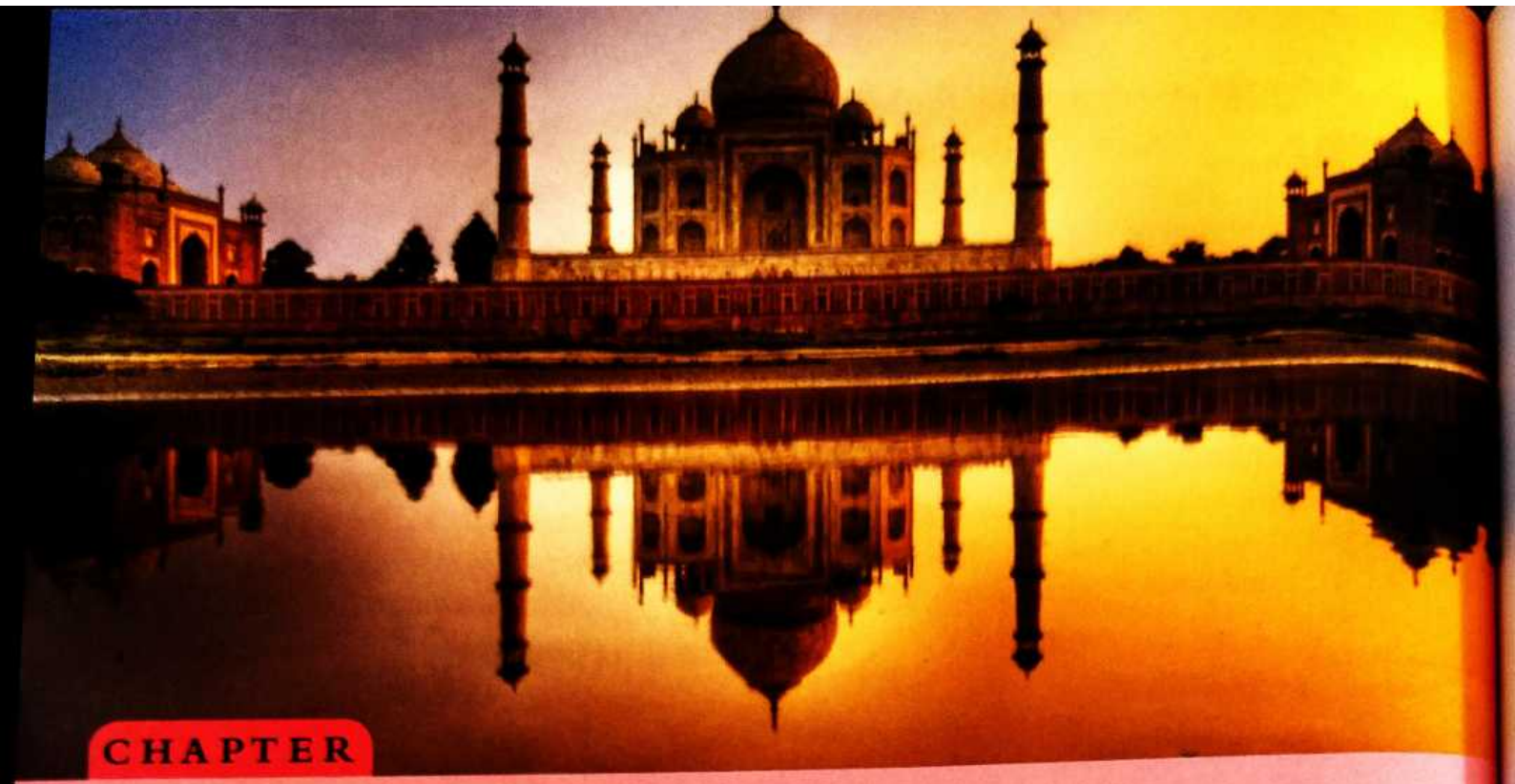
Across →

1. Charging by rubbing.
2. A natural electrical discharge phenomenon.
3. A positive charge gets attracted by a _____ charge.
4. Loud sound.

Down ↓

5. Transfer of charge from one object to another.
6. Charging an object without touching it.
7. Charging by making contact.
8. Transfer of charge to earth.





CHAPTER

12 | Light

Look at the picture shown above. We see not only the original monument itself but also its 'picture' in the water. This 'picture' in the water source, as we now know, is due to the phenomenon known as **reflection of light**.

We have already learnt, in Class-VI, that a plane mirror can change the direction of light falling on it. Such a change of direction, by a mirror, is due to the reflection of light by the mirror. Reflection of light from plane shiny (or polished) surfaces (mirrors, stainless steel spoon/plate) is known as **regular** or **plane reflection**. This is because light is reflected from these surfaces in a well defined, orderly manner and this often results in a glare. Reflection of light from non-shiny, non-polished, or irregular surfaces, often takes place in an irregular diffused manner. This is known as **diffused reflection**. Can you now guess about the type of reflection which helps us in seeing different objects around us?

Let us perform an activity to recall the characteristics of the image of object formed by a plane mirror.

Activity 1

To study the characteristics of an image formed by a plane mirror.

Fix a graph paper on the drawing board (or a thick cardboard piece). Draw a thick line in the middle of the graph paper. Hold the plane mirror strip vertically on this line using a wooden groove or some moulding clay.

(i) Place one small object (for example, a pencil/an eraser/a crayon/a figure from your toy game) at the end of one of the squares of graph, on the line that is perpendicular to the mirror. Note the width of the object (size) by counting the number of squares on the graph paper. Now look at the image formed in the plane mirror. Note down the position and size of this image. Move the object on the perpendicular line, first closer and then farther away from the mirror. What do we observe?

The image is always of the same size as that of the object and as far behind the mirror as the object is in the front of it.

(ii) Place a vertical screen (cardboard piece/thick sheet of paper) behind, or in front of, the mirror. Let us try to obtain the image of a given object on the screen. What do we observe now?

We find that the **image of an object formed by a plane mirror cannot be obtained on the screen.** (This image is, therefore, a **virtual image.**)

(iii) Cover an eraser with a sheet of paper and draw a figure (cartoon) on one side of the eraser. Place the side of eraser, having this figure, in front of the mirror. What do we observe now? Move the figure to different positions in front of the mirror. Is the image of the figure upright or upside down? Is the 'right' side of figure towards the 'right' side in the image?

We find that the **image does not appear upside down and is always upright (erect).** The image also shows an interesting property. The 'right' side of the object appears as 'left' in the image. Similarly, the 'left' side of the object appears as the 'right side' of the image. We call this phenomenon as **lateral inversion.**

Note: The above activity can also be performed using a chessboard in place of a graph paper.

Laws of Reflection

It has been observed that the reflection of light, from a surface, always takes place (in a well defined manner) in accordance with two simple rules or laws. We call these two rules or laws as the **two laws of reflection**. We must, however, first know some terms to understand, and explain, the two laws of reflection.

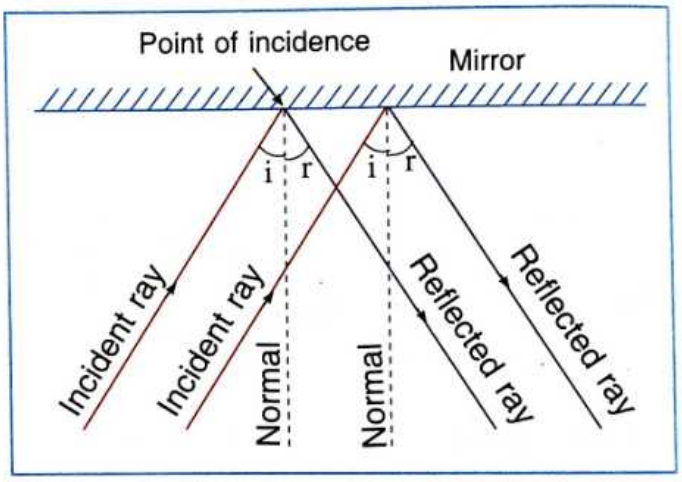
Some Important Terms

The 'Point of Incidence' and the 'Normal'

The **Point of incidence** is that point on the surface of the mirror where the incident ray falls. A line perpendicular to the surface, at the point of incidence, is known as the **Normal** at the point of incidence.

The Incident ray and the Reflected ray

The ray of light, coming towards the mirror, is called the **Incident ray**. Similarly, the ray of light, which turns back, after 'reflection' from the mirror surface, is called the **Reflected ray**.



Angle of Incidence and Angle of Reflection

The angle, between the incident ray and the normal at the point of incidence, is known as the **Angle of incidence**. Similarly, the angle between the normal and the reflected ray, at the point of incidence, is called the **Angle of reflection**.

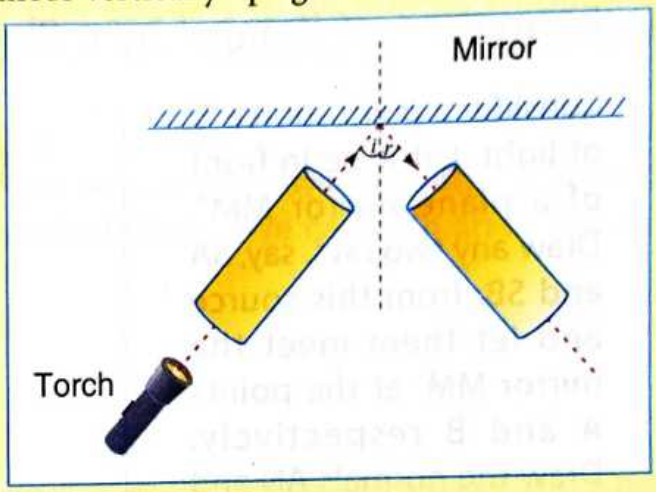
The Plane of Incidence and the Plane of Reflection

We know that we can use two points to define a line and two lines to define a plane. The plane, defined by the incident ray and the normal at the point of incidence, is called the **Plane of incidence**. Similarly, the plane defined by the reflected ray, and the normal at the point of incidence, is called the **Plane of reflection**.

Activity 2

To study the relationship between the angle of incidence and the angle of reflection.

Take a drawing board and keep the plane mirror vertically upright on it, near its centre. Hold one cylindrical tube (cardboard), (with a narrow opening at its front), in an inclined position with its front end (almost) touching the mirror. Direct a powerful torch light into the tube. Ask your friend to hold a second similar cylindrical tube (cardboard) at a matching angle. Now you move your tube so that it makes different angles with the plane mirror. What is your observation? What does your friend do to get the reflected light to come out from the end of the second tube? You will see a circle of reflected light, at the end of second tube, provided the second tube is oriented at the correct angle (angle of incidence = angle of reflection). The light will be reflected from the mirror, and will move down through the second tube to its end, whenever the angle of reflection equals the angle of incidence. However, when a ray of light falls normally on a mirror, 'it gets reflected' in such a way that it retraces its path in the opposite direction.



[**Note:** You can also perform this activity using a 'laser pointer'. However, do seek the guidance of your teacher/instructor while using this set up. Appropriate precautions are a must in this case.]

We can now put together the two laws of reflection which govern the formation of an image by a mirror.

The two laws of reflection are as follows:

First Law: The incident ray, the normal at the point of incidence and the reflected ray, all lie in the same plane.

Second Law: The angle of incidence and the angle of reflection are equal to each other.

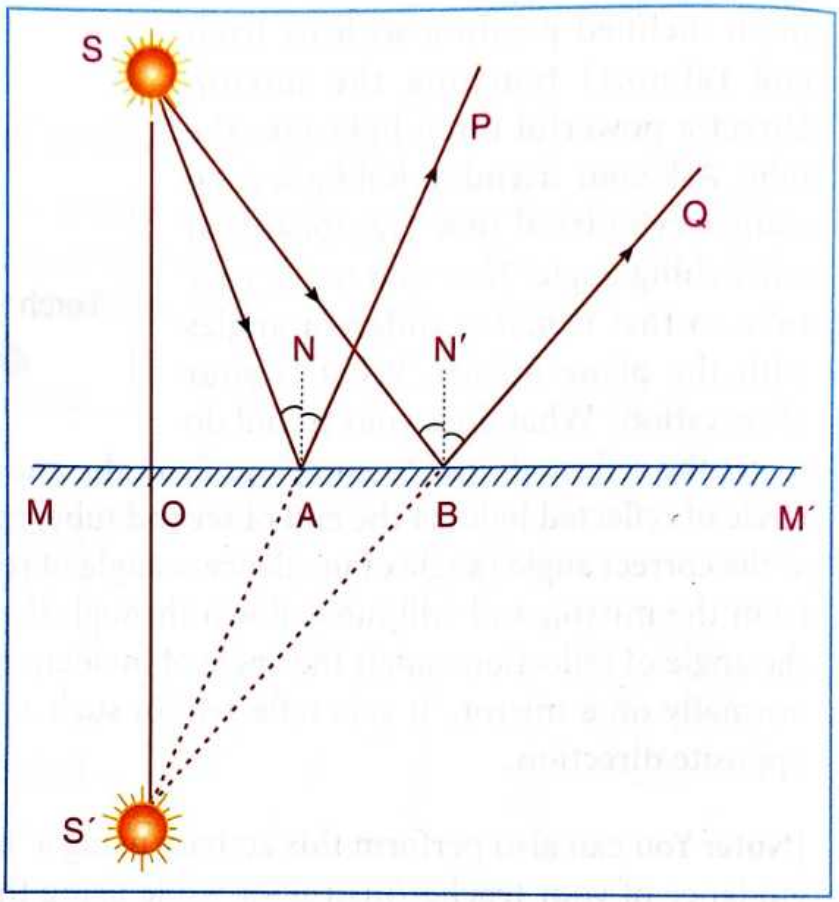
We use these laws to understand reflection in all cases and situations.

Image Formation

The laws of reflection help us to understand the formation of the 'image' of an object by mirrors.

Formation of 'Image' by a Plane Mirror

Consider a point source 'S' of light. Let it be in front of a plane mirror MM'. Draw any two rays, say, SA and SB, from this source and let them meet the mirror MM' at the points A and B respectively. Draw the normals AN and BN' at these two points. Now draw the reflected rays AP and BQ making $\angle PAN = \angle SAN$ and $\angle QBN' = \angle SBN'$. The two reflected rays AP and BQ, when produced backwards, appear to meet at the point S'. This point S' is the image of the point source S. Now join the points S' and S. The resulting line S'S cuts the plane mirror (MM') at the point O. On measuring, we find that—



(i) S'O = OS and (ii) $\angle SOM' = \angle S'OM' = 90°$.

We, therefore, observe that, for a point source S, the—

- image formed by a plane mirror is as far behind the mirror as the object is in front of it; and
- the line, joining the image of a point object and the object itself, is normal to the plane mirror.

(The line SOS' is bisected by the plane mirror because S'O = OS)

In the above case, we found that the two reflected rays, AP and BQ were 'going away' from each other after reflection by the plane mirror. They, however,

appeared to meet at the point S' when produced backwards. The image S' formed by a plane mirror is, therefore, not due to an actual intersection of the reflected rays. It appears to be formed through the intersection of the reflected rays, when produced backwards. Such images are known as **virtual images**.

A **virtual image** is, thus, an image that appears to be formed through an apparent intersection of the reflected rays. There is no actual intersection of the reflected rays.

By using appropriate (spherical) mirrors we can get an image that is formed through an actual intersection of the reflected rays. We call such an image as a **real image**.

Multiple Images

It is interesting to note that the rays, reflected by one mirror, can get reflected again if they are incident on another mirror. This fact is used to obtain more than one image (multiple images) by using two, or more, plane mirrors, inclined at different angles.

This idea of multiple images, formed by plane mirrors, kept inclined to one another, is used in a 'toy' known as the **kaleidoscope**. This helps us to make numerous beautiful patterns.

Do You Know ?

- Even a plane mirror can show the full image of a large object. However, to see the full image of yourself, you need a plane mirror half of your height.
- When a plane mirror moves towards a stationary object with a speed 'u', the image will move with a speed '2u' in the same direction as that of the mirror.

Activity 3

Take two plane mirrors. Set them at right angles to each other with their edges touching (use moulding clay). Place some object in between the mirrors. How many images of the object do we see? Now set the plane mirrors at different angles (say 30°, 45°, 60°, etc.). Observe that you can see more than one image in each case.

We can now understand how we are able to see the back of our head at the hair dresser's saloon when he keeps a plane mirror behind our head.

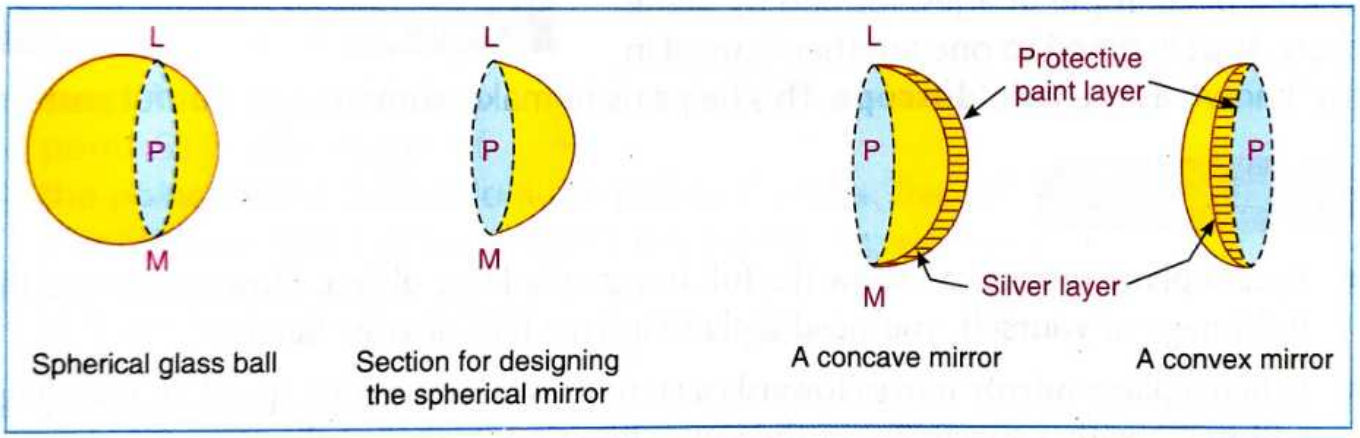
Spherical Mirrors

When we look into a large shining stainless steel serving spoon, kept nearby, our face may appear bigger or smaller than its normal size. It appears bigger when seen from one side of the spoon and smaller when seen from its other side. This is unlike the case of a plane mirror where we get an image of the same size as the object. The difference is due to the curved nature of the surfaces of the spoon.

We, thus, realise that a curved reflecting surface, or mirror, behaves in a different way as compared to a plane reflecting surface or a plane mirror. Curved mirrors can occur in a variety of shapes but the simplest of them are the spherical mirrors.

A **spherical mirror** is a special type of mirror whose surface is a part of a sphere. There are two types of spherical mirrors—the **concave mirror** and the **convex mirror**.

Suppose there is a spherical ball of glass and we cut out a section of this ball. If we now polish the outer side of this section, and then cover it with a silver layer and a protective paint, we get a **concave mirror**. When the silvering and protective paint coating is done on the inner side, we get a **convex mirror**.



Terms Used in Connection with Spherical Mirrors

We use quite a few basic terms to understand the details of formation of images by spherical mirrors. Some of them are as follows:

- **Centre of Curvature**

  The **centre of curvature** of a spherical mirror is the centre of the sphere of which the given mirror is a part.

- ## Radius of Curvature

The radius of the sphere, of which the given mirror is a part, is known as the **radius of curvature** of the mirror.

- ## The Pole

This is the **mid-point**, or the **central point**, of the section (or part) of the sphere used for making the given spherical mirror.

- ## The Principal Axis

The **principal axis**, of a spherical mirror, is the line joining the pole of the mirror and its centre of curvature.

- ## The Normal

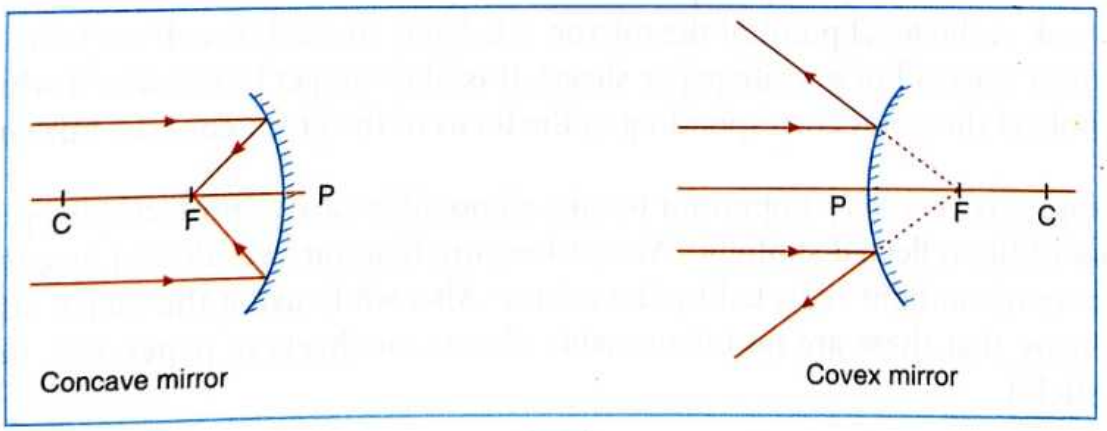
The **normal** to a spherical mirror, at any point on its surface, is simply the line joining that point (on the mirror surface) to the centre of curvature of the mirror. In other words, it is just the radius of the sphere (of which the given mirror is a part) at that point on the mirror.

- ## The Focus

Suppose there is a beam of light rays, parallel to the principal axis of a spherical mirror. We find that all these rays actually meet, or converge, at a point on the principal axis for a concave spherical mirror. For a convex spherical mirror, all these rays appear to meet at, or diverge from, a point on its principal axis. In both cases, we call this point as the **focus** of the spherical mirror.

- ## The Focal Length

The distance, between the pole and the focus of the mirror, is known as its **focal length**.



It is easy to prove that there is a very simple relation between the focal length and the radius of curvature of a spherical mirror. The focal length (f) is (nearly) half the radius of curvature (r), i.e.

$$f = r/2$$

This means that, the focus is situated mid-way between the pole and the centre of curvature of the mirror.

Do You Know?

The radius of curvature and focal length of a plane mirror are infinite, i.e. very very large indeed!

Activity 3

To find the focus of a given concave mirror.

Take a concave spherical mirror and a sheet of white paper. Hold the concave mirror in front of a (distant) table lamp and also keep the sheet of white paper in its front. Adjust the mirror, and the position of the sheet, and we will see the rays of light concentrating at a point on the sheet. This point is the focus of the given concave mirror. (The bright spot at the focus is the real image of the lamp.)

If we were to do this experiment in sunlight and were to put the tip of a match stick at the focal point of the mirror, it is likely to catch fire. If we take a black paper sheet (instead of a white paper sheet), it is likely to get burnt after a while and have a hole at the point corresponding to the focus of the given concave mirror.

[**Warning:** It is very very important to take all possible care to protect our eyes from the glare of the reflected sunlight. We must ensure that our eyes do not face the sun, or the rays of sunlight reflected by the mirror. Also while using the match stick, we must ensure that there are no inflammable objects, or sheets of paper, etc., near the match stick.]

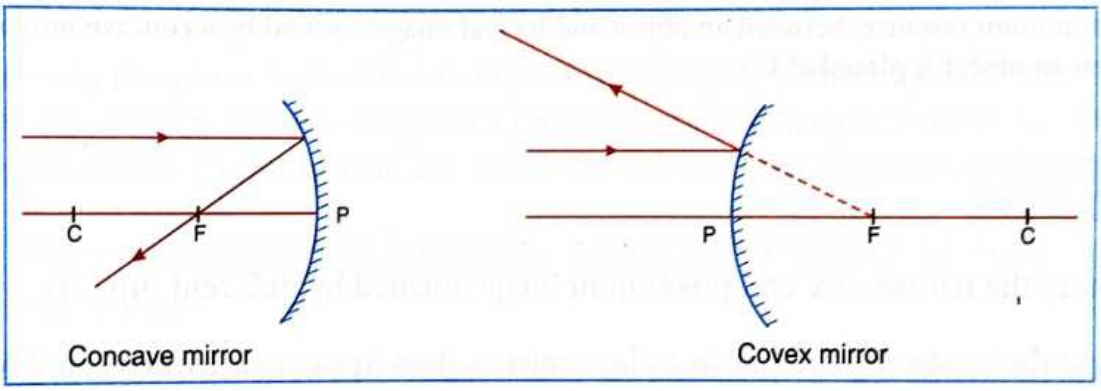
Laws of Reflection and Spherical Mirrors

The 'special properties' of spherical mirrors are just an application of the laws of reflection. At every point, the spherical mirror reflects an incident ray in such a way that the angle of reflection equals the angle of incidence. [Here, we have to remember that the normal, at the point of incidence, is simply the radius of the sphere (of which the given mirror is a part) at that point].

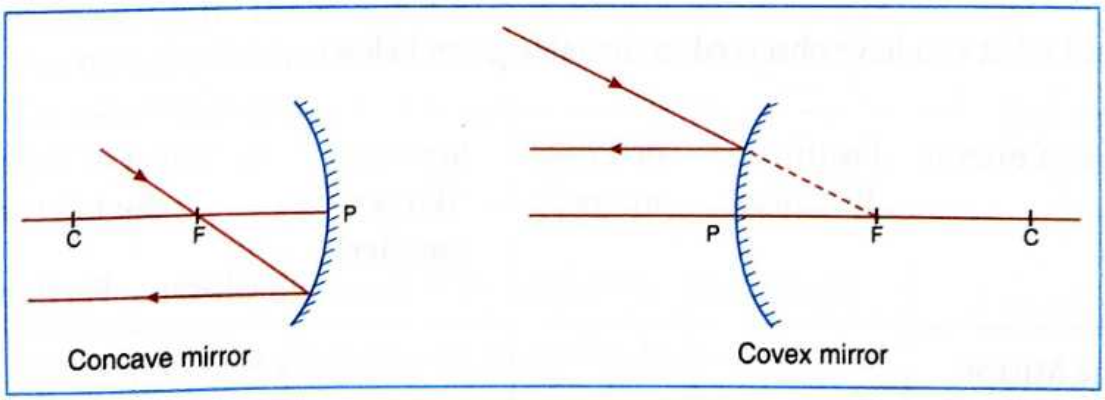
If a ray is incident in such a way that it passes through (or appears to pass through) the focus of a spherical mirror, it becomes parallel to its principal axis, after reflection. A ray directed towards the centre of curvature of a mirror retraces its path as it is incident normally on the mirror.

We, thus, note that for a spherical mirror,

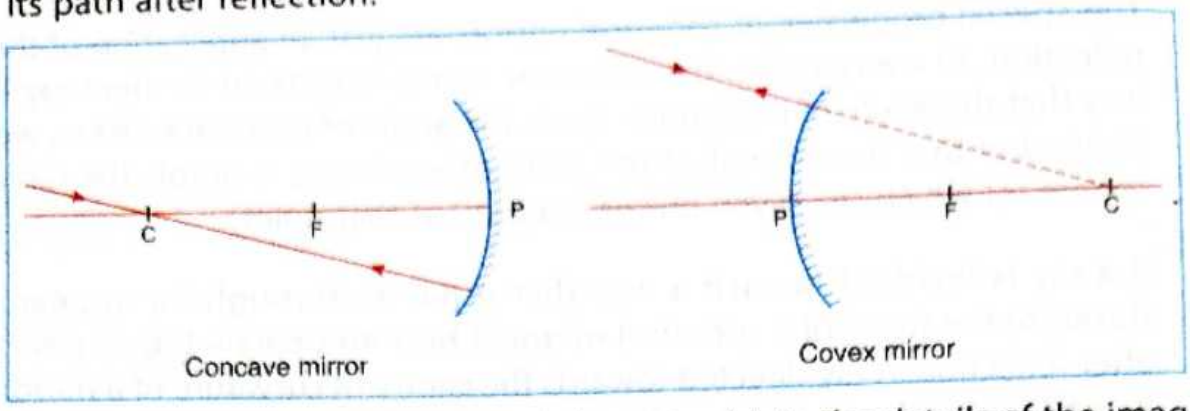
(i) a ray, parallel to the principal axis, passes through (or appears to diverge from) the focus of the mirror, after reflection.



(ii) a ray, directed towards the focus of a spherical mirror, becomes parallel to its principal axis, after reflection.



(iii) a ray, directed towards the centre of curvature of a spherical mirror, retraces its path after reflection.



We can use any two of these special rays to obtain the details of the images (formed by spherical concave and convex mirrors) when the object is situated at different distances from the mirror.

Do You Know ?

The minimum distance, between an object and its real image, formed by a concave mirror, is zero. (When an object is placed at C.)

Activity 4

To study the nature, size and position of image formed by different mirrors.

Look at the image of your face in a plane mirror, then in a concave mirror and finally in a convex mirror. Does the image of your face seem to be in front, or behind, the mirror? Is it inverted or erect? Does it look larger, smaller or of the same size as your face? Move the mirror closer to, and farther away, from your face. Does it make a difference?

Record what you have observed in the table given below:

Type of mirror	Position of the Image	Inverted or erect	Size seen (larger/ smaller)	Effect of moving the mirror	
				Closer	Farther Away
Plane Mirror					
Concave Mirror					
Convex Mirror					

Compare the image of your face in a plane mirror and that formed in a convex mirror. In what way these images are different from each other? In what way are these images similar?

Plane mirror

Convex mirror

In both cases the image is virtual and erect. The convex mirror forms a diminished image (smaller in size) whereas the image formed by a plane mirror is of the same size as the object.

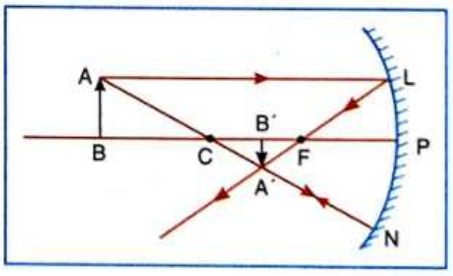
Images Formed by a Concave Mirror

We use ray diagrams to find the details of the images, formed by a concave mirror, when the object, initially supposed to be far away from the mirror, is gradually brought nearer to the mirror. We show the relevant ray diagrams below:

- **When the object is far away, beyond the centre of curvature of the mirror**

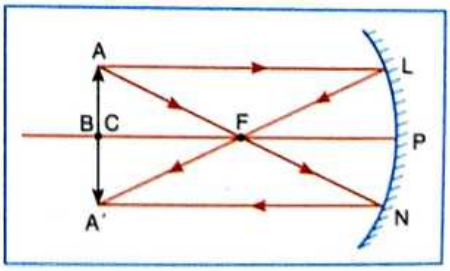
  Ray AL parallel to the principal axis gets reflected along LF. Ray ACN, passing through the centre of curvature, gets reflected back along NCA.

  These two rays intersect at A′. The image formed is A′B′. The image A′B′ is, therefore, an inverted, diminished image formed between F (focus) and C (centre of curvature) of the mirror. It is a real image as the two reflected rays, LF and NCA, actually meet at the point A′.



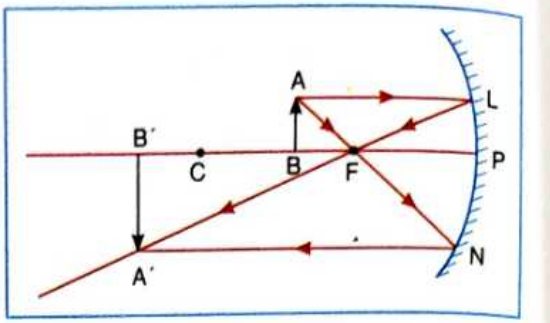
- **When the object is at the centre of curvature**

  The two rays used here are AL and AFN. These reflected rays actually meet at A′. In this case a real, inverted image is formed. It has the same size as the object. It is also formed at the centre of curvature itself.



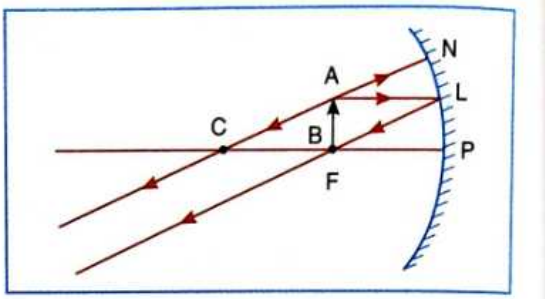
- **When the object is between the centre of curvature and the focus of the mirror**

The two rays used are as shown in the figure. The image formed in this case is a real, inverted and enlarged one. It is formed beyond the centre of curvature.



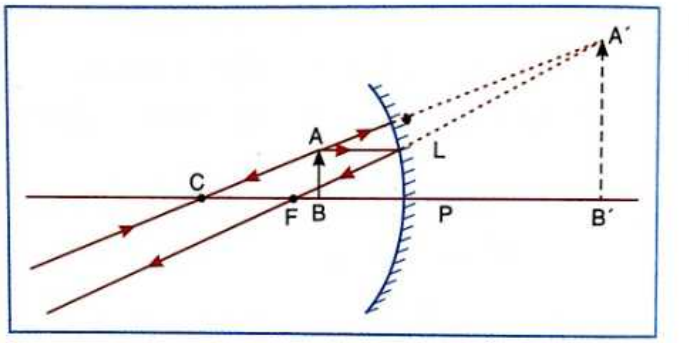
- **When the object is at the focus of the mirror**

The two reflected rays here are parallel to each other. Therefore, they do not meet. We, however, say that they meet at infinity, or at a point very very far away. Thus, in this case, we get a real, inverted and enlarged image formed at infinity.



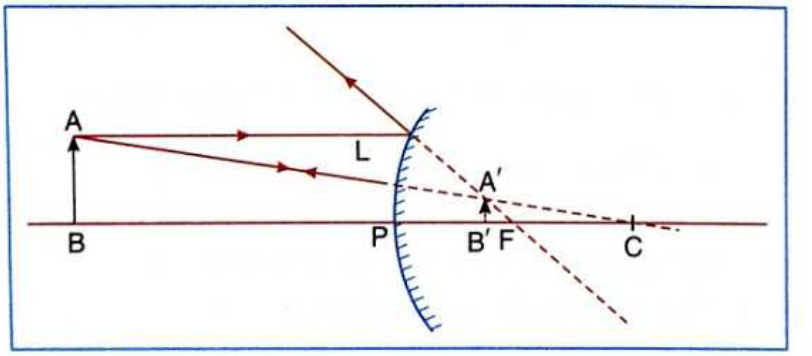
- **When the object is between the focus and the pole of the mirror**

The two reflected rays are seen to move away, or diverge, from each other. They, however, appear to meet at a point A′ behind the mirror. Thus, in this case, we get a virtual, erect and enlarged image that appears to be formed behind the mirror.



Images Formed by a Convex Mirror

The same method can be used to draw ray diagrams for a convex mirror. Here, however, no matter where the object is, we get an image that is always virtual, erect and diminished and is formed between the focus and the pole of the mirror.



We summarise these results, for the two mirrors, in the form of a table.

S.No.	Object distance	Details of Image formed (P = Pole, F = Focus, C = Centre of curvature)	
		Concave Mirror	**Convex Mirror**
1.	Beyond C	Real, inverted, diminished, formed between F and C	Virtual, erect, diminished, formed between P and F
2.	At C	Real, inverted, equal in size, formed at C	— do —
3.	Between C and F	Real, inverted, enlarged and formed beyond C	— do —
4.	At F	Real, inverted, enlarged and formed at infinity	— do —
5.	Between F and P	Virtual, erect, enlarged and formed behind the mirror	— do —

Activity 5

To study image formation by a concave mirror using a lighted candle and a screen.

Take a concave mirror, a small candle (having a suitable plate under it) and a thick sheet of paper. Use moulding clay/stand to hold the mirror and candle in a vertical position. Keep the lighted candle some distance away from the mirror. Put a thick sheet of paper in front/behind the candle and adjust its position till you get a sharp image of the flame on the sheet. Make sure that the screen does not obstruct the light from the candle falling on the mirror. Now move the candle first towards the mirror and then away from the mirror. Is the image real or virtual? Is it smaller/larger compared to the flame itself? Record your observations for different positions in a tabular form. Is it possible to obtain the image on the screen when the candle is too close to the concave mirror? When the candle is too close to the concave mirror, the image, as we know, is virtual, erect and magnified.

What happens when you replace the concave mirror by a convex mirror?

Practical Uses of Mirrors

We often put concave and convex mirrors to a number of practical uses. Concave mirrors are used by ENT doctors as 'head mirrors'. They have this mirror strapped on their head. Light from a lamp is made to fall on the mirror, that, after reflection from it, gets focused on to the throat or ear of the patient. The doctor is then able to examine that part clearly.

Dentists also use concave mirrors to get a magnified image of the teeth. Concave mirrors also serve as reflectors of light in torches.

Convex mirrors serve as good 'rear view' mirrors in motor vehicles. They help the drivers to see the traffic behind them over a wide range of view.

You might have seen eye-specialists using a special instrument called the **ophthalmoscope**. It is fitted with a concave mirror having a small hole near its centre. The concave mirror helps the doctor to direct a beam of light into the patient's eye and see his/her retina clearly through the hole in the mirror.

Rear view miror of a car

Ophthalmoscope

We all know that we need telescopes for viewing distant heavenly objects. Telescopes are made by using either convex lenses or suitably shaped curved mirrors. Of the two, telescopes made by using mirrors are better in several respects. Curved mirrors are, therefore, used in designing large reflector type telescopes.

Reflective telescope

Periscope

People need plane mirrors while dressing up, combing the hair, shaving the beard and so on. As we already know that plane mirrors are used in the 'Kaleidoscope'. Similarly, plane mirrors are also used in designing scientific metres and the periscope. The **periscope** is a simple device that enables us to see 'overhead objects' that are not directly in the range of our sight.

Keywords

angle of incidence	the angle between the incident ray and the normal at the point of incidence.
angle of reflection	the angle between the reflected ray and the normal at the point of incidence.
centre of curvature	the centre of the sphere of which the given (spherical) mirror is a part.
concave mirror	a spherical mirror whose reflecting surface is curved inwards.
convex mirror	a spherical mirror whose reflecting surface is curved outwards.
diffused reflection	reflection that takes place from non-shiny, non-polished or irregular surfaces.
focal length	the distance between the pole and the focus of the mirror.
focus	the point, on the principal axis, where all the rays, incident parallel to the principal axis, actually meet, or appear to meet, after their reflection by the given spherical mirror.
plane mirror	the mirror which has a highly polished plane reflecting surface.
pole	the 'central point' for the given spherical mirror.
principal axis	the line, joining the pole and the centre of curvature, of the spherical mirror.
radius of curvature	the radius of the sphere of which the given mirror is a part.
real image	an image formed by actual intersection of light rays.
regular reflection	reflection of light that takes place from plane, shiny or polished surfaces.
spherical mirror	a mirror whose reflecting surface is a part of a sphere.
virtual image	an image formed by the apparent intersection of light rays.

You Must Know

1. The phenomenon, of change in the direction of light rays, when they 'fall' on a polished surface, is called 'reflection of light'.
2. The two laws of reflection which always govern the reflection of light rays, by any reflecting surface, are as follows:
   (i) The incident ray, the normal at the point of incidence and the reflected ray, all lie in the same plane.
   (ii) The angle of incidence, and the angle of reflection, are equal to each other.
3. The image formed by a plane mirror is an erect, virtual and laterly inverted image. It is of the same size as the object. The image is also at the same distance behind the mirror as the object is in front of it.
4. A spherical mirror is a mirror whose reflecting surface is a part of sphere.
5. A spherical mirror whose inner curved surface is polished and whose reflecting surface is curved outwards is called a convex mirror.
6. A spherical mirror whose outer curved surface is polished and whose reflecting surface is curved inwards is called a concave mirror.
7. A concave mirror usually forms a real and inverted image of a given object. However, when an object is placed very close to a concave mirror, the image formed is a virtual, erect and magnified image.
8. The image, formed by a convex mirror, is always a virtual and erect image. This image is smaller in size than the object.
9. Concave mirrors are used by ENT doctors as 'head mirrors'. They are also used by dentists and are also used as reflectors in torches and in many other optical instruments.
10. Convex mirror is used as a rear view mirror in vehicles. This is because it gives a virtual erect and diminished image of the object and provides a wide range of view to the driver.
11. Plane mirrors are used in scientific meters, periscopes and in toys like the kaleiodoscope. They are also an important part of our daily life.

Something To Know

A. Fill in the blanks.

1. An image, which can be obtained on a screen, is called a _____ image.

2. The angle of reflection _____ the angle of incidence.

3. The incident ray, the _____ at the point of incidence and the reflected ray all lie in the same _____

4. The point, where a concave mirror forms the image of a very distant object, is known as the _____ of the mirror.

5. A spherical mirror, that always forms a virtual, erect and diminished image of an object, is a _____ mirror.

6. Eye specialists use ophthalmoscope, which is fitted with _____ mirror.

B. Write True or False for the following statements.

1. The image, formed by a plane mirror, shows the right side of the object as its right side and the left side of the object as its left side. ☐

2. When we stand between a pair of parallel plane mirrors, we can see an infinite number of images. ☐

3. A concave mirror can never form a virtual image of an object. ☐

4. We can use either a concave mirror, or a convex mirror, as the 'reflector' in torches. ☐

5. Motor vehicles generally use either a plane mirror, or a convex mirror, as their 'rear view' mirror. ☐

C. Tick (✓) the correct option.

1. The angle of incidence equals the angle between the incident ray and the—

   ☐ mirror surface.

   ☐ normal at the point of incidence.

   ☐ reflected ray.

   ☐ line inclined at 60° to the mirror surface.

2. A ray of light, falling normally on a plane mirror, gets reflected in such a way that it—

   ☐ becomes parallel to the mirror surface after reflection.

   ☐ now makes an angle of 30° with the plane mirror.

   ☐ now makes an angle of 60° with the plane mirror.

   ☐ just retraces the path.

3. The central point, of the section of the sphere, used for making a spherical mirror, is known as the—

   ☐ pole of the mirror. ☐ centre of curvature of the mirror.

   ☐ focus of the mirror. ☐ mid point of the mirror.

4. The distance, between the object and its image, in a plane mirror is 6 m. If the object moves 1 m towards the mirror, then the (new) distance between the object and its image will be—

   ☐ 5 m ☐ 6 m

   ☐ 8 m ☐ 4 m

5. The rear view mirror of a car is a plane mirror. A driver is reversing his car at a speed of 4 m/s. The driver sees, in his rear view mirror, the image of a scooter parked behind his car. The speed, at which its image appears to approach the driver, will be—

   ☐ 2 m/s ☐ 4 m/s

   ☐ 8 m/s ☐ 16 m/s

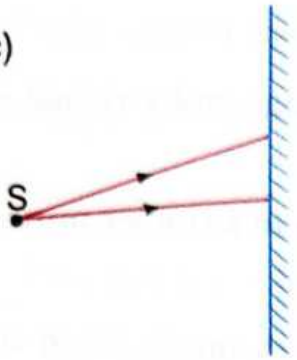
D. Answer the following questions in brief.

1. Explain clearly the difference between a real image and a virtual image. Give one example of a virtual image.
2. How does changing the distance of the object, from a convex mirror, affect the size and nature of the image formed by it?
3. Draw a ray diagram to show the formation of an image when the object is placed between the C and F points of a concave mirror.
4. Where should we keep an object, in front of a concave mirror, so as to get a virtual and magnified image of it?
5. The magnified image, of an object, appears to be formed, behind the mirror, by an apparent intersection of the reflected rays. What can you say about (a) nature of the image (b) the type of mirror used?
6. Rohit suggested to his father to fix a 'security mirror' which would provide them with a wider view of the surrounding of their shop. Name the type of mirror that Rohit must have suggested to his father. Also mention the basic characteristics of the image formed by this type of mirrors.
7. State the type of mirror that the following items/objects would correspond to:
   (a) inside of a stainless steel bowl
   (b) reflector of a torch
   (c) a polished shining wooden surface
   (d) the shiny outer surface of the bicycle bell.

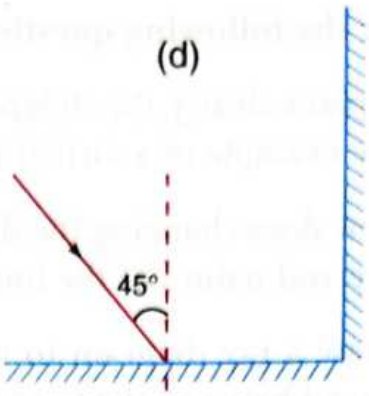
E. Answer the following questions.

1. State the laws of reflection. Describe an activity to show that incident ray, reflected ray and the normal, at the point of incidence, all lie in same plane.
2. Trace the path of reflected ray in the following ray diagrams.

(c)

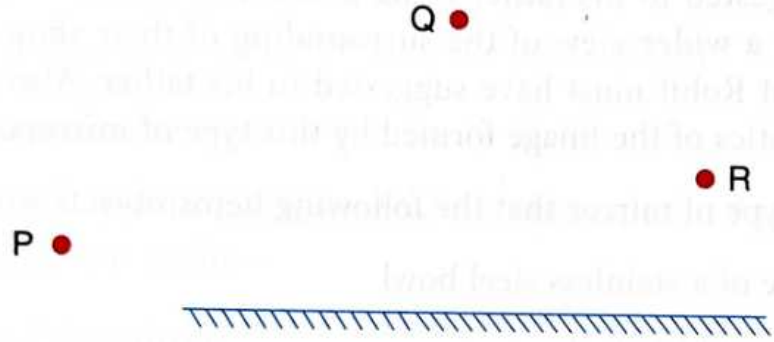


(d)



3. Draw a ray diagram to show the formation of the image of a point object by (i) a plane mirror and (ii) a convex mirror.

4. Three persons are standing at points P, Q and R in front of a plane mirror. Can 'P' see himself in the mirror? Also can he see the image of Q and R in the mirror?



5. With the help of a suitable diagram, explain the meaning of the following terms for a concave mirror.

(a) centre of curvature (b) pole

(c) principal axis (d) focus

6. What type of mirror is used in the following cases? Is the image formed virtual and erect in each case?

(a) 'make up' mirror (b) 'rear view' mirror of vehicles

(c) reflecting type telescope (d) shaving mirror

Value Based Question

It was celebration time for Menons as their son had become a full fledged and registered dentist. The father advised his son to always maintain the same level of empathy, sincerity and dedication towards all his patients irrespective of their financial or social status.

'Yes brother,' said his younger sister. 'You must behave like the spherical mirror that you would often use. It reflects light to any one whosoever is being examined.'

1. List at least two other 'values' you may like to add to the suggestion given by the senior Mr. Menon.

2. Name the type of spherical mirror used by dentists. Draw an appropriate ray diagram in support of your answer.

Something To Do

1. **List those letters of English alphabet, or any other language, known to you, in which the image formed in a plane mirror appears exactly like the letter itself. Discuss your findings.**

2. **You must have seen the laughing gallery (in science centres/parks/fairs) where you can see distorted and funny images in different mirrors. Using your family photographs from an old album, and pieces of different types of mirrors, try to create your own laughing gallery.**

3. **Take three long rectangular plane mirror strips and use them to make a kaleidoscope. Put some pieces of coloured bangles in it and try to draw the images, which you see in it, on a sheet of paper.**

4. **You must have heard the story of the lion and the rabbit, from the *Panchtantra*, in which the rabbit fooled the lion by showing it, its reflection in water. Try to collect some more stories which are related with the phenomenon of reflection of light.**

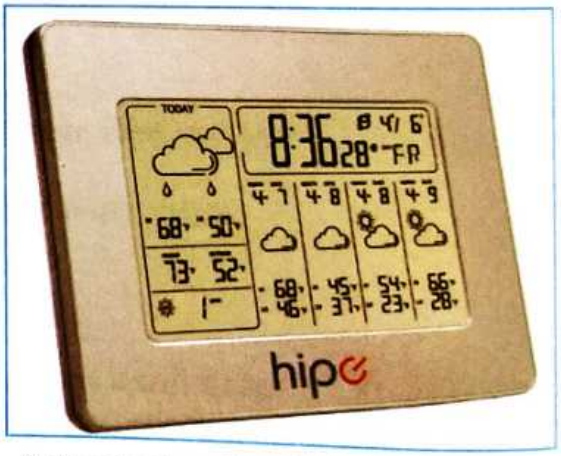
CHAPTER

13 Weather, Climate and Adaptation of Animals

Weather

We always think of weather wherever we may be. Weather is one of the first things we notice after we wake up. If it is cold, we wear a sweater. If it is hot and sunny, we wear light cotton clothes. We may also look at the weather forecast in a newspaper, or on the internet, in case we have to go out for a picnic, or for a 'holiday break'. But what does 'weather' imply? Let us find out.

Weather is the state of the atmosphere, at a particular time and place, in terms of certain well defined 'terms', or 'elements'. These 'elements' are: temperature, humidity, cloudiness, precipitation, wind and atmospheric pressure. These conditions are studied in **meteorology**, the science of understanding weather and weather forecasting.



A sample of weather forecast on internet

Meteorologists (scientists who study weather) record these 'elements' of the weather every

day. Such constant recording of weather information helps in determining the climate of a given region.

The Weather Elements

Let us now try to understand the meaning of the different 'elements' that define the weather at a given place.

Temperature

Temperature is an indicator of the 'degree of hotness or coldness' of the air. Temperature on the earth averages 15°C at sea level but varies according to latitude, elevation, season and time of the day. It can range from a record high of 58°C to a record low of –88°C. Temperature is generally highest in the Tropics and lowest near the Poles. On any given day, it is usually warmest during mid-afternoon and coldest around 'dawn' (just before sunrise).

Humidity

Humidity is a measure of the amount of water vapour in the atmosphere. The most common measure of humidity is the 'relative humidity.' It equals the amount of water vapour, actually present in the atmosphere, divided by the atmosphere's maximum water vapour holding capacity at that temperature.

Cloudiness

Most clouds are produced due to the cooling of air as it rises up. When air temperature gets reduced, the excess water vapour, in the air, condenses into liquid droplets, or ice crystals, to form clouds or fog. Fog refers to clouds that almost touch the ground. In dense fog, the visibility range may be around 50 m or so.

Precipitation

Precipitation is produced when the droplets and crystals in clouds grow large enough to fall on to the ground. Precipitation takes a variety of forms including rain, drizzle, snow, hail, ice pellets, or sleet.

Wind

The horizontal movement of air is referred to as the **wind**. It is named after the direction from which it comes, for example, a wind, coming from the north, is known as a 'northern wind'. In most places, near the ground, the

wind speed usually averages from 8 km/hr to 24 km/hr. However, it can be very much higher during intense storms.

- Atmospheric pressure

It plays a vital role in all weather systems. **Atmospheric pressure** is the force, due to the weight of the air, on a given surface, divided by the area of that surface. Falling pressure usually indicates an approaching storm; rising pressure usually indicates clear skies.

Do You Know?

Manned weather stations are expensive to operate because of the manpower costs. Hence, they are being gradually replaced by Automatic Weather Stations (AWS) in developed countries.

It was in the year 1982 that the Indian Meteorological Department started operating one hundred land-based Data Collection Platforms, now renamed as Automatic Weather Stations (AWS), for collecting meteorological data, from remote and inaccessible places, using India's geostationary satellite INSAT.

Climate

Climate is the average weather in a particular region over a long period of time. The word 'climate' comes from the Greek word '*klima*', referring to the 'inclination of the sun'. Climate is not the same as weather. It is the average pattern of weather for a particular region. A place, that usually does not get much rain over a year, would be said to have a **dry climate**. A place, where it usually stays cold for most of the year, would be said to have a **cold climate**. Climate is useful for weather forecasting. It also helps in determining the best time for the farmers to plant their crops. It is helpful for us to plan a vacation.

Climate is usually described in terms of the familiar elements of the weather. Temperature and precipitation are its two essential indicators. The other important indicators, of the climate, include sunshine, wind, cloud cover, atmospheric pressure and humidity. When these elements are measured systematically, at a given site, over a period of several years, we eventually accumulate a record of observations, from which one can 'construct' an accurate summary of the climate of that region.

Comparing Climates

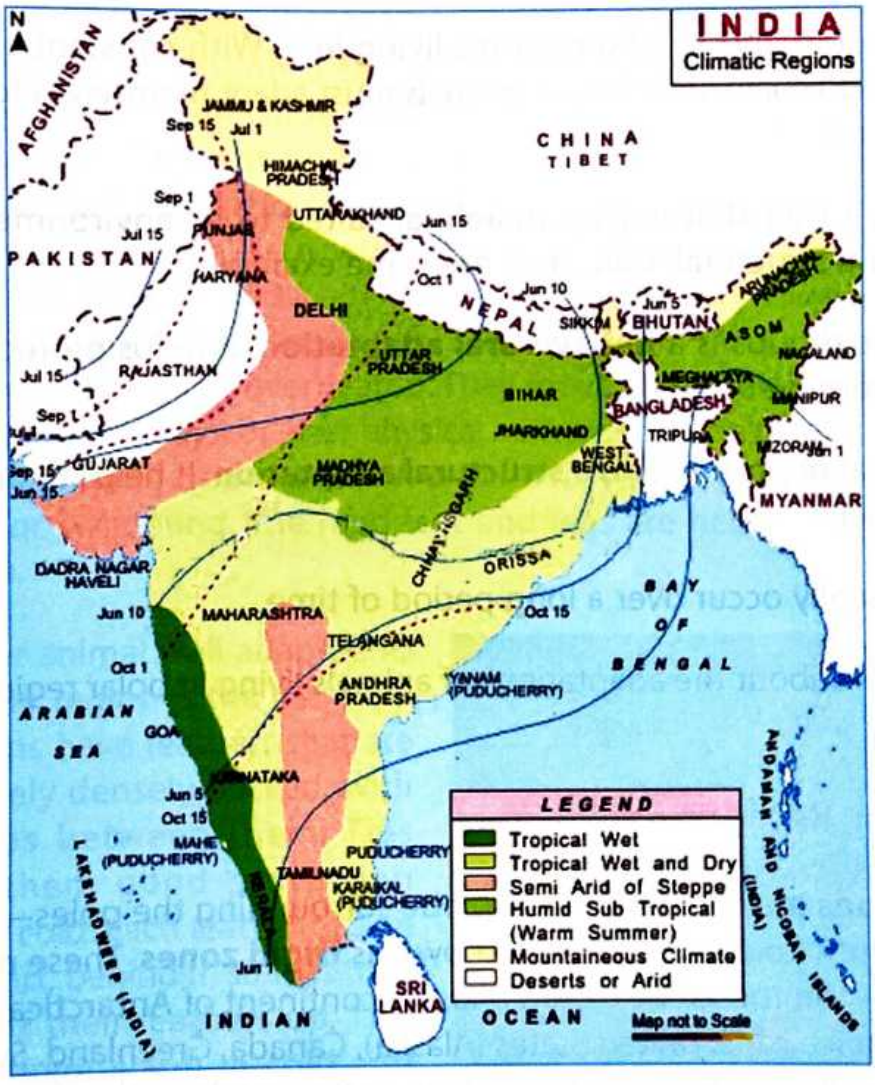
The climate of India can be divided mainly into four climatic zones. These are the Alpine, Sub-tropical, Tropical and Arid zones. Let us now discuss them one by one.

Alpine zone

This climate zone can be experienced at the high altitudes of the Himalayas. In this zone, we have snow throughout the year.

Sub-tropical zone

This zone is prevalent in most of the northern part of India. Here, summers are hot and wet. In winter, the temperature may drop down even close to the freezing point of water in the regions of higher ranges. Rainfall is quite common in summer season whereas winters are usually cold and dry.



Climate map of India

- **Tropical zone**

  It can be divided into two sub types: the Tropical Wet and the Tropical Dry Monsoon zones. In the Tropical Wet Monsoon zone, the average temperature, normally does not fall below 18°C and it is accompanied by average to high rainfall. In Tropical Dry Monsoon zone, the rainfall is not so common.

- **Arid zone**

  High temperature and low rainfall are the two main marked features of this climatic zone. It is prevalent in western part of the country and includes a large part of Rajasthan. The temperature in this zone may shoot up to as high as 50°C in summer.

Climate and Adaptation

Climate of a region affects all organisms living in it. With constant changes in their environment, food chain and climate, animals must adapt themselves to these changes or face extinction.

Adaptation is a trait that makes an animal suited to its environment. It can be a behavioural, or a structural, trait. Here are some examples:

Moving in large groups is a **behavioural adaptation**. It helps protect the members of the group from predators.

The thick fur coat of polar bear is a **structural adaptation**. It helps to protect it against the cold weather.

Adaptations usually occur over a long period of time.

We shall now talk about the adaptations of animals living in polar regions and tropical rain forests.

The Polar Regions

Polar regions are the areas of the globe surrounding the poles—the North Pole and the South Pole. They are also known as **frigid zones**. These regions, resting, respectively, on the Arctic Ocean and the continent of Antarctica are dominated by the polar ice caps. United States (Alaska), Canada, Greenland, Sweden, Finland, Norway and Russia (Siberian region) are some countries that have some of their parts in this region.

These regions are very cold. The coldest temperature, ever known on earth (–89°C) was recorded in Antarctica. The average winter temperature in the Arctic is about –30°C. In winter, the seas surrounding Antarctica freeze into solid snow that covers an area almost as big as the continent itself. At the Poles, the sun shines for half of the year and it is dark for the other half of the year. Polar bear, penguin, reindeer, seal, whale and walrus are some animals found in such regions.

Let us now find out how these animals are able to survive in such regions having such severe and extreme conditions.

- ## Adaptation by animals of the polar reigons

Polar Bears in polar regions

Polar bears have white fur so that they are not easily visible in the snowy white background. The body temperature, of polar bears, which is normally 37°C, is maintained through a thick layer of fur, a tough hide, and an insulating layer of blubber. This excellent insulation keeps a polar bear warm even when air temperatures drop to –37°C. Polar bears are so well insulated that they tend to get overheated. They move slowly, and rest often, to cool down, on warm days, or after physical activity. Polar bear can close its nostrils while swimming under water. A polar bear's front paws propel it through water for swimming. The hind feet and legs are held flat and are used as rudders.

Penguins in polar region

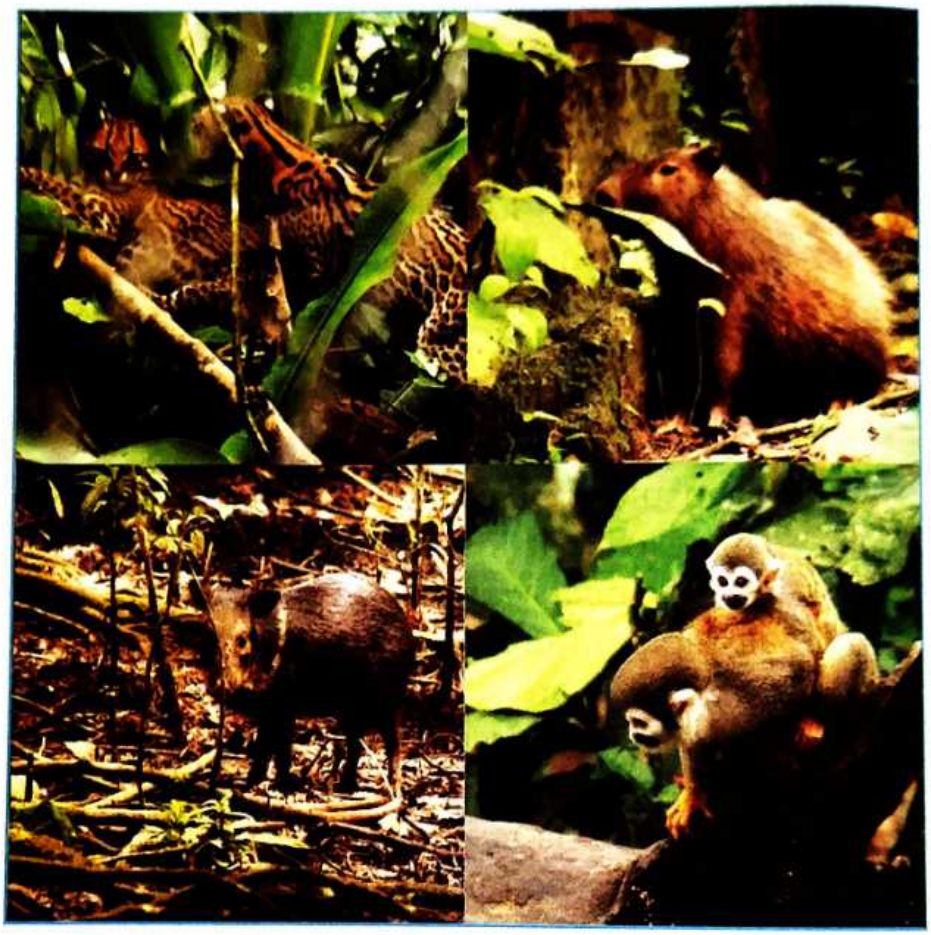
Another animal well adapted to the polar region is the penguin. Penguins have feathers that are extremely densely packed, with no gaps between them. This gives them good protection against cold. Each feather has an extra part, behind it, so that they can fluff their feathers up. This keeps them warm in cold and allows them to cool off when the weather is warm.

Penguins do not have air spaces in their bones as normal birds have. This helps them to sink in water. They have a layer of blubber (fat), beneath their skin, which helps them to stay warm. A streamlined body and paddle-like feet help them to swim under water.

The Tropical Rain Forests

Tropical Rain forests are generally found near the equator. The tropical rain forests are home to more species of plants and animals than all other biomass combined together. Such forests are found in India, Malaysia, Indonesia, Brazil, Republic of Congo, Uganda and Nigeria.

The Amazon jungle is the world's largest tropical rain forest. The forest covers the basin of the Amazon, the world's second longest river. Central Africa holds the world's second largest rain forest.



Rain Forest Animals

Rain forests are characterised by a high rainfall. This often results in poor soils due to leaching of soluble nutrients. Rain forests are home to two-thirds of all the living animal and plant species on the earth. It has been estimated that many hundreds of millions of new species of plants, insects and micro-organisms are still undiscovered and, as yet, unnamed by scientists.

Temperature, in such regions, has an average value of 20-25°C and varies little throughout the year. The average temperatures, of the three warmest, and the three coldest months, do not differ by more than 5°C. Precipitation is evenly distributed throughout the year, with the average annual rainfall usually exceeding 2000 millimetres (mm).

In India, these forests are found in Western Ghats and Assam. These forests are home to animals like monkeys, apes, gorillas, lions, tigers, lizards, elephants, leopards, snakes, birds and insects. Animals, living in these forests, have got adapted to living in areas, ranging from trees to lakes, and even underground.

Adaptation by animals of the tropical rain forests

An animal, that provides a good example of such adaptation, is the red-eyed frog. The long limbs, of these frogs, are better suited for climbing than for swimming. Another feature, of these frogs, is the sucker pads on their feet. These pads allow the frogs to stick to various objects; they also provide better traction on wet leaves and branches.

Red-eyed frog

Monkeys also provide a good example of adaptation. Some monkeys have long prehensile tails for grasping branches. Their long arms, and legs, help them to swing from one branch to another; their fingers, and toes, act like hooks and help them to hold on to the branches.

Monkey with prehensile tail

The lion-tailed macaque is a medium-sized monkey with shiny black fur and long greyish-white hair around its face. It gets its name from its long tail, which has a tassel at the end quite like that of a lion. These monkeys use 17 different vocal patterns to communicate. These monkeys have cheek pouches that open beside the lower teeth and extend down the side of the neck. When fully extended, these pouches can store an amount of food that is equivalent to their stomach's capacity. They gather food quickly

Lion-tailed Macaque

with their hands and promptly stuff it in their pouches. When their pouches are full, they retreat to the safety of the forest's upper canopy and eat leisurely.

Toco Toucan

The large beak of the Toco Toucan is perfect for picking the fruit. It has a 20 cm long beak which looks beautiful and is deep orange in colour. It sports a large black spot near the tip. It uses this beak to skin the fruit it eats as well as to scoop up water.

The big cats, like lion, tiger and leopards, are the predators that rule the tropical rain forests. They have flexible bodies designed for running, jumping and climbing. Their intestines are short as they only digest meat and not the vegetable matter. Their sharp teeth are scissors-like to tear into the flesh. Most big cats hunt at night; in dark, they can see six times better than human beings. They have a larger field of vision, but cannot see colours as human beings can.

An Elephant

The elephant has adapted to the conditions of the tropical rain forests in a remarkable way. Its nose, and upper lip, are fused to form a long trunk that has about 150,000 muscles. The versatile trunk acts like a hand, for grasping low-growing shrubs and other food materials, and placing them into the mouth. This trunk also acts like an arm for breaking off tree branches, and as a snorkel (tube projecting above water), for breathing, when the elephant's body is submerged. Elephants also use their trunks to suck and drink water or to squirt it over their bodies for bathing. Nostrils, at the trunk's tip, enable elephants to detect odours. Though their eyesight is poor, elephants can smell water at great distances and can hear certain sounds from distances more than 1.5 km.

Do You Know ?

The tusks of elephants are the largest, and the heaviest, teeth of any living animal.

Activity 1

Take an outline map of the world. Mark the polar regions in red. Similarly mark the tropical regions in blue.

Activity 2

Read the given list of animals and climatic conditions and place them in the relevant columns.

Animals: leopard, long-tailed macaque, polar bear, penguin, walrus, apes, red-eyed frog.

Climatic conditions: winter temperature is about –30°C, sun shines for six months, average temperature is around 20–25°C.

Polar Regions	Tropical Rain Forests
Animals _____ _____	Animals _____ _____
Climatic conditions _____ _____	Climatic conditions _____ _____

Keywords

adaptation	special features that help an organisms to survive in its environment.
atmospheric pressure	pressure exerted by the earth's atmosphere at any given point.
climate	average weather pattern in a region over a long period of time.

humidity	a measure of the amount of water vapour or moisture in the air.
meteorology	study and forecasting of weather.
polar regions	areas surrounding the poles of earth.
tropical rainforest	dense forest near the equator and the tropical region.
weather	day to day atmospheric conditions.

You Must Know

1. The day to day condition of the atmosphere at a place, with respect to certain well defined 'elements', specifies the weather at that place.
2. The (main) 'elements', used for describing weather, are temperature, humidity, cloudiness, precipitation, wind and atmospheric pressure.
3. The average weather pattern, taken over a long time, specifies the climate of that place.
4. The climate of India can be divided mainly into four climatic zones—Alpine, Sub-tropical, Tropical and Arid.
5. Adaptation is a trait that makes an animal suited to its environment.
6. The polar regions are very cold throughout the year. The sun does not set here for six months in a year and does not rise during the other six months.
7. Polar bear, living in polar regions, have adapted, to their extremely cold climate, by having white fur, a layer of fat under their skin, and wide and large paws for swimming and walking.
8. Some adaptations of animals, living in tropical rainforests, include living in areas ranging from trees to lakes, (and even underground), development of strong tails, large beaks, sharp eye sight and so on.

Something To Know

A. Fill in the blanks.

1. A common measure of humidity, used very often, is known as _____
2. _____, _____, _____ and _____ are different forms of precipitation.
3. _____ are formed when water vapour, in air, condenses to liquid droplets or ice crystals.
4. The average weather of a place, taken over a period of 20–25 years, will specify its _____.
5. Rajasthan falls in the _____ climatic zone.
6. Penguins are different from other birds as they do not have _____

B. Match the following:

1.	Humidity	(a)	Prehensile tail
2.	Sub-tropical	(b)	Equator
3.	Tropical Rain Forest	(c)	Hot and wet summer
4.	Red-eyed Frog	(d)	Water vapour
5.	Monkey	(e)	Sucker pads

C. Tick (✓) the correct option.

1. Which of the following is not an element used for describing weather?

☐ wind ☐ temperature

☐ humidity ☐ mountain

2. An organism, with fur on its body, and a layer of fat (blubber) under the skin, is likely to be found in the—

☐ tropical rain forests ☐ desert regions

☐ sub-tropical regions ☐ polar regions

3. Which features best describe a tropical region?

- ☐ hot and humid
- ☐ moderate temperature, heavy rainfall
- ☐ cold and humid
- ☐ hot and dry

4. An animal, generally found in the tropical rain forests is the—

- ☐ penguin
- ☐ reindeer
- ☐ lion-tailed macaque
- ☐ polar bear

5. Lion-tailed Macaque gets its name from—

- ☐ its 'roar' like a lion
- ☐ the colour of its fur
- ☐ the tassel at the end of its tail
- ☐ its eating habits

D. Answer the following questions in brief.

1. List the main elements that determine the weather of a place.
2. When are the maximum and minimum temperatures likely to occur during the day?
3. How can forecast, about a 'clear sky', or an 'approaching storm' be made by measuring the atmospheric pressure of a given region?
4. Name the major climatic zones of India. Also mention the names of two states each, that fall in these zones.
5. Mention two adaptive features of a penguin that help it in swimming.
6. State the function of sucker pads on the feet of the red-eyed frogs.

E. Answer the following questions.

1. Differentiate between:
   (a) Weather and climate
   (b) Climate in polar regions and in tropical rain forests.

2. What is adaptation? Give one example each of behavioural and structural adaptations.

3. Mention any four adaptations that have helped the polar bear to survive in the Polar Region.

4. Give reasons.

   (a) Big cats have sharp teeth.

   (b) Some monkeys have long prehensile tails.

   (c) Penguins do not have air spaces in their bones.

5. 'The tropical rainforest has a large population of animals.' Explain why it is so?

6. How is the trunk useful to the elephant?

Value Based Question

Neha had to change her school several times because of the transfer of her parents. However, being a multi-talented and friendly girl, having a positive attitude, she was always able to adjust, and adapt, herself to her new surroundings and environment. Her mother would often say that Neha's adaptative nature was similar to the adaptation shown by animals as per their environment.

1. State any two values that, you think, Neha must have always upheld.

2. Give two examples to show the ability of animals to adapt themselves to their environment and surroundings.

Something To Do

1. **Make your own 'Weather Scrap Book'.**

   Collect cuttings from newspapers and magazines relating to the weather. You could use information, such as weather charts to show that the weather changes over several days or weeks. How many different symbols are used on weather charts? Can you invent your own symbols?

   You could also find other weather-related stories in newspaper, for example, about recent storms or natural disasters. What meteorological events do the articles mention? Do some particular areas of the world seem to be more affected by bad weather than others? Which areas are they and can you think why this might be so?

2. We can measure changes in air pressure by making a barometer using a few simple pieces of equipment.

You will need:

- a jam jar or a straight-sided glass
- a long-necked bottle
- water mixed with food colouring
- a marker pen

Place the bottle upside down in the jar so that it is resting on the rim. The top of the bottle should be just above the bottom of the jar.

Remove the bottle and pour some coloured water into the jar. You should use enough water so that it just covers the neck of the bottle when it is in place.

On the side of the jar, use the marker pen to mark the current level of the water in the bottle. Put your barometer in a place where the temperature is fairly constant.

Mark any changes in the water level, over the next few weeks, on the side of the jar.

- When the water is high in the bottle, air pressure is high and the weather should stay fine.
- When the water is low in the bottle, air pressure is low and it is likely to be stormy.

CHAPTER

14 Fabric from Fibre

In the previous class, we learnt about the role and importance of clothes in our daily life. They not only protect us from heat and cold but also make us look nice and decent.

We have also learnt that clothes are made from different kinds of fibres. These fibres are obtained from plants as well as animals. We also use synthetic fibres that are man-made and are manufactured in factories.

Activity 1

Write down the names of some fibres obtained from (i) plants (ii) animals. Also, try to get their samples.

Fibres obtained from plants	Fibres obtained from animals

Animal Fibres

Let us now learn about some animal fibres that we often use. Wool and silk are two well known animal fibres.

Wool

Wool is obtained from the body coat of some animals that have fine, soft hair close to their skin. This body coat of fine, soft hair is called **fleece**. We get the fleece of animals, like sheep, goat, camel and yak, for making wool fibres and woollen clothes.

Animals with fleece

Although wool is obtained from the fleece of many animals, sheep wool is most commonly available wool. We also often hear names of other varieties of wool like angora, pashmina, shahtoosh, etc.

Do You Know?

In India, the breeding of sheep for wool is done mainly in the states of Himachal Pradesh, Punjab, Jammu and Kashmir, Rajasthan, Haryana and Gujarat. These sheep are fed on grass, leaves, pulses, corn and oil cakes. When a thick coat of hair, or fleece, develops on their skin, it is shaved-off, or sheared, to get wool.

How do woollen clothes protect us from cold in winter?

It is because wool traps air. Since air is a poor conductor of heat, it does not allow our body heat to escape. This keeps our body warm during winters.

Making wool from fleece

Let us now learn about the details of the process of changing fleece into wool. This involves the following steps:

1. **Shearing:** The fleece of sheep, along with a very thin layer of dead skin, is removed from the body.

Shearing of a sheep

2. **Scouring:** The sheared fleece contains dirt and grease. It is cleaned by washing with detergent in hot water in large tanks. Suitable machines are also used for this purpose. This process is called **scouring**.

Scouring

For the Teacher

Please explain to the students that shearing does not hurt or cause pain to the sheep. It is because it is only the uppermost thin, dead layer of their skin that is 'touched' during shearing.

3. **Sorting:** The process of separating hair of different textures from the fleece is called **sorting**. The sorted fibres are scoured again and then dried.

Do You Know ?

Sorting is a hazardous job because the person involved may get infected by a bacterium called anthrax, which can cause a fatal disease called **sorter's disease**.

4. **Dyeing:** The natural hair of sheep is white, brown or black. The raw fibres are, therefore, dyed in different colours.

5. **Spinning:** The raw and dyed fibres are then twisted together to make threads called **yarn**.

The yarn threads may be long or short in size. The longer threads are usually knitted to make sweaters, mufflers, caps, gloves, socks, etc. The shorter threads are woven to make woollen fabrics which are used for making coats, trousers, jackets and shawls.

Woollen clothes

Silk

Silk is obtained from silkworms which feed on the leaves of mulberry plant. The rearing of silkworms, for obtaining silk, is known as **sericulture**.

Different varieties of silk are obtained from different types of silkworms.

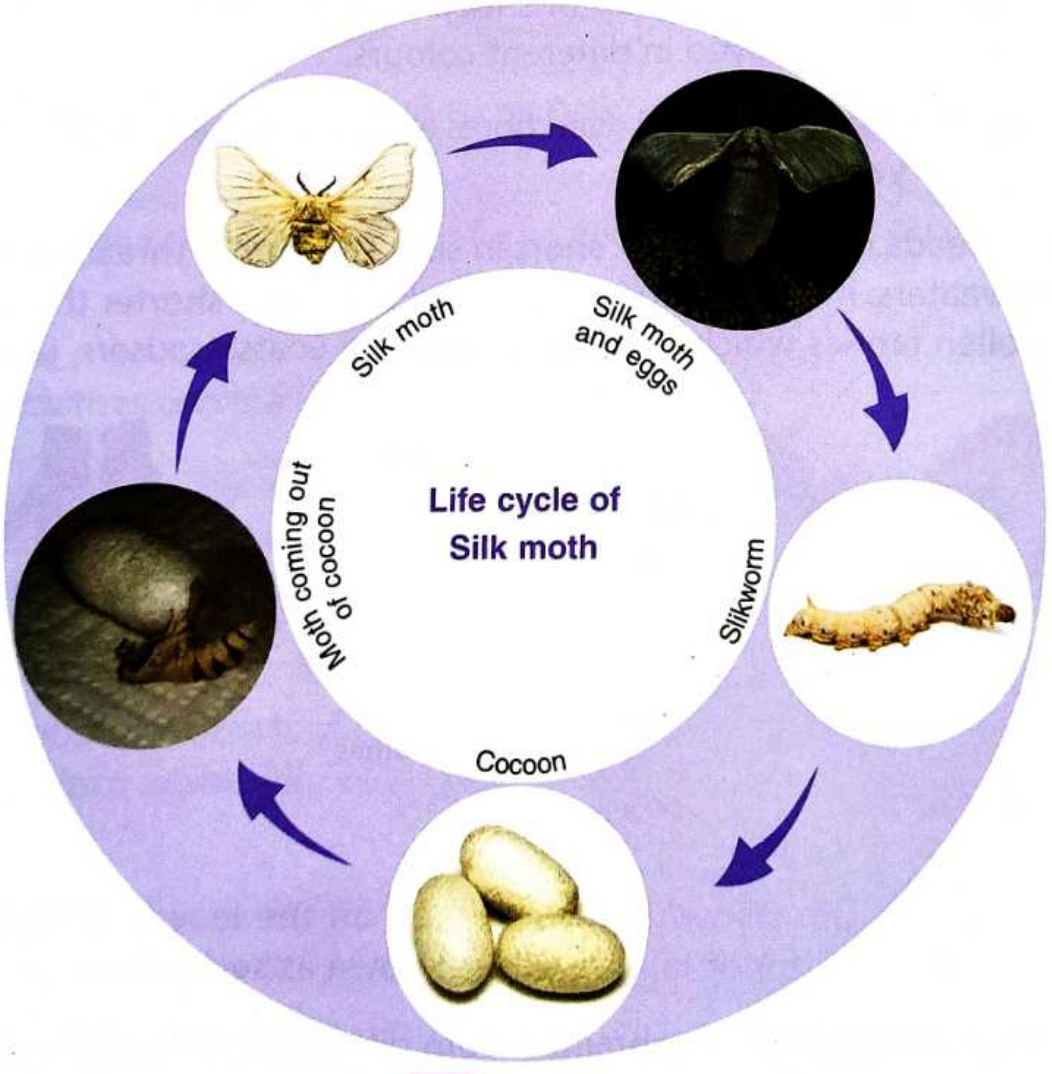
Activity 1

Find out the names of different varieties of silk. Try to collect their samples. Also try to compare properties, like shine, smoothness, strength, etc., of the samples collected by you.

Let us now learn about the process of obtaining silk from silk moth.

- ### Obtaining silk from silk moth

1. **Rearing of silkworms:** Silk moth is a large, white insect. A female silk moth lays hundred of eggs which are stored at a suitable temperature. These eggs hatch to produce larvae which are called **caterpillars** or **silkworms**. These larvae are kept in clean boxes where they feed on fresh mulberry leaves for 25–30 days and grow in size. The caterpillar then secretes a liquid. This liquid hardens on coming in contact with air and changes into a fine thread which is made up of a protein. The caterpillar covers itself completely with these fine fibres. This covering is called as **cocoon**. The silkworm develops into a silk moth inside the cocoon.



2. **Reeling:** The cocoons are collected and exposed to steam. The silk fibres then separate out from cocoons. This process is called **reeling**.
3. **Dyeing:** The silk fibres are then dyed in different colours.
4. **Spinning and Weaving:** The silk fibres are then spun into threads which are woven into silk cloth.

Silk clothes

China ranks first in the world in silk production. India is also a leading producer of wide varieties of silk.

Keywords

cocoon	the covering of fine silk fibres around the caterpillar.
fleece	body coat of fine, soft hair of animals like sheep and goats.
reeling	the process of taking out silk threads from the cocoons.
scouring	washing the sheared wool in hot water and detergent, followed by drying.
sericulture	the process of rearing of silkworms for obtaining silk.
shearing	the process of removal of the fleece from the animal.
sorting	the process of separating hair of different textures from the fleece.

You Must Know

1. Wool and silk are two well known animal fibres.
2. Animals, like sheep and goats, have fine, soft hair close to their skin. This is called fleece. Wool is obtained from the fleece of such animals.
3. The process of changing fleece into wool involves the following steps, in sequence– Shearing, Scouring, Sorting, Dyeing and Spinning.
4. The long yarn threads are usually knitted to make sweaters, mufflers, caps and socks. The shorter threads are woven into fabrics.
5. The rearing of silkworms, for obtaining silk, is known as sericulture.
6. Silk is obtained from silkworms which feed on the leaves of mulberry plants.
7. The process of obtaining silk, from silk moth involves—rearing of silkworms, reeling and dyeing. This is followed by spinning and weaving.

Something To Know

A. Fill in the blanks.

1. The hairy body coat of sheep and goat is called _____.
2. Shaving off the body coat of sheep is called _____.
3. Cleaning of fleece to remove dirt and grease is called _____.
4. The process of separating hair, of different textures, from the fleece, is called _____.
5. The rearing of silkworms to obtain silk is called _____.
6. _____ is the process of separating silk fibres from cocoons.
7. The silk thread is made up of _____.

B. Write True or False for the following statements.

1. Synthetic fibres are manufactured in factories. ☐
2. Air is a good conductor of heat. ☐
3. Scouring is the process of removal of fleece of sheep. ☐
4. The process, of twisting of raw and dyed fibre, is known as sorting. ☐
5. Silkworms feed on mulberry leaves. ☐
6. The larvae secrete very fine filaments made of protein. ☐
7. Reeling is the process of getting silk fibres from cocoons. ☐

C. Tick (✓) the correct option.

1. The process, of removing fleece along with a very thin layer of dead skin of sheep, is called—

☐ shearing ☐ scouring

☐ spinning ☐ sorting

2. Which of the following animals does not yield wool?

☐ sheep ☐ yak

☐ camel ☐ buffaloe

3. The caterpillars of silkworms feed on—

☐ rose leaves ☐ teak leaves

☐ mulberry leaves ☐ grass

4. The egg of a silk moth hatches into a—

☐ caterpillar ☐ cocoon

☐ pupa ☐ larva

5. The process of taking out silk threads from the cocoon is called—

☐ reeling ☐ rearing

☐ sorting ☐ scouring

D. Answer the following questions in brief.

1. Name three animals whose fleece is used for making woollen fibres.
2. Name three common varieties of wool.
3. Give the meaning of the term: 'sorting'.
4. Define the term: 'sericulture'.
5. How is silk fibre obtained from cocoon?
6. Name two countries in which silk is produced on a large scale.

E. Answer the following questions.

1. How do woollen clothes keep us warm in winter?
2. Describe the purpose of 'scouring' in the production of wool?
3. State the practical uses of the (a) long (b) short yarn threads, obtained during the making of wool.

4. Write a short note on 'rearing of silkworms'.

5. Describe the different stages in the life cycle of a silk moth.

Value Based Question

The villagers of Uttkarsh village were very happy when they learnt that their senior citizen, Madam Sevika, was to be honoured by the state government. At the award ceremony, the *sarpanch* of the village, told the gathering how Madam Sevika had devoted all her life to improve the education, health, sanitation and other basic facilities in the village. He went on to compare her village-centered life with that of a silk caterpillar that develops inside the cocoon and helps one and all in getting good quality silk.

1. List three values that Madam Sevika must have 'held' throughout her life in Uttkarsh village.

2. State the role of the silkworms in the production of silk.

Something To Do

1. **Find out for yourself:**

   (a) the names of different breeds of sheep found in India and the places where they are found.

   (b) the names of different breeds of wool-yielding animals found in different countries.

   (c) about the hazards of working in wool and silk industry.

2. **Find out the names of different varieties of silk made in India. Also find the names of traditional silk *sarees* woven in different parts of our country.**

   Mark these places, along with the name of silk *saree*, on a political map of India.

CHAPTER

15 | Forests

The green lungs of nature
That purify the atmosphere
Forests are our lifeline
It is through them that nature shines

A **forest** is an area with a high density of trees. The trees, which make up the main area of the forest, create a special environment. This, in turn, affects the kinds of animals and plants that can exist in a forest.

Human beings began life on earth as forest dwellers. In the early stages, they were food gatherers and depended on the forest for all their needs: food, clothing and shelter. They gradually became food growers, clearing small patches in forests, to grow their food. However, they continued to depend on forests for their requirements of daily life. Even today, people depend on the forest for paper, timber, fuel wood, medicine and fodder.

Over the years, the area under forest cover has decreased steadily. This is because forests have been cleared for agriculture, industry, housing and many other

developmental activities. These include the construction of roads, railways and hydroelectric plants, among others.

Do You Know?

The largest area of rain forest is in South America. It is called the **Amazon rain forest**. Over 3,000 kinds of trees grow in this rain forest. Many kinds of flowers also grow here. The Amazon rain forest is very important for all of us. Some people call the Amazon Rain forest the "lungs of the world." The very many trees and other plants here give off lots and lots of oxygen. People and animals, all need oxygen to breathe. The Amazon rain forest 'breathes out' more than 20 per cent of the world's oxygen supply.

Components of a Forest

A forest consists of many components. These can be broadly divided into two categories—the **biotic (living)** components and the **abiotic (non-living)** components. The living parts of a forest include trees, shrubs, vines, grasses and other herbaceous (non-woody) plants, mosses, algae, fungi, insects, mammals, birds, reptiles, amphibians and many micro-organisms, which live on the plants and animals as well as in the soil. The non-living components of the forest include the soil, water and minerals. The different living and non-living parts of the forest interact with one another.

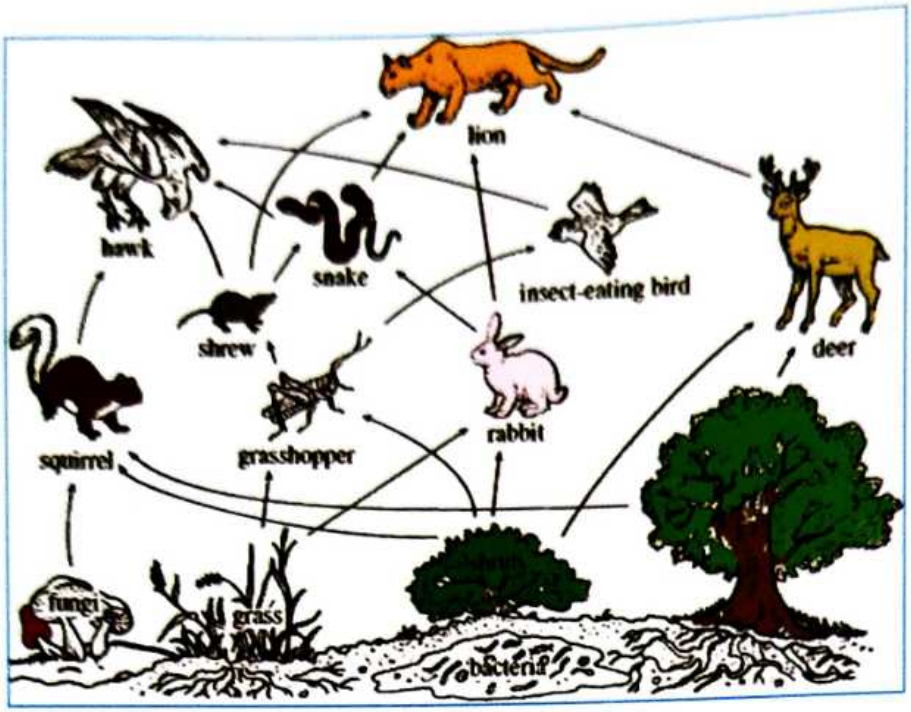
Life in a Forest

You already know that living organisms can be classified as autotrophs, heterotrophs and saprotrophs. All animals, whether herbivores, carnivores or omnivores, ultimately depend on plants for food. The herbivores consume plants and are, in turn, eaten by the carnivores. Such a sequence of 'who eats whom' makes up a **food chain**. For example, a rabbit, that eats grass, may itself be eaten by a snake.

Grass Rabbit Snake

Many such food chains can be found in a forest. They are interlinked in nature and hence, form **food webs**. If any component, from this link, is removed, the rest of the chain gets affected. For example, if the plants are removed, the herbivores, like rabbits,

will die and there will be scarcity of food for the carnivores, like snake and lion. If the decomposers, like bacteria, are removed, the nutrients will not be recycled and soil would become deficient in nutrients and would not be able to support plant life.



Food web in a forest

A forest is able to function as an independent unit. This is so because there is no direct addition of fertilisers and seeds; or food and water, for animals. How is this possible? Within a forest, materials move in a continuous nutrient cycle, along a food chain, and through a food web that goes from plants to plant eaters, (herbivores), then to meat eaters (carnivores), and then to decomposers and again, back to plants. The term 'food web' is a better description for a forest than a food chain. This is because a single plant, or animal, may have links to many others. For example, those animals that eat both plants and other animals (omnivores), can have links with many plants and a variety of other meat eating animals (carnivores).

Decomposers, such as bacteria, fungi, and some worms, are especially important members of food chains and food webs, in the forest habitats. Their role is to break down the rough, woody fibres of trees, thus, enabling the nutrient cycle to begin all over again.

Do You Know ?

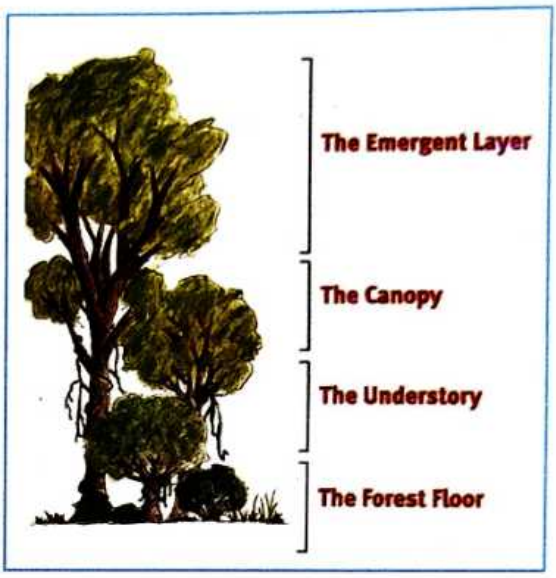
Mangrove are short dense trees that tolerate and adapt themselves well to both saline and fresh water and grow in coastal areas. The Gangetic Sunderbans in West Bengal is the largest mangrove area in India.

The Layers of the Forest

A forest is made up of many layers. Starting from the ground level, and moving up, the main layers of all types of forests are: the forest floor, the understory and the canopy. In tropical rain forests, there exists another layer, known as the emergent layer. Each layer has a different set of plants and animals, depending upon the availability of sunlight, moisture and food. Let us discuss them one by one.

Forest Floor Layer

This layer is made up of decomposing leaves, animal droppings, dead trees and animals. All of these decay on the forest floor and form the new soil that provides nutrients to the plants. The forest floor supports ferns, grasses, mushrooms and tree seedlings.



Layers of a forest

Understory Layer

The understory is made up of bushes, shrubs and young trees that are adapted to living in the shade of the canopy.

Canopy

The canopy is formed by the mass of intertwined branches, twigs and leaves of the tall, mature trees. The crowns of the dominant trees receive most of the sunlight. This is the most productive part of the trees where maximum food is produced. The canopy forms a shady, protective "umbrella" over the rest of the forest.

Emergent Layer

The emergent layer exists in tropical rain forests. It is composed of a few scattered trees that tower over the canopy.

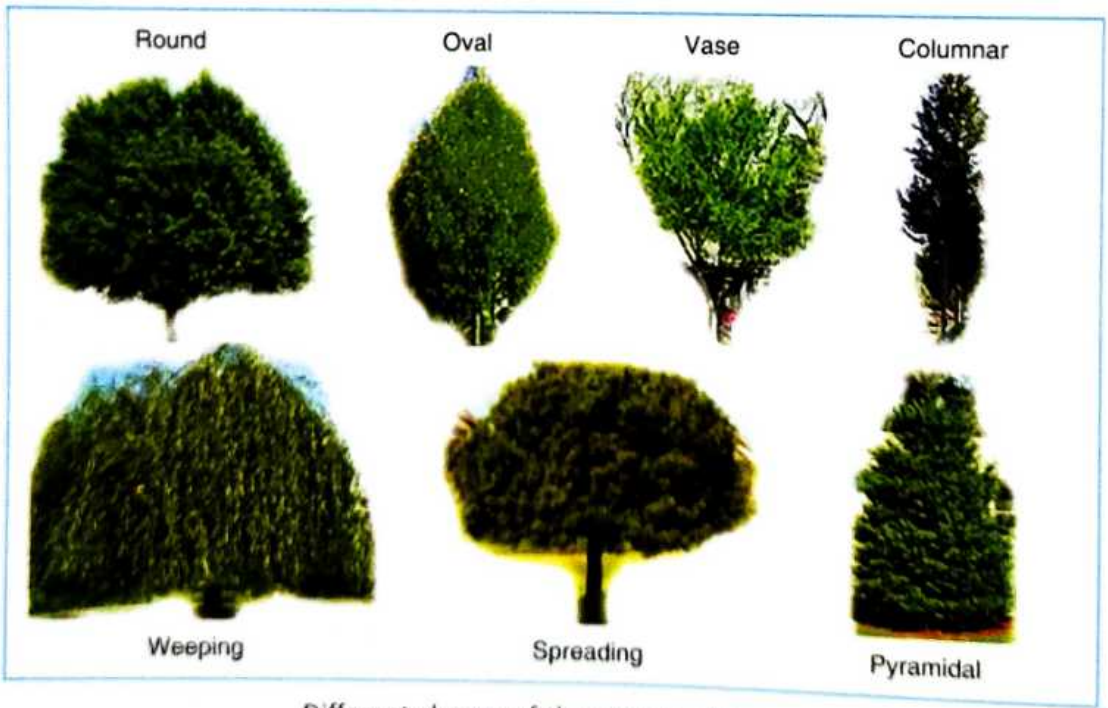
Do You Know ?

The Constitution of India has given due recognition to forest and wildlife, and the tribal communities dependent on forest in the form of some Fundamental Duties. One such duty is to protect and improve the natural environment including forests, lakes, rivers and wildlife, and to have compassion for living creatures.

Crown of Trees

The crown of woody plants (trees, shrubs) includes branches, twigs and leaves extending from the trunk, or the main stems.

The shape of the crowns of trees has a lot to do with where it is located. If a tree is located nearer to the equator, the noon-time sun is almost directly overhead all the year round. Tall trees, with flat treetops (or crowns), are very common in this part of the world because the flat shape helps expose more of their leaves to the direct, overhead sunlight.



Different shapes of the crowns of trees

Up near the Arctic circle, the sun is never directly overhead and is usually quite low in the sky. Trees, in this part of the world, tend to be cone-shaped (like the pine trees). This helps their leaves, from the top of the tree to its bottom, to make the most of the available sunlight.

Finally, many of the trees, (like spruce, pines, and fir trees) near the Arctic circle have leaves modified to form needles. This is partly because needles are especially adapted to cold, dry climates and the leaf needles tend to retain water better than broad-leafed trees, like oaks and maples.

Importance of Forests

Forests play a vital role in the social, cultural, historical, economic and industrial development of any country. They are very important for maintaining the ecological balance. The Hindi proverb

Vano ke hain teen upkar
mitti, pani aur bayar

beautifully brings out the varied utility of forests.

- Forests are the habitat for the living organisms and are a storehouse of biodiversity.
- Practices, such as agriculture and animal husbandry, are dependent on forests and forest lands.
- Forests maintain, and improve, the moisture content of the atmosphere. This helps in determining the rainfall in an area.
- Forests provide clean air as they are the reservoirs of life giving oxygen. They help to maintain the oxygen–carbon dioxide ratio in the atmosphere. They are, therefore, rightly known as the **lungs of the earth**.
- Forests produce humus and maintain soil fertility.
- Forests are the natural absorbers of rain water. Because of the thick humus layer, loose soil and the soil-retaining powers of tree-roots, forests are important for maintaining and regulating water flow to the lower layers of soil.
- Forests also reduce the speed of strong winds and trap dust and gases.
- A wide variety of food-giving plants and livestock occur in the forests and grasslands.
- Forests are the most important sources of timber and raw material for paper industries.

- The non-timber forest products include gums, resins, fruits, nuts, oils, dyes and medicinal plants. They are all important, and useful, for us in a variety of ways.

Do You Know ?

Following the uproar caused by the news that the national animal had disappeared from one of the Tiger Reserves, namely Sariska in Rajasthan, the Chairman of the National Board for Wildlife and the then Prime Minister of India, Dr. Manmohan Singh, set up a Task Force. This task force had to assess the situation vis-à-vis Project Tiger and to submit a time-bound report. Sariska was a crisis waiting to happen, and it is bound to recur elsewhere, if matters are not rectified. It also brought into limelight the prevalent situation with regard to wildlife conservation in the country. However, things have taken a turn for the better. Tigers, from Ranthambhor, are being released in Sariska to repopulate this reserve laid barren by the poachers.

Deforestation and Other Problems Related to Forests

Deforestation is the indiscriminate cutting, or over-harvesting, of trees for timber or paper, or to clear the land for agriculture, ranching, construction or other human activities.

Indiscriminate cutting of trees

Forests are being lost due to an increase in deforestation and encroachment. The forest productivity has declined due to overuse. For example, grazing of cattle in forest areas is increasing and this is adversely affecting the fertility of the soil and also causing soil erosion.

Consequences of Deforestation

- The carbon cycle

  Forests act as a major 'carbon store'. Carbon dioxide (CO_2) gas is taken up from the atmosphere by trees and plants, and used for photosynthesis. When forests are cleared, and the trees are either burnt or allowed to rot, carbon gets released in the form of CO_2 gas. This leads to an increase in the atmospheric CO_2 concentration. Carbon dioxide gas is a major contributor to the greenhouse effect.

- The water cycle

  Trees draw ground water up through their roots and release it, into the atmosphere, through transpiration. In Amazon, over half of all the water circulating through the region's ecosystem, remains within the plants. With removal of a part of the forest, the region cannot hold as much water. The effects of this could be a drier climate.

- Soil erosion

  With the loss of a protective cover of vegetation, more soil gets lost.

- Silting of water courses, lakes and dams

  This occurs as a result of soil erosion.

- Extinction of species

  The existence of animals and plants depends on the forests. Forests contain more than half of all the living species on our planet. If the habitat of these species is destroyed, the number of species would also decline.

- Desertification

  The causes of desertification are complex, but deforestation is one of the contributing factors.

Do You Know ?

Conservation of wildlife

The first national park, in India, now famous as the Corbett National Park was so declared in 1935. Since Independence, there has been a steady rise in the number of Protected Areas (PAs) (National Parks and Wildlife Sanctuaries), especially after the enactment of the Wildlife Protection Act in 1972. In 1988, there were 54 national parks and 372 sanctuaries covering a total area of 109,652 sq. km. By the year 2000, this number had increased to 566, covering 1,53,000 sq. km, or 4.66% of India's geographical area. There are currently about 597 national parks and sanctuaries in India, covering 1,54,572 sq. km, or 4.74%, of the country's geographical area. The latest review, of the Wildlife Protected Area Network document, brought out by the Wildlife Institute of India, Dehradun, recommends to bring the total area, under the Protected Area network, to 1,88,764 sq. km, or 5.74%, of the country's geographical area. This would translate into 163 national parks covering 54,789 sq. km (or 1.67%), and 707 sanctuaries, covering 1,33,975 sq. km (or 4.07%) of the geographical area of the country.

Some Common Trees in India

The national tree of India is the **banyan**. This huge tree towers over its neighbours and has the widest reaching roots of all known trees, easily covering several acres. It sends off new shoots from its branches to form roots, so that one tree is really a tangle of branches, roots and trunks. The banyan tree regenerates, and lives, for an incredible length of time. It is, therefore, thought of as an immortal tree.

Banyan tree

Teak is one of the most popular trees of India. It is mainly used in the making of furniture and doors. Teak also has medicinal value. The bark is a bitter, health giving tonic and is considered useful in fever.

Neem tree is popularly known as the **Miracle Tree**. It is a useful tree in rehabilitating the waste land areas. Even today, the neem tree is the 'focal point' of village life; the village council meetings are often held under the shade of this huge tree. It also has good medicinal value.

Eucalyptus is a tall evergreen tree. There are more than 700 species of Eucalyptus all over the world. Eucalyptus is mainly used as the pulpwood in the manufacture of the paper.

Teak

Neem

Eucalyptus

Deodar, or Himalayan Cedar, is a species of cedar native to the western Himalayan, north-east and north-central India (Himachal Pradesh and Uttrakhand). It is a large evergreen coniferous tree reaching heights of 40-50 m and sometimes, even up to 60 m. The trunk diameter can be up to 3 m. It has a conic crown with level branches and drooping branchlets.

Deodar

Sal

Amaltas

Sal is a large sub-deciduous tree. It is worshipped by the Buddhists and the Hindus in India. It is mentioned in many scriptures that Buddha was born and died under a Sal tree. It is found in almost all parts of India.

Amaltas, also called **The Golden Shower Tree,** is a deciduous tree. It is called the **Indian laburnum**. It is widely grown as an ornamental plant. Every part of this plant is recognised for its medicinal properties.

Ashoka tree (the "sorrow-less" tree) is a **flowering tree**, considered sacred through out India and Sri Lanka. It is prized for its beautiful foliage and flowers.

Ashoka

Keywords

abiotic components	the non-living components, like soil, water and minerals, of the forest.
biotic components	the living parts, like trees, shrubs, grasses, animals, etc., of a forest.
canopy	uppermost layer of a forest containing intertwined branches and twigs.
crown of trees	combination of branches, twigs and leaves of trees.

deforestation	indiscriminate cutting or over-harvesting of trees, for different human activities.
food chain	the interdependence of plants and animals on each other for food, forms a food chain.
food web	interconnection of different food chains in nature.
forest floor	the forest layer consisting of dead leaves, animal droppings, dead trees and animals.
understorey	the layer beneath the crown where small trees and large shrubs grow.

You Must Know

1. A forest is an area having a high density of trees.
2. A forest has many biotic (living) as well as abiotic (non-living) components.
3. The interdependence of plants and animals on each other for food is known as a food chain.
4. Several interconnected food chains form a food web.
5. A forest is able to function as an independent unit as the nutrients move in a producer, consumer and decomposer cycle, in it.
6. Decomposers break down the rough, woody fibres of trees, enabling the nutrient cycle to begin all over again.
7. A forest is made up of following layers:
   - Forest floor: consists of dead leaves, animal dropping and dead animals.
   - Understorey: consists of bushes and young trees.
   - Canopy: the uppermost layer of a forest.
   - Emergent layer: consists of a few scattered trees over the canopy.
   - Crown: consists of branches, twigs and leaves.

8. The shape of the crowns of trees depends on their location.

9 Forests are important because they

- maintain the ecological balance in nature.
- are the habitat for the living organisms.
- improve moisture content of the atmosphere.
- are reservoirs of oxygen.
- help to maintain the balance of oxygen and carbon dioxide in nature.
- prevent soil erosion, harvest rainwater naturally and maintain soil fertility.
- provide us many useful products, such as wood, paper, fruits, spices, fuel, etc.

10. Large scale removal, or cutting of trees is called deforestation.

11. Deforestation leads to many harmful consequences. These include increase: in carbon dioxide level, extinction of plant and animal species, leading to floods and soil erosion.

12. Banyan is the national tree of India. It regenerates and lives for a very long time.

13. Other common trees, found in India, are Teak, Neem, Eucalyptus, Deodar, Sal, Amaltas and Ashoka.

Something To Know

A. Fill in the blanks.

1. Decomposers play an important role in _____ of nutrients.
2. Herbs are found in the _____ layer of the forest.
3. Forests maintain a balance between the amount of _____ and _____ gases in the atmosphere.
4. Overgrazing in forests may cause a decrease in soil _____ and an increase in soil _____.
5. _____ is the national tree of India.

B. Write True or False for the following statements.

1. Forests depend on man for water and fertilisers. ☐
2. The plants and animals, in a forest, are not dependent on one another. ☐
3. Raw material, needed for making paper, is obtained from forests. ☐
4. Forests help in decreasing soil erosion. ☐
5. Forests play an important role in maintaining the water cycle in nature. ☐

C. Tick (✓) the correct option.

1. The layer of forest, where intertwined branches of trees are found, is known as the—

   ☐ canopy ☐ crown

   ☐ understorey ☐ forest floor layer

2. Decomposers help in—

   ☐ cooling of atmosphere ☐ recycling of nutrients

   ☐ absorption of excess water ☐ feeding the animals.

3. An increase in cutting down of the trees in forests will lead to—

- ☐ an increase in the amount of carbon dioxide in air.
- ☐ a decrease in the amount of carbon dioxide in air.
- ☐ an increase in the amount of oxygen in air.
- ☐ a decrease in the amount of both oxygen and carbon dioxide in air.

4. The tree, that is thought of as an 'immortal tree', is the—

- ☐ ashoka tree
- ☐ banyan tree
- ☐ neem tree
- ☐ teak tree

5. The tree that is often referred to as "The golden shower tree" is the—

- ☐ ashoka tree
- ☐ deodar tree
- ☐ amaltas tree
- ☐ sal tree

D. Answer the following questions in brief.

1. Define the terms 'food chain' and 'food web'.
2. Name the different layers of the forest.
3. Give the meaning of the term 'soil erosion.'
4. Name four useful products that are provided to us by the forests.
5. Name any four trees that are common to the Indian sub-continent.

E. Answer the following questions.

1. Comment on the statement: "Early man began his life as a forest dweller."
2. How are the shapes of crowns of trees, and their location on earth, related to each other?
3. State any five points highlighting the importance of forests to mankind.
4. Discuss, in brief, the likely consequences of deforestation.
5. How are the Eucalyptus tree, Teak tree and the Neem tree important for us?

Value Based Question

Sonu was a rather 'self-centered' boy and never cared to help others. His sister, Shweta, on the other hand, always showed empathy towards the needs of the others and would go out of the way, to help and guide others. Their mother advised Sonu to follow the example of his sister. She told him that all of us are interdependent on one another in much the same way as the many biotic and abiotic components, of a forest, are interdependent on one another.

1. State the values that you think Sonu needs to imbibe.

2. Name any two components of a forest and discuss their interdependence on each other.

Something To Do

1. **Adopt a tree: Cutting down of trees is a major concern for mankind. Choose a tree near your school, or house, and prepare a scrap book about it. You can find out its name in different languages, as well as its scientific name. Draw pictures, or click photographs, of that tree. Also, write how this tree is useful for the community (medicinal value, providing shade, etc.)**

2. **Visit a forest (under proper guidance and security provisions) and make a list of animals and plants that you see there. Try to prepare a diagrammatic representation of some food chains, and food webs, that exist in that forest.**

3. **Make a list of 5-10 wildlife sanctuaries and national parks in India. Try to locate them on the map.**

CHAPTER

16 Water

In the previous classes, we have learnt about the availability, importance and uses of water. We tend to think of water as a very common and easily available substance. We are, therefore, often not very careful about using it judiciously. However, we all know, and realise, the importance of water in our daily life. In fact, it is the presence of water on the earth that is one of the main reasons for the survival of all forms of life on it.

Activity 1

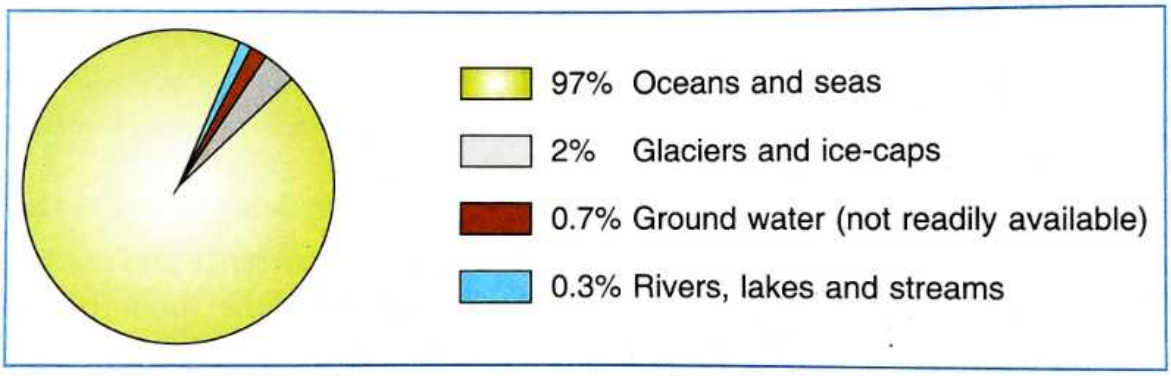
Write ten uses of water in our daily life.

Water on Earth

Water is present in all its three forms—solid(ice), liquid(water) and gaseous(water vapour) on the earth. Water, in its liquid form, is available in oceans, seas, rivers, lakes and ponds on the surface of the earth. It occurs in its frozen(solid) form on polar ice-caps and glaciers. Its gaseous, or vapour, form is present in air that surrounds us.

Water is present in abundance but is still scarce.

About 97 per cent of all the water on earth is present in oceans and seas. This water is very salty and cannot be used for our daily needs. Only 3 per cent of water, on the earth, is fresh water which is good for human use. Most of this fresh water, however, occurs as snow, in the form of glaciers and ice caps, or as water vapour in air. Some amount of fresh water is present as ground water. This may be used for some purposes but it is often not readily available. It is only 0.3 per cent of fresh water, present in rivers, lakes and streams, that is readily available for use. The following diagram illustrates this.



Local Sources of Water

Earlier, there was no proper system of water supply. People had to fetch water from rivers, lakes or ponds. Even today, at some places, people have to travel long distances to fetch water for their daily needs.

We all know that in cities, water is supplied through a water supply system maintained by the civic agencies. Water, from rivers or lakes, is purified in a water treatment plant and is then, supplied through a network of pipes to homes, offices and schools.

Ground Water and Water Table

Most of the rain water, and water from rivers and ponds, seeps through the soil and goes underground. This water is trapped in the space between the

underground rocks. The upper layer of this water is called the **water table**. The water, below this layer, is known as **ground water**.

Ground water is drawn from wells, tubewells or hand pumps and is used for irrigation as well as for our daily needs.

We know that nearly three-fourth of the surface of earth is covered with water. Then, why do we face shortage of water? Let us try to understand this.

Scarcity of Water

Water is considered precious as it supports life on earth. But the amount of readily available, and usable, water on earth is decreasing alarmingly. We are, therefore, facing an acute shortage of water. Some of the major reasons of shortage of water are explained below:

Water bodies on earth receive water mainly from rainfall. The amount of rainfall in most regions has decreased. This has happened due to many factors. Some of them are deforestation, increase in construction activity, increase in number of vehicles and industries. As the amount of rainfall decreases, farmers depend more on ground water for irrigation. Hence, level of ground water is constantly decreasing. With increase in population, demand for water has increased whereas its resources have depleted. This causes a shortage or scarcity of water.

Do You Know ?

Carbon dioxide gas, breathed out by humans and animals, is used up by the plants to prepare their own food through the process of photosynthesis. Thoughtless, and unnecessary, cutting of trees will cause an increase in the level of carbon dioxide gas in the atmosphere. This gas helps in trapping a part of the energy of sun rays in the earth's atmosphere by not allowing that energy to escape. This causes an increase in temperature on the surface of earth.

This phenomenon is called **'Green House Effect'**. An increase in the level of this effect can lead to Global Warming. This can cause melting of glaciers and ice caps and an increase in the level of water in seas and oceans. If that happens, large areas of earth's surface may get sunk. Hence, cutting of trees should be avoided and more trees should be planted.

Water Management

Better management of water resources can help in conserving water. The rain water should not be allowed to flow into drains.

Rain Water Harvesting

Rain water should be collected in underground tanks and allowed to seep through the soil. This will replenish the ground water. Rain water can also be collected in open tanks and used for daily needs. This is called **rain water harvesting**. Use of sprinklers and drip irrigation technique, for irrigating the crops, can help in reducing wastage of water.

Unnecessary cutting of trees should be checked and more trees should be planted. This will increase the rainfall and purify the air. The civic agencies should also take sufficient care to avoid wastage of water. Any broken, or leaking, pipe should be immediately repaired or replaced. All of us can also play a very important role in saving water and avoiding its wastage. Thus, we should—

(a) turn off the tap while brushing teeth.

(b) get the leaking taps repaired immediately.

(c) water the plants with a mug instead of a pipe.

Now, suggest four more ways of saving water at home.

1. _____

2. _____

3. _____

4. _____

Use water judiciously and save it for future. We need to remember that, if there is no water, there would not be any life on earth!

Waste Water Management

We use water in our daily life for various purposes like washing clothes, bathing, and in toilets, etc. All these activities produce a lot of water which is dirty and contains many impurities. Such water is called **waste water**. Waste water is also produced in offices, hospitals and factories. This waste water is called **sewage**. Rain water which runs down the roads and roof tops also becomes a part of waste water. This is something that needs to be avoided. We should try to harvest rain water and not allow it to go waste.

Just as a network of pipes brings clean water to our homes, a network of pipes takes the waste water, or sewage, away. This network of pipes is called the **sewerage system**. It carries the sewage, from its source, to a waste water treatment plant. The waste water is cleaned, and purified, by various processes at these treatment plants. The water, thus, treated and cleaned, is then allowed to mix with river or sea water.

Do You Know ?

The waste water, or sewage, flows through a network of underground drains. You must have seen some open drains also in your locality. These open drains not only give out foul smell but are also a breeding ground for mosquitoes which cause diseases like malaria. Sometimes sewage starts stagnating in the drains. The waste water may then seep underground and contaminate the ground water which is used by many people for drinking. Contaminated drinking water can cause diseases like cholera, typhoid, jaundice, etc. It is very important, therefore, to have a proper, and well functioning, sewage system.

Our Role: We can play an active role in waste water management and maintaining a clean and healthy surrounding. The suggestions, given below, can help us achieve these aims.

(a) Reduce the quantity of waste water being produced in our homes.

(b) Do not throw solids, like left over food, leaves, cotton, polythene bags, etc., in the drains. These can choke the drains.

(c) Do not throw cooking oil in the drain. It hardens and blocks the pipes of the sewerage system.

(d) Do not throw chemicals, like paints, medicines, engine oil, etc., in the drain. These chemicals kill the (friendly) micro-organisms, present in the sewage, which help to purify water.

Keywords

groundwater	the water that seeps through the soil and goes underground.
rain water harvesting	the methods of conserving rain water and not allowing it to get wasted.
scarcity of water	an acute shortage of water due to decrease in amount of readily available, and usable, water on earth.

sewage	the waste water, released from domestic activities, industries, hospitals, offices and agricultural activities.
sewerage system	a proper drainage system, or 'waste water management' system which helps to carry sewage far away from its sources to a waste water treatment plants.
water table	the top level of the ground water is called 'water table'.

You Must Know

1. Water is present in all its three forms—solid (ice), liquid (water) and gaseous (water vapours) on the earth.
2. Water is present in abundance but is still scarce.
3. About 97 per cent of the all water on earth is present in oceans and seas. Only 3 per cent of water on the earth is fresh water.
4. Ground water is drawn from wells, tubewells or handpumps and is used for irrigation as well as our daily needs.
5. Due to increase in population, the demand for usable water has increased whereas its availability has decreased.
6. Amount of rainfall is decreasing due to cutting of trees and increase in level of air pollution, affecting the agricultural production.
7. Water is being excessively drawn but is not getting sufficiently replenished. This is due to decrease in rainfall and deforestation. There is, therefore, a shortage, or scarcity, of water.
8. Better management of water resources can help in conserving water.
9. Rain water harvesting should be done by collecting rain water in underground tanks. This would help in replenishing the ground water.
10. Waste water from homes, schools, factories, offices, hospitals, etc., is called sewage, which is carried away by a sewerage system to a waste water treatment plant where it is purified.
11. We can, and should, play an active role in 'waste water management' and in maintaining clean and healthy sorroundings.
12. We all need to use water judiciously and save it for future.

Something To Know

A. Fill in the blanks.

1. About _____ of water is present in oceans and seas.
2. Only 0.3 per cent of fresh water available for use is present in rivers, _____ and _____.
3. Ground water is drawn from wells, _____ and _____.
4. Use of _____ and _____ for irrigation reduces wastage of water.
5. The network of pipes which carries waste water to water treatment plant is called _____.

B. Write True or False for the following statements.

1. About 97 per cent of water on earth is fresh water and is good for human use. ☐
2. Water occurs in its solid form in glaciers and ice caps. ☐
3. Farmers rely on ground water for irrigating their crops when there in no rain. ☐
4. Deforestation increases the level of groundwater. ☐
5. More use of ground water causes decrease in water table. ☐

C. Tick (✓) the correct option.

1. Ocean water is unfit for drinking as it is—

☐ very salty ☐ tasteless

☐ too clean ☐ generally frozen

2. 'Rain water harvesting' can help us to conserve—

☐ sea water ☐ fresh water

☐ rain water ☐ pond water

3. On the earth, the percentage of water, that is fresh and readily available for use, is, nearly—

- ☐ 99.7%
- ☐ 97%
- ☐ 3%
- ☐ 0.3%

4. One of the important factors, that can lead to a scarcity of water, is—

- ☐ excessive rainfall
- ☐ afforestation
- ☐ deforestation
- ☐ processing of sea water

5. 'Waste water' is also called—

- ☐ sewage
- ☐ potable water
- ☐ water table
- ☐ salty water

D. Answer the following questions in brief.

1. Name the three forms in which water exists on the earth.
2. Give the meaning of the term 'water table'.
3. Name two methods of drawing out ground water.
4. Name two activities which lead to the formation of sewage.
5. State any two precautions that can help avoid the 'choking of drains'.

E. Answer the following questions.

1. How is increase in population responsible for shortage of water?
2. Discuss, in brief, how 'rain water harvesting' can be done.
3. Discuss any two causes that lead to a decrease in ground water level.
4. How can 'better management of water resources' help in conservation of water?
5. Write, in brief, about the basic details and the role of the 'sewerage system'.

Value Based Question

The school had invited a noted speaker for a talk on 'Our Environment'. The speaker first gave many suggestions and ideas that could help in improving the environment. She, then, went on to say that though water exists in all its three forms in nature it is the liquid form of water that is most 'liked' by all forms of life. In the same way, she said that our habits and activities can be in many 'forms' but we should make greater use of only those 'forms' that are more liked by the environment.

1. Suggest at least two 'habits' or 'values' that can help in having a better environment.

2. Write five 'daily-life related activities' that usually require the use of water in its liquid form.

Something To Do

1. **Make posters related to water shortage and water conservation and display them in the school.**

2. **On the map of India, indicate the places where there is generally—**

   (a) heavy rainfall

   (b) medium rainfall

   (c) practically no rainfall

3. **Try to find out the 'water related problems' faced by people living in different regions. Take the help of newspaper clippings, encyclopaedia or internet.**

CHAPTER

17 Electric Current and Its Effects

We all know that energy, in nature, exists in very many different forms. Heat energy, light energy, sound energy, mechanical energy, magnetic energy and electrical energy are some of the well known forms of energy. We also know that these different forms of energy can be transferred from one form to another. Out of these, electricity is now perhaps the most widely used and indispensable form of energy.

Some appliances which use electricity

We have already learnt in Class-VI that a battery, or an electric cell, is a source of electric current. In an electric cell, chemical energy is converted into electrical energy. We now use many electrical appliances in our day to day life where we find electrical energy getting converted into heat, chemical, light, sound or magnetic energy.

Activity 1

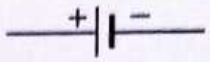
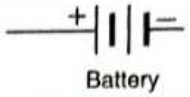
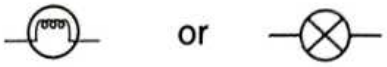
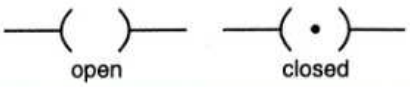
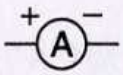
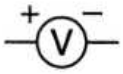
Let us list some of the energy changes associated with appliances that use electricity (electric devices).

Electric appliance		Its practical use in our daily life	Energy change involved
Electric iron			
Room blower			
Hair dryer			
Electric stove			
Hot plate			
Electric fan			
Electric bulb			
Electromagnet			
Electric bell			

We, thus, realise that energy changes involving electricity play an important role in our day to day life. It has become almost impossible for us to think of a life without electricity.

We have also learnt in Class-VI that some common electric components can be represented by their electric symbols.

We give below symbols of some devices/parts used in electric circuits. We have already talked in Class-VI about the need and advantages of using these symbols in electrical circuits.

Name of the device or part of the electric circuit	Practical shape	Symbol
Cell		
Battery		 Battery
Connecting wire		–
Bulb/Lamp		 or
Electric switch		 OFF position ON position
Plug key		 open closed
Ammeter		
Voltmeter		
Resistance wire	Very many	

Heating Effect of Electric Current

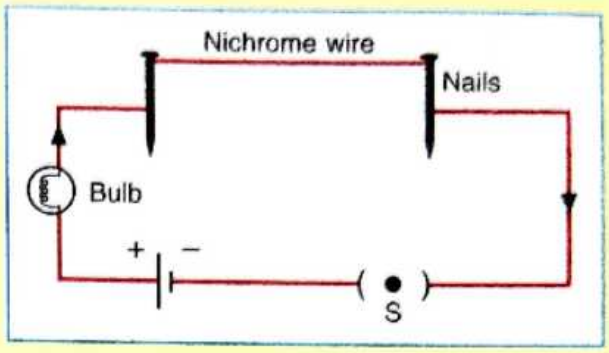
It is a common experience that when an electric current flows through the filament of an electric toaster, the wires of the filament soon become 'red-hot'. It follows that a flow of current can produce heat. This is known as the the '(Joule's) **Heating effect of electric current**'. Joule did a number of experiments to find the 'factors' which affect the amount of heat produced in a given coil. He found that the heat produced, in a given wire depends on (i) the strength of the current through the wire; (ii) the nature of the material and the length and thickness of the given wire*; (iii) the time for which electric current flows through the given wire.

* These factors, taken together, determine the **'electrical resistance'** of the given wire. Resistance of a given wire affects the flow of current through it.

Let us examine through an activity the factors on which the heating effect of an electric current depends.

Activity 2

Take a piece of nichrome wire, about 10 cm long, and tie it between two nails. Make a simple circuit as shown in the adjoining diagram.



- Allow the current to pass through the nichrome wire for some time. What do we observe? The bulb glows up, the nichrome wire gets (strongly) heated up but the connecting wires, supplying current to the circuit are practically not heated up at all. It is so because the resistance of wires, supplying current to the circuit is negligible, while that of the bulb and the nichrome wire is not. Remember, that the current flowing through the entire circuit is the same.

- Replace the cell by a battery (combination of two/three cells) in the circuit. (Recall how terminals of the cells are connected together to form a battery. To make a battery we connect the positive terminal of one cell to negative terminal of other cell and so on) What happens now? The nichrome wire now gets 'red-hot' and that too more quickly. This shows that the heat produced has increased with an increase in the strength of the current through the wire.

We can, therefore, conclude that the heat produced depends upon strength of electric current and the resistance of the electrical wire.

Advantages and Disadvantages of Heating Effect of Current

We put the heating effect of current to many uses in our daily life. Devices, like the electric heater, geyser, electric kettle, and electric iron, all depend on the heating effect of current for their working. All these appliances contain a **'heating coil'** (usually made up of a nichrome wire, known as its 'element'). We all must have seen the heating coil in an electric heater (used for cooking) or that in a room heater. When any such appliance is switched on, a large amount of heat is produced in its heating coil. The heating coil become **'red-hot'** and gives out heat energy which is put to practical use.

(i) (ii) (iii)

Elements of (i) Electric iron (ii) immersion rod and (iii) electric heater

Do You Know ?

Nichrome (an alloy of nickel and chromium) is used for making wires of heating coils because (i) it has a high melting point (ii) it has a high resistivity (iii) it can remain red hot for a long time without getting oxidised or 'burning out'.

The heating effect of current has also been used in 'electric bulbs' for producing light energy. When electric current flows through the metal filament of the bulb it gets heated to a very high temperature. It then becomes **'white-hot'** and start emitting light.

Electric bulb

There are, however, some serious practical **disadvantages of the heating effect** of current. When electricity is transmitted from the generating stations to the consumers, the heat produced in the transmitting wires gets wasted as it is simply radiated into the atmosphere. This is an unwanted loss of electrical energy. We, of course, adopt ways and means to minimise this loss. The heating effect of electric current is also capable of breaking the insulation of different wirings/devices.

Do You Know ?

The metal filament of an electric bulb is (usually) made up of tungsten wire. Tungsten is used because (i) it has a very high melting point; (ii) when current passes through it, it becomes 'white-hot' and glows brightly for a long time; (iii) it is quite stable and has a long life vis-a-vis 'burn out' or possible oxidation.

Electric 'Fuses'

We now know that the heat produced in a wire increases with an increase in the strength of current flowing through it. If, therefore, the current through a wire increases beyond a limit, the wire will become too hot and can even melt

down and break. The amount of current at which **'melt down'** occurs depends on the nature of material used. We have put this fact to practical use in designing **'electric fuses'** for our household circuits and for protection of different electrical and electronic devices.

Activity 3

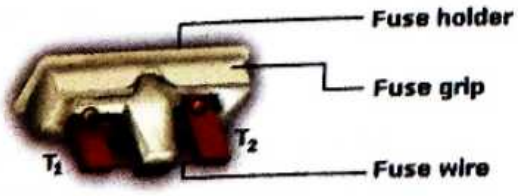
Set the circuit of the previous activity but in place of nichrome wire tie a thin strand of steel wool. (Steel wool is commonly used for cleaning utensils.) Now pass the current through the circuit for sometime. Observe the strand of wool carefully. Note what happens. Does the strand of steel wool melt and break?

Wires made from special materials melt quickly and break when large currents are passed through them. These wires are used for making 'electric fuses'.

An **electric fuse** is a safety device which is used to limit the current in an electric circuit. The purpose of the **'fuse'** is to safeguard the circuit and appliances connected to it from getting damaged due to excessive heating caused by the flow of a large amount of current.

Electrical fuses

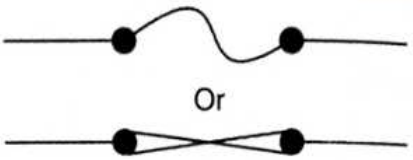
There is always a **maximum limit** of the current which can safely flow through a given circuit or a given appliance. When the current in the circuit exceeds the specified maximum (safe) value due to (i) **short circuit** (touching of wires leads to short circuiting), (ii) **overload** (more than one device/appliance connected to single socket), (iii) **insulation break down**, the wires may become overheated and this can even result in a fire. It is in such situations that the 'fuse' plays its role. When we use a proper, and correctly positioned, fuse wire in the circuit, the fuse wire is the first to melt down when it gets heated up. This happens when the current in the circuit becomes 'close to', or more than, the specified safe limit of the circuit. As a result a 'break' is created in the circuit and current flow, through it, stops immediately. The appliances are, thus, saved from damages.



The 'melt down action' of a fuse wire depends upon its **current rating**. The fuse wire must be of a current rating a little less than the maximum safe current which a circuit or appliance can withstand. For this reason, fuse wires of different kinds are used for different circuits and different appliances.

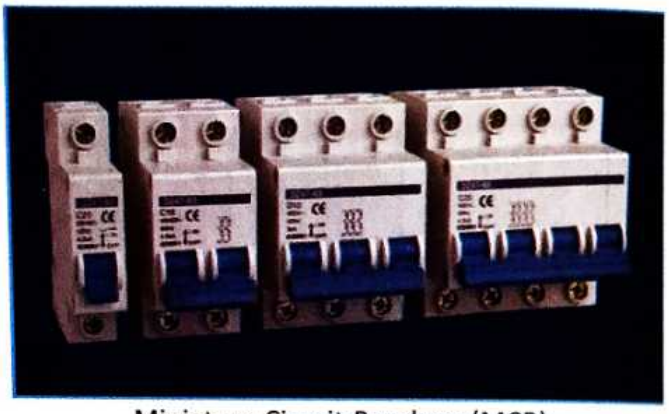
Do You Know ?

It is interesting to note that the 'melt down' limit of the current, for a given fuse wire does not depend on its length. We very often use an alloy of tin and lead, which has high resistivity and a low melting point, for making fuse wires.



Circuit symbol of fuse

We now also have an alternative to the 'fuse wires' for our household circuits.



Miniature Circuit Breakers (MCB)

These are the **Miniature Circuit Breakers** (MCBs). These are now more commonly used, as safety devices, in our households. MCBs are (automatic) electric switches which automatically turn off when the current exceeds its safety limit. Most of these switches work on the basis of the **magnetic effects of current**.

Magnetic Effect of Current

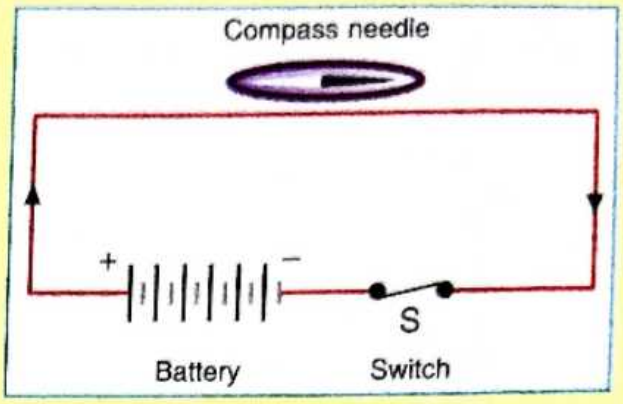
We have discussed the heating effect of current and understood how we use it to our advantage. Does the electric current have some other effects also?

We have already discussed in Class-VI, the properties of a bar magnet and methods of making a magnet. Have your ever wondered at the possibility of making a magnet without using any magnetic material at all? Is there any relationship between electricity and magnetism? Hans Christian Orested was the first person to establish the relationship between these two. He observed that a current carrying wire can deflect a compass needle and this deflection lasts as long as the current flows through the wire.

Let us now do some activities to observe the 'magnetic effects' of electric currents.

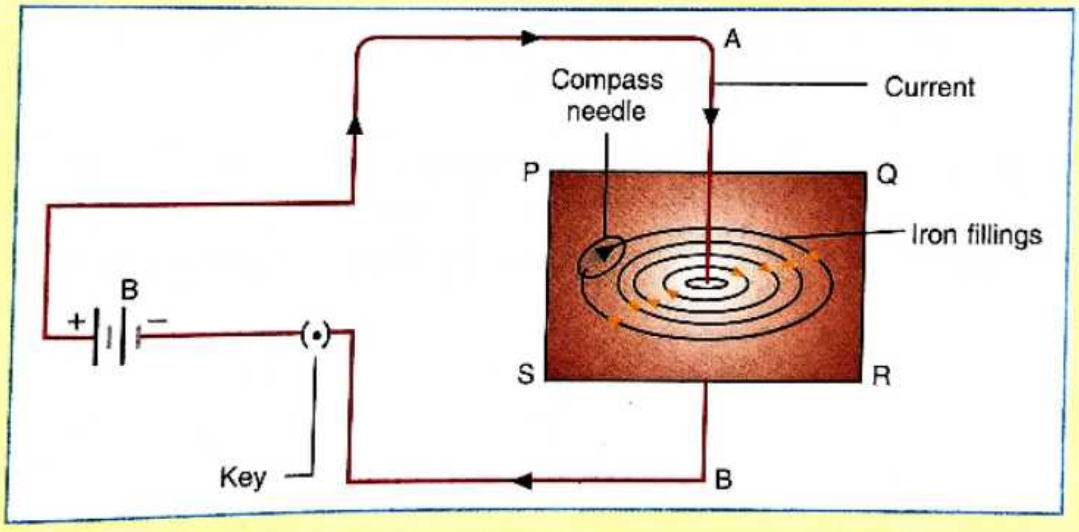
Activity 4

Make a simple electrical circuit consisting of a long straight wire, switch/pug key, a torch bulb and a battery (of nine volts, i.e. six cells of 1.5 volts) as shown in the diagram. Now, hold a compass needle parallel to and over the wire. Switch on the current (for a short time only). What do we observe? As the current flows through the wire, the needle gets deflected. This shows that the current carrying wire can act like a 'magnet'.



Activity 5

Take a piece of cardboard. Insert a wire through its centre, perpendicular to the cardboard. Now sprinkle some iron filings on the cardboard. Complete the circuit as shown (for a short time only) and gently tap the cardboard. We will observe that the iron filings get rearranged in circles centered on the wire. This shows that a current carrying wire can affect the iron filings. Hence, the current carrying wire produces a 'magnetic effect.'



We can now say that it is possible to produce magnetism without using 'magnet'. A current carrying wire also acts like a 'magnet' and produces magnetic effects; quite like a bar magnet. We call this phenomenon as the **'magnetic effect of current.'**

Do You Know?

The magnitude of magnetism produced by an electric current in a wire (i) increases with an increase in the strength of electric current (ii) decreases, as the distance from the wire increases.

Electromagnets

We often utilise the magnetic effect of current to make temporary magnets known as **electromagnets**.

Electromagnets

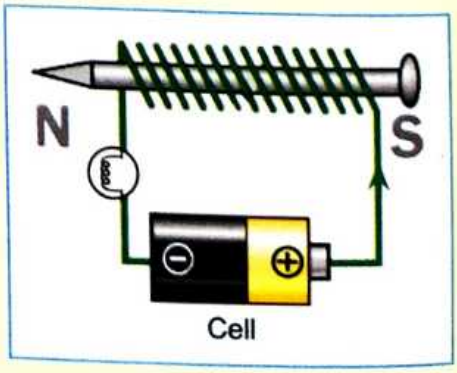
A coil, of a large number of circular turns of insulated wire, wrapped on a (suitable) cylindrical core, behaves like a magnet when an electric current flows through it. When the current is switched off, the coil loses its magnetism immediately. We call such a device as an **electromagnet**.

The **magnetic strength of an electromagnet** can be increased by (i) wrapping the insulated coil around a soft iron core; (ii) increasing the number of turns in the coil; and (iii) increasing the strength of the electric current flowing through the coil.

Activity 6

To make an electromagnet and to study the factors on which its strength depends.

Wrap about 30 to 40 turns of a coil of insulated copper wire around a large iron nail. Remove a little bit of insulation, from the wire, at its both ends. Connect these ends to two terminals of a cell/battery through a (torch) bulb. Now bring the pointed end of the nail near some iron pins/clips. What do we observe? Count the number of clips/pins that the electromagnet has picked up. As we switch off the current, the clips/pins



fall down. Repeat the above step by increasing the number of turns of coil. Again count the number of clips/pins picked up by the electromagnet. Try to observe the relationship between the number of turns of coil and number of paper clips picked up by the electromagnet. (You can plot a graph between the two.) Next use a bunch of iron nails and wrap the coil on it. Observe the difference, if any, in the strength of this 'new electromagnet'.

Repeat these steps by using a **battery** having more cells in it.

Note: In the above activity, if we use steel nail/rod, instead of soft iron nails, we will find that the steel nail/rod can pick up a few clips even after the current is switched off. This shows that the steel nail retains some magnetism even after the current through its coil has been switched off. We, therefore, use steel for making 'long lasting' or permanent magnets.

Practical Uses of Electromagnets

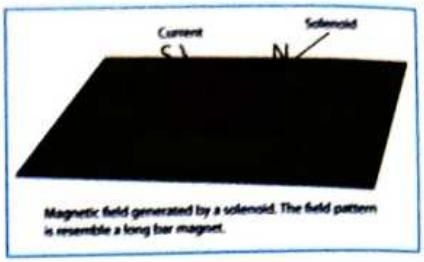
We usually want our electromagnets to act like 'switches'. They should show magnetism as soon as the current is switched on and should lose their magnetism (almost immediately) when the current is switched off. An iron-cored electromagnet does show such a behaviour. We, therefore, prefer iron cores for making electromagnets.

We use electromagnets of different sizes and shapes in many devices. Electromagnets are used in electric bells, loudspeakers and telephone diaphragms. Giant electromagnets are used in mobile cranes to lift and transfer heavy iron rods and machinery, etc. Doctors use tiny magnets to take out small devices of magnetic material that might have fallen in the eye. Many toys also have electromagnets inside them.



Do You Know?

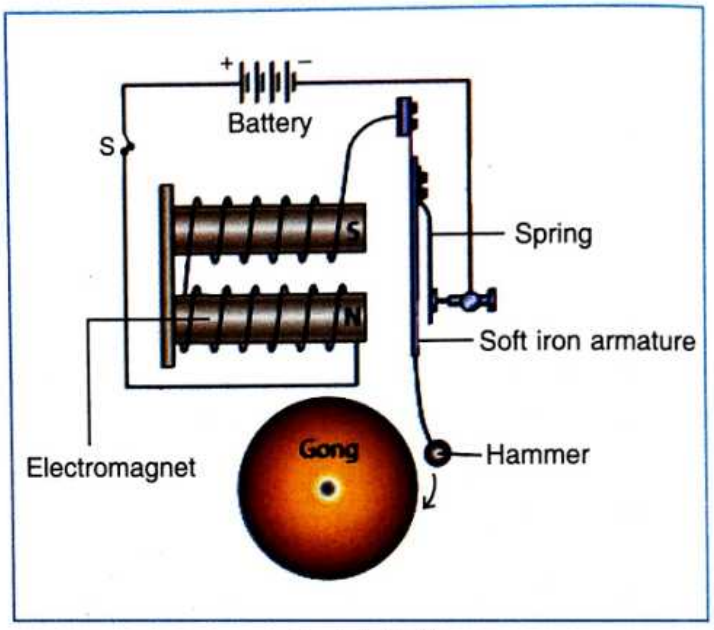
A current carrying coil, made up of a large number of circular turns of wire, produces magnetic effects very much similar to those of a bar magnet. One end of the coil acts like a magnetic north pole while the other acts like a magnetic south pole. We call such a coil as a **solenoid**.



Magnetic field generated by a solenoid. The field pattern is resemble a long bar magnet.

Electric Bell

The **electric bell** is a simple household device based on the magnetic effects of current. It consists of a gong, an electromagnet, a soft iron rod (armature) and a contact screw, all arranged in an electric circuit as shown in the diagram here.



Electric bell

Working of an electric bell

- When current flows through the electromagnet it acquires magnetism and attract the armature.
- As the armature bends towards the electromagnet, the gong is struck. But at the same time contact between armature and contact screw gets broken and the circuit gets switched off.
- As the current flow stops (due to the break in the circuit), the electromagnet (immediately) loses it magnetism. It, therefore, no longer attracts the armature.
- The armature gets pulled back to its original position by spring action. It, now, again comes in contact with the contact screw; the circuit gets completed again. The cycle repeats itself and the gong gets struck again. This, in turn, again breaks the circuit.
- Due to this alternate making and breaking of the circuit (which takes place very rapidly), the electric bell goes on ringing continuously as long as the switch is kept pressed.

Keywords

electric bell	a device which produces sound when an electric current flows through its coil.
electric fuse	a safety device used to limit electric current in an electric circuit.
electromagnet	a temporary magnet that runs on electricity.
heating coil	an appropriate wire loop, usually wound in a spiral form.
heating effect of electric current	production of heat in a wire/coil due to the flow of an electric current.
magnetic effect of electric current	the display of behaviour/properties, similar to that of a magnet, by a current carrying wire/coil.
MCB	miniature circuit breaker (an automatic switch), now often used as a replacement for an electric fuse.
nichrome	an alloy of nickel and chromium; often used for making 'resistance coils.'
overloading	connection of more than one device/appliance to a single socket.
short circuit	touching of the live and neutral wire, due to faulty insulation.

You Must Know

1. When an electric current passes through a wire, it gets heated up. This is known as 'heating effect' of electric current.
2. According to Joule, heat produced in a current carrying wire depends upon the, strength of electric current, resistance of the wire and the time for which electric current flows through the wire.
3. Electric fuse is a safety device used to prevent electric fire due to short circuit or overloading. It works on the principle of heating effect of current.
4. When an electric current flows through a wire, it behaves like a magnet. This is known as the 'magnetic effect' of current.

5. A current carrying coil, of an insulated wire, wrapped on a cylindrical core, makes up an electromagnet.

6. The strength of an electromagnet can be increased by—

   (i) increasing the number of turns in the coil,

   (ii) using a soft iron core, and

   (iii) increasing the strength of the electric current flowing through the coil.

7. Electromagnets are used in electric cranes, electric bells, loudspeakers, telephone diaphragms, etc.

8. Electric bell is a simple device based on the magnetic effect of current.

Something To Know

A. Fill in the blanks.

1. When current is switched on, an electric fan converts _____ energy (mainly) into _____ energy.
2. When current is switched 'on' in a room heater, it converts _____ energy into _____ energy.
3. We prefer a wire of _____ for making the 'heating element' in domestic appliances like the electric iron, electric heater and the electric toaster.
4. A safety device, based on the heating effect of current is the _____
5. Electromagnet should show rapid _____ when the current is switched _____

B. Write True or False for the following statements.

1. An electric current can produce a heating effect but not a magnetic effect. ☐
2. The heating coils/elements of different electrical appliances are usually made from copper or aluminium wires. ☐
3. When the current through a fuse wire exceeds its specified value, the fuse wire melts and breaks. ☐
4. Connecting many devices in a single socket is not likely to cause any problem in a circuit. ☐
5. The strength of an electromagnet can be increased by decreasing the number of turns of its coil. ☐

C. Tick (✓) the correct option.

1. When electric current flows through a filament of electric bulb, the filament gives out—

☐ heat energy only ☐ light energy only

☐ both heat and light energy ☐ chemical energy

2. A fuse wire is a wire of—

- [ ] high resistivity and low melting point.
- [ ] high resistivity and high melting point.
- [ ] low resistivity and low melting point.
- [ ] low resistivity and high melting point.

3. We are more likely to observe a strong magnetic effect with a—

- [ ] current carrying straight wire.
- [ ] current carrying circular coil of many turns wound on a soft iron core.
- [ ] current carrying coil of many circular turns.
- [ ] current carrying circular coil of a single turn.

4. A common household device, that uses an electromagnet in its working, is—

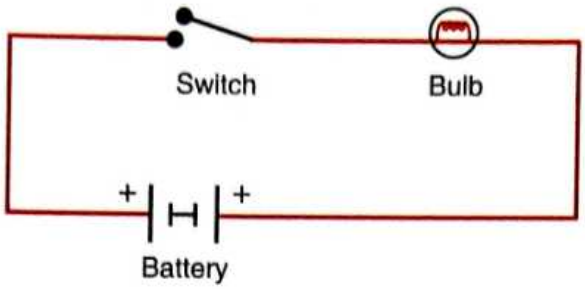
- [ ] the electric bell
- [ ] a room heater
- [ ] a geyser
- [ ] the tube light

5. A good electromagnet would—

- [ ] act like a magnet when the current is 'ON' but would not do so when the current is 'OFF'.
- [ ] not act like a magnet when the current is 'ON' but acts like one when the current is 'OFF'.
- [ ] act like a magnet both when the current is 'ON' or is 'OFF'.
- [ ] not act like a magnet both when is current is 'ON' or is 'OFF'.

D. Answer the following questions in brief.

1. The bulb in the circuit shown in figure does not glow. Why? Redraw the circuit diagram by making the necessary changes in it, so that the bulb starts glowing.



2. Name three practical devices based on the heating effect of current.

3. Write two special characteristics of the wire needed for making the 'element' of an electric heater.

4. Give the meaning of the terms 'short circuiting' and 'overloading' in an electric circuit?

5. Do you think an electromagnet can be used for separating plastic bags from a garbage heap? Explain.

6. State any three applications of an electromagnet.

E. Answer the following questions.

1. The same amount of current flows through the connecting wires and the bulb filament. However, it is only the filament that glows. Why?

2. The brightness of light, emitted by a bulb, is observed to decrease when an electric heater is connected in series with it. Suggest the likely reason for this observation.

3. Suggest an experimental set up to illustrate the action of an electric fuse.

4. A novice electrician, while carrying out some repairs in Sumit's house, tried to put a piece of tungsten wire in a 'fuse'. Sumit's father, on noticing this, stopped him from doing so. Give reasons as to why he did that.

5. Draw a labelled diagram of an electric bell and explain its working.

Value Based Question

The school principal, in her morning address, urged the students to work in a hard, dedicated and focused way. She also advised the teachers, seniors and parents to go a 'little out of their way' to guide those who need a 'little extra help'.
Mohan, on returning home, discussed the principal's comments with his grandfather. The grandfather told him that the principal's suggestions were very good. These suggestions, if followed, can increase the student's strength, and capability, in the same way as appropriate adjustments can help increase the strength of an electromagnet.

1. State any two of the values that the principal urged her students to develop in themselves.

2. Write two factors that can be adjusted to increase the strength of an electromagnet.

3. Share, with your friends and classmates, any incidence in which you went 'a little out of the way' to help/guide someone.

Something To Do

1. **Collect data about the maximum current rating of domestic appliances like an electric mixer, television set, washing machine, toaster, electric oven, etc. With the help of your teacher/electrician, find out the type of fuse used for their safety.**

2. **Take out the parts of an old and 'out of use' electric bell, or a telephone, or a toy working with cells/battery. Is an electromagnet used in them? Discuss and record your findings.**

3. **Make an electric circuit consisting of an electric switch, two electric bulbs and a battery (three cells of 1.5 Volts each). Connect the switch between the two bulbs. Does any of the bulbs glow when the switch is in the 'OFF' position? Is there an order, in which the bulbs glow when the switch is in the 'ON' position?**

4. **In the Activity 2, use (i) nichrome wires of longer lengths but of same thickness; (ii) nichrome wires of same length but of different thickness. Switch on the circuit. Observe the change, if any. Try thinking of an explanation for your observations.**