Government of Karnataka

Curiosity

Textbook of Science for Grade 7

PART - II

7

0777

English Medium

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NCERT

राष्ट्रीय शैक्षिक अनुसंधान और प्रशिक्षण परिषद्
NATIONAL COUNCIL OF EDUCATIONAL RESEARCH AND TRAINING

Karnataka Textbook Society (R.)
6th Cross, Malleshwaram, Bengaluru-560 003

CONSTITUTION OF INDIA

Part III (Articles 12 – 35)
(Subject to certain conditions, some exceptions and reasonable restrictions)

guarantees these

Fundamental Rights

Right to Equality

- before law and equal protection of laws;
- irrespective of religion, race, caste, sex or place of birth;
- of opportunity in public employment;
- by abolition of untouchability and titles.

Right to Freedom

- of expression, assembly, association, movement, residence and profession;
- of certain protections in respect of conviction for offences;
- of protection of life and personal liberty;
- of free and compulsory education for children between the age of six and fourteen years;
- of protection against arrest and detention in certain cases.

Right against Exploitation

- for prohibition of traffic in human beings and forced labour;
- for prohibition of employment of children in hazardous jobs.

Right to Freedom of Religion

- freedom of conscience and free profession, practice and propagation of religion;
- freedom to manage religious affairs;
- freedom as to payment of taxes for promotion of any particular religion;
- freedom as to attendance at religious instruction or religious worship in educational institutions wholly maintained by the State.

Cultural and Educational Rights

- for protection of interests of minorities to conserve their language, script and culture;
- for minorities to establish and administer educational institutions of their choice.

Right to Constitutional Remedies

- by issuance of directions or orders or writs by the Supreme Court and High Courts for enforcement of these Fundamental Rights.

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Constitution of India

Part IV A (Article 51 A)

Fundamental Duties

It shall be the duty of every citizen of India —

(a) to abide by the Constitution and respect its ideals and institutions, the National Flag and the National Anthem;

(b) to cherish and follow the noble ideals which inspired our national struggle for freedom;

(c) to uphold and protect the sovereignty, unity and integrity of India;

(d) to defend the country and render national service when called upon to do so;

(e) to promote harmony and the spirit of common brotherhood amongst all the people of India transcending religious, linguistic and regional or sectional diversities; to renounce practices derogatory to the dignity of women;

(f) to value and preserve the rich heritage of our composite culture;

(g) to protect and improve the natural environment including forests, lakes, rivers, wildlife and to have compassion for living creatures;

(h) to develop the scientific temper, humanism and the spirit of inquiry and reform;

(i) to safeguard public property and to abjure violence;

(j) to strive towards excellence in all spheres of individual and collective activity so that the nation constantly rises to higher levels of endeavour and achievement;

*(k) who is a parent or guardian, to provide opportunities for education to his child or, as the case may be, ward between the age of six and fourteen years.

Note: The Article 51A containing Fundamental Duties was inserted by the Constitution (42nd Amendment) Act, 1976 (with effect from 3 January 1977).

*(k) was inserted by the Constitution (86th Amendment) Act, 2002 (with effect from 1 April 2010).

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7 Heat Transfer in Nature

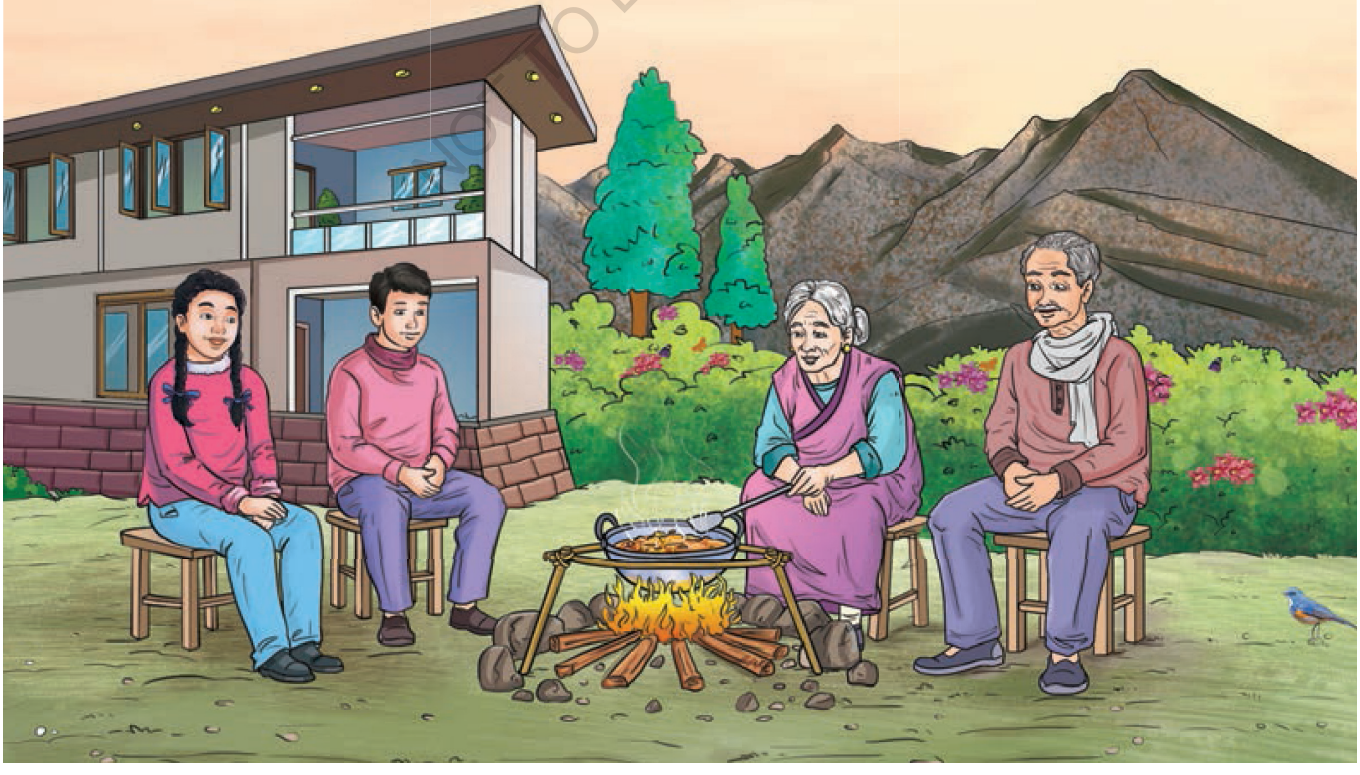
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Pema and her brother Palden reside in Gangtok. On a cold winter evening, they are sitting around a fireplace. Palden shares his experiences of visiting Kerala during the winter vacation. He says that compared to Gangtok, winter in Kerala is comparatively warm and humid. Both Pema and Palden are curious about why some places are so cold and others quite hot.

Hearing them express their curiosity, their grandfather, a retired science teacher, says, “Kerala is closer to the equator than Sikkim and it also has a long coastline, which results in warmer and more humid weather conditions”. Palden replies, “Yes, we learnt in Grade 6 Science and Social Science that for us on the Earth, the Sun is the main source of heat and light, and around the equator, the climate is generally hot”.

As they are talking, Pema is keenly observing her grandmother cooking *thukpa* (a traditional Sikkimese dish) in a large metal pan. Pema asks, “Why are cooking utensils generally made of metals?” Palden immediately responds that they had studied in the chapter ‘The World of Metals and Non-metals’ that such materials are good conductors of heat.

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Let us **perform** an activity to learn why certain materials are good conductors of heat.

7.1 Conduction of Heat

Activity 7.1: Let us experiment

Caution—This activity should be carried out under the supervision of a teacher or an adult.

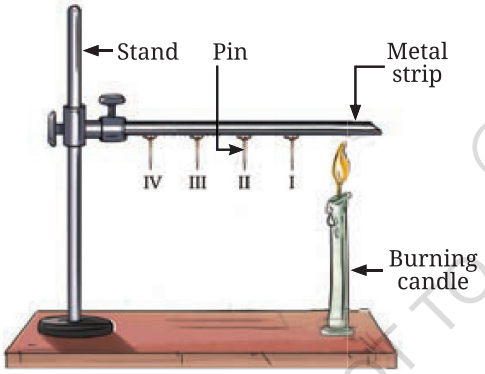


Fig. 7.1: Heat transfer in a metal strip

- Take a strip of a metal, such as aluminium or iron, about 15 cm long.
- Attach four pins to the strip with the help of wax such that they are arranged at nearly equal distances (about 2 cm apart), as shown in Fig. 7.1.
- Secure the strip to a stand and label the pins as I, II, III, and IV, as shown in Fig. 7.1. (If a stand is not available, place the strip between two bricks for support.)
- Heat the end of the strip that is away from the stand with a candle or a spirit lamp.
- What will happen to the pins? Will they remain attached to the strip or will they fall?
- **Predict** the order in which the pins will fall from the strip.
- **Record** your observations in Table 7.1.

Table 7.1: Falling of pins

Pin falling first		Reasons for what you observed
Prediction	**Observation**	

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You **observed** that the pin closest to the candle flame (pin I) falls first, followed by pins II, III, and IV. Why does pin I fall before pin II? Why did all the pins not fall together?

From your observations, what can you **infer**? Do you think that heat is being transferred along the metal strip from the end that is being heated? As the heat travels along the strip and approaches a pin, the wax holding it melts and the pin falls. Here, the transfer of heat takes place from the hot end of the strip to the colder end. The process of heat transfer from the hotter part of an object to the colder part is called **conduction**. In this process, the particle that gets heated, passes the heat on to its neighbour, and so on. However, the particles themselves do not move from their positions.

Materials like metals that allow heat to pass through them easily are called **good conductors** of heat. Because metals are good conductors of heat, we use utensils made of metals for cooking. In solids, heat transfer takes place mainly through the process of conduction.

If we use a strip made of a material like wood or glass in place of a metal strip to perform Activity 7.1, the pins will not fall. Can you think of the reason for this based on our learning from the chapter 'The World of Metals and Non-Metals'?

Materials such as glass and wood do not allow heat to pass through them easily and are **poor conductors** (insulators) of heat. Clay and porcelain are also poor conductors of heat—that is why tea or coffee kept in such cups stays hot longer.



List some materials around you and **classify** them as good or poor conductors of heat in Table 7.2.

Table 7.2: List of good or poor conductors of heat

S.No.	Material	Good or Poor conductor of heat
1.	Steel	Good conductor
2.	Wood	
3.		

Does your list include air? If it is there on the list, where have you placed it?

You must have experienced that during winters, we prefer wearing woollen clothes to keep ourselves warm.

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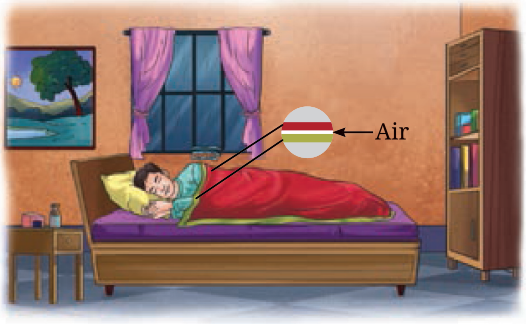


Fig. 7.2: Air trapped between two thin blankets acts as an insulator

Woollen fabric traps air in its pores and as air is a poor conductor of heat, it reduces heat flow from our bodies to our surroundings. As a result, we feel warm. Similarly, air trapped between the layers of clothing acts as a poor conductor of heat and keeps us warm. The presence of air between two thin blankets is the reason why we prefer them over one thick blanket to keep us warm (Fig. 7.2).

Is it possible to construct houses that are not affected much by the outside heat and cold? Houses constructed in places with a very hot or cold climate often use the concept of heat transfer to keep them cool or warm.



Fascinating Facts

The upper regions of the Himalayas, such as the Mori block of Uttarkashi in Uttarakhand, experience an extremely cold climate and heavy snowfall during winters. Houses here are often built to stay warm during winters, with walls made of two wooden layers filled with cow dung and mud between them. As wood and mud are poor conductors of heat, they prevent heat loss and help in keeping the houses warm.

There are houses with outer walls that are constructed using hollow bricks that keep them warm in winters and cool in summers. This happens because the air that gets trapped in the hollow bricks is a poor conductor of heat.



Pema draws Palden's attention to the rising smoke from the burning firewood, around which they are sitting.

7.2 Convection

To understand why smoke rises, let us perform an activity.

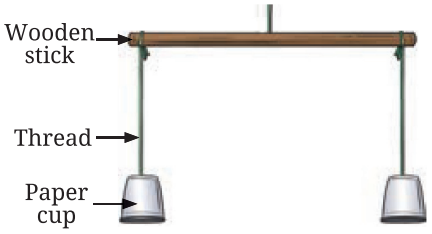


Fig. 7.3(a): Initial set-up

Activity 7.2: Let us investigate

- Take two identical paper cups.
- Hang them using threads of equal length in an inverted position on the two ends of a wooden stick, as shown in Fig. 7.3a.

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- Now, adjust the positions of the cups, so that the stick is horizontal.
- Place a burning candle below one of the cups (Fig. 7.3b).
- Observe what happens to the cup.
- Record your observations in Table 7.3 and think of probable reasons.

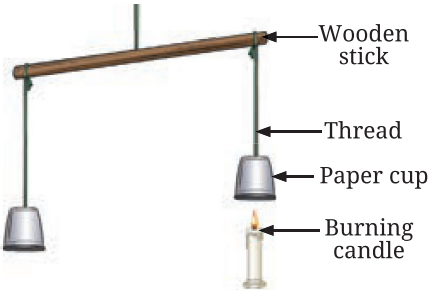


Fig. 7.3(b): Hot air rising up

Table 7.3: Recording observations and probable reasons

Observation about the cups	Probable reasons for the observation

You observed that the cup under which the candle was placed, rises up (Fig. 7.3b). Why is it so? The air around the candle flame heats up. As the air in the cup warms up, it expands and occupies more space. As a result, it becomes lighter and rises up.

You can experience the expansion of air on heating it by placing a partially inflated balloon in the Sun (Fig. 7.4). After the air in the balloon gets heated, it expands and the balloon becomes larger.

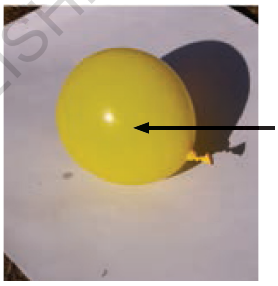
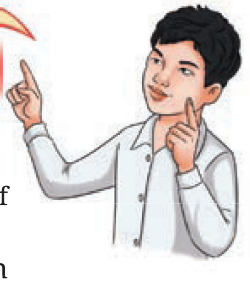


Fig. 7.4: An inflated balloon in the Sun

You must have observed that when an incense stick (*agarbatti*) is burnt, smoke rises up. Smoke is a mixture of hot gases and tiny solid particles that are released when something burns. As it is warmer than the surrounding air, it rises up.

Let us find out how heat transfer takes place in liquids by performing the following activity.

How does heat transfer take place in liquids? Do liquids also rise up when heated like air?



Activity 7.3: Let us find out

Caution—This activity should be carried out under the supervision of a teacher or an adult.

- Take a 500 mL beaker, half-filled with water as shown in Fig. 7.5a.
- With the help of a straw, place a grain of potassium permanganate at the centre of the beaker's base (Fig. 7.5a).
- Place a candle right below the centre of the base of the beaker.

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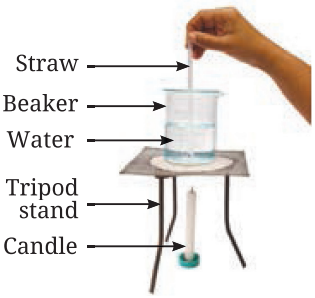


Fig. 7.5(a): Initial set-up for demonstration

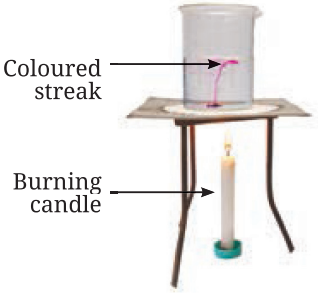


Fig. 7.5(b): Demonstration of convection in heated water

- Observe the movement of the coloured streak in the water.
- As you supply heat, a streak of colour starts moving up and then coming down from the sides (Fig. 7.5b).

Why does the streak of coloured water go up in the middle and come down from the sides? The water at the bottom of the beaker gets heated up and becomes hot. It expands, becomes lighter, and rises. The water on the sides of the beaker is comparatively cooler and heavier, and comes down to take the place of the rising water. Then, this water gets heated and in turn also rises.

This cycle continues until the entire volume of water gets heated. In this case, the entire volume of water gets heated through the actual movement of water particles. This process of heat transfer is known as **convection**. It is because of convection that we see the movement of the coloured streak inside the beaker.

Thus, we can **conclude** that water, like air, gets heated up by the process of convection. Here, heat transfer takes place by the actual movement of particles of liquids and gases from one place to another.

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7.2.1 Land and Sea Breeze

Palden shares his experience of visiting a beach in Kerala during winter vacation and says, “During the day, the sand or soil near the beach is hotter than the water in the sea. However, at night, the sand or soil is cooler than the water.” Pema replies, “Yes, different objects get heated and cooled differently.”

Let us check how land and water get heated and cooled by performing an activity.

Activity 7.4: Let us investigate

Caution—This activity should be carried out on a clear, sunny day under the supervision of a teacher or an adult.

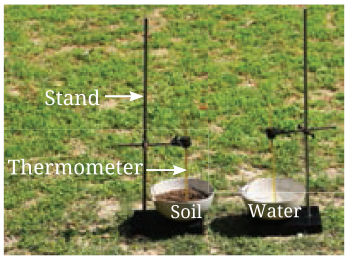


Fig. 7.6: Measurement of the temperature of soil and water

- Take two identical bowls as shown in Fig. 7.6.
- Fill one bowl halfway with soil and the other bowl halfway with water.
- Fix a laboratory thermometer in each bowl as shown in Fig. 7.6. Make sure that the bulbs of the thermometer are immersed in soil and water, and do not touch the bottoms or the sides of the bowls.
- Place the set-up in sunlight.

- Measure the temperature of soil and water every 5 minutes and record the data in Table 7.4.

Table 7.4: Temperature of soil and water when heated

S.No.	Time (min)	Temperature of soil (°C)	Temperature of water (°C)
1.	0		
2.	5		
3.	10		
4.	15		
5.	20		

- Study the rise in temperature of soil and water.
- Did the temperature rise by the same amount for both the soil and the water at the same time?
- If not, which one got heated faster?
- How much was the rise in temperature of the soil and the water in 20 minutes?

After 20 minutes, you will find that the temperature of the soil rises more than that of the water. This indicates that the soil heats up faster than water.

Does the soil also cool faster than water? After letting the soil and water get heated, bring the set-up indoors and let it cool for 20 minutes. You will observe that the soil cools faster than water, just as it gets heated faster.

People living in coastal areas experience an interesting phenomenon caused by the heating and cooling of land and water at different rates. As the land gets heated faster than water during the day, it causes warm air above the land to rise. This causes cooler air to move from the sea towards the land. This movement of cooler air from the sea to the land is called **sea breeze** (Fig. 7.7a). Hence, in hot places, sea breeze relieves people from the heat. That is why, windows of the houses in coastal areas are placed facing the sea.

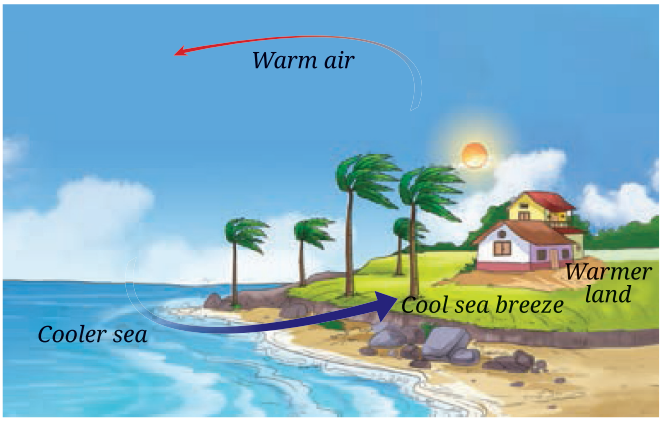


Fig. 7.7(a): Sea breeze

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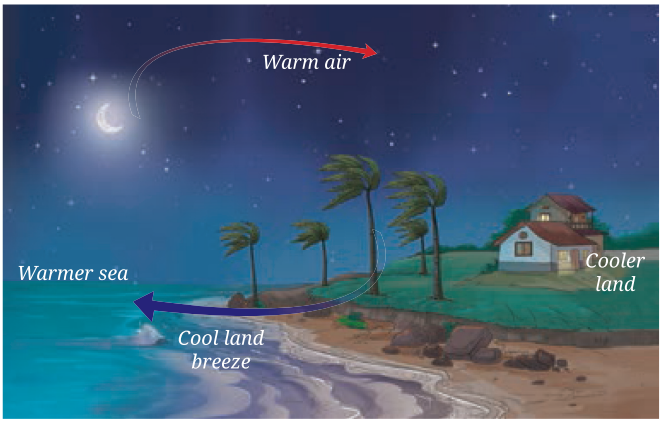


Fig. 7.7(b): Land breeze

At night, the process reverses. In the absence of sunlight, land cools down faster than the water in the sea. As a result, the air above the sea is warmer and rises up. Cooler air from the land then moves towards the sea, creating a **land breeze** (Fig. 7.7b).

Thus, people living near the seashore experience that the direction of the wind reverses in the day and night.

7.3 Radiation



I wonder how heat from the fire reaches us?

Do you remember when Pema and Palden were sitting around the fireplace? They felt warm.

Their grandfather tells them that the heat transfer, in this case, takes place directly from the fire (hot object) to us by a process known as **radiation**. The heat of the Sun reaches us through this process. Heat transfer by radiation does not require any medium.

All objects radiate heat. You must have observed that a hot utensil kept away from the flame cools down after some time. What is the reason for it? The hot utensil cools down by radiating heat to its surroundings.

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DIVE DEEPER

Why is it more comfortable to wear white or light-coloured clothes during summers and dark-coloured clothes during winters?

Light-coloured clothes reflect most of the heat that falls on them, and therefore, we feel more comfortable wearing them during summers. Dark surfaces, on the other hand, absorb more heat, and therefore, we feel more comfortable with dark-coloured clothes during winters.

There are many examples in our daily life, where we can observe conduction, convection, and radiation happening together.

Consider the case of water being heated up, as shown in Fig. 7.8. Let us **identify** the various ways in which the pan and the water get heated up, as well as the warmth we feel around the flame and the hot pan. Heat is transferred from the flame to the utensil by conduction. Subsequently, water in the utensil gets heated up by convection. The warmth that we feel around the flame and the hot utensil is due to radiation.



Fig. 7.8: Heating water in a pan

Let us wrap up!

From the activities, examples, and discussions so far, we find that there are three processes by which heat gets transferred. These are conduction, convection, and radiation.

- In conduction, heating takes place when one particle receives heat, transfers heat to the next particle in contact, and so on. The particles themselves do not move away from their positions.
- In convection, heat transfer takes place by the actual movement of particles.
- Note that in conduction and convection, a medium must be present whose particles help in the transfer of heat.
- In the case of radiation, heat travels from one place to another and no material medium is required for its transfer.

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Fascinating Facts

In the upper reaches of the Himalayan region, a traditional room heater locally known as *bukhari* is used to keep rooms warm during winters. It consists of an iron stove in which wood or charcoal is burnt. A long pipe attached to the upper part of the heater serves as a chimney, venting out the smoke. Additionally, the *bukhari* can be used for cooking, as its flat top provides a platform for placing utensils. All the three processes of heat transfer are involved when this device is used for cooking and warming up the room.



Bukhari



You have learnt in the Grade 6 Science textbook *Curiosity*, that the Sun is the main source of heat for the Earth. You have seen your parents drying wet clothes on the clothesline at home. Wet clothes dry faster on a sunny day since the heat from the Sun makes the evaporation of water faster.

Thus, heat from the Sun plays an important role in the evaporation of water, be it from clothes drying on a line or from water bodies like oceans and lakes. Let us look at the phenomenon of water cycle to understand this in more detail.

7.4 Water Cycle

You have also learnt in the Grade 6 Science textbook *Curiosity*, that water exists in three states in nature. As a liquid, it fills the oceans, rivers, and lakes on the Earth. As a solid, it forms snow, ice sheets, and glaciers in the mountains and the polar regions. As a gas, it exists in the form of water vapour in the Earth's atmosphere. During summers, some of the snow and ice gets converted to water due to the Sun's radiation and flows down as rivers, and ultimately into the oceans. The melted ice is replenished by fresh snow during winters.

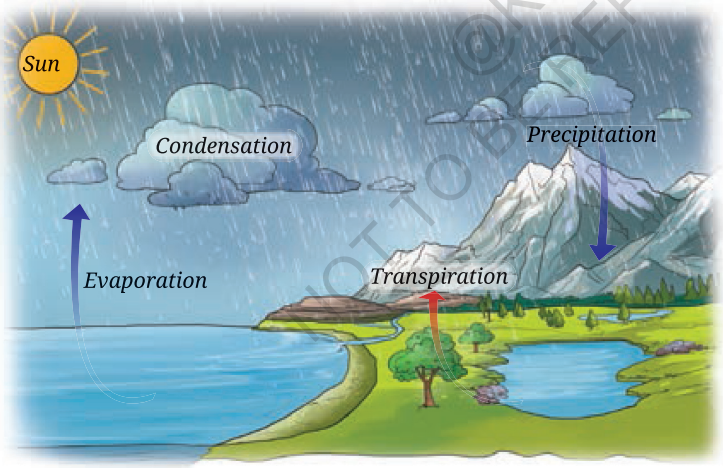


Fig. 7.9: Water cycle

Water in the oceans, rivers, and lakes gets heated due to the Sun, and as a result, it evaporates as water vapour. Water also evaporates from trees and plants through transpiration.

When water vapour rises up, it cools down and condenses to form clouds. Clouds bring rain, snow, and hail. This process is called **precipitation**.

The continuous movement of water — upward as water vapour and downward through precipitation, passing through soil, rocks, and plants, and finally returning to water bodies, is called **water cycle** (Fig. 7.9). Thus, the water cycle helps in redistributing and replenishing water in rivers, lakes, and oceans. It also serves to conserve the total amount of water on the Earth. Rainwater that falls on the surface of the Earth, flows into ponds, lakes, rivers, and oceans or seeps into the ground.

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Know a Scientist

Varahamihira was an astronomer and mathematician of the sixth century CE in Ujjaini (modern-day Ujjain), Madhya Pradesh. In his work *Brihatsamhita*, he gave methods for predicting seasonal rainfall. His predictions of seasonal rainfalls were based on factors, such as cloud formation, wind patterns, position of stars and the moon, and other natural phenomena.

You may have seen people drawing water from wells or handpumps. This is the water that has seeped into the ground.

Let us understand how water seeps through the surface of the earth by performing an activity.

How does water seep through the surface of the Earth?



7.4.1 Seepage of water beneath the Earth

Activity 7.5: Let us investigate

- Take three transparent, used plastic bottles of 1 L capacity.
- Cut them in the middle and make a small hole in the cap of each bottle.
- Keep them inverted and put some clay in one bottle, sand in the second, and gravel in the third, as shown in Fig. 7.10.

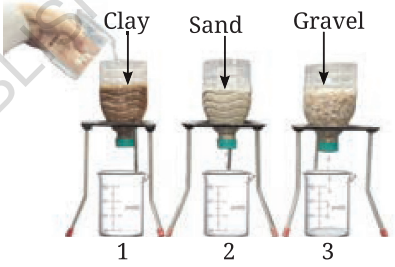


Fig. 7.10: An activity to compare the flow of water through clay, sand and gravel

- Place three identical beakers below each bottle.
- Add 200 mL of water to each bottle.
- Predict the amount of water flowing out of each bottle.
- Collect the water that flows through each bottle for 10 minutes.
- Compare the amount of water that comes through each bottle.

Table 7.5: Seepage of water

Bottles filled with	Prediction	Observation
	Seepage of water (very slow/slow/fast)	Seepage of water (very slow/slow/fast)
Bottle 1 (Clay)		
Bottle 2 (Sand)		
Bottle 3 (Gravel)		

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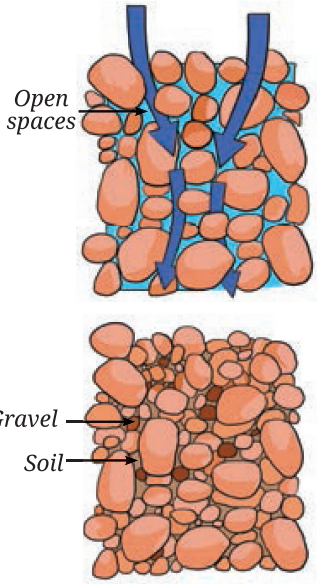


Fig. 7.11: Water readily moves, and is stored where spaces are wide, open and connected

Do your findings match with your predictions?

You may have observed that water seeps fastest through gravel, slower through sand, and slowest through clay. Why is it so? The spaces between gravel particles are wider when compared to those in sand and clay. Hence, water can seep through the gravel more easily. In this way, water seeps beneath the surface of the Earth. This process of surface water seeping through soil and rocks is called **infiltration**. Water can infiltrate more readily if the spaces between soil and rock particles are wider, open, and interconnected (Fig. 7.11).

The water that seeps through gets stored in the pore spaces of sediments and the openings in rocks beneath the surface as **groundwater**. The underground layers of sediments and rocks that store water in pore spaces are called **aquifers** (Fig. 7.12). This is the water we extract by digging wells or drilling bore wells into aquifers. This water may be a few metres to hundreds of metres below the ground, depending on the location.



Fig. 7.12: Aquifer

However, groundwater is not unlimited. The growing water requirements of an increasing population have led to excessive groundwater extraction. Additionally, decreased vegetation cover and increased concrete surfaces in urban areas have limited water infiltration. As a result, groundwater is getting depleted. To address this, rainwater harvesting and recharge pits are used to replenish groundwater. Hence, the water cycle ensures that groundwater sources are recharged, thereby helping to ensure a sustainable groundwater supply.

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Since water scarcity makes life difficult, people have developed different ways to conserve water. For example, in Ladakh, people have developed innovative ways to conserve water by making ice stupas (Fig. 7.13) during the winters.

Science and Society

Ice Stupa

During the spring season in Ladakh, streams often dry up, leading to scarcity of water as the heat from the Sun's radiation is not enough to melt the snow on the mountains. During winters, water from mountain streams is channeled down through underground pipes. This water is then sprayed into the cold air. As it falls, it freezes due to extremely low temperatures.

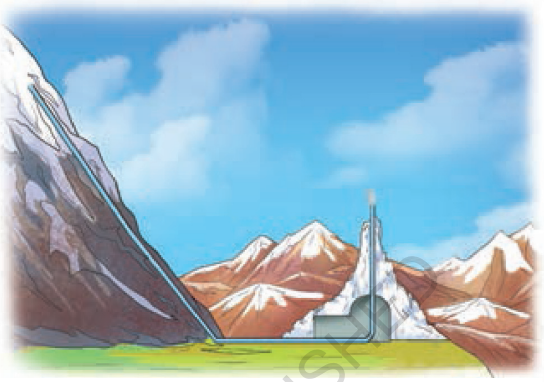


Fig. 7.13: Ice stupa

The ice builds up layer by layer, creating a tall, cone-shaped structure called an **ice stupa** as shown in Fig. 7.13. The ice stupa melts slowly during spring, providing water for farming and other needs throughout the summer.

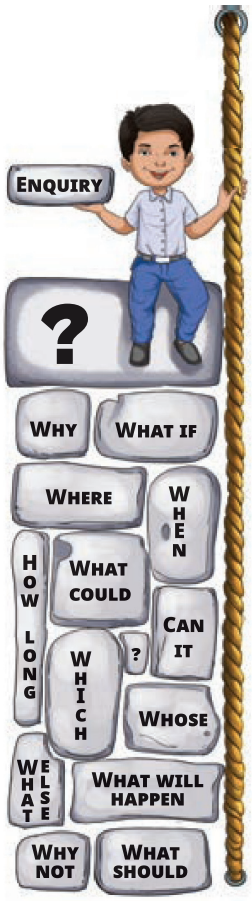


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In a Nutshell

- There are three ways in which heat is transferred from one place to another—conduction, convection, and radiation.
- The process of heat transfer from the hotter part of an object to a colder part is called conduction. In this process, particles do not move from their positions.
- Materials that allow heat to pass through them easily are called good conductors of heat.
- Materials that do not allow heat to pass through them easily are called poor conductors (insulators) of heat.
- In solids, heat is mainly transferred through the process of conduction. In liquids and gases, heat is transferred by the process of convection.





- In convection, heat transfer takes place by the actual movement of particles. Land and sea breezes are examples of the process of convection.
- Heat from the Sun reaches the Earth through radiation.
- All objects exchange heat with their surroundings through the process of radiation.
- Processes of conduction and convection require a medium for heat transfer but no medium is required for the radiation process.
- The principles of heat transfer are utilised in designing houses and clothing.
- The continuous movement of water—upward as water vapour and downward through precipitation, passing through soil, rocks and plants, and finally returning to water bodies, is called water cycle.
- The process of surface water seeping through soil and rocks is called infiltration.
- Groundwater is the water that seeps through and gets stored in the pore spaces of sediments and the openings in rocks beneath the surface.
- The underground layers of sediments and rocks that store water in pore spaces are called aquifers.

Let Us Enhance Our Learning

1. Choose the correct option in each case.

(i) Your father bought a saucepan made of two different materials, A and B, as shown in Fig. 7.14. The materials A and B have the following properties—

(a) Both A and B are good conductors of heat
(b) Both A and B are poor conductors of heat
(c) A is a good conductor and B is a poor conductor of heat
(d) A is a poor conductor and B is a good conductor of heat

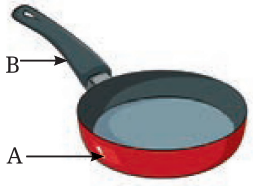


Fig. 7.14: Saucepan

(ii) Pins are stuck to a metal strip with wax and a burning candle is kept below the rod, as shown in Fig. 7.15. Which of the following will happen?

(a) All the pins will fall almost at the same time
(b) Pins I and II will fall earlier than pins III and IV
(c) Pins I and II will fall later than pins III and IV
(d) Pins II and III will fall almost at the same time

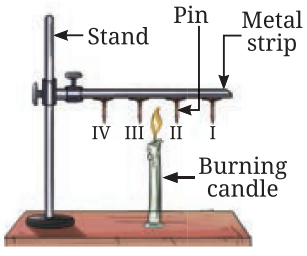
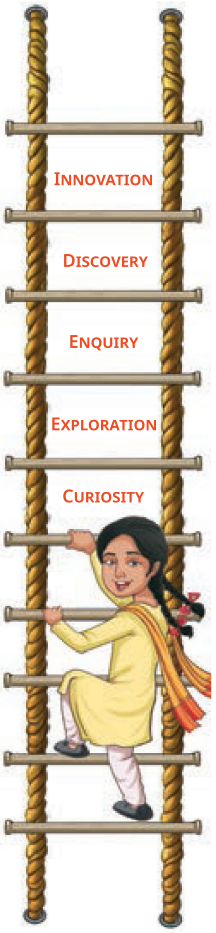


Fig. 7.15: Heat transfer set-up

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(iii) A smoke detector is a device that detects smoke and sounds an alarm. Suppose you are fitting a smoke detector in your room. The most suitable place for this device will be:

(a) Near the floor
(b) In the middle of a wall
(c) On the ceiling
(d) Anywhere in the room



2. A shopkeeper serves you cold *lassi* in a tumbler. By chance, the tumbler had a small leak. You were given another tumbler by the shopkeeper to put the leaky tumbler in it. Will this arrangement help to keep the *lassi* cold for a longer time? Explain.
3. State with reason(s) whether the following statements are True [T] or False [F].
   (i) Heat transfer takes place in solids through convection. [ ]
   (ii) Heat transfer through convection takes place by the actual movement of particles. [ ]
   (iii) Areas with clay materials allow more seepage of water than those with sandy materials. [ ]
   (iv) The movement of cooler air from land to sea is called land breeze. [ ]
4. Some ice cubes placed in a dish melt into water after sometime. Where do the ice cubes get heat for this transformation?
5. A burning incense stick is fixed, pointing downwards. In which direction would the smoke from the incense stick move? Show the movement of smoke with a diagram.
6. Two test tubes with water are heated by a candle flame as shown in Fig. 7.16. Which thermometers (Fig. 7.16a or Fig. 7.16b) will record a higher temperature? Explain.

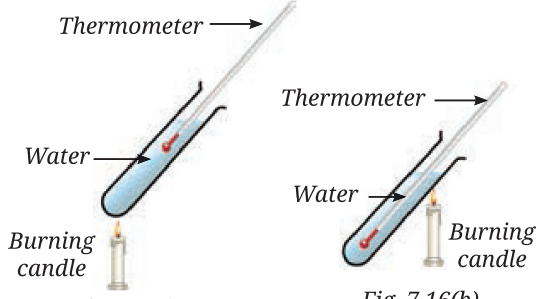


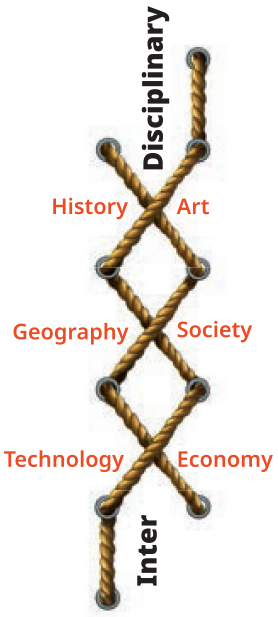
Fig. 7.16(a) Fig. 7.16(b)

Fig. 7.16: Two thermometers dipped in two test tubes

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7. Why are hollow bricks used to construct the outer walls of houses in hot regions?
8. Explain how large water bodies prevent extreme temperature in areas around them.
9. Explain how water seeps through the surface of the Earth and gets stored as groundwater.
10. The water cycle helps in the redistribution and replenishment of water on the Earth. Justify the statement.

Exploratory Projects



- Society: Visit a site of water harvesting or a recharge pit. Find out from people how they are constructed and how they work. Prepare a report with illustrations.
- Activity: Tightly wrap a thin paper strip around a metallic rod. Try to burn the paper with a candle while rotating the rod continuously. Does the paper burn? Explain your observations.
- Activity: Take a sheet of paper. Draw a spiral on it, as shown in Fig. 7.17a. Cut the paper along the spiral. Suspend the paper as shown in the Fig. 7.17b above a burning candle. Observe what happens. Provide an explanation for your observation.

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Fig. 7.17(a): Cutting paper in spiral



Fig. 7.17(b): Spiral paper above a burning candle

8 Measurement of Time and Motion

Prerna and her younger sister are watching a sports channel on television. Prerna enjoys running and she has been declared the fastest runner among the girls in her district for winning the 100 metre sprint at an interschool competition held at the district level. She is now training to compete at the state level. She dreams of representing India at the international level in 100 metre sprint contests in future.

While watching the rerun of sprints at the Olympic games held in the past, Prerna is always amazed that the measurement of the time taken for the race is so advanced that they could identify the winner even when two sprinters seemed to cross the finish line almost together. However, in her school, the sports teacher only used a special kind of watch called a 'stopwatch' for timing the school races. She had noticed her mother wearing a watch on her wrist and her sister looking at her mobile phone when she needed to check the time. Her uncle used a Braille watch and had recently acquired a talking watch that announced the time at the touch of a button. There was also a large clock on the wall near the school entrance. Her thoughts turned to people in the ancient past, who did not have the modern gadgets we have today and she wondered...

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How was time measured when there were no clocks and watches?

8.1 Measurement of Time

Humans got interested in keeping track of time long ago. They started noticing that many events in nature repeat themselves after definite intervals of time. For example, the rising and setting of the Sun, the phases of the Moon and the changing seasons. They started using the cycles of these events for timekeeping. First, they devised calendars. A day was defined by the cycle of rising and setting of the Sun. Then began the quest to find ways of knowing the time of day.



Fig. 8.1 A sundial

So, they made many devices which helped them to measure smaller intervals of time within a day. Some of these were sundials, water clocks, hourglasses, and candle clocks.

In a sundial, time is determined with the changing position of the shadow of an object cast by the light of the Sun during the day (Fig. 8.1).

The water clocks used the flow of water out or into a vessel to measure time. In one type, water flowed out from a vessel which had markings for time (Fig. 8.2a). In the other type, there would be a bowl, with a fine hole at the bottom, which was floated on the surface of water (Fig. 8.2b). It gradually filled up in a fixed time and finally sank. Then, it was lifted up and floated again.



(a) (b)

Fig. 8.2 A water clock (a) Water flowing out-type (b) Floating bowl-type

In an hourglass (Fig. 8.3), time was measured on the basis of the flow of sand from one bulb to another.

Candle clocks (Fig. 8.4) were candles with markings that indicated the passage of time when burned.



Fig. 8.3 An hourglass



Fig. 8.4 A candle clock

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Fascinating Facts



The world's largest stone sundial, the Samrat Yantra, was built around 300 years ago at the Jantar Mantar, in Jaipur, Rajasthan, a UNESCO World Heritage site that houses several astronomical instruments. With its imposing height of 27 metres, its shadow moves at about 1 millimetre per second and falls on a scale finely marked to measure time intervals as short as 2 seconds. Like any sundial, it measures local or 'solar time', requiring a correction to determine Indian Standard Time.



Should we make a simple water clock?

Activity 8.1: Let us construct

- Take a used transparent plastic bottle (1/2 litre or larger) with its cap.
- Cut it into two, roughly in the middle as shown in Fig. 8.5a.
- Using a drawing pin, make a small hole in the cap of the bottle (Fig. 8.5b).



(a) (b) (c) (d)

Fig. 8.5: Making a simple water clock

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- Place the upper part of the bottle in an inverted position over the lower half (Fig. 8.5c).
- Fill the upper part of the bottle with water. You may add a few drops of ink or colour to make the water level easily visible (Fig. 8.5d).
- The water will start dripping into the lower part of the bottle. Using a watch, mark the level of water after every one minute till all the water drips down.

Your water clock is ready. Can you now guess how to use it? Pour the water from the lower part back into the top part and watch the level of water dripping into the lower part. Every time it touches a mark made by you, one more minute has passed.

Fascinating Facts

In ancient India, time was measured using both shadows and water clocks. The earliest reference to shadow-based time measurement appears in the *Arthasastra* by Kautilya (was composed and revised between the second century BCE–third century CE). An accurate expression for time in terms of the shadow of a vertical stick was given by Varahamihira around 530 CE. The water clock with water flowing out was described in the *Arthasastra*, *Sardulakarnavadana*, and some other texts (early CE centuries). These clocks were not very accurate because as water levels dropped, the flow rate decreased. This led to the development of the sinking bowl water clock (Fig. 8.2b), or *Ghatika-yantra*, first mentioned by Aryabhata, and then in several astronomical texts later. Time was measured constantly with *Ghatika-yantra* at Buddhist monasteries, royal palaces, town squares, and each time the bowl sank, it was announced by drums, conch shells, or striking a gong. Though the *Ghatika-yantra* was progressively replaced by pendulum clocks in the late nineteenth century, it continued to be used at the religious places for rituals.



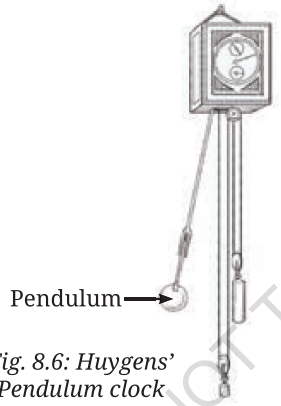


Fig. 8.6: Huygens' Pendulum clock

As human civilisation advanced, and as people began to travel long distances, the measurement of time became very critical. This led to the development of increasingly better mechanical devices for the measurement of time, driven by weights, gears, and springs from the fourteenth century onwards. However, the invention of the pendulum clock in the seventeenth century marked a major breakthrough in mechanical timekeeping.

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Know a Scientist



The pendulum clock was invented in 1656 and patented in 1657 by Christiaan Huygens (1629–1695). He was inspired by the investigations of pendulums by Galileo Galilei (1564–1642). It is said that once while sitting in a church, Galileo's attention was drawn to a lamp suspended from the ceiling, which was swinging back and forth. Using his pulse to measure time, Galileo found that the lamp took the same time for each swing. After experimenting with different pendulums, Galileo concluded that the time taken to complete one oscillation was always the same for a pendulum of a given length.

8.1.1 A simple pendulum

A simple pendulum consists of a small metallic ball (called the **bob** of the pendulum) suspended from a rigid support by a long thread as shown in Fig. 8.7a.

We did an activity in the chapter 'Measurement of Length and Motion' in the Grade 6 Science textbook *Curiosity*, where we observed the oscillatory motion of an eraser hung with a thread. Is the pendulum similar to that?



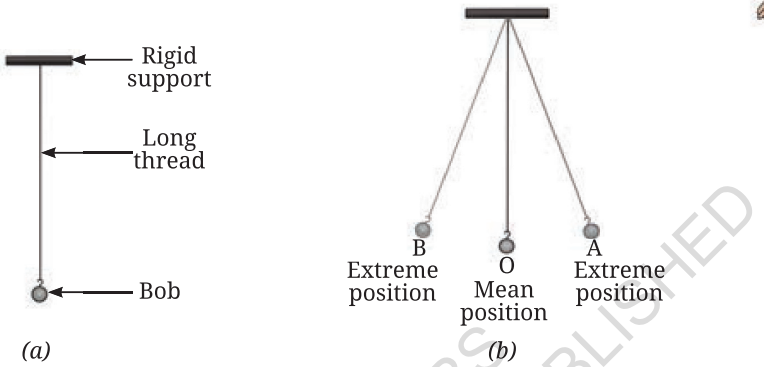


Fig. 8.7 A simple pendulum

The pendulum at rest is in its mean position. When the bob of the pendulum is moved slightly to one side and released, it starts oscillatory motion. Its motion is **periodic** in nature because it repeats its path after a fixed interval of time.

The pendulum is said to have completed one oscillation when its bob, starting from its mean position O, moves to extreme position A, changes direction and moves to another extreme position B, changes direction and comes back to O (Fig. 8.7b). The pendulum also completes one oscillation when its bob moves from one extreme position A to another extreme position B and comes back to A. The time taken by the pendulum to complete one oscillation is called its **time period**. Let us now set up a pendulum and measure its time period.

Activity 8.2: Let us experiment

- Collect a piece of string around 150 cm long, a heavy metal ball with hook/ a stone (bob), a stopwatch/ watch, and a ruler.
- Tie the bob at one end of the string.
- Fix the other end of the string to a rigid support such that the length of the string in between support and bob is around 100 cm.
- Wait for the bob to come to rest. Your pendulum is now ready.

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- Gently hold the bob, move it slightly to one side and release it. Take care not to push the bob while releasing it and that the string is taut. Is your pendulum now oscillating?
- Using a watch, **measure** the time it takes for the pendulum to complete 10 oscillations. **Record** the time in Table 8.1.
- Repeat this activity 3–4 times.
- Divide the time taken for 10 oscillations by 10 to **calculate** the time period of your pendulum. Note it down in Table 8.1.

Table 8.1 Time period of a simple pendulum

Length of the string = 100 cm

S.No.	Time taken for 10 oscillations (seconds)	Time period (seconds)
1.		
2.		
3.		

Is the time period of your pendulum almost the same every time? What do you **conclude** from this observation? The time period of the pendulum is almost the same every time.

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Think Like a Scientist!



You just did an important historical experiment which was first done by Galileo, except you used a watch to measure time in place of your pulse beat. Suppose you were Galileo experimenting with pendulums, what all would you investigate? What questions could you ask? Would all pendulums have the same time period? How would you test this?

Repeat Activity 8.2 using the same bob but with pendulums of two or three different lengths. Does the time period change? If so, how does the length affect it? If changing the length influences the time period, does the bob's mass also matter? Test this by repeating Activity 8.2 with a fixed pendulum length but with bobs of different mass. Do you observe any change?

The time period of a simple pendulum depends on its length but not on the bob's mass. All pendulums of the same length have the same time period at a given location.

The time period of a simple pendulum of a given length is constant at a place. This property is used in the measurement of time.

All clocks, old or modern, are based on some process repeating continuously, which can be used to mark equal intervals of time.

DIVE DEEPER

Modern clocks measure time using the same basic principle—periodically repeating processes—but use tiny and very rapid vibrations either from a quartz crystal (quartz clocks) or from some specific atoms (atomic clocks). While Huygens' early pendulum clocks could gain or lose 10 seconds each day, today's atomic clocks are so precise that they lose only one second in millions of years! Scientists are constantly searching for even better ways to measure time with greater accuracy.



Fig. 8.8: Some common clocks and watches

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8.1.2 SI unit of time

The **SI unit of time** is the **second**. Its **symbol** is **s**. The larger units of time are **minute** (**min**) and **hour** (**h**).

60 s = 1 min 60 min = 1 h

DIVE DEEPER

Units of time, such as second, minute, and hour begin with a lowercase letter, except at the beginning of a sentence. Their symbols 's', 'min', and 'h' are also written in lowercase letters and in singular. Note that a full stop is not written after the symbol, except at the end of a sentence. While writing the time, always leave a space between the number and the unit. Also, note that writing 'sec' for second and 'hrs' for hour is incorrect.

FASCINATING FACTS

The hole in the bowl of *Ghatika-yantra* was made in such a manner that it took 24 minutes to fill and sink. The time unit measured by this clock was called *ghatika* or *ghati*. It became the standard unit of time measurement and continued until the end of the nineteenth century. A 24-hour-long day was, thus, divided into 60 equal *ghatis*.



Fig. 8.9: A wall clock

Activity 8.3: Let us identify

- Look at the wall clock shown in Fig. 8.9 carefully. What is the smallest interval of time you can measure with it?

One second is the smallest interval of time that we can measure using this clock.

Science and Society

In today's world, measuring tiny fractions of a second is very important! For example, in sports, timekeeping devices can record events down to one-hundredth or even one-thousandth of a second (a millisecond) to determine the winners in a race. In medicine, heart monitors like Electrocardiogram (ECG) machines measure the millisecond variations in heartbeats to detect health issues. In music, digital recordings capture sound thousands of times per second for smooth playback. Many devices use even shorter intervals, smartphones, and computers process signals in microseconds (one-millionth of a second), allowing them to operate very fast. Scientists continue to develop even more precise time-measuring tools for space exploration, medicine, and advanced science experiments. The faster and more accurate our clocks become, the more they help society in ways we may not even notice!



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For races covering the same distance, we can tell who was faster by measuring time. But how can we tell that when comparing races for different distances?

8.2 Slow or Fast

What do we mean when we say something is moving fast or slow? Suppose you are watching a 100 metre race on a straight track. All the players begin from the starting line together but after sometime they are not running together (Fig. 8.10). How do you **decide** who is running faster amongst them?



Fig. 8.10: Boys running a race on a straight track

Someone who is ahead of others at some instant of time, is running faster than them. Hence, someone who has covered more distance within the same time is running faster.

The distances moved by objects in a given interval of time decide which one is faster or slower. We often say that the faster runner has a higher speed. You are probably familiar with the word 'speed'.

8.3 Speed

By comparing the distances moved by two or more objects in a unit time, it can be found out which of them is moving faster. The unit time may be one second or one minute or one hour. We call the distance covered by an object in a unit time as the **speed** of the object.

How can we **determine** the speed of an object? It can be calculated, if we know the total distance covered by an object and the time taken to cover it. The speed of an object is the total distance covered divided by the total time taken to cover it. Thus,

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

What would be the unit of speed? We know the SI units of length and time. Since the speed is distance/time, the **SI unit of speed** is **metre/second** and is expressed as **m/s**.

Speed can also be expressed in other units. If we **express** the distance in kilometre and time in hour, then the unit of speed is **kilometre/hour**, expressed as **km/h**.

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Example 8.1: Swati's school is 3.6 km from her house. It took her 15 min to reach her school riding on her bicycle. Calculate the speed of the bicycle in m/s.

Solution: Speed of the bicycle $= \frac{\text{Distance covered}}{\text{Time taken}}$

$$= \frac{3.6 \text{ km}}{15 \text{ min}}$$

$$= \frac{3.6 \cancel{\text{km}} \times 1000 \frac{\text{m}}{\cancel{\text{km}}}}{15 \cancel{\text{min}} \times 60 \frac{\text{s}}{\cancel{\text{min}}}}$$

$$= \frac{3.6 \times 1000 \text{ m}}{15 \times 60 \text{ s}}$$

$$= 4 \text{ m/s}$$

Activity 8.4: Let us calculate

- Look up at the railway timetable on the internet.
- **Identify** a train stopping at the railway station nearest to your place of stay.
- Find out the name of the next station where this train stops. Also, find the distance to that station as given in the timetable.
- Note the time at which the train departs from your station and arrives at the next station. Find the difference to calculate the time taken by the train to cover the distance till the next station.
- Calculate the speed of the train between the two stations and record it in Table 8.2.
- Repeat for 4–5 different types of trains (Passenger/ Express/ Superfast).

Table 8.2: Finding the speed of trains

Name of the railway station nearest to your place of stay _____.

S.No.	Name of the train	Name of the next station	Distance till the next station (km)	Time taken till the next station (h)	Speed of the train between these two stations (km/h)

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❖ **Compare** the speeds of the trains. Which is the fastest train?

The train which has covered the maximum distance in unit time is the fastest train, that is, the one with the highest speed.

8.3.1 Relationship between speed, distance, and time

We already know how to calculate speed using

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

if the distance travelled and time taken for it are known to us.

We can write this equation in a different form to calculate the distance covered by an object, if we know its speed and the time taken, by using

Total distance covered = Speed × Total time taken

Similarly, we can also calculate the time an object will take to cover a distance, if the distance and speed are given, by using

$$\textbf{Total time taken} = \frac{\textbf{Total distance covered}}{\textbf{Speed}}$$

Example 8.2: Raghav is going to a neighbouring city in a bus moving at a speed of 50 km/h. If it takes him 2 h to reach that city, how far is that city?

Solution: Distance covered by bus = Speed × Time

$$= 50\frac{\text{km}}{\cancel{\text{h}}} \times 2\cancel{\text{h}}$$
$$= 100 \text{ km}$$

Example 8.3: A train is travelling at a speed of 90 km/h. How much time will it take to cover a distance of 360 km?

Solution: Time taken by the train = $\frac{\text{Distance covered}}{\text{Speed}}$

$$= \frac{360\cancel{\text{km}}}{90\frac{\cancel{\text{km}}}{\text{h}}}$$
$$= 4 \text{ h}$$

In all the examples so far, we have found the speed of an object by using 'the total distance covered divided by the total time taken'. However, the object might not have travelled with the same speed during the entire duration of time. The object might have sometimes moved slower or sometimes faster. So, the speed that we have calculated is the **average speed**, but, in this book, we have used the term 'speed' for 'average speed'.

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Science and Society

Vehicles such as scooters, motorbikes, cars, and buses have an instrument which measures and displays the vehicle's speed in km/h. It is called a speedometer. Another instrument, known as an odometer, is also fitted in the vehicles that measures the distance travelled by the vehicle in kilometre.







I once watched a part of marathon on a straight road stretch. I noticed that some people seemed to be running at the same speed during that distance while some people would speed up or slow down. How were their motion different?

8.4 Uniform and Non-uniform Linear Motion

Do you remember learning about linear motion in the chapter 'Measurement of Length and Motion' in the Grade 6 Science textbook *Curiosity*? When an object moves along a straight line, its motion is called linear motion. Now, imagine a train on a track which is along a straight line between two adjacent railway stations. So, the motion of the train between these two stations is an example of linear motion (Fig. 8.11). The train starts from the first station A at a slow speed, then moves at a faster speed, then slows down and comes to a halt at the next station D. In between the two stations, for some distance (B to C), the train moves at a constant speed, that is, at an unchanging speed.

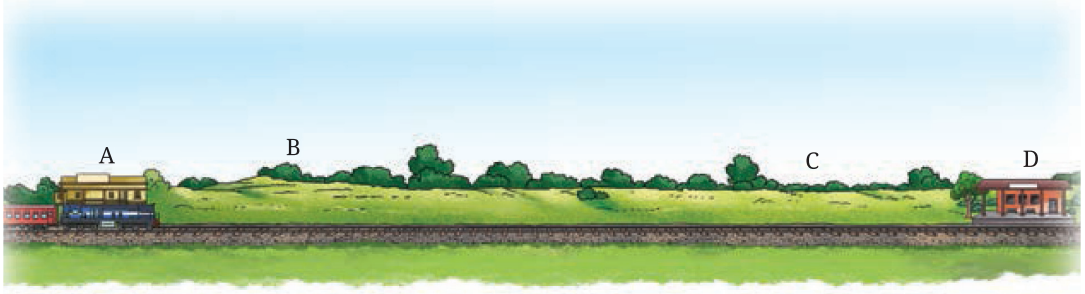


Fig. 8.11: A train on a straight track

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An object moving along a straight line with a constant speed is said to be in **uniform linear motion**. So, the train is in uniform motion between B and C (Fig. 8.11). On the other hand, if the speed of an object moving along a straight line keeps changing, it is said to be in **non-uniform linear motion**. The motion of the train between A and B, as well as between C and D, is non-uniform (Fig. 8.11).

An object in uniform linear motion covers equal distances in equal intervals of time, while it covers unequal distances in equal intervals of times when it is in non-uniform linear motion. In Table 8.3, data are given for the distances travelled by two trains, X and Y, between the time 10:00 AM and 11:00 AM.

Table 8.3: Distances travelled by two trains in equal time intervals of 10 minutes

Time (AM)	Train X		Train Y	
	Position (km)	Distance (km)	Position (km)	Distance (km)
10:00	0	0	0	0
10:10	20	20	20	20
10:20	40	20	35	15
10:30	60	20	50	15
10:40	80	20	75	25
10:50	100	20	95	20
11:00	120	20	120	25

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Which of the two trains is in uniform linear motion between 10:00 AM and 11:00 AM? Train X covers equal distances in equal intervals of time, so it is in uniform linear motion while Train Y is in non-uniform linear motion.

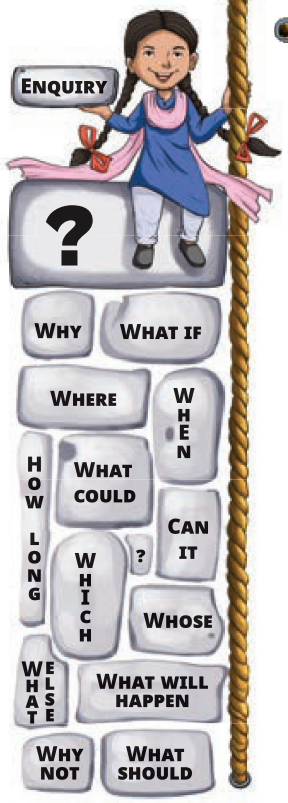
Uniform linear motion is an idealisation. In everyday life, we seldom find objects moving with a constant speed over long distances or for long intervals of time. That is why we have to use average speeds.

In a Nutshell



- ❖ The time taken by the pendulum to complete one oscillation is called its time period.
- ❖ The time period of a simple pendulum of a given length is constant at a place.
- ❖ The SI unit of time is the second. Its symbol is s.
- ❖ The average speed of an object is the total distance covered divided by the total time taken to cover it.
- ❖ An object moving along a straight line with a constant speed is said to be in uniform linear motion.
- ❖ If the speed of an object moving along a straight line keeps changing, it is said to be in non-uniform linear motion.

Let Us Enhance Our Learning



1. Calculate the speed of a car that travels 150 metres in 10 seconds. Express your answer in km/h.
2. A runner completes 400 metres in 50 seconds. Another runner completes the same distance in 45 seconds. Who has a greater speed and by how much?
3. A train travels at a speed of 25 m/s and covers a distance of 360 km. How much time does it take?
4. A train travels 180 km in 3 h. Find its speed in:
   (i) km/h
   (ii) m/s
   (iii) What distance will it travel in 4 h if it maintains the same speed throughout the journey?
5. The fastest galloping horse can reach the speed of approximately 18 m/s. How does this compare to the speed of a train moving at 72 km/h?
6. Distinguish between uniform and non-uniform motion using the example of a car moving on a straight highway with no traffic and a car moving in city traffic.
7. Data for an object covering distances in different intervals of time are given in the following table. If the object is in uniform motion, fill in the gaps in the table.

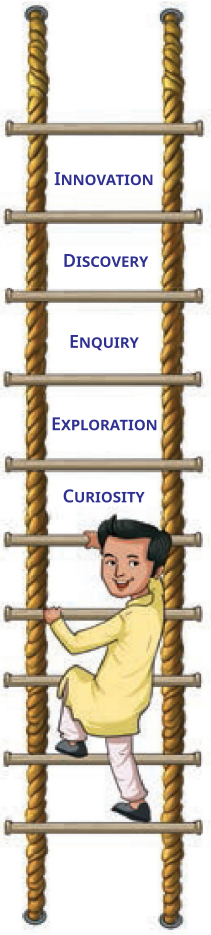
Time (s)	0	10	20	30		50		70
Distance (m)	0	8		24	32	40		56

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8. A car covers 60 km in the first hour, 70 km in the second hour, and 50 km in the third hour. Is the motion uniform? Justify your answer. Find the average speed of the car.
9. Which type of motion is more common in daily life—uniform or non-uniform? Provide three examples from your experience to support your answer.
10. Data for the motion of an object are given in the following table. State whether the speed of the object is uniform or non-uniform. Find the average speed.

Time (s)	0	10	20	30	40	50	60	70	80	90	100
Distance (m)	0	6	10	16	21	29	35	42	45	55	60

11. A vehicle moves along a straight line and covers a distance of 2 km. In the first 500 m, it moves with a speed of 10 m/s and in the next 500 m, it moves with a speed of 5 m/s. With what speed should it move the remaining distance so that the journey is complete in 200 s? What is the average speed of the vehicle for the entire journey?

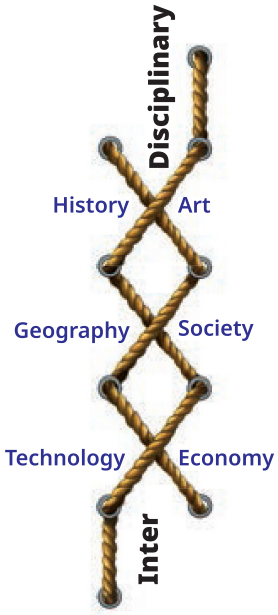


Exploratory Projects

- Construct a floating bowl-type water clock. Experiment by using bowls of different sizes and making holes of different sizes in them so that the sinking time of the bowl can be close to 24 minutes.
- Design an activity for measuring the pulse rate (number of times the pulse of a person beats in 1 minute) of your friends. Think of an activity where you can use your pulse to measure time and develop a story over that idea.
- What might be the reasons for the slight differences in the time periods of a pendulum of a given length in different readings taken in Activity 8.2. Think of ways to control those and repeat the activity to check if the difference in readings is reduced.
- Visit a playground with a few swings. Measure the time taken by a swing for 10 oscillations and calculate its time period. Repeat it a few times with children of different weights to find out if its time period is almost the same. Repeat this with swings of different lengths. Find out how the time period changes with increasing length of the swings. Is the swing also an example of a pendulum?

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❖ Gather the timings of the winners of the races—100 m, 200 m, and 400 m for men and women in the last two Olympic games. Calculate and compare their speeds. In which event is the speed the fastest?



Fascinating Facts

Time started when our Universe was created and will continue in the future. We cannot see or feel time but we can only measure its passage in terms of a time interval between events. These time intervals can be fractions of a second, or even days or months, or years or centuries. We can only say when an event occurred or for how long it lasted. Though we have learnt to measure time with increasing accuracy, and our lives are governed by watches and clocks, 'What is time?' continues to be a tricky question with no easy answer!



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9 Life Processes in Animals

மருந்தென வேண்டாவாம் யாக்கைக்கு அருந்தியது
அற்றது போற்றி உணின்.

If your food is fully digested before you eat again, you won't need medicine for pain.

(Thirukkural 942*)*

In the Grade 6 Science textbook *Curiosity*, chapter 'Living Creatures: Exploring their Characteristics', we learnt about processes essential for survival of living beings like nutrition, respiration, excretion, and reproduction. These are collectively called life processes. In this chapter, we will learn about life processes such as nutrition and respiration in detail.

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Observe your surroundings and **notice** what animals eat. Animals eat different types of food. Bees and sunbirds suck the nectar of flowers, while infants of humans and many other animals feed on their mother's milk. Snakes, like python, swallow the animals they prey upon. Some aquatic animals filter tiny food particles floating nearby and feed upon them.

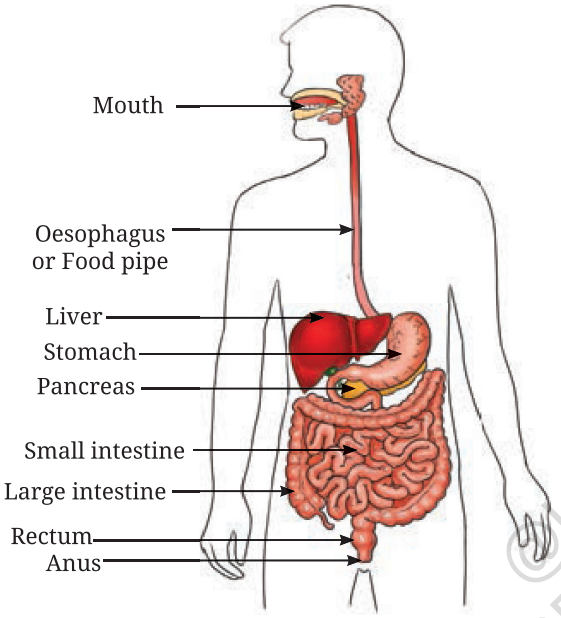


Fig. 9.1: Human digestive system

Animals, including humans, obtain energy from food, which enables them to carry out various life processes. Animals consume food that contains complex components, such as carbohydrate, protein, and fat. These complex food components have to be broken down into simpler forms before the body can use them. But how does this process happen?

Breaking down of complex food components into simpler forms occurs in a long tube called the **alimentary canal**. This process starts in the mouth and ends at the anus (Fig. 9.1). As food moves through this canal, digestive juices secreted at different parts break it down into simpler forms. This simpler form of food is absorbed by different parts of our alimentary canal and transported to various parts of our body to carry out various functions.

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9.1 Nutrition in Animals

How do the complex food components get broken down into simpler forms and used by the body in various animals? Is this process the same in all animals or does it vary? Let us first try to understand this process in humans.

9.1.1 Digestion in human beings

Let us trace the journey of food inside our body as it passes through different parts of the alimentary canal.

Beginning with the mouth cavity

The journey of the food you eat begins when it enters your mouth. Your teeth break down food you eat into smaller pieces by the processes of crushing and chewing. This process of initial breakdown of food into fine pieces is called **mechanical digestion**. Think about your favourite food. Does your mouth feel watery?

This happens because of more **saliva** that gets released when you recall your favourite food.

What do you think is the role of saliva in your mouth? What do you feel when you eat other types of food, such as *chapati*? Let us find out.

Take a small piece of *chapati* or a bite-sized portion of boiled rice and chew it properly for 30–60 seconds. At first, the *chapati* or rice has its usual taste, but as you continue chewing, do you notice a change in taste? The food begins to taste sweet! Have you ever wondered why this happens?

Chapati or rice contains starch, which is a type of carbohydrate. Our saliva contains a digestive juice that helps break down starch into sugar. This explains why starchy food, like *chapati*, tastes sweet when you chew it for a long time. Saliva helps to break down components of food into simpler ones.

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A healthy mouth requires good oral hygiene. We should brush our teeth and clean our tongue twice a day, and rinse our mouth with water after each meal to prevent tooth decay and bad smell in the mouth. Find out the ways our elders were maintaing oral hygiene.



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Activity 9.1: Let us investigate

- Take two test tubes and label them as ‘A’ and ‘B’.
- Take one teaspoonful of boiled rice in test tube A, and take a teaspoonful of boiled rice after chewing it for 30–60 seconds in test tube B.
- Add 3–4 mL of water in both the test tubes.
- Note the initial colour of the rice-water mixture in Table 9.1.
- Add 3–4 drops of iodine solution into each test tube with the help of a dropper. Mix the content of each test tube separately and observe.

Record your observations in Table 9.1.

Table 9.1: Action of saliva on starch

Test tube	Initial colour before adding iodine	Final colour after adding iodine	Possible reason for the change in colour, if any
A: Boiled rice			
B: Chewed boiled rice			

Did you observe that the colour of boiled rice turned blue-black in test tube A, while in test tube B, chewed boiled rice either did not change colour or turned only a very light blue-black colour? What causes the change of colour in test tube A? In Grade 6, we learned that iodine gives a blue-black colour when it reacts with starch. In test tube A, the appearance of the blue-black colour **indicates** the presence of starch. In test tube B, which contains chewed boiled rice, if there is no change in colour, it indicates that the starch is no longer present; if there is only a slight change in colour, it indicates that starch is present only in very small amount. It has been broken down into simple sugars by the action of saliva. If the colour still appears in test tube B, what changes would you make in the activity to **explore** it further? Would the colour change if chewing time is increased? Try to find out by repeating the activity.

Now, we know that saliva secretion in the mouth helps break down starch into sugars. This process of breaking complex food components into simpler forms in the body is called digestion. Food is partially digested in the mouth. Let us learn how this partially digested food gets further digested through the alimentary canal.

Food pipe (Oesophagus): A passage from the mouth to the stomach

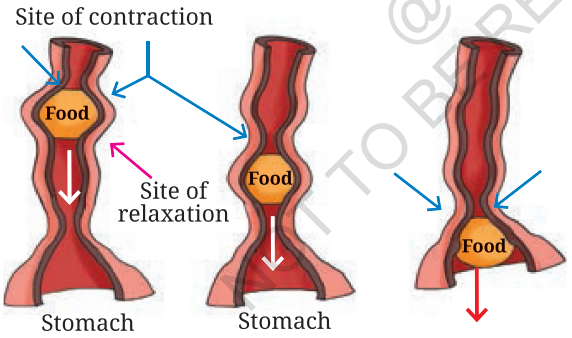


Fig. 9.2: Movement of food in the food pipe

When you chew your food, your saliva not only helps in digesting the starch but also moistens it, making it soft and easy to swallow. Your tongue helps in mixing chewed food with saliva and pushing this softened food into a long, flexible tube called the food pipe or **oesophagus** (Fig. 9.2). But how does the food move down?

The walls of the food pipe gently contract and relax in a wave-like motion to push the food down into the stomach. This movement takes place throughout the alimentary canal and pushes the food forward.

Stomach

In the stomach, the walls contract and relax to churn the food. The churned food is then mixed with a secretion from the inner lining of the stomach. The secretion from stomach contains digestive juice, acid, and mucus.

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The digestive juice of the stomach breaks down proteins present in the food into simpler components.

The acid not only helps break down proteins but also kills many harmful bacteria. The mucus protects the stomach lining from the acid, preventing damage. In the stomach, the food is partially digested and transformed into a semi-liquid mass, preparing it for the next stage of digestion.

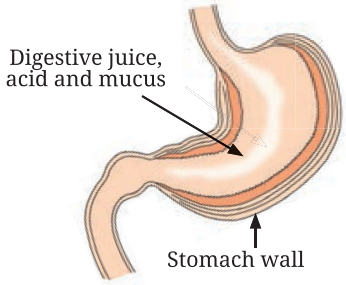
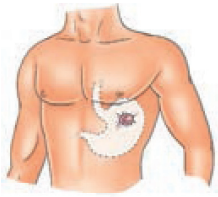


Fig. 9.3: Stomach

Fascinating Facts

How did scientists learn about digestion in the human body?



Alexis St. Martin's shotgun wound

The discovery of how the stomach works happened by chance. In 1822, a man named Alexis St. Martin was accidentally shot in the stomach. He was treated by a doctor, William Beaumont. However, his wound never fully healed, leaving a small permanent hole. This opening allowed Dr. Beaumont to observe digestion in the stomach as it happened. He conducted experiments on how different foods were broken down and studied how emotions affect digestion.



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Small Intestine

After its journey through the stomach, the partially digested food moves into the small intestine. Look at Fig. 9.4. It is a sketch of a stretched-out alimentary canal. Guess how long it is. You will be surprised that although it is called small intestine, it is almost 6 metres long—almost twice the height of your classroom! You will be surprised to know that the small intestine is the longest part of the alimentary canal.

The small intestine receives digestive secretions from three sources—the inner lining of the small intestine itself, and two more structures associated with the alimentary canal—the liver and the pancreas (Fig. 9.4). The **liver** secretes bile, which is mildly basic in nature. Recall the neutralisation reaction in chapter 'Exploring Substances: Acidic, Basic, and Neutral'. Bile neutralises acids present in the food moving down from the stomach and breaks down fats into tiny droplets, making its digestion easier.

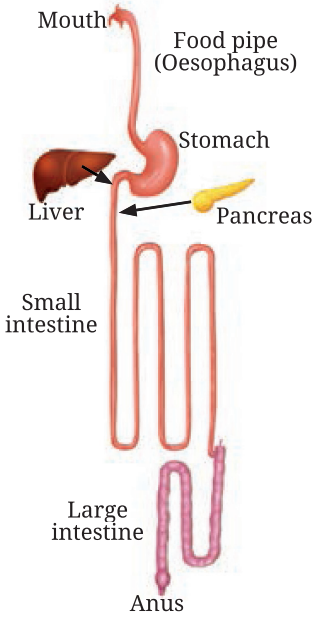


Fig. 9.4: Alimentary canal if it is stretched out

The **pancreas** secretes pancreatic juice, which is also basic in nature and helps neutralise acids present in the food. Additionally, pancreatic juice also breaks down carbohydrates, proteins, and fats. The digestive juice secreted by the wall of the small intestine further breaks down fats, proteins, and partially digested carbohydrates into simpler forms.

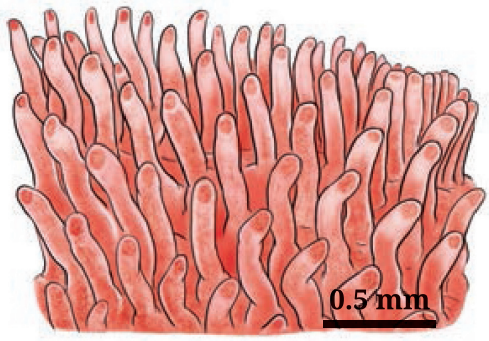


Fig. 9.5: Inner lining of the small intestine

The digested nutrients pass on from the small intestine into the blood present in blood vessels found in the walls of the small intestine. This process is called **absorption** of nutrients. How are these nutrients absorbed from the small intestine? The inner lining of the small intestine is thin and has thousands of finger-like projections (Fig. 9.5) that increase the surface area for efficient nutrient absorption. These finger-like projections allow the digested nutrients to pass into the blood, which carries them to different parts of the body. These nutrients provide energy, support growth and repair, and help the body function properly.

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Celiac disease is a condition in which the body reacts to gluten, a protein found in wheat, barley, and rye. This reaction damages the inner lining of the small intestine, where nutrients are absorbed. As a result, the intestine cannot function properly. The only way to manage celiac disease is to avoid foods that contain gluten. Millets (like *jowar*, *bajra*, and ragi) are good alternatives because they are naturally gluten-free.



Large intestine

After most of the nutrients are digested and absorbed in the small intestine, what happens to the undigested food? It moves into the large intestine. The large intestine is about 1.5 metres in length. It is shorter than the small intestine. Then why is it called the large intestine? The reason is that it is wider than the

small intestine. The large intestine absorbs water and some salts from the undigested food, thus making the waste semi-solid. This semi-solid waste is called **stool**. The stool is then stored in the lower part of the large intestine, called the **rectum**, until the body is ready to get rid of it. Eating fibre-rich foods like fruits, vegetables, and whole grains helps the large intestine function properly by making the stool easier to pass. Finally, it is expelled through the anus—a process known as **egestion**. This is how your body removes the waste it does not need, keeping you healthy!

Isn't it fascinating how the digestive system works, absorbing nutrients from food and eliminating waste?

Fascinating Facts

The large intestine contains various small living organisms, such as bacteria, that help in digestion. They help in keeping our digestive system healthy. They break down undigested food, especially fibre, and produce essential nutrients. Fibre-rich food, and especially 'fermented foods' (like curd, buttermilk, *shrikhand, kanji,* pickles, *gundruk,* and *poita bhat*) are good for a healthy digestive system and overall well-being.



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The importance of digestion in maintaining good health has been recognised for centuries. The *Charaka Samhita,* an ancient Ayurvedic text, highlights the role of easily digestible foods and the judicious use of spices like ginger, black pepper, and cumin to enhance digestion. Advances in science in the area of nutrition also emphasise eating meals at proper timings, practising mindful eating, and avoiding overeating as key factors in maintaining digestive health.

9.1.2 Do all animals digest food the same way as humans do?

I have seen cows keep chewing the food even when they are not actively grazing or eating anything. Why?



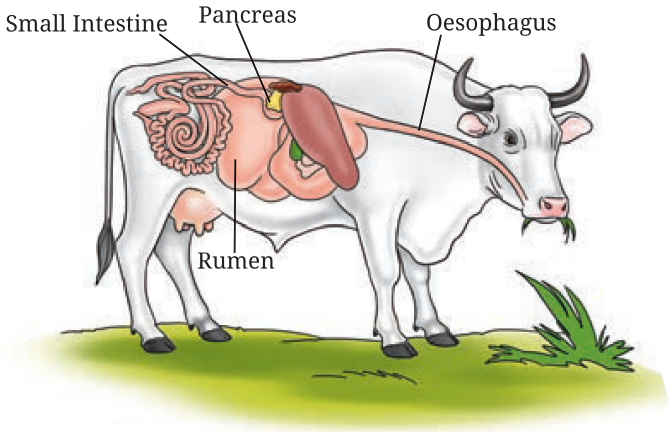


Fig. 9.6: Digestive system of a ruminant

Grass-eating animals, such as cows (Fig. 9.6) and buffaloes, partially chew the grass and swallow it into their stomachs. In the stomach, partial digestion of the food takes place. The partially digested food is brought back to the mouth for gradual chewing. This process is called rumination, and these animals are called ruminants. A cow spends about 8 hours a day just chewing the food! The thoroughly chewed food again passes down the alimentary canal for further digestion.

Birds do not have teeth, but they have a chamber called a gizzard (Fig. 9.7). Food is broken down by the contraction and relaxation of the walls of the gizzard, often with the help of grit (small stones) that the birds swallow.

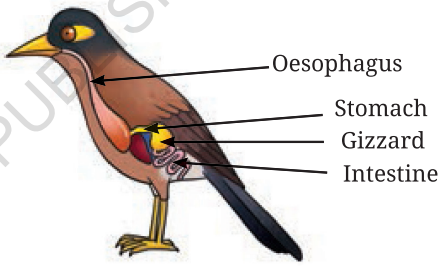


Fig. 9.7: Digestive system in birds

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This shows that animals exhibit variations in the structure and function of the alimentary canal to adapt to different ways of digesting different kinds of food.

We have learnt that the nutrients from digested food are carried to different parts of the body. Some of the nutrients help build and repair the body, while others, like sugar, are broken down inside the body to release energy. The process by which nutrients are converted into usable energy is called **respiration**. Let us now explore how this process occurs in animals.

9.2 Respiration in Animals

We learnt in Grade 6 chapter 'Living Creatures: Exploring their Characteristics', that all living beings respire. Is the process of respiration the same in all animals? Let us first understand the process of respiration in humans.

9.2.1 Respiration in humans

You know that we breathe in (inhale) and breathe out (exhale) air continuously to obtain oxygen and release carbon dioxide. How is this oxygen used in the body? Are breathing and respiration different? Let us find out.

How do we breathe?

The process of inhaling and exhaling air is called breathing. It is difficult to live without food for a week; without water for a day or two, but without breathing, we usually cannot survive more than a few minutes. Why is that? All of us are alive because we breathe. Not just humans, plants and other animals also breathe. But how do we breathe?

Just as food follows a specific pathway in the digestive system, our body also has a specific system for breathing and respiration. This system is called **respiratory system.** The respiratory system consists of various parts as shown in Fig. 9.8. In this system, the exchange of gases follows a specific pathway. The pathway through which the air is inhaled and exhaled involves various parts of the respiratory system assisting in the process of breathing and respiration.

The respiratory system begins with a pair of nasal openings called **nostrils** through which we inhale and exhale air (Fig. 9.8). The inhaled air passes into a pair of small passages called the **nasal passages**. Have you noticed tiny hair inside your nostrils? These hair, along with mucus, help trap dust and dirt from the air we breathe in. This is why we should breathe through the nose and not through the mouth. From the nasal passages, the air reaches our lungs through the windpipe. The windpipe forms two branches, which enter the two lungs. In the lungs, these branches further divide into smaller and finer branches that end in small balloon-like sacs called alveoli (Fig. 9.8). Our lungs are protected by the rib cage.

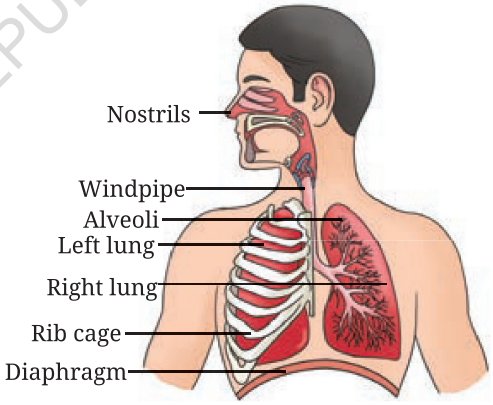


Fig. 9.8: Human respiratory system

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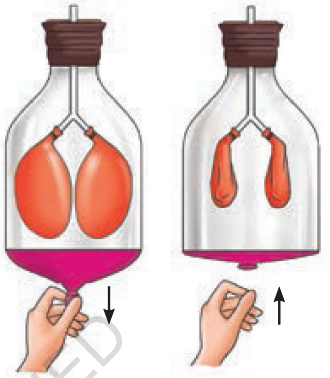
While a lot of the dust is filtered out from the inhaled air, often small infectious particles can get through the lungs. For example, during the COVID-19 pandemic, the SARS-CoV-2 virus affected the respiratory system, leading to breathing difficulties and often causing serious lung problems.



Let us understand the mechanism of breathing by making a simple model.

Activity 9.2: Let us make a model

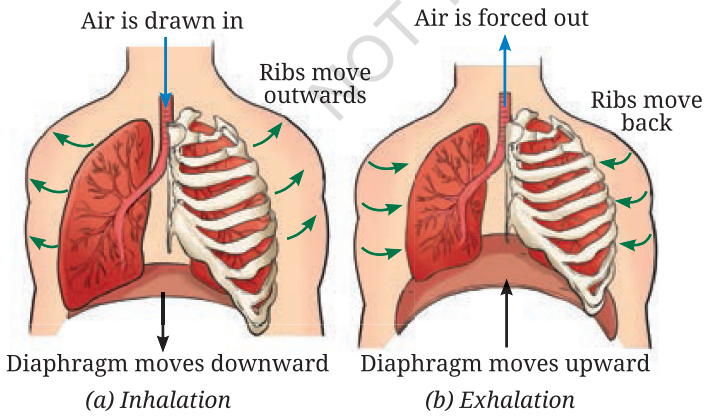
- Take a wide transparent plastic bottle with a lid. Remove its bottom.
- Make a hole in the lid of the bottle.
- Take a Y-shaped hollow tube, as shown in Fig. 9.9.
- Fix two deflated balloons to the forked end of the tube. Secure them with rubber bands to make them airtight.
- Insert the straight end of the tube tightly through the lid from the open base of the bottle and seal the lid with clay to make it airtight.
- To the open base of the bottle, attach a thin rubber sheet tightly using a large rubber band.



(a) Inhalation *(b) Exhalation*

Fig. 9.9: Model to show mechanisms of breathing

Pull the rubber sheet from the centre of the base downwards and watch the balloons (Fig. 9.9a). What do you observe? Now, release the rubber sheet upwards and observe the balloons (Fig. 9.9b). What changes do you see in the balloons? When you pull the rubber sheet downwards, the balloons inflate. Conversely, when you release the rubber sheet upwards, the balloons deflate.



(a) Inhalation *(b) Exhalation*

Fig. 9.10: Mechanism of breathing

When you breathe in (inhale), your chest expands as the ribs move up and outwards. The diaphragm (a dome-shaped muscle below the lungs) moves downwards during inhalation (Fig. 9.10a). This increases the space inside the chest, and air enters the lungs. When you breathe out (exhale), the ribs move down and inwards, and the diaphragm moves upwards (Fig. 9.10b), reducing space and pushing air out of the lungs.

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What do the balloons in the model mentioned in Fig. 9.9 represent? What does the rubber sheet represent? In this model, the balloons represent the lungs, and the rubber sheet represents the diaphragm.

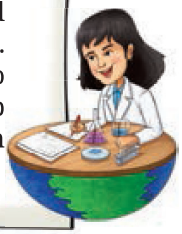
Science and Society

Breathing Practices for a Healthy Life

Breathing exercises have been practised across different cultures in India and worldwide for centuries. *Pranayama* is well known for improving respiratory health, mind relaxation, and concentration.



In Ladakh, people practise *Tummo* breathing, a technique that improves lung function and helps keep the body warm even in cold weather. Similarly, deep breathing techniques are used to promote well-being. Some traditions combine deep breathing with chanting, using rhythmic breath control to enhance relaxation and mental clarity.



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What do we breathe out?

Activity 9.3: Let us explore

To be demonstrated by the teacher

- Take an equal amount of freshly prepared lime water in two test tubes, A and B, as given in Fig. 9.11.
- In test tube A, pass the air using a syringe/*pichkari* (Fig. 9.11a). This is the same air that you inhale.
- In test tube B, repeatedly blow air through your mouth into the lime water using a straw (Fig. 9.11b).

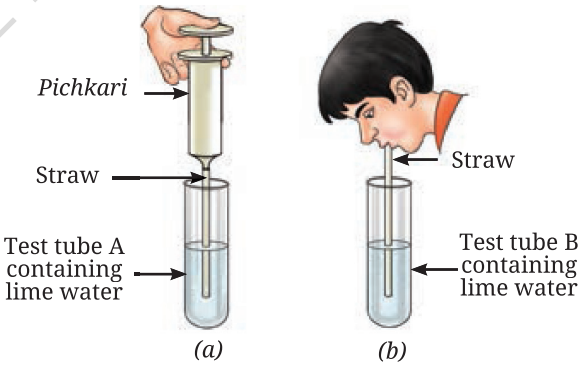


Fig. 9.11: (a) Air is passed into lime water with a pichkari/syringe (b) Air is exhaled into lime water

- Do you observe any changes in the colour of the lime water?

The lime water in test tube B turns milky (or cloudy), but the lime water in test tube A does not. What does this indicate? Lime water turns milky when it reacts with carbon dioxide. Therefore, this indicates that the exhaled air contains more carbon dioxide than the air we inhale.

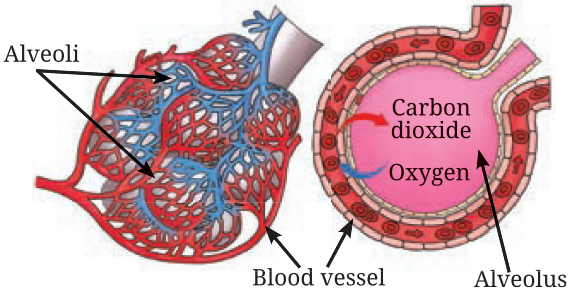


Fig. 9.12: Gas exchange through alveoli

How does the exchange of gases happen?

Through the process of breathing, fresh air from outside enters the lungs and fills the alveoli. The alveoli have thin walls surrounded by fine tubes containing blood (Fig. 9.12). Blood carries carbon dioxide from the body to the alveoli, where it is released into the air. At the same time, oxygen from the alveoli passes into the blood and is transported to all parts of the body.

Have you ever wondered how the food you eat gives you energy? The key is not only the food but also the oxygen we breathe! When we eat food, our body breaks it down into simple substances like sugar (glucose). Oxygen helps break down glucose to release energy. This process is called respiration. The word equation of the process of **respiration** is as follows—

Glucose + Oxygen ⟶ Carbon dioxide + Water + Energy

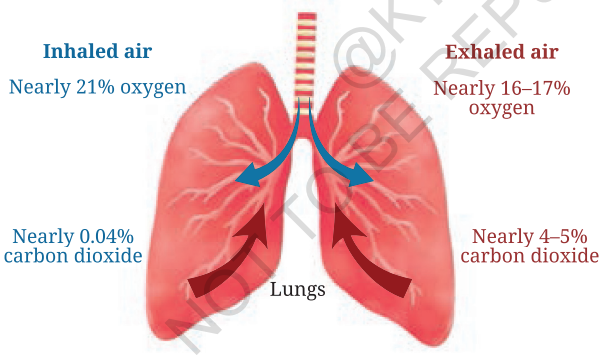


Fig. 9.13: The percentage of oxygen and carbon dioxide in inhaled and exhaled air

During breathing, we inhale air from our surroundings and exhale air having more carbon dioxide than the inhaled air. Note that not all the oxygen is used up (Fig. 9.13). Some other animals can use a larger fraction of the oxygen during respiration. This exchange of gases ensures that each segment of our body gets oxygen to produce energy and remove waste products. In simple words, breathing brings in oxygen and removes carbon dioxide, while respiration uses oxygen to break down food and release energy. This energy helps us walk, run, play, and even think!

Breathing is a physical process, while respiration is a chemical process that occurs inside the body. Both the processes are essential for our survival!

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Our body has a unique system for the transport of nutrients, oxygen, and other substances. This system is called the circulatory system. It includes the heart, blood, and blood vessels. The heart pumps blood through blood vessels, ensuring the transport of nutrients, oxygen, and other substances to all parts of the body, while waste products are carried away.

Science and Society

Smoking is extremely harmful to health. It damages the lungs and increases the risk of serious diseases, including lung cancer and other respiratory illnesses. It leads to persistent coughing and frequent infections.

In addition to harming the smoker, smoking releases toxic chemicals into the air, putting others at risk. When non-smokers inhale this polluted air, they experience passive smoking, which can be especially dangerous for children, pregnant women, and the elderly. Due to these risks, avoiding smoking helps protect both personal health and the well-being of those around us.



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9.2.2 Do other animals breathe the same way as humans do?

You have learnt that different animals live in different habitats. You may have observed birds flying and fish swimming. How do they breathe? Animals, such as birds, elephants, lions, cows, goats, lizards, and snakes, breathe through their lungs. Although all these animals have lungs, the structure of their lungs are quite different. Most aquatic animals like fish, have specialised structures known as **gills** (Fig. 9.14). These are richly supplied with blood vessels. The exchange of oxygen and carbon dioxide between the blood and the gases dissolved in water takes place across the gills.

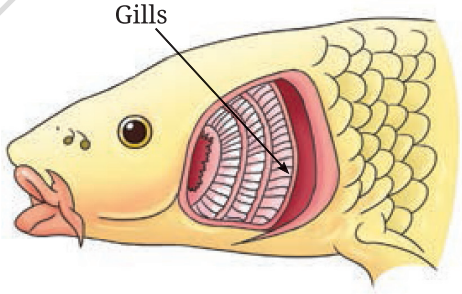


Fig. 9.14: Breathing body parts in a fish

Amphibians, like frogs, live both on land and in water. They use different body parts for breathing at various stages of their life. For example, tadpoles breathe through gills, while adult frogs use lungs for breathing on land and skin for gas exchange when they stay in water. This adaptation helps them survive both in water and on land, showing how animals have adapted over time to different environments. Earthworms use their moist skin for the exchange of oxygen and carbon dioxide.

Thus, different animals have different breathing mechanisms to suit their unique habitats. Apart from the digestive system, the respiratory system, and the circulatory system, there are other systems which work in coordination with each other in the body and perform different functions to sustain life. You will study about them in higher grades.

In a Nutshell



- Life processes such as nutrition, circulation, respiration, excretion, and reproduction are essential for the survival of living beings. These processes are collectively called life processes.
- The human digestive system consists of an alimentary canal which includes the mouth, oesophagus, stomach, small intestine, large intestine, and anus, and its associated parts, the liver and the pancreas.
- The digested food is primarily absorbed through the walls of the small intestine.
- The nutrients absorbed are distributed through the blood to different parts of the body where they are used for performing various functions.
- The large intestine absorbs most of the remaining water and some salts from the undigested food.
- Grass-eating animals such as cows and goats are called ruminants. They chew the food partially and swallow it. Later, the partially digested food is returned to the mouth, and the animal chews it thoroughly.
- Breathing involves the movement of air into the lungs (inhalation) and out of the lungs (exhalation).
- The exchange of oxygen and carbon dioxide occurs in the alveoli of the lungs.
- Respiration uses oxygen from inhaled air to break down glucose into carbon dioxide and water. The process by which nutrients are converted into usable energy is called respiration.
- The circulatory system transports nutrients and oxygen to all parts of the body. It includes the heart, which pumps blood through blood vessels, delivering oxygen and nutrients while also removing waste from the body.
- Breathing is a physical process and respiration is a chemical process.
- Different animals have different breathing mechanisms adapted to suit their habitats.

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Let Us Enhance Our Learning

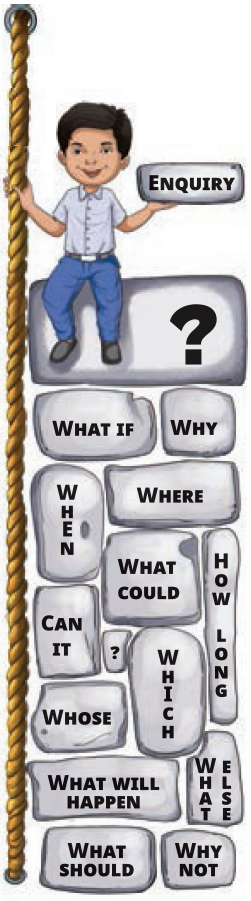
1. Complete the journey of food through the alimentary canal by filling up the boxes with appropriate parts—

Food → Mouth → ____ → Stomach → ____ → ____ → Anus

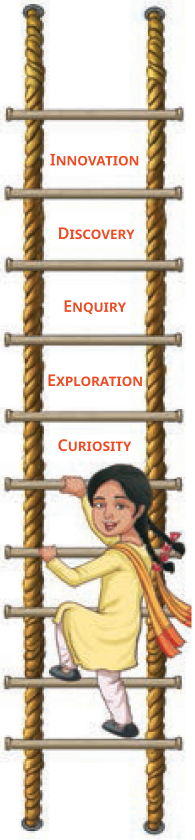
2. Sahil placed some pieces of *chapati* in test tube A. Neha placed chewed *chapati* in test tube B, and Santushti took boiled and mashed potato in test tube C. All of them added a few drops of iodine solution to their test tubes—A, B, and C, respectively. What would be their observations? Give reasons.
3. What is the role of the diaphragm in breathing?
   (i) To filter the air
   (ii) To produce sound
   (iii) To help in inhalation and exhalation
   (iv) To absorb oxygen
4. Match the following

Name of the part	Functions
(i) Nostrils	(a) fresh air from outside enters
(ii) Nasal passages	(b) exchange of gases occurs
(iii) Windpipe	(c) protects lungs
(iv) Alveoli	(d) tiny hair and mucus help to trap dust and dirt from the air we breathe
(v) Ribcage	(e) air reaches our lungs through this part

5. Anil claims to his friend Sanvi that respiration and breathing are the same process. What question(s) can Sanvi ask him to make him understand that he is not correct?
6. Which of the following statements is correct and why?
   Anu: We inhale air.
   Shanu: We inhale oxygen.
   Tanu: We inhale air rich in oxygen.
7. We often sneeze when we inhale a lot of dust-laden air. What can be possible explanations for this?
8. Paridhi and Anusha of Grade 7 started running for their morning workout. After they completed their running, they counted their breaths per minute. Anusha was breathing faster than Paridhi. Provide at least two possible explanations for why Anusha was breathing faster than Paridhi.



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9. Yadu conducted an experiment to test his idea. He took two test tubes, A and B, and added a pinch of rice flour to the test tubes, half-filled with water and stirred them properly. To test tube B, he added a few drops of saliva. He left the two test tubes for 35–45 min. After that, he added iodine solution into both the test tubes. Experimental results are as shown in Fig. 9.15. What do you think he wants to test?

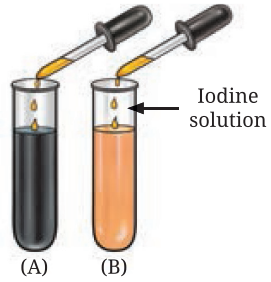


Fig. 9.15: Experimental results

10. Rakshita designed an experiment taking two clean test tubes, A and B and filled them with lime water as shown in the figure. In test tube A, the surrounding air that we inhale was passed on by sucking air from the pipe, and in test tube B, the exhaled air was blown through the pipe (Fig. 9.16). What do you think she is trying to investigate? How can she confirm her findings?

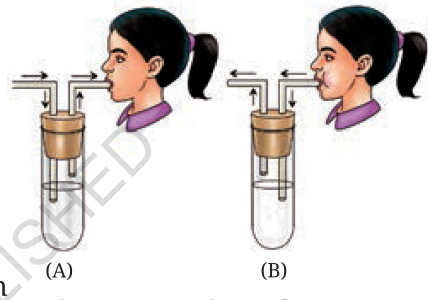


Fig. 9.16: Experimental set-up

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Exploratory Projects



- What are the good practices for maintaining oral hygiene? Try to gather information on the same from books/newspapers/ conversation with elders. Prepare a report.
- Find out different ways to maintain a healthy digestive system. Suggest some food items that help to maintain good digestive health. Make a report and present it in class.
- Using coloured clay, prepare a 3-D model of the digestive system and label all parts of the digestive system using black paper strips.
- What is air quality and AQI? Find out the effect of air quality on the respiratory systems of people working in various fields — farmers, factory workers, or street vendors.
- Try to read about the box-breathing technique (Fig. 9.17). What are its benefits?
- Both birds and mammals have lungs for breathing, but birds can fly at high altitudes where oxygen levels are low. How might their respiratory system be adapted to help them survive in such conditions?

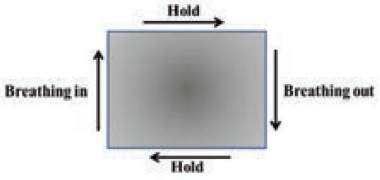
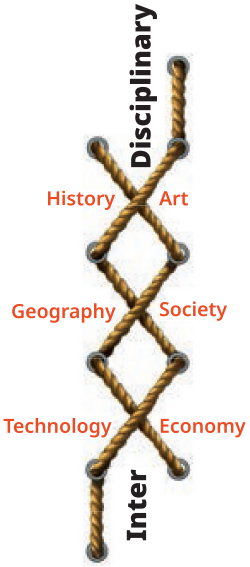


Fig. 9.17: Box-breathing



10 Life Processes in Plants

In Grade 6, we learnt that all living beings grow and need food for their growth. Also, in the previous chapter, we discussed the process through which animals obtain nutrition.

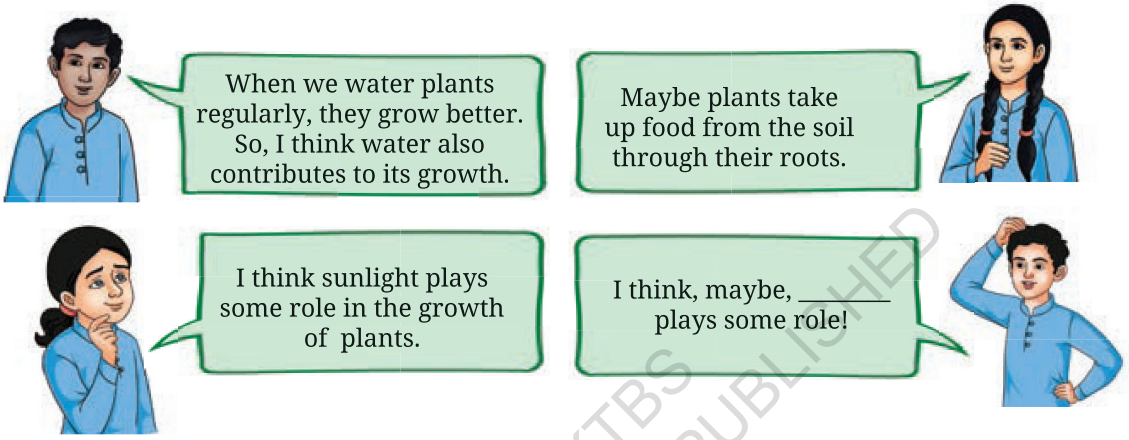
We know that animals eat food to grow, but what about plants? Have you ever seen plants eating food like animals do? As animals grow, their size and weight usually increase, and their bodies undergo various changes. What changes do you notice in plants when they grow?

We learnt that food provides nutrients like carbohydrates, fats, proteins, vitamins, and minerals, which, along with water, are all essential for growth. Let us **explore** how plants obtain nutrients for their growth.



10.1 How Do Plants Grow?

Look around your neighbourhood. Have you observed any changes in a plant during its life span? As a plant grows, new leaves and branches emerge, its height increases, and its stem thickens. What do you think causes these changes? Discuss with your friends and provide your explanation as well.

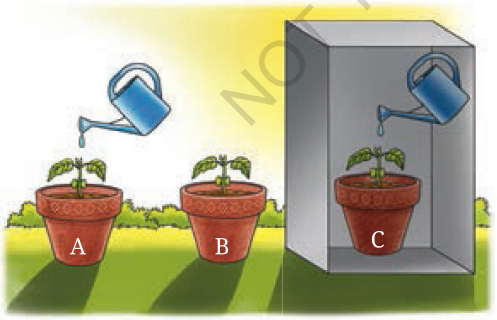


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Let us perform an experiment to test some of these explanations.

Activity 10.1: Let us test some explanations

- Take three earthen pots (or used bottles/containers) of the same size filled with garden soil. Plant saplings of similar sizes of a fast-growing plant like chilli or tomato in each pot (Fig. 10.1).
- Label the pots A, B, and C.
- Count the number of leaves on each sapling and record your observations.
- Place pot A in direct sunlight. Keep the soil in this pot slightly moist by adding an adequate amount of water every day (Fig. 10.1a).
- Place pot B in direct sunlight, without adding water to the soil (Fig. 10.1b).



(a) Pot A kept in direct sunlight, with water *(b) Pot B kept in direct sunlight, without water* *(c) Pot C kept in the dark, with water*

Fig. 10.1: Experimental set-up to understand the role of sunlight and water in plant growth

- Place pot C in the dark. Keep the soil in this pot slightly moist by adding an adequate amount of water every day (Fig. 10.1c).
- **Observe** the plants for two weeks[1] and record changes in their height, number of leaves, colour of leaves, and any other changes that may appear.
- **Record** your observations in Table 10.1.

Table 10.1: Effect of sunlight and water on plant growth

Pots kept under different conditions	Availability of		Height of plant (cm)		Number of leaves		Colour of leaves (Green/Yellow)
	Sunlight	Water	Day 1	After 2 weeks	Day 1	After 2 weeks	
Pot A: In direct sunlight, with water							
Pot B: In direct sunlight, without water							
Pot C: In the dark, with water							

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- What differences did you observe between the plants in the three pots?
- Which pot has the plant with the maximum growth?
- Which pot has the plant with the least growth?

Analyse the observations recorded in Table 10.1, and discuss them with your teacher and friends.

You are likely to find that the plant in Pot A, kept in direct sunlight with adequate water, grows better than the plant in Pot C, which gets adequate water but no sunlight. The plant in Pot B may have died as it did not get water even though it received adequate sunlight.

What do you **infer** from the observations made in this activity? The results indicate that plants require both sunlight and water for their growth.

1 This experiment will need two weeks. Teachers can plan this activity accordingly.

FASCINATING FACTS

फलकुसुमसंपदुचिता रोपणतो भवति केवलान्न यत: ।

"Trees do not produce fruits and flowers merely because they are planted."

This line is from an ancient Indian text named *Vrikshayurveda*. It records useful observations about plant growth, soil, and agricultural practices to help improve crop health, growth and production. The knowledge in the text seems to be based on practical experiences and patterns seen over time. These ideas were then systematically documented to guide farming practices. For instance, there are references to different methods of organic manure preparation, such as mixing water, barley, and various seeds, like green, black, and horse grams.



10.2 How Do Plants Get Food for their Growth?

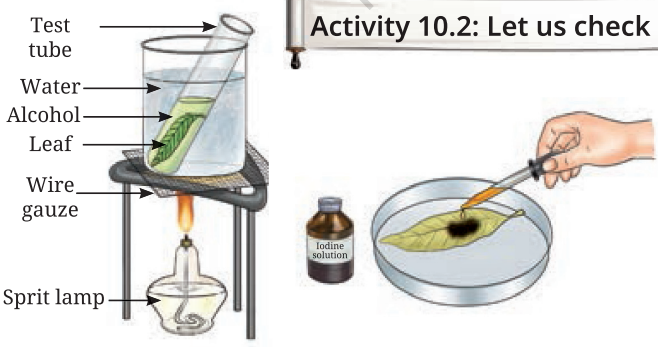
We know that animals get their food from plants, either directly by eating plants or indirectly by eating animals that in turn eat plants for their nutrition and growth. But how do plants obtain the food they need to grow? Unlike animals, plants do not *eat* food.

10.2.1 Leaves: the 'food factories' of plants

Plants store food in the form of starch, a type of carbohydrate. This starch is produced in the leaves of a plant which, by design, are generally broad and flat. These are mostly green because of the presence of a green pigment called **chlorophyll**, that helps in capturing sunlight efficiently.

Let us find out the role chlorophyll plays in the preparation of food in the form of starch in plants.

Activity 10.2: Let us check (demonstration activity)



(a) Boiling set-up *(b) Iodine test*

Fig. 10.2: Starch test in a leaf

The teacher may demonstrate this activity.

- Keep a leaf in boiling water for five minutes to soften it.
- Dip this leaf in a test tube containing alcohol.
- Place the test tube in a beaker containing boiling water. Wait until the leaf becomes colourless (Fig. 10.2a).

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- Take out the leaf and place it on a plate.
- Now, put a few drops of diluted iodine solution with the help of a dropper on the decolourised leaf (Fig. 10.2b). Wait for a few minutes and observe.
- If the colour of the leaf changes to blue-black, it indicates the presence of starch.

Caution — Alcohol should never be placed near a heat source directly, as it is highly flammable and can easily lead to fire and burns.

DIVE DEEPER

Did you wonder why we decolourise the leaf in the beginning of this activity?

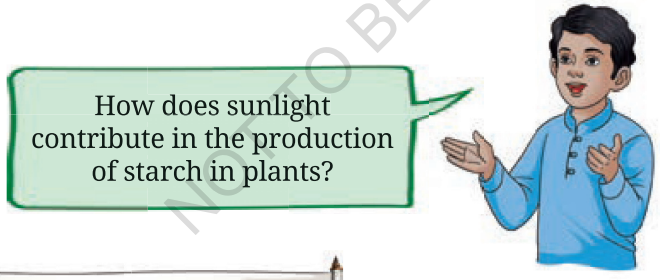
Decolourisation of a leaf enables us to easily observe colour change and, thus, the presence of starch.



In Activity 10.1, we have learnt that water and sunlight are essential for plant growth. In Activity 10.2, we have discovered that green leaves store starch as food.

Bhaskar loves gardening during his free time. Being a curious student, he often looks around his garden and wonders how plants produce food. From his experiences, Bhaskar knows that water and sunlight are essential for plant growth. But he wonders if sunlight contributes to the production of food in the form of starch in plants.

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Activity 10.3: Let us check

Bhaskar took a leaf having both green and non-green patches from each of two similar potted plants — one kept in sunlight and the other kept in the dark for 36 hours. He wanted to compare the leaves before and after the starch test.

He made a sketch of the leaves to record the location of the green and the non-green patches on them with the help of a tracing paper. After that, he performed an iodine test (as shown in Activity 10.2) on the leaves. Bhaskar recorded his observations in Table 10.2.

Table 10.2: Presence of starch in green and non-green parts of the leaves of plants

S.No.	Light conditions for potted plant	Initial colours before iodine test	Final colours after iodine test
1.	Plant kept in sunlight 	Green and non-green patches on the leaf 	Green patches of leaf turned blue-black 
2.	Plant kept in the dark 	Green and non-green patches on the leaf 	No change in colour 

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In Table 10.2, Bhaskar recorded a blue-black colour (indicating the presence of starch) on the green patches of the leaf obtained from the plant placed in sunlight. Bhaskar also recorded that the leaf obtained from the plant kept in the dark does not show a blue-black colour, even on the green patches, indicating that no starch has been produced. Non-green patches of the leaf obtained from the plant placed in sunlight do not turn blue-black. Does it indicate that there is no chlorophyll present in those patches? The non-green patches may not have sufficient chlorophyll to prepare enough starch to be detected using the iodine test.



Fascinating Facts

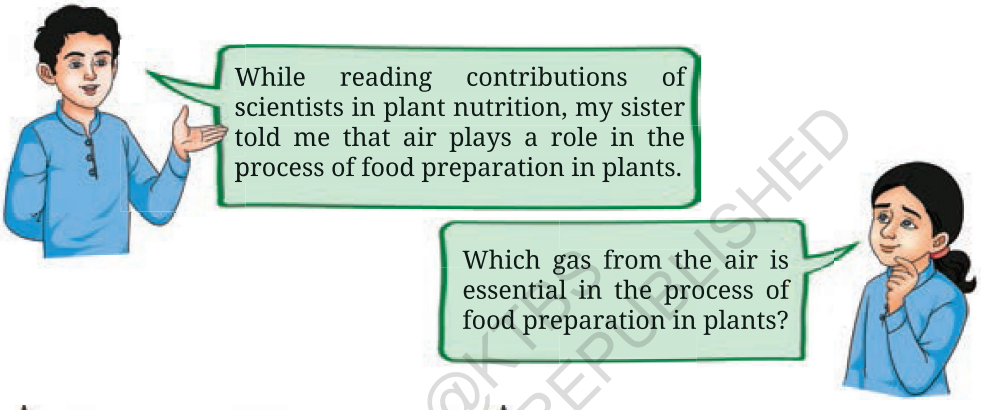
Some plant leaves appear red, violet, or brown because they contain more of these coloured pigments than the green-coloured chlorophyll. This hides the green colour. Some of these pigments also help in photosynthesis. You can use an iodine test to check for the presence of starch in these leaves, indicating that photosynthesis has indeed taken place.



What do we infer from the observations listed in Table 10.2? As we know, leaves are mostly green because of the presence of chlorophyll. We have also seen that the starch is produced where green patches of the leaf are present. We can infer that chlorophyll helps in preparing starch in the presence of sunlight. In fact, it is essential for the preparation of starch. Hence, the leaves are also called 'food factories' of plants.

What else is essential for the preparation of food in plants? Let us find out.

10.2.2 Role of air in the preparation of food



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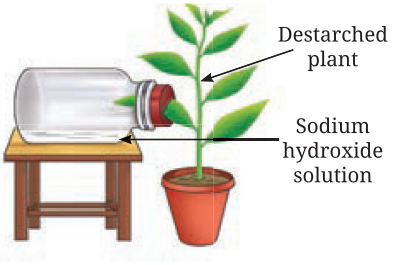
Activity 10.4: Let us experiment (demonstration activity)

The teacher may demonstrate this activity.

- Take a potted green plant and keep it in the dark for two to three days to allow it to destarch (i.e., lose any stored starch). Then, locate one leaf of this plant for this experiment.
- Take a wide-mouthed bottle and pour some caustic soda (sodium hydroxide) into it (caustic soda absorbs carbon dioxide from the air).

Caution — Caustic soda is a strong chemical that can cause skin burns; only teachers should handle it.

- Insert half of the destarched leaf into the bottle through a split cork, leaving the other half of the leaf outside, and place the bottle as shown in Fig. 10.3a.



(a) The set-up



(b) Iodine test on the leaf

Fig. 10.3: Testing the role of chlorophyll and air

- ❖ Place the set-up in sunlight for a few hours.
- ❖ Observe and record the availability of water, sunlight, chlorophyll, and carbon dioxide in Table 10.3.
- ❖ Remove the leaf and test it for starch using the iodine test, as was done in Activity 10.2.
- ❖ Record your observations in Table 10.3.

Table 10.3: Role of air in the preparation of starch by plants

Part of the leaf	Availability of				Starch present (Yes/No)
	Water	Sunlight	Chlorophyll	Carbon dioxide	
Part of the leaf inside the bottle					
Part of the leaf outside the bottle					

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We **notice** that the part of the leaf that was outside the bottle turns blue-black, indicating the presence of starch. However, the part of the leaf inside the bottle does not turn blue-black in colour, indicating that food is not made in that part of the leaf. This is because the caustic soda solution inside the flask absorbs the carbon dioxide present in the air. What does this experiment show?

This experiment shows that carbon dioxide present in the air is essential for plants to prepare starch.

Based on Activities 10.3 and 10.4, what do you **conclude**? Which part of the plant is involved in the synthesis of starch?

Based on our learnings so far, we have found that **sunlight**, **water**, **chlorophyll** and **carbon dioxide** are essential for the synthesis of food in plants. This process by which plants prepare food in the presence of sunlight and chlorophyll is called **photosynthesis**. A leaf is the primary site for photosynthesis. Do other green parts of the plant also perform photosynthesis? Yes, other parts of the plants which have chlorophyll also perform photosynthesis.

So far, we have learnt that plants take in carbon dioxide from the air and water, and use sunlight to prepare their food by the process of photosynthesis. But have you ever thought about what more happens during this process? Do plants only take in

substances from their surroundings, or do they also release something? Let us explore this through an experiment performed by Barkha didi.

Activity 10.5: Let us explore

- Look at Fig. 10.4. **Compare** the two set-ups labelled as A and B, and analyse.
- In Fig. 10.4, set-up A is placed in sunlight, and set-up B is placed in the dark. What difference do you observe in the two set-ups? Do you observe air bubbles emerging in the inverted test tube in set-up A? The gas produced in this set-up caused bubbles to emerge and get accumulated in the inverted test tube. Which gas is this?

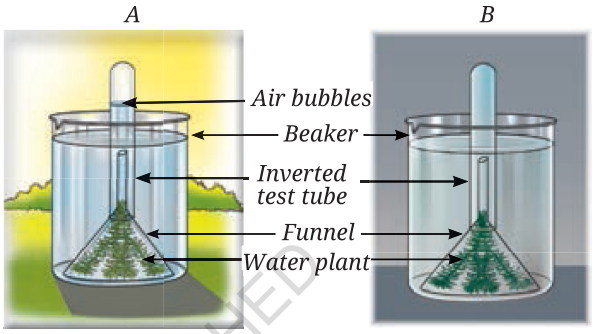
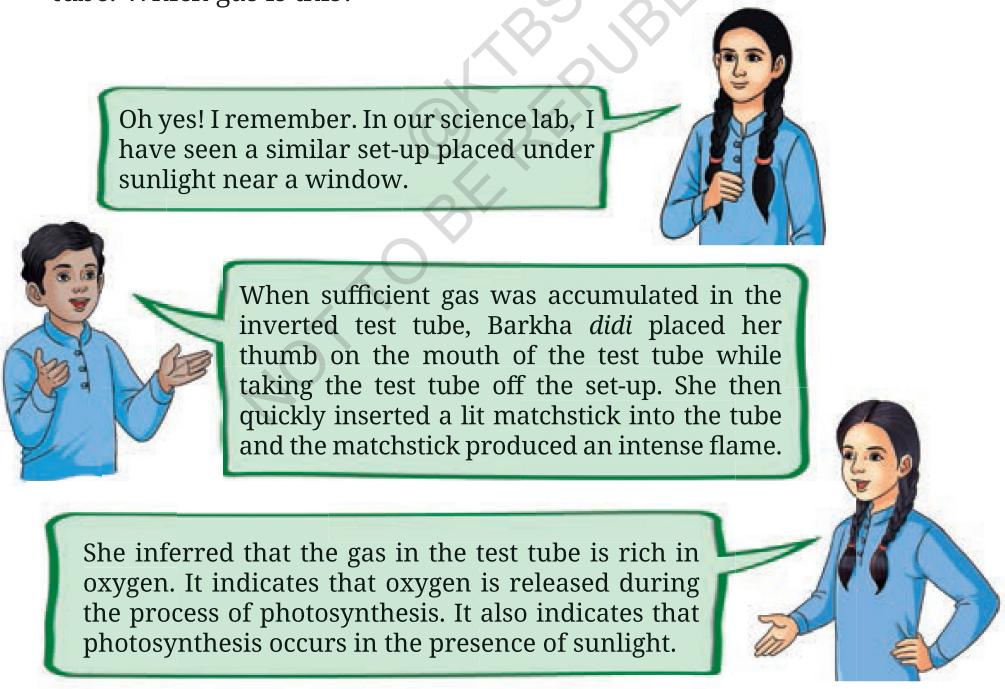


Fig. 10.4: Activity showing the release of oxygen during photosynthesis

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Based on Barkha *didi*'s experiment, we can conclude that oxygen is released during photosynthesis.

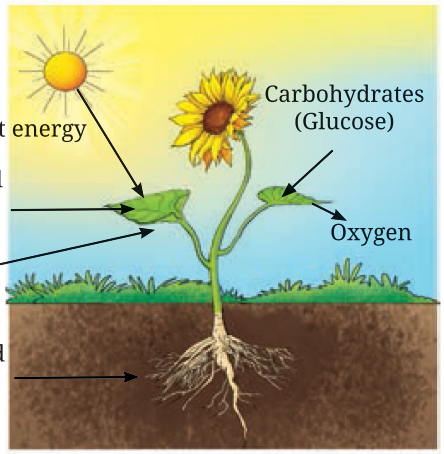


Fig. 10.5: A diagram showing photosynthesis

10.2.3 Photosynthesis: in a nutshell

We know that water, sunlight, carbon dioxide from the air, and chlorophyll are necessary to carry out the process of photosynthesis that produces carbohydrates (Fig. 10.5). During photosynthesis, food is actually produced in the form of glucose, a simple carbohydrate. This glucose not only serves as an instant source of energy but also later gets converted into starch for storage. The word equation of photosynthesis is given below—

$$\text{Carbon dioxide + Water} \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} \text{Glucose + Oxygen}$$

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Know a Scientist

Many scientists across the world contributed to develop an understanding of photosynthesis. In India, Rustom Hormusji Dastur (1896–1961) studied the process of photosynthesis. He was a plant scientist and served as the head of the Botany Department at the Royal Institute of Science, Bombay (now the Institute of Science, Mumbai), from 1921–1935. He studied effects of the amount of water and temperature on photosynthesis. He examined the importance of water, temperature, and the colour of light in the process of photosynthesis.





10.2.4 How do leaves exchange gases during photosynthesis?

We now know that photosynthesis requires carbon dioxide, and oxygen is released in the process. Which part of the plant helps in the exchange of carbon dioxide and oxygen? Let us **conduct** an activity to understand where the exchange of gases takes place.

Activity 10.6: Let us examine (demonstration activity)

The teacher may demonstrate this activity.

- Collect a leaf from a plant such as rhoeo, money plant, onion, hibiscus, coleus, or any grass.
- Put it in a beaker filled with water.
- Carefully peel a thin layer from the lower surface of the leaf.
- Place the peel in a watch glass with water.
- Now, take a microscope slide and carefully put a drop of water on it.
- Using forceps, transfer the peel of the leaf from the watch glass to the slide with the help of forceps.
- Put a drop of ink on the leaf peel with the help of a dropper.
- Cover the peel with a coverslip and observe it under a microscope.

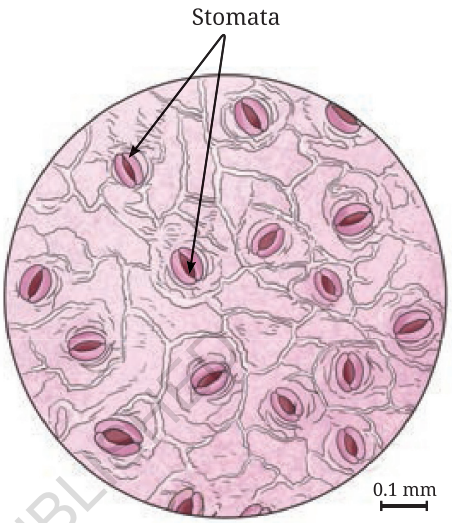


Fig. 10.6: Stomata on the lower surface of a rhoeo leaf

What do you observe? Do you notice tiny pores on the peel, as shown in Fig. 10.6? These pores are called **stomata**. Stomata, present on the surface of leaves, help in the exchange of gases.

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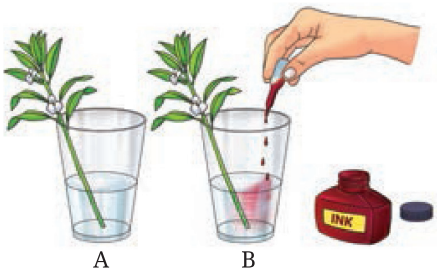
10.3 Transport in Plants

10.3.1 Transport of water and minerals

All living beings need water to grow. Plants use water in the process of photosynthesis. Water, along with minerals present in the soil, is taken up by the roots of a plant. Minerals are important nutrients for the growth of plants. How do water and minerals taken up by the roots move to all parts of the plant?

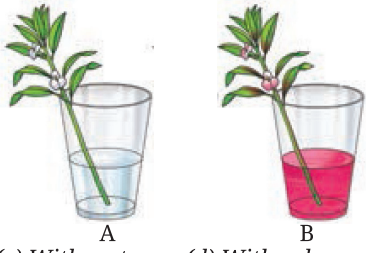
We can study water transport in plants by carrying out an activity. For this activity, we require two glass tumblers, some water, red ink, and twigs of two similar tender plants, preferably with white-coloured flowers (for example, white *sadabahar*, balsam), as shown in Fig. 10.7.

Activity 10.7: Let us experiment



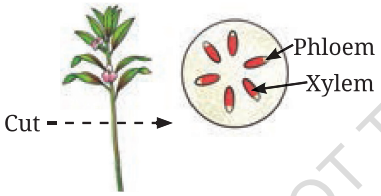
A B

(a) With water (b) With coloured water plant twigs placed in water with different treatments



A B

(c) With water (d) With coloured water plant twigs after one day



(e) Enlarged view of cut end of the twig

Fig. 10.7: Experiment to check for water transportation in plants

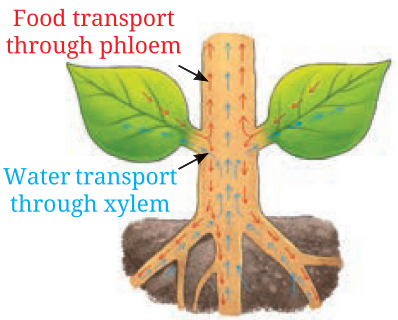


Fig. 10.8: Transport of water and minerals in a plant

- Take two tumblers and label them A and B.
- Fill one-third of each tumbler with water.
- Add a few drops of red ink to tumbler B.
- Obliquely cut the stems of both plants at their base while keeping them inside the water and immediately place one plant in each tumbler, as shown in Fig. 10.7a and Fig. 10.7b.
- Observe these plants the next day.

What do you notice? Compare the plant stems placed in the tumblers. Do you observe red colour in the stem, leaves, and flowers of the plant from Tumbler B? Fig. 10.7c and Fig. 10.7d show the plants after one day. Compare the plant in Fig. 10.7c with that in Fig. 10.7d. A red colour is visible in the stem, leaves, and flowers of the plant in Fig. 10.7d. How did different parts of the plant acquire this red colour?

Cut the stem from the upper part of the plant that is not immersed in the red-coloured water. Observe the cut stem using a magnifying glass. Do you spot the red colour in the stem (Fig. 10.7e)? How does the red colour ink move upwards? This is due to the thin tube-like structure called the **xylem** present in the stem, branches, and leaves of plants. Just like red ink, minerals dissolved in water also move up the stem through the xylem.

Now, we know that water and minerals are transported to the leaves and other parts of plants through the xylem (Fig. 10.8). The water transported through the xylem is used to perform various functions. How does food get transported to other parts of a plant?

10.3.2 Transport of food

We know that leaves are the primary site for photosynthesis. The food prepared by plants in the leaves is transported to all parts of the plant. This food is transported through another set of thin tube-like structures called the **phloem** (Fig. 10.8). The transported food may also be stored in some other parts of a plant, such as seeds and roots.

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10.4 Do Plants Respire?

In the Grade 6 Science textbook *Curiosity*, chapter 'Living Creatures: Exploring their Characteristics', you learnt that all living beings respire. Do plants also respire like we do?

Activity 10.8: Let us find out (demonstration activity)

- Soak some *moong* bean seeds in water overnight.
- Put a layer of cotton in a conical flask (Fig. 10.9) and moisten the cotton with water to keep it wet.
- Place the soaked seeds over the wet cotton in the conical flask.
- Cover the mouth of the conical flask with a cork having two holes.
- Fit two tubes A and B through the two holes on the cork, as shown in Fig. 10.9.
- Leave it undisturbed for 24 hours in the dark.
- Take two test tubes and fill them with lime water.
- Cover the mouth of one test tube with a cork having one hole in it.
- Dip one glass tube in the test tube through a hole in the cork.
- Connect the flask and test tube with a rubber pipe as shown in Fig. 10.9.

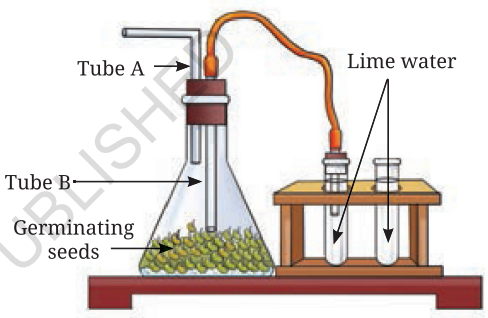


Fig. 10.9: Set-up to test respiration in plants

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Compare both the test tubes for any change in colour. Does the lime water turn milky in both the test tubes? Why does the lime water turn milky in the test tube connected to the flask? Lime water turns milky due to the presence of more carbon dioxide in the flask. But where does this carbon dioxide come from? As we know, carbon dioxide is naturally present in very small quantities in the air. In the flask, additional carbon dioxide is produced by the seeds as they respire.

During respiration, glucose is broken down in the presence of oxygen, releasing carbon dioxide, water, and energy. The word equation for the proccess of respiration, is as follows—

Glucose + Oxygen $\longrightarrow$ Carbon dioxide + Water + Energy

The energy produced during respiration is used by plants for their growth and development. All parts of a plant, green or non-green, carry out respiration.

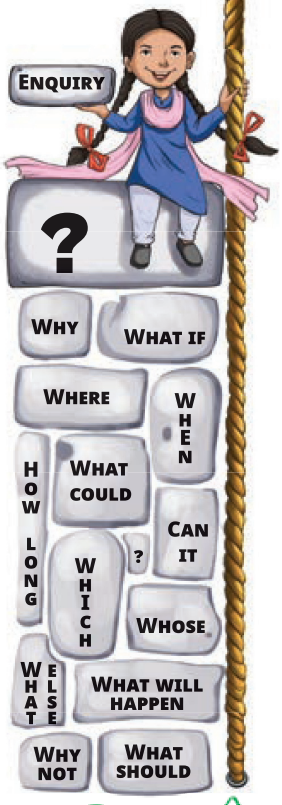
Thus, plants have different mechanisms for synthesising, transporting, and utilising food to get energy.

In a Nutshell



- All living organisms require food that provide energy for their growth and development.
- Plants use carbon dioxide and water in the presence of sunlight and chlorophyll to produce glucose and oxygen. This process of synthesis of food is known as photosynthesis.
- Leaves are the 'food factories' of a plant.
- Tiny pores on the surface of leaves, called stomata, help in the exchange of oxygen and carbon dioxide during photosynthesis and respiration.
- The xylem transports water and minerals from roots, while the phloem carries food from leaves to all parts of the plants.
- Plants break down glucose and release energy by a process called respiration. They use oxygen and release carbon dioxide in this process.

Let Us Enhance Our Learning



1. Complete the following table

S.No.	Feature	Photosynthesis	Respiration
1.	Raw materials		
2.	Products		
3.	Word equation		
4.	Importance		

2. Imagine a situation where all the organisms that carry out photosynthesis on the earth have disappeared. What would be the impact of this on living organisms?
3. A potato slice shows the presence of starch with iodine solution. Where does the starch in potatoes come from? Where is the food synthesised in the plant, and how does it reach the potato?
4. Does the broad and flat structure of leaves make plants more efficient for photosynthesis? Justify your answer.
5. X is broken down using Y to release carbon dioxide, Z, and energy.

   $$X + Y \longrightarrow \text{Carbon dioxide} + Z + \text{Energy}$$

   X, Y, and Z are three different components of the process.

   What do X, Y, and Z stand for?

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6. Krishna set-up an experiment with two potted plants of same size and placed one of them in sunlight and the other in a dark room, as shown in Fig. 10.10.

   Answer the following questions—

   (i) What idea might she be testing through this experiment?

   (ii) What are the visible differences in plants in both the conditions?

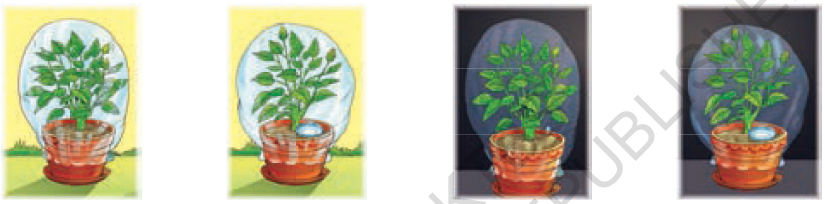
   (iii) According to you, leaves of which plants confirm the iodine test for the presence of starch?



(a) Sunlight *(b) Complete dark*

Fig. 10.10: Experimental pots

7. Vani believes that 'carbon dioxide is essential for photosynthesis'. She puts an experimental set-up, as shown in Fig. 10.11, to collect evidence to support or reject her idea.



(a) Sunlight with carbon dioxide *(b) Sunlight without carbon dioxide* *(c) Dark with carbon dioxide* *(d) Dark without carbon dioxide*

Fig. 10.11: A potted plant with sufficient water is placed under the prescribed conditions

Answer the following questions—

(i) In which plant(s) in the above set-up(s) will starch be formed?

(ii) In which plant(s) in the above set-up(s) will starch not be formed?

(iii) In which plant(s) in the above set-up(s) will oxygen be generated?

(iv) In which plant(s) in the above set-up(s) will oxygen not be generated?

8. Ananya took four test tubes and filled three-fourth of each test tube with water. She labelled them A, B, C, and D (Fig. 10.12). In test tube A, she kept a snail; in test tube B, she kept a water plant; in test tube C, she kept both a snail and a plant. In test tube D, she kept only water. Ananya added a carbon dioxide indicator to all the test tubes. She recorded the initial colour of water and observed if there are any colour changes in the test tubes after 2–3 hours. What do you think she wants to find out? How will she know if she is correct?

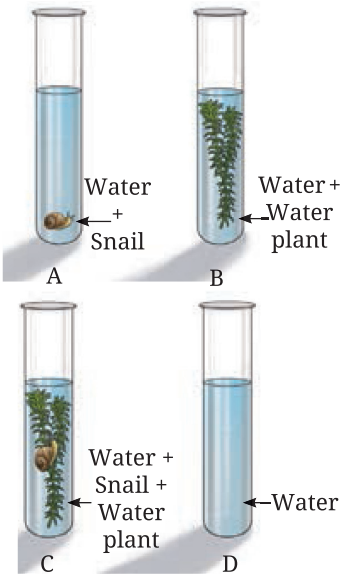
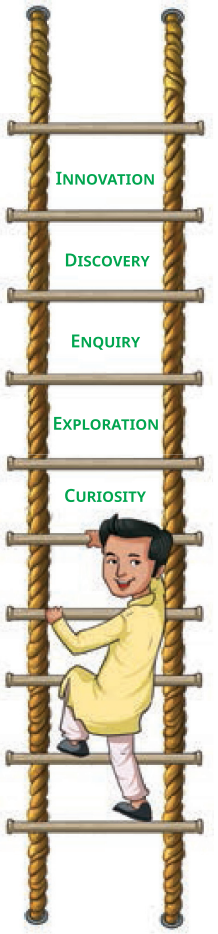
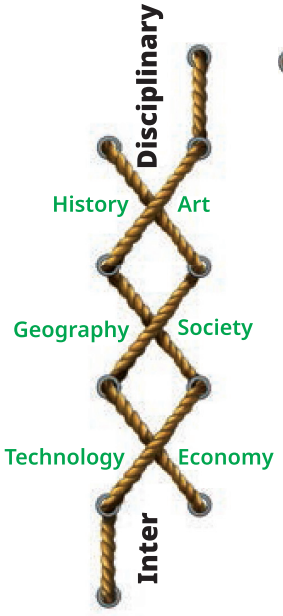


Fig. 10.12: Experimental set-up



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9. Design an experiment to observe if water transportation in plants is quicker in warm or cold conditions.
10. Photosynthesis and respiration are essential to maintain balance in nature. Discuss.



Exploratory Projects



Fig. 10.13: Bottle garden

- Develop a bottle garden by planting a growing plant like spider plant or jade plant in a large transparent bottle (Fig. 10.13). After growing the plant properly for some time, seal the mouth of the bottle. Observe the growth of the plant. If the plant is growing well that means the plant is maintaining the exchange of gases, that is, carbon dioxide produced in the process of respiration of the plant is utilised for performing photosynthesis, and oxygen generated in photosynthesis is utilised in respiration by the plant inside the bottle.
- How are plant processes like photosynthesis, respiration, and water and food transportation crucial for crop production?
- Visit a greenhouse, if there is one near your place. Observe how people grow plants in a green house. Find out how they regulate the amount of light, water, and carbon dioxide used to grow plants.

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Know a Scientist

Kamala Sohonie (1911–1998) was a woman scientist of India. She received a Ph.D. degree for her remarkable contribution in the area of respiration in plants from Cambridge University. She returned to India and worked at the Lady Hardinge Medical College in New Delhi, and later at the Nutrition Research Laboratory, Coonoor. Thereafter, she moved to the then Royal Institute of Science, Bombay, where she was eventually appointed as Director. Much of her work helped improve the nutritive values of plant foods. She also worked on the sap of the coconut palm as a nutritive drink called Neera.





11 Light: Shadows and Reflections

In the Western Ghat region of Maharashtra, Keshav spends part of his summer vacation at his friend Jatin's grandparents' village. Having lived in a big city, he finds the forests, fresh air, sounds of gushing streams, and chirping birds a novel experience.

However, for Keshav, the most fascinating sight is the dance of hundreds of fireflies at night, flashing their lights in a wonderful performance. Jatin's grandparents explain that fireflies are seasonal insects and they use light to communicate. Unfortunately, Keshav also learns the number of fireflies is decreasing due to light pollution, reduced forest cover, and excessive tourism.

At the end of their vacation, Keshav and Jatin board an evening bus back to their city. As the bus winds through the hilly roads, Keshav watches the moonlit landscape and the beams from the headlights of passing vehicles flashing by. He is reminded of the many poems and songs about moonlight, and wonders—does the Moon actually produce its own light? Did we not learn in the chapter 'Beyond Earth' in the Grade 6 Science textbook *Curiosity* that all other objects in our solar system shine only by reflecting the light of the Sun? Is moonlight just reflected sunlight? Which objects give off their own light? While thinking, he notices something strange— light seems to move in a straight line!

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11.1 Sources of Light

The Sun gives out or emits its own light and is the main source of natural light on the Earth. Stars, lightning, natural fire, and certain animals also emit their own light (Fig. 11.1).



Fig. 11.1: Some natural sources of light

In ancient times, humans learnt to create fire — the earliest form of artificial lighting. With time, they learnt to create fire using different fuels, such as animal fat, oil, wax, and gas (Fig. 11.2).

With the invention of electricity and different kinds of electric light sources, most of the lighting needs of humans are now met by electric lighting (Fig. 11.3).

Objects that emit their own light are called **luminous** objects. Objects that do not emit their own light are called **non-luminous** objects. The Moon is a non-luminous object. It does not emit its own light. It just reflects the light emitted by the Sun that falls on it.



Fig. 11.2: Fire as a source of artificial light



Fig. 11.3: Some sources of electric light

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Science and Society



Light Emitting Diode (LED) lamps are modern light sources that consume much less power, are brighter and last longer than traditional lamps. This not only reduces electricity bills but is also better for environment. Recognising their advantages, the Indian government has made substantial efforts to promote the use of LED lamps nationwide. At their end of life, LED lamps must be appropriately disposed or recycled, and not thrown in the garbage.



11.2 Does Light Travel in a Straight Line?

Let us do an activity to try to find out.

Activity 11.1: Let us investigate

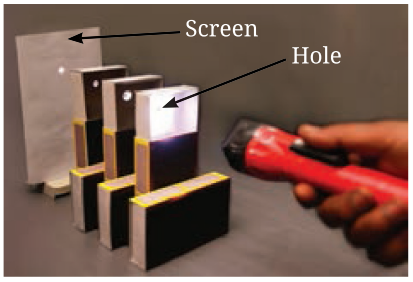
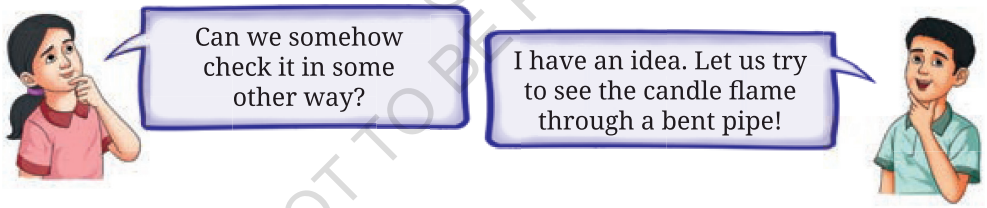


Fig. 11.4: Matchbox activity—light through holes

- Take three matchboxes and make a hole in the inner tray of each matchbox, exactly at the same position.
- Arrange these three matchboxes in a straight line. Make sure that all three holes are exactly at the same height and are in a line as shown in Fig. 11.4.
- Place a torch light on one side of the matchboxes, ensuring that its lamp is at the height of the holes.
- Place a cardboard (screen) on the other side of the matchboxes and obtain a bright spot on it. (You may need to slightly adjust the heights of boxes.)
- Move one of the matchboxes slightly to a side or up and down. Are you able to obtain the light spot on the screen now?

When all the three holes are not in the same line, we could not obtain the light spot on the screen. These observations suggest that light travels in a straight line.



Should we also try out this idea?

Activity 11.2: Let us explore

Caution—Use a lighted candle under adult supervision only.

- Take a long hollow pipe of some flexible material and align it so that you can see the candle flame as shown in Fig. 11.5a.
- Now, bend the pipe and try to see the candle flame again (Fig. 11.5b). Can you still see it?

You could see the candle flame through a straight pipe but not through a bent pipe. This shows that light travels in a straight line.

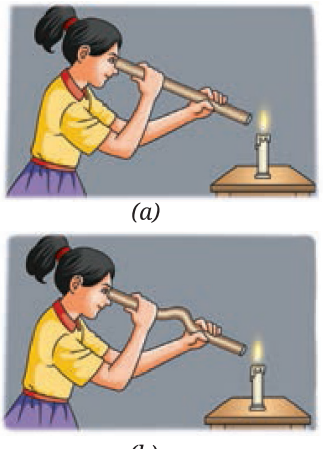
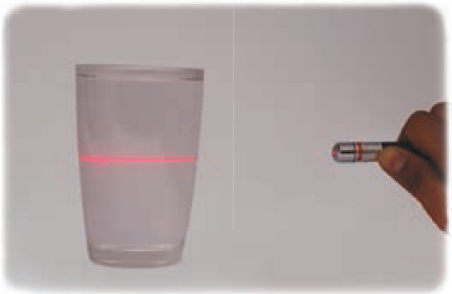


Fig. 11.5: Viewing candle flame through (a) a straight pipe (b) a bent pipe

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Caution—Use a laser only under teachers' supervision. Avoid using high-power lasers for this activity; a low-power laser pointer is sufficient. Never point the laser beam directly at anyone's eyes, as it can cause serious eye damage.





Pass a laser beam through a beaker filled with water in which a drop of milk is added to make the laser beam easily visible. What do you observe? Do you see that the beam of laser light inside water follows a straight path?

However, light can sometimes even bend around corners! This is something you will learn in the higher grades.

11.3 Light through Transparent, Translucent, and Opaque Materials



What happens when an object comes in the path of light?

Let us place objects made of different materials in the path of light and find out.

Activity 11.3: Let us experiment

- Collect objects made of different materials. Also, you will need a torch.

Table 11.1: Light through different materials

Material	Transparent/ Translucent/ Opaque	Light will pass fully/partially/not at all	
		My prediction	My observation
Cardboard			
Paper			
Glass			
Tracing paper			
Thick cloth			
...			
...			

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- List the materials of the objects in Table 11.1 and **classify** them into transparent, translucent, and opaque (In the chapter 'Materials Around Us' in the Grade 6 Science textbook *Curiosity* you learnt to classify materials into transparent, translucent, and opaque, depending on how you could see through them).
- Go to a dark room, turn on the torch, and place it at such a position that you get a spot of light from the torch on a wall. Or you may place a cardboard screen as shown in Fig. 11.6 and get the spot of light on it.
- We will now conduct this activity in two parts—prediction and observation.
  - **Predict** what will happen if you hold an object in front of the light coming out of the torch. Would you continue to see the spot of light on the screen? Note your prediction in Table 11.1.
  - Now, actually place the object between the torch and the screen. Does light pass through the object? Note your observation in Table 11.1.
- Repeat this for all the objects.

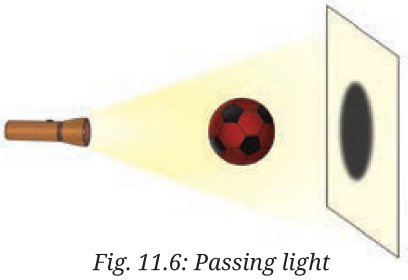
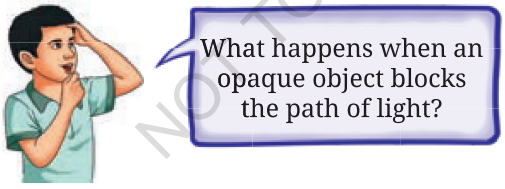


Fig. 11.6: Passing light through different materials

Was your observation the same as your prediction? What conclusions could you draw? Light passes almost completely through **transparent** materials. Light passes partially through **translucent** materials. Light does not pass through **opaque** materials.

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11.4 Shadow Formation

What did you see on the screen in Activity 11.3 when an opaque object was placed in the path of light? Did you see a dark patch on the wall? Why was this dark patch formed?

We now know that light travels in a straight line. So, when an opaque object is placed in its path, light is blocked. The dark patch, where light does not reach, is the **shadow**.



Fig. 11.7: Shadows around us

We have noticed shadows of ourselves and other objects around us when we are in the Sun or under a light (Fig. 11.7). Also, you might have had fun making different shapes with shadows sometime.

Do translucent and transparent objects create shadows or not? Did you **notice** that in Activity 11.3? Opaque objects form darker shadows. Translucent objects make lighter shadows. Even some transparent objects can create faint shadows!

Let us learn more about shadows.

Activity 11.4: Let us explore

- Collect some opaque objects of different shapes and sizes.
- Repeat Activity 11.3, but this time, carry out the actions mentioned in the first column of Table 11.2.
- **Observe** the shape and size of the shadow on the screen for each of the actions.

Did the shadow form in all cases? Was the shape and size of the shadow the same as the object?

- **Record** your observations in the second column of Table 11.2.

Table 11.2: Observation of shadows

Action	Observations regarding shadow
The screen is removed.	
The object is removed.	
The torch is switched off.	
The object is moved closer to the screen, keeping the torch and the screen fixed.	
The object is moved closer to the torch, keeping the torch and the screen fixed.	
The object is tilted, keeping the torch and the screen fixed.	
The colour of the object is changed.	

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What **conclusions** do you draw from this activity? What do we need to observe a shadow? Does the colour of the shadow change when the colour of the object is changed?

Shadows are formed when an object blocks light from falling on a screen. We need a source of light, an opaque object, and a screen

to observe a shadow. The walls, floor, ground, or any other surface acts as a screen for observing shadows in our daily life.

The shape, size, and sharpness of the shadow depend on the position of the object relative to the light source and the screen. The shadows may give information about the object or we may not be able to guess the object at all. Changing the colour of opaque objects does not change the colour of the shadows.

Fascinating Facts



Shadow play, or shadow puppetry, has been a part of our cultural heritage for centuries. In this art form, flat cut-out figures called shadow puppets are placed between a light source and a screen. By moving the puppets and the light, puppeteers can create life-like movements, bringing the characters to life. Different regions have their own unique styles, like the *Charma Bahuli Natya* in Maharashtra, *Keelu Bomme* and *Tholu Bommalata* of Andhra Pradesh, *Togalu Gombeyaata* in Karnataka, *Ravana Chhaya* in Odisha, *Tholpavakoothu* in Kerala, and *Bommalattam* in Tamil Nadu. These are used not only for entertainment but also communicate important messages to the community.



11.5 Reflection of Light



When the opaque object was a shiny object like a polished steel plate, I got a shadow on the screen, but I also saw that there was a bright spot of light on the wall on the opposite side. Why was it so?

Activity 11.5: Let us investigate

- Find a shiny flat steel plate or a plane mirror, that is, a mirror that is flat and not curved.
- Take it outside and let the sunlight fall on the shiny surface. What can you do to redirect light on the wall on which the sunlight is not falling directly?

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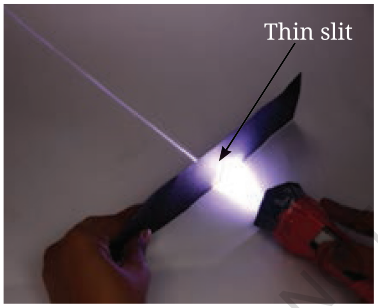
Fig. 11.8: Using mirror to redirect sunlight on a wall

- Turn the shiny plate or mirror in different directions to redirect the light onto a wall or a nearby surface (Fig. 11.8). Do you see a spot of light on the wall? Does it mean that the shiny plate or mirror has changed the direction of light?
- Now, tilt the shiny plate or mirror in different ways and observe the light spot on the wall. Does it change position? Notice how light always travels in straight lines and changes direction when it falls on the shiny plate or mirror.

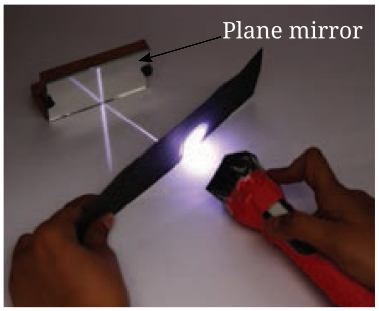
What conclusion do you draw from your observations? This activity suggests that a shiny surface or a mirror changes the direction of light that falls upon it. This change in direction of light by a mirror is called the **reflection of light**. Let us try to understand the reflection of light by a mirror.

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Activity 11.6: Let us experiment



(a)



(b)

Fig. 11.9: (a) A light beam (b) Reflection of light in a plane mirror

- Take a plane mirror with stand, a torch, a comb, a sheet of white paper, and a strip of black paper.
- Using the black paper, close all openings of the comb, except for one to make a thin slit.
- Spread a white paper on a table, hold the comb perpendicular to the sheet of paper and shine the torch light on the slit. Adjust the comb and torch slightly till you see a thin beam of light along the paper which has passed through the slit (Fig. 11.9a).
- Now, place the mirror in the path of the light beam while keeping the comb steady (Fig. 11.9b). What do you observe?

The path of the light beam is changed after falling on the mirror. The reflection of light occurs at the mirror.

In a mirror, I can also see my face. Is that also due to the reflection of light?



11.6 Images Formed in a Plane Mirror

Look into the mirror. Do you see your face in it? What you see is a reflection of your face in the mirror. We also see reflections of other objects that are in front of the mirror. Let us try to find out more about this.

Activity 11.7: Let us experiment

- Take a plane mirror and a pen or some other object.
- Place the pen in front of the mirror as shown in Fig. 11.10.



Fig. 11.10: Image of a pen in a plane mirror

What do you see in the mirror? It appears as if a similar pen is placed behind the mirror. The pen which appears behind the mirror is the **image** of the pen formed by the mirror. The pen itself is the **object**.

- Now, move the pen to different positions in front of the mirror and **compare** the sizes of the images of the pen at each position.

Are the two sizes the same? The image formed by a plane mirror is of the same size as the object.

- Again, move the pen to different positions in front of the mirror and observe if the image is upright at each position.

Does the tip of the pen appear on top at each position? An upright image is called **erect**. An image formed by a plane mirror is erect.

- Now, place a screen vertically behind the mirror. Move it around. Do you get the image on the screen? Repeat this by placing the screen in front of the mirror.

The image formed by a plane mirror cannot be obtained on a screen.

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Activity 11.8: Let us experiment

- Stand in front of a plane mirror and look at your image (Fig. 11.11). Notice how far it appears to be from the mirror.
- Now, stand close to the mirror. Is the image also closer to the mirror?
- Stand at different distances from the mirror and notice how far the image appears to be from the mirror in each case. Do you find any relation between your distance from the mirror and the distance of your image from the mirror?

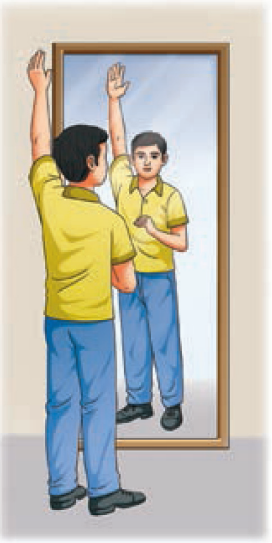
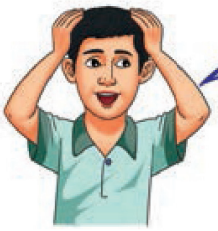


Fig. 11.11: Observing one's own image in a mirror

You might have noticed that when you stand close to the plane mirror, the image also appears to be close to the mirror. The image appears to be far from the mirror when you stand far from the plane mirror.

- Raise your left arm. Which arm does your image raise?
- Touch your right ear. Which ear does your image touch?

You find that your left appears right in your image and your right appears left in your image. This type of perceived left-right reversal is called **lateral inversion**. There is lateral inversion in the images formed by a plane mirror.



Oh! Now I realise why 'ƎNↃИAJUBMA' is written on an ambulance. It reads 'AMBULANCE' when viewed from the rear-view mirrors of the vehicle ahead of the ambulance.



Fascinating Facts

When mirrors were invented is not known. Earlier, mirrors were made by polishing stone or metal. When glass mirrors started being made, the art of making metal mirrors got lost gradually. However, it still survives, for example, in Kerala, where *Aranmula Kannadi*, a unique metal surface mirror has been made for centuries.



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Can we see an image of an object only in a mirror or are there some other ways as well?



11.7 Pinhole Camera

A pinhole camera is a device in which the light rays from an object pass through a tiny hole (a pinhole) and form an image on a screen.

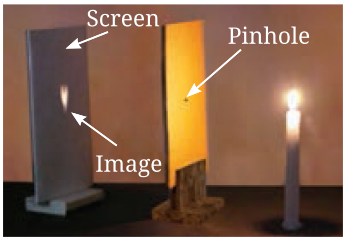
Activity 11.9: Let us explore

Caution—Use a lighted candle under adult supervision only.

- Take a piece of cardboard and a candle. Make a small hole in the cardboard.
- In a dimly lit room, position the cardboard at a short distance from a screen.
- Place a lighted candle in front of it as shown in Fig. 11.12a.

What do you see on the screen? Light coming from the flame passes through the hole on the cardboard and forms an image of the candle flame on the screen. Do you notice anything surprising? The image of the candle flame is upside down, that is, inverted.

Let us now make a pinhole camera, which you can use outdoors.



(a)



(b)

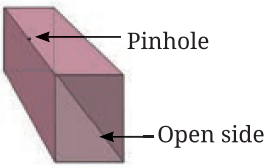
Fig. 11.12: (a) A simple pinhole camera (b) Image of a candle flame on screen

Activity 11.10: Let us construct

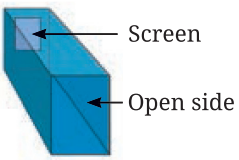
- Take two boxes of cardboard such that one can slide into another with very little gap in between them. Cut open one side of each box.
- On the opposite face of the larger box, make a small hole in the middle (Fig. 11.13a).
- On the opposite face of the smaller box, cut out a square from the middle with a side of about 5–6 cm. Cover this opening with a thin translucent paper (like a tracing paper) to form a screen (Fig. 11.13b).
- Slide the smaller box inside the larger one in such a way that the side with the tracing paper is inside (Fig. 11.13c).

Hold the pinhole camera with the pinhole facing the object and look through the open side of the smaller box. Cover your head and the camera with a dark cloth. Look at a distant object, like a tree or building, in bright sunlight and move the smaller box forward or backward until an image appears on the tracing paper.

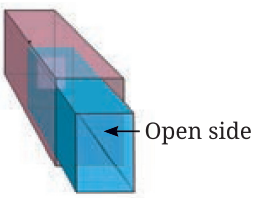
Do the images seen in the camera show the colours of the objects on the other side? Are the images erect or upside down?



(a)



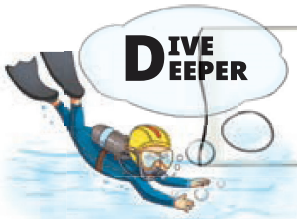
(b)



(c)

Fig. 11.13: A sliding pinhole camera

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A pinhole camera gives an upside down image. On the other hand, there is lateral inversion in the image formed by a mirror but it is not upside down. We will learn more about this in higher grades.

11.8 Making Some Useful Items

After having learnt that light travels in a straight line and is reflected by mirrors, it is time to **create** some useful items based on this learning.

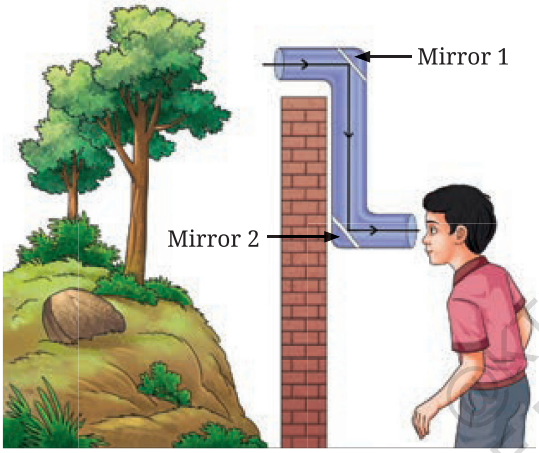


Fig. 11.14: A periscope

11.8.1 Periscope

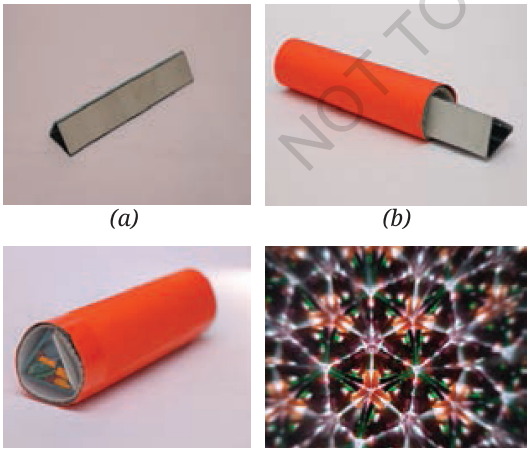
We can make a simple periscope by placing two plane mirrors in a Z-shaped box as shown in Fig. 11.14.

Reflection from two mirrors enables us to see objects that are not visible directly. Periscopes are used in submarines, tanks, or by soldiers to see outside their bunkers. You may use it to look ahead when standing behind taller friends.

11.8.2 Kaleidoscope

Get three rectangular plane mirror strips of equal width and join them together in a triangular manner as shown in Fig. 11.15a. You may use three strips of thick reflective paper instead of mirrors. Fix these in a circular tube of thick chart paper (Fig. 11.15b). On one end of the tube, fix a transparent plastic sheet using a rubber band or an adhesive tape. Place several broken pieces of coloured bangles or beads on this (Fig. 11.15c), and cover it with a tracing paper using a rubber band or an adhesive tape.

When you peep through the open side, you view a beautiful pattern (Fig. 11.15d). Even if you leave both sides of the kaleidoscope open and



(a) *(b)* *(c)* *(d)*

Fig. 11.15: A kaleidoscope

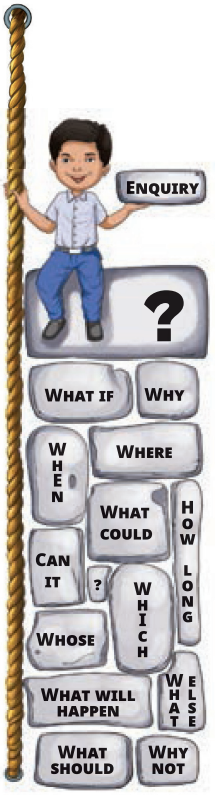
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point it towards a tree or other objects, you see beautiful patterns. An interesting feature of the kaleidoscope is that one always gets to see a different pattern every time the kaleidoscope is turned about. Since there are 3 mirrors, and multiple images (due to reflections of reflections), many interesting patterns are formed. Designers and artists often use kaleidoscopes to get ideas for new patterns.

In a Nutshell



- Objects that emit their own light are called luminous objects.
- Light travels in a straight line.
- Light passes almost completely through transparent materials. Light passes partially through translucent materials. Light does not pass through opaque materials.
- A shadow is formed when light is blocked by an object. Opaque objects form darker shadows. Translucent objects make lighter shadows. Some transparent objects can create faint shadows.
- The change in the direction of light by a mirror is called reflection of light.
- The image formed by a plane mirror is of the same size as the object, is erect, cannot be obtained on a screen, and is laterally inverted.
- A pinhole camera creates an inverted image of an object on a screen.



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Let Us Enhance Our Learning

1. Which of the following are luminous objects?
   Mars, Moon, Pole Star, Sun, Venus, Mirror
2. Match the items in Column A with those in Column B.

Column A	Column B
Pinhole camera	Blocks light completely
Opaque object	The dark region formed behind the object
Transparent object	Forms an inverted image
Shadow	Light passes almost completely through it

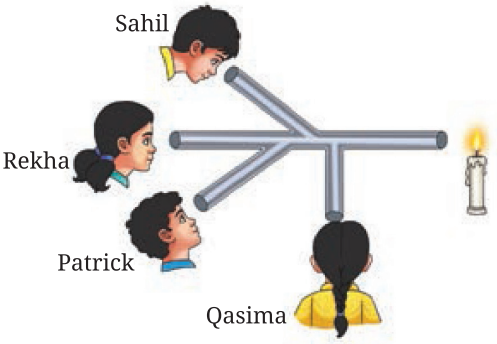


Fig. 11.16

3. Sahil, Rekha, Patrick, and Qasima are trying to observe the candle flame through the pipe as shown in Fig. 11.16. Who can see the flame?
4. Look at the images shown in Fig. 11.17 and select the correct image showing the shadow formation of the boy.

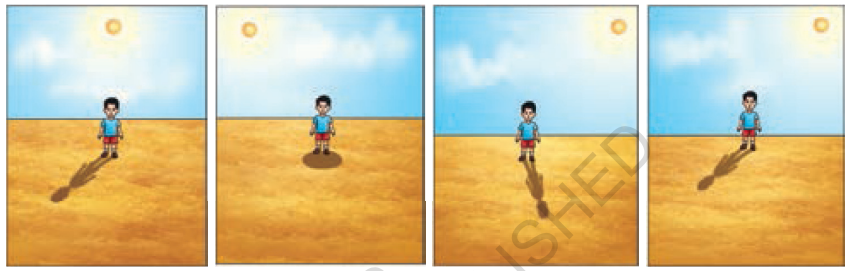


Fig. 11.17

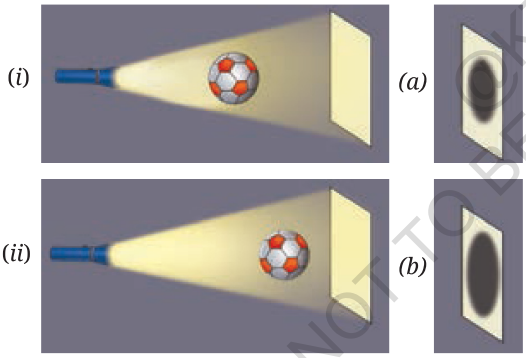


Fig. 11.18

5. The shadow of a ball is formed on a wall by placing the ball in front of a fixed torch as shown in Fig. 11.18. In scenario (i) the ball is closer to the torch, while in scenario (ii) the ball is closer to the wall. Choose the most accurate representation of the shadows formed in both scenarios from the options provided (a and b).
6. Based on Fig. 11.18, match the position of the torch in Column A with the characteristics of the ball's shadow in Column B.

Column A	Column B
If the torch is close to the ball	The shadow would be smaller
If the torch is far away	The shadow would be larger
If the ball is removed from the set-up	Two shadows would appear on the screen
If two torches are present in the set-up on the left side of the ball	A bright spot would appear on the screen

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7. Suppose you view the tree shown in Fig. 11.19 through a pinhole camera. Sketch the outline of the image of the tree formed in the pinhole camera.



Fig. 11.19

8. Write your name on a piece of paper and hold it in front of a plane mirror such that the paper is parallel to the mirror. Sketch the image. What difference do you notice? Explain the reason for the difference.
9. Measure the length of your shadow at 9 AM, 12 PM, and 4 PM with the help of your friend. Write down your observations:
   (i) At which of the given times is your shadow the shortest?
   (ii) Why do you think this happens?
10. On the basis of following statements, choose the correct option.

    Statement A: Image formed by a plane mirror is laterally inverted.

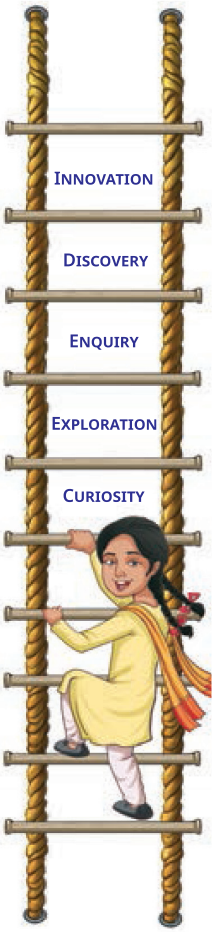
    Statement B: Images of alphabets T and O appear identical to themselves in a plane mirror.

    (i) Both statements are true
    (ii) Both statements are false
    (iii) Statement A is true, but statement B is false
    (iv) Statement A is false, but statement B is true
11. Suppose you are given a tube of the shape shown in the Fig. 11.20 and two plane mirrors smaller than the diameter of the tube. Can this tube be used to make a periscope? If yes, mark where you will fix the plane mirrors.



Fig. 11.20

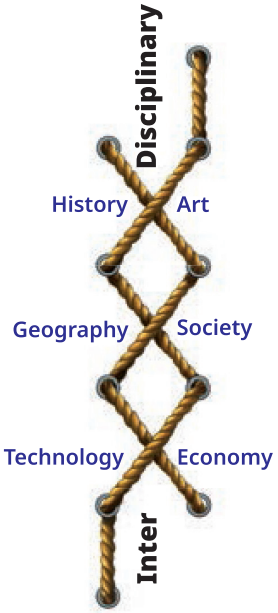
12. We do not see the shadow on the ground of a bird flying high in the sky. However, the shadow is seen on the ground when the bird swoops near the ground. Think and explain why it is so.



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Exploratory Projects

- Have you ever seen a firefly where you live? If no, ask your elders if fireflies were seen earlier in your region. If yes, find out the reasons for their not being seen anymore. Develop a story about it.
- Repeat Activity 11.4, but this time cover the face of the torch with a coloured transparent paper and observe the colour of



the shadow. Repeat this using transparent paper of different colours. Report your conclusions.

- A plane mirror forms only a single image of an object. But what will happen if two or more mirrors are kept at an angle with each other or parallel to each other? Find out by placing two mirrors as shown in Fig. 11.21.

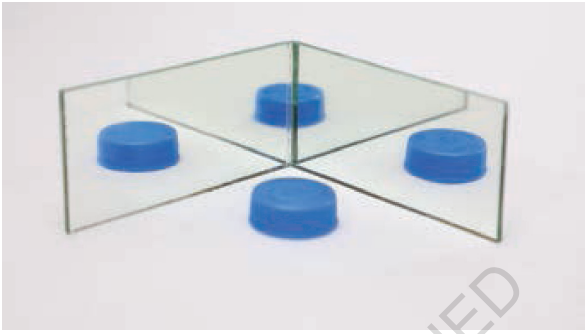


Fig. 11.21: Observing images in two mirrors

- You are given a small piece of a plane mirror. Can this piece form an image of an object much larger than the mirror, like a large tree? Think and predict. Then carry out the activity.



Fascinating Facts

Light emitted by the Sun takes about 8 minutes and 20 seconds to reach the Earth. Hence, if the Sun were to suddenly stop emitting light, we would not know that for another 8 minutes 20 seconds.

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12 Earth, Moon, and the Sun

One morning in Kanniyakumari, Tamil Nadu, 12-year-old Rashmika was eagerly cycling to school. She was excited. That was the day her science teacher had dedicated a class for students to share and try to explain interesting observations.

Rashmika had been noticing that the coconut tree shadows were long in the morning but shorter in the afternoon on her way back. She thought about it and decided that the size of the shadows changed because the Sun moved across the sky during the day. But she also remembered learning that the Earth moved around the Sun (in chapter 'Beyond Earth' in the Grade 6 Science textbook *Curiosity*) so she was puzzled. She wondered—does the Sun move in the sky? Or does the Earth move?

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12.1 Rotation of the Earth

You might have also noticed that the Sun rises in the East and sets in the West. Have you ever wondered why? Let us try to understand why. Have you ever enjoyed riding a merry-go-round at a park or at your school? Let us go back to riding a merry-go-round!

Activity 12.1: Let us explore

- Sit on a merry-go-round facing towards the outer side as shown in Fig. 12.1.



Fig. 12.1: A girl observing objects around her while riding a merry-go-round

- Ask someone to turn the merry-go-round slowly in the anti-clockwise direction as shown in Fig. 12.1. While you are sitting on the moving merry-go-round, look around you. Do the objects around you appear to be moving? In which direction do they appear to be moving?

While you turn in the anti-clockwise direction, the objects appear to turn around you in the opposite direction, that is, in the clockwise direction.

- Now fix your gaze at a particular tree (or a building) ahead of you while sitting on the merry- go-round turning around in anti-clockwise direction.

In which direction do you find the tree turning around you? Is it in your view all the time?

The tree appears to turn around you in the opposite direction, that is, the clockwise direction. The tree appears in your view from your left-hand side and then moves out of your view on the right-hand side when you view it from a merry-go-round turning around in anti-clockwise direction.

Using the observations made by us while riding a merry-go-round, let us now think. When we view from the Earth, the Sun appears in the East, moves across the sky from the East to the West and disappears in the West. Does it indicate that the Sun is moving in the sky? Or might it be that the Earth itself is turning around and the Sun just appears to move?

The fact is that the Sun appears to be moving because we view it from the Earth, which is turning around itself.

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In which way is the Earth turning around itself? To visualise this, let us recall some of the objects which turn around themselves. Have you watched a top spinning around its spindle (Fig. 12.2a)? Or a spinning fan (Fig. 12.2b)? Or tried spinning a ball (Fig. 12.2c)?

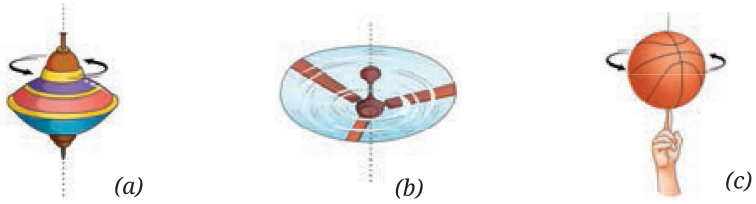


Fig. 12.2: (a) A spinning top (b) A spinning fan (c) A spinning ball

In a similar manner, the Earth also spins (or **rotates**) on its own axis in space as shown in Fig. 12.3. The **Earth's axis of rotation** passes through its geographic North Pole and the South Pole. The Earth completes **one rotation** in about 24 hours.

When viewed from the top of the North Pole (Fig. 12.3), the Earth is rotating in the anti-clockwise direction, that is, from West to East.

Let us try to understand this with the help of a globe. You have used a globe in Grade 6 to represent the Earth and identified North Pole, South Pole, and Equator on it. You also learnt that its axis passed through its North and South poles (in the Grade 6 Social Science textbook *Exploring Society India and Beyond*).

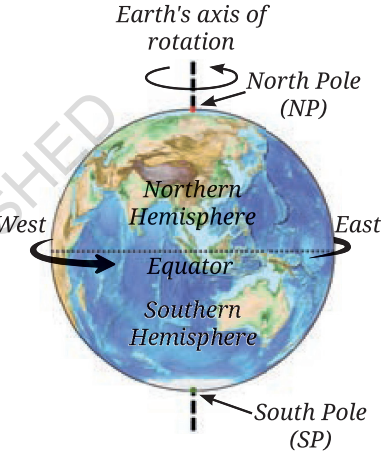


Fig. 12.3: Rotation of the Earth

Activity 12.2: Let us explore

- Use a globe to represent the Earth and place a small sticker to mark your location on it (Fig. 12.4a).
- While viewing from above the North Pole, slowly rotate the globe on its axis in anti-clockwise direction.
- **Observe** how your location turns around and finally comes back to its original position completing one rotation.

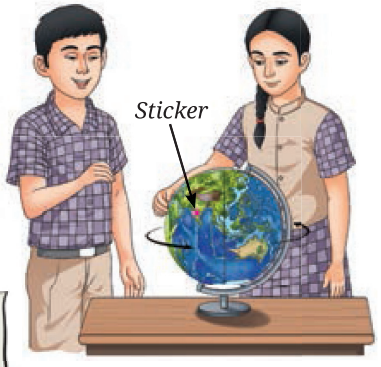
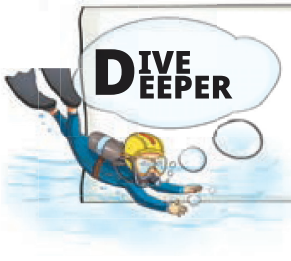


Fig. 12.4(a): Using a globe to understand rotation of the Earth



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Rotation is the motion of an object in which all its parts move in circles around an imaginary line that passes through it. This line is called the axis of rotation.

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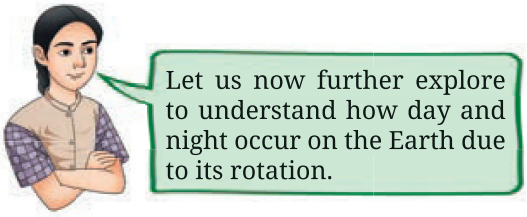




Fig. 12.4(b): Using a globe and a torchlight to understand day and night

- Use a torch to represent the Sun. Go to a relatively dark room to carry out the further steps of the activity.
- Now, shine light from the torch placed at some distance, say 1.5 metres, on the globe as shown in Fig. 12.4b. Do you **notice** how half of the globe receives the light from the torch, while the other half stays dark?

It is day time in that half of the globe which receives light, and night time in the other half.

- In India, sunrise first occurs in the eastern part and then in other parts. While looking at the eastern part of India on the globe, rotate the globe in one direction and then in the opposite direction. What is the direction of rotation when light falls on the eastern part of India first?

The light falls on the eastern part of India first when the globe rotates from West to East with respect to the North-South axis of the globe.

- Now while rotating the globe from West to East, observe your location on the Earth. Does it go through a cycle of day and night?

Sunrise occurs as your location moves into light and sunset occurs as it moves into darkness.

The Earth's rotation from West to East causes the day-night cycle. As shown in Fig. 12.5, the side facing the Sun experiences daytime, while the other side is dark and experiences night.

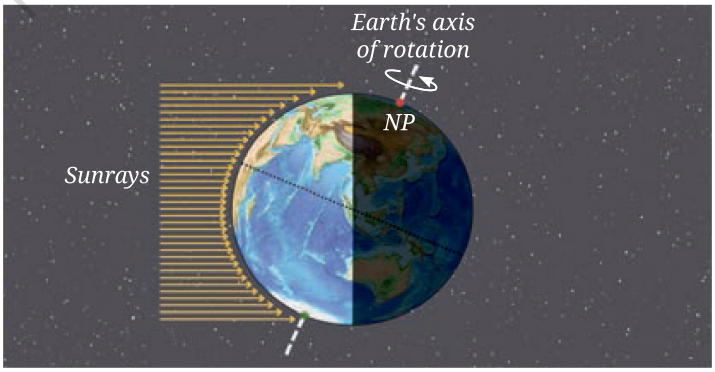


Fig. 12.5: Sunlight falls on half of the Earth's surface

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Now **imagine** that you are standing on the Equator on the Earth and watching the sky during one rotation of the Earth while it rotates from West to East. What will you observe? Will your observation be the same as that of the girl shown in Fig. 12.6?

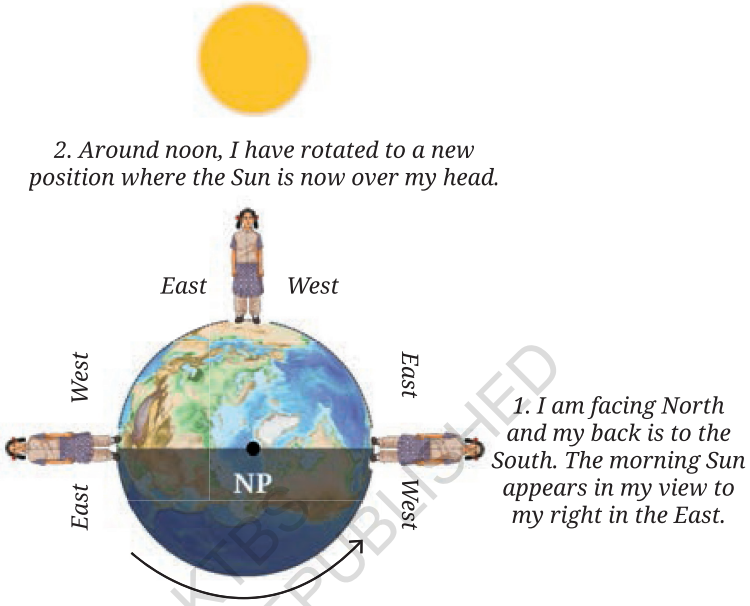


Fig. 12.6: A girl on the rotating Earth viewing the Sun from the Equator

Due to the rotation of the Earth, the Sun appears to rise in the eastward direction, move across the sky from the East to the West and set in the westward direction (Fig. 12.6). Then the night begins and the stars become visible in the sky.

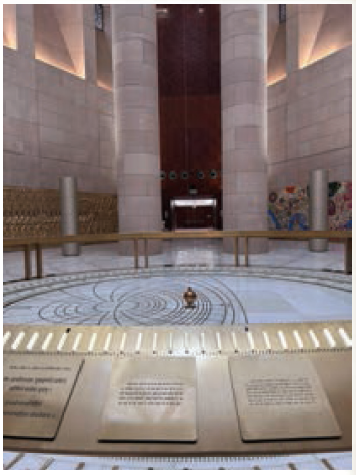
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Fascinating Facts



In an earlier chapter 'Measurement of Time and Motion', you learnt how the scientist Galileo discovered an important property of a pendulum, and in the seventeenth century, another scientist, Huygens, used that property to make pendulum clocks that measured time. In the middle of nineteenth century, another scientist, Leon Foucault, used a long pendulum to give the first simple demonstration of the Earth's rotation. The pendulum, known as a Foucault pendulum in his honour, consists of a long string with a heavy bob, suspended from a high ceiling.

A Foucault pendulum with a length of 22 metres has been hung from a skylight in the Constitution Hall of the new Parliament building in New Delhi, India. It symbolises the integration of the idea of India with the vastness of the cosmos.





Since the Earth is rotating, shouldn't the stars also appear to move in the sky like the Sun?

Yes, indeed! Let us look at the stars in the night sky to see the effect of Earth's rotation.

Activity 12.3: Let us explore

- On an early evening between March and May, **identify** the Big Dipper (Saptarishi), and the Pole Star (Dhruva Tara), if visible, as you did in the chapter 'Beyond Earth' in the Grade 6 Science textbook *Curiosity*.
- Note down your location and date of your night sky observations. The activity must be carried out on the same night.
- **Draw** the orientation of the Big Dipper in the sky with respect to the Pole Star (or a fixed tree/building on the ground in a direction towards the Big Dipper if you cannot see the Pole Star). Mark the time of your observation along with your sketch as shown in Fig. 12.7.

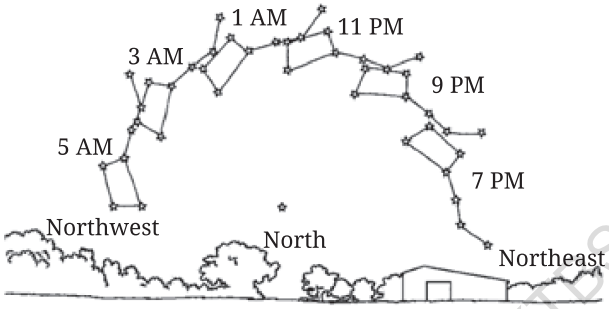


Fig. 12.7: Illustrative sketch of Big Dipper (for activity 12.3) by a student located in Pune on the night of 1–2 April

- After two hours, observe the Big Dipper again. Has it moved? Again, draw its orientation and note down the time.
- Repeat the above step after two hours. Do you observe that the Big Dipper appears to move around the Pole Star (notice just the movement even if you cannot see the Pole Star)?

The Earth's axis of rotation points very close to the Pole Star in the Northern Hemisphere. Therefore, the Pole Star appears nearly stationary in the sky from the Earth. All the stars appear to move around it. Just like the Sun, the Moon also appears to rise in the eastward direction and set in the westward direction because the Earth rotates from West to East.



(Picture taken from Mahuli, Maharashtra)

Fascinating Facts

Astrophotographers take long exposure photographs, keeping the camera's shutter open for a long time. In such a photograph, the apparent motion of the stars is recorded as arcs of a circle, known as star trails.



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Fascinating Facts

Ancient Indian astronomers, including Aryabhata, had also noticed the daily apparent motion of the celestial objects, such as the Sun, Moon, planets and stars. Aryabhata was a famous mathematician and astronomer of ancient India who wrote an important treatise, *Aryabhatiya*, around the fifth century CE. The apparent motion of the stars due to the rotation of the Earth is explained in Verse 9, Golapada, *Aryabhatiya.*

अनुलोमगतिर्नौस्थः पश्यत्यचलं विलोमगं यद्वत्।

अचलानि भानि तद्वत् समपश्चिमगानि लङ्कायाम्॥

Just as a man in a boat moving forward sees stationary objects as moving backwards, so also the stars that are stationary are seen by people of Lanka as moving towards the west.

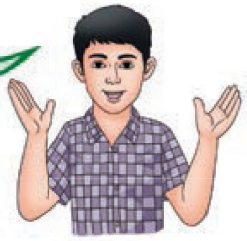
Aryabhata's stated value for the time taken by the Earth to complete one full rotation about its axis is around 23 hours 56 minutes 4.1 seconds (in modern units). This value is impressively close to the currently accepted value.





I have seen that the stars and constellations that appear in the East at sunset change during different months.

Yes. Maybe that is why we were told to look for certain stars and constellations at certain times of the year in Grade 6. But, why do different stars appear in the night sky over the course of a year?



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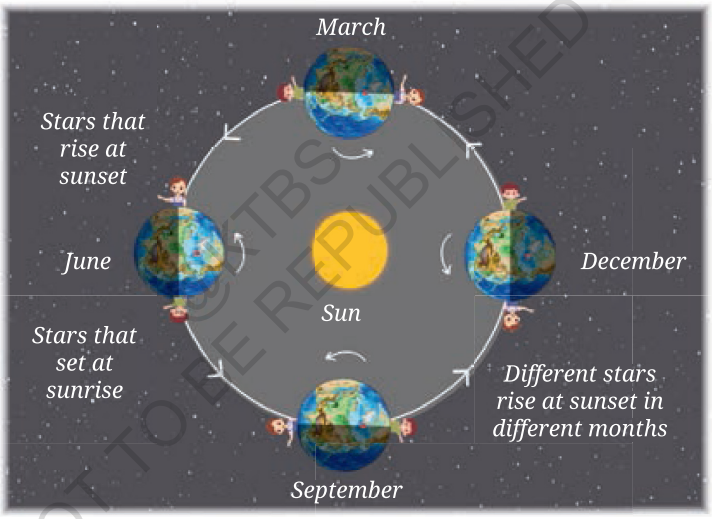
12.2 Revolution of the Earth

While rotating on its own axis, the Earth also revolves around the Sun as we learnt in Grade 6. This movement is different from rotation. **Revolution** is the motion of an object around another object.

The path an object takes while revolving around another object is called its **orbit**. If viewed from the top (Fig. 12.8), the orbit of the Earth around the Sun is nearly circular. (In the figure of the Solar System given in chapter 'Beyond Earth' in the Grade 6 Science textbook *Curiosity*, the orbit appeared elongated because it was a side view of the orbit). The Earth completes **one revolution** around the Sun in about 365 days and 6 hours.

12.2.1 Changing view of night sky from the Earth

Every evening the Sun sets in the westward direction and the night sky becomes visible. We know that this occurs due to the Earth's rotation. As the Earth also revolves around the Sun continuously, the stars seen in the night sky after sunset gradually change over a year as we look in different directions, as shown in Fig. 12.8.



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Fig. 12.8: Revolution of the Earth around the Sun leads to changing view of the night sky throughout the year (The sizes and distances are not to scale)

You can also notice this change by looking at the pattern of stars (such as those that you learnt about in Grade 6), at a fixed time of the night, on days separated by a month.



FASCINATING FACTS

The *Bhil* and *Pawara* are indigenous communities from the Tapi Valley in western India, who used the appearance of certain patterns of stars in the sky as markers for the arrival of monsoon rain.

12.2.2 Seasons on the Earth



The Earth's axis of rotation is not upright with respect to the orbit, but is tilted. The Earth maintains this tilt as it orbits around the Sun (Fig. 12.9). The tilt of the Earth's axis and the spherical shape of the Earth gives rise to seasons. Let us find out, how.

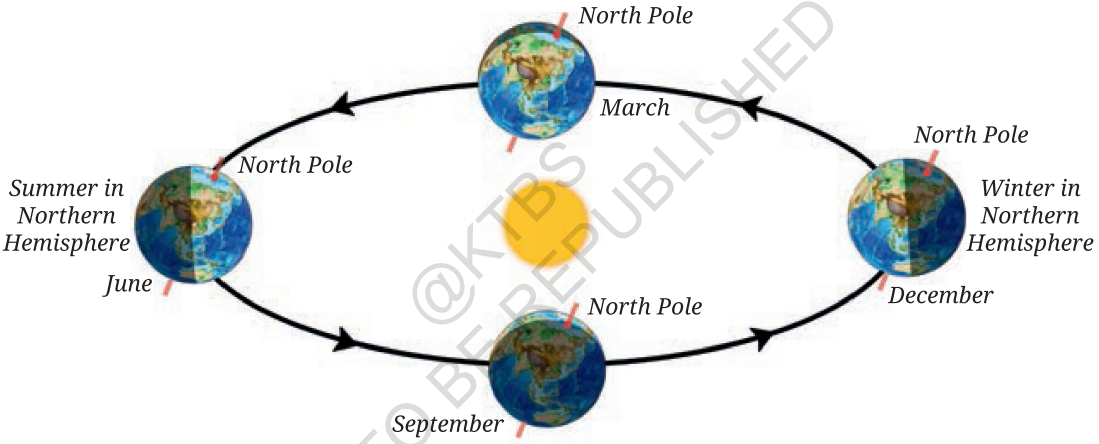


Fig. 12.9: Different positions of the Earth while revolving around the Sun (The Earth's orbit appears elongated because this is a side view and not the top view. The sizes and distances are not to scale)

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In June, the Northern Hemisphere is tilted towards the Sun while the Southern Hemisphere is tilted away from the Sun (Fig. 12.9). As seen in Fig. 12.10a, a given amount of sunrays are spread in a smaller area in the Northern Hemisphere as compared to the Southern Hemisphere due to the spherical shape of the Earth's surface. So that area is heated more.

Further, the Northern Hemisphere receives sunlight for more than 12 hours in June (Fig. 12.11a). So, the Northern Hemisphere experiences more intense sunlight, which lasts for a longer time, causing the summer season. In December, the situation is opposite in the Northern Hemisphere and it experiences winter season with sunlight for shorter time (Fig. 12.10b and Fig. 12.11b).

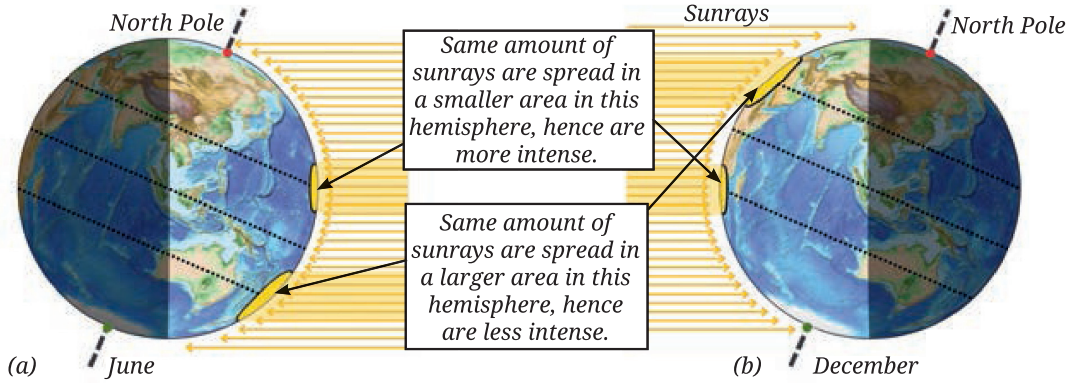


Fig. 12.10: (a) More intense sunlight in the Northern Hemisphere and less intense sunlight in the Southern Hemisphere in June (b) The opposite situation happens in December.

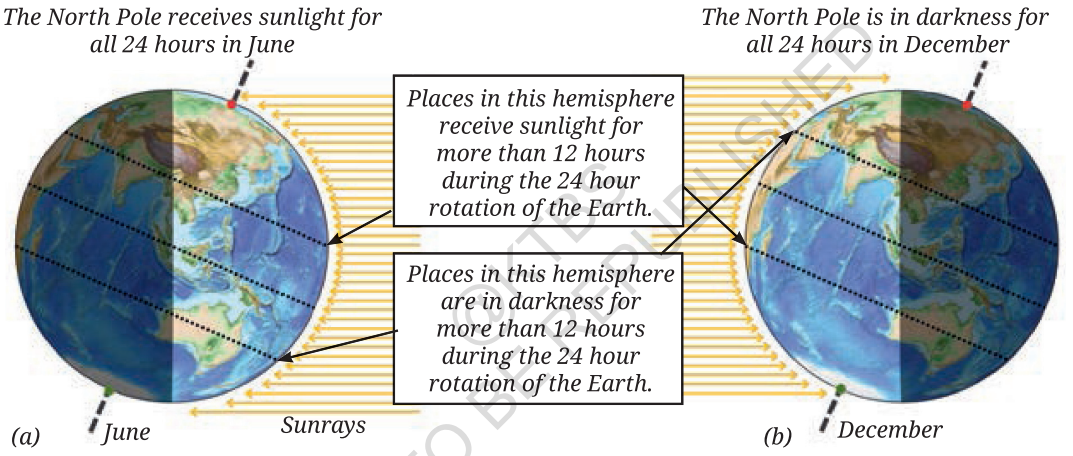
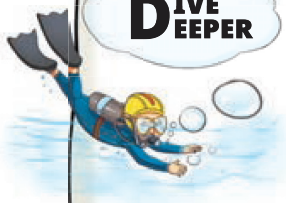


Fig. 12.11: In the Northern Hemisphere (a) Longer daytime in June (b) Shorter daytime in December

The seasons and length of daytime are reversed in the Southern Hemisphere as compared to the Northern Hemisphere. There, it is winter in June and summer in December (Fig. 12.10 and Fig. 12.11).



Two incorrect reasons often given to explain why seasons occur on the Earth are:

- When the Northern Hemisphere tilts towards the Sun, it is closer to the Sun.
- The orbit of the Earth is an oval with the Sun slightly displaced from its centre so the Earth is at different distances from the Sun over the year.

However, the difference in distances in either of these cases is very small and these are not the reasons why seasons occur on the Earth. In fact, the Earth is closest to the Sun in January.

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DIVE DEEPER

In the Northern Hemisphere, the longest day occurs around 21 June—this is known as summer solstice. After the summer solstice, the duration of a day becomes shorter while that of a night becomes longer. The shortest day and longest night in this Hemisphere occur around 22 December known as the winter solstice. Around 21 March and 23 September, the daytime lasts for 12 hours. In the Northern Hemisphere, these days are called the spring and the autumn equinox, respectively.



Fascinating Facts

At the North Pole, the Sun rises in the East direction on the equinox day—21 March, and remains continuously in the sky for six months. The Sun sets on 22 September. The South Pole experiences the opposite behaviour. The polar regions thus experience continuous sunshine for six months followed by a six-month period of darkness.

On the equator, there is always 12 hours of sunlight and 12 hours of darkness. There is little difference in the intensity of the sunrays falling on the equator in different months. Thus, for the southern states of India that lie close to the equator, the effect of seasons is not very prominent. Other effects, such as local geographical features and proximity to oceans or seas, can also influence these broader patterns seen in the two hemispheres, as you have learnt in social science.

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12.3 Eclipses

Day and night cycle, seasons, the life on the Earth... so much is dependent upon the Sun. Could the light from the Sun get blocked by the two planets which are revolving between the Earth and the Sun?



The planets Mercury and Venus appear very small compared to the Sun, and never block the entire light from the Sun reaching us. However, you may be surprised to know that the Moon can do that. Do you remember studying in Grade 6 that the Moon is a natural satellite of the Earth and it revolves around the Earth as the Earth revolves around the Sun?

12.3.1 Solar eclipse

At certain times, the Moon can come in between the Sun and the Earth in a way that obstructs the light from the Sun from reaching us. This is known as a **solar eclipse**. You may wonder how the Moon, which is smaller than the Sun, blocks the light coming from the Sun that we see in the sky.

Activity 12.4: Let us explore

- ❖ Ask your friend to stand in front of you at a distance of about 5 metres. Consider his head to be the Sun.
- ❖ Now close one eye and show a thumbs up with your outstretched hand towards your friend as shown in Fig. 12.12. Are you able to cover the entire head of your friend with your thumb?



Fig. 12.12: Trying to cover a friend's head with the thumb

You can cover the entire head of your friend with the help of your thumb, even though your thumb is much smaller than the actual size of your friend's head. How could it be? The size of any object as seen by your eye—also known as **apparent size**—depends upon both its actual physical size and its distance from you. The thumb being much closer to you as compared to your friend, the apparent sizes of your thumb and your friend's head as seen by you in Activity 12.4 are similar.

The apparent sizes of the Moon and the Sun in the sky are similar when viewed from the Earth. This is so because though the Moon is much smaller in physical size than the Sun, the Moon is much closer to us compared to the Sun. Therefore, the Moon can appear to cover the entire Sun as viewed from the Earth.

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DIVE DEEPER

Though the planets Mercury and Venus are much larger than the Moon in size, they are also much farther from the Earth as compared to the Moon. Thus, their apparent sizes are very much smaller than the Sun and they cannot block the Sun. For example, when Venus passes between the Sun and the Earth, it appears as a tiny black dot passing against the bright face of the Sun. This event, known as a Transit of Venus, is a rare event.

Figure 12.13 shows the arrangement of the Sun, the Moon, and the Earth during a solar eclipse. The shadow of the Moon falls on a small area on the surface of the Earth as seen in Fig. 12.13. This area is in total darkness, and no part of the Sun can be seen from there. The observers in this area witness a **total solar eclipse** (Fig. 12.14a).

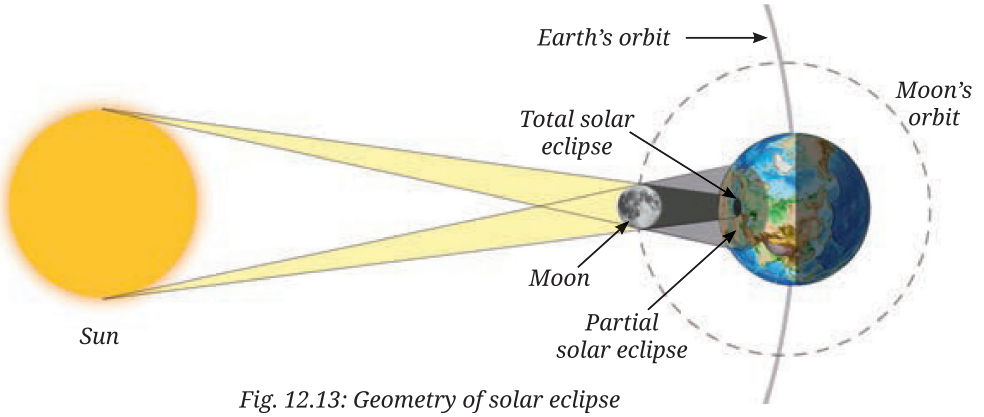
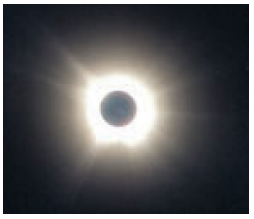


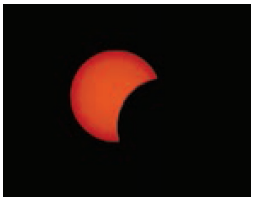
Fig. 12.13: Geometry of solar eclipse
(The sizes and distances are not to scale)

In areas where the Moon partially blocks out only some regions of the Sun, the observers see a **partial solar eclipse** (Fig. 12.13 and Fig. 12.14b).

During a total solar eclipse, for a few minutes it turns dark during the day as no sunlight reaches the Earth. Due to the Earth's rotation and the motion of the Moon in its orbit, the Moon's shadow moves across the surface of the Earth. Thus, the total solar eclipse is visible only for a few minutes. As the Moon begins to move away from the front of the Sun (Fig. 12.14c), we see a partial solar eclipse and daylight begins to return.



(a) Total solar eclipse



(b) Partial solar eclipse



(c) A 'diamond ring' seen after a total solar eclipse, just when the Moon starts to move away

Fig. 12.14: Solar eclipse

Safe Viewing of a Solar Eclipse

Caution—During a solar eclipse, one might be tempted to look at the Sun, thinking that it wouldn't be strong enough to cause harm to our eyes. However, even during the eclipse, the Sun is intense enough to damage the eyes and cause blindness. Thus, directly viewing solar eclipse must be strictly avoided. Also, do not view it through sunglasses, binoculars, or telescopes.

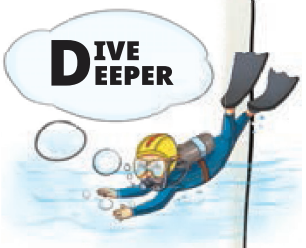


Fig. 12.15: A public solar eclipse viewing organised in Ooty, Tamil Nadu

Usually, astronomy organisations, such as planetaria and astronomy clubs hold eclipse viewing events during a solar eclipse (Fig. 12.15).

Participating in such events is the best way to observe a solar eclipse since the organisers not only provide specialised eye protection for solar viewing, but also offer scientific explanations.

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This activity, similar to Activity 11.5, is to be set up by your teacher. A mirror can be used to project an image of the Sun onto a wall. However, holding it at the correct angle throughout a solar eclipse can be difficult. To solve this, make a movable stand for the mirror. Use a hollow ball with a small hole, half-fill it with sand (to keep it stable), and attach a small mirror (such as an embroidery mirror) to it. Place the ball on a circular ring, like an adhesive tape ring, so it can be turned around easily. Adjust it until the Sun's image appears on a wall or screen. Fig. 12.15 shows this set-up where the mirror is fixed to a green ball.

Caution—This activity should be performed strictly under supervision of a teacher. Take care not to direct the reflected light beam in anyone's eyes.

People have observed eclipses and maintained records since ancient times. When the reasons for eclipses were not known, they feared the occurrence of eclipses. As you can imagine, something blocking the Sun, the main source of heat and light on the Earth, even for a brief period of time, would have been extremely concerning. Many superstitions were attached to solar eclipses in various parts of the world related to the activities that could not be carried out during eclipses—such as eating, cooking, or going out of home. But now that we know the reason why a solar eclipse occurs, we need not fear these events as long as we do not look at the Sun directly. In fact, scientists go around the world to observe the eclipses from wherever these are observable. The eclipses provide them an opportunity to study phenomena that cannot be observed otherwise.

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Fascinating Facts

An eclipse is known as *grahan* in Sanskrit and in many Indian languages. Many ancient Indian astronomical texts provide calculations to predict eclipses. The best known and most referred text is the *Surya Siddhanta*, which is written in the classical Sanskrit poetry tradition in rhythmic shlokas.

12.3.2 Lunar eclipse

As the Moon revolves around the Earth, sometimes the Earth can block the sunlight from reaching the Moon. This is known as a **lunar eclipse**. On such days, we see the Earth's shadow falling on the full disc of the Moon. Fig. 12.16 shows the arrangement of the Sun, the Earth, and the Moon during a lunar eclipse.

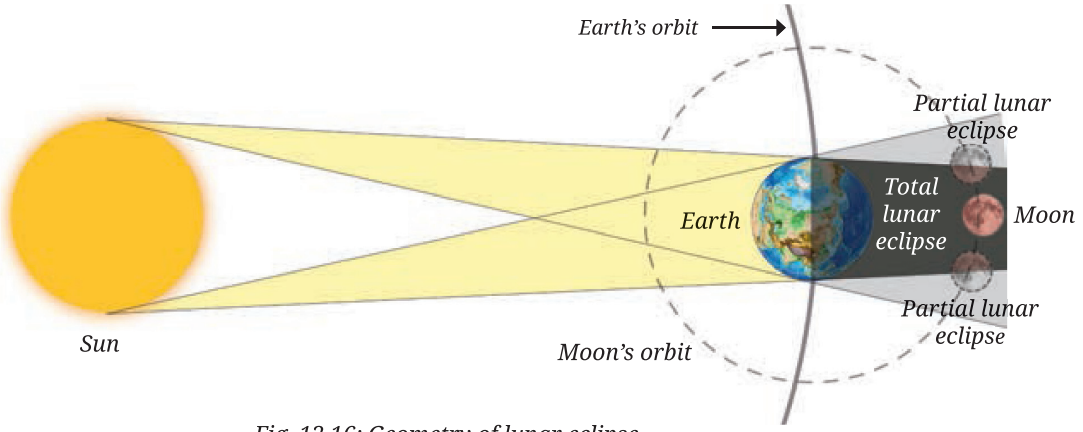


Fig. 12.16: Geometry of lunar eclipse
(The sizes and distances are not to scale in the figure)

When the Moon is completely in the Earth's shadow, it is called a **total lunar eclipse**. The bright disc of the Moon starts to appear dark red in colour and stays that way until the Moon moves out of the shadow of the Earth. When part of the Moon is in the Earth's shadow and the rest of the Moon is visible, it is called a **partial lunar eclipse**. Unlike the Sun, we can safely watch the eclipsed full Moon with our naked eye.

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Science and Society

Using the computer version of Stellarium app, which is free, you may get information about the upcoming solar and lunar eclipses (if any) which may be visible from your location.



Fascinating Facts



The Kodaikanal Solar Observatory is located in the beautiful Palani range of hills in southern India. It was established in 1899 and has provided data about the Sun for over 100 years. It is operated by the Indian Institute of Astrophysics (IIA), Bengaluru.



Know a Scientist



M.K. Vainu Bappu is known as the father of modern Indian astronomy. He led efforts in setting up many instruments and telescopes in India, such as the telescopes at Manora Peak near Nainital (Uttarakhand) and Kavalur (Tamil Nadu). The observatory at Kavalur has been named after him. He mainly studied stars and even discovered a comet. He also travelled to different parts of the world to study solar eclipses.



In a Nutshell



- The Earth rotates on its own axis in about 24 hours.
- The Earth's rotation from West to East causes day and night as well as the apparent motion of the Sun, the Moon, and the stars.
- The Earth revolves around the Sun and takes nearly 1 year to complete a revolution.
- The Earth's axis of rotation is not upright with respect to the orbit, but is tilted.
- Seasons occur because of the tilt of the Earth's axis of rotation and its spherical shape.
- A solar eclipse occurs when the Moon is in the path of the Sun as seen from the Earth, and sunlight is blocked from reaching the Earth.
- A lunar eclipse occurs when the Earth comes in between the Sun and the Moon, blocking sunlight from reaching the Moon.

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Let Us Enhance Our Learning



Fig. 12.17

1. In Fig. 12.17, how many hours of sunlight do the North Pole and the South Pole receive during one rotation of the Earth?
2. Fill in the blanks
   (i) Stars rise in the _____ and set in the _____.
   (ii) Day and night are caused by the Earth's _____.
   (iii) When the Moon fully covers the Sun from our view, it is called a _____ solar eclipse.

3. State whether True or False
   (i) Lunar eclipse occurs when the Sun comes between the Earth and the Moon.
   (ii) Sunrise happens earlier in Gujarat than in Jharkhand.
   (iii) In Chennai, the longest day occurs on the summer solstice.
   (iv) We should watch the solar eclipse directly with our naked eye.
   (v) Seasons occur due to the tilt of Earth's axis of rotation and its spherical shape.
   (vi) The Earth's revolution around the Sun causes day and night.
4. Padmashree saw the Orion constellation nearly overhead at 8 pm yesterday. When will she see Orion overhead today?
5. Nandhini saw a group of stars rising at midnight on 21 June. When will she see the same group of stars rising at midnight next year?
6. Abhay noticed that when it was daytime in India, his uncle who was in the USA was generally sleeping as it was night-time there. What is the reason behind this difference?
7. Four friends used the following ways to see the solar eclipse. Who among them was being careless?
   (i) Ravikiran used a solar eclipse goggle.
   (ii) Jyothi used a mirror to project the Sun's image.
   (iii) Adithya saw the Sun directly with his eyes.
   (iv) Aruna attended a programme arranged by a planetarium.
8. Fill in the circles in Fig. 12.18 appropriately with one of the following: Sun, Moon, Earth.

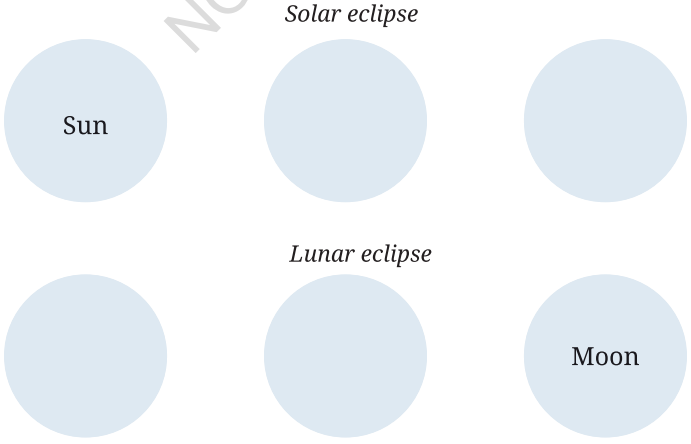
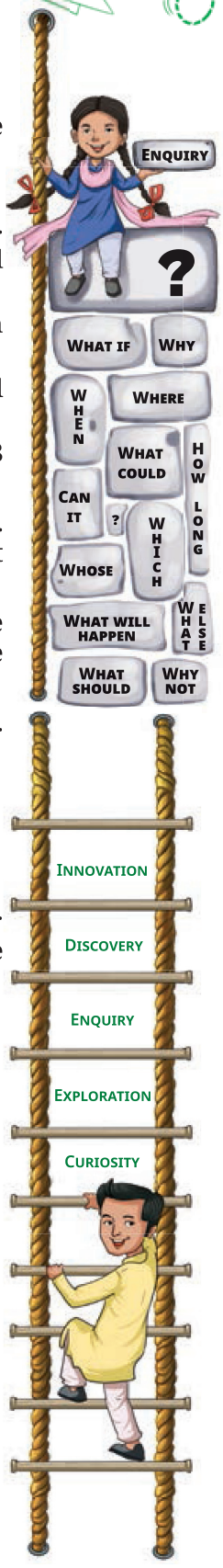
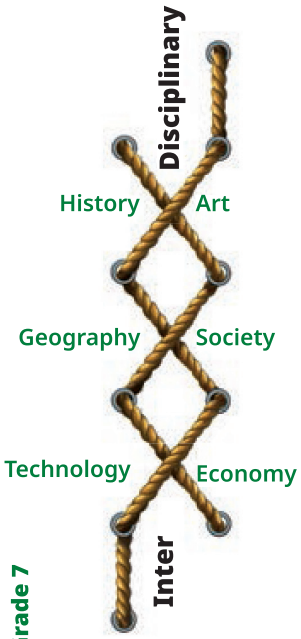


Fig. 12.18



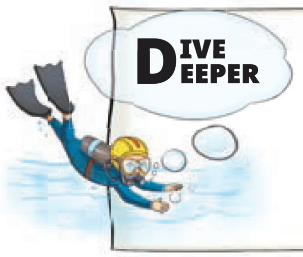
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9. The Moon is much smaller than the Sun, yet it can block the Sun completely from our view during a total solar eclipse. Why is it possible?
10. The Indian cricket team matches in Australia are often held in December. Should they pack winter or summer clothes for their trip?
11. Why do you think lunar eclipses can be seen from a large part of the Earth when they happen, but total solar eclipse can be seen by only a small part of the Earth?
12. If the Earth's axis were not tilted with respect to the axis of revolution, explain what would be the effect on seasons?



Exploratory Projects

- Repeat Activity 12.2 but replace the torch with an electric lamp. Then place the globe at different positions on a circle around the lamp while maintaining the tilt of the globe.
  (i) Note down your observations regarding how much of the Northern and Southern hemispheres of the globe are illuminated at different positions.
  (ii) Rotate the globe and take a note of the length of the day and night on different parts of the globe.
  (iii) Repeat (ii) for different positions of globe on the circle.
- The Earth goes around the Sun in an oval-shaped path. Draw two circles with the same centre, one with a radius of 14.7 cm, and another one with a radius of 15.2 cm. If 1 cm corresponds to 10 million km, the two circles represent the closest and farthest distances from the Sun. Note how small is the difference between these two distances.
- Suppose the tilt of the Earth's axis of rotation increases. Will it cause more extreme seasons? Find out if the tilt of Uranus is more than the Earth and about the seasons there. Write an interesting article for a newspaper or your school magazine about it.



DIVE DEEPER

In reality, the planets move around a special point in the solar system, which is very close to the Sun but not exactly at its centre! The Sun also moves around the same point a little instead of staying perfectly still. Scientists use such tiny wobbles in the movement of other stars to discover exoplanets around them!

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It's Still Not the End, My Friend!

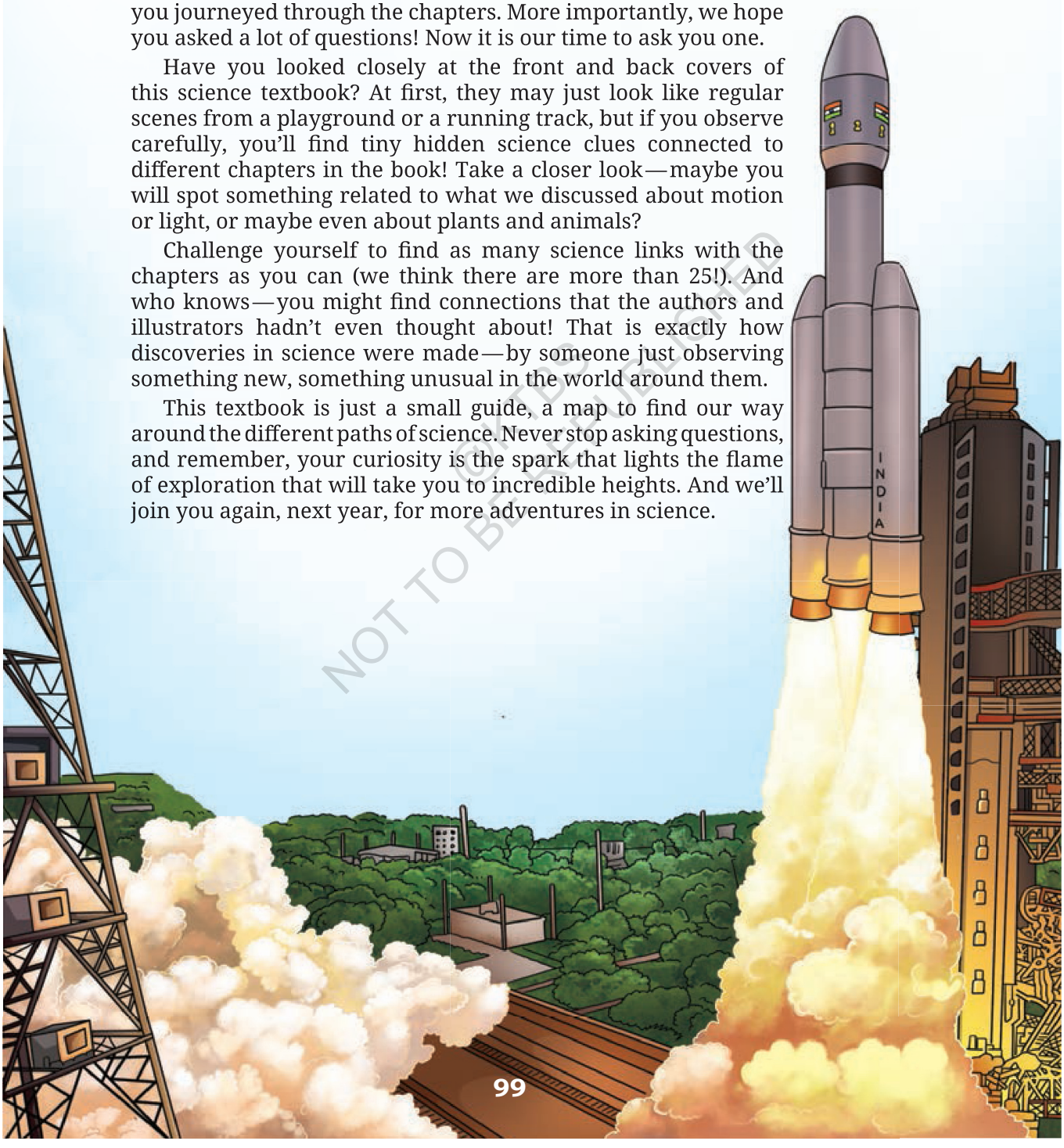
And once again, we've reached the last page of this book, and as we said earlier, it is certainly not the end of our curiosity—our *jigyasa*. We hope you've enjoyed the activities and experiments as you journeyed through the chapters. More importantly, we hope you asked a lot of questions! Now it is our time to ask you one.

Have you looked closely at the front and back covers of this science textbook? At first, they may just look like regular scenes from a playground or a running track, but if you observe carefully, you'll find tiny hidden science clues connected to different chapters in the book! Take a closer look—maybe you will spot something related to what we discussed about motion or light, or maybe even about plants and animals?

Challenge yourself to find as many science links with the chapters as you can (we think there are more than 25!). And who knows—you might find connections that the authors and illustrators hadn't even thought about! That is exactly how discoveries in science were made—by someone just observing something new, something unusual in the world around them.

This textbook is just a small guide, a map to find our way around the different paths of science. Never stop asking questions, and remember, your curiosity is the spark that lights the flame of exploration that will take you to incredible heights. And we'll join you again, next year, for more adventures in science.

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Notes

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