1 The Ever-Evolving World of Science

0777CH01

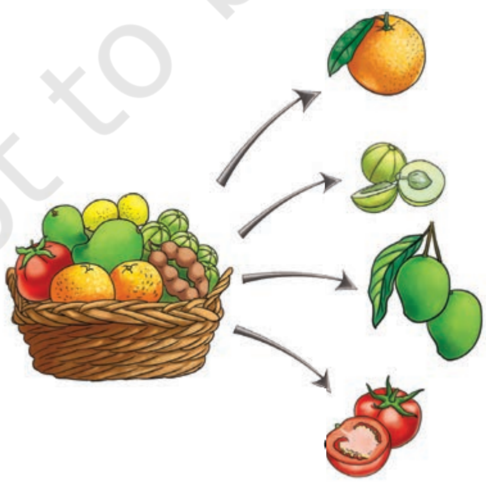
We hope you enjoyed your adventures with *Curiosity* in Grade 6, and are now ready to continue our journey into the wonderful world of science. This again, is not just a textbook with facts — it is an invitation to question, to perform experiments, and to explore, as we try to understand the beautiful world we live in. The world of science covers everything — small and large, near and far. We may be looking at tiny cells inside a leaf, or the movement of the sun and the stars. We may be testing out the materials around us at home, or discussing how water flows underground. As you go through the chapters in this book, you will start new adventures that challenge your thinking, expand your knowledge, and help you become an explorer, making small discoveries for yourself.

Before we dive into our exciting journey, take a moment to observe something special about this book. Look at the page numbers — they follow the playful flight of a butterfly and the soaring of a paper plane! Just as a butterfly flutters freely and a paper plane flies into the sky, learning takes flight when curiosity leads the way. Did you know that something as simple as a paper plane inspired real scientific explorations of flight? From early inventors studying bird wings to modern engineers designing aircraft, the dream of flying started with simple observations and experiments. So, as you turn each page, let your imagination take flight — exploring new ideas, discovering wonders, and reaching for the skies!

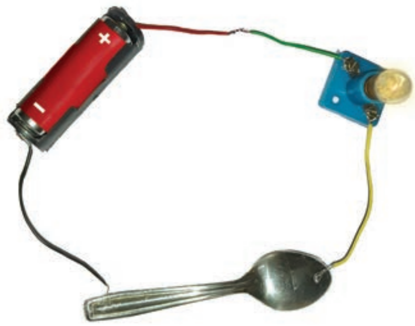
Exploration, of course, isn't just about discovering new facts or learning about different things in nature. Science, as we said in Grade 6, is a process, so it is about a way of thinking that welcomes curiosity, asks questions, and is open to the unknown. In Grade 7, we will try to ask deeper questions: How do things work? Why do events happen the way they do? And what can we learn from the patterns that we see in nature?

To do this, we have to step out of this book, step out of the classroom perhaps, and experience the world through activities and experiments. These are experiences that we hope will not just be interesting or exciting but also serve as stepping stones to a deeper understanding of the environment we live in and of our place on this planet. We believe that this will also help you to see science as an ongoing process of discovery. And not just about discovery alone, but also about responsibility. As young science explorers, you will soon see how human activities are linked to what happens in the natural world and are connected to the society we live in. You will, we hope, also see the role that science can play in addressing environmental challenges and help in creating a more sustainable world.

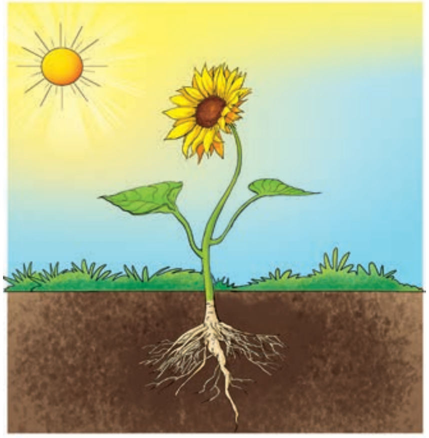
But let's get back into this book for now. You will read about topics in different fields of science, from physics and chemistry to biology and earth sciences. While they might appear as different chapters, just as we had said in Grade 6, they are all interconnected. Scientific ideas in one area often inspire discoveries in another, or at least allow us to ask questions in another area. So, let's take a quick journey through our book for this year. We will start by looking at the properties of materials around us, mostly the things we experience but perhaps never ask questions about—why are some fruits sour? What happens when we wash a *haldi* stain on our school uniform?



We then move on and play with some electric batteries, lamps and wires to try to find other kinds of properties of materials. What kind of materials do we need to make a lamp glow? This will lead us to classifying materials based on their properties — and we will enter the world of metals and non-metals. We know from our experience that a torch battery runs out eventually, and can't be used again. We'll explore what kind of changes happen around us. Some changes can be reversed and others cannot be reversed.

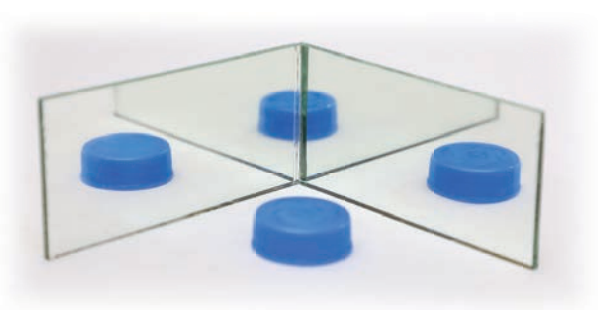


Batteries run out, ice melts into water, fruits ripen, rocks break into pebbles… what kind of changes are these? Some of these happen, or happen faster, when things are heated. We will look at how heat flows — whether it is the melting of an ice cube in a glass, or the melting of a glacier. Water is, of course, everywhere, and with the heat from the Sun, it evaporates from the seas and falls as rain, perhaps trickling down into the ground, somewhere far away.

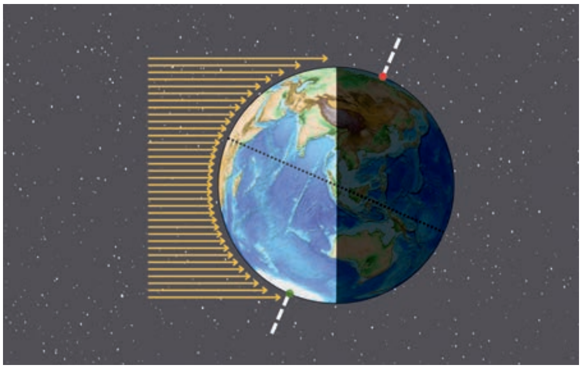


However, it isn't just changes in materials around us that we see, or the hidden changes in water that we do not see. As we are growing, our bodies are changing as well. Especially around the middle-school years, our bodies are changing rapidly! Why? Not just us humans, there are life processes that are essential to all animals for their survival. To grow, we have to eat and breathe, blood has to circulate the nutrients from the food all over the body and so on. But why animals alone? Don't plants also need food to grow? How do they get their food? Do they also breathe? How? Over the time that life has evolved on our planet Earth, it has figured out how to do this in a beautiful and carefully balanced way. Ah, but what is time? The clock on the wall or a wrist watch tells us the time and how it passes. We get prepared to go to school in the morning and are ready to sleep at night but have you thought about how we measure time? And how fast does something happen?

Long before the age of electric clocks and digital watches, early humans observed the shadows of objects in the Sun and used the position of the shadows to tell the time. Light and shadows are not just useful for shadow puppets or to tell the time. Naturally, light helps us see and today, we've developed a lot of ways to generate light (so we can read a book at night, even when the Sun doesn't shine). But, more importantly, asking questions about the nature



of light has given us a very deep understanding of the universe we live in. While we'll perhaps learn about it only later, light and shadows are not just limited to things around us at home.



Even the Earth and the Moon can cast shadows, leading to the fascinating phenomena of eclipses. And of course, we have day and night that depend on receiving light from the Sun. To understand all of this, we need to know how the Earth rotates around its axis, how the Moon goes around the Earth, and the Earth around the Sun. And the consequences of these movements on life on our beautiful planet. While all this might have your head spinning, think about it. Isn't it amazing that we humans can wonder about the wonderful world we live in?

In the chapters that follow, you'll also make simple observations and do fun experiments, and dive into topics that need careful thinking. Each chapter builds on what you already know and encourages you to ask questions, explore, do hands-on experiments, and think like a scientist! As you will find out, even those experiments that seem to confirm what we think will happen, might lead to some additional questions that might need more experiments and more questions.

1.1 Happy Exploring!

Activity 1.1: Question the Answer

In school or during tests, you're usually given questions and expected to find the answers. But let's turn that around! To think like a scientist, it is equally important to ask interesting questions! Great scientists don't just answer questions — they ask amazing ones! (Remember last year we had said, "To be a wise person, you must be a whys person".)

Look at the answers below. Your task is to come up with a curious, creative, and fun question or situations that could lead to these answers. There are never any wrong questions, so let your imagination run wild! Since such exercises might not be very familiar, here is an example to help you! Suppose the answer was 'just make it half!' — what all could this be a response to? Well, it could range from "How do we ensure getting equal shares of cake?" to "My essay is too long", or "I can't fit this in the envelope" or even "I cannot dance to such a long song"... all very different! So, let's see what kind of creative questions you can ask!

Question: ____?

Answer: Just add some milk.

Question: ____?

Answer: Because the cat's teeth were crooked.

Question: ____?

Answer: Don't panic, I have my towel.

Question: ____?

Answer: 42

(Please ask a more interesting, and not obvious questions like "What is 32+10?", or even "What is the answer to life, the universe, and everything?")

2 Exploring Substances: Acidic, Basic, and Neutral

0777CH02

On 28 February, the school hosted a science fair to celebrate National Science Day. At the entry gate, siblings Ashwin and Keerthi were greeted with a white sheet of paper. They were curious to know why a white sheet of paper was given to them!

A few steps ahead, there was a volunteer spraying a liquid on these sheets of paper. The siblings also got their white sheets sprayed. To their surprise, the words 'Welcome to the Wonderful World of Science' appeared on the papers the moment the liquid was sprayed (Fig. 2.1). They were excited and eager to know how this happened and the **reason** behind it.

Their curiosity was partly satisfied at the 'Colourful World of Substances' stall. They saw many activities showing colour changes on mixing different substances. They decided to **explore** these changes further. Let us join them on this learning adventure.

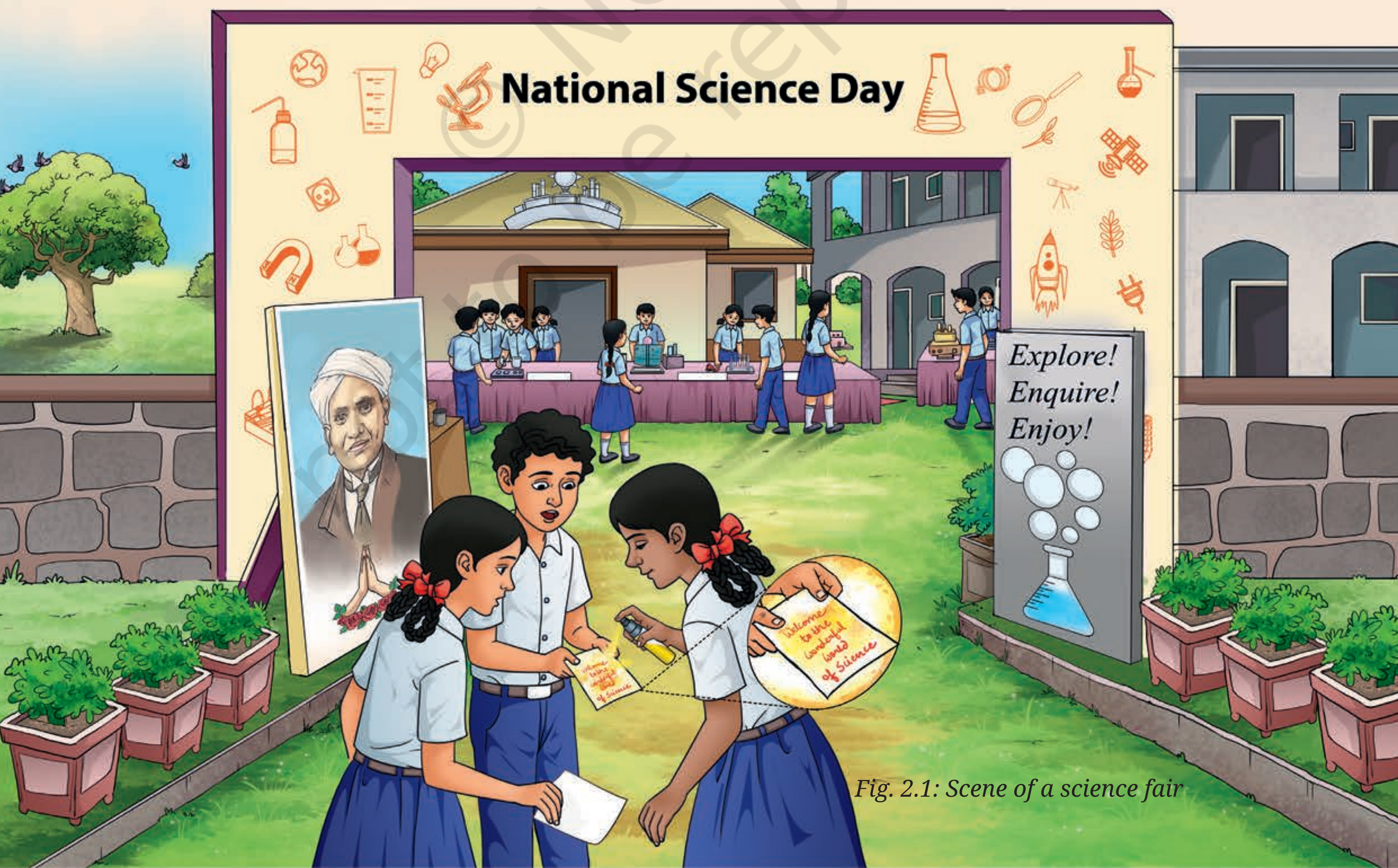


Fig. 2.1: Scene of a science fair

2.1 Nature — Our Science Laboratory

2.1.1 Litmus as an indicator

Activity 2.1: Let us explore

- ❖ Collect samples of lemon juice, soap solution, *amla* juice, tamarind water, vinegar, baking soda solution, lime water, tap water, washing powder solution, sugar solution, and salt solution.
- ❖ Take a strip of blue litmus paper and cut it into small pieces.
- ❖ Spread these pieces on a clean and dry white tile.
- ❖ Using a dropper, put one drop of each of the samples, one-by-one, on these litmus paper pieces, as shown in Fig. 2.2a.

Fig. 2.2(a): Colour change in blue litmus paper

- ❖ Do you **observe** any change in the colour of the blue litmus pieces?
- ❖ **Record** your observations in Table 2.1.
- ❖ Repeat the same activity with pieces of red litmus paper as shown in Fig. 2.2b and record your observations in Table 2.1.

Fig. 2.2(b): Colour change in red litmus paper

How to prepare lime water?

Do not confuse lime water with the word lime, which is a fruit similar to lemon.

Lime water (solution of calcium hydroxide in water) can be easily prepared by mixing lime (*chuna,* i.e. calcium oxide) in water and leaving it undisturbed for some time, say an hour. Filter the liquid into another container and use it as lime water.

Table 2.1: Testing the nature of samples with blue and red litmus papers

S.No.	Name of the sample	Colour of blue litmus paper after putting a drop of sample	Colour of red litmus paper after putting a drop of sample
1.	Lemon juice		
2.	Soap solution		
3.	*Amla* juice		
4.	Tamarind water		
5.	Vinegar		
6.	Baking soda solution		
7.	Lime water		
8.	Tap water		
9.	Washing powder solution		
10.	Sugar solution		
11.	Salt solution		
12.	Any other		

Now, let us **analyse** Table 2.1 and sort the samples into three groups as follows —

- Group A with samples that turn the blue litmus paper to red.
- Group B with samples that turn the red litmus paper to blue.
- Group C with samples that do not affect either of the two litmus papers.

Record the data in Table 2.2.

Table 2.2: Grouping of samples tested in Table 2.1

Group A	Group B	Group C

I am curious to know—what are these red and blue litmus paper strips made of? Why do they change colour when drops of some samples are put on them?

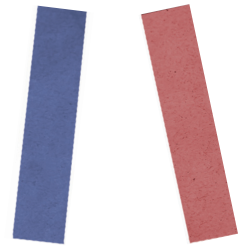


Fig. 2.3: Blue and red litmus paper strips

Let us find out!

Litmus is a natural substance obtained from lichens. It is available both as a solution and in the form of paper strips, known as litmus paper. The litmus paper is available in two colours—blue and red, as shown in Fig. 2.3.

Substances that turn blue litmus paper to red are **acidic** in nature, while those that turn red litmus paper to blue are **basic** in nature. Since litmus shows different colours in acidic and basic solutions, it is called an **acid-base indicator**.

Some other substances, both natural and synthetic, can also be used as indicators. Synthetic indicators are made in laboratories, and you will learn more about them in higher grades.

Lichens

Holistic Lens

Lichens are formed by the association of two living organisms, a fungus and an alga. They grow on rocks and trees in regions that have abundant rainfall and clean air. Do you find lichens on trees in your neighbourhood?

Now, let us **classify** the substances sorted in Group A, Group B, and Group C in Table 2.2.

- The substances in Group A, such as lemon juice, *amla* juice, tamarind water, and vinegar turned the blue litmus paper to red, implying that these substances are acidic in nature.
- The substances in Group B, such as soap solution, baking soda solution, lime water, and washing powder solution turned the red litmus paper to blue. Hence, these substances are basic in nature.
- The substances in Group C, such as tap water, sugar solution, and salt solution, did not change the colour of either litmus paper. Can you **predict** their nature?

These substances are said to be **neutral** because they are neither acidic nor basic.

Activity 2.2: Let us relate and explore

Are all the substances in Group A of Table 2.2 edible? Have you ever tasted these edible substances? Can you recall their taste? You will find that all these substances taste sour. Thus, we can say that substances that taste sour tend to contain **acids** and are acidic in nature.

Caution — Do not taste anything until asked to do so. Do not taste any unknown substance.

Some common edible substances and the names of the most common acids present in them are given in Fig. 2.4.

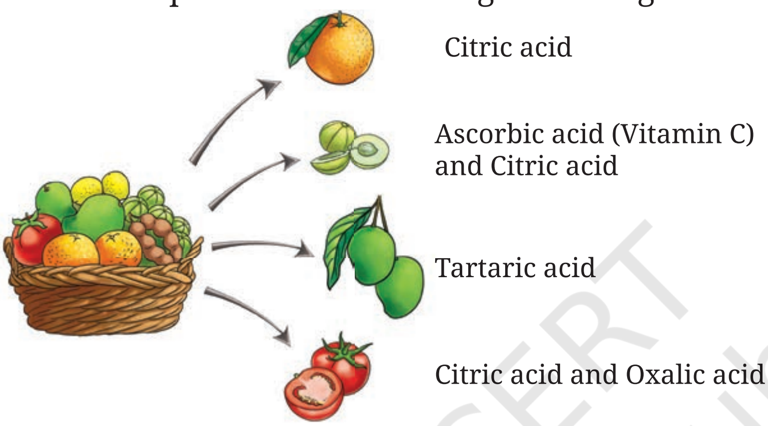


Fig. 2.4: The most common acids present in some edible substances

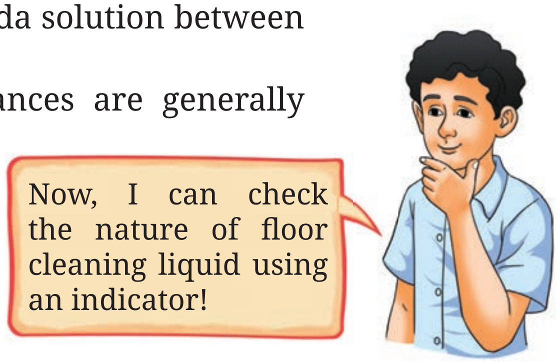
Find out and write the names of the most common acids present in the following substances —

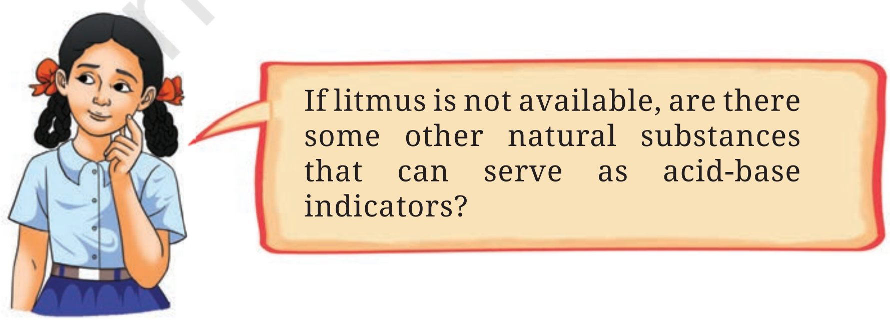
Lemon________, Curd________, Tamarind________, Vinegar________.

Now, let us take one of the substances — baking soda solution — from Group B. Rub the baking soda solution between your fingers. What do you observe?

It feels soapy or slippery. Basic substances are generally slippery to touch.

Also, **bases** generally taste bitter, but everything that tastes bitter may not contain a base. For example, bitter gourd (*karela*) possesses a bitter taste but is not basic in nature.





2.1.2 Red rose as an indicator

You might have observed many coloured flowers in your surroundings. Try making your indicators using these flowers.

Activity 2.3: Let us prepare

Fig. 2.5: Red roses

Fig. 2.6: Red rose petals immersed in hot water

- ❖ Collect some fallen petals of red roses available in your surroundings (Fig. 2.5). It is advised not to pluck flowers. You may pick petals or flowers fallen on the ground.
- ❖ Take a fistful of the collected petals of red roses and wash them with water.
- ❖ Crush the petals using a mortar and pestle.
- ❖ Place them in a glass tumbler.
- ❖ Pour some hot water into the glass tumbler to ensure that the crushed flower petals are completely immersed.

⚠ **Caution** — Perform this step under the supervision of an adult.

- ❖ Cover the glass tumbler with a lid. Wait for 5 – 10 minutes till the water becomes coloured (Fig. 2.6), and filter it.
- ❖ The filtrate (liquid after filtration) is the required flower extract (Fig. 2.7) to be used as an acid-base indicator.

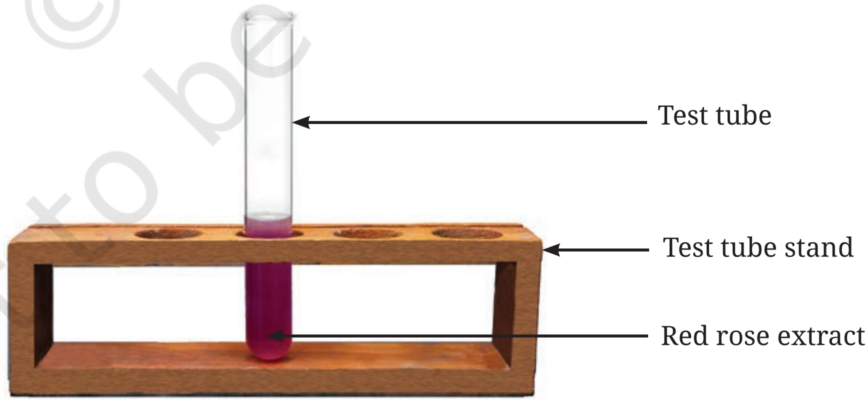


Fig. 2.7: Test tube containing the red rose extract

Activity 2.4: Let us find out

- ❖ Place 10 – 20 drops of the prepared red rose extract in each of two small transparent bottles or test tubes. Mark them A and B.

- ❖ Add 20–30 drops of lemon juice in test tube A and 20–30 drops of soap solution in test tube B with the help of droppers.
- ❖ Observe and record any colour changes (Fig. 2.8) to the extract in Table 2.3.
- ❖ Repeat the same with the other samples used in Activity 2.1 and record your observations in Table 2.3.

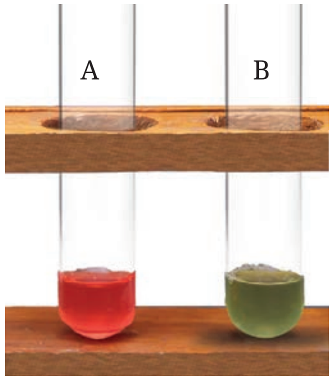


Fig. 2.8: The changes in colour of the red rose extract on adding lemon juice (A) and soap solution (B)

Table 2.3: Testing the nature of samples with the red rose extract

S.No.	Name of the sample	The colour of the red rose extract after adding the sample	Nature of the substance
1.	Lemon juice		
2.	Soap solution		
3.	*Amla* juice		
4.	...		

Discuss your observations with your classmates.

- ❖ Are the samples that change the colour of the flower extract to a shade of red the same as those that changed the colour of blue litmus paper to red? (Group A, Table 2.2)
- ❖ Are the samples that change the colour of the flower extract to a shade of green the same as those that changed the colour of red litmus paper to blue? (Group B, Table 2.2)
- ❖ Are the samples that do not change the colour of the flower extract the same as those that did not change the colour of red and blue litmus papers? (Group C, Table 2.2)

From the above activity, we can **conclude** that the red rose extract can also be used to test the nature of the substances; hence, it is another example of an acid-base indicator. We can conclude that the red rose extract seems to give red colour in an acidic solution and green colour in a basic solution.

Can you now fill in the nature of the substances in Table 2.3?

We are sure that you will be excited about the above results. You may repeat the process of preparing the extract and testing substances with some vegetables, fruits, or flowers, such as beetroot, purple cabbage, turmeric, Indian blackberry (*jamun*), and red hibiscus (*gudhal*) flower. They can also act as acid-base indicators.

Fascinating Facts

Hydrangea is a plant that grows in cooler climates in the Himalayan region and the North-eastern states. It gives flowers of different colours, depending on the nature of the soil. Acidic soil produces blue-coloured flowers, whereas in basic soil, the flowers are pink or red. Can gardeners alter the colour of hydrangea flowers by adjusting the acidic or basic nature of the soil?

Hydrangea flowers

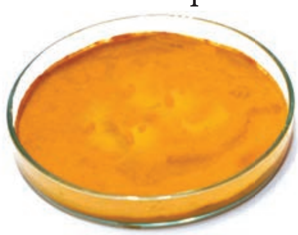
2.1.3 Turmeric as an indicator

We have used blue and red litmus paper strips in Activity 2.1. Can you also make paper strips with some other natural indicators? Find out by performing the following activity.

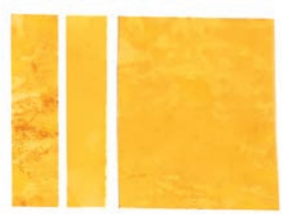
Activity 2.5: Let us prepare

- ❖ Take a spoonful of turmeric (*haldi*) in a petri dish or container and add a little water to make a paste (Fig. 2.9a). You may also grind a piece of fresh turmeric.
- ❖ Carefully dip a piece of filter paper in the turmeric paste until it gets yellow colour.
- ❖ Take it out and allow it to dry.
- ❖ Cut this yellow paper into thin strips, which are used as 'turmeric paper' (Fig. 2.9b).

Caution — Perform this step under the supervision of an adult.



(a) Turmeric paste



(b) Turmeric paper strips

Fig. 2.9: Preparing turmeric paper

- Using a dropper, put a drop of each of the samples used in Activity 2.1, one by one, on separate pieces of turmeric paper.
- Record your observations in Table 2.4.

Table 2.4: Testing the nature of samples with turmeric paper

S.No.	Name of the sample	The colour of the turmeric paper after putting a drop of the sample
1.	Lemon juice	
2.	Soap solution	
3.	*Amla* juice	
4.	…	

What did you observe?

- Do all samples change the colour of the turmeric paper?
- Group the samples which do not change the colour of the turmeric paper.

Compare them with the samples in Group A, Group B, and Group C in Table 2.2.

Can turmeric paper be used as an indicator for acidic substances? Discuss your observations with your classmates.

Based on the observations, we can conclude that turmeric paper can be used to test basic substances. However, it cannot differentiate between acidic and neutral substances.

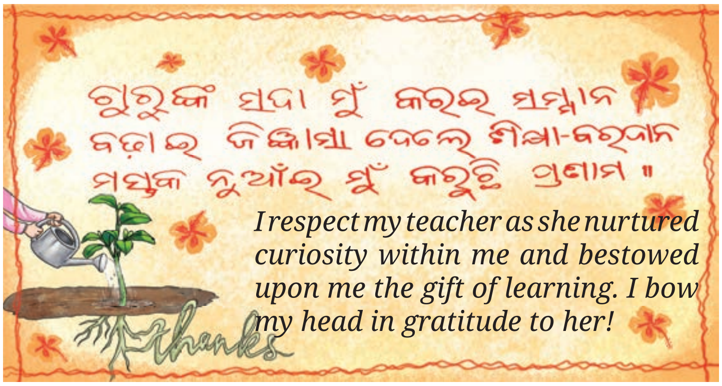
Fascinating Facts

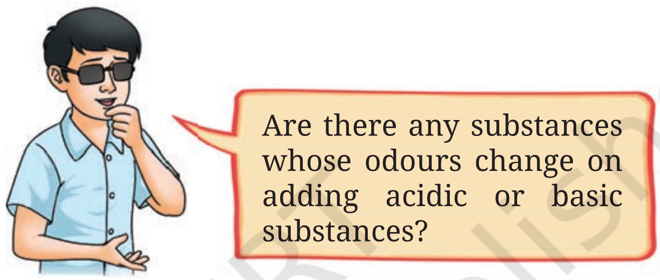
Why is turmeric known as a 'Golden' spice?

Turmeric (Haldi)

Turmeric is a member of the ginger family, which is grown in India and other countries. A common spice in daily households, it is being researched for benefits beyond the taste and colour it provides to the food! In the Ayurvedic system of medicine, turmeric is considered to have numerous health benefits, and is commonly used in several traditional home remedies.

Ashwin created a greeting card to pay gratitude to his teacher on the day of Guru Purnima. He applied turmeric paste on white paper and dried it. He wrote his wishes in the teacher's mother tongue (Odia language) on the dried paper using one of the solutions tested in Table 2.4. Which solution can be used to write the message? His teacher applauded his creative use of this concept.





There are some substances whose odours change in an acidic or basic medium. These are called **olfactory indicators**.

Let us explore more!

Activity 2.6: Let us investigate

- Take some finely chopped onions in a container, along with some strips of clean cotton cloth or filter paper.
- Tightly close the container and leave it overnight.
- Take two of the cotton cloth or filter paper strips from the container and check their odour.
- Keep them on a clean surface and put a few drops of tamarind water on one strip and a few drops of baking soda solution on the other. Allow the drops to spread on the strips.
- Check the odour again.
- Do you notice any change in the odour of the onion strips before and after putting tamarind water and baking soda solution on them?
- Note your observations.
- Similarly, test the change in the odour with other acidic and basic substances and record your observations.

Know A Scientist

Acharya Prafulla Chandra Ray (P.C. Ray) is known as the 'Father of Modern Indian Chemistry'. He earned a doctorate in chemistry from the United Kingdom and returned to

India. He contributed towards advancing scientific research in India. He also established India's first pharmaceutical company (a company in the field of medicines) in 1901. He was a person rooted in Indian culture and knowledge traditions. Through his writings on the history of chemistry in India, he highlighted the achievements and expertise of ancient Indian scientists to the modern world. Ray, a social reformer, also advocated the use of the mother tongue as a medium of instruction in educational institutions.

2.2 What Happens When Acidic Substances Mix with Basic Substances?

Let us investigate by performing the following **experiment**.

Activity 2.7: Let us experiment

- ❖ Take one drop of lemon juice in a test tube and add around twenty drops of water to it. Observe the colour.
- ❖ Add a drop of blue litmus solution to it.
- ❖ Do you observe any colour change (Fig. 2.10a)?
- ❖ Slowly add drops of lime water to this test tube with the help of a dropper and swirl it well.
- ❖ What do you observe? Is there any change in the colour of the solution?
- ❖ A stage comes when the colour of the solution changes from red to blue (Fig. 2.10b).
- ❖ Again, add one drop of lemon juice to the above solution.

Can you predict why there is a change in colour?

Fig. 2.10(a): The colour of the solution on adding blue litmus solution

Fig. 2.10(b): The colour of the solution on adding lime water

Initially, when a drop of blue litmus solution is added to the lemon juice solution, the colour of the solution turns red. When lime water is added to this test tube, the colour of the solution eventually changes from red to blue. This shows that the solution in the test tube is no longer acidic. Lime water has neutralised the effect of the acid.

When the solution of an acid is mixed with the solution of a base in sufficient quantity, we find that the resulting solution is neither acidic nor basic. Such reactions are called **neutralisation** reactions. In a neutralisation reaction, **salt** and water are formed with the evolution (i.e., release) of heat.

$$\text{Acid} + \text{Base} \rightarrow \text{Salt} + \text{Water} + \text{Heat}$$

There are many examples in everyday life where you can observe the use of neutralisation processes.

Let us find out!

2.3 Neutralisation in Daily Life

Fig. 2.11: Stinging effect of an ant bite

Situation 1: Keerthi was observing a butterfly in the garden with her hand resting on a tree trunk. Suddenly, a red ant bit her, leaving her skin red with stinging pain (Fig. 2.11). Her brother helped her by applying moist baking soda to the affected area, which relieved the pain. What do you think might be the reason for this?

When an ant bites, it injects an acidic liquid (formic acid) into the skin. The effect of the acid can be neutralised by rubbing moist baking soda, which is a base.

What remedies do people use to treat ant bites in your region?

Fig. 2.12: Neutralising the acidic nature of soil

Situation 2: On the Farmer's Portal (an online platform from the Department of Agriculture, Cooperation and Farmers Welfare), a query from a farmer states, "My plants are not growing well lately". After a detailed discussion, it was found that the excessive use of chemical fertilisers (substances added to soil to help plants grow better) made the soil acidic. What remedy might be provided to him?

When the soil is too acidic, the plants do not grow well. It can be treated with lime, which is a base. (Fig. 2.12).

If the soil is basic, organic matter like manure and composted leaves are added to it. Organic matter releases acids that neutralise the basic nature of the soil.

Sometimes, the soil may be neutral, but the plants growing in it may still show poor health, which can be due to the deficiency of nutrients in the soil.

Situation 3: Ashwin's friend Gurbir stays near an industrial area. He shared with him that the fish population in his neighbourhood lake was declining day by day! What do you think might be the causes for this? It may be due to factory waste being released into the lake.

If the factory waste is acidic in nature, what could be done to save the fish in the lake?

The factory waste can be neutralised by adding basic substances before releasing into the lake.

Let us wrap up!

Now, can you explain why the words 'Welcome to the Wonderful World of Science' appeared on Ashwin and Keerthi's paper sheets when the liquid was sprayed on them?

Do you think that one possibility could be using a turmeric solution for the spraying liquid and a soap solution for writing on the paper?

In a Nutshell

- ❖ Substances around us may be classified as acidic, basic, and neutral in nature.
- ❖ Extracts of lichen, red rose, red hibiscus, purple cabbage, turmeric, etc., can be used to indicate the nature of substances.
- ❖ Substances that show different colours in acidic and basic solutions are called acid-base indicators.
- ❖ Acids turn the colour of blue litmus to red. Bases turn the colour of red litmus to blue.
- ❖ Extract of red rose gives red colour in acidic solutions and green colour in basic solutions.
- ❖ The yellow colour of turmeric turns red in basic solutions but remains unchanged in acidic and neutral solutions.
- ❖ An acid and a base neutralise each other, forming salt and water, along with the evolution of heat.
- ❖ Many day-to-day problems like a red ant bite, acidic or basic nature of soil, and industrial waste can be attempted to be managed by the process of neutralisation.

Let Us Enhance Our Learning

1. A solution turns the red litmus paper to blue. Excess addition of which of the following solution would reverse the change?
   (i) Lime water
   (ii) Baking soda
   (iii) Vinegar
   (iv) Common salt solution
2. You are provided with three unknown solutions labelled A, B, and C, but you do not know which of these are acidic, basic, or neutral. Upon adding a few drops of red litmus solution to solution A, it turns blue. When a few drops of turmeric solution are added to solution B, it turns red. Finally, after adding a few drops of red rose extract to solution C, it turns green.

   Based on the observations, which of the following is the correct sequence for the nature of solutions A, B, and C?
   (i) Acidic, acidic, and acidic
   (ii) Neutral, basic, and basic
   (iii) Basic, basic, and acidic
   (iv) Basic, basic, and basic
3. Observe and analyse Figs. 2.13, 2.14, and 2.15, in which red rose extract paper strips are used. Label the nature of solutions present in each of the containers.

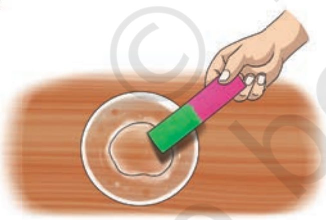


Fig. 2.13

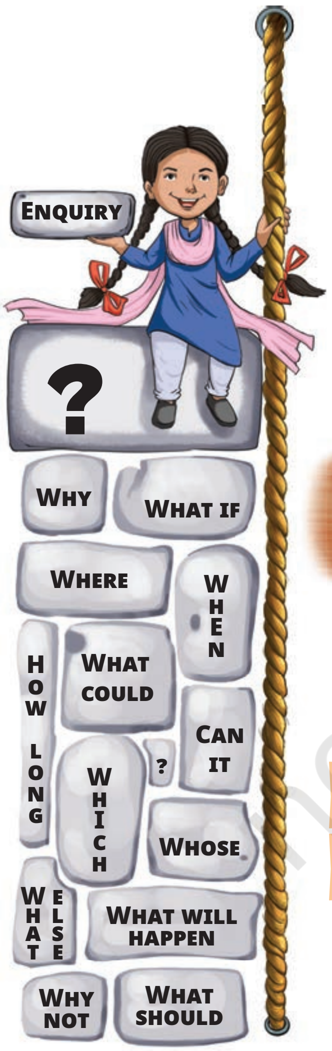

Fig. 2.14


Fig. 2.15

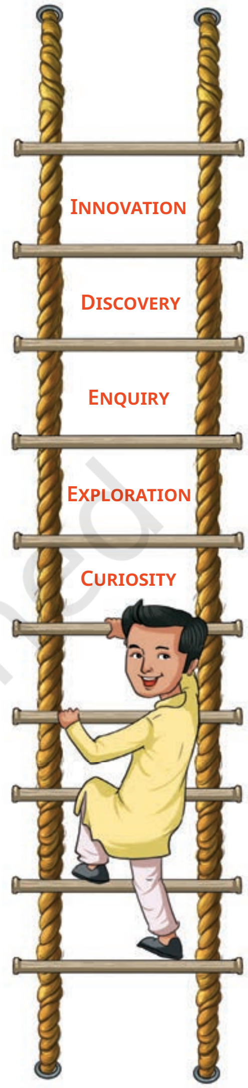
4. A liquid sample from the laboratory was tested using various indicators:

Indicator	Red litmus	Blue litmus	Turmeric
Change	No change	Turned red	No change in colour

   Based on the tests, identify the acidic or basic nature of the liquid and justify your answer.



5. Manya is blindfolded. She is given two unknown solutions to test and determine whether they are acidic or basic. Which indicator should Manya use to test the solutions and why?
6. Could you suggest various materials which can be used for writing the message on the white sheet of paper (given at the beginning of the chapter) and what could be in the spray bottle? Make a table of various possible combinations and the colour of the writing obtained.
7. Grape juice was mixed with red rose extract; the mixture got a tint of red colour. What will happen if baking soda is added to this mixture? Justify your answer.
8. Keerthi wrote a secret message to her grandmother on her birthday using orange juice. Can you assist her grandmother in revealing the message? Which indicator would you use to make it visible?
9. How can natural indicators be prepared? Explain by giving an example.
10. Three liquids are given to you. One is vinegar, another is a baking soda solution, and the third is a sugar solution. Can you identify them only using turmeric paper? Explain.
11. The extract of red rose turns the liquid X to green. What will the nature of liquid X be? What will happen when excess of *amla* juice is added to liquid X?
12. Observe and analyse the information given in the following flowchart. Complete the missing information.



Imagine a garden with plants showing signs of poor health.

The soil can be ______ in nature.

The soil can be ______ in nature.

Which indicator can be used to test the nature of the soil?

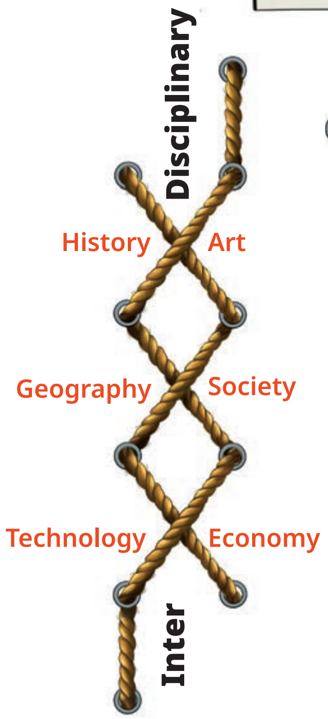
____

The acidic soil can be treated with ________________________.

The basic soil can be treated with ________________________.

DIVE DEEPER

Aman accidentally spilt vinegar on some pieces of an eggshell or marble and noticed bubbling. He then poured a soap solution on another piece of eggshell or marble, but no bubbles appeared. Why did bubbles occur with vinegar but not with soap solution?



Exploratory Projects

- ❖ Create rangoli using acidic or basic substances and natural indicators.
- ❖ You may discuss in your class the acidic, basic, or neutral nature of water obtained from various sources. You may like to test the water samples available from sources such as rain, taps, rivers, etc.
- ❖ Collect a soil sample of your area and find out whether it is acidic, basic, or neutral in nature.

3 Electricity: Circuits and their Components

Nihal and his classmates were excited for their school trip to the Bhakra Nangal Dam. There they would visit the hydroelectric power house where the force of falling water was used to generate electricity. They also looked forward to the free 13 kilometre-train ride from Nangal in Punjab to Bhakra in Himachal Pradesh, along the beautiful Sutlej river and through the Shivalik hills.

Prior to the trip, Nihal and his classmates were given a group assignment to prepare a presentation on the uses of electricity. They began by looking around their houses, then their school, followed by their neighbourhood, their city, and finally they searched the internet. To their astonishment, their list kept growing. They decided to organise the uses under different headings.

Cooking
Electric kettle, mixer grinder, toaster, oven, microwave, ______

Lighting
Homes, offices, streets, markets, factories, ______

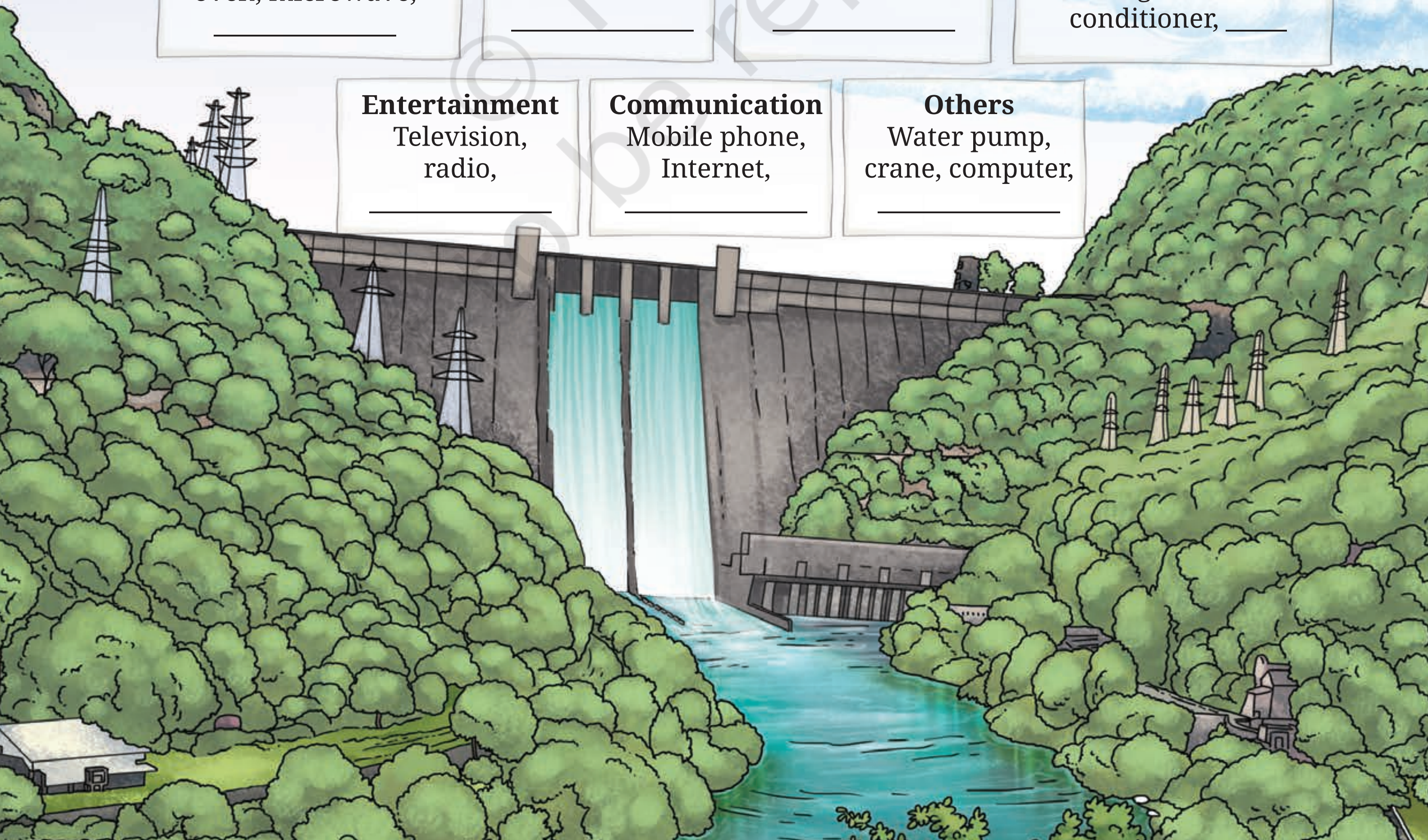
Transportation
Train, bus, car, scooter, lift, escalator, ______

Heating and Cooling
Fan, room heater, immersion rod, geyser, refrigerator, air conditioner, ______

Entertainment
Television, radio, ______

Communication
Mobile phone, Internet, ______

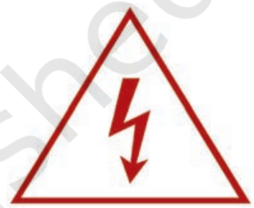
Others
Water pump, crane, computer, ______



Can you help Nihal by adding some more uses to his lists? Also, suggest some other ways of grouping the uses of electricity.

We use electricity all the time, so let us learn something more about electricity. You have learnt earlier that electricity is generated in multiple ways—by windmills, by using wind energy, by solar panels capturing the Sun's energy, by falling water and by using natural gas or coal (in the chapter 'Nature's Treasures' in the Grade 6 Science textbook *Curiosity*). The electric supply from these sources reaches our homes and factories via wires. For example, at home we plug in various devices to the electrical sockets in the wall. However, to learn about electricity, we will focus on a portable source of electricity that most of us may have used. Let us start with its use in a common device like a torchlight.

Caution—The danger signs on electric poles and other appliances warn people that electricity can be dangerous if not carefully handled. Never ever perform experiments with power supply at your home or school. Even electricity from portable generators can be dangerous. Use only batteries or cells, like those in torchlights, wall clocks, radios, or remotes, for experiments with electricity.



3.1 A Torchlight

You might have used a torchlight, also called a torch or a flashlight.

Activity 3.1: Let us explore

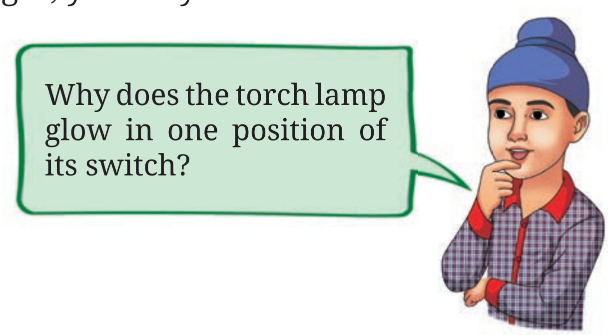
Fig. 3.1: A torchlight

- ❖ Take a torchlight similar to the one shown in Fig. 3.1.
- ❖ **Observe** it carefully. Do you notice a lamp? And a switch?
- ❖ Slide its switch and observe. Does the torch lamp glow?
- ❖ Now slide the switch back to its original position and observe the torch lamp.

You might have noticed that in the first position of the switch, the torch lamp glows and in the other position the lamp does not glow.

- ❖ Now, open the torchlight. What do you find inside?

Inside the torchlight, you may find two or more electric cells.



3.2 A Simple Electrical Circuit

To understand how a torch works, let us first find out about its components.

3.2.1 Electric cell

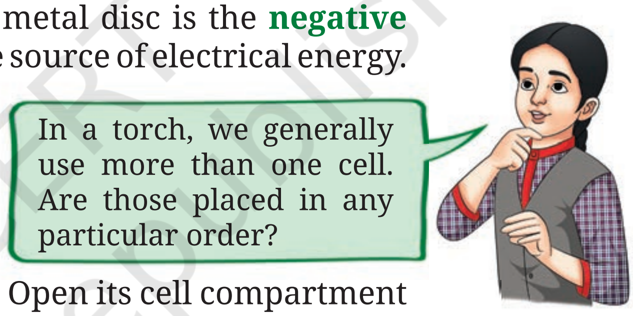
Activity 3.2: Let us observe

- Take an electric cell, turn it around and look at it carefully (Fig. 3.2). Do you notice a positive (+) sign and a negative (–) sign marked on the electric cell? Do you also notice that it has a small protruding metal cap on one side and a flat metal disc on the other side?

Fig. 3.2: An electric cell

All electric cells have two terminals; one is called positive (+ ve) while the other is negative (– ve). The metal cap is the **positive terminal** of the electric cell and the metal disc is the **negative terminal**. The electric cell is a portable source of electrical energy.

3.2.2 Battery



Activity 3.3: Let us experiment

- Take a torch which uses two cells. Open its cell compartment and take out the cells.
- Put the cells back in a different order. Also, try reversing the direction of one cell. Then, slide the switch and check whether the lamp glows in each case.
- Check the order in which the cells were placed in the torch when the lamp glows.

The lamp glows when the cells are placed in the order as shown in Fig. 3.3. Notice how the terminals of the two cells are connected. The positive terminal of one cell is connected to the negative terminal of the next cell. Such a combination of two or more cells is called a **battery**.

(a)

(b)

Fig. 3.3: A battery made up of (a) two cells (b) four cells

For many devices, we may need more than one cell. So, we connect two or more cells together as shown in Fig. 3.3. Connecting more than one cell provides energy to the circuit for a longer time and/or more energy.

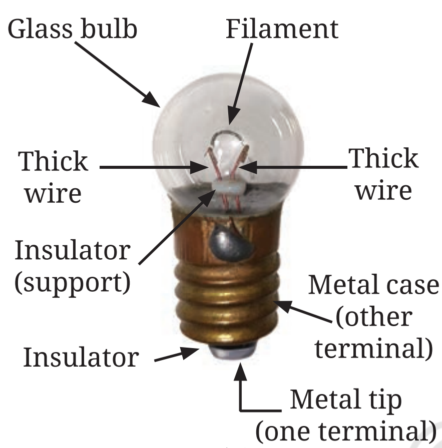
Fascinating Facts

The term battery is also used for a single cell. We use the term battery even for the single cell that powers our mobile phones.

3.2.3 Electric lamp

Incandescent Lamp

Activity 3.4: Let us observe



(a)

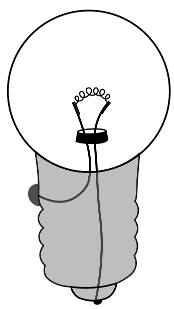

(b)

Fig. 3.4: (a) A small incandescent lamp used in a torch (b) its simplified drawing showing the connection of wires to the terminals

For this activity, you will require a torchlight with an incandescent lamp (or light bulb). Many old torchlights still use such lamps. With your teacher's help, confirm that your torchlight uses an incandescent lamp.

- Take the torch and **examine** its lamp. What do you see? Do you notice a thin wire fixed in the middle of the glass bulb?
- Now, switch on the torch. Which part of the lamp glows?

The thin wire inside the glass bulb of the lamp glows. The glowing thin wire is called the **filament** of the lamp.

- Take out the lamp with the help of your teacher and inspect it from all sides. How is the filament fixed?

The filament is attached to two thicker wires that support it, as shown in Fig. 3.4a. One thick wire connects to the metal case at the lamp's base, while the other connects to the metal tip at the centre of the base (Fig. 3.4b). These form the two terminals of the lamp, and are fixed in a way that they do not touch each other. In such **incandescent lamps**, the filament gets hot and glows to produce light.

However, my torch has a different kind of lamp. In fact, it cannot be taken out of the torch as it is fixed in it.

LED Lamp

Many torches in use today have a Light Emitting Diode (LED) lamp, instead of an incandescent lamp, as shown in Fig. 3.5.

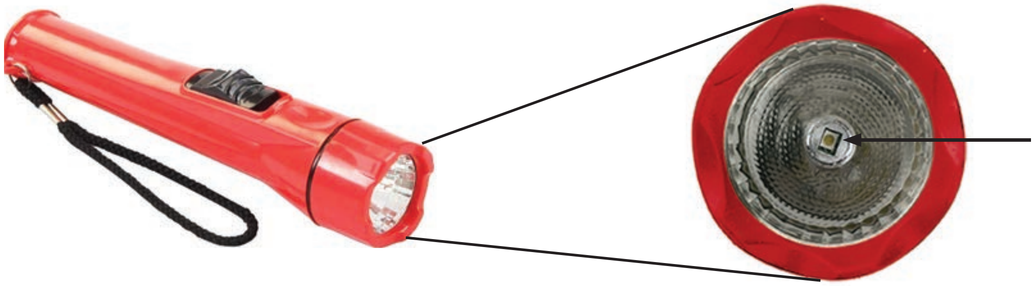


Fig. 3.5: An LED lamp for torch

Activity 3.5: Let us observe

- ❖ Take an LED of any colour (Fig. 3.6) and observe. Do you see any filament inside it?
- ❖ **Notice** the length of two wires attached to the LED. Do you find one of those longer than the other?

Fig. 3.6: LEDs of different colours

Unlike incandescent lamps, LEDs do not have filaments (Fig. 3.6). They also have two terminals, but one is positive (attached to a longer wire) and the other is negative (the shorter wire). A torch may use one or more LEDs, sometimes of different shapes, in its lamp.

After having learnt about the electric cell, battery, and electric lamps, we are now ready to make the torch lamp glow using an electric cell or battery.

3.2.4 Making an electric lamp glow using an electric cell or battery

Activity 3.6: Let us construct

- ❖ Take an electric cell, an incandescent lamp used in a torch, a cell holder, a lamp holder, and four lengths of electric wire.
- ❖ Remove about 1 cm of the plastic covering from both ends of each wire to expose the metal.
- ❖ Attach two wires to the two ends of the cell holder as shown in Fig. 3.7a.

(a) (b) (c)

Fig. 3.7: (a) An electric cell holder with two wires attached (b) An electric cell inside the cell holder (c) Wires connected to an electric cell using electrical tape

- ❖ Insert the cell in the holder such that its negative terminal is towards the spring side of the holder (Fig. 3.7b). In case a cell holder is not available, fix the two wires to the cell using electrical tape (Fig. 3.7c).
- ❖ Attach two wires to the screws of the lamp holder as shown in Fig. 3.8a. Fix the lamp in the holder by turning it around in the holder (Fig. 3.8b). In case a lamp holder is not available, use electrical tape to attach two wires to the two ends of the lamp (Fig. 3.8c).

(a) (b) (c)

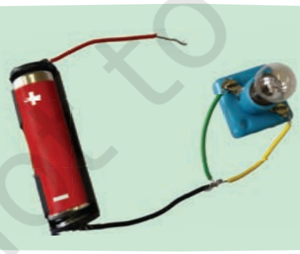
Fig. 3.8: (a) An electric lamp holder with wires attached (b) An incandescent lamp inside the lamp holder (c) Wires connected to incandescent torch lamp with electrical tape

Now, we are ready to connect the cell to the lamp to make it glow.

- ❖ We will conduct this activity in two parts—prediction and observation. Some of the ways in which the lamp and the cell can be connected are shown in Table 3.1.
  - **Predict**, for each arrangement, if the lamp will glow or not and write your prediction in Table 3.1.
  - Now, connect the lamp and the cell, and observe if the lamp glows or not. Note down your observation in Table 3.1. Also, for the lamps which glow, colour their glass bulbs yellow.

Table 3.1: Trying to make the lamp glow

Note: The lamps are not shown glowing in any circuit

S.No.	Arrangement of Cell and Lamp	Prediction	Observation
1.			
2.			
3.			
4.			
5.			
6.			

The lamp glows in the arrangements at S.No. 1 and 6 and does not glow in the remaining arrangements. Now, carefully look at the arrangements in which the lamp glows. **Compare** these with those in which the lamp does not glow. Can you find the reason for the difference?

3.2.5 An electrical circuit

The lamp glows when one terminal of the lamp is connected to one terminal of the electric cell and the other terminal of the lamp to the other terminal of the cell as shown in Fig. 3.9. This setup forms an **electrical circuit**, which provides a complete path for electric current to flow through the lamp. The lamp glows only when current passes through the circuit.

Fig. 3.9: An electrical circuit

The direction of electric current in an electrical circuit is taken to be from the positive to the negative terminal of the electric cell. When the terminals of the lamp are connected with those of the electric cell by wires, the current passes through the filament of the incandescent lamp and makes it glow. With an incandescent lamp, it does not matter which of its terminals connects to the positive or negative terminal of the cell. The lamp will glow as long as the circuit is complete and current flows through the filament.

FASCINATING FACTS

Sometimes, an incandescent lamp does not glow even when connected to a cell. We say the lamp has 'fused' usually due to a broken filament. A broken filament stops the flow of current, preventing the lamp from glowing.

Let us now try to make an LED glow.

Activity 3.7: Let us experiment

- ❖ Take two electric cells, an LED of any colour, a cell holder that can fit two cells (Fig. 3.8a), and two lengths of electric wire.
- ❖ Remove about 1 cm of the plastic covering from both ends of each wire to expose the metal.
- ❖ Connect the two wires to the cell holder as shown in Fig. 3.10a.

- Insert two cells in the holder, taking care that for each cell, its negative terminal is towards the spring side of the holder (Fig. 3.10b) and the battery is ready to use. How will you decide which is the positive terminal of this battery?

The terminal of the holder which is connected to the positive terminal of one cell is positive and the one connected to the negative terminal of the other cell is the negative terminal.

- Now, connect the free end of the battery positive terminal wire to the longer wire of LED, and the free end of the second wire to the shorter wire of LED (Fig. 3.10c). Does the LED glow?
- Repeat the above step but interchange the wires connected to the LED (Fig. 3.10d). Does the LED glow again?

You would have observed that the LED glows in the first case (Fig. 3.10c) and does not glow in the other (Fig. 3.10d). It is because the current can pass through the LED in one direction only. The current passes through the LED only when the positive terminal (longer wire) of the LED is connected to the positive terminal of the battery, and negative terminal (shorter wire) of the LED is connected to the negative terminal of the battery. When current passes through the LED, it glows. Always take care to connect an LED correctly in a circuit to make it glow.

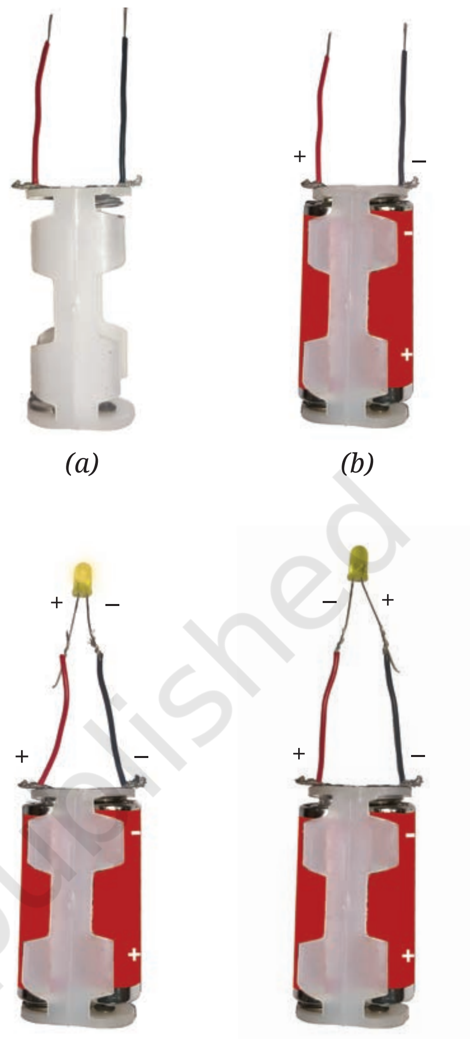
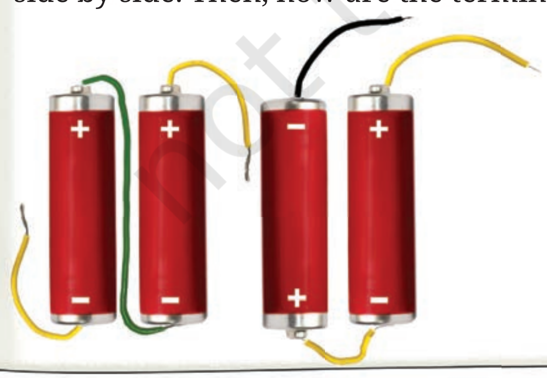


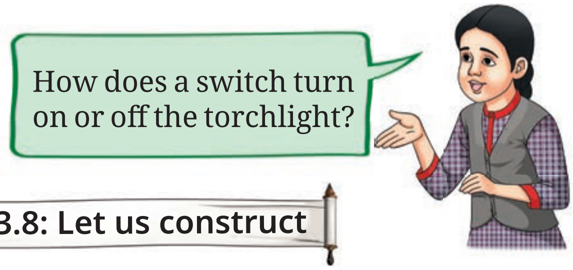
Fig. 3.10: Making an LED glow

Sometimes you may come across a device in which the cells are placed side by side. Then, how are the terminals of the cells connected?



If you carefully look inside the battery compartment, you will usually see a thick wire or metal strip connecting the positive terminal of one cell to the negative terminal of the next. To help with proper placement, '+' and '–' symbols are typically printed inside.

3.2.6 Electric switch



Let us first make a simple switch on our own.

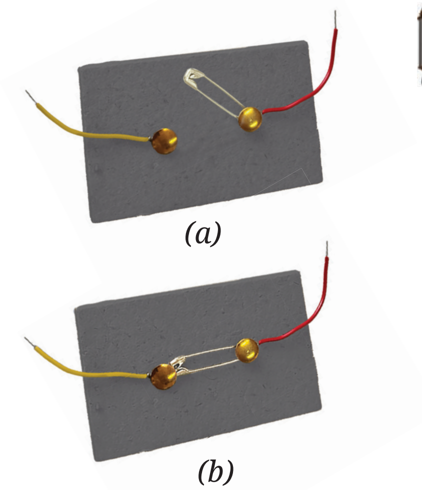


Fig. 3.11: A switch (a) in 'OFF' position (b) in 'ON' position

Activity 3.8: Let us construct

- Collect two drawing pins, a safety pin (or a paper clip), two wires, and a small piece of cardboard.
- Insert a drawing pin through the ring of the safety pin and fix it to the cardboard piece, ensuring that the safety pin can rotate freely (Fig. 3.11a).
- Fix the second drawing pin to the cardboard piece so the free end of the safety pin can touch it (Fig. 3.11b).
- Connect a wire to each drawing pin — our switch is ready!

Let us now test our switch.

Activity 3.9: Let us test

- Connect the electric cell, lamp, and switch as shown in Fig. 3.8a. Does the lamp glow?
- Rotate the free end of the safety pin till it touches the other drawing pin as shown in Fig. 3.8b. Does the lamp glow now?

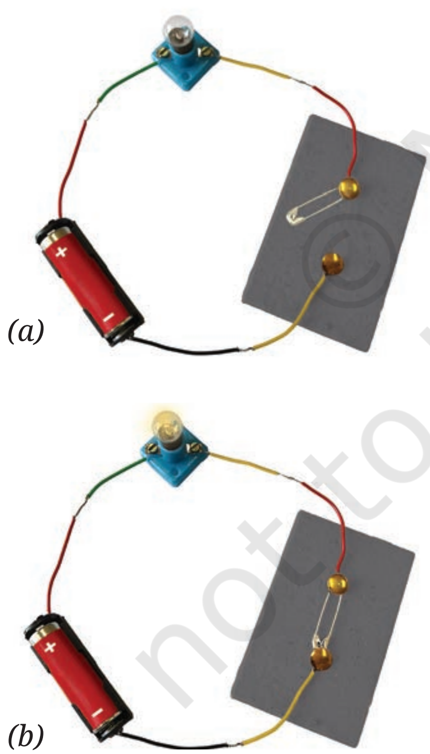


Fig. 3.12: An electrical circuit with a switch in (a) 'OFF' position (b) 'ON' position

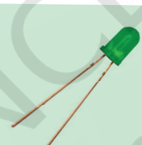
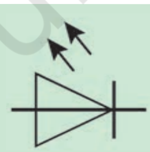
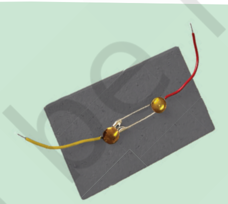
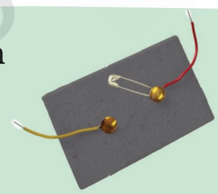
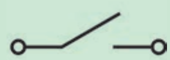
When the safety pin touches both drawing pins, it closes the gap and completes the path, and allows the current to flow. We call this the **ON** position (Fig. 3.8b) where the **circuit is closed** and current flows from the cell's positive to negative terminal making the lamp glow. When the safety pin does not touch the second drawing pin, the gap in the circuit prevents current flow, and the lamp does not glow. In this **OFF** position (Fig. 3.8a), we say that the **circuit is open**.

Note that a switch can be placed anywhere in a circuit. A **switch** is a simple device that either completes or breaks a circuit. The switches used for lights and other devices at home work the same way, though they are designed differently.

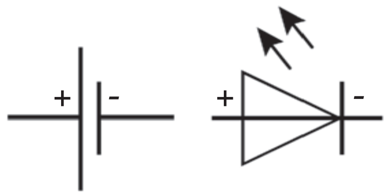
3.3 Circuit Diagrams

The various components of an electrical circuit can be represented by symbols shown in Table 3.2.

Table 3.2: Electrical components and their symbols

S.No.	Electrical component	Symbol
1.	Electric cell 	
2.	Battery 	
3.	Electric lamp 	
4.	Light Emitting Diode (LED) 	
5.	Switch in 'ON' position 	
6.	Switch in 'OFF' position 	
7.	Wire 	

In the symbol for an electric cell, the long line represents the positive terminal, while the short line represents the negative terminal (Fig. 3.13a).



(a) (b)

Fig. 3.13: Positive and negative terminals in the symbols of (a) a cell (b) an LED

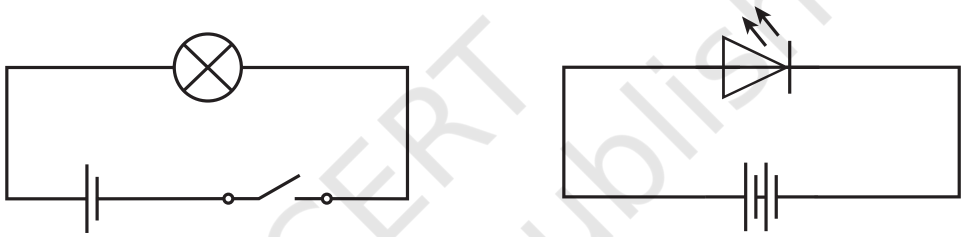
In the symbol for an LED, the triangle points to the direction in which the current can flow. The two arrows indicate that light is emitted by an LED (Fig. 3.13b).

By using symbols to represent electrical components, it is easier to draw and understand electrical circuits. A representation of an electrical circuit using symbols is called its **circuit diagram**.

Activity 3.10: Let us draw

- Using symbols shown in Table 3.2, **draw** the circuit diagram of an electrical circuit given in Fig. 3.12a and Fig. 3.10c.

Are your circuit diagrams similar to Fig. 3.14a and Fig. 3.14b respectively?



(a) (b)

Fig. 3.14: A circuit diagram (a) with an incandescent lamp (b) with an LED lamp

International organisations, such as the International Electrotechnical Commission (IEC), American National Standards Institute (ANSI), and the Institute of Electrical and Electronics Engineers (IEEE) create standard symbols for electrical and electronic parts. Using the same symbols across the world helps people from different countries and industries understand each other easily.

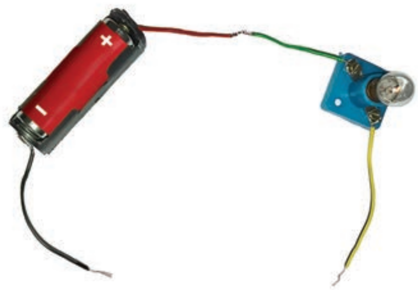
3.4 Electrical Conductors and Insulators

Why did we use metal wires for making electric circuits? Can we not use some other materials for wires?

Also, why are electric wires covered with plastic or rubber?

Suppose, we make wires of materials other than metal and use them for making the electrical circuit. Do you think the electric current will pass through those materials in such a circuit?

Activity 3.11: Let us identify



(a)

(b)

Fig. 3.15: (a) Conduction tester (b) Using the conduction tester for testing a material

- Connect an electric cell and a lamp while leaving the two ends of wires free as shown in Fig. 3.15a.
- Touch the two free ends of the wires momentarily. Does the lamp glow? If yes, our tester is ready. We can use this tester to **identify** the materials through which electric current passes.
- Collect objects of different materials, such as metal spoons, coins, cork, rubber, glass, keys, pins, plastic scale, wooden block, aluminium foil, candle, sewing needle, cardboard, paper, and pencil lead.
- One by one, touch the free ends of the tester's wires to both ends of each object you have collected (Fig. 3.15b). Make sure the wires don't touch each other. Does the lamp glow every time?
- Record your observations in Table 3.3.

Table 3.3: Identifying Conductors and Insulators

S.No.	Object	Material it is made up of	Lamp glows (Yes/No)	Conclusion (Conductor/ Insulator)
1.	Stick	Wood	No	
2.	Scale	Plastic		
3.	Bangle	Glass		
4.	Paper strip	Paper		
5.	Candle	Wax		
6.	Key	Metal		
7.	Eraser	Rubber		
8.				
9.				

❖ **Analyse** your observations. Did the lamp glow for all materials?

The lamp glows for some materials only. This means that electric current can pass easily through some materials but not through others. The materials through which electric current can flow easily are called **good conductors**, or **conductors of electricity**. The materials through which current cannot pass through are called **insulators**, or **poor conductors of electricity**.

❖ Based on the observations you have recorded in Table 3.3, **conclude** which materials are conductors of electricity and which are insulators. Note it in Table 3.3.

From your conclusions in Table 3.3, you would have realised that metals are conductors of electricity, and thus, are used for making wires.

Silver, copper, and gold are the best electrical conductors. However, for making electrical wires, mainly copper is used due to its comparatively lower cost and abundant supply. Different types of electrical wires are used for different uses.

From Table 3.3, you would have also realised that plastic, rubber, and ceramics are electrical insulators. Have you now understood why wires are covered with those materials?

Conductors and insulators are both important. Electrical wires, switches, connectors of plugs, and sockets are made of conductors. Insulators like rubber, plastics, and ceramics are used to cover wires, plug tops, and switches to protect people from electric shocks.

Caution—Our body is a conductor of electricity. Electric current passing through our body may cause severe injury or even death. Always handle electrical appliances with care. Never touch switches or plugs with wet hands, or use electrical devices in wet areas, or handle equipment with damaged insulation or broken plugs.

Have you ever wondered how the electricity from a cell or battery is different from the electricity coming from a wall socket? Electricity from batteries usually powers small devices and is of a type called Direct Current (DC). In contrast, the electricity from power plants that come to the wall socket is known as Alternating Current (AC) and can run larger appliances.

In a Nutshell

- ❖ An electric cell is a portable source of electrical energy.
- ❖ An electric cell has two terminals; one is called positive (+ve) while the other is negative (–ve).
- ❖ In an incandescent electric lamp, there is a thin wire called the filament, which gets hot and glows to produce light when electric current passes through it.
- ❖ An LED has two terminals, one is positive (attached to a longer wire) and the other is negative (the shorter wire).
- ❖ Electric current can pass through LED in one direction only.
- ❖ An LED lights up only when its positive terminal (longer wire) connects to the positive terminal of the battery and its negative terminal (shorter wire) connects to the negative terminal of the battery.
- ❖ A switch is a simple device that either completes or breaks a circuit.
- ❖ The direction of electric current in a closed electrical circuit is taken to be from the positive to the negative terminal of the electric cell.
- ❖ A representation of an electrical circuit using symbols is called its circuit diagram.
- ❖ Materials through which electric current can flow easily are called good conductors or conductors of electricity.
- ❖ Materials through which current cannot pass through are called insulators or poor conductors of electricity.

Let Us Enhance Our Learning

1. Choose the incorrect statement.
   (i) A switch is the source of electric current in a circuit.
   (ii) A switch helps to complete or break the circuit.
   (iii) A switch helps us to use electricity as per our requirement.
   (iv) When the switch is in 'OFF' position, there is an air gap between its terminals.
2. Observe Fig. 3.16. With which material connected between the ends A and B, the lamp will not glow?

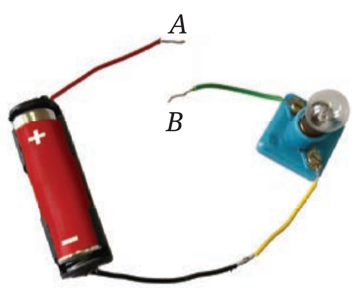


Fig. 3.16

3. In Fig. 3.17, if the filament of one of the lamps is broken, will the other glow? Justify your answer.

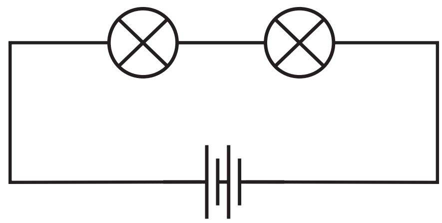
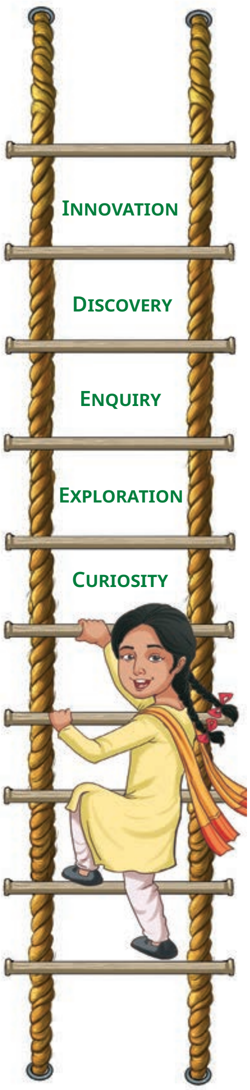


Fig. 3.17



4. A student forgot to remove the insulator covering from the connecting wires while making a circuit. If the lamp and the cell are working properly, will the lamp glow?
5. Draw a circuit diagram for a simple torch using symbols for electric components.
6. In Fig. 3.18:
   (i) If S_2 is in 'ON' position, S_1 is in 'OFF' position, which lamp(s) will glow?
   (ii) If S_2 is in 'OFF' position, S_1 is in 'ON' position, which lamp(s) will glow?
   (iii) If S_1 and S_2 both are in 'ON' position, which lamp(s) will glow?
   (iv) If both S_1 and S_2 are in 'OFF' position, which lamp(s) will glow?

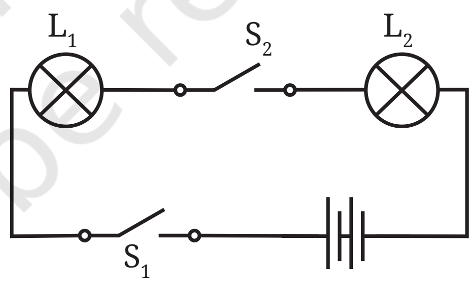


Fig. 3.18

7. Vidyut has made the circuit as shown in Fig. 3.19. Even after closing the circuit, the lamp does not glow. What can be the possible reasons? List as many possible reasons as you can for this faulty operation. What will you do to find out why the lamp did not glow?

Fig. 3.19

8. In Fig. 3.20, in which case(s) the lamp will not glow when the switch is closed?

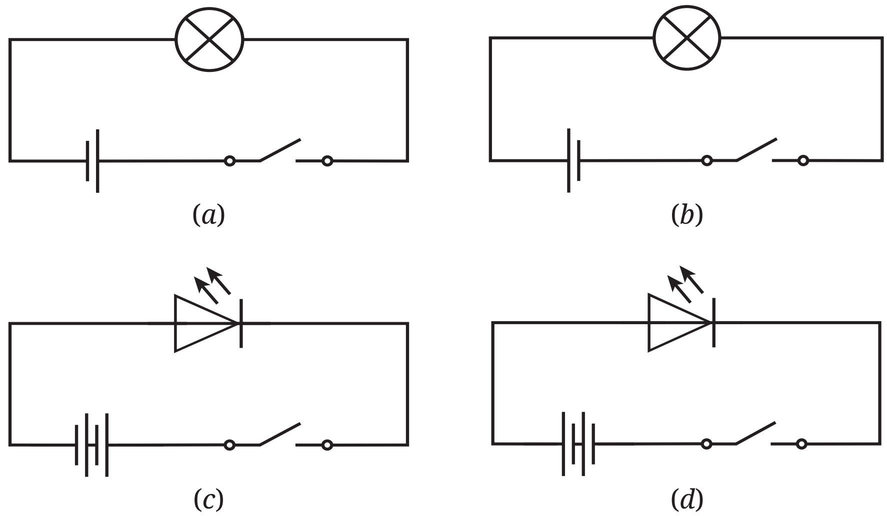


Fig. 3.20

9. Suppose the '+' and '–' symbols cannot be read on a battery. Suggest a method to identify the two terminals of this battery.
10. You are given six cells marked A, B, C, D, E, and F. Some of these are working and some are not. Design an activity to identify which of them are working.
    (i) List the items that you require.
    (ii) Write the procedure that you will follow.
    (iii) With the items, carry out the activity to identify the cells that are working.
11. An LED requires two cells in series to glow. Tanya made the circuit as shown in Fig. 3.21. Will the lamp glow? If not, draw the wires for correct connections.

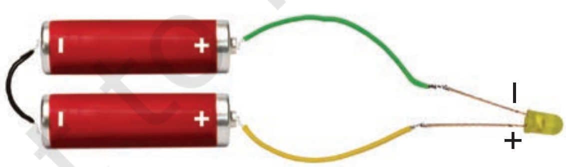
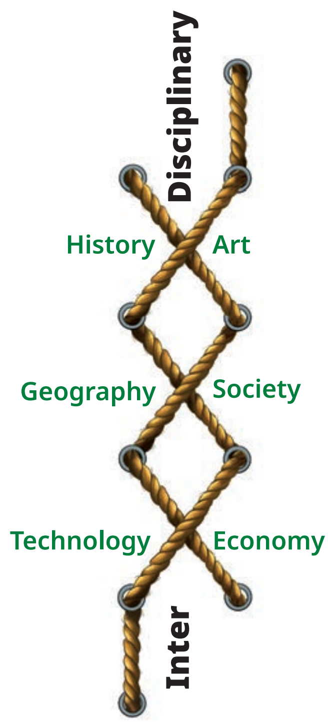


Fig. 3.21

Exploratory Projects

❖ Suppose that due to some problem, the power supply is disrupted in your area for two days. List out which actions from your daily life you would not be able to do.



- Using a solar panel (Fig. 3.22a) as a source of electrical energy, make a circuit to run a toy fan (Fig. 3.22b) as shown in Fig. 3.22c.

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

Fig. 3.22

- Visit an electrical items shop. With the help of the shopkeeper, identify the various types of cells available. For each cell, also find out which device(s) it is used for. Prepare a report.
- Prepare a list of objects in your home under three categories:
  - (i) Objects which are electrical insulators only
  - (ii) Objects which are electrical conductors only
  - (iii) Objects which are made of both, whose some parts are insulators and some electrical conductors

SCIENCE AND SOCIETY

Electric cells or batteries are compact portable sources of electrical energy that make the use of some electrical devices more convenient. These cells and batteries come in various shapes and sizes for different purposes, such as cylindrical batteries for torchlights, clocks, remotes, toys; button cells for watches, hearing aids; rechargeable batteries for mobile phones, laptops, and electric vehicles.

4 The World of Metals and Non-metals

Yashwant and Anandi live in a village in Rajasthan. Their school has assigned them a project to learn about craftspersons who work with metals. They decide to visit the local ironsmiths who practise this craft. Yashwant and Anandi request their grandfather to accompany them (Fig. 4.1). They are curious to learn how these ironsmiths make different items of daily use. They interact with an elderly craftsperson, Sudarshan uncle.

Yashwant: Which items do you generally make?

Sudarshan: Generally, we make items of daily use, such as flat pans (*tawa*s), buckets (*balti*s), tongs (*chimta*s), and farming tools like spades (*phawra*s), axes (*kulhadi*s), trowels (*khurpi*s), and rakes (*jelee*s).

Anandi: What materials are they made of?

Fig. 4.1: Ironsmith making various items

Sudarshan: We use iron metal to make these items. We also use wood to prepare handles wherever required. Additionally, we use coal in our furnaces to heat the iron.

Sudarshan is heating an iron block in the furnace. It has become red hot. He starts beating it hard with a hammer.

Anandi is amazed and asks, "Why are you beating it?"

Sudarshan: I am beating it to shape it into an axe.

Anandi: Wow, a piece of iron can be beaten into a flat shape! Can we do this with other metals as well?

You may also have many such questions—let us **explore** what else we can do with metals.

4.1 Properties of Materials

4.1.1 Malleability

Activity 4.1: Let us explore

Caution—Conduct this activity under the supervision of your teacher or an adult.

- Collect some waste pieces of copper and aluminium, an iron nail, a piece of coal, a pea-sized lump of sulfur (*gandhak*), and a block of wood.
- Recall the chapter 'Materials Around Us' in the Grade 6 Science textbook *Curiosity* and **observe** the appearances of the above items. Are they lustrous? Also, note whether they are hard or soft and **record** your observations in Table 4.1.
- Now, place each of these items one by one on any hard surface and beat them with a hammer (Fig. 4.2).
- What do you think will happen? Do the objects become slightly flattened or do they break into pieces?
- Record your observations in Table 4.1.

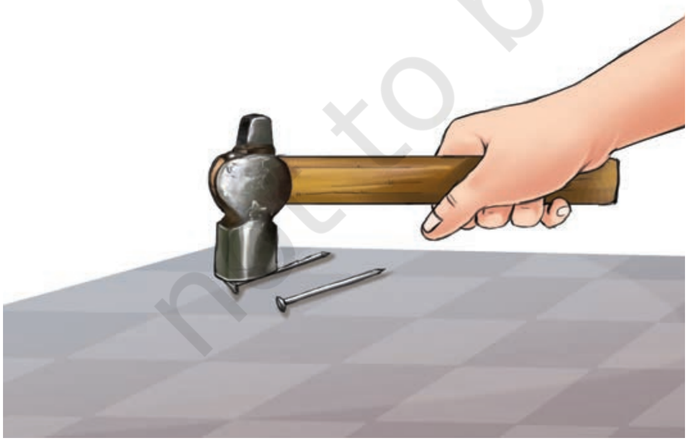


Fig. 4.2: Beating an iron nail with a hammer

Table 4.1: Appearance, hardness, and effect of hammering on different objects or materials

S.No.	Object/Material	Appearance (lustrous/ non-lustrous)	Hard/Soft	Effect of hammering (flattens/breaks into pieces)
1.	Piece of copper			
2.	Piece of aluminium			
3.	Iron nail			
4.	Piece of coal			
5.	Lump of sulfur (pea-sized)			
6.	Block of wood			

Analyse Table 4.1. **Identify** the objects that are **lustrous** in appearance and **hard**. You might have observed that objects made from copper, aluminium, and iron are lustrous in appearance and are hard. Lustre shown by metals is known as metallic lustre. Materials like copper, aluminium, and iron are known as **metals**, whereas, coal, sulfur, and wood are **non-lustrous** and not as hard as metals.

Are all metals hard and solid? Not really; some metals like sodium and potassium are so **soft** that they can be cut with a knife. There is one metal, mercury, that is found in a liquid state at room temperature, which you might have seen in thermometers. Recall the chapter 'Temperature and its Measurement' from the Grade 6 Science textbook *Curiosity*.

Which objects did you find become flat on beating with a hammer?

You must have observed that objects such as a piece of copper, an iron nail, and a piece of aluminium become flat when beaten; whereas other objects or materials behave differently. This property by which materials can be beaten into thin sheets is called **malleability**. Most metals possess this property. Can you give some examples of metal sheets? You might have seen thin silver foil on some sweets and aluminium foil used for wrapping food items. These are formed due to their malleability. Gold and silver are the most malleable metals.

A piece of coal or a lump of sulfur does not show this behaviour. They break into pieces and are said to be **brittle**. On the other hand, wood neither gets flattened into a sheet nor breaks into pieces. Therefore, wood is neither malleable nor brittle.

HOLISTIC LENS

The impact of iron on the progress of civilisation of India

In the Grade 6 Social Science textbook *Exploring Society India and Beyond*, you learnt about the Harappans. They knew how to use metals like copper and gold. They used these metals to make various objects, from utensils to jewellery. However, you would hardly find any evidence of the Harappans using a very prominent metal iron, which you see a lot around you today. This is because it took a long time before iron was used in day-to-day activities.

However, once the use of iron gained prominence in the times that followed, it contributed significantly to the progress of civilisation in India. For instance, due to its strength, agricultural tools like ploughs made from iron were much superior to those used previously.

What could be the potential reason that it is generally considered that copper was discovered earlier as compared to iron?

4.1.2 Ductility

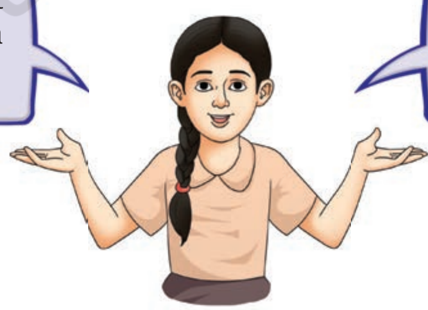
Where do you find the use of metal wires?

You might have seen wires of metals like copper or aluminium in electrical fittings. Some ornaments, like bangles, necklaces, earrings, etc., are also made from metal wires. Metal wires play important functions in a variety of stringed musical instruments, such as veena, sitar, violin, and guitar.

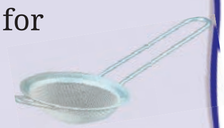
This property of materials by which they can be drawn into wires is called **ductility**.

This property of ductility is mainly possessed by metals.

Gold is so ductile that one gram of it can be drawn into a 2 kilometre-long wire!



The ductile nature of metals enables for the creation of this tea strainer with metal wire.



Have you ever seen wires made of coal or sulfur? Obviously not! We can say that coal and sulfur are not ductile.

DIVE DEEPER

Do you know that ropes made of steel [a mixture of metal (iron) and non-metal (carbon)] wires can support heavy loads? Therefore, they are used in suspension bridges and in cranes to lift heavy objects.

Suspension bridge

4.1.3 Sonority

Have you ever noticed the sound produced when a metal spoon, or a metal plate, or a metal coin is dropped on the floor? How is it different from the sound produced when a piece of coal or wood is dropped on the floor?

Activity 4.2: Let us investigate

Caution — Be careful while dropping the objects.

- Take a few objects, such as a metal spoon, a coin, a piece of coal, and a block of wood.
- Drop them one by one from a certain height.
- Do you notice any difference in the sound produced by these objects?

You would observe that the metal spoon and the metal coin produce a ringing sound. Coal and wood, on the other hand, produce dull sounds.

This property of metals that enables them to produce a ringing sound is called **sonority**, and metals are said to be sonorous in nature.


4.1.4 Conduction of heat

Have you ever observed the vessels used for cooking in the kitchen? You might have noticed that the vessels used for heating are made of metals. Can you name some metals that are used for making cooking vessels? Do you know why these metals are used for this purpose?

Let us find out!

Activity 4.3: Let us investigate

Caution—This activity must be performed under the supervision of your teacher or an adult. Be careful while handling hot water.

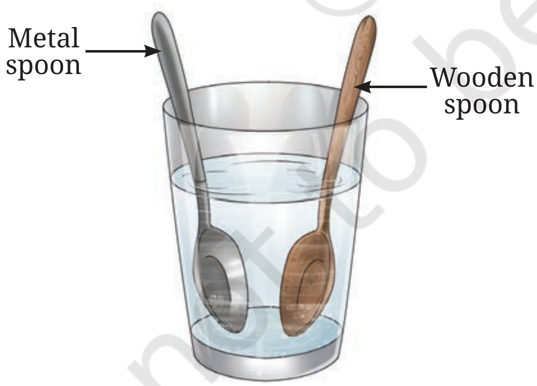


Fig. 4.3: Metal and wooden spoons immersed in hot water

- Place a glass tumbler on a table.
- Fill it with hot water.
- Take a metal spoon and a wooden spoon of almost the same size and thickness.
- Immerse both the spoons simultaneously into the hot water (Fig. 4.3) and leave them undisturbed for a few minutes.
- Now, carefully touch the upper end of each spoon.

Some discussion points:

- ❖ Which of the spoons get hotter?
- ❖ What does this experiment tell us about heat transfer along the two spoons?

You may have noticed that the metal spoon is hotter to touch than the wooden spoon. Even though both spoons are immersed in the water of the same temperature and for the same time. This shows that the heat transfers through the metal spoon, making it hotter. In contrast, the wooden spoon transfers heat poorly.

In such cases, the transfer of heat from one point to another of a material is called conduction, and materials that transfer heat are called **conductors**.

Based on the observations, one can say that metals are **good conductors of heat**, whereas wood is a **poor conductor of heat**. Now, we can understand why mostly metal vessels are used for cooking, and their handles are made with wood or other materials that do not conduct heat. You will learn more about this in the chapter 'Heat Transfer in Nature'.

4.1.5 Conduction of electricity

Have you ever seen an electrician using a screwdriver? What type of material is used for making its handle? You may have also noticed the electrician wearing rubber gloves and shoes while working. What can be the **reason** for this?

Activity 4.4: Let us design and create

Design an electric circuit, like the 'tester' circuit in the chapter 'Electricity: Circuits and their Components'. Repeat the same activity using the materials listed below and record your observations in Table 4.2.

- ❖ You may collect a few objects, such as a piece of aluminium foil, an iron nail, a lump of sulfur (pea-sized), a copper wire, a piece of coal, a piece of dry wood, a stone, an eraser made of rubber and a piece of nylon rope.
- ❖ **Predict** which of these could make the bulb of the tester glow and which could not.

Table 4.2: Conduction of electricity by different objects or materials

S.No.	Object/Material	Observation (bulb glows/does not glow)	Good conductor of electricity or poor conductor of electricity
1.	Piece of aluminium foil		
2.	Iron nail		
3.	Lump of sulfur (pea-sized)		
4.	...		

You might have observed that objects made of aluminium, iron, and copper make the bulb glow, whereas sulfur, coal, wood, stone, eraser, and nylon rope could not make it glow. Do you see any pattern in the glowing of bulbs when using different materials in Activity 4.4? It is observed that all the materials that make the bulb glow are metals.

Materials that allow electricity to flow through them easily are called **good conductors of electricity**. In contrast, materials that prevent the bulb from glowing by not allowing electricity to pass through them are called **poor conductors of electricity**.

So, now we can understand that the plastic covering on screwdrivers and rubber gloves protect the electrician from electric shock because these materials are poor conductors of electricity.

We learnt that metals are generally hard, lustrous, malleable, ductile, and good conductors of heat and electricity. Now, let us learn how metals behave in the presence of air and water.

4.2 Effect of Air and Water on Metals: Iron

You would have often noticed that iron objects develop brown deposits when left in the open for a few days. In which conditions would an iron object develop brown deposits?

- When it comes into contact with dry air only.
- When it comes into contact with water only.
- When it comes into contact with both air and water.

Activity 4.5: Let us experiment

Caution — Be careful while handling iron nails.

- Take a few shining iron nails. If you are using old iron nails, make sure to remove brown deposits from their surface by scrubbing them with the help of a small piece of sandpaper.
- Take three clean, dry glass bottles or test tubes with tight-fitting caps or stoppers. Label them A, B, and C.
- Take three iron nails and tie each iron nail with a thread.
- Place one iron nail and some silica gel in the glass bottle 'A', and tighten the cap or stopper (Fig. 4.4a). Silica gel makes the air dry. It is the substance that is used in small pouches in some medicine bottles, water bottles, shoe boxes, etc., to keep them dry.
- Place one iron nail in the glass bottle 'B'. Pour freshly boiled and cooled water (to remove dissolved gases) into it until the iron nail is completely dipped in it. Now, pour some oil to form a layer over the surface of the water (Fig. 4.4b). The layer of oil on the surface of the water prevents the air from dissolving in the water. Cap the glass bottle tightly.
- Place one iron nail in the glass bottle 'C', and pour some water so that the iron nail is partially dipped. Keep this glass bottle unstoppered. This allows the iron nail to come into contact with both water and air, as shown in Fig. 4.4c.
- Place all the glass bottles undisturbed at room temperature and observe the changes for 8 – 10 days.
- Record your observations in Table 4.3.

Fig. 4.4(a)

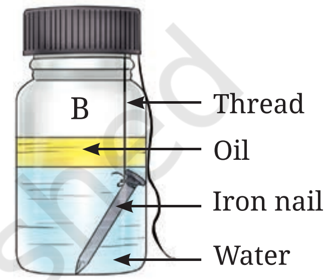


Fig. 4.4(b)

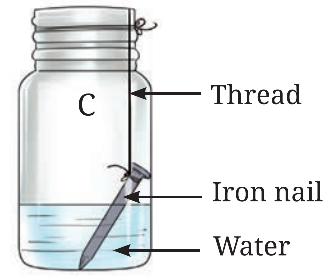


Fig. 4.4(c)

Fig. 4.4: Glass bottles containing iron nails

Table 4.3: Formation of brown deposit on iron nails

Glass Bottle	Conditions		Observations
	Presence of water (Yes/No)	Presence of air (Yes/No)	
A	No	Yes	
B			
C			

What can you **conclude** from this experiment?

It is observed in glass bottles A and B that the iron nails do not show any brown deposits. What does this observation indicate? This indicates that brown deposits or discolouration on the iron nails do not develop when the iron nail is kept in dry air alone (bottle A) or water alone (bottle B). However, in glass bottle C, the iron nail shows the presence of brown deposits. This indicates that the presence of both water and air is essential for these deposits to develop. Thus, moist air is responsible for the development of brown deposits on objects made of iron. This brown deposit is called rust. The process of formation of rust on objects made of iron is called **rusting**.

Many other metals also exhibit discolouration when kept open in the atmosphere. Have you noticed the formation of a green coating on the surface of copper objects or a black coating on the surface of silver objects? Gradual deterioration of metal surfaces caused by air, water, or other substances is known as **corrosion**.

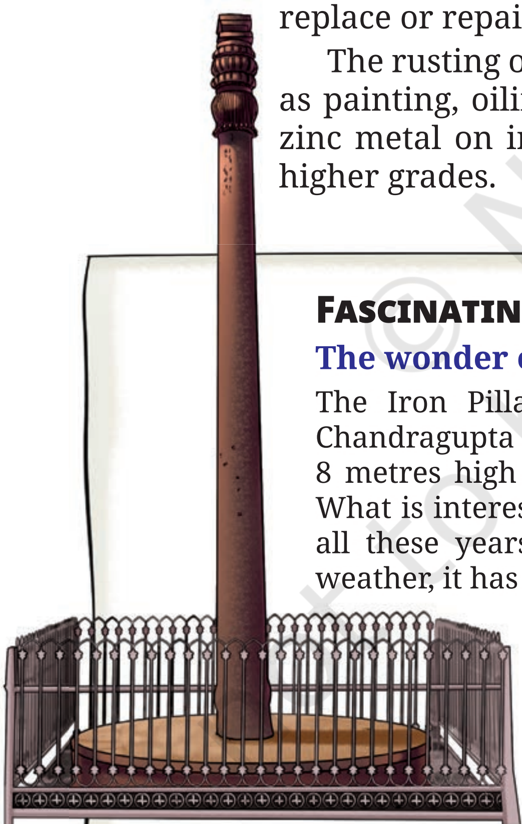
Do you know that rusting of iron is a serious problem in our country? Every year, an enormous amount of money is spent to replace or repair iron structures damaged due to rusting.

The rusting of iron can be prevented by several methods such as painting, oiling, greasing, and applying a protective layer of zinc metal on iron (galvanisation). We will learn about this in higher grades.

Fascinating Facts

The wonder of ancient Indian metallurgy!

The Iron Pillar of Delhi was made in the time of Chandragupta II more than 1600 years ago. It is about 8 metres high and weighs more than 6000 kilograms. What is interesting about this iron pillar is that despite all these years of facing winds, rainfall, and intense weather, it has barely any rust.



The Iron Pillar (Delhi)

In other words, it has been made in a way that it resists rusting. This tells us about the skills that were developed in metal technology in India.

4.3 Effect of Air and Water on Other Metals

Activity 4.6: Let us investigate (demonstration activity)

The teacher may demonstrate this activity.

Caution—It is advisable for students to wear protective eyeglasses and keep safe distance.

- Take a magnesium ribbon about 3–4 centimetres long. Clean it by rubbing with a piece of sandpaper.
- Hold it with a pair of tongs. Ignite the other end using a spirit lamp or a candle (Fig. 4.5).
- Let the magnesium ribbon burn.
- What do you observe?

Fig. 4.5: Burning magnesium ribbon

- You must have observed that magnesium ribbon burns with a dazzling white flame and changes into a white powder. Collect it on a watch glass. This powder is magnesium oxide. It is formed due to the reaction between magnesium and oxygen present in the air.
- Add a few drops of warm water to this white powder, stir it well, and check its nature.
- Recall the chapter 'Exploring Substances: Acidic, Basic, and Neutral'. Find out whether the solution of magnesium oxide is acidic or basic or neutral in nature. You can use any acid-base indicator.
- What effect does this solution have on blue and red litmus papers?

You would observe that it changes the colour of red litmus paper to blue (Fig. 4.6); hence, it is basic in nature. Generally, oxides of metals are basic in nature.

We will discuss this burning of magnesium ribbon further in the chapter 'Changes Around Us: Physical and Chemical'.

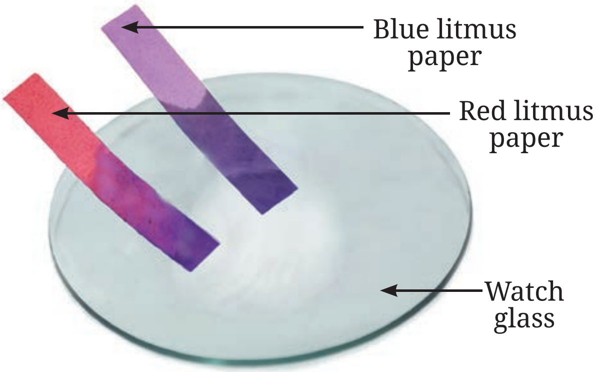


Fig. 4.6: Testing the nature of magnesium oxide

Do you know that sodium is a metal which is stored in kerosene because it reacts vigorously with oxygen and water. A lot of heat is generated in the reaction. Storing sodium in kerosene prevents its exposure to moisture and air. Can you predict the nature of its oxide?

Let us now discuss some substances that do not behave like metals.

4.4 Substances that Behave Differently from Metals in Air and Water

Activity 4.7: Let us experiment (demonstration activity)

Fig. 4.7(a): Deflagrating spoon

Fig. 4.7(b): Improvised deflagrating spoon

Fig. 4.7(c): Burning of sulfur

The teacher may demonstrate this activity.

Caution—This activity must be performed in a fume hood or well-ventilated area. Burning sulfur produces gases, which can be harmful if inhaled.

- Take a small amount of powdered sulfur in a deflagrating spoon (it is a long-handled metal spoon used in experiments to safely heat and burn substances Fig. 4.7a). If a deflagrating spoon is not available, you may take a metallic cap of any bottle, wrap a metallic wire around it and give it the shape as shown in Fig. 4.7b.
- Heat it on a flame, and as soon as the sulfur starts burning, introduce the deflagrating spoon into a gas jar or glass tumbler (Fig. 4.7c). Cover the gas jar or glass tumbler with a lid to ensure that the gas produced does not escape.
- Remove the lid after 3–4 minutes and take out the deflagrating spoon. Add a small quantity of water into the gas jar, quickly place the lid back and shake it so that the gas dissolves.
- Again, recall the chapter 'Exploring Substances: Acidic, Basic, and Neutral'. Using an acid-base indicator, check whether the solution obtained after the addition of water to the gas jar is acidic or basic or neutral.
- What do you observe?

You would observe that it is acidic in nature (Fig. 4.7d).

On burning sulfur in air (oxygen), sulfur dioxide gas is formed. On dissolving sulfur dioxide gas in water, sulfurous acid is formed.

Does sulfur behave in water the same way metals do?

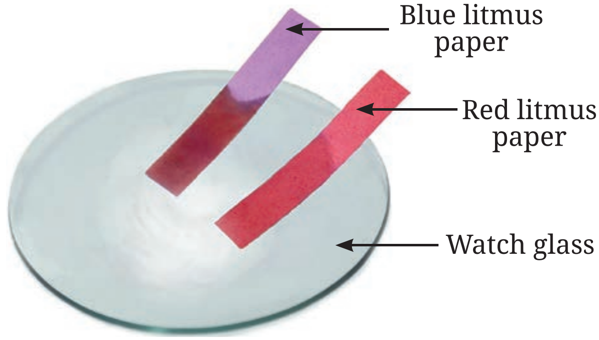


Fig. 4.7(d): Testing of solution with litmus papers

Activity 4.8: Let us explore

- Take some sulfur powder in a glass tumbler.
- Add a small amount of water to it.
- What do you observe?

You may have noticed that there is no reaction when sulfur is placed in water.

Substances like sulfur and phosphorus behave differently with air and water than metals. Phosphorus is stored in water as it catches fire when exposed to atmospheric air. These substances are usually soft and dull in appearance. They are neither malleable nor ductile, and they are not sonorous. They are also poor conductors of heat and electricity. These are called **non-metals**. Their oxides are acidic in nature.

Some other non-metals are oxygen, hydrogen, nitrogen, carbon, etc. These must not be confused with materials such as plastic, glass, wood, rubber, and paper. These materials are not classified as metals or non-metals because they are not elements.

Metals and non-metals are sub-categories of substances called elements. An element is a substance that cannot be broken down into simpler substances.

Presently 118 elements are known. These elements are the basic building blocks of all matter. Some are naturally occurring, while others are artificially made in the laboratory, and do not exist in nature. You will study more about elements in higher grades.

4.5 Are Non-metals Essential in Everyday Life?

You often observe many metals in your day-to-day lives because of their distinct properties, such as their lustrous nature, heat and electrical conductivity, and high strength. However, this should not give an impression in your mind that non-metals are not important in our lives.

We breathe in oxygen, which is a non-metal, and without it, we would not be able to survive. Can you think of any other uses of oxygen?

Carbon is essential in everyday life because it is the building block of all life forms. It is a key component of proteins, fats, and carbohydrates, which are necessary for growth and energy.

Nitrogen is used in the manufacturing of fertilisers and other chemicals. It is an essential nutrient for the growth of plants. Chlorine is a non-metal commonly used in water purification. A solution of iodine, a non-metal, is applied on wounds as an antiseptic.

Science and Society

Do you know that many metals and their alloys (mixtures of two or more metals or a metal and a non-metal) are important for daily use as utensils and tools. These are also important for modern technologies and essential in almost every industry. Some special metals are also used in atomic energy (such as zirconium), aerospace (titanium), etc. In India, many metals, especially iron and aluminium, are recycled to minimise waste and contribute to sustainability.

In a Nutshell

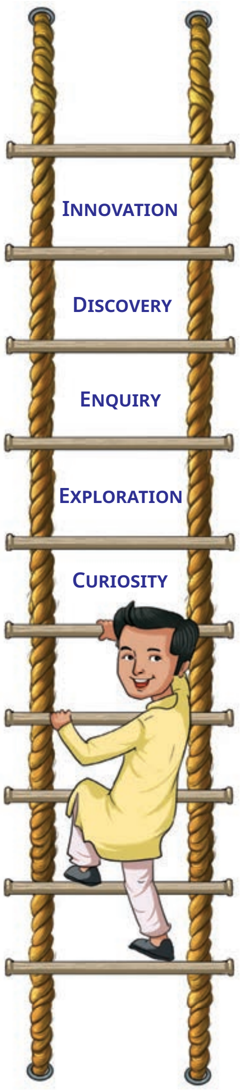
- ❖ Metals and non-metals are differentiated based on their properties.
- ❖ Generally, metals are lustrous, whereas most non-metals are non-lustrous.
- ❖ Metals are generally malleable and ductile, while non-metals do not have these properties.
- ❖ Metals are good conductors of heat and electricity, but non-metals are generally poor conductors.
- ❖ Metals react with oxygen to produce metal oxides which are basic in nature.
- ❖ Non-metals react with oxygen to produce oxides which are acidic in nature.
- ❖ Generally, non-metals do not react with water.
- ❖ Metal objects get damaged when exposed to moist air, and the process is known as corrosion.
- ❖ Metals and non-metals have wide applications in everyday life.

Let Us Enhance Our Learning

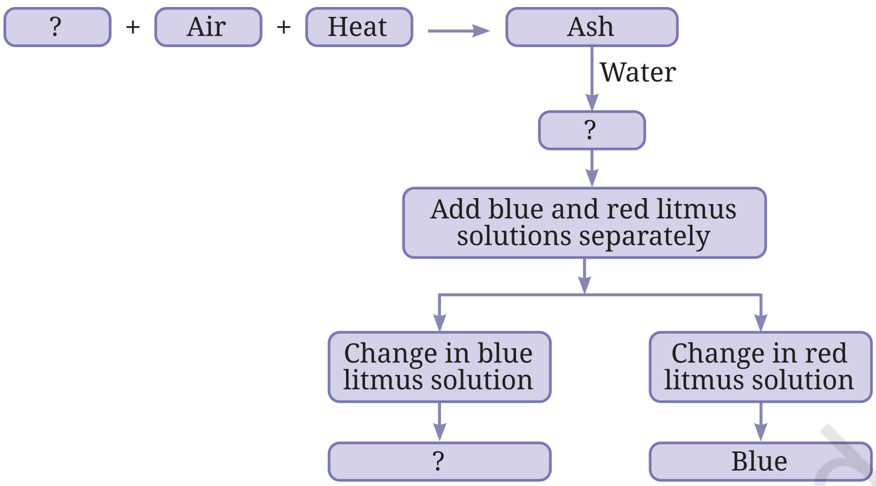
1. Which metal is commonly used to make food packaging materials as it is cheaper, and its thin sheets can be folded easily into any shape?
   (i) Aluminium (ii) Copper
   (iii) Iron (iv) Gold
2. Which of the following metal catches fire when it comes in contact with water?
   (i) Copper (ii) Aluminium
   (iii) Zinc (iv) Sodium
3. State with reason(s) whether the following statements are True [T] or False [F].
   (i) Aluminium and copper are examples of non-metals used for making utensils and statues. [ ]
   (ii) Metals form oxides when combined with oxygen, the solution of which turns blue litmus paper to red. [ ]
   (iii) Oxygen is a non-metal essential for respiration. [ ]
   (iv) Copper vessels are used for boiling water because they are good conductors of electricity. [ ]
4. Why are only a few metals suitable for making jewellery?
5. Match the uses of metals and non-metals given in Column I with the jumbled names of metals and non-metals given in Column II.

Column I	Column II
(i) Used in electrical wiring	(a) E N X Y G O
(ii) Most malleable and ductile	(b) N E C O H I R L
(iii) Living organisms cannot survive without it.	(c) P E P O R C
(iv) Plants grow healthy when fertilisers containing it are added to the soil.	(d) T E N G O I N R
(v) Used in water purification	(e) O G D L

6. What happens when oxygen reacts with magnesium and sulfur. What are the main differences in the nature of products formed?



7. Complete the following flow chart:



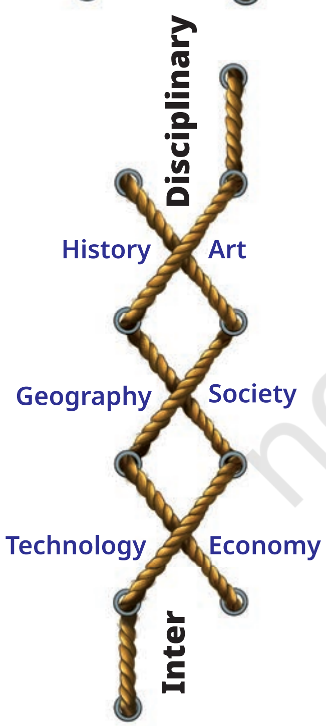
8. You are provided with the following materials. Discuss which material would be your choice to make a pan that is most suitable for boiling water and why?

Iron	copper	sulfur	coal	plastic	wood	cardboard

9. You are provided with three iron nails, each dipped in oil, water and vinegar. Which iron nail will not rust, and why?
10. How do the different properties of metals and non-metals determine their uses in everyday life?
11. One of the methods of protecting iron from getting rusted is to put a thin coating of zinc metal over it. Since sulfur does not react with water, can it be used for this purpose? Justify your answer.
12. An ironsmith heats iron before making tools. Why is heating necessary in this process?

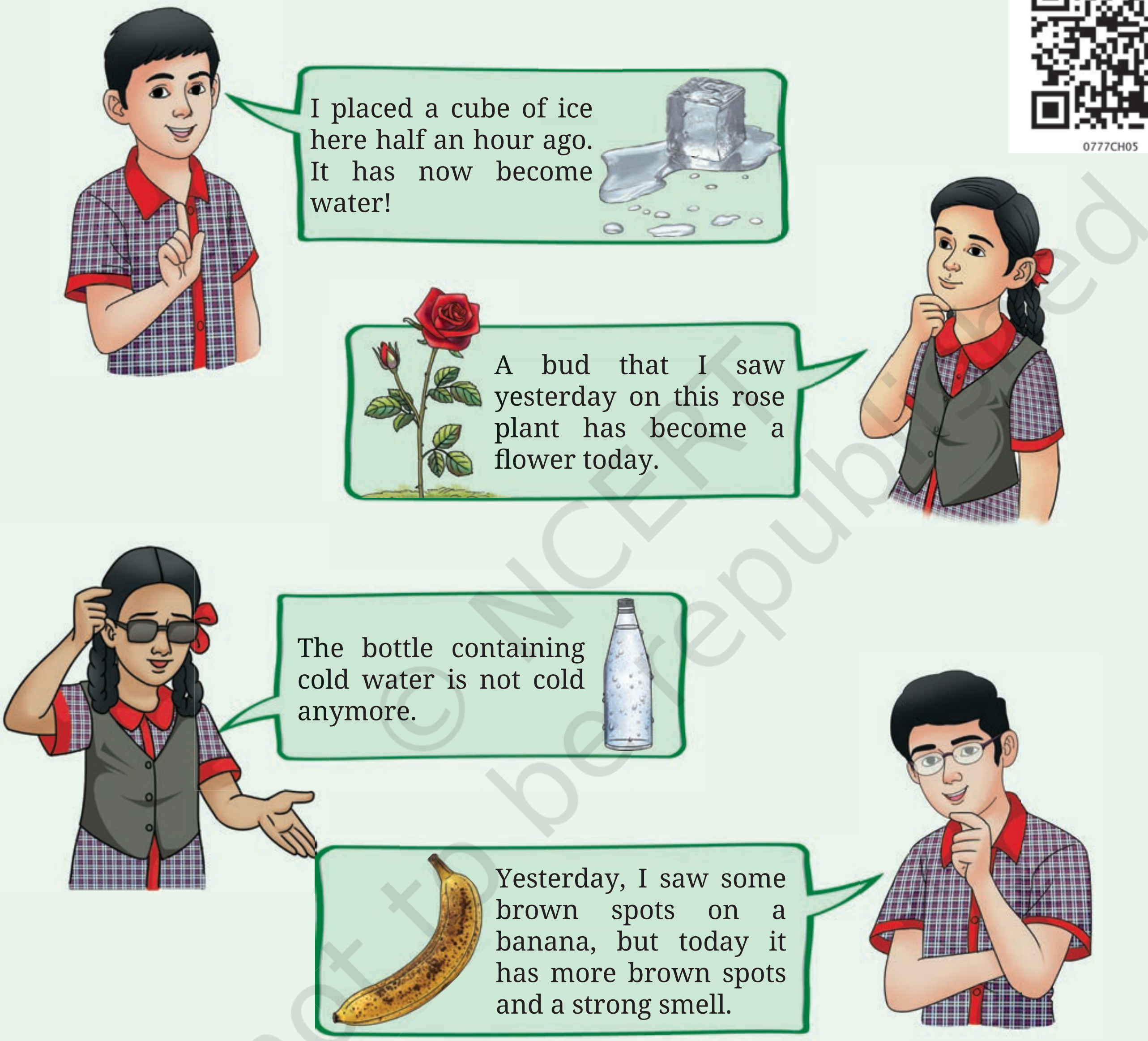
Exploratory Projects

- Dhokra, Bidriware, Pembarthi, and Kamrupi are some of India's famous metal art styles. Find out the states where these artworks are made. Also, make a collage of their photographs.
- On a map of India, mark the states where iron, gold, aluminium and other metals are found.
- Explore the metals and non-metals found in smartphones and find out how they help the phone work properly.
- Organise a classroom debate on whether the use of metals for comfort and luxury should be increased or decreased.



5 Changes Around Us: Physical and Chemical

0777CH05



These students are describing some changes. What kinds of changes are they talking about?

Activity 5.1: Let us think and reflect

You might have **observed** various changes happening around you. Some of them are listed in Table 5.1, you may notice that something is changing in each case. Take a moment to **reflect** on the changes in each case. **Record** your observations in Table 5.1.

Table 5.1: Some changes observed around us

S.No.	Change	Observation(s)
1.	Melting ice cubes	
2.	Chopping vegetables	
3.	Boiling water	
4.	Making popcorn from corn	
5.	Cutting a piece of paper	
6.	Adding beetroot extract to water	
7.	Burning wood	
8.	Drying wet clothes	
9.	Making small balls of dough	
10.	Rolling small balls of dough into *chapatis*	
11.	Any other	

You might have noticed that these changes could be in the size, shape, smell, or other property of the substance or object. Can you think of some other changes that happen in your surroundings? Make a list of those changes too.

We observe the changes occurring around us with the help of our senses of sight, smell, touch, hearing, and taste.

Let us try to answer this question.

5.1 A Substance May Change in Appearance but Remain the Same!

Activity 5.2: Let us create and discuss

A. Creating some objects with paper

- Take a few sheets of paper and fold them to create new objects (Fig. 5.1).
- Do you get the same paper back when you unfold these objects?

Fig. 5.1: Objects made from paper

B. Playing with a balloon

- Take a balloon and inflate it. Now, loosen your grip and let the air escape out.
- Do you get the uninflated balloon back?
- Take another balloon; inflate it and grip the opening tightly. Now, prick it with a pin.

Caution—Be careful while using a pin.

- What happens? Will you be able to get the uninflated balloon back?

C. Crushing a piece of chalk

- Crush a small piece of chalk into powder.
- Can you get the chalk piece back from the powder?

Is there any similarity in the changes listed in A, B, and C?

During all these changes, materials, such as the paper, the rubber sheet of the balloon, and the chalk, remained the same, though their appearances (shape or size) may have changed. You may also recall from the Grade 6 Science textbook *Curiosity* that water can exist in different states (solid, liquid, and gas), and can change from one state to another.

In all these cases, although we observe a change in the appearance, no new substance is formed. Such changes in which only physical properties like shape, size, and state of substances change are called **physical changes**.

Let us **explore** a different type of change.

5.2 A Substance May Change in Appearance and Not Remain the Same!

Activity 5.3: Let us explore

- Take two glass tumblers or small transparent bottles. Mark them A and B.
- Fill one-fourth of glass tumbler A with tap water and one-fourth of glass tumbler B with lime water.
- Now, blow air (exhale) into each glass tumbler, one at a time, using separate straws (Fig. 5.2) and observe them.

Caution — Do not suck the water or lime water while doing this.

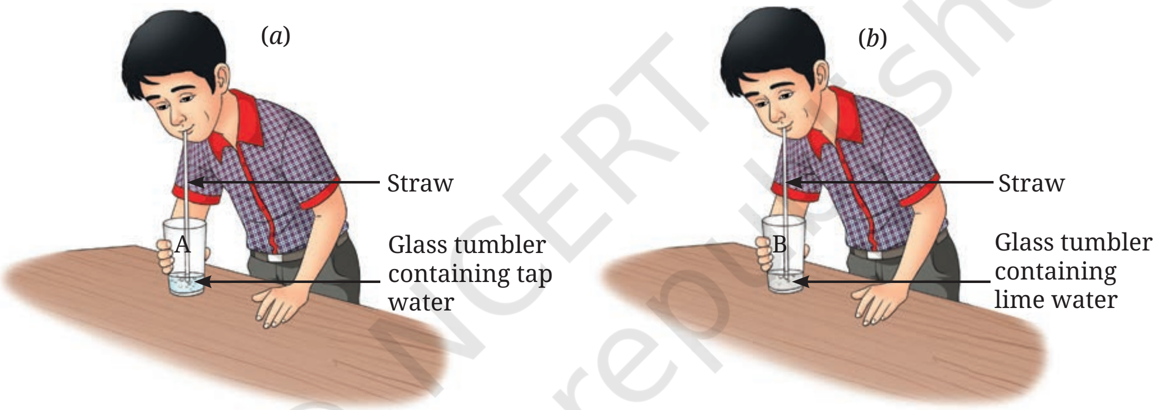


Fig. 5.2: Blowing air in (a) tap water; (b) lime water

Do you notice any changes?

In glass tumbler A, blowing air into water creates bubbles only, and there is no change in the appearance of the water. In glass tumbler B, blowing air into lime water creates bubbles, and turns the lime water milky (or cloudy). If we leave it for some time, a white substance settles at the bottom of the glass tumbler, indicating something new has formed. Such changes, in which one or more new substances are formed, are called **chemical changes**. New substances are formed through a process called **chemical reaction**. In this case, carbon dioxide from the air you breathe out (exhale) reacts with lime water, and forms a new white-coloured substance (calcium carbonate) that is insoluble in water. Therefore, the liquid in the bottle appears milky. Along with this a small amount of water is also formed. This formation of a new substance indicates a chemical change. The chemical reaction involved in this change can be represented in short form as a chemical equation.

Calcium hydroxide + Carbon dioxide → Calcium carbonate + Water
(Lime water)   (Insoluble substance)

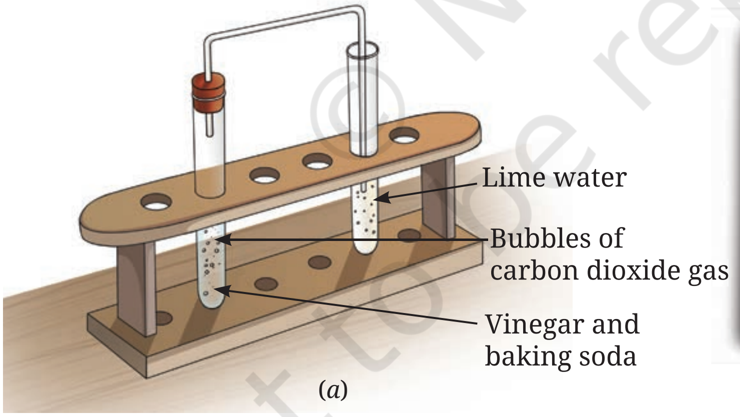
The turning of lime water milky is also used as a test for carbon dioxide. Let us explore this with another activity using some substances from our kitchen.

Activity 5.4: Let us experiment

- Take a teaspoonful of vinegar or lemon juice in a test tube.
- Add a pinch of baking soda (sodium hydrogen carbonate) to it.
- What do you observe?
- You would hear a fizzing bubbling sound and see the gas bubbles forming.
- Pass this gas through freshly prepared lime water kept in another test tube, as shown in Fig. 5.3a.
- What do you observe?
- The lime water turns milky. What do you **infer** about the gas formed by mixing vinegar and baking soda?

This indicates that the gas formed is carbon dioxide.

This activity can also be performed using two small used bottles instead of test tubes and a flexible straw, as shown in Fig. 5.3b.



(*a*)

(*b*)

Fig. 5.3: Reaction of vinegar and baking soda

Since a new substance, carbon dioxide, is formed in this reaction, we say that a chemical change has occurred here as well. It can be represented as—

Vinegar + Baking soda → Carbon dioxide + Other substances

Repeat the above activity using baking soda and water. Do you observe any bubble formation? Is this a physical or a chemical change?

5.3 Some Other Processes Involving Chemical Changes

5.3.1 Rusting

In the rusting of iron, which you studied in the chapter 'The World of Metals and Non-metals', a new brown-coloured substance called rust is formed. Thus, rusting is also a chemical change because it involves the formation of a new substance, iron oxide (Fig. 5.4).

Fig. 5.4: Rusted iron nails

Fig. 5.5: Burning magnesium ribbon

5.3.2 Combustion

Let us recall the burning of a magnesium ribbon (Fig. 5.5) learnt in the chapter 'The World of Metals and Non-metals'. Can you **predict** if this is a physical or a chemical change?

When the magnesium ribbon is burnt, a new substance, magnesium oxide, is formed. So, the burning of magnesium ribbon also involves a chemical change. We observed that heat and light are also produced along with the formation of a new substance in this reaction.

The burning of magnesium ribbon can be represented as—

Magnesium + Oxygen → Magnesium oxide + Heat + Light
(Ribbon) (Air) (White powder)

A chemical reaction in which a substance reacts with oxygen and produces heat and/or light is called **combustion**. Substances that undergo combustion reactions are called **combustible substances**. For example, wood, paper, cotton, kerosene, etc., are combustible substances.

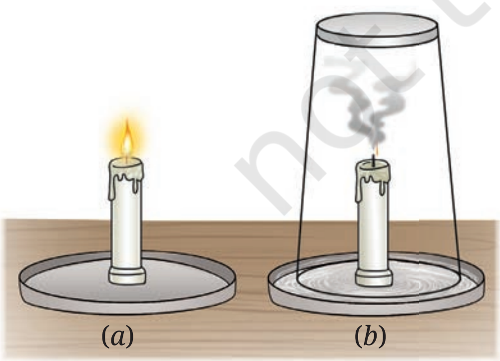


Fig. 5.6: Candle (a) burning (b) covered with a glass tumbler

Let us find out whether the presence of oxygen is essential for combustion.

Activity 5.5: Let us investigate

❖ Place two identical candles on two separate petri dishes and light them.

❖ Cover one of these with a glass tumbler, as shown in Fig. 5.6.

❖ What happens to the candle flames in the two cases?

We observe that the candle that was not covered (Fig. 5.6a) continues to burn, whereas the candle that was covered with a glass tumbler (Fig. 5.6b) stops burning after some time. Why does this happen?

Since the candle covered by the glass tumbler does not have a continuous supply of air, the flame gets extinguished soon. The component of air that supports combustion is oxygen. This can be confirmed by the presence of carbon dioxide in the glass tumbler inverted on the candle. How can you test the presence of carbon dioxide gas?

You can test the carbon dioxide gas by adding a small amount of lime water in the petri dish. You will notice that it turns milky. This carbon dioxide was formed by the carbon from the wax and the oxygen from the air. In other words, oxygen is required for combustion.

Science and Society

If a person's clothes catch fire, what is the best way to extinguish the fire?

Wrap a blanket or cloth around the person. This cuts off the supply of air, and the fire gets extinguished.

Caution—Synthetic blanket or cloth should never be used to put out a fire, as these can melt and stick to the skin.

Fascinating Facts

Nature's wonders: You might have seen some insects emitting light in a garden or a field in late evenings. These insects are called fireflies, and their light is produced by a chemical change. This type of light production (without heat) in living organisms is called bioluminescence.

Fireflies

Is the Presence of Air Enough for Combustion?

We learnt above that combustible substances and oxygen are necessary for combustion. We also know that paper is a combustible substance, but we can keep it in the air for any length of time without it catching fire. What else is needed to start combustion?

Let us learn about this.

Activity 5.6: Let us investigate

Caution — Perform this activity under the supervision of your teacher or an adult.

Fig. 5.7(a): Focusing the sunrays using a magnifying glass

Fig. 5.7(b): Paper catching fire

- Hold a piece of paper with a pair of tongs and bring a lighted matchstick to it. It quickly catches fire. Do we say that we need a fire to start the burning process?
- Take another piece of paper. Using a magnifying glass, focus the sunrays to make the smallest and brightest spot on the paper, as shown in the Fig. 5.7a. Hold it there for some time.

What do you observe?

We observe that the paper starts to emit smoke, and then catches fire (Fig. 5.7b). Thus, we find that a substance can burn even without fire. How do we explain this change?

Focusing sunrays on the paper heats it. The temperature of the paper increases with time. After some time, the paper becomes so hot that it starts burning. This minimum temperature at which a substance catches fire is called its **ignition temperature**. Since the temperature of the lighted matchstick was already higher than the ignition temperature of the paper, it caught fire almost immediately.

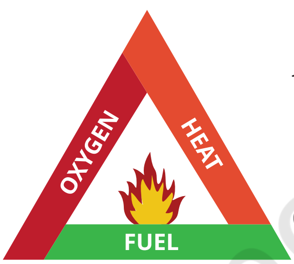


Fig. 5.8: Fire triangle

So, we can **conclude** that for the combustion process to occur, there are three requirements (Fig. 5.8)—

(i) A combustible substance, also called 'fuel'

(ii) Oxygen

(iii) Heat that allows the fuel to reach its ignition temperature.

5.4 Can Physical and Chemical Changes Occur in the Same Process?

What changes take place when a candle is lit? Let us explore!

Activity 5.7: Think, pair, and share

Look at the Fig. 5.9. **Analyse** what students are discussing about the burning candle.
What do you think?

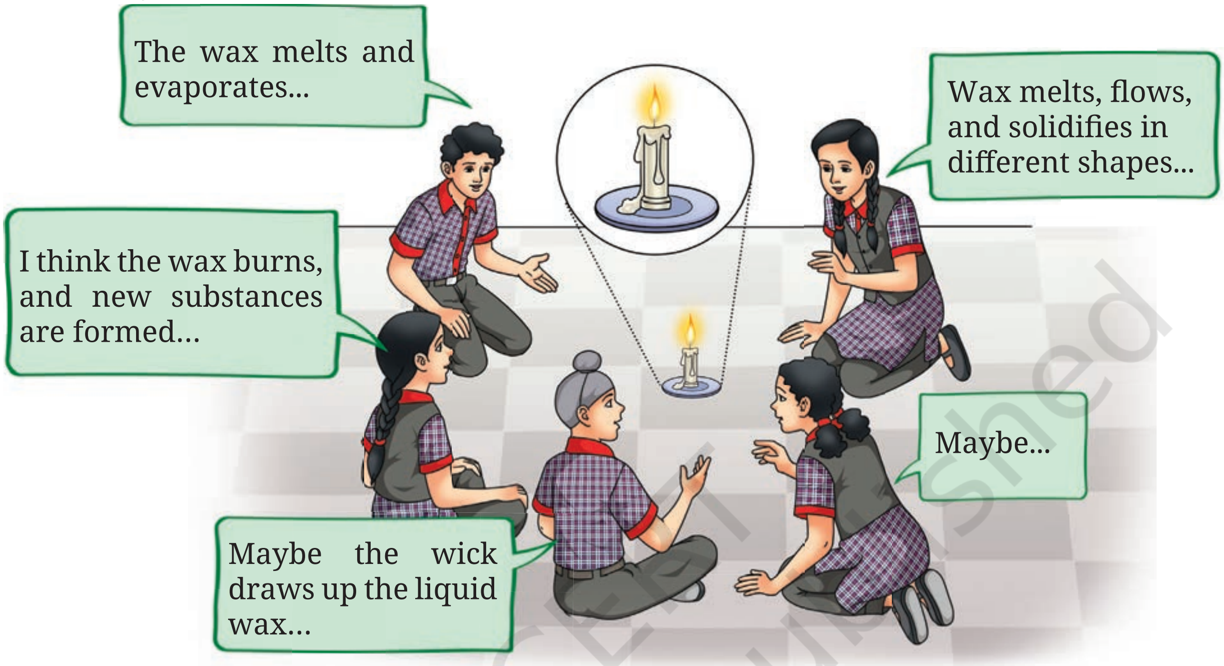
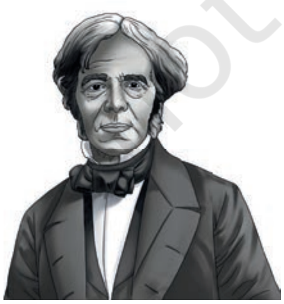


Fig. 5.9: What changes occur when a candle burns?

The wax of the candle melts, is carried up the wick, and evaporates due to the heat of the flame. The vapour of wax burns to produce a flame. The melting of wax, its solidification, and evaporation are physical changes. The burning of vapour on the other hand, is a chemical change. This shows that the burning of a candle involves both physical and chemical changes.

Know a Scientist

The candle you just observed has long been an object of curiosity for several scientists including Michael Faraday, who made significant contributions to several areas of science. In the nineteenth century, Faraday delivered a series of lectures called *Chemical History of a Candle*. Faraday believed that the candle was the perfect object to introduce scientific study. Through it, he discussed differences between various physical and chemical processes like melting, vapourisation, and combustion.



5.5 Are Changes Permanent?

Once something has undergone a change, can we get it back in its original form?

Activity 5.8: Let us think

Think again about all the changes that we have discussed or talked about so far. In which of these can we get back the object or substance in the form we started with? Record your observations in Table 5.2.

Table 5.2: Can changes be reversed?

S.No.	Change	The original state can be brought back (Yes/No)
1.	Melting ice cubes	Yes
2.	Chopping vegetables	No
3.	Boiling water	Yes
4.	Making popcorn from corn	No
5.		
...		
12.		

Returning to the original object or substance with which we started shows that the changes we brought can be **reversed**. For example, when ice melts, it can be refrozen into ice. Similarly, when water evaporates, it can be condensed back into liquid water. However, some changes cannot be reversed since we cannot get the original object or substance back after the change. For example, chopped vegetables cannot return to their original size and shape, and making popcorn cannot go back to its original form. Thus, changes around us could be grouped into those that can be reversed and those that cannot be reversed.

5.6 Are All Changes Desirable?

Many useful changes happen in our daily life. For example, the changing of milk into curd, ripening of fruits, cutting of fruits, and cooking of food. All these are **desirable** changes. Can you think of some other desirable changes happening around you?

On the other hand, some changes may be **undesirable**, such as the rusting of iron or the decay of food during its storage. A change that is undesirable in some situations may be desirable in other situations. For example, decomposition of food can be very useful in converting food waste into compost.

Some changes occurring over the years due to human activity can have a long-term environmental impact. For example, the increased consumption of fuels in cars, trains, aeroplanes, etc., is increasing the amount of carbon dioxide in the atmosphere. Drying of paint on walls, doors, furniture, etc., releases many substances through evaporation, causing atmospheric pollution.

5.7 Some Slow Natural Changes

5.7.1 Weathering of rocks

Have you seen heaps of sand, soil, and stones lying at the base of mountains as shown in Fig. 5.10a? These are called sediments. How have these formed? These are formed by physical changes that break up large rocks into smaller pieces. Temperature changes due to climatic conditions, growing roots of trees, and even freezing of water within cracks in the rocks can cause them to break.

Water or chemicals present in water, can also react with the rocks and cause chemical changes in their composition. An example of such a chemical change is shown in Fig. 5.10b. Here, an originally black-coloured rock called basalt, which contains iron, has chemically changed to produce a red-coloured layer. The red colour is a result of the iron oxide produced when the rock surface was exposed for a long time to water or air containing water vapour. These physical and chemical changes in rocks are collectively called **weathering**, which eventually leads to the formation of soil.

(a) (b)

Fig. 5.10: (a) Sediments at the base of a cliff (b) red sediment layer

5.7.2 Erosion

Have you noticed fine sand collecting on riverbeds or in lakes? This sand is formed when rock pebbles, soil, and sediments are broken down and moved from one location to another by natural forces like wind and flowing water. This process is called **erosion**.

Erosion during a landslide is an example of a physical change. River rocks and pebbles often appear smoother due to the constant erosion caused by the flowing water. When the speed of the water or wind decreases, such as in an ocean or a lake, the material transported during erosion settles down at the bottom. These sediments harden over time and become new rocks. Most of these changes take place over thousands of years and cannot be reversed.

In a Nutshell

- A physical change is one in which a substance or object undergoes a change in its physical properties and no new substance is formed.
- A chemical change is one in which one or more new substances are formed. It involves a chemical reaction and can be represented by a chemical equation.
- Combustion, cooking, and rusting are examples of chemical changes.
- Substances that undergo combustion are combustible substances. Heat and/or light are given out during combustion.
- The lowest temperature at which a substance can catch fire is called its ignition temperature.
- Some changes can be reversed and some cannot.
- Some changes are desirable and some are not.
- Rocks undergo physical and chemical changes due to weathering to form soil.
- Erosion caused by flowing water and wind is a physical change.

Let Us Enhance Our Learning

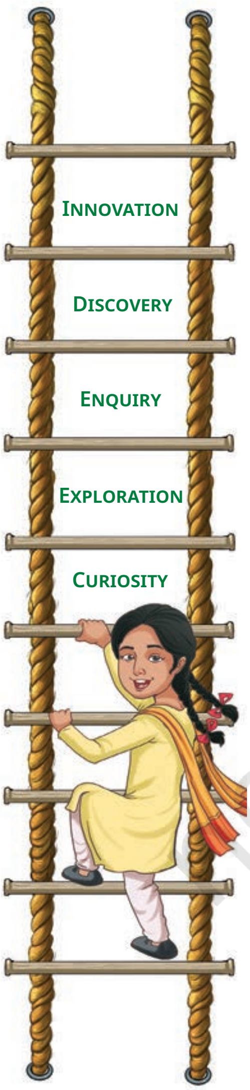
1. Which of the following statements are the characteristics of a physical change?
   (i) The state of the substance may or may not change.
   (ii) A substance with different properties is formed.
   (iii) No new substance is formed.
   (iv) The substance undergoes a chemical reaction.
   (a) (i) and (ii) (b) (ii) and (iii)
   (c) (i) and (iii) (d) (iii) and (iv)

2. Predict which of the following changes can be reversed and which cannot be reversed. If you are not sure, you may write that down. Why are you not sure about these?
   (i) Stitching cloth to a shirt
   (ii) Twisting of straight string
   (iii) Making idlis from a batter
   (iv) Dissolving sugar in water
   (v) Drawing water from a well
   (vi) Ripening of fruits
   (vii) Boiling water in an open pan
   (viii) Rolling up a mat
   (ix) Grinding wheat grains to flour
   (x) Forming of soil from rocks

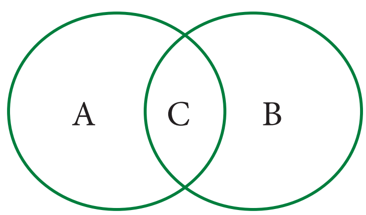
3. State whether the following statements are True or False. In case a statement is False, write the correct statement.
   (i) Melting of wax is necessary for burning a candle. (True/False)
   (ii) Collecting water vapour by condensing involves a chemical change. (True/False)
   (iii) The process of converting leaves into compost is a chemical change. (True/False)
   (iv) Mixing baking soda with lemon juice is a chemical change. (True/False)

4. Fill in the blanks in the following statements:
   (i) Nalini observed that the handle of her cycle has got brown deposits. The brown deposits are due to ________, and this is a________ change.
   (ii) Folding a handkerchief is a ________________ change and can be________.
   (iii) A chemical process in which a substance reacts with oxygen with evolution of heat is called _________, and this is a __________ change.
   (iv) Magnesium, when burnt in air, produces a substance called __________. The substance formed is _________ in nature. Burning of magnesium is a _________ change.
5. Are the changes of water to ice and water to steam, physical or chemical? Explain.
6. Is curdling of milk a physical or chemical change? Justify your statement.
7. Natural factors, such as wind, rain, etc., help in the formation of soil from rocks. Is this change physical or chemical and why?
8. Read the following story titled 'Eco-friendly Prithvi', and tick the most appropriate option(s) given in the brackets. Provide a suitable title of your choice for the story.

   Prithvi is preparing a meal in the kitchen. He chops vegetables, peels potatoes, and cuts fruits (physical changes/chemical changes). He collects the seeds, fruits, and vegetable peels into a clay pot (physical change/chemical change). The fruits, vegetable peels, and other materials begin to decompose due to the action of bacteria and fungi, forming compost (physical change/chemical change). He decides to plant seeds in the compost and water them regularly. After a few days, he notices that the seeds begin to germinate and small plants start to grow, eventually blooming into colourful flowers (physical change/chemical change). His efforts are appreciated by all his family members.



9. Some changes are given here. Write physical changes in the area marked 'A' and chemical changes in the area marked 'B'. Enter the changes which are both physical and chemical in the area marked 'C'.



Process of burning a candle; Tearing of paper; Rusting; Curdling of milk; Ripening of fruits; Melting of ice; Folding of clothes; Burning of magnesium and Mixing baking soda with vinegar.

10. The experiments shown in Fig. 5.11a, b, c, and d were performed. Find out in which case(s) did lime water turn milky and why?

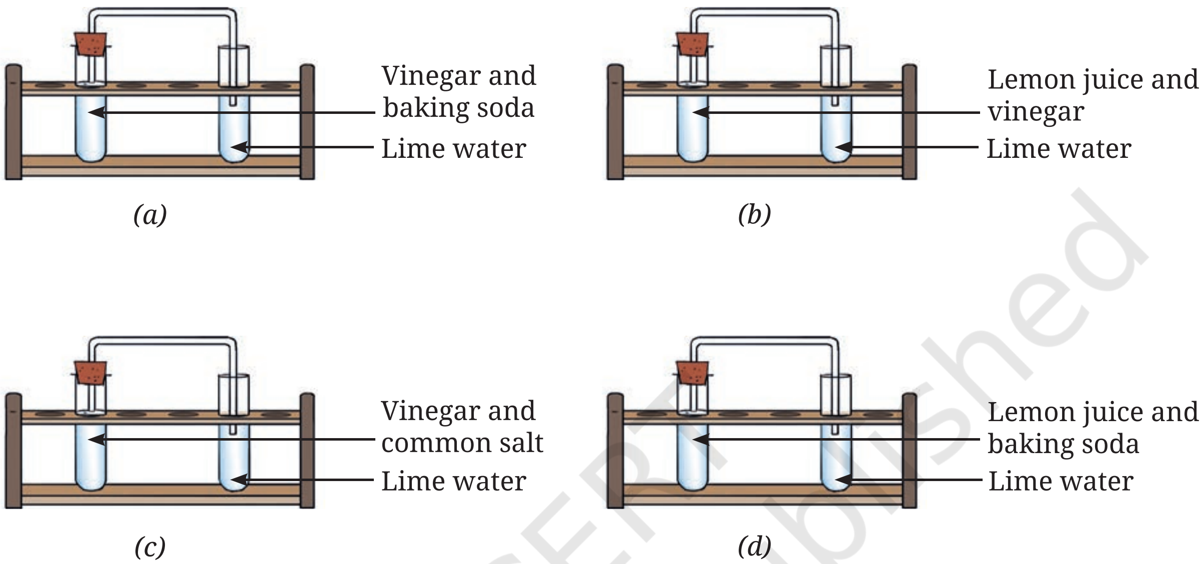


Fig. 5.11

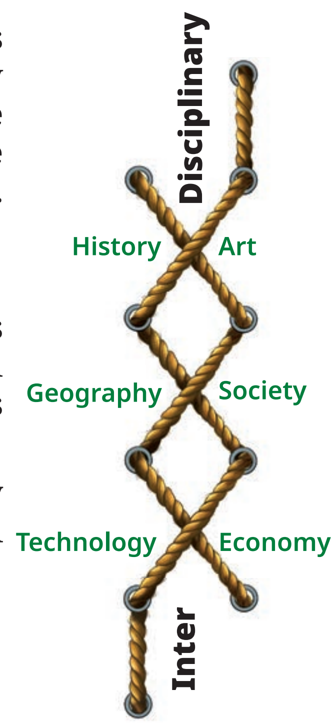
Exploratory Projects

❖ Write a message on a piece of paper using lemon juice as ink and let it dry. The message will become invisible. Now use a warm iron over the paper (or hold the paper over the flame of a candle, taking care that it does not catch fire). The invisible letters turn dark brown as the paper gets warm. Can any of these changes be reversed?

Caution—Perform this activity under the supervision of an adult.

❖ We hear a lot of news about landslides and breaking of rocks in hilly regions these days, causing a lot of damage to life and property. Discuss what steps we can take to reduce landslides and rock erosion.

❖ Observe the activities going on in the kitchen and note any changes that can be reversed. Are these physical or chemical changes?



❖ Yeast is added while baking bread to make it fluffy and soft. How does yeast work? Try and find out!

- Take a small bottle, some sugar, fresh yeast, water, and a balloon. Make a sugar solution in the bottle by mixing two teaspoons of sugar and a small amount of water. Now add a spoonful of yeast and cover the mouth of the bottle with a balloon. Leave it undisturbed for about an hour.
- What do you observe?
- Carefully take off the balloon, holding its mouth tightly closed and attach it to another small bottle containing freshly prepared lime water. Shake the bottle so that the contents of the balloon get mixed with lime water.
- What do you observe?
- What can you conclude from this experiment?
- Identify all the changes occurring in the experiment and state which of them are physical and chemical changes.

❖ Chameleons (*Girgits*) change colour to blend in with their surroundings and also when they are angry or sense danger (Fig. 5.12). Is this a change that can be reversed? Explore from the internet or from your school library.

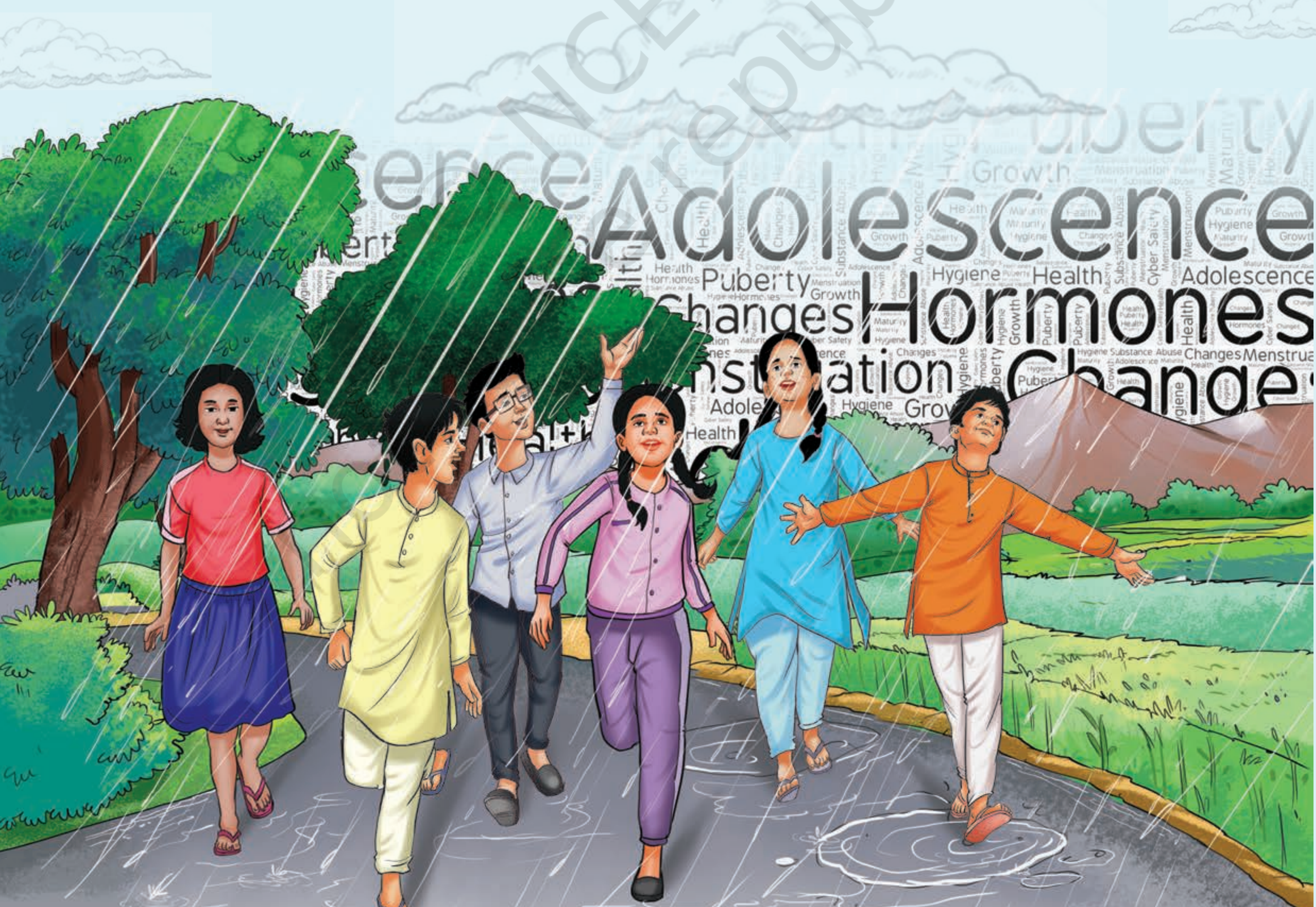
Fig. 5.12: A chameleon

6 Adolescence: A Stage of Growth and Change

0777CH06

The journey of a plant generally begins with the germination of a seed. With proper nourishment, the seed becomes a sapling and matures into a young plant. This journey is marked by some specific changes. Some of the visible changes are an increase in its height, the appearance of more leaves, and the development of flowers, fruits, and new seeds. From these seeds, new plants emerge.

It is quite unlikely that a seedling will develop the capabilities to produce its own seeds immediately after germination. It needs to grow and reach maturity to become capable of producing seeds. Similarly, animals also need to grow and reach maturity before they can reproduce. Some animals lay eggs that hatch into young ones, while others, like humans, directly give birth to young ones. In both cases, the young ones gradually grow in size and develop over time.



The journey of life of a human can be divided into different stages—infancy, childhood, adolescence, adulthood, and old age. Each person experiences these stages at their own pace, and the duration of each stage may vary from one individual to another. From infancy to adulthood, our bodies undergo various changes. Until around 10–12 years of age, most changes are related to height and weight. After this, other noticeable changes begin to occur, marking the onset of adolescence. This is a period of rapid growth and development, typically occurring between the ages of 10–19. During adolescence, the body prepares for adulthood.

Humans, like most other living beings, can not reproduce immediately after their birth. Their bodies need to grow and reach a stage of maturity to be able to reproduce.

As humans grow and develop, they experience significant physical, emotional, and behavioural changes, along with the ability to reproduce. Some of these changes may be quite clearly observable, while others occur internally and may go unnoticed. In this chapter, you will explore adolescence, understand its importance, and learn how to handle it with a sense of responsibility.

6.1 Growing With Age: The Teenage Years

During the summer vacation, Venkatesh visited his grandparents. As he entered the house, his 12-year-old cousin, Devyani came running to greet him.

Let us try to understand this interesting conversation between Venkatesh and Devyani.

Activity 6.1: Let us discuss

- Take a jar and some paper slips.
- Write down the changes you can notice among students as they go from Grades 5 to 8. These could be related to height, strength, behaviour, or any other aspect. Please avoid writing names on the slips.

- Fold the slips and place them in the jar.
- Mix all the slips received from the students in the class and unfold the collected slips one by one. Based on the information on the slips, **discuss** the changes with the students in the class.

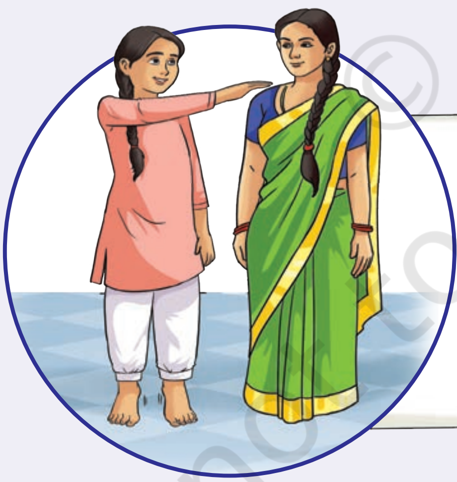
What were the most commonly observable changes among students, as mentioned on the slips? **List** these in Table 6.1.

Table 6.1: Most common changes during growing up

S.No.	Changes	Your observations
1.	Height	
2.	Weight and strength	
3.	Appearance	
4.	...	

Have you also experienced some of these changes? If yes, then it is because you are also reaching this stage gradually. This stage starts around 10 years of age and can continue up to the age of 19. It is usually a stage of development between childhood and adulthood, and is called **adolescence**.

While analysing Table 6.1, you might have noticed the following:



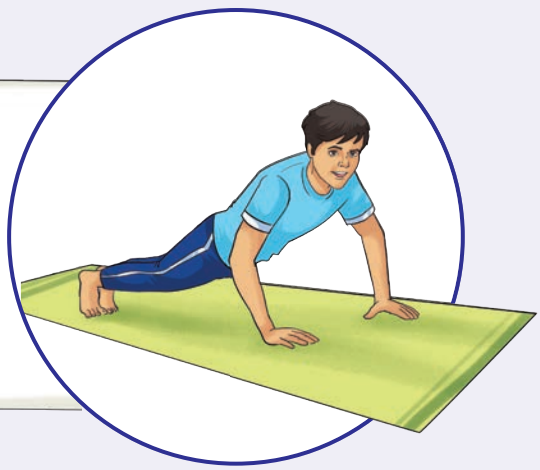
Increase in height

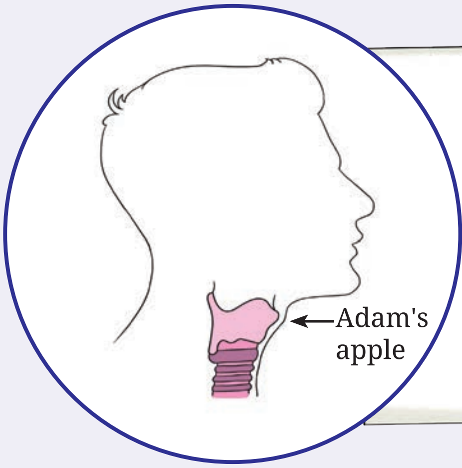
From birth, our body undergoes continuous growth and development including an increase in height. However, the increase in height becomes more prominent during adolescence.

Changes in body structure, weight gain, and strength

As boys grow, it might be seen that along with growing taller, they gain weight, their shoulders might become a bit broader, and their chests may get wider.

Girls also undergo changes in height and weight, and other body changes like development of breasts.





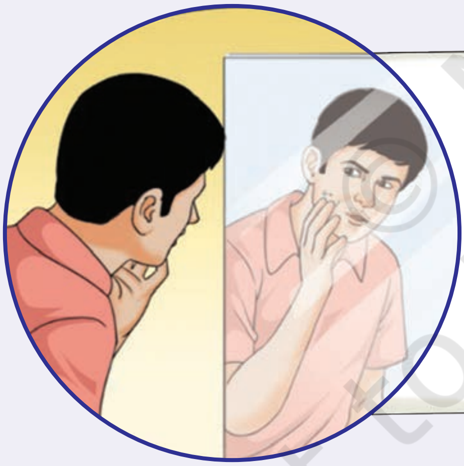
Changes in voice

In adolescent boys, the growth of the voice box leads to a voice that sounds hoarse. The voice box is a structure in our throat that helps us to speak. The growth may be seen as a bump in the throat region and is called the Adam's apple. However, it is not noticeable in every individual. The voice box also grows in adolescent girls but it is not as big as in the boys, leading to only slight changes in voice.

Appearance of hair in different parts of body

Both boys and girls experience the growth of hair in different parts of their bodies, such as the armpits and pubic region.

Boys often develop facial hair, which later grows into a moustache and a beard as they move towards adulthood. Some boys may also develop chest hair and back hair, though few boys may have no significant hair growth. Variations in and timing of appearance of hair growth is completely normal.



Changes in facial skin: emergence of pimples

Another common occurrence during the adolescent years is a skin condition called acne, in which small, reddish pimples appear. These are commonly visible on the face. Acne occurs due to an increase in oily secretions from the skin during adolescence that can clog the skin pores and lead to infections. While acne is a condition, pimples are a manifestation of it.

A key point to remember

Whether it is a change in height, voice, or facial hair, it is important to recognise that the timing, nature, and extent of these changes vary among individuals. These variations are completely normal.

Each person experiences adolescence at his or her own pace, and its duration also varies from one person to another.

Now, we have understood some of the changes that take place during adolescence, particularly those that are easily observable. Some of these characteristic changes, like change in voice, the growth of facial and chest hair in boys, and the development of breasts in girls are not directly involved in the process of reproduction. However, these characteristic changes help distinguish males from females. For this reason, they are called **secondary sexual characteristics**.

Secondary sexual characteristics are natural signs that the body is preparing for adulthood. They mark the onset of puberty. **Puberty** is the stage in which the body of an adolescent undergoes external and internal changes to develop into an adult capable of reproduction.

6.2 Changes that Indicate Reproductive Capability

Adolescence is marked not only by observable changes but also by internal changes that are not visible from the outside. One such change is the maturation of various parts involved in the process of reproduction.

Both boys and girls experience such changes gradually, and these changes are a natural part of the process of growing up. An important internal change associated with adolescent girls is the onset of the **menstrual cycle**. It recurs generally every 28–30 days and is more commonly known as 'the period'. Many healthy girls may have longer or shorter menstrual cycles ranging from 21–35 days. The menstrual cycle is an important natural process and is one of the signs of good reproductive health. The phase of the cycle when blood discharge occurs from the body is referred to as **menstruation**. It may last for three to seven days. Some girls may feel pain or discomfort in the lower abdomen during these days. Usually, by the age of 45–55, menstruation stops naturally, marking the end of the reproductive capability in a woman's life.

Breaking myths about menstruation

There are many wrong beliefs about menstruation that often lead to unnecessary fear, shame, or even guilt. These beliefs have given rise to certain myths and taboos. Among such myths and taboos, physical isolation of menstruating girls is unfortunately still quite prevalent. Menstruation is a natural process, and such myths have no scientific basis. By encouraging a scientific outlook towards menstruation, we can help society appreciate the need to promote good reproductive health of women and contribute positively towards a healthier lifestyle for women.

Adolescence is not just about physical changes or changes associated with reproductive capability but also about emotional and behavioural changes. Let us discuss them!

6.3 Emotional and Behavioural Changes in Adolescents

Activity 6.2: Let us list

Take a moment to think if there are any changes in your emotions or behaviour or that of your classmates and friends in the past one or two years. These changes may be exciting, confusing, or both.

Let us list some emotional changes in Table 6.2 along with their probable effects on behaviour and ways for positive growth and development.

Table 6.2: Emotional changes, their probable effects on behaviour, and ways for positive growth and development

Key emotional changes	Probable effects on behaviour	Ways for positive growth and development
Mood swings	Engage in varied activities like music, dance, or sports	Self-exploration and involvement in activities that may lead to creativity and innovation
Strong emotions	Increased sensitivity	Compassion, involvement in social work
Any other		

While discussing Table 6.2, you may have explored the diverse behavioural changes in adolescents. This is because adolescence is often marked by stronger emotions than childhood. These emotions might affect adolescents' behaviour like taking up/joining social initiatives to support the needy and the disadvantaged, or developing deeper interest in new areas.

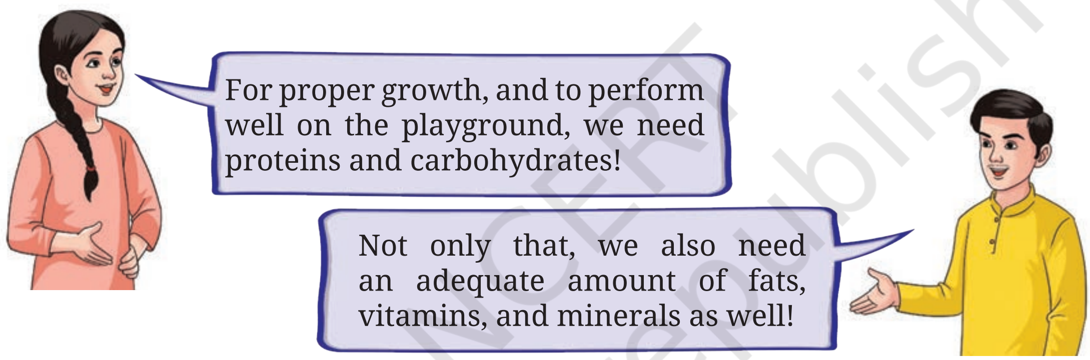
Understanding how our emotions influence our behaviour and actions, can help us make better choices and respond to situations thoughtfully.

6.4 Making Adolescence a Joyful Experience

The journey of adolescence is a unique experience. Heightened curiosity and excitement during this stage of life give adolescents a new viewpoint towards almost everything around them. Good habits, thoughtful decisions, and small actions can have a powerful positive impact on the overall well-being of adolescents. Let us know about them!

6.4.1 Meeting nutritional needs

In Grade 6 chapter 'Mindful Eating: A Path to a Healthy Body', you learnt about the need for a healthy diet. Since adolescence is a period of growth and development marked by several changes in the body, a nutritious diet is of utmost importance.



Activity 6.3: Let us list

Based on the locally available foods, fill Table 6.3 with the healthy food sources, nutrients present in them and how these nutrients can help our growth and development.

Table 6.3: Food sources, nutrients present in them, and functions of these nutrients

Food sources	Nutrients we get from them	Functions of these nutrients
Milk, millets, curd, cheese, and paneer	Calcium, proteins, fats ________________	To help optimal bone growth ________________
________________	Proteins ________________	To help proper growth, gain strength, and improve levels of energy ________________
Spinach, kidney beans, and dried fruits like raisins, and figs	Iron ________________	To help in the formation of blood

Science and Society

Adolescents, especially girls, may sometimes suffer from blood-related health problem(s) because of a deficiency of iron or vitamin B12 in the body.

❖ Find out about such health problem(s).

❖ How can we manage iron deficiency in our body?

❖ Find out about government schemes aimed to prevent such deficiencies.

Know a Scientist

Dorothy Hodgkin was a brilliant scientist who studied the structure of vitamin B12. In 1964, she became the third woman to win the Nobel Prize in the field of chemistry. Did you know that vitamin B12 is required for the proper functioning of the human body? Like most vitamins, it cannot be made in the human body and has to be obtained from the food we eat. Discuss the sources of vitamin B12 with your teacher.

6.4.2 Personal hygiene

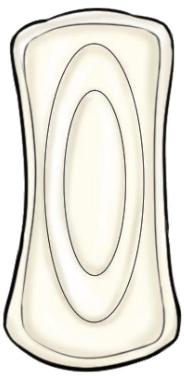


Fig. 6.1: Sanitary pad

Besides nutrition, personal hygiene is also crucially important during adolescence. Maintaining body hygiene, particularly in the armpits and the pubic region, may protect us from potential infections.

For girls, maintaining proper hygiene during menstruation is essential for both comfort and health. Menstrual hygiene can be maintained using items such as sanitary pads (Fig. 6.1) and reusable cloth pads designed for this purpose.

The government also attempts to provide these products free of charge or at a low price to improve the menstrual hygiene of girls and women. As a society, we should all make efforts to ensure the availability of necessary facilities in schools and public places to promote menstrual hygiene. Collectively, we should move forward, reducing any stigma around sanitary pads and helping in menstrual hygiene.

It is important to dispose of used sanitary pads properly by wrapping them in newspaper and disposing inside a dustbin. This is to ensure community health and environmental cleanliness. These days, biodegradable sanitary pads are also available that are environment-friendly.

Science and Society

To support menstrual hygiene, the government has introduced several initiatives—

- **Menstrual Hygiene Scheme (MHS):** Under this scheme by the Government of India, sanitary pads are provided free of charge or at a reduced price to adolescent girls in rural areas. Awareness programmes are also conducted to educate girls about menstrual hygiene and health.
- **Rashtriya Kishor Swasthya Karyakram (RKSK):** It aims to improve the overall health of adolescents, including menstrual health and hygiene. It encourages peer education, where older students help younger ones learn about these topics.
- **Suvidha Sanitary Napkin Initiative:** Under this initiative, biodegradable sanitary pads are provided at affordable prices through Jan Aushadhi Kendras. The initiative aims to improve access to menstrual hygiene products for women and adolescent girls.
- **State-Level Initiatives:** Various state governments have their own programmes, such as the 'Shuchi Scheme' in Karnataka and free sanitary napkin schemes in states like Tamil Nadu and Odisha. These programmes aim to distribute free sanitary pads in government schools.

6.4.3 Physical activities

Regular exercise and physical activities are also very important during adolescence. Do you exercise regularly or participate in games and sports? What kinds of exercises do you do? These activities will keep your body and mind fit and healthy, build up your stamina and boost your mood (Fig. 6.2).

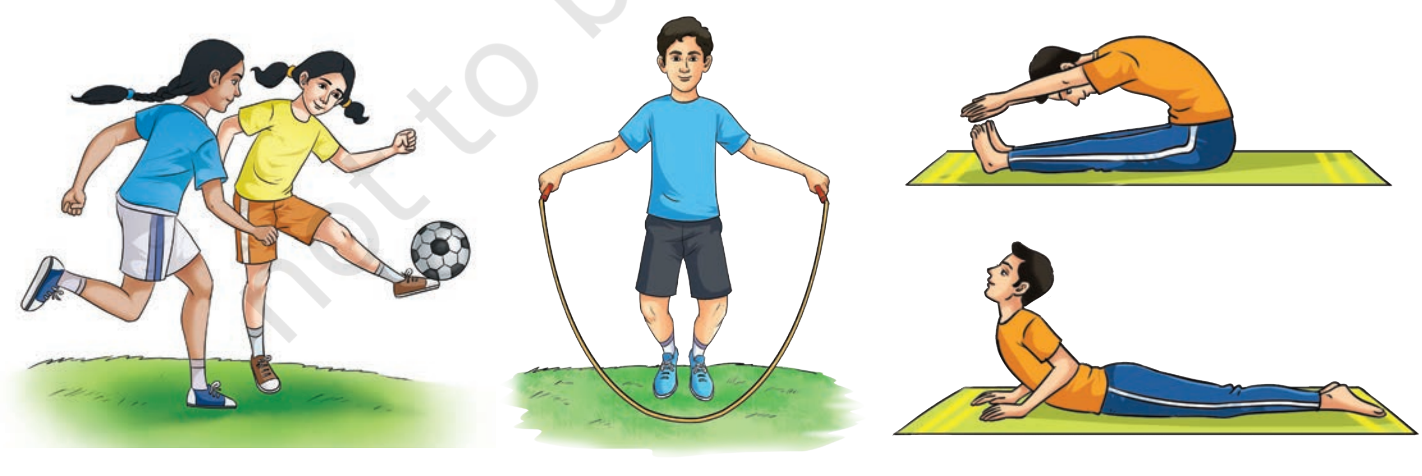


Fig. 6.2: Physical activities for fitness

6.4.4 Balanced social life

We all live in a society and interact with each other in our day-to-day life. We should all be polite and respectful towards each other (Fig. 6.3). This helps create a favourable and safe environment.

Since adolescence is a stage of life marked by new experiences and emotions, we must be thoughtful and responsible while interacting with others—whether in person or through social media. This is the time adolescents may feel attracted to their peers, and mimic their behaviour. Today, they often interact with each other online.

Fig. 6.3: Collaborative learning in action

Fig. 6.4: Cyberbullying

Modern technologies have made online platforms available for all to obtain information, make connections, interact, and share information with each other. We should use these platforms responsibly for the collective well-being of all. Sometimes, we, knowingly or unknowingly, use social media platforms carelessly. Seeking guidance from elders and teachers can help use these platforms positively.

Science and Society

Cyberbullying involves the use of digital devices such as phones, computers, or online platforms to harass others by sending misleading messages, spreading false rumours, or sharing personal information without consent (Fig. 6.4). However, if someone tries to bully you, it is important not to feel scared or helpless. Rather, handle it wisely and seek help from parents and teachers.

Additionally, you should be cautious when uploading any picture online or sharing personal information with strangers.

Activity 6.4: Let us spread awareness

Work in groups to **design** posters and pamphlets about various aspects of responsible social media behaviour and paste them at designated places in the school. Also, fill in Table 6.4 based on your collective observations.

Table 6.4: Dos and don'ts to be followed on social media

Dos	Don'ts
Be respectful and kind.	Do not share personal photos with strangers/ virtual friends.
Think before posting.	________________
Protect privacy	________________

6.4.5 Avoiding harmful substances — learn to say NO

Some people, including your peers, may tempt, persuade, force or, create pressure on you to consume harmful substances such as tobacco, *gutka*, cigarettes, *beedi*, alcohol, or even life-threatening illegal drugs. Since adolescence is marked by curiosity and excitement, adolescents might get influenced by such people and try these substances.

These substances are not just harmful to physical and mental health but are also addictive. This means that once people start consuming them, they develop a strong urge to take them again and again. Over time, they start using them regularly. This is called **substance abuse**.

Someone who is addicted today, might have started once with 'just one time'!

Say no to addictive substances the first time and every time!

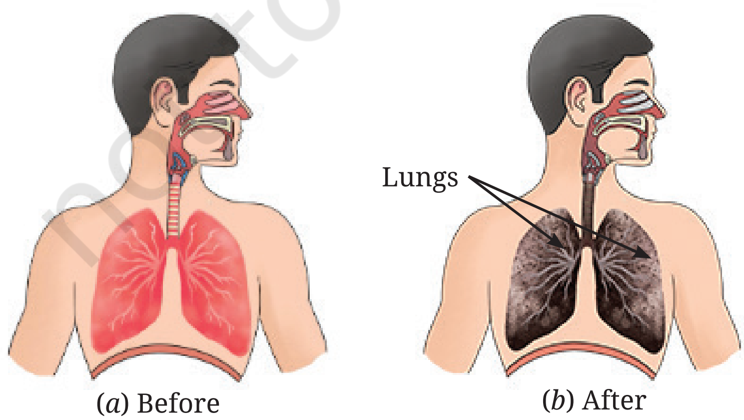


Fig. 6.5: Condition of the lungs before and after prolonged exposure to bidi/cigarette smoke

Using these substances can cause serious health problems, such as breathing difficulties, memory loss, and damage to the lungs (Fig. 6.5), depending on the substance. To stay healthy, it is important to completely avoid these substances and make healthy choices instead. It is important to remain firm and confident in your decision to say ‘NO’.

The first step to overcoming addiction is seeking help and support from family and friends, and talking to trusted people, such as parents or teachers. Counselling and medical advice can also be helpful in handling such situations. Remember, your health and your future are in your hands—choose wisely!

Science and Society

Nasha Mukt Bharat Abhiyaan

The Nasha Mukt Bharat Abhiyaan was launched by the Ministry of Social Justice and Empowerment, Government of India. It intends to reach out to the masses and spread awareness on the issue of avoiding substance abuse through active participation of the youth, women, and the community. The special focus is on the prevention of substance abuse among early-age children.

The Government has launched a National De-addiction Helpline—14446, to deal with drug addiction and to help drug addicts.

6.5 The ‘Why’ Question for Adolescence

We now understand the different changes in adolescence and also know some ways to handle it with a sense of responsibility.

But I wonder why these changes occur at this stage of life!

Many changes in adolescence, including menstruation and other signs of puberty, are mainly due to **hormones**—certain chemicals produced in our bodies. Hormones play a crucial role in regulating various aspects of growth and development, contributing to the proper functioning of the body. They are produced in different parts of the body and are released at an appropriate time in response to signals from the brain. Some hormones influence mood and behaviour.

By staying informed, seeking support and guidance when needed, and making healthy decisions, you can build a strong foundation for your life ahead.

In a Nutshell

- ❖ Adolescence is the period of change from childhood to adulthood. It generally begins around the age of 10 years and usually lasts until 19 years.
- ❖ Adolescence is marked by significant and characteristic physical, biological, and emotional changes.
- ❖ Features that help to distinguish the male from the female but are not directly involved in reproduction are called secondary sexual characteristics.
- ❖ Puberty is the stage in which the body of a child undergoes observable and internal changes to develop into an adult capable of reproduction.
- ❖ Adolescence in girls is also marked by start of the menstrual cycle, during which there is a discharge of blood generally after every 28–30 days, a process called menstruation. Menstruation begins at puberty and generally ends by the age of 45–55 years.
- ❖ Adolescents face several emotional and behavioural changes.
- ❖ Eating a balanced and healthy diet, maintaining good personal hygiene, and participating in physical activities help adolescents to stay healthy.
- ❖ Addictive substances, such as tobacco, alcohol, and drugs, have adverse effects on the body and mind. It is wise to say 'NO' to these substances and stay away from them.
- ❖ Changes that take place in the body during adolescence are primarily controlled by certain chemicals produced in the body. These chemicals are called hormones.
- ❖ Proper guidance and awareness help adolescents manage physical, emotional, and behavioural changes effectively.

Let Us Enhance Our Learning

1. Ramesh, an 11-year-old boy, developed a few pimples on his face. His mother told him that this is because of ongoing biological changes in his body.
   (i) What could be the possible reasons for the development of these pimples on his face?
   (ii) What can he do to get some relief from these pimples?

2. Which of the following food groups would be a better option for adolescents and why?


(i)


(ii)

3. Unscramble the underlined word in the following sentences:
   (i) The discharge of blood in adolescent girls which generally occurs every 28–30 days is nstmnoiaretu.
   (ii) The hoarseness in the voice of adolescent boys is due to enlarged iceov xob.
   (iii) Secondary sexual characteristics are natural signs that the body is preparing for adulthood and mark the onset of urtypeb.
   (iv) We should say NO to lahoclo and srugd as they are addictive.
4. Shalu told her friend, "Adolescence brings only physical changes, like growing taller or developing body hair." Is she correct? What would you change in this description of adolescence?
5. During a discussion in the class, some of the students raised the following points. What questions would you ask them to check the correctness of these points?
   (i) Adolescents do not need to worry about behavioural changes.
   (ii) If someone tries a harmful substance once, they can stop anytime they want.
6. Adolescents sometimes experience mood swings. On some days, they feel very energetic and happy, while on other days, they may feel low. What other behavioural changes are associated with this age?
7. While using a toilet, Mohini noticed that used sanitary pads were scattered near the bin. She got upset and shared her feelings with her friends. They discussed the importance

of menstrual hygiene and healthy sanitary habits. What menstrual hygiene and sanitary habits would you suggest to your friends?

8. Mary and Manoj were classmates and good friends. On turning 11, Mary developed a little bulge on the front of her neck. She visited the doctor who gave her medication and asked to take iodine-rich diet. Similarly, a bump was developed on the front of Manoj's neck when he turned 12. However, the doctor told him that it was a part of growing up. According to you, what could be the possible reason for advising Mary and Manoj differently?

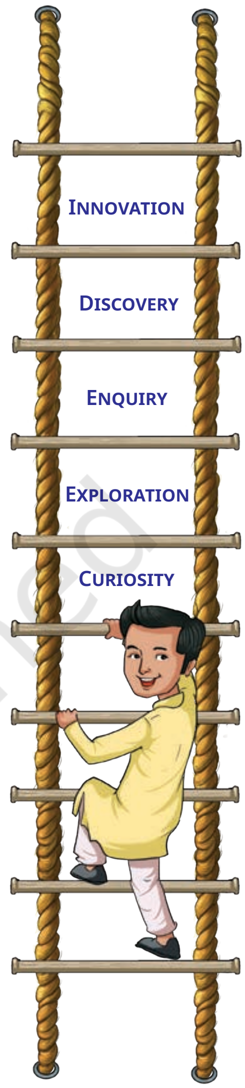
9. During adolescence, the boys and girls undergo certain physical changes, a few of which are given below.

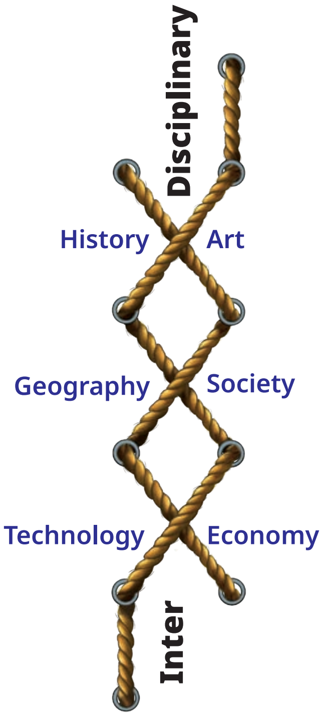
   (i) Change in voice
   (ii) Development of breasts
   (iii) Growth of moustache
   (iv) Growth of facial hair
   (v) Pimples on the face
   (vi) Growth of hair in the pubic region
   (vii) Growth of hair in armpits

Categorise these changes in the table given below:

Physical changes during adolescence		
Observed only in boys	**Observed only in girls**	**Common in boys and girls**

10. Prepare a poster mentioning the tips for adolescents to live a healthy lifestyle.





Exploratory Projects

- Find out about some personalities and organisations working in your locality to improve mental health of youth. Interview them. List at least five questions that you will ask in the interviews.
- Perform a role play on the theme 'Child marriage: A social evil', highlighting how it negatively impacts the overall well-being of children, particularly the health of young girls.
- 21 June is celebrated as International Yoga Day. Organise a small camp with the help of your teachers and practise some *asanas*.

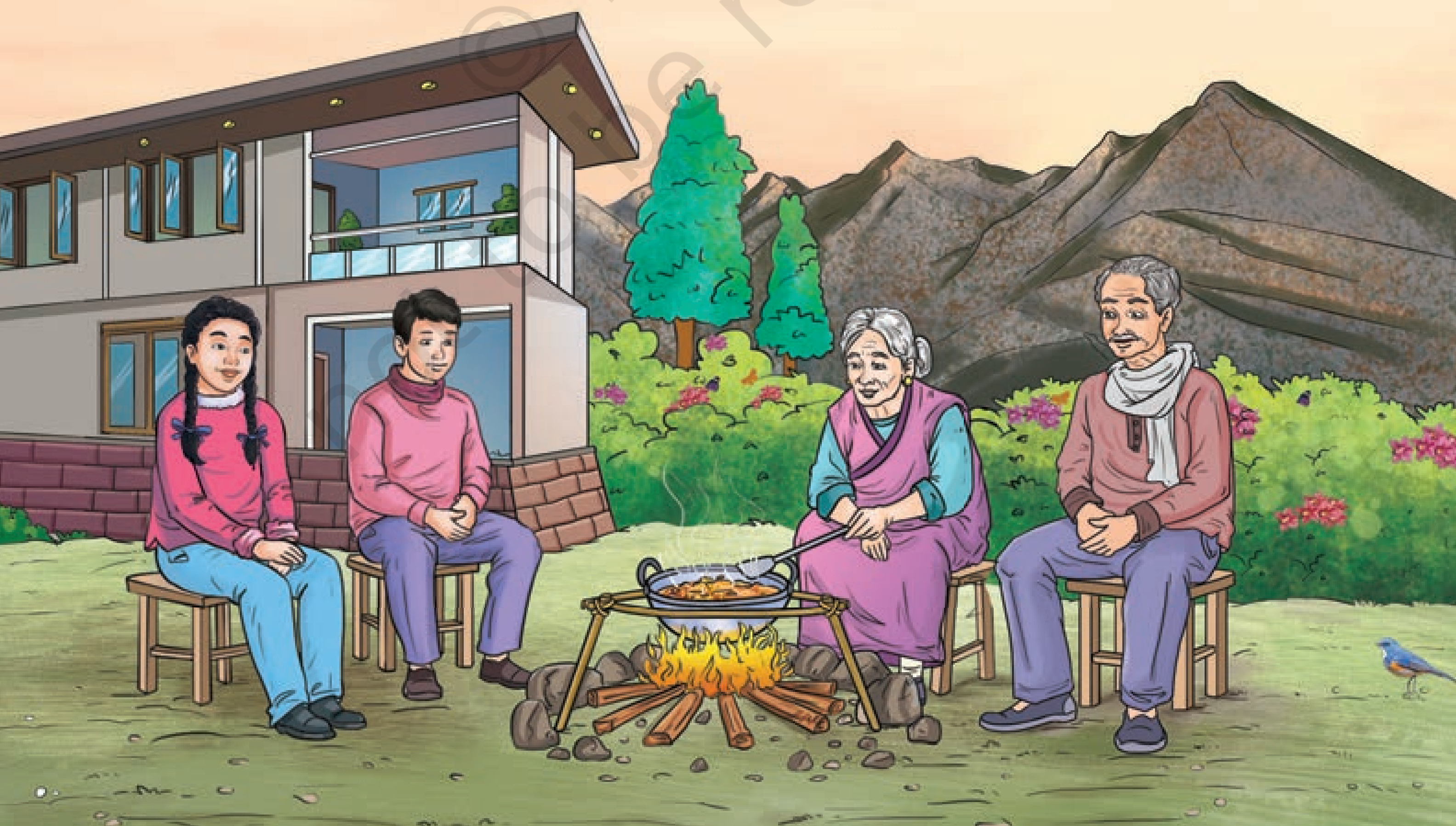
7 Heat Transfer in Nature

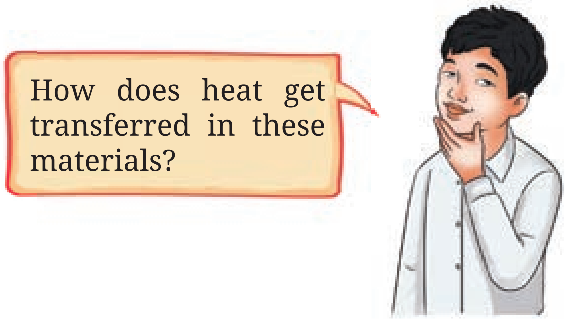
Pema and her brother Palden reside in Gangtok. On a cold winter evening, they are sitting around a fireplace. Palden shares his experiences of visiting Kerala during the winter vacation. He says that compared to Gangtok, winter in Kerala is comparatively warm and humid. Both Pema and Palden are curious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

0777CH07

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.





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.

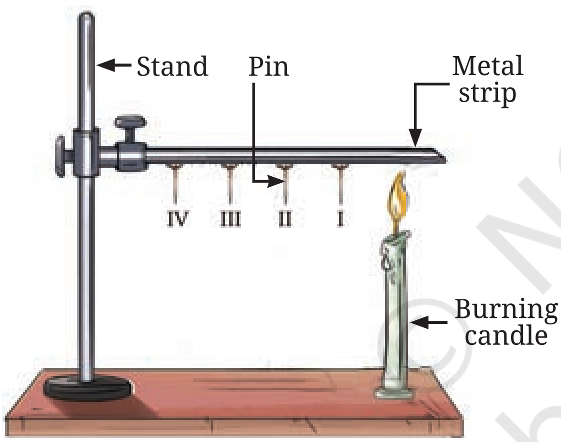


Fig. 7.1: Heat transfer in a metal strip

- 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	

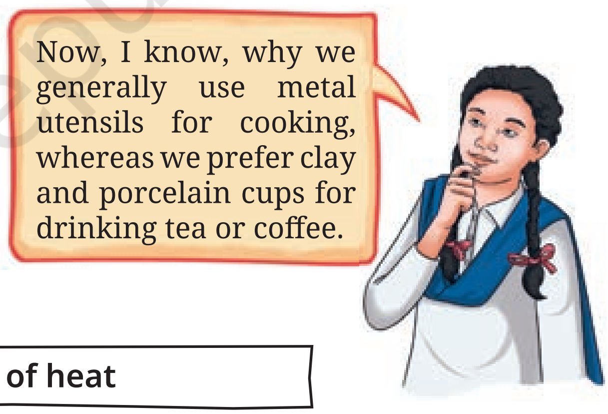
You **observed** that the pin closest to the candle flame (pin I) falls first, followed by pins II, III, and IV. Why does pin I fall before pin II? Why did all the pins not fall together?

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.

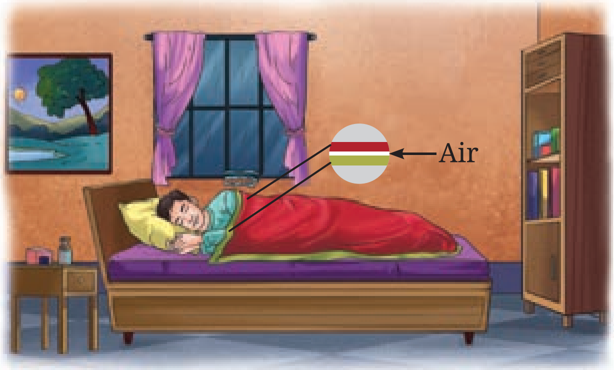


Fig. 7.2: Air trapped between two thin blankets acts as an insulator

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.

Why is the smoke going up?

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.

- 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.

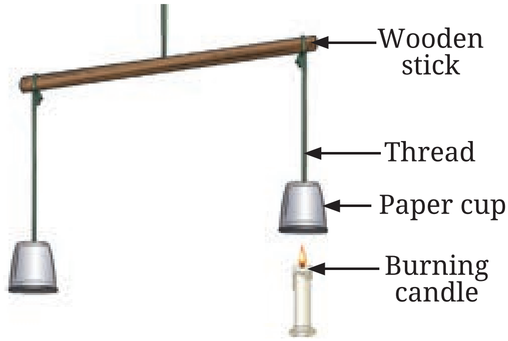


Fig. 7.3(b): Hot air rising up

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.

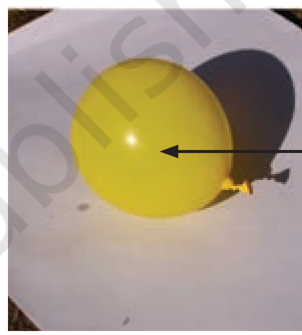
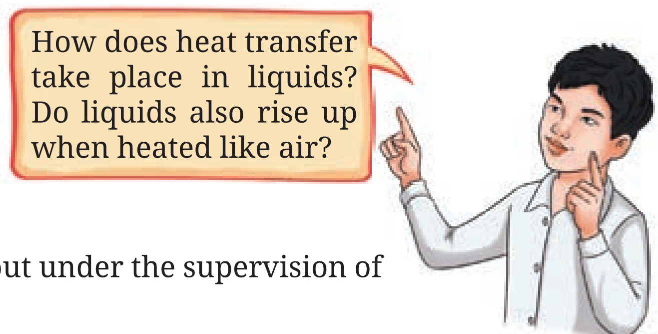


Fig. 7.4: An inflated balloon in the Sun

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.

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.



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.

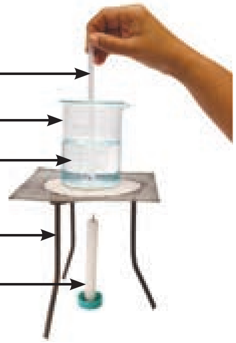


Fig. 7.5(a): Initial set-up for demonstration

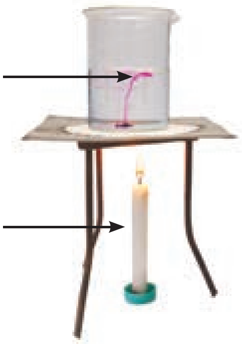


Fig. 7.5(b): Demonstration of convection in heated water

- ❖ 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.

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.

- ❖ 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.

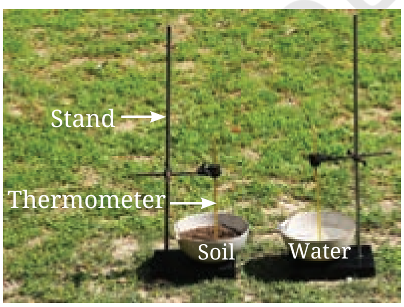


Fig. 7.6: Measurement of the temperature of soil and water

- ❖ 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.

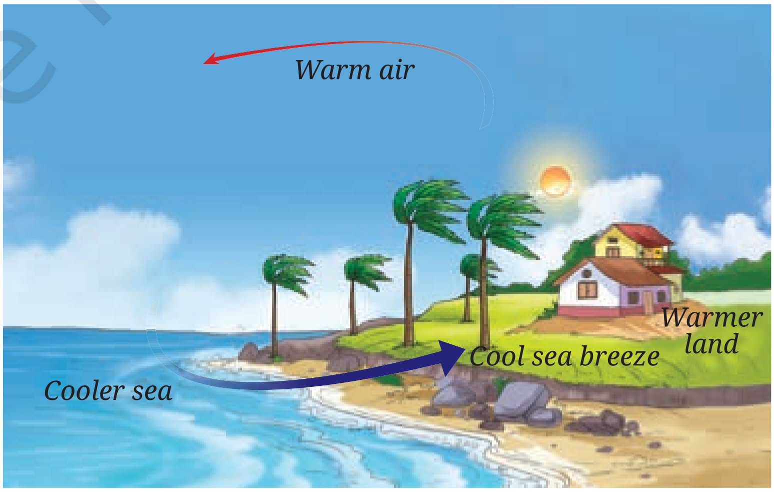


Fig. 7.7(a): Sea breeze

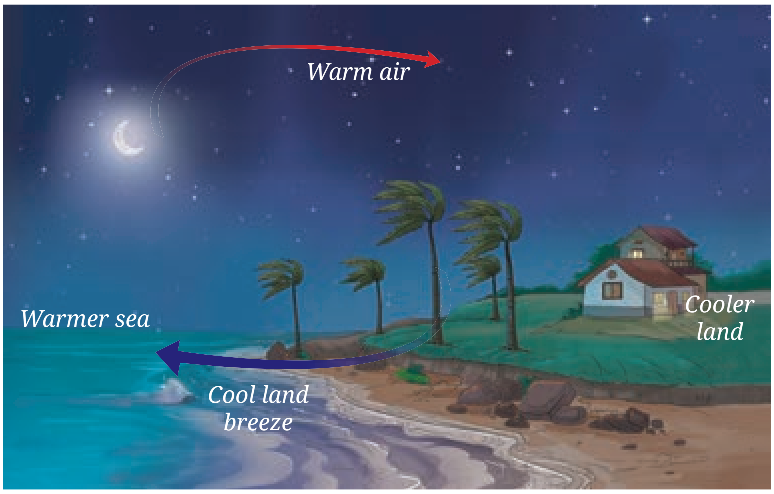
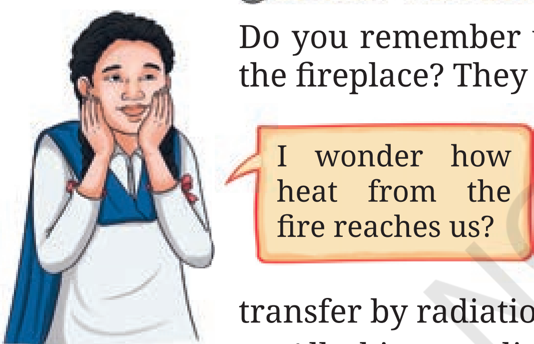


Fig. 7.7(b): Land breeze

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



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.

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.

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.

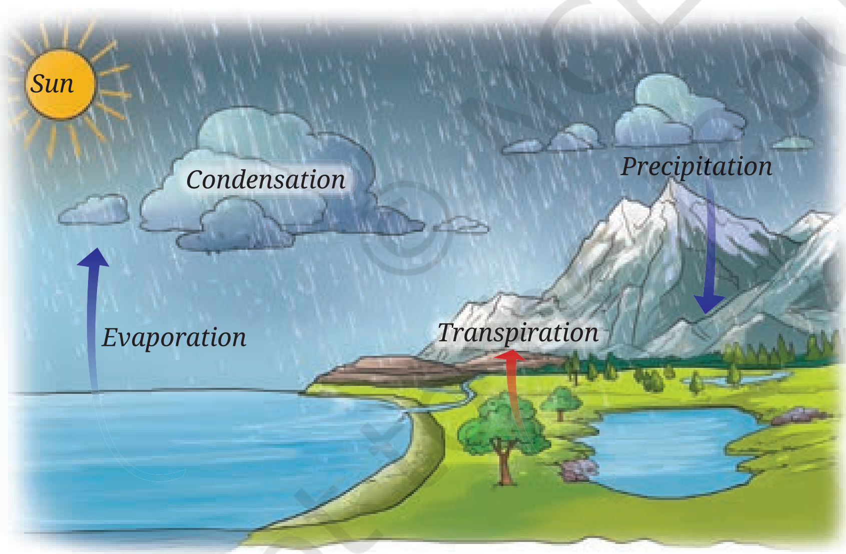


Fig. 7.9: Water cycle

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.

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.

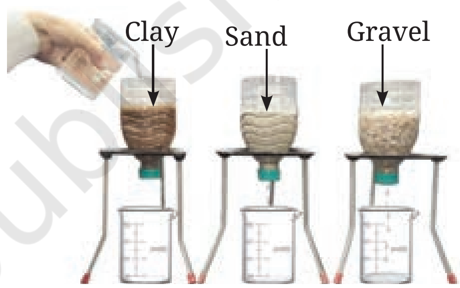


Fig. 7.10: An activity to compare the flow of water through clay, sand and gravel

- 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)		

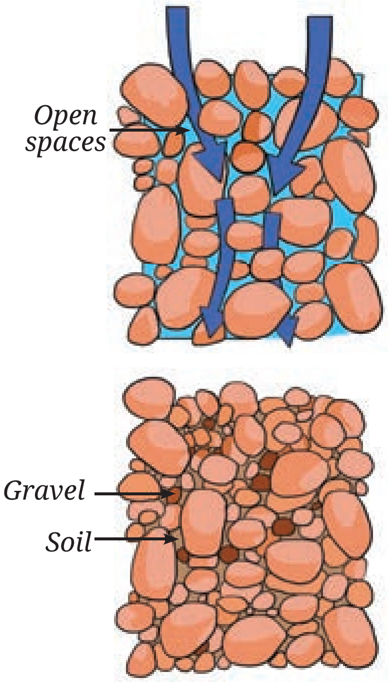


Fig. 7.11: Water readily moves, and is stored where spaces are wide, open and connected

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.

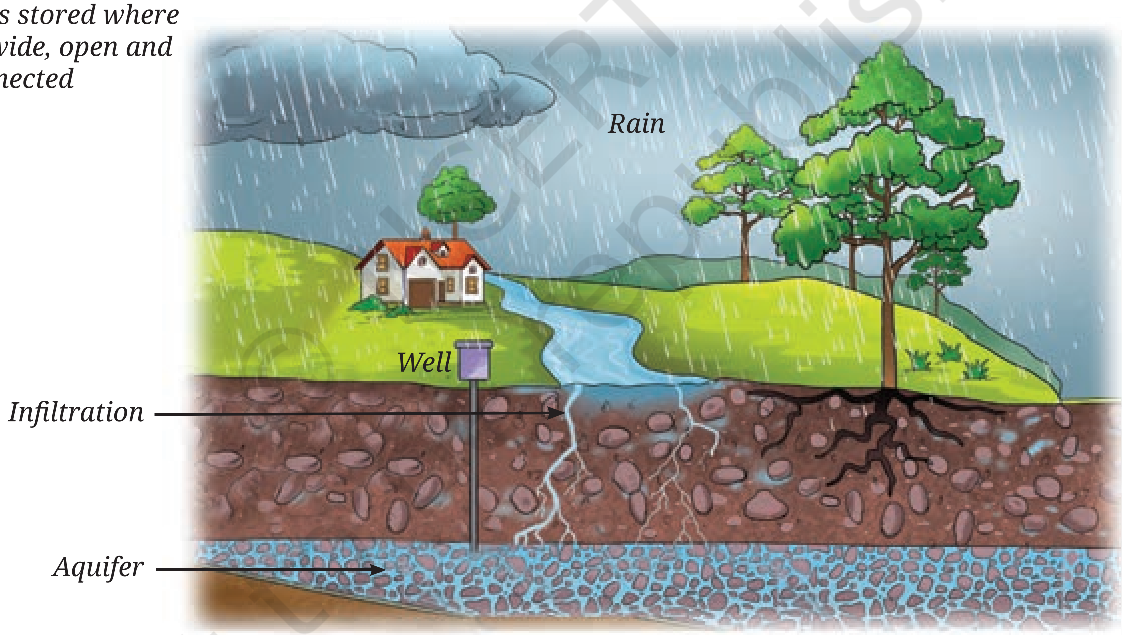


Fig. 7.12: Aquifer

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.

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

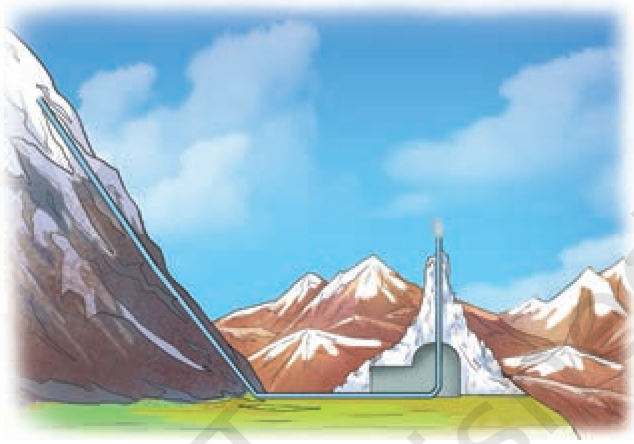


Fig. 7.13: Ice stupa

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.

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.

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

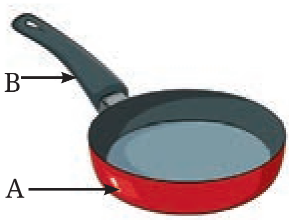


Fig. 7.14: Saucepan

   (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

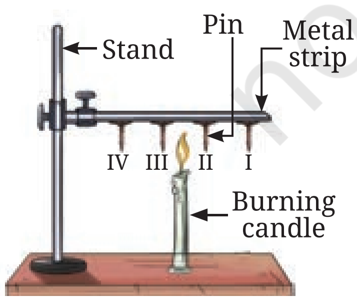


Fig. 7.15: Heat transfer set-up

(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.

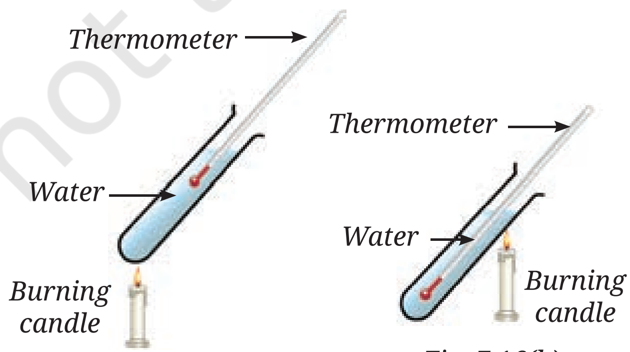
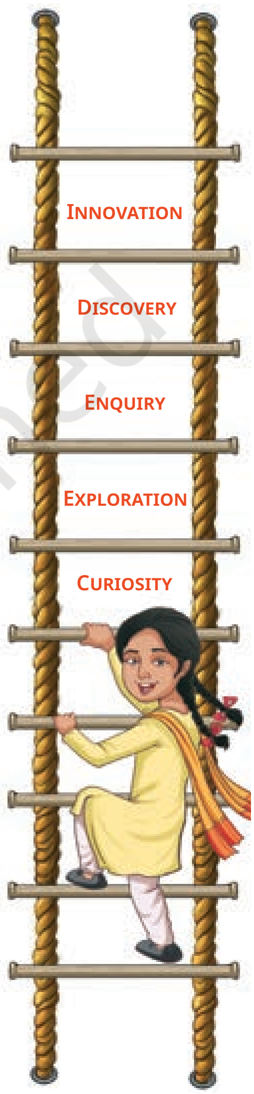


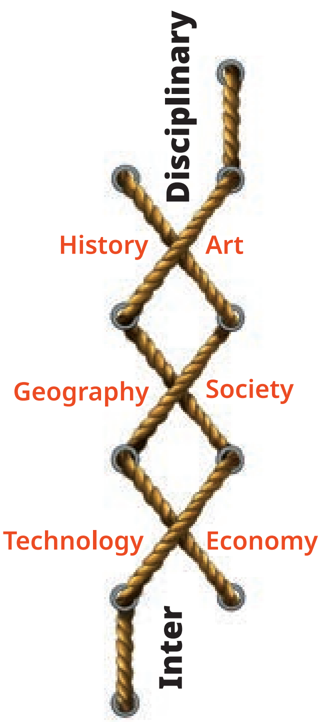
Fig. 7.16(a) Fig. 7.16(b)

Fig. 7.16: Two thermometers dipped in two test tubes



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.

Fig. 7.17(a): Cutting paper in spiral

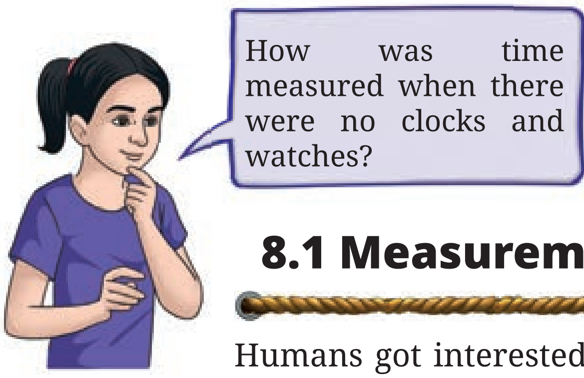
Fig. 7.17(b): Spiral paper above a burning candle

8 Measurement of Time and Motion

0777CH08

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...



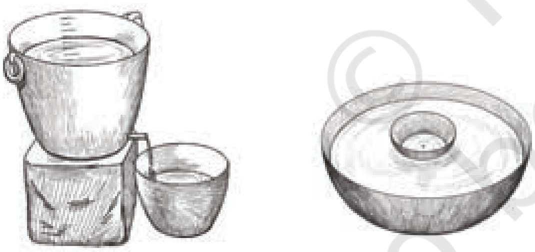
8.1 Measurement of Time

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).



(a) *(b)*

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

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.

Fig. 8.3 An hourglass

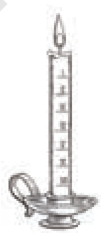


Fig. 8.4 A candle clock

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.

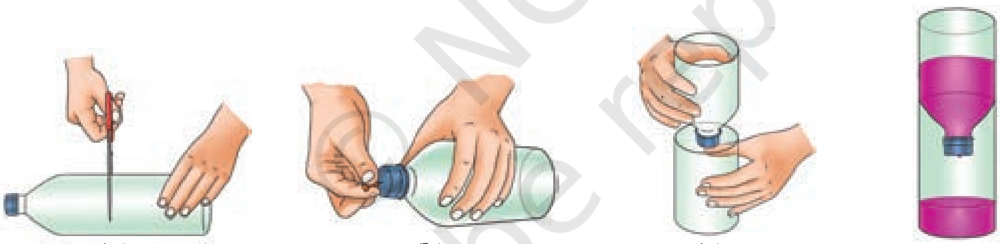
FASCINATING FACTS

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

- 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.

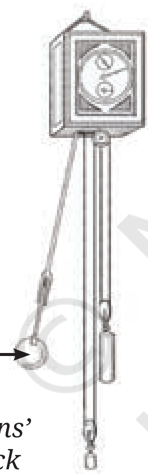


Fig. 8.6: Huygens' Pendulum clock

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.

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?

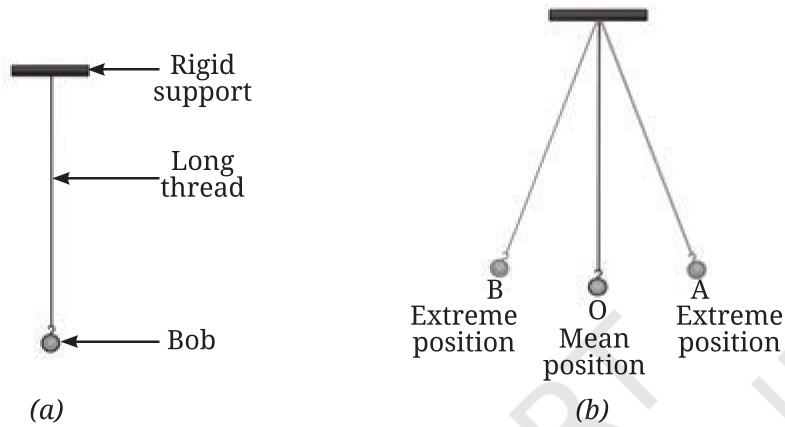


Fig. 8.7 A simple pendulum

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.

- 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.

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.

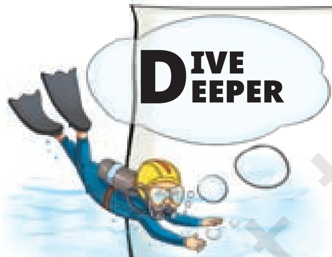
Modern clocks measure time using the same basic principle—periodically repeating processes—but use tiny and very rapid vibrations either from a quartz crystal (quartz clocks) or from some specific atoms (atomic clocks). While Huygens' early pendulum clocks could gain or lose 10 seconds each day, today's 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

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



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

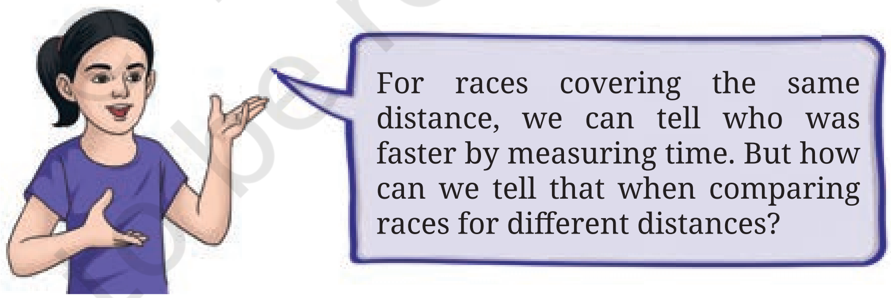
Activity 8.3: Let us identify

- 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!



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,

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

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**.

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 $= \dfrac{\text{Distance covered}}{\text{Time taken}}$

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

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

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

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

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)

❖ **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

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

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 $= \dfrac{\text{Distance covered}}{\text{Speed}}$

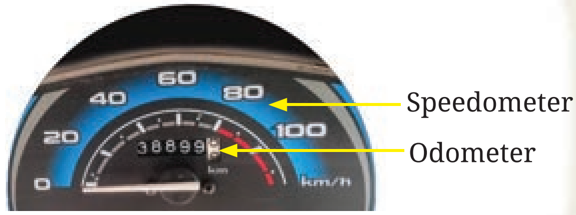
$$= \frac{360\cancel{\text{km}}}{90\dfrac{\cancel{\text{km}}}{\text{h}}}$$

$$= 4 \text{ h}$$

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'.

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.

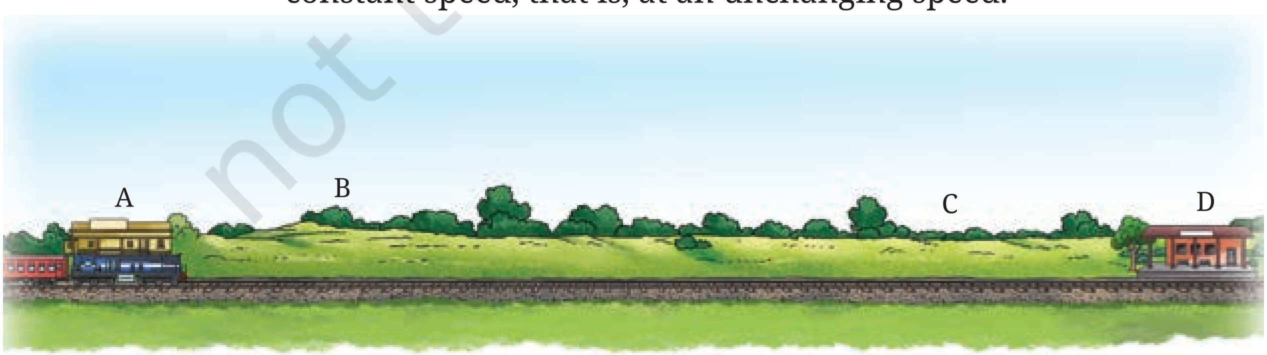


Fig. 8.11: A train on a straight track

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

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

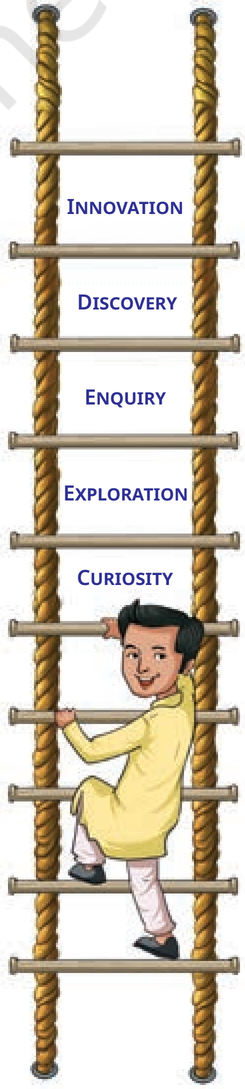
1. Calculate the speed of a car that travels 150 metres in 10 seconds. Express your answer in km/h.
2. A runner completes 400 metres in 50 seconds. Another runner completes the same distance in 45 seconds. Who has a greater speed and by how much?
3. A train travels at a speed of 25 m/s and covers a distance 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

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

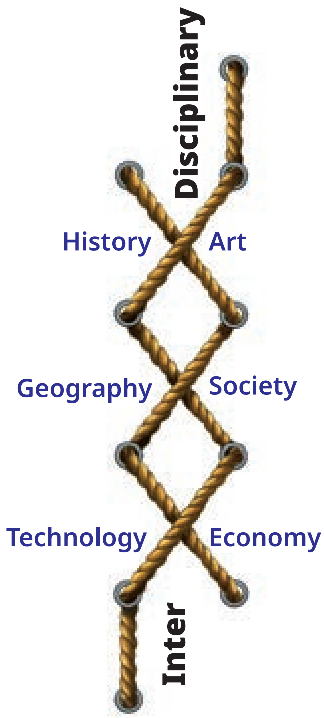
11. A vehicle moves along a straight line and covers a distance of 2 km. In the first 500 m, it moves with a speed of 10 m/s and in the next 500 m, it moves with a speed of 5 m/s. With what speed should it move the remaining distance so that the journey is complete in 200 s? What is the average speed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

❖ 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!

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.

0777CH09

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.

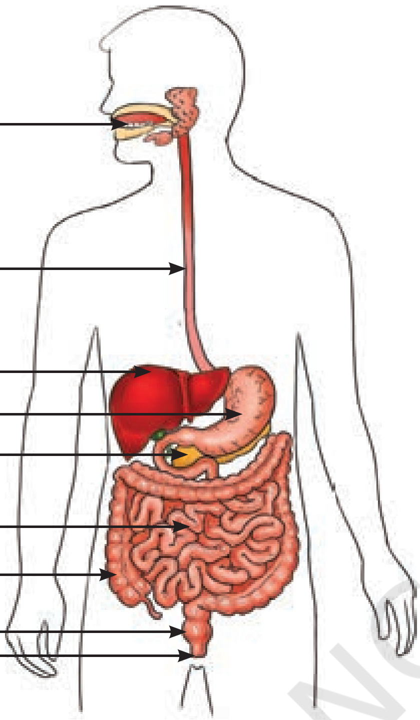


Fig. 9.1: Human digestive system

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.

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.

Science and Society

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.

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

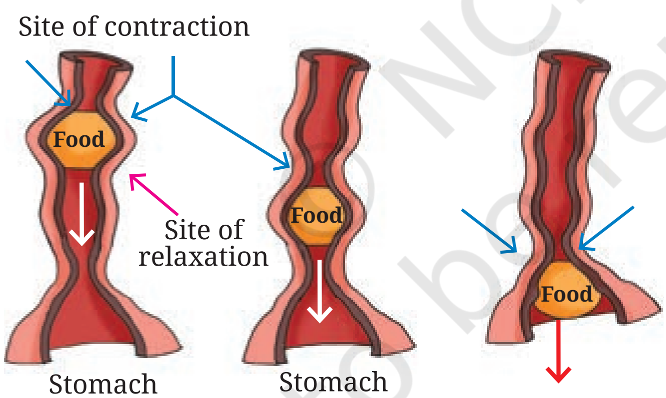


Fig. 9.2: Movement of food in the food pipe

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.

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.

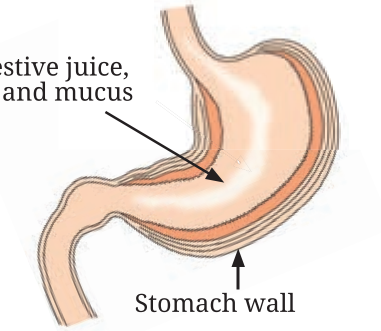
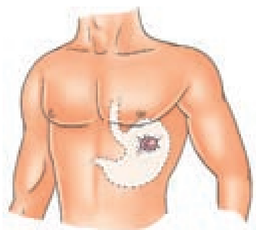


Fig. 9.3: Stomach

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.

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.

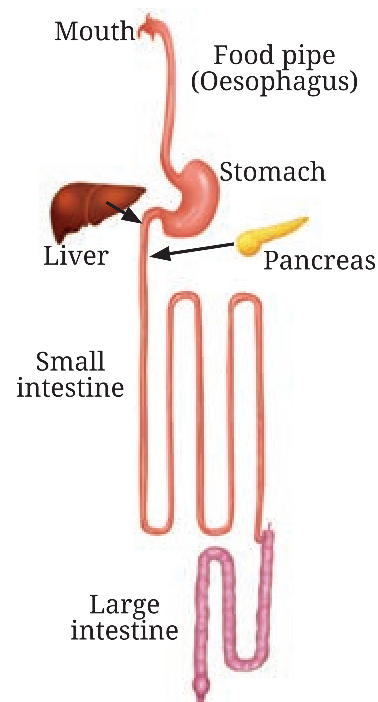


Fig. 9.4: Alimentary canal if it is stretched out

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.

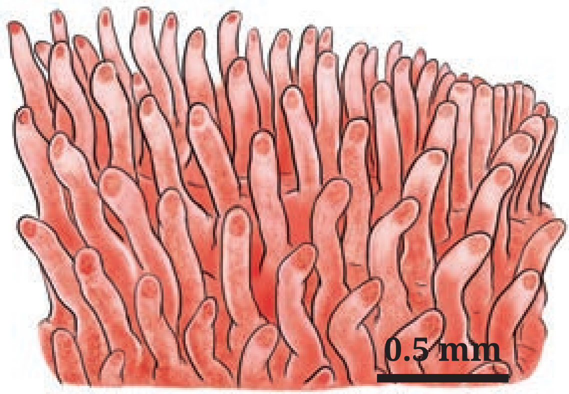


Fig. 9.5: Inner lining of the small intestine

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.

SCIENCE AND SOCIETY

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.

Science and Society

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?

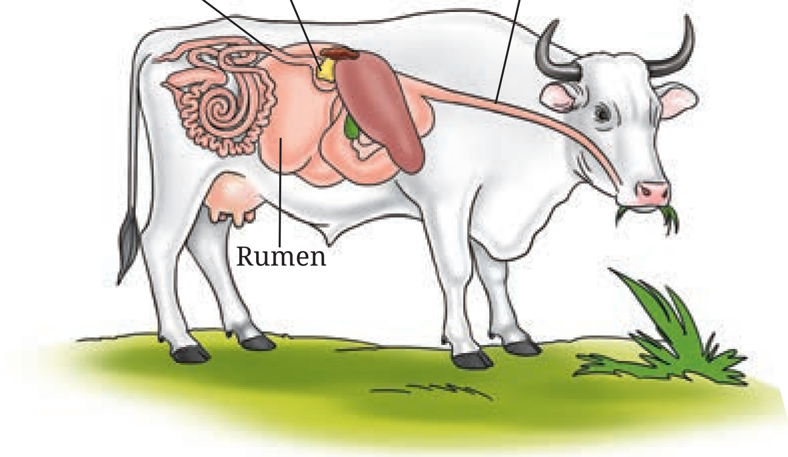


Fig. 9.6: Digestive system of a ruminant

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.

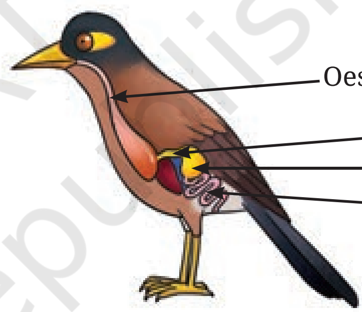


Fig. 9.7: Digestive system in birds

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.

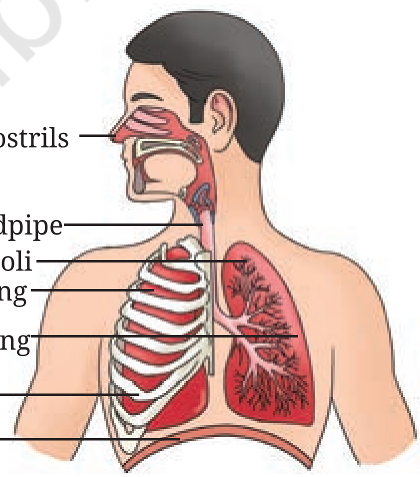


Fig. 9.8: Human respiratory system

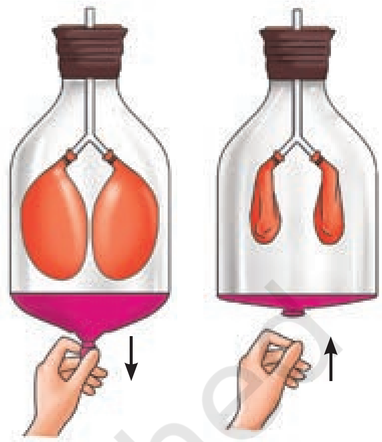
Science and Society

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

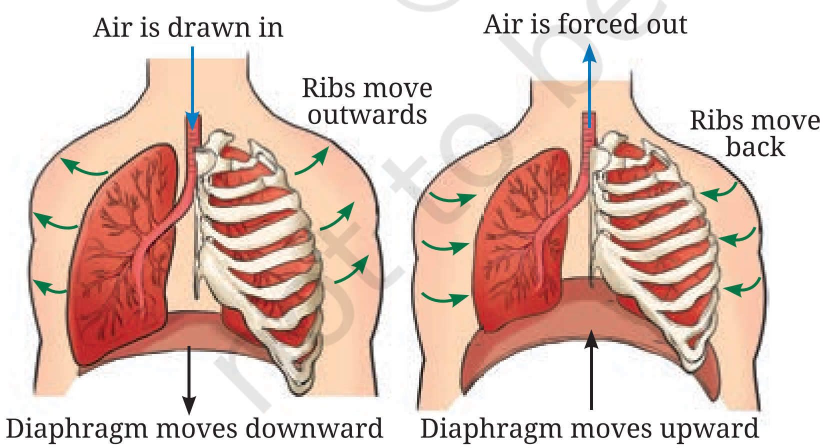
- ❖ Take a wide transparent plastic bottle with a lid. Remove its bottom.
- ❖ Make a hole in the lid of the bottle.
- ❖ Take a Y-shaped hollow tube, as shown in Fig. 9.9.
- ❖ Fix two deflated balloons to the forked end of the tube. Secure them with rubber bands to make them airtight.
- ❖ Insert the straight 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.

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.

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).

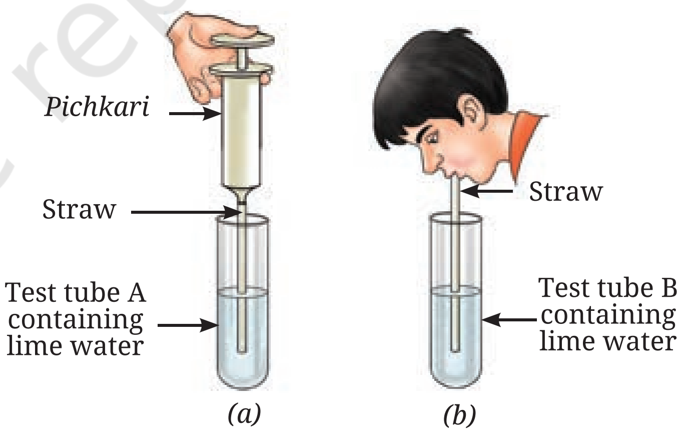


Fig. 9.11: (a) Air is passed into lime water with a pichkari/syringe (b) Air is exhaled into lime water

- ❖ 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.

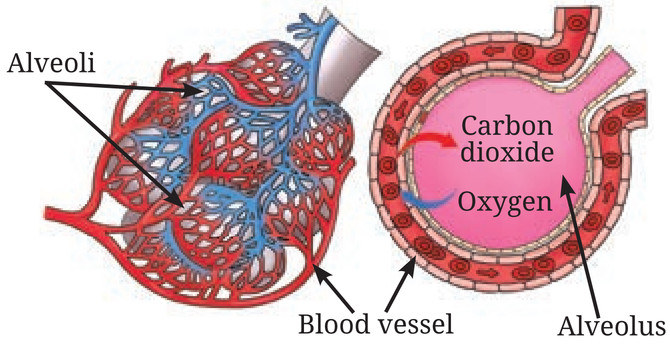


Fig. 9.12: Gas exchange through alveoli

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

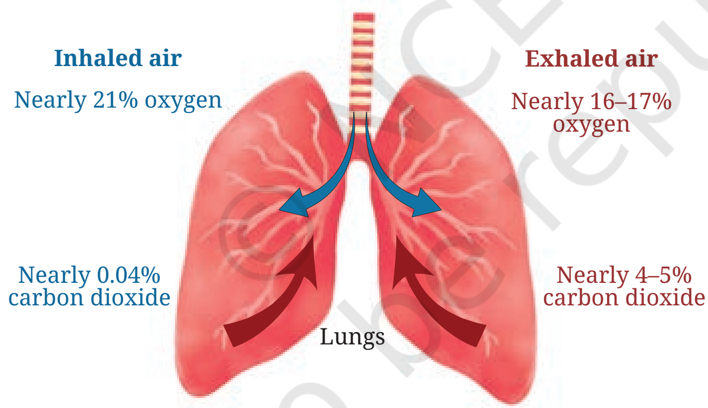


Fig. 9.13: The percentage of oxygen and carbon dioxide in inhaled and exhaled air

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!

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.

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.

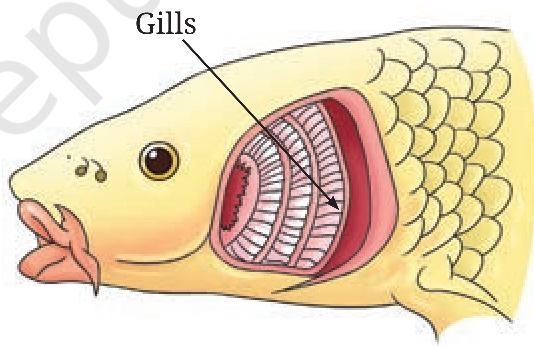


Fig. 9.14: Breathing body parts in a fish

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.

Let Us Enhance Our Learning

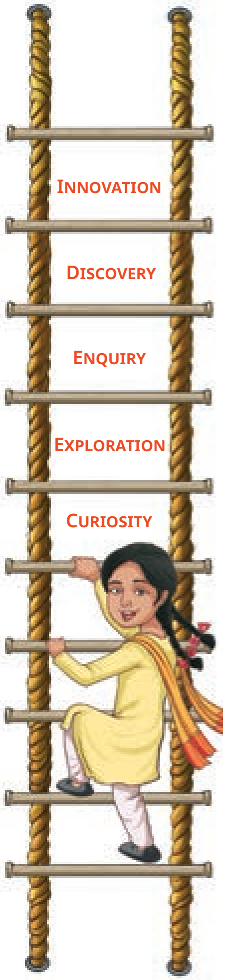
1. Complete the journey of food through the alimentary canal by filling up the boxes with appropriate parts—

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.



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?

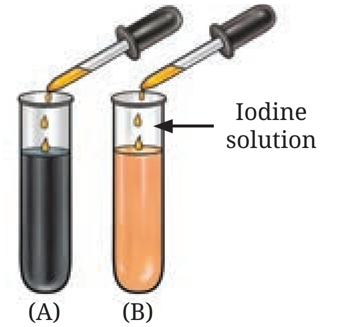


Fig. 9.15: Experimental results

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?

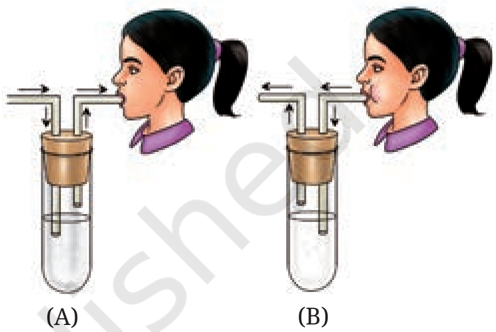


Fig. 9.16: Experimental set-up

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?

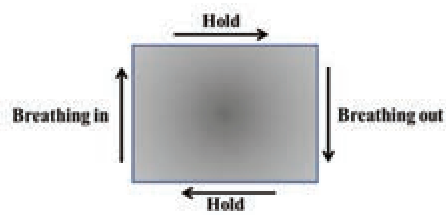
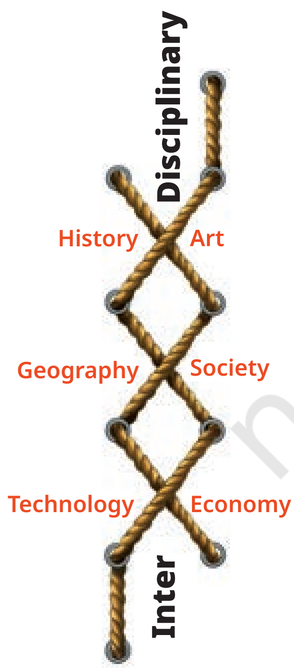


Fig. 9.17: Box-breathing



10 Life Processes in Plants

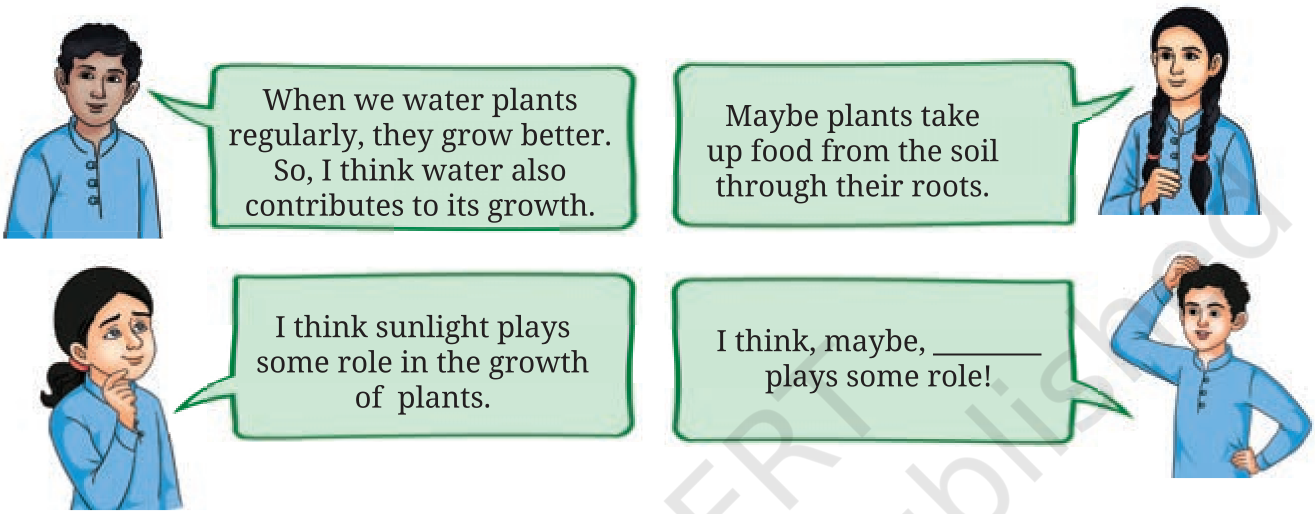
In Grade 6, we learnt that all living beings grow and need food for their growth. Also, in the previous chapter, we discussed the process through which animals obtain nutrition.

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?

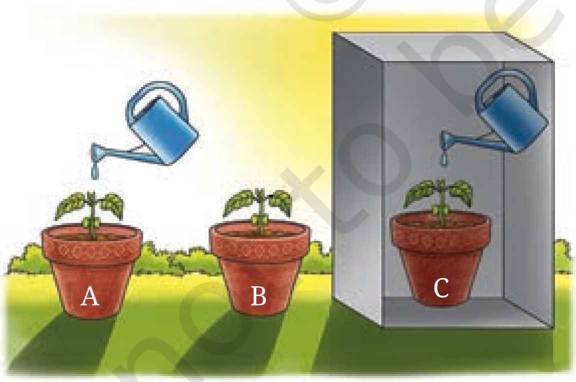
Look around your neighbourhood. Have you observed any changes in a plant during its life span? As a plant grows, new leaves and branches emerge, its height increases, and its stem thickens. What do you think causes these changes? Discuss with your friends and provide your explanation as well.



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							

- 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?

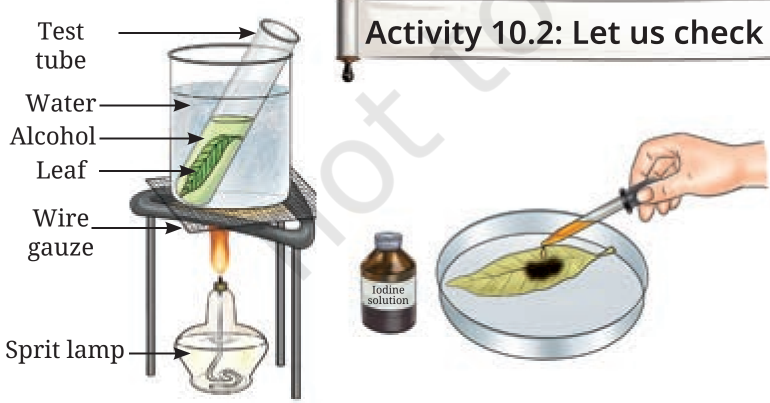
We know that animals get their food from plants, either directly by eating plants or indirectly by eating animals that in turn eat plants for their nutrition and growth. But how do plants obtain the food they need to grow? Unlike animals, plants do not *eat* food.

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).

- ❖ 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.

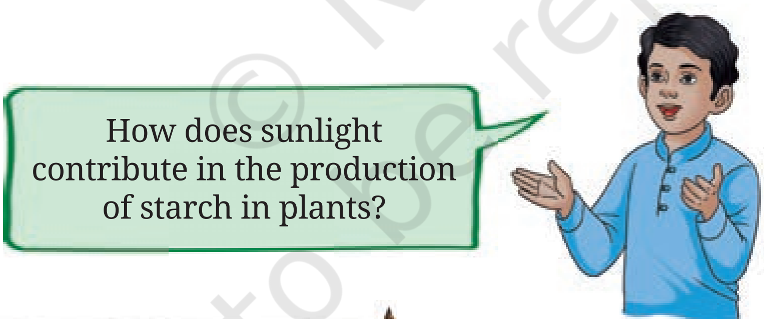
Caution — Alcohol should never be placed near a heat source directly, as it is highly flammable and can easily lead to fire and burns.

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.



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 

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.

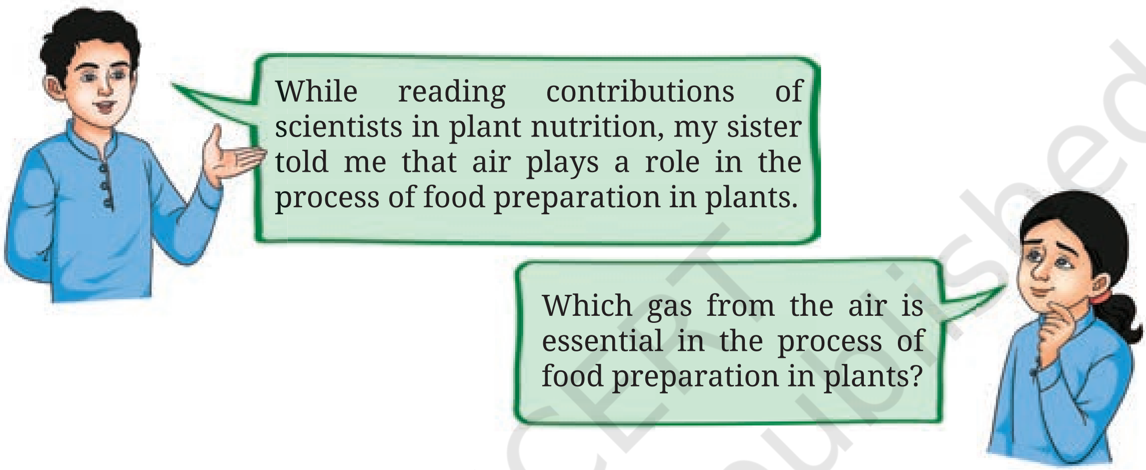
Fascinating Facts

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



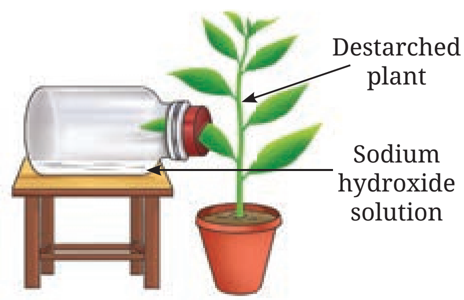
Activity 10.4: Let us experiment (demonstration activity)

The teacher may demonstrate this activity.

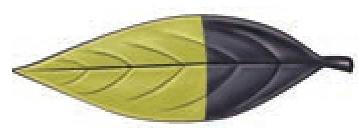
- Take a potted green plant and keep it in the dark for two to three days to allow it to destarch (i.e., lose any stored starch). Then, locate one leaf of this plant for this experiment.
- Take a wide-mouthed bottle and pour some caustic soda (sodium hydroxide) into it (caustic soda absorbs carbon dioxide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

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?

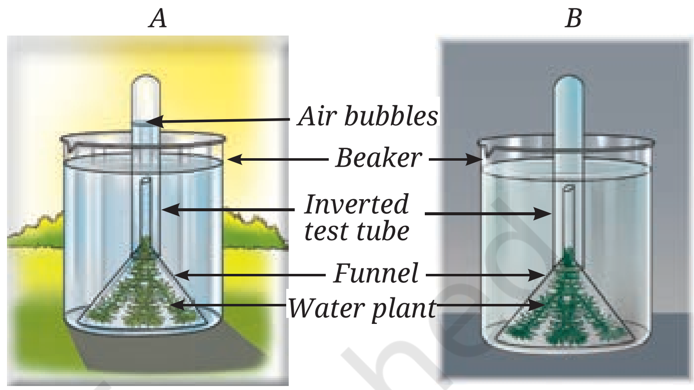
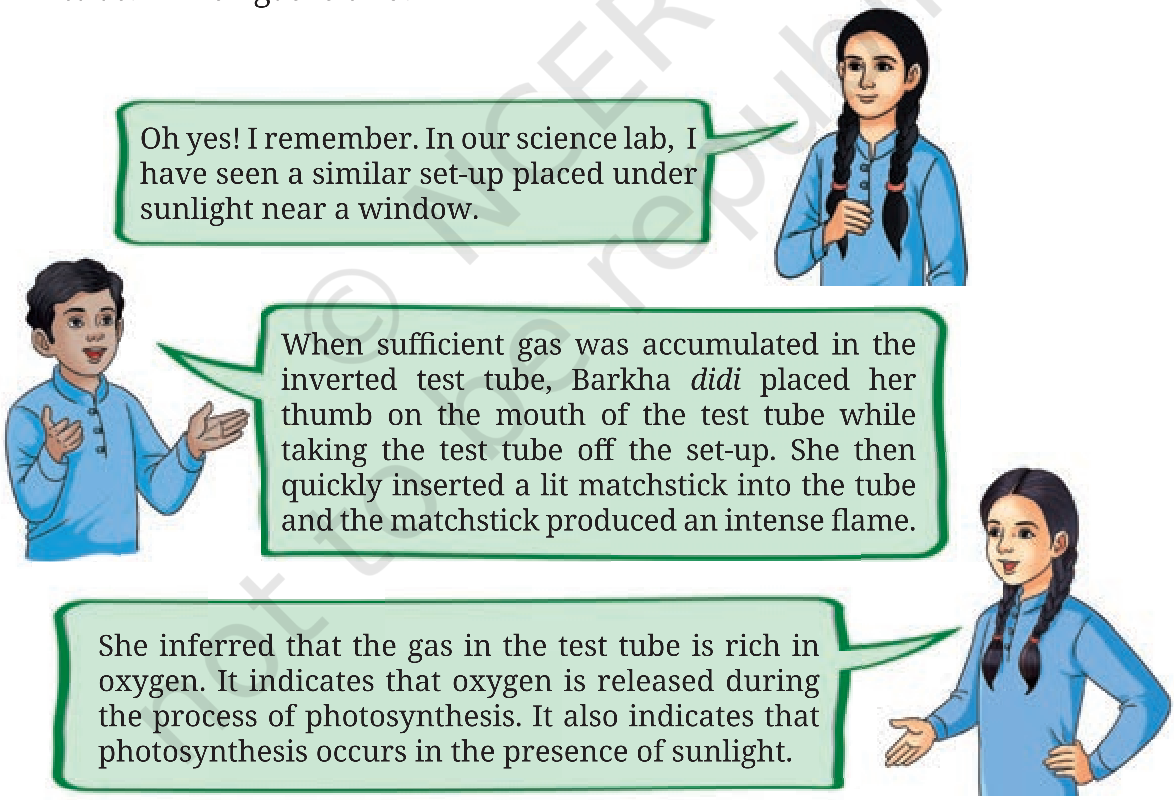


Fig. 10.4: Activity showing the release of oxygen during photosynthesis



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

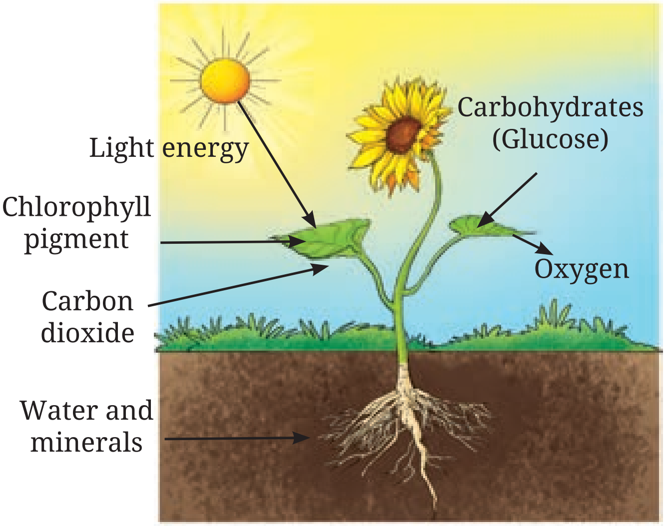


Fig. 10.5: A diagram showing photosynthesis

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—

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

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.

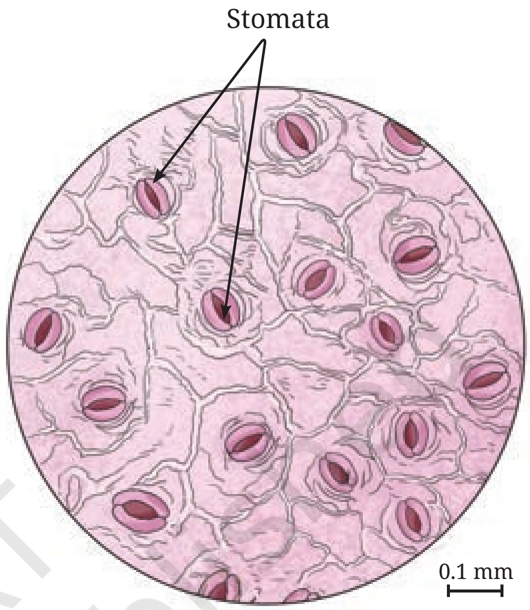


Fig. 10.6: Stomata on the lower surface of a rhoeo leaf

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.

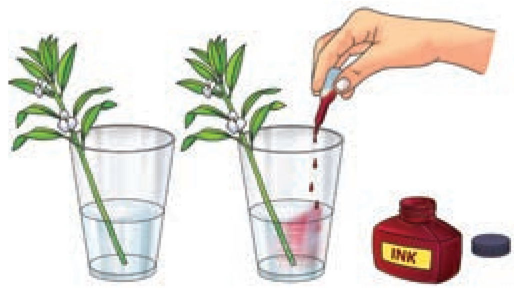
10.3 Transport in Plants

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?

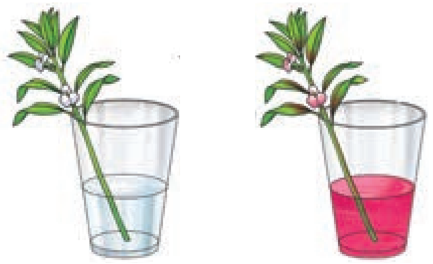
We can study water transport in plants by carrying out an activity. For this activity, we require two glass tumblers, some water, red ink, and twigs of two similar tender plants, preferably with white-coloured flowers (for example, white *sadabahar*, balsam), as shown in Fig. 10.7.

Activity 10.7: Let us experiment



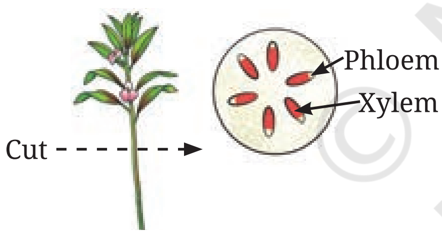
(a) With water (b) With coloured water

plant twigs placed in water with different treatments



(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

- ❖ 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?

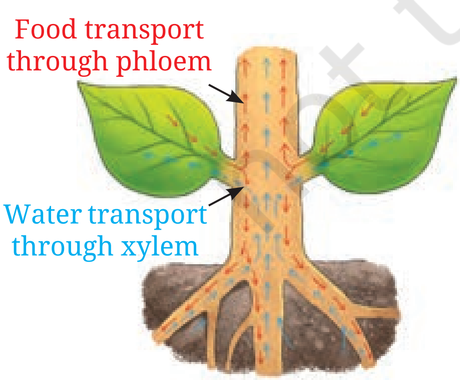


Fig. 10.8: Transport of water and minerals in a plant

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.

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.

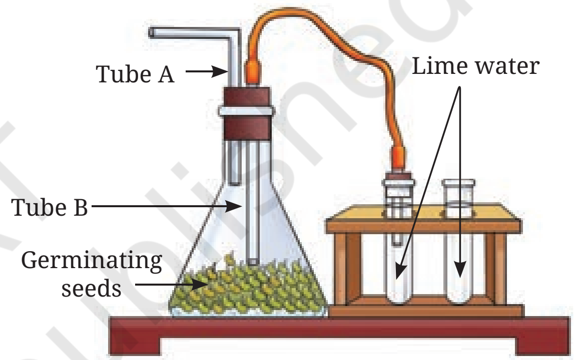


Fig. 10.9: Set-up to test respiration in plants

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—

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

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

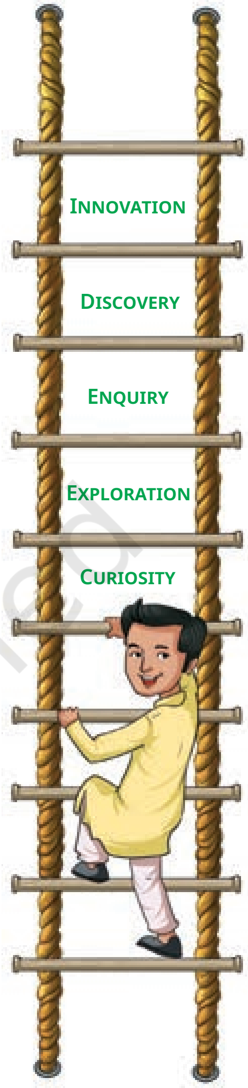
S.No.	Feature	Photosynthesis	Respiration
1.	Raw materials		
2.	Products		
3.	Word equation		
4.	Importance		

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?



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?

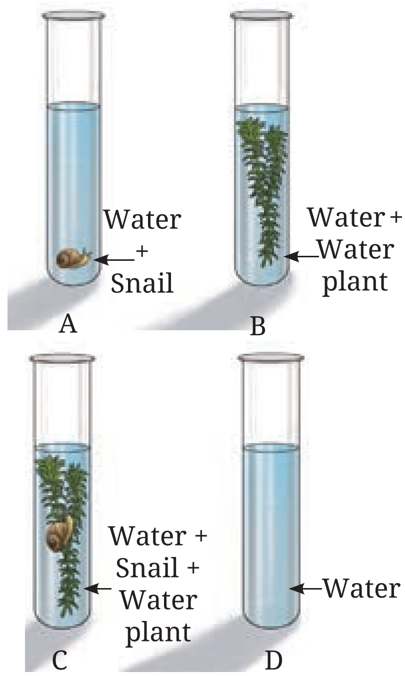
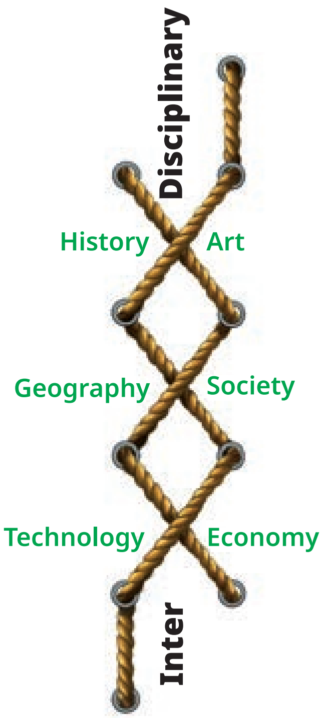


Fig. 10.12: Experimental set-up

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

❖ 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.

Fig. 10.13: Bottle garden

❖ 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.

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

0777CH11

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!

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).

Fig. 11.2: Fire as a source of artificial light

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.

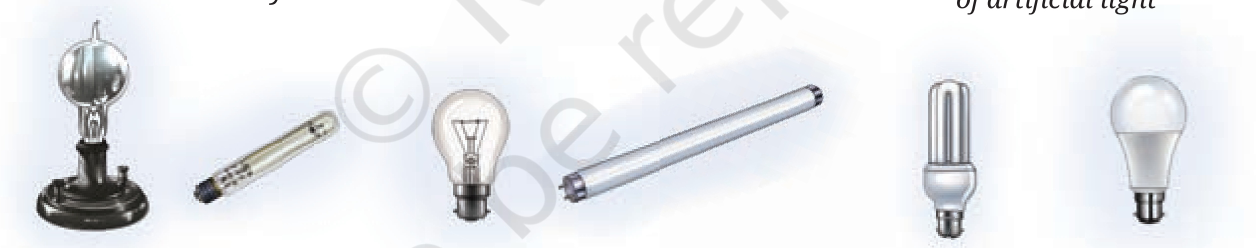


Fig. 11.3: Some sources of electric light

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.

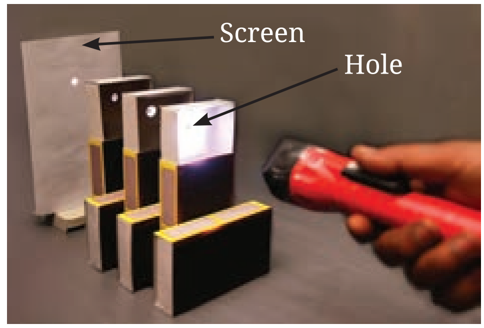
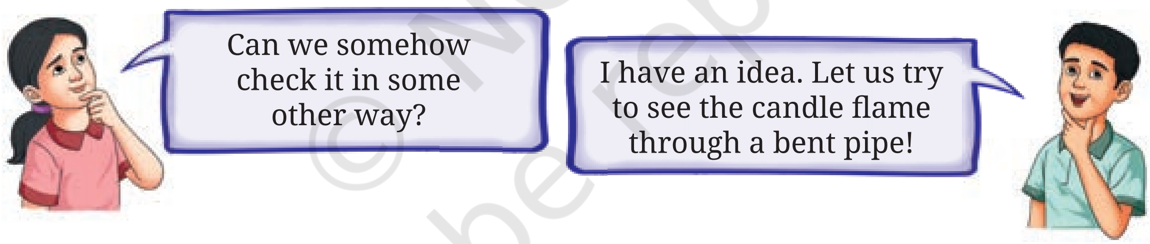


Fig. 11.4: Matchbox activity—light through holes

Activity 11.1: Let us investigate

- 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?

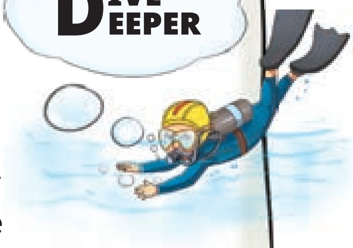
You could see the candle flame through a straight pipe but not through a bent pipe. This shows that light travels in a straight line.


(a)


(b)

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

DIVE DEEPER



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

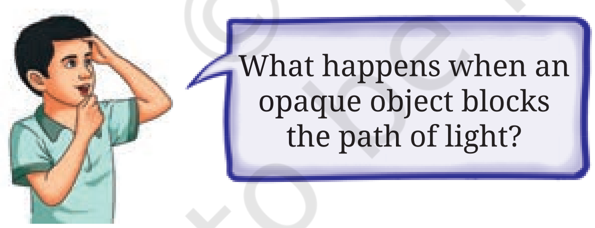
Material	Transparent/ Translucent/ Opaque	Light will pass fully/partially/not at all	
		My prediction	My observation
Cardboard			
Paper			
Glass			
Tracing paper			
Thick cloth			
...			
...			

- 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.

Fig. 11.6: Passing light through different materials

- 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.

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.



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.	

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

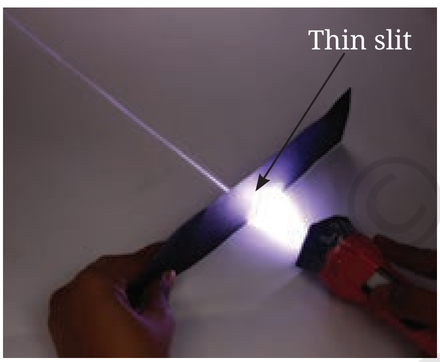
- Find a shiny flat steel plate or a plane mirror, that is, a mirror that is flat and not curved.
- Take it outside and let the sunlight fall on the shiny surface. What can you do to redirect light on the wall on which the sunlight is not falling directly?

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

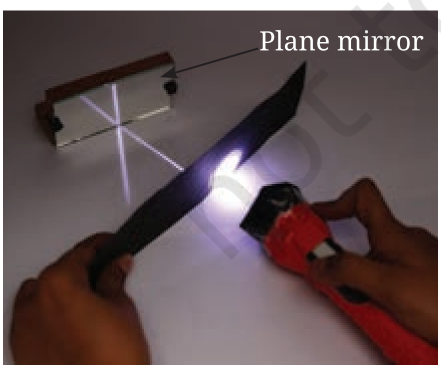
- ❖ Turn the shiny plate or mirror in different directions to redirect the light onto a wall or a nearby surface (Fig. 11.8). Do you see a spot of light on the wall? Does it mean that the shiny plate or mirror has changed the direction of light?
- ❖ Now, tilt the shiny plate or mirror in different ways 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.

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

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

- 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.

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.

Activity 11.8: Let us experiment

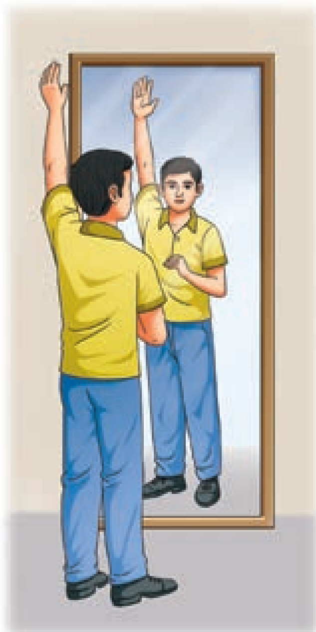


Fig. 11.11: Observing one's own image in a mirror

- 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?

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 'ƎƆИA⅃UᗺMA' 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.

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.

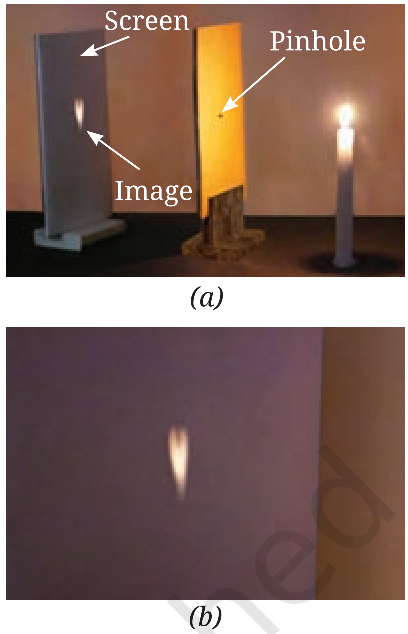


Fig. 11.12: (a) A simple pinhole camera (b) Image of a candle flame on screen

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?

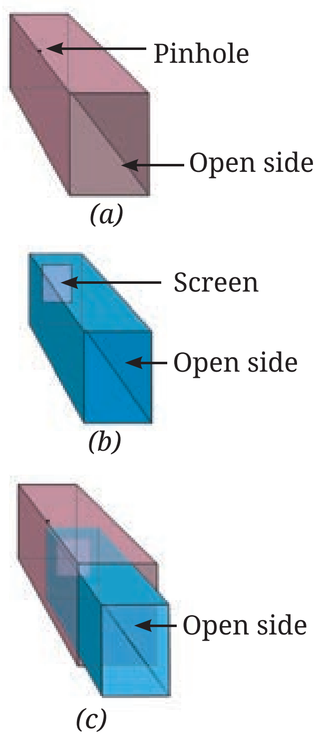


Fig. 11.13: A sliding pinhole camera

DIVE DEEPER

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.

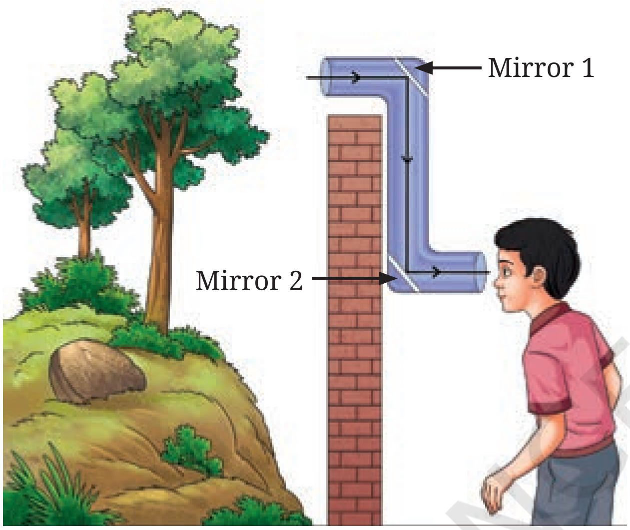
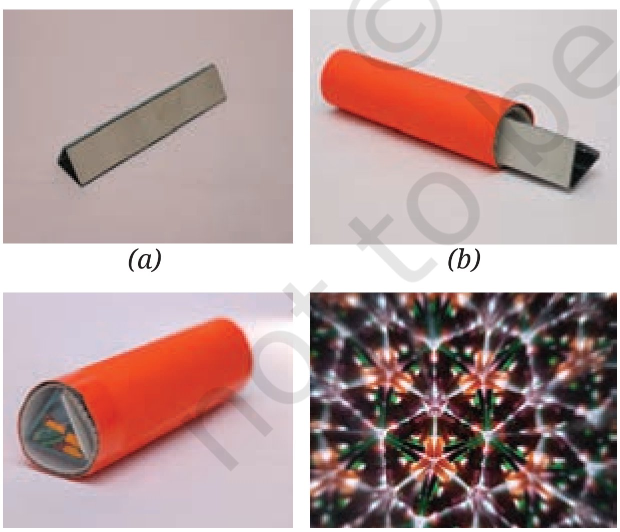


Fig. 11.14: A periscope

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.



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

Fig. 11.15: A kaleidoscope

11.8.2 Kaleidoscope

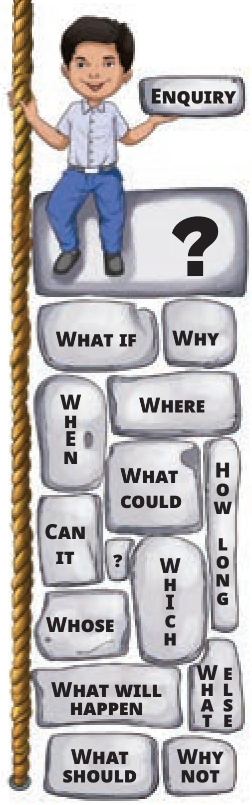
Get three rectangular plane mirror strips of equal width and join them together in a triangular manner as shown in Fig. 11.15a. You may use three strips of thick reflective paper instead of mirrors. Fix these in a circular tube of thick chart paper (Fig. 11.15b). On one end of the tube, fix a transparent 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 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.

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

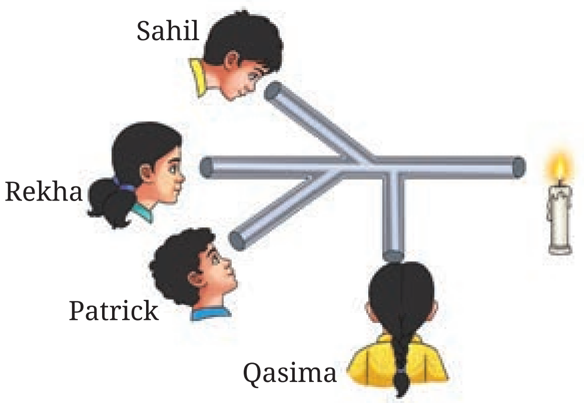


Fig. 11.16

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.

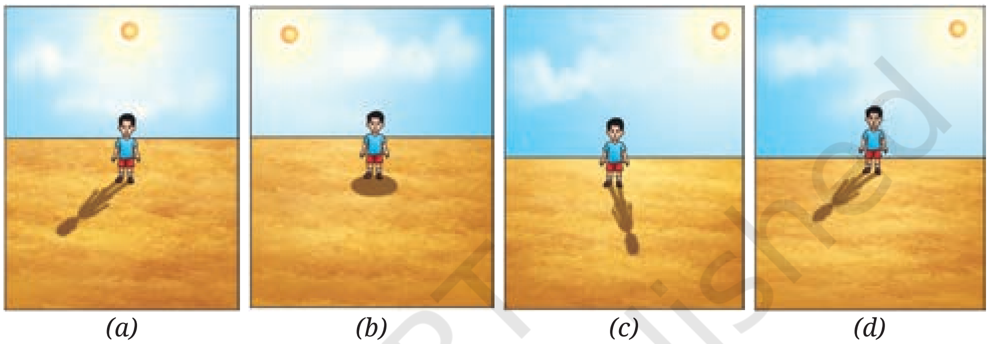


Fig. 11.17

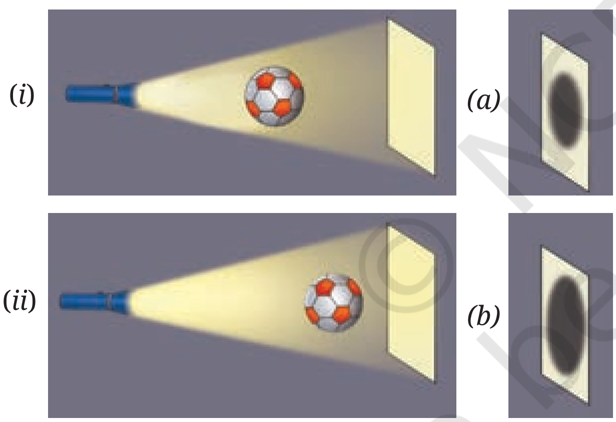


Fig. 11.18

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

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.

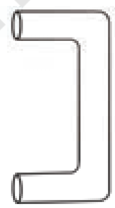
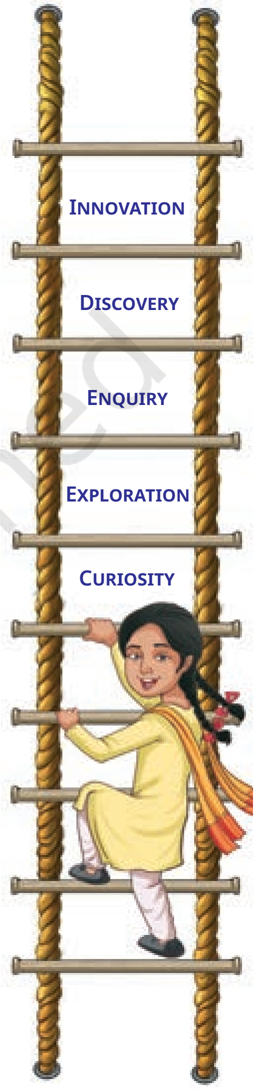


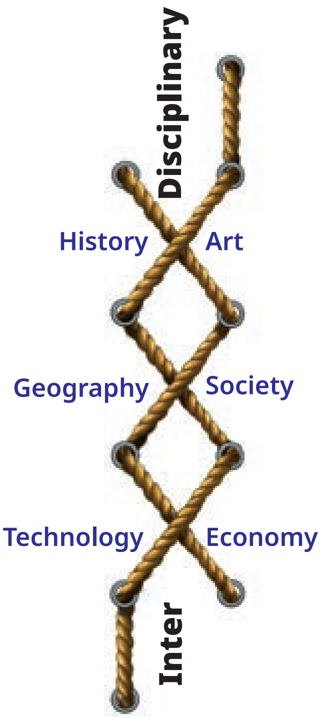
Fig. 11.20

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.



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.

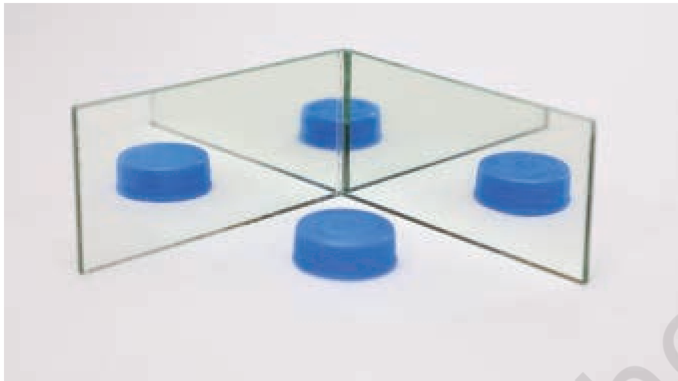


Fig. 11.21: Observing images in two mirrors

❖ 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.

12 Earth, Moon, and the Sun

0777CH12

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?

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.

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)?

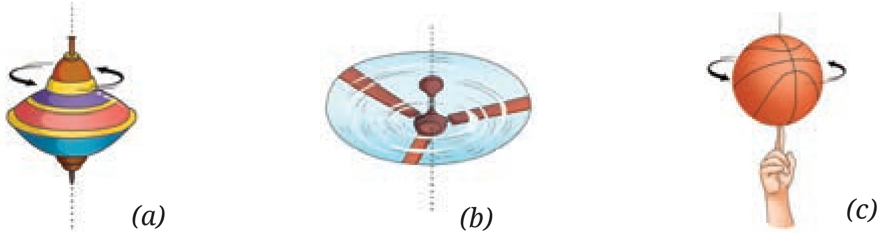


Fig. 12.2: (a) A spinning top (b) A spinning fan (c) A spinning ball

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*).

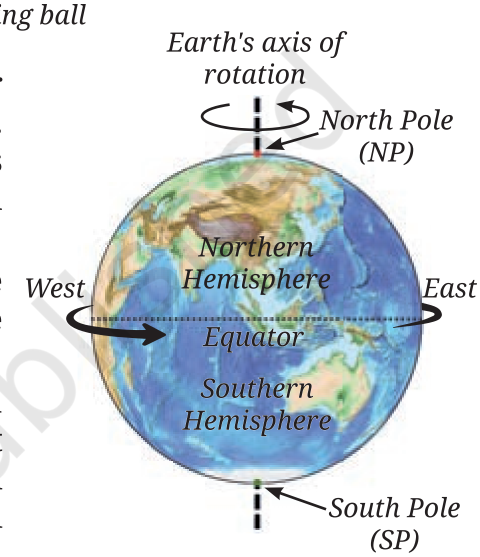


Fig. 12.3: Rotation of the Earth

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

DIVE DEEPER

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.

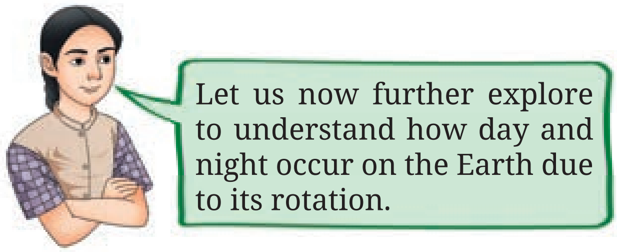


Fig. 12.4(b): Using a globe and a torchlight to understand day and night

- ❖ 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.

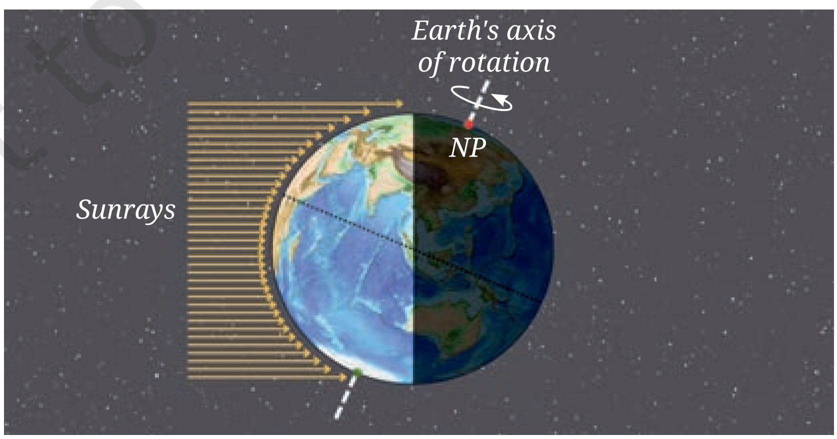


Fig. 12.5: Sunlight falls on half of the Earth's surface

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?

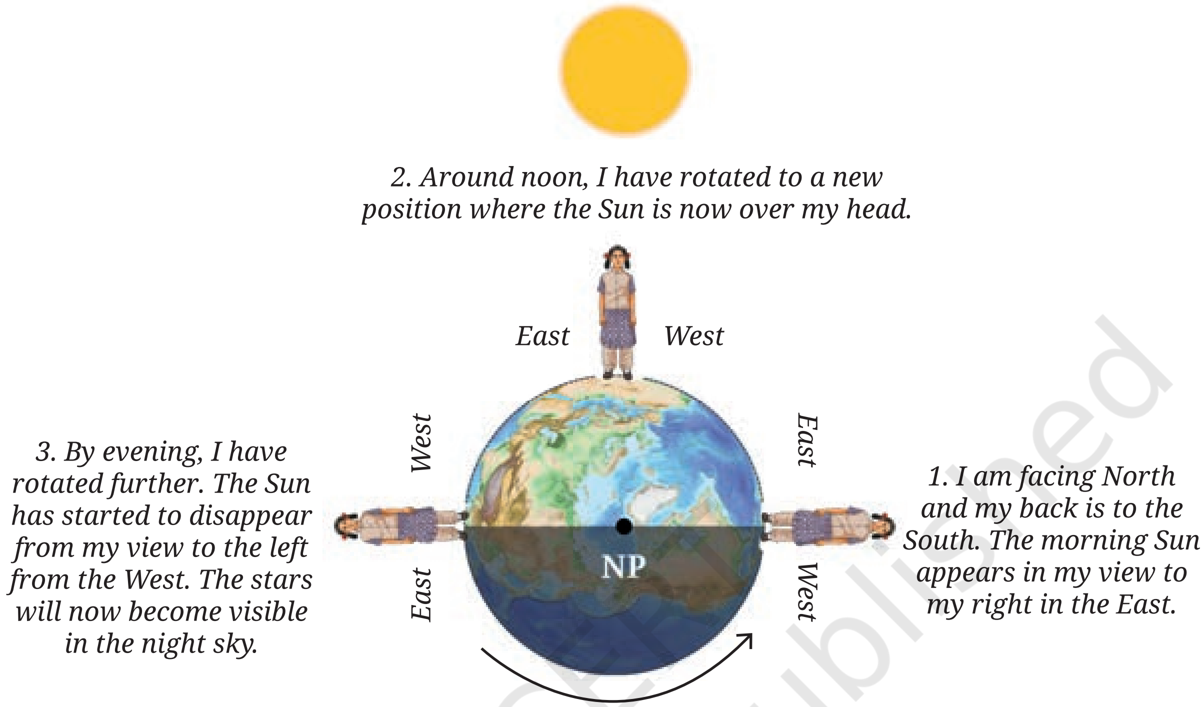
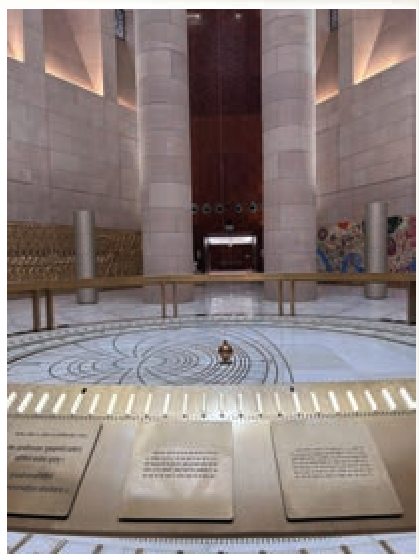


Fig. 12.6: A girl on the rotating Earth viewing the Sun from the Equator

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.

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.

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.

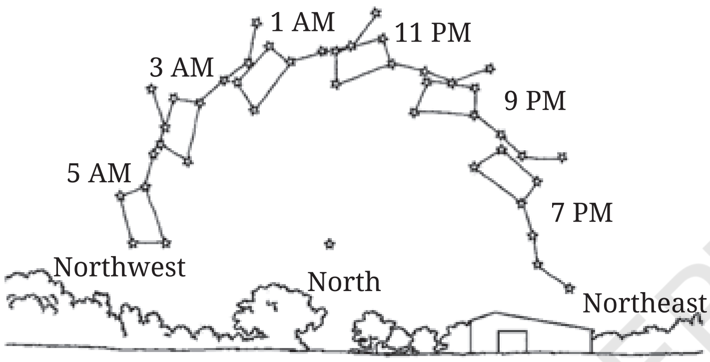


Fig. 12.7: Illustrative sketch of Big Dipper (for activity 12.3) by a student located in Pune on the night of 1–2 April

- ❖ 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.

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*.

अनुलोमगतिर्नौस्थ: 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?

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.

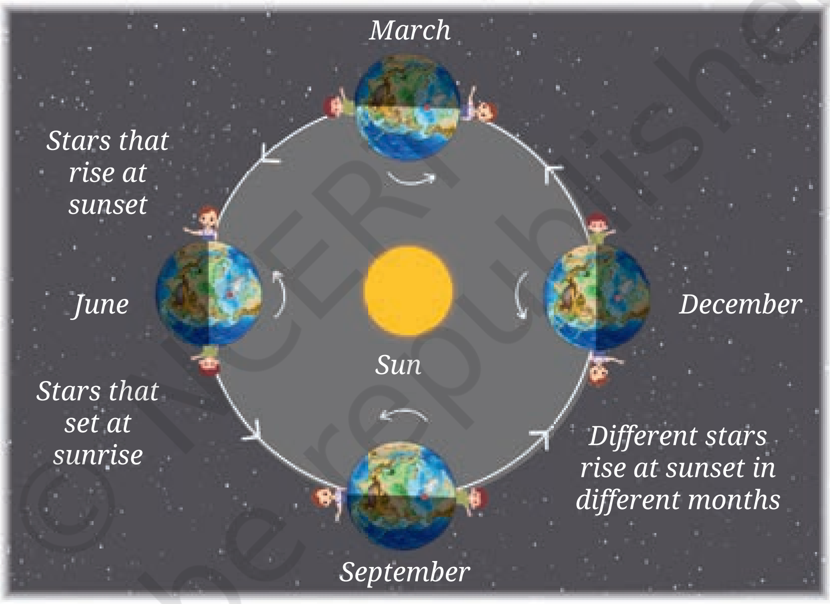


Fig. 12.8: Revolution of the Earth around the Sun leads to changing view of the night sky throughout the year (The sizes and distances are not to scale)

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.

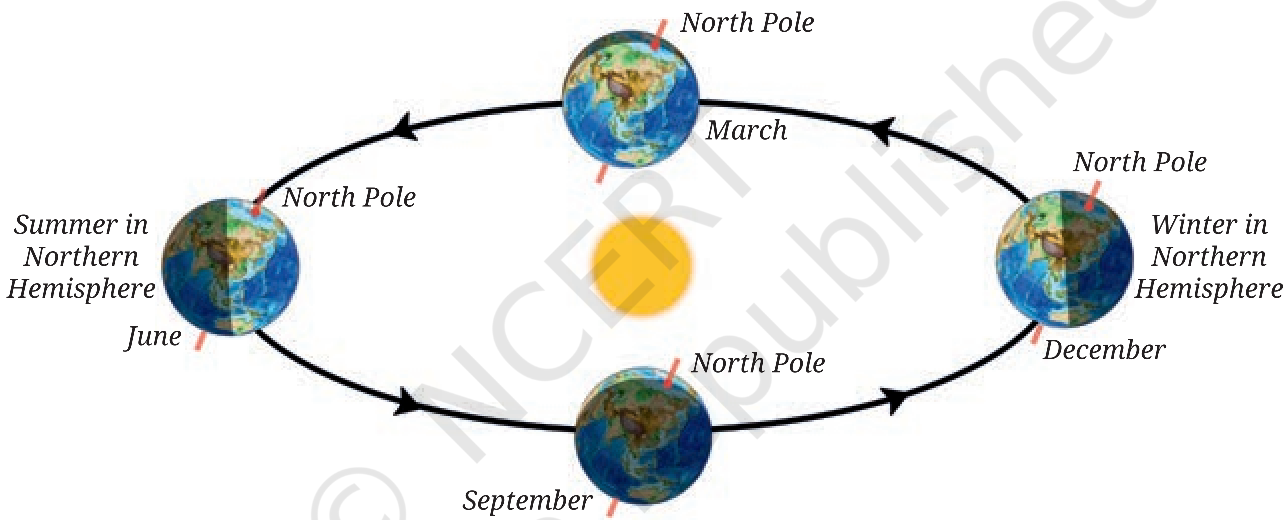


Fig. 12.9: Different positions of the Earth while revolving around the Sun (The Earth's orbit appears elongated because this is a side view and not the top view. The sizes and distances are not to scale)

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).

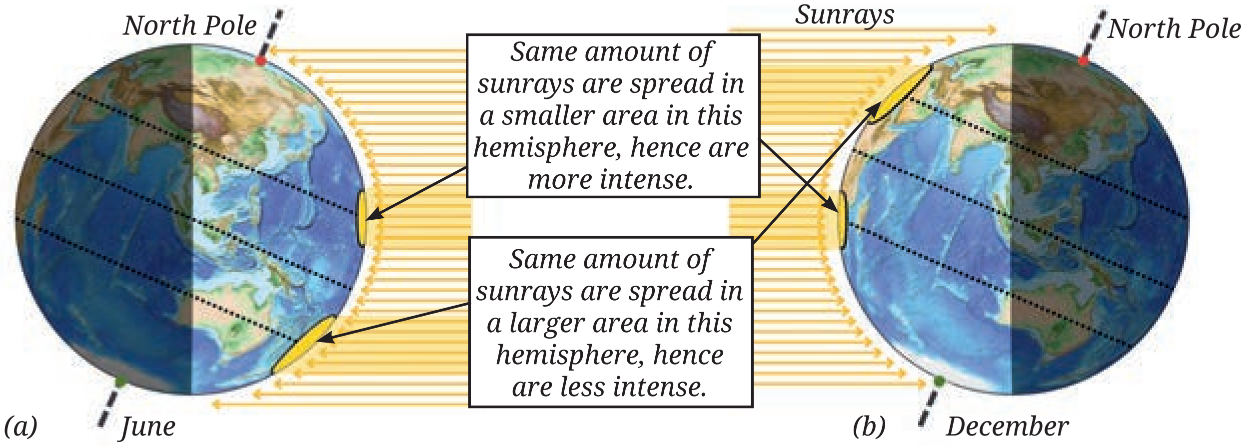


Fig. 12.10: (a) More intense sunlight in the Northern Hemisphere and less intense sunlight in the Southern Hemisphere in June (b) The opposite situation happens in December.

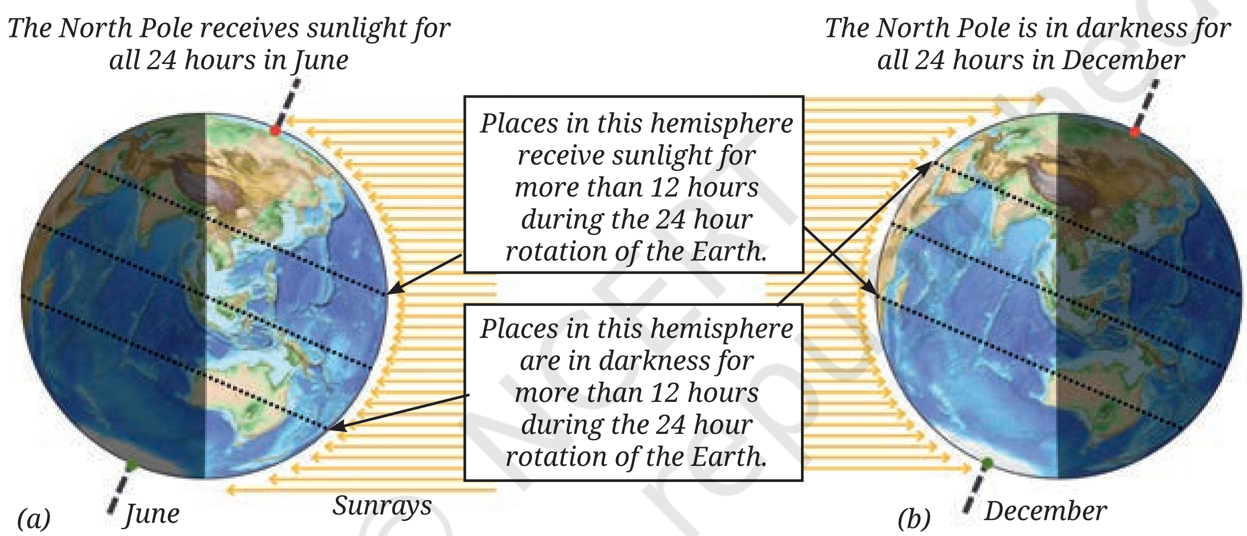


Fig. 12.11: In the Northern Hemisphere (a) Longer daytime in June (b) Shorter daytime in December

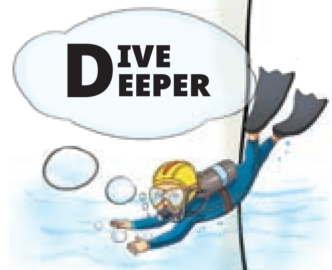
The seasons and length of daytime are reversed in the Southern Hemisphere as compared to the Northern Hemisphere. There, it is winter in June and summer in December (Fig. 12.10 and Fig. 12.11).

DIVE DEEPER

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.



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.

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.

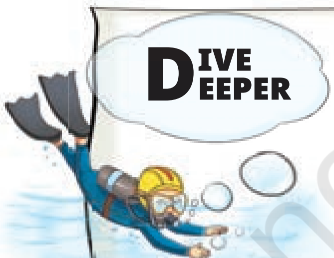
Activity 12.4: Let us explore

- 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.



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).

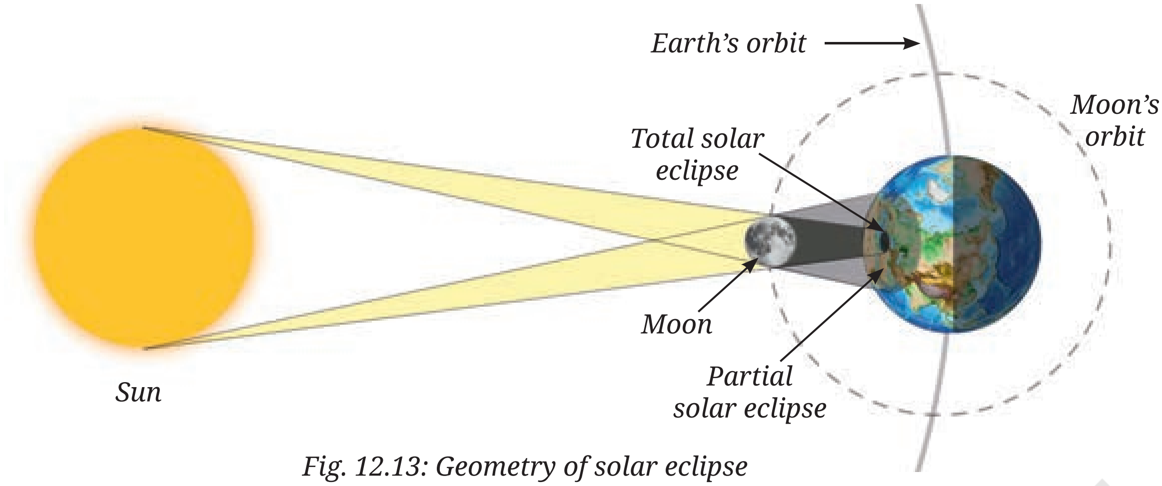
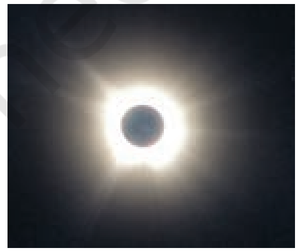


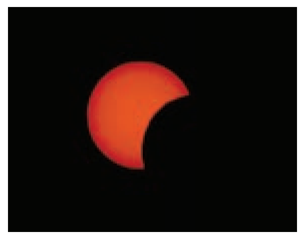
Fig. 12.13: Geometry of solar eclipse (The sizes and distances are not to scale)

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).

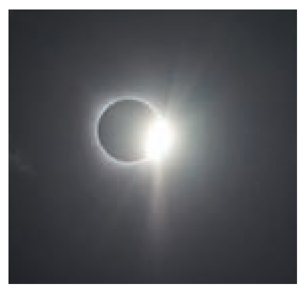
During a total solar eclipse, for a few minutes it turns dark during the day as no sunlight reaches the Earth. Due to the Earth's rotation and the motion of the Moon in its orbit, the Moon's shadow moves across the surface of the Earth. Thus, the total solar eclipse is visible only for a few minutes. 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

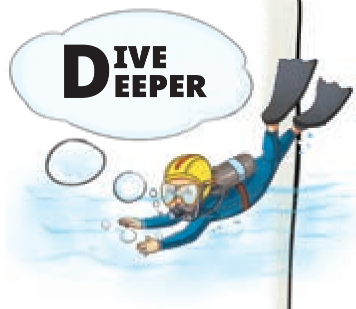
Safe Viewing of a Solar Eclipse

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.

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.

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



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.

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.

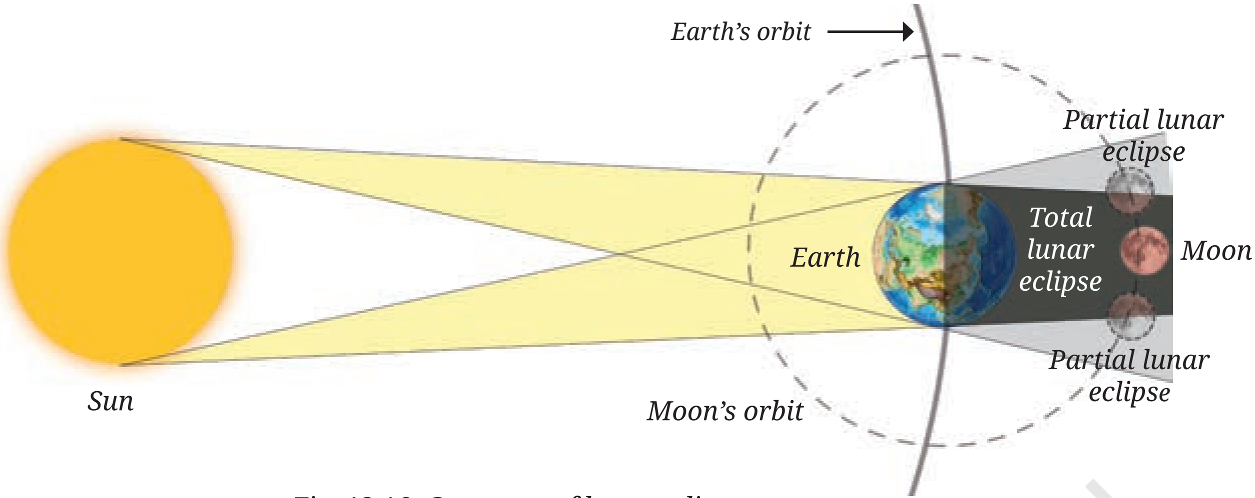


Fig. 12.16: Geometry of lunar eclipse
(The sizes and distances are not to scale in the figure)

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.

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.

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.

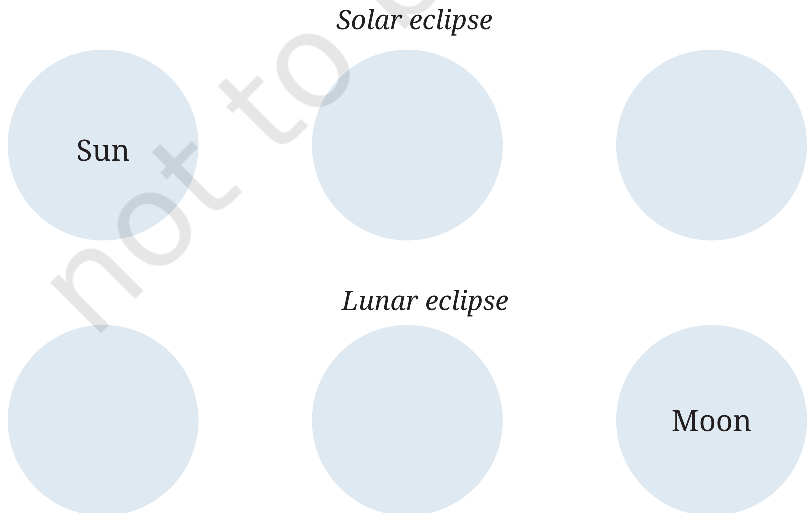
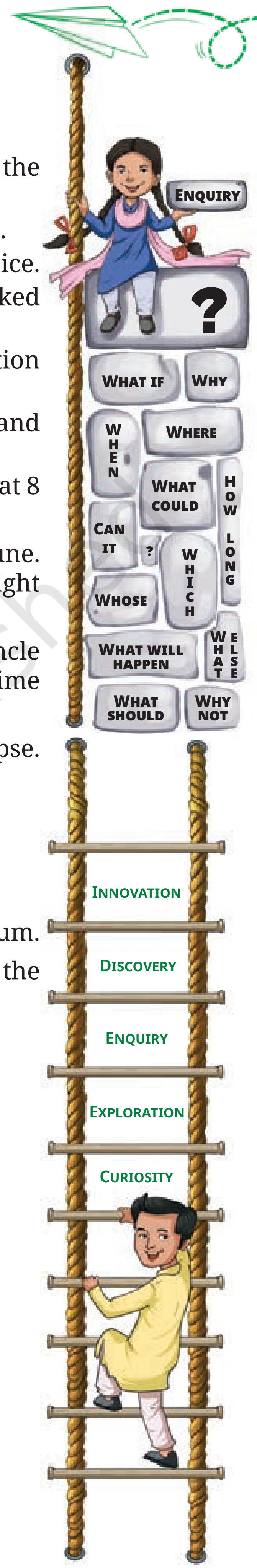
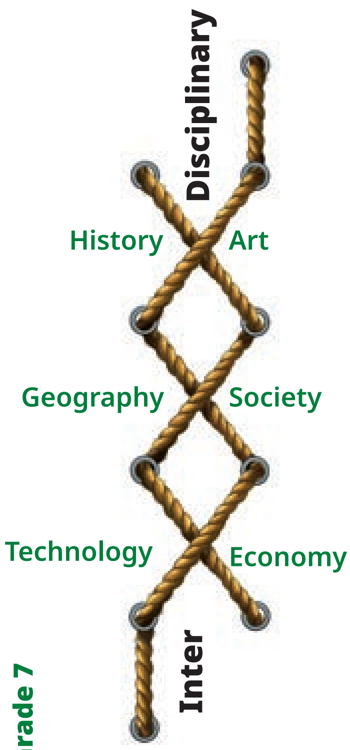


Fig. 12.18



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.

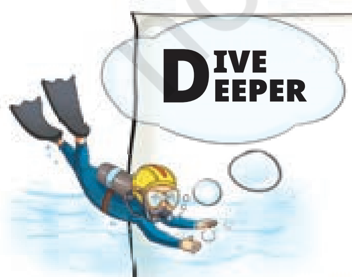
(i) Note down your observations regarding how much of the Northern and Southern hemispheres of the globe are illuminated at different positions.

(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.



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!

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.

Notes