Government of Karnataka

Curiosity

Textbook of Science for Grade 8

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Part - II

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

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About this Book

After exploring the *Curiosity*, Grade 7 textbook, we hope you discovered new ideas and found yourself wondering even more about the world around you! Our journey of exploration continues in *Curiosity* for Grade 8, where you will learn to ask deeper questions, design investigations, and think like real scientists.

The Grade 8 textbook of science has been developed in alignment with the National Education Policy (NEP) 2020 and the National Curriculum Framework for School Education (NCF-SE) 2023. It is expected that all competencies outlined for the final year of Middle Stage (Grade 8) are achieved. This textbook is designed to help you learn about important topics, such as matter, the physical and living world, health, hygiene, and the connection between science, technology, and society. It also helps you understand how science works and how scientists think and explore. The main aim of *Curiosity* is to help you become a responsible and thoughtful member of society.

The textbook integrates topics from biology, chemistry, physics, and earth science. It also incorporates essential themes, such as environmental care, value education, inclusivity, health, hygiene, and India's traditional knowledge systems. The goal is to help you learn through real experiences rather than by simply memorising facts.

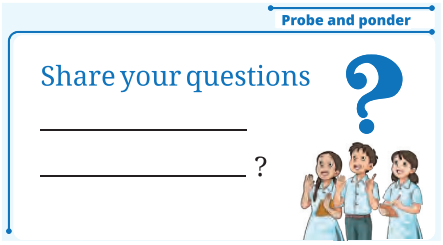
Curiosity, the textbook of science for Grade 8, contains 13 chapters. Each chapter includes engaging activities, thought-provoking questions, and clear illustrations to support your learning. The first chapter is titled **Exploring the Investigative World of Science**. It gives you a quick look at the various topics you will come across in this book and is designed to get you more excited about science! This chapter takes you to the next step—entering the investigative world of science, where curiosity, wonder, and discovery come together. You will learn to ask focused questions, design and try out simple experiments to help answer them, and use your observation, exploration, and investigation skills to understand how things work. This chapter is meant to be a fun and friendly introduction to your science journey.



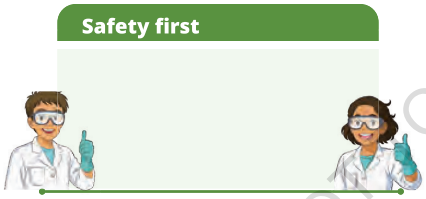
Each chapter begins with a picture linked to the chapter that is designed to spark curiosity, capture your attention, and connect prior knowledge to new concepts. There are a few **Probe and ponder** questions. These are critical thinking questions that are not for evaluation and do not always have simple answers. Instead, they make you think more deeply and explore new ideas. Some of these

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questions are open-ended and thought-provoking because they do not just ask for a fact or a quick answer. Instead, they ask *why* or *how*, encouraging you to think critically and stay curious. You may not always be able to find the answers to these questions even after going through the chapter, but do not worry. They will help you link different concepts and deepen your curiosity, and perhaps help you understand the process of science. Many of these questions will also be explored further in higher grades. In fact, we are sure you may also have such questions, and there is space to add your own!



The activities in the book are designed to reflect how science works, offering both hands-on and minds-on experiences. These activities promote teamwork and are inclusive in nature, ensuring participation from all students. Teachers are expected to pay extra attention while supporting children with special needs, especially during experiments involving light, heating devices, microscopes, etc. Teachers should assist these students in visualising the experimental setup. Additionally, they may encourage peer interactions to help students understand concepts of science better. The text also includes questions to help students assess their understanding and reflect how much they have learnt. Many of these questions are aimed at encouraging students to think deeply, reflect on their own ideas, and analyse concepts critically.



In some activities **Safety first**, has been given to keep students safe, especially when using hot, sharp, or breakable materials. These precautions help prevent accidents and make sure everyone can enjoy the activity while learning safely.

To sustain the students' interest, some challenging ideas, additional information, interesting facts, and other engaging materials are presented in boxes labelled **Ever heard of ...**, which highlight fascinating facts, interesting observations, and curiosity-driven questions.





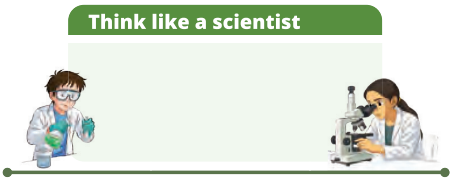
A step further boxes contain advanced concepts that explore the topic in more depth. The information given in these boxes also brings scientific principles and knowledge into real-life

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applications, showing how science has contributed to societal development.

Our scientific heritage offers information about institutions which have contributed to the progress of scientific temper and any personality or their works of 'heritage level repute'.





You will find a **Think like a scientist** section in some chapters, where you can explore the experiment further by making modifications or trying different approaches. It will help you to investigate more deeply and allow new questions to emerge in your minds.

Some chapters also feature a section called **Be a scientist**, where you can learn about the contributions of Indian and international scientists related to the topic. These sections include brief biographies and show how scientists have made a difference. Additionally, an interesting element that has been incorporated in some of the chapters is the introduction of certain verses from various Indian texts to promote rootedness in the learners as envisaged in NEP 2020.

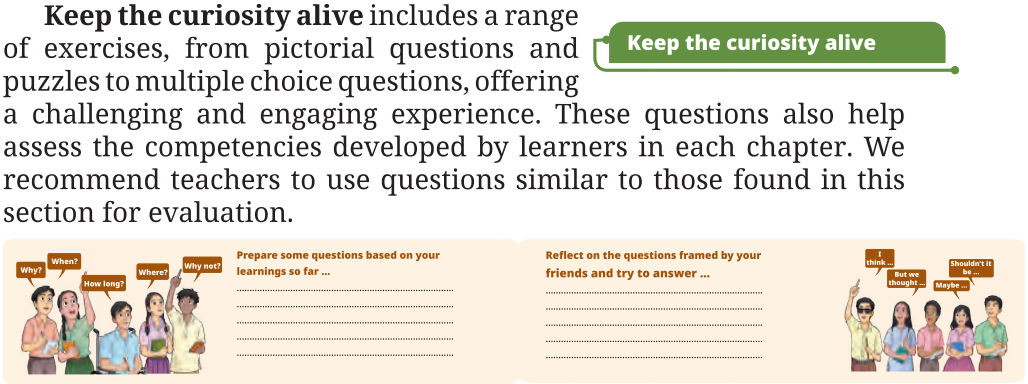


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The **Snapshots** section provides the summary of a chapter, which offers an overview of the chapter's main points, reinforcing the key ideas discussed. Each chapter includes **Keywords** in between the text that highlight key concepts and steps in science, helping learners understand ideas and think critically. These keywords also outline the procedures in scientific activities.



Keep the curiosity alive includes a range of exercises, from pictorial questions and puzzles to multiple choice questions, offering a challenging and engaging experience. These questions also help assess the competencies developed by learners in each chapter. We recommend teachers to use questions similar to those found in this section for evaluation.



A key feature of the book is **Discover, design, and debate**, which includes activities/projects designed to encourage interaction with experts, teachers, parents, and the community. Students are encouraged to gather diverse information and draw their own conclusions. These support the development of thoughtful, active, and compassionate learners. It makes science more fun, meaningful, and connected to life—as it no longer remains about reading and memorising, but also about doing. Some projects may require prior preparation.



Friends! Science is full of wonders, and there is always more to discover. That is why the Grade 8 textbook also ends with a page called **It's never the end, my friend!**

The textbook is one way to learn, but learners should also explore and observe their surroundings. Information and Communication Technology (ICT) can further enhance learning when used appropriately. QR codes in the textbook provide access to interactive resources like videos, puzzles, games, quizzes, audio, and additional content, allowing learners to explore at their own pace.

Now, with *Curiosity* in your hands, keep exploring, keep questioning, and never stop being curious.

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Textbook Development Team

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CONSTITUTION OF INDIA

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

guarantees these

Fundamental Rights

Right to Equality

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

Right to Freedom

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

Right against Exploitation

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

Right to Freedom of Religion

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

Cultural and Educational Rights

- for protection of interests of minorities;
- for minorities to establish and administer educational institutions;
- saving of certain Laws 31A–31D.

Right to Constitutional Remedies

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

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Nature of Matter: Elements, Compounds, and Mixtures

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Probe and ponder

- Which of the entities in the picture above consist of matter, and which of them do not?
- How can elements be combined to form a compound?
- How could the discovery of a compound that absorbs carbon dioxide from the air contribute to solving environmental challenges?
- Share your questions

_____

_____ ?



Have you ever wondered what the world around you is made of? Look around! The staircase you use, the air you breathe, the water in your bottle, the food in your lunch box, the clothes and shoes you wear, the book you read, the trees outside, the ball you play with and even the stick you carry—all of these are examples of **matter**, which you have learnt in earlier grades.

You have also learnt that all these things are made up of tiny particles. Most of the things around us are not made of just one substance; rather they are made up of two or more substances mixed together. Let us now understand how different substances come together to form mixtures.

8.1 What Are Mixtures?



Fig. 8.1: Poha

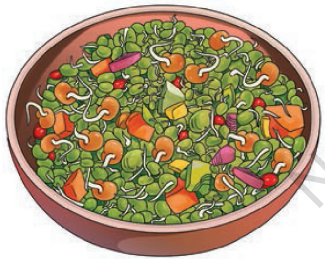


Fig. 8.2: Sprout salad

Have you ever wondered what makes your *poha* (Fig. 8.1) so delicious or how to make the perfect sprout salad? While these dishes may seem very different, they share something in common—they are both made by mixing several ingredients. We **observe** the mixing of substances in everyday life. Sugar dissolved in water is also a mixture, and so are soups and lemonade.

When two or more substances are mixed, where each substance retains its properties, it is called a **mixture**. The individual substances that make up a mixture are called its **components**. The components of a mixture do not react chemically with each other. In some mixtures, the components—like green gram, chickpeas, onion, and tomato in a sprout salad (Fig. 8.2), are easy to see. Such mixtures, where the different components are generally visible with the naked eye or with a magnifying device, are **non-uniform** in nature. Can you **identify** a few more examples of non-uniform mixtures around you?

On the other hand, some mixtures have components that cannot be seen separately even with the help of a microscope. For example, sugar and water particles cannot be seen separately in their mixture. Such types of mixtures, where the components are evenly distributed and cannot be distinguished, are **uniform** in nature (Fig. 8.3). Can you list a few uniform mixtures?



Fig. 8.3: Uniform mixture of sugar and water

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A step further



Do you know that stainless steel is also a mixture? Stainless steel contains iron, nickel, chromium, and a small amount of carbon. They are mixed so uniformly that the entire mixture appears the same throughout and one cannot see the individual substances. Such mixtures are known as alloys. Brass, a mixture of copper and zinc, and bronze, a mixture of copper and tin, are some other examples of alloys (Fig. 8.4).



Fig. 8.4: Utensils made of stainless steel, brass, and bronze

Our scientific heritage



Mishraloha was the name given to the mixture of two or more metals that had properties distinct from its constituent metals. Ancient Indian texts, such as the *Charaka Samhita*, *Susruta Samhita*, *Rasaratna Samucchaya*, *Rasa Jala Nidhi*, etc., mention the use of alloys for medicinal purposes. For example, Bronze, also known as *Kamsya*, is an alloy made up of Copper (*Tamra*, 4 parts) and Tin (*Vanga*, 1 part), was used to improve digestion and boost immunity.

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8.1.1 Is air a mixture?

In *Curiosity*, Grade 6, you learnt about air and its composition in the chapter 'Nature's Treasures'. Is air a mixture? What kind of mixture is it?

You have learnt that air is a uniform mixture of mainly nitrogen, oxygen, argon, carbon dioxide, and water vapour. Out of these, oxygen is required by most of the living beings to stay alive. It also helps in combustion. Nitrogen, which constitutes about 78% of the air, does not take part in combustion. We also learnt that air has water vapour in it. When warm air touches a cool surface, the water vapour turns into liquid water, forming tiny droplets. Recall the experiment where you tested the presence of carbon dioxide in the air that we exhale. Let us **confirm** the presence of carbon dioxide in the air.

Activity 8.1: Let us experiment



Safety first

Perform this step carefully.

- Take a glass tumbler and fill it half with water.
- Add a small amount of calcium oxide (quick lime) slowly to it.
- What do you observe?
- Calcium oxide reacts vigorously with water to form calcium hydroxide and releases heat.

- Stir continuously to make a solution of calcium hydroxide. This solution is called lime water.
- Filter it and observe its colour.
- Leave this colourless solution in a petri dish for a few hours (Fig. 8.5a).
- Keep stirring the solution at regular intervals.
- What do you observe (Fig. 8.5b)?
- Does it turn milky?

Can you **explain** why the solution has turned milky?

You know that lime water turns milky when carbon dioxide reacts with calcium hydroxide to form calcium carbonate (insoluble tiny white particles) and water (Fig. 8.5). Since lime water turns milky when exposed to air, this activity **demonstrates** the presence of carbon dioxide in the air.

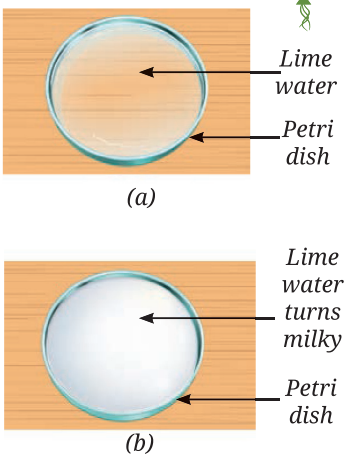


Fig. 8.5: Lime water turns milky in the presence of carbon dioxide

Calcium hydroxide + Carbon dioxide ⟶ Calcium carbonate + Water

Apart from gases, have you ever observed anything else present in the air? Have you ever noticed tiny shining particles moving in a beam of sunlight entering a dark room through a small opening? What are these particles?

Activity 8.2: Let us explore

- Take a black sheet of paper. Ensure that it is free from any visible dust particles.
- Place the black sheet of paper undisturbed near an open window (Fig. 8.6a), or in the garden, for a few hours.
- What do you observe?

You may notice tiny particles settled on its surface. You may use a magnifying glass to **examine** the particles more closely (Fig. 8.6b).

This shows that dust particles are suspended in the air. They are not an integral part of the air and are considered pollutants. The nature and the number of dust particles in the air may vary from time to time and from place to place.

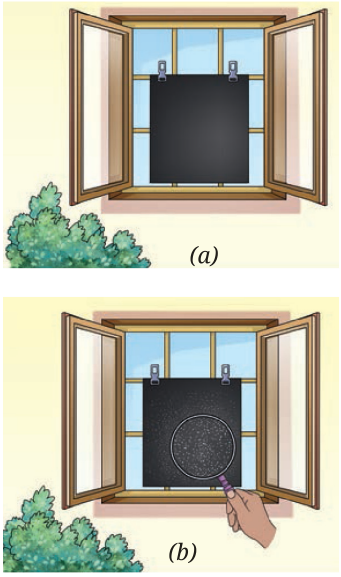


Fig. 8.6: Black sheet of paper (a) with no dust particles; (b) with dust particles

A step further

The major pollutants present in the air are particulate matter (dust, soot) and gases like carbon monoxide, ozone, nitrogen dioxide, and sulfur dioxide. The **air quality index** (AQI) is a tool used to describe the air quality.



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8.1.2 Types of mixtures

You know that the term 'mixture' in common usage refers to the mixing of two or more components. The components of a mixture may themselves be mixtures, as in *poha* and sprout salad, or pure substances like sugar or common salt dissolved in water. However, in science, all the components of a mixture must be pure substances only.

Mixtures could be of several types depending on the physical state of their components. Some mixtures with their examples are shown in Table 8.1. Complete the third column—

Table 8.1: Different types of mixtures

S.No.	Mixture-type	Examples	Uniform or non-uniform
1.	Gas and gas	Air	Uniform
2.	Gas and liquid	Aerated water (soda water) Oxygen dissolved in water	....
3.	Solid and gas	Carbon particles in air	.....
4.	Liquid and liquid	Acetic acid in water (vinegar) Oil and water	....
5.	Solid and liquid	Sand and water Seawater	....
6.	Solid and solid	Baking powder (baking soda and tartaric acid) Alloys	....

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You learnt in earlier grades about the separation of mixtures. It is done to separate the components of a mixture. The examples discussed were from everyday life, where separation is done to obtain the component of interest and other components are discarded. However, in science, the purpose of separating a mixture is to obtain pure substances.



Fig. 8.7: Some consumable items

8.2 What Are Pure Substances?

Have you ever noticed the word 'pure' written on the packs of some consumables, such as milk, ghee, and spices (Fig. 8.7)? The word 'pure' has slightly different meanings in common usage and in science.

In common usage, '**pure**' means unadulterated products. **Adulteration** is an illegal process of adding substances which are cheaper, or of a poor quality, to a product. This is usually done to increase the quantity or reduce the manufacturing cost. However, it deteriorates the quality of the product. It can also make the product hazardous to health.

In science, however, a pure substance is the one that has no other substance present in it. For a scientist, even these products that look pure can be considered **impure** if they are made of more than one substance.

A pure **substance** is a kind of matter that cannot be separated into other kinds of matter by any physical process. When a scientist says that something is pure, it means that the substance consists of the same type of particles.



A step further

According to science, how would you **classify** milk, packed fruit juice, baking soda, sugar, and soil—as mixtures or pure substances?

8.3 What Are the Types of Pure Substances?

Recall the different states of water that you studied in *Curiosity*, Grade 6. What happened when water was cooled or heated? We observed that on cooling water gets converted into ice, and on boiling it gets converted into vapour. We can get back water up on heating ice or cooling water vapour. It shows that during these processes, the particles of water remain the same. Now, let us **perform** another activity in which we pass electricity through water and observe its effect.

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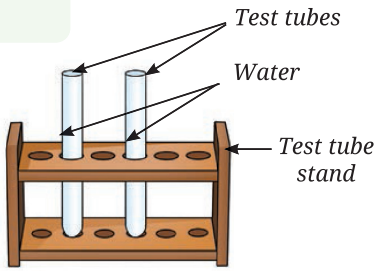
Activity 8.3: Let us experiment (Demonstration activity)

Safety first

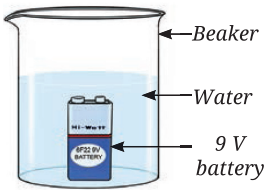
This activity must be performed under the supervision of the teacher. Be careful while handling sulfuric acid. Do not use lithium-ion battery.



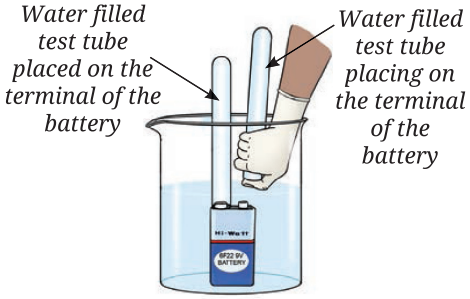
- Collect two small test tubes, a beaker or a glass tumbler, and a 9 V battery.
- Fill 2/3rd of the beaker with water and add a few drops of dilute sulfuric acid to it.
- Fill both the small test tubes completely with water taken from the beaker (Fig. 8.8a).
- Place a 9 V battery inside the beaker (Fig. 8.8b).
- Without spilling the water, carefully place the water-filled test tubes on each of the terminals of the battery (Fig. 8.8c).



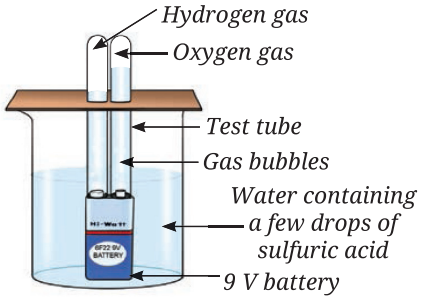
(a) Test tubes filled with water



(b) 9 V battery placed inside the beaker containing water



(c) Water filled test tubes placing over the terminals of the battery



(d) Gases collected in the test tubes

Fig. 8.8: Passing electricity through water

- Wait for a few minutes.
- Do you observe the formation of any gas bubbles at both the terminals inside the test tubes?
- Let it continue for 10–15 minutes.
- Observe the volume of gas collected in each test tube (Fig. 8.8d).
- Is the volume of the gas collected the same in both the test tubes?
- Remove these test tubes one-by-one carefully.
- Test these gases one-by-one by bringing a burning candle close to the mouth of the test tubes.
- What happens in each case?
- Which gas is present in each test tube?



Can these collected gases be water vapour?



These gases are not water vapour otherwise they would have condensed back to form water. Let us try to identify these gases.



Safety first

Perform gas testing with care. Maintain a safe distance from the set-up.

To test the gases present in the two test tubes, bring a burning candle near the mouth of each test tube. A pop sound can be heard from one, indicating the presence of hydrogen gas (Fig. 8.9a). In the other test tube, the flame of the burning candle will glow brighter, confirming the presence of oxygen gas (Fig. 8.9b).

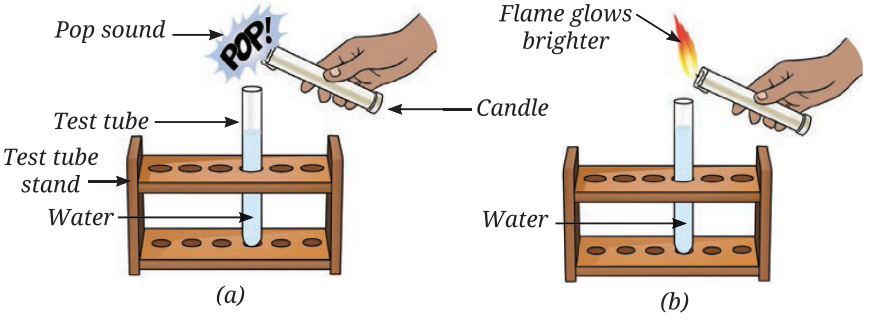


Fig. 8.9: Testing the nature of gas (a) hydrogen; (b) oxygen

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From Activity 8.3, we can **infer** that water is composed of two different constituents—hydrogen and oxygen.

Water ⟶ Hydrogen + Oxygen

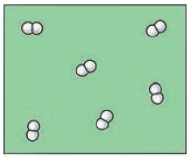
Ever heard of ...



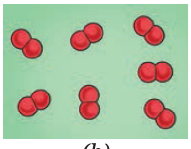
When electric current is passed through water, it breaks down into hydrogen and oxygen. Is this a chemical change or a physical change? Recall *Curiosity*, Grade 7, chapter 'Changes Around Us: Physical and Chemical'.

8.3.1 Elements

The two substances hydrogen and oxygen formed in Activity 8.3, are pure substances and are termed as **elements**. Each element is made up of identical particles called atoms. These particles are different from the particles of any other element. Elements are substances that cannot be further broken down into simpler substances. They are the building blocks of all matter. Some other examples of elements are gold, silver, sulfur, carbon, etc.



(a)



(b)

Fig. 8.10: Depiction of molecules of (a) hydrogen; (b) oxygen

A step further

The atoms of most of the elements cannot exist independently. Two or more such atoms combine and form a stable particle of that element called a molecule. For example, two atoms of hydrogen combine to form one molecule of hydrogen. Similarly, two atoms of oxygen combine to form one molecule of oxygen (Fig. 8.10).



Elements can be classified into **metals** and **non-metals**. You have already studied that gold, silver, magnesium, iron, and aluminium are metals, whereas carbon, sulfur, hydrogen, and oxygen are non-metals. Isn't it interesting to know that some elements like silicon and boron have intermediate properties between those of metals and non-metals? They are called **metalloids**, about which you will learn in higher grades.

A step further

- The number of elements known at present is 118, and most of them exist in a solid state.
- Eleven elements exist in a gaseous state at room temperature, all of which are non-metals like oxygen, helium, nitrogen, etc.
- Only two elements are liquid at room temperature—mercury, which is a metal and bromine, which is a non-metal.
- Although gallium and caesium are solid elements, they become liquid at a temperature around 30 °C (303 K) and turn into liquid.



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A step further

More than 45 different elements, like aluminium, copper, silicon, cobalt, lithium, gold, silver, etc., are used in manufacturing a mobile phone, including its screen, battery, and other components.

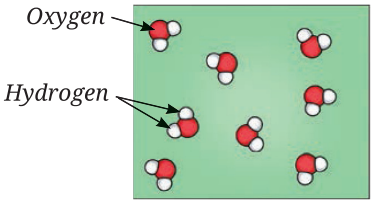
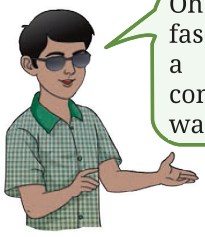


Fig. 8.11: Depiction of molecules of water

8.3.2 Compounds

Why cannot we separate hydrogen and oxygen present in water by physical means?

In water, the particles of hydrogen and oxygen are so tightly attached to each other that it is generally impossible to separate them apart using physical methods. That is why water is a compound. **Compounds** are formed when different elements combine in fixed ratios to form something entirely new. The properties of compounds are different from those of elements forming that compound. The constituent elements of a compound cannot be separated by any physical method. From Activity 8.3, we find that molecules of water are made of two different elements: hydrogen and oxygen (Fig. 8.11), combined chemically in a fixed ratio. The ratio of the number of atoms of hydrogen to oxygen in water has been found to be 2:1.



Are common salt and sugar elements or compounds? Let us find out.

Sodium, a soft metal, and chlorine, a hazardous gas, combine to form a harmless yet taste-enhancing substance that is essential for our lives. This substance is known as sodium chloride, which is made up of particles of sodium and chlorine in a 1:1 ratio. We learnt that dissolved sodium chloride (common salt) may be separated from water by the physical process of evaporation.

Is it possible to separate sodium chloride into its elements by physical processes?

Let us now explore if we can separate the elements in sugar!

Activity 8.4: Let us experiment



Safety first

This activity must be performed in the presence of a teacher.

- Put a teaspoon of sugar in a boiling tube.
- Heat it gently as shown in Fig. 8.12a.
- What do you observe?

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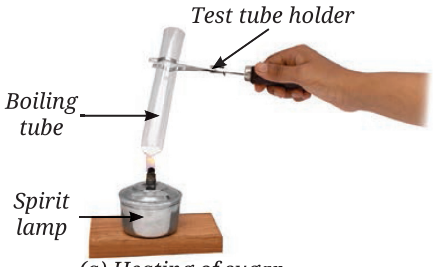
As you heat the sugar, it turns brown (Fig. 8.12b). Later, it begins to char, i.e., it turns blackish (Fig. 8.12c).

You will find small droplets of water inside the boiling tube near its open end. Where did this water come from? Was it in the dry sugar, or did it come by the condensation of water vapour in the air?

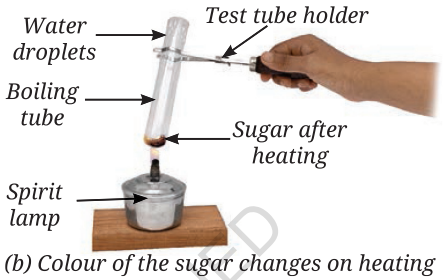
Since we are heating the tube, the water must have come from the dry sugar and not from the air. Can you **predict** what is left behind? Charcoal (carbon) is left behind in the boiling tube. You can scoop it out in a watch glass (Fig. 8.12c) and explore if it burns like coal.

Sugar decomposes on heating and gives carbon and water. As you know, water consists of hydrogen and oxygen. Hence, sugar cannot be an element. It may be stated that sugar is a chemical compound consisting of the elements carbon, hydrogen, and oxygen.

Let us explore more about compounds.



(a) Heating of sugar



(b) Colour of the sugar changes on heating



(c) Charcoal placed on a watch glass

Fig. 8.12: Heating sugar in a boiling tube

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Activity 8.5: Let us experiment (Demonstration activity)

Safety first

This activity may be demonstrated under the supervision of the teacher. It may be performed in a fume hood or a well-ventilated area. Do not inhale the gases.



- Take 5.6 grams of iron filings (Fig. 8.13a) and 3.2 grams of sulfur powder (Fig. 8.13b) on a watch glass. Observe them carefully.

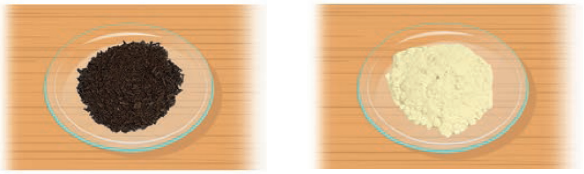

(a) (b)

Fig. 8.13: (a) Iron filings; (b) Sulfur powder

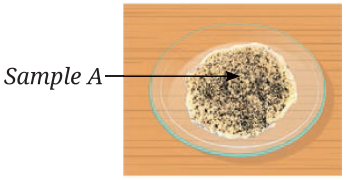
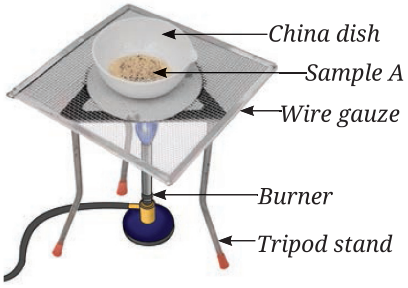
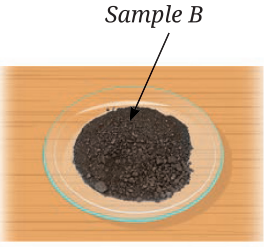


Fig. 8.14: A mixture of iron filings and sulfur powder

- Mix them thoroughly in a watch glass. Label this mixture as Sample A (Fig. 8.14).
- Observe it carefully.
- Is this a uniform or a non-uniform mixture? Can you still observe both iron and sulfur as separate substances?



(a)



(b)

Fig. 8.15: (a) Heating Sample A; (b) Black mass

- Take half of Sample A in a china dish and gently heat it (Fig. 8.15a) with continuous stirring until a black mass is formed.
- Let the content of the china dish cool.
- Place this black mass in a mortar and grind it with the help of a pestle.
- Now, put it on another watch glass and label it as Sample B (Fig. 8.15b).
- Now, you have two samples— Sample A and Sample B (Fig. 8.16a and 8.16b). **Compare** both the Samples A and B step by step and **record** your observations in Table 8.2.

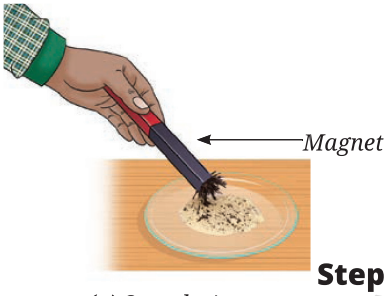


(a)

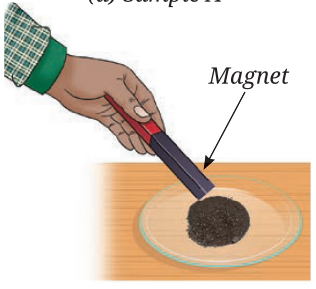


(b)

Fig. 8.16: (a) Sample A; (b) Sample B



(a) Sample A



(b) Sample B

Fig. 8.17: Responses of Samples A and B to a magnet

Step 1 — Appearance

- Compare the appearance of Sample A and Sample B like colour and texture.

Step 2 — Magnet test

- Take a magnet and move it over the Samples A (Fig. 8.17a) and B (Fig. 8.17b), one by one.
- What do you observe?

Step 3 — Gas test

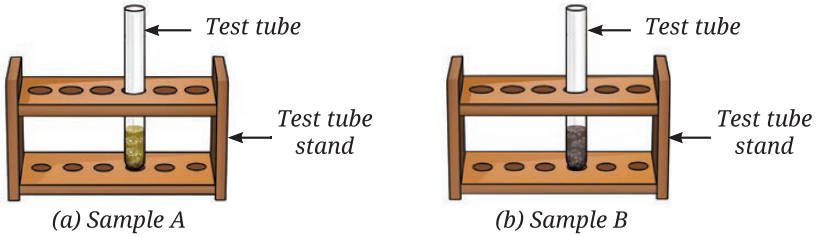
- Take a small amount of Sample A in a test tube and add a few drops of dilute hydrochloric acid (Fig. 8.18a).

Safety first

Be careful while handling hydrochloric acid.



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(a) Sample A (b) Sample B

Fig. 8.18: Samples A and B in dilute hydrochloric acid



Fig. 8.19: Correct way to waft the fumes of an evolved gas

- What do you observe?
- Gently smell the evolved gas by wafting it towards your nose (Fig. 8.19).
- Test the evolved gas by bringing a burning splinter or a lighted candle near the mouth of the test tube (Fig. 8.20a).

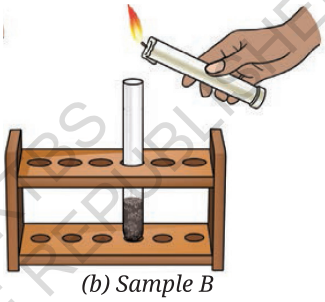
Safety first

Never smell anything directly.





(a) Sample A



(b) Sample B

Fig. 8.20: Testing gases

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- What do you observe?
- Repeat the above steps with Sample B as well (Fig. 8.18b and 8.20b).

Table 8.2: Comparison of Samples A and B

S.No.	Experiment	Observations	
		Sample A	Sample B
1.	Appearance (i) Colour (ii) Texture		
2.	Magnet test		
3.	Gas test (i) Odour (ii) Burning		

Some discussion points

- Do the Samples, A and B look the same?
- Which sample exhibits magnetic properties?
- Can we separate the components of Samples A and B?
- On adding dilute hydrochloric acid, do gases evolve in both Samples A and B?
- In both the cases, do the gases smell the same or different?
- Also, **categorise** the substances used in this activity into mixtures, compounds, and elements.



Sample A

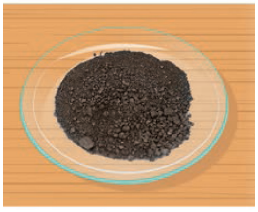
Sample A: We can say that Sample A is a mixture of the two elements—iron and sulfur. Its components retain their properties, and their black and yellow coloured particles can be seen. On bringing magnet near Sample A, the iron filings get attracted towards the magnet. Hence, iron and sulfur can be separated.

You might have observed that in Sample A, iron in the mixture reacts with dilute hydrochloric acid to form iron chloride and hydrogen gas. The gas is colourless, has no smell, and burns with a 'pop' sound.

The reaction can be represented as—

Iron + Dilute Hydrochloric acid → Iron chloride + Hydrogen gas

Sulfur on the other hand, is left as a yellow solid at the bottom of the test tube. This shows that sulfur does not react with hydrochloric acid.



Sample B

Sample B: The black mass obtained in Sample B is iron sulfide. We observe that the texture and the colour are the same throughout. It is formed by heating the two elements, iron and sulfur. It is not attracted by a magnet. The new substance has completely different properties, and iron and sulfur can no longer be separated. Hence, we can say that a compound has been formed. Can you explain now why the magnet has no effect on Sample B?

Also, Sample B, iron sulfide, reacts with dilute hydrochloric acid, to form iron chloride and hydrogen sulfide gas. The gas is colourless and has a rotten egg-like odour.

The reaction can be represented as—

Iron sulfide + Dilute Hydrochloric acid → Iron chloride + Hydrogen sulfide

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8.4 How Do We Use Elements, Compounds, and Mixtures?

Elements, compounds, and mixtures are all around us. The air we breathe is a mixture of gases like oxygen, nitrogen, and carbon dioxide. Water, which is essential for life, is a compound

made of elements, hydrogen and oxygen. Elements like iron and aluminium are used to construct bridges, buildings, and vehicles.

Understanding these concepts is not just about recognising what surrounds us; it is also the key to innovation. For instance, chemists study how elements combine to create compounds, enabling them to invent life-saving medicines and vaccines to fight diseases. This knowledge also helps in the creation of fertilisers thereby enhancing crop production that feeds the ever-increasing human population globally.

Engineers and material scientists rely on their understanding of compounds and mixtures to design materials with unique properties. For example, they have developed alloys like stainless steel, which is stronger and more durable than pure iron. Wood, steel, and concrete, which are used as building materials, are all mixtures.

You learnt that various metals are obtained from minerals. Let us learn about these minerals.

A step further



Fig. 8.21

An example of a 'wonder' material developed by material scientists is graphene aerogel. This is made from carbon and is said to be the lightest material on earth. It is so light that even grass can hold it (Fig. 8.21). It is highly porous and therefore, has a high absorbing capacity. For this reason, it can potentially be used as an environmental cleaner, for example, to clean up oil spills in both seas and on land. It is useful in fabricating energy-saving devices and special coatings for buildings.



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8.5 What Are Minerals?

Most rocks are a mixture of **minerals**, which can be viewed with the eyes, or by using a magnifying glass or a microscope. Some of the minerals are called native minerals, which are pure elements and not compounds. These can be metals, such as gold, silver, copper, etc., or non-metals like sulfur, carbon, etc.

Most of the minerals are compounds made up of more than one element. Some common examples of minerals include quartz, calcite, mica, pyroxene, and olivine (Fig. 8.22). Many things that we use in our everyday life are made up of minerals or elements extracted from minerals. For example, cement is made from calcite, quartz, alumina, and iron oxide, which are minerals or are obtained from minerals. Talcum powder is made from the mineral talc.



Fig. 8.22: Some minerals

Our scientific heritage

Use of elements, compounds, and mixtures in Indian Art

The Dhokra art is an old craft from Bihar and Odisha that uses different metals to create beautiful figures inspired by nature (Fig. 8.23). The process begins with shaping a design in beeswax. This wax model is covered with clay to make a mould. After the clay hardens, the wax is melted out, leaving a hollow space. This space is then filled with molten brass or bronze which makes Dhokra art strong and gives it a shiny golden colour. The figures often show animals, people, and nature, reflecting tribal creativity and tradition.



Fig. 8.23: Dhokra art



Elements and compounds are the building blocks of matter—everything that has mass and takes up space. They make the materials we see and use every day. However, not everything around us is matter. Light, heat, electricity, and even thoughts and emotions are important parts of our world, but they are not made of matter. Understanding what matter is—and what it is not—helps us better understand the world around us.

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Snapshots

- A mixture consists two or more substances mixed together. These substances retain their individual properties and do not react chemically with each other.
- The individual substances that make up a mixture are called its components.
- A pure substance consists the same type of particles. All the constituent particles of that substance behave identically.
- Pure substance can be either an element or a compound.
- Elements are the simplest substances that cannot be broken down further into simpler substances. They are the building blocks of all matter.
- Substances which are composed of two or more elements combined chemically in a fixed ratio and have different properties from their constituent elements are called compounds.
- Minerals are natural, solid substances found on the Earth. They have a fixed chemical composition. Most often they are compounds but rarely, they can also be pure elements.

Keep the curiosity alive

1. Consider the following reaction where two substances, A and B, combine to form a product C:

   $$A + B \longrightarrow C$$

   Assume that A and B cannot be broken down into simpler substances by chemical reactions. Based on this information, which of the following statements is correct?
   (i) A, B, and C are all compounds and only C has a fixed composition.
   (ii) C is a compound, and A and B have a fixed composition.
   (iii) A and B are compounds, and C has a fixed composition.
   (iv) A and B are elements, C is a compound, and has a fixed composition.
2. Assertion: Air is a mixture.
   Reason: A mixture is formed when two or more substances are mixed, without undergoing any chemical change.
   (i) Both Assertion and Reason are true and Reason is the correct explanation for Assertion.
   (ii) Both Assertion and Reason are true, but Reason is not the correct explanation for Assertion.
   (iii) Assertion is true, but Reason is false.
   (iv) Assertion is false, but Reason is true.
3. Water, a compound, has different properties compared to those of the elements oxygen and hydrogen from which it is formed. Justify this statement.
4. In which of the following cases are all the examples correctly matched? Give reasons in support of your answers.
   (i) Elements — water, nitrogen, iron, air.
   (ii) Uniform mixtures— minerals, seawater, bronze, air.
   (iii) Pure substances— carbon dioxide, iron, oxygen, sugar.
   (iv) Non-uniform mixtures — air, sand, brass, muddy water.
5. Iron reacts with moist air to form iron oxide, and magnesium burns in oxygen to form magnesium oxide. Classify all the substances involved in the above reactions as elements, compounds or mixtures, with justification.

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Prepare some questions based on your learnings so far ...

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.....



6. Classify the following as elements, compounds, or mixtures in Table 8.3.
   Carbon dioxide, sand, seawater, magnesium oxide, muddy water, aluminium, gold, oxygen, rust, iron sulfide, glucose, air, water, fruit juice, nitrogen, sodium chloride, sulfur, hydrogen, baking soda.

Table 8.3

Elements	Compounds	Mixtures

Identify pure substances amongst these and list them below.

Pure substances

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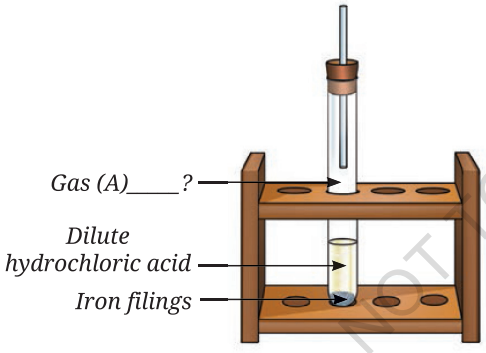
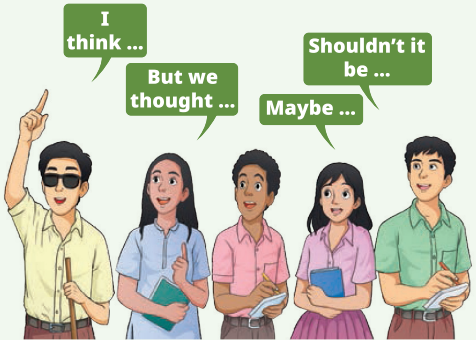


Fig. 8.24

7. What new substance is formed when a mixture of iron filings and sulfur powder is heated, and how is it different from the original mixture? Also, write the word equation for the reaction.
8. Is it possible for a substance to be classified as both an element and a compound? Explain why or why not.
9. How would our daily lives be changed if water were not a compound but a mixture of hydrogen and oxygen?
10. Analyse Fig. 8.24. Identify Gas A. Also, write the word equation of the chemical reaction.
11. Write the names of any two compounds made only from non-metals, and also mention two uses of each of them.
12. How can gold be classified as both a mineral and a metal?



Reflect on the questions framed by your friends and try to answer ...

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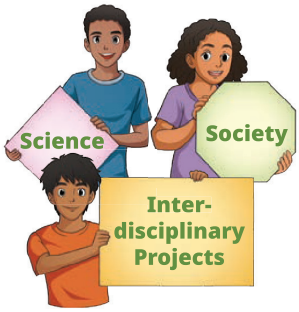
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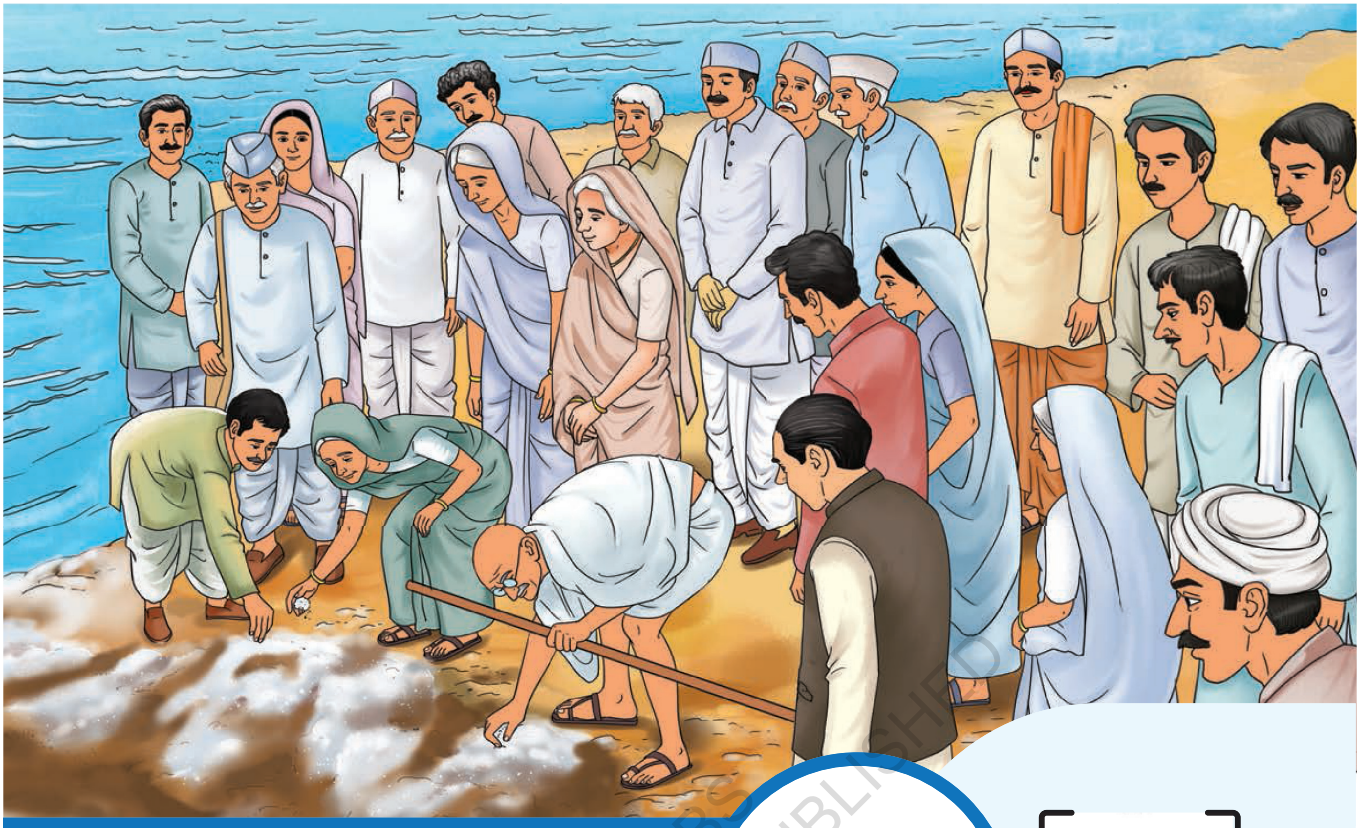
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Discover, design, and debate



- Design and create comic strips from real-life examples to differentiate between elements, compounds, and mixtures with diagrams and illustrate their properties and uses.
- Search for discoveries of some elements (such as phosphorus, sodium), compounds (such as penicillin) and mixtures (such as brass, bronze, stainless steel). Present your findings in the class.
- Let us search: Read labels on items like detergents or snacks, and try to list the mixtures and compounds they contain.
- Work in groups: Each group will pretend to be in the role of either an element, a compound, or a mixture. Debate which category among them is the most important.

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The Amazing World of Solutes, Solvents, and Solutions

9

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Probe and ponder

- What do you think is happening in the picture above?
- What happens when you add too much sugar to your tea and it stops dissolving? How can you solve this problem?
- Why do sugar and salt dissolve in water but not in oil? Why is water considered a good solvent?
- Why are water bottles usually tall and cylindrical in shape instead of spherical?

Share your questions

_____

_____ ?



You must have taken an Oral Rehydration Solution (ORS) at some time in your life. ORS is used to treat dehydration by keeping your body hydrated. You have learnt to prepare ORS at home in *Curiosity*, Grade 6. You may have wondered why every sip of your homemade ORS tastes the same, no matter how much you drink. Why does it not taste salty in one sip and sweet in another?



Fig. 9.1: Mixture of sugar, salt, and water

This is because when you add sugar and salt to water, they form a mixture in which the components are evenly distributed throughout.

Can you **predict** whether this mixture is uniform or not (Fig. 9.1)? What happens when chalk powder is mixed with water—does it form a uniform mixture?



Fig. 9.2: Mixture of (a) Sand and water; (b) Sawdust and water

When salt and sugar are mixed with water, a **uniform mixture** is formed, whereas when chalk powder or sand, or sawdust is mixed with water, the components are not evenly distributed. Such mixtures are known as **non-uniform mixtures** (Fig. 9.2a and 9.2b).

Let us **explore** the science of mixing things together.

9.1 What Are Solute, Solvent, and Solution?

A uniform mixture, such as that of salt or sugar, and water, is called a solution. Whenever a solid is mixed with a liquid to form a solution, the solid component is called the **solute**, and the liquid component is called the **solvent**. The solute dissolves in the solvent to form a **solution** (Fig. 9.3).

Solute + Solvent ⟶ Solution

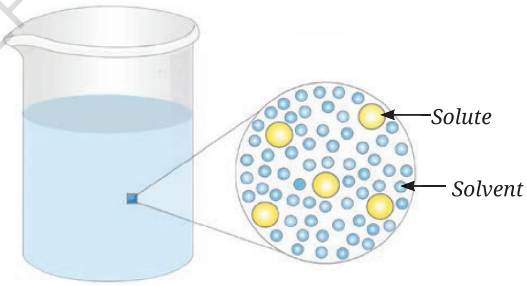
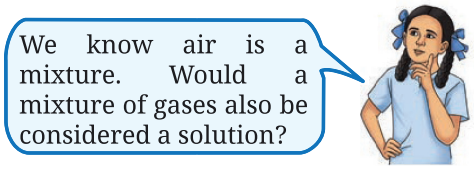


Fig. 9.3: Magnified schematic picture of a solute evenly distributed in a solvent

When a solution is formed by mixing two liquids, it is not always clear which substance is dissolving the other. In such cases, the substance present in smaller amount is called the solute, while the one in larger amount is called the solvent.



Just as water can act as a solvent in liquid solutions, gases can also form solution— with air being a common example.

Air is a gaseous solution. Since nitrogen is present in the largest amount in the air, it is considered as the solvent, while oxygen, argon, carbon dioxide, and other gases are considered as solutes.

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Ever heard of ...



The *Chashni* (sugar syrup) of the Indian sweet Gulab jamun is made of a large amount of sugar (solid) dissolved in a small amount of water (liquid). However, the water is still considered as the solvent and sugar as the solute (Fig. 9.4)!

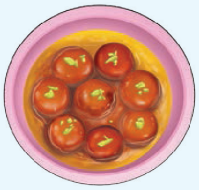


Fig. 9.4: Gulab jamuns dipped in sugar syrup

9.2 How Much Solute Can a Fixed Amount of Solvent Dissolve?

Activity 9.1: Let us investigate



What will happen if we keep on adding more salt in a given amount of water?

- Take a clean glass tumbler and fill it half with water.
- Add one spoon of salt into it and stir well till it dissolves completely (Fig. 9.5).
- Gradually add a spoonful of salt into the glass tumbler and stir. **Observe** how many spoons of salt you can add before it stops dissolving completely.
- **Record** your observations in Table 9.1.

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Table 9.1: Dissolution of salt in water

Amount of salt taken (teaspoon)	Observation (salt dissolves/salt does not dissolve)
One	
Two	
Three	
Four	
...	

Some discussion points

- How many spoons of salt were you able to dissolve before some of it remained undissolved?
- What does this indicate about the capacity of water to dissolve salt?

You might have observed that, initially, the salt completely dissolves in the water, forming a solution. After adding a few more spoons of salt, a stage comes when the added salt does not dissolve completely and the undissolved salt settles at the bottom. This indicates that the water can no longer dissolve any more salt because it has reached its limit. The solution in which more solute can be dissolved at a given temperature, is called an **unsaturated solution** (Fig. 9.5). However, when the solute stops dissolving and begins to settle at the bottom, the solution is called a **saturated solution** at that particular temperature (Fig. 9.6).



Fig. 9.5: Unsaturated solution

The amount of solute present in a fixed quantity of solution (or solvent) is termed as its **concentration**. Depending upon the amount of solute present in a fixed quantity of solution, it can be called a **dilute solution** (less amount of solute) or a **concentrated solution** (more amount of solute). Dilute and concentrated are relative terms.

So, one can say in Activity 9.1, the solution obtained by dissolving one spoon of salt is dilute as compared to that obtained by dissolving two or more spoons of salt.

Can you now **reflect** — which solution is more concentrated; 2 spoons of salt in 100 mL of water or 4 spoons of salt in 50 mL of water?

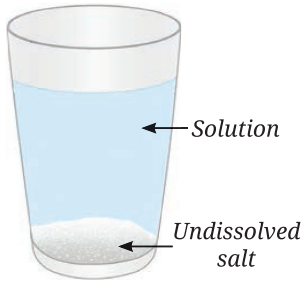


Fig. 9.6: Saturated solution

From Activity 9.1, we can say that the maximum amount of solute that dissolves in a fixed quantity of the solvent is called its **solubility**.

Does temperature affect the solubility of a solute?
Let us find out!

9.2.1 How does temperature affect the solubility of a solute?

Activity 9.2: Let us experiment (Demonstration activity)

- Take about 50 mL of water in a glass beaker and **measure** its temperature using a laboratory thermometer, say 20 °C.
- Add a spoonful of baking soda (sodium hydrogen carbonate) to the water and stir until it dissolves. Continue adding small amounts of baking soda while stirring, till some solid baking soda is left undissolved at the bottom of the beaker.

Safety first

Be careful while using the heating device.



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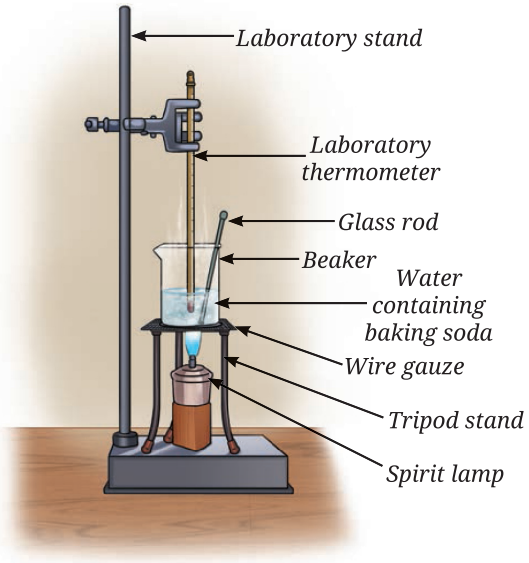


Fig. 9.7: Dissolution of baking soda in water

- Now, heat the contents to 50 °C while stirring (Fig. 9.7).
- What happens to the undissolved baking soda?
- You will observe that it has dissolved.
- Continue adding more baking soda while stirring at this temperature until some solid baking soda remains undissolved.
- Again, heat the contents further to 70 °C while continuing to stir. What do you observe?
- The undissolved baking soda dissolves.
- What do you **infer** from this experiment?

Water at 70 °C dissolves more baking soda than water at 50 °C. The amount of baking soda dissolved in water at 20 °C is even lesser.

It has been found that for most of the substances, the solubility increases with an increase in temperature. We can also say that a saturated solution at a particular temperature behaves as an unsaturated solution if the temperature is increased.

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Our scientific heritage



Water has primarily been used as a solvent for the preparation of medicinal formulations in Ayurveda, *Siddha*, and other traditional systems of medicine in India. Additionally, drug formulations have been prepared using hydro-alcoholic extracts of the herbs. The Indian systems of medicine have also referred to the use of oils, ghee, milk, and other substances as solvents for drug formulations, to help achieve the therapeutic benefits of the drug.

Be a scientist

What inspired Asima Chatterjee to work on medicinal plants?



Asima Chatterjee is renowned for her work in developing anti-epileptic and anti-malarial drugs. She used solvents and solutions extensively to extract and isolate important compounds from medicinal plants. She earned a Doctorate of Science, becoming the second Indian woman to do so after Janaki Ammal. She became the first woman to receive the Shanti Swarup Bhatnagar Award in the field of chemical science and was also honoured with the Padma Bhushan.





Do gases also dissolve in water?

9.3 Solubility of Gases

Many gases, including oxygen, dissolve in water. Oxygen dissolves in water only to a small extent. Even though present in minute quantities, it is this dissolved oxygen that sustains all aquatic life, including plants, fishes, and other organisms.

Is the mixture of gases in water a uniform or non-uniform mixture?

It is a uniform mixture because the gases dissolve evenly in water to form a solution.

Does temperature affect the solubility of gases in liquids also? If so, how?

It has been observed that the solubility of gases generally decreases as temperature increases. More oxygen can dissolve in cold water, ensuring sufficient oxygen for aquatic life (Fig. 9.8). On the other hand, when water warms up, the solubility of oxygen decreases.



Fig. 9.8: Aquatic species in water



Now I understand that the mixtures we use can be of two types—uniform and non-uniform. Uniform mixtures are called solutions, and their components are not visible separately. In non-uniform mixtures, the components can be seen either with the naked eye or with a magnifying device.

I observed that in some non-uniform mixtures, such as sawdust in water, the sawdust floats, whereas in the mixture of sand and water, the sand sinks. I wonder why that happens?



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9.4 Why Do Objects Float or Sink in Water?



Fig. 9.9: Some objects float while others sink in water

You must have observed that some objects float while others sink in water (Fig. 9.9). You may have noticed that, while washing rice, husk particles present in the rice float on the surface of water while rice sinks to the bottom of the container. Why does this happen? If you add oil to water, it floats on water. Generally, it is believed that objects that **float** in a liquid are lighter and others that **sink** are heavier than the liquid.

A wooden stick and an iron rod may be of the same size, yet the iron rod feels much heavier. When we say that iron is heavier than wood, we are referring to a special property known as density, which describes the heaviness of an object.

Note

However, the density of a substance is not the only factor that decides whether it will float or sink in a particular liquid.

Let us explore further.

9.5 What Is Density?

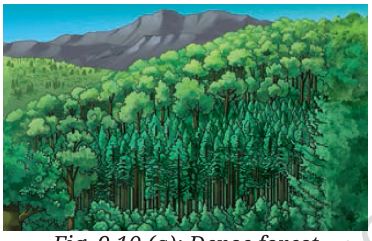


Fig. 9.10 (a): Dense forest

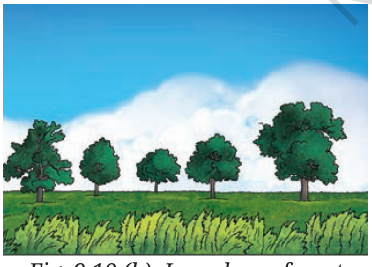


Fig. 9.10 (b): Less dense forest

Imagine a crowded bus where many people are packed together—this is an example of high density whereas, the same bus with only a few people is an example of low density. Similarly, a forest where trees grow close to each other is called a dense forest (Fig. 9.10a), but if the trees are far apart (Fig. 9.10b), it is considered less dense.

How do scientists define density?

Let us find out.

We have learnt that matter is anything that possesses mass and occupies space (volume). **Density** is defined as the mass present in a unit volume of that substance.

The density of a substance may be expressed mathematically using the formula:

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

The density of a substance is independent of its shape or size. However, it is dependent on temperature and pressure. Pressure primarily affects the density of gases, while its effect on solids and liquids is negligible.

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The units in which density is expressed will depend upon the units of mass and volume taken. As you have learnt, the **SI units** of **mass** and **volume** are **kilogram** (**kg**) and **cubic metre** (**m^3**), respectively. Therefore, the **SI unit** of **density** is **kilogram per cubic metre**, abbreviated as **kg/m^3**. In case of liquids, other units of density are also used for convenience, such as gram per millilitre, abbreviated as g/mL and gram per cubic centimetre, abbreviated as g/cm^3.

Conversion factor for density

1 kg/m^3 = 1000 g/m^3 = 1000 g/1000 L = 1 g/L = 1 g/1000 mL = 1 g/1000 cm^3

The mass of 1 mL of water is close to 1 g at room temperature. For the measurement of the mass of water, we generally consider the volume in mL and its mass in g. Hence, 10 mL of water would be approximately 10 g. Similarly, 100 mL of water would be approximately 100 g.

Suppose the mass of an aluminium block is 27 g and its volume is 10 cm^3, its density is 2.7 g/cm^3.

From this, it can be said that aluminium is 2.7 times denser than water. We express this fact by saying that the relative density of aluminium with respect to water is 2.7. It is a number without any units.

$$\text{Relative density of any substance with respect to water} = \frac{\text{Density of that substance}}{\text{Density of water at that temperature}}$$

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Think like a scientist

Have you noticed that some packets of ghee or oil are labelled with a volume of 1 litre but a weight of only say 910 grams (Fig. 9.11)? What does this tell us about the density of the oil, and is it less or more than that of water?



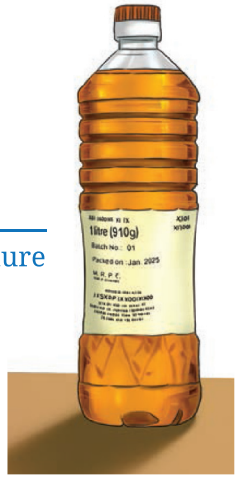


Fig. 9.11: Packed oil

9.5.1 Determination of density

The density of an object can be determined by measuring its mass and volume.

How to measure mass?

You learnt the term 'mass' in *Curiosity*, Grade 6. **Mass** is the quantity of matter present in any object. The instrument used to measure the mass of an object is known as a **balance**. You must have seen various types of balances being used by shopkeepers. Here, we are using a **digital weighing balance** to measure the mass. You learnt in chapter 'Exploring Forces' that on Earth, weight and mass are closely related.

You may measure the mass by doing the following activity.

Activity 9.3: Let us measure



Fig. 9.12(a): Digital weighing balance

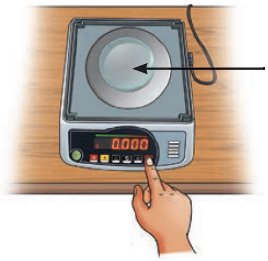


Fig. 9.12(b): Tare the balance after placing a watch glass



Fig. 9.12(c): Weighing a solid object on digital balance

- Switch ON the digital weighing balance.
- Observe the initial reading on the digital weighing balance display.
- It should show a zero reading. If not, then we must bring it to zero by pressing the tare or reset button (Fig. 9.12a).
- Place a dry and clean watch glass or butter paper on the pan.
- Note the reading on the digital weighing balance.
- Reset the digital weighing balance reading to zero by pressing the tare or reset button as shown in Fig. 9.12b.
- Now, carefully place the solid object, such as stone, on the watch glass (Fig. 9.12c).
- Note the reading displayed on the balance, which gives the mass of the stone, say 16.400 g.

(You may use any other type of balance available in your school.)

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Note

The mass of a liquid may be measured by replacing the watch glass with a beaker and pouring the desired amount of liquid into it.

A step further



As mentioned in Chapter 5, the words 'mass' and 'weight' are often used interchangeably in everyday language. But they have different meanings in science, which can sometimes cause confusion. Mass is the quantity of matter present in an object or a substance. Its units are gram (g) and kilogram (kg). On the other hand, weight is the force by which the Earth attracts an object or a substance towards itself, and it is measured in newtons (N). Most balances (except two-pan balances like in Fig. 9.13) actually measure weight, but their scales are marked in mass units, so they show values in grams or kilograms (Fig. 9.12c).

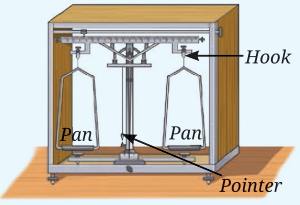


Fig. 9.13: Two-pan balance

How to measure volume?

A tetra pack says it contains 200 mL buttermilk (*chach)* (Fig. 9.14). What does that mean?



Fig. 9.14: A pack of buttermilk of 200 mL

You learnt in *Curiosity*, Grade 6 that **volume** is the space occupied by an object. You also know that the SI unit of volume is cubic metres, written as m^3. It is the volume of a cube whose each side is one metre in length. Volume of smaller objects is conveniently expressed in a decimetre cube (dm^3) or centimetre cube (cm^3). One centimetre cube is also written as one cc. Volume of liquids is expressed in litres (L) which is equivalent to 1 dm^3. A commonly used submultiple of a litre is millilitre (mL) which is equivalent to 1 cm^3.

One of the common apparatuses used to measure the volume of liquids is a **measuring cylinder**. It is a narrow transparent cylindrical container with one side open and the other side closed as shown in Fig. 9.15. There are markings on the transparent body of the cylinder that indicate the volume of liquid in the measuring cylinder. We can use it to measure the desired amount of a liquid.

Measuring cylinders are available in different sizes to measure volume — 5 mL, 10 mL, 25 mL, 50 mL, 100 mL, 250 mL, etc (Fig. 9.15). How accurately can these measuring cylinders measure?

Let us find out!



Fig. 9.15: Measuring cylinders of different capacities

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Activity 9.4: Let us observe and calculate

In *Curiosity*, Grade 6, chapter 'Temperature and Its Measurement', you learnt how to use the thermometer and to find its smallest reading; you can do the same with a measuring cylinder.

Take a measuring cylinder and observe it carefully. Note down the following:

- What is the maximum volume it can measure?

Now look at the measuring cylinder (Fig. 9.16) carefully. The cylinder is marked as 100 mL; therefore, it can measure volume up to 100 mL.

What is the smallest volume it can measure? Look at the measuring cylinder again.

- How much is the volume difference indicated between the two bigger marks (for example, between 10 mL and 20 mL)?

- How many smaller divisions are there between the two bigger marks?
- How much volume does one small division indicate?

The smallest volume that the measuring cylinder can read is_____.



Why are measuring cylinders always designed narrow and tall instead of wider and short like a beaker?

For the measuring cylinder shown in Fig. 9.16, the volume difference indicated between 10 mL and 20 mL, or between 40 mL and 50 mL, is 10 mL.

The number of divisions between these marks is 10.

So, one small division can read 10 ÷ 10 = 1 mL.

That is, the smallest value that this measuring cylinder can read is 1 mL.

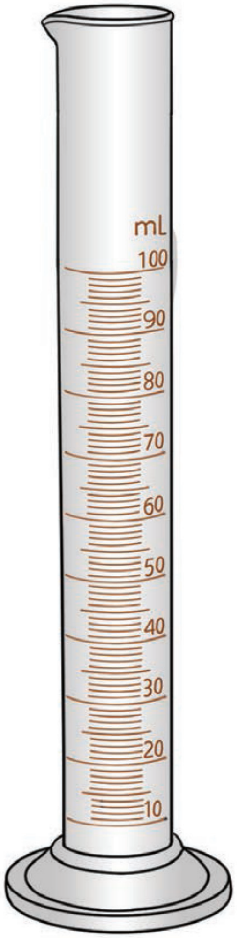


Fig. 9.16: Measuring cylinder of 100 mL

The smallest volume that a measuring cylinder can measure depends on the capacity of the measuring cylinder. Usually it is 0.1 mL in smaller measuring cylinders with a capacity of 10 mL or 25 mL, it is 1 mL in a 100 mL measuring cylinder, 2 mL in a 250 mL measuring cylinder, and 5 mL in a 500 mL measuring cylinder. Suppose we want to take 70 mL of water. If we use a 50 mL measuring cylinder, it would not be possible to measure 70 mL of water in one step. First, we have to measure 50 mL water and then 20 mL. Measuring volume in more than one step is not convenient. On the other hand, if a 250 mL or 500 mL measuring cylinder is used, the measurement can be done in one step but the accuracy would be reduced as the smallest volume that these measuring cylinders can measure is greater than that of a 100 mL measuring cylinder. Hence, a 100 mL measuring cylinder is the best choice for this measurement.

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Activity 9.5: Let us measure 50 mL of water

- Place a clean, dry measuring cylinder on a flat surface.
- Pour water slowly into the measuring cylinder up to the required mark, as shown in Fig. 9.17.
- If required, adjust the level of water in the measuring cylinder by adding or removing a small amount of water using a dropper.
- On careful observation, you will notice that the water inside the measuring cylinder forms a curved surface. This curved surface is called the **meniscus** (Fig. 9.18).
- Read the mark on the measuring cylinder that coincides with the bottom of the meniscus for water or other colourless liquids.

- Make sure that the eyes are at level with the bottom of the meniscus while noting the readings as shown in Fig. 9.18.

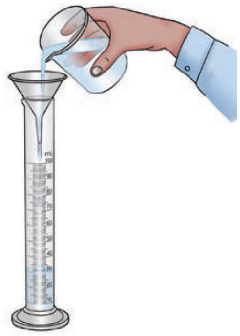


Fig. 9.17: Pouring water into the measuring cylinder

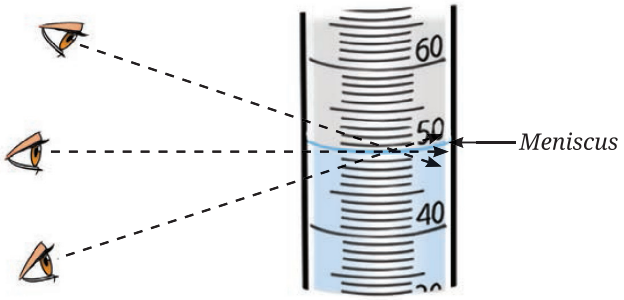


Fig. 9.18: Measuring the reading



I wonder how the level of a coloured liquid is measured?

- Once it reaches the required level—that is, 50 mL—transfer this water to the required container.

In case of coloured liquids the mark on the measuring cylinder should coincide with the top of the meniscus!

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Determining volume of solid objects with regular shapes

Activity 9.6: Let us calculate

- **Collect** various objects with a cuboid shapes, such as a notebook, a shoe box, or a dice.
- Measure the length (l), width (w), and height (h) of the objects using a scale. Suppose the length of the notebook is 25 cm, the width is 18 cm, and the height is 2 cm.
- **Calculate** the volume by using the following formula.

$$\text{Volume} = l \times w \times h$$

$$\text{Volume} = 25 \text{ cm} \times 18 \text{ cm} \times 2 \text{ cm} = 900 \text{ cm}^3$$

- Record in your notebook.

Determining volume of objects with irregular shapes

Imagine you have an object, like a stone, that does not have a regular shape. To calculate its density, the main challenge is to find its volume. Let us learn how the volume of a solid with an irregular shape can be determined.

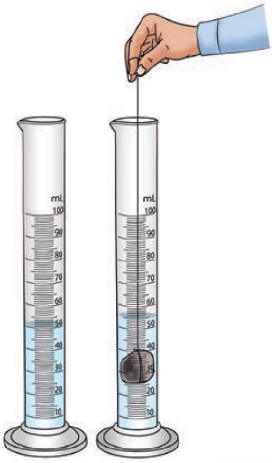


Fig. 9.19: Level of water in the measuring cylinder (a) Without object; (b) With object

Activity 9.7: Let us measure

- Collect various objects from your surroundings, such as a stone, metal keys, and so on.
- Fill a measuring cylinder with water up to any desired volume, say 50 mL (Fig. 9.19a) and record the initial volume taken in Table 9.2.
- Tie the object, say a stone, with a thread and slowly lower it into the measuring cylinder.
- What do you notice?
- Record the final volume after the level rises, say 55 mL, as shown in Fig. 9.19b.
- Subtract the initial volume from the final volume after the object is put into the measuring cylinder. This is the volume of the object.
- Record your observations in Table 9.2.

Table 9.2: Volume of irregular solids

S.No.	Object	Initial volume of water in the measuring cylinder (mL) (A)	Final volume of water in the measuring cylinder (mL) (B)	Volume of water displaced in the measuring cylinder (mL) (B–A)	Volume of the object (cm^3)
1.	Stone	50 mL	55 mL	5 mL	5 cm^3
2.	Metal key				
3.	Any other				

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Note

The values of volume are obtained in units of mL, which can be written in the equivalent unit cm^3 for solids.

We have already learnt to measure the mass and volume of liquids and solids of different types. These quantities can be used to calculate the density of the object or the substance.

Let us calculate the density

Density can be calculated using the following formula:

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}} = \frac{16.400\ \text{g}}{5\ \text{cm}^3} = 3.28\ \text{g/cm}^3$$

Let us dig deeper!

Did you know that our planet, Earth, is composed of several layers, such as crust, upper mantle, lower mantle, outer core, and inner core, each with its particular range of density? The outermost layer, called the crust, is the lightest and the density of the different layers increases as we move towards the centre (Fig. 9.20). As one moves deeper into the Earth, both the pressure and the temperature rise significantly, making the materials heavier and more compact.

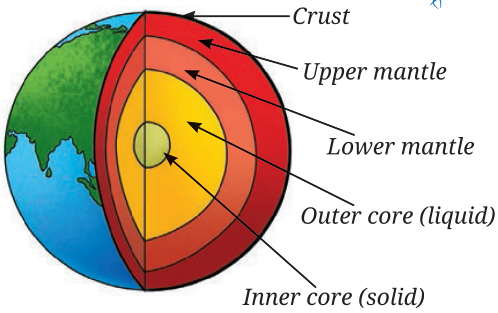


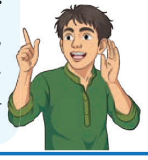
Fig. 9.20: Layers of Earth

Ever heard of ...



Fig. 9.21: Bamboo raft floats on water

In ancient times, before large ships were invented, people used bamboo and wooden logs to travel across rivers and seas (Fig. 9.21). Bamboo was used because it is light, hollow, and floats easily on water. People tied bamboo poles together to make rafts and small boats for fishing, trading, and crossing water bodies. Wooden logs, especially from strong trees were either hollowed out to make boats or used as rafts. These simple boats, made from locally available materials, were important for moving around and connecting different places. Even today, similar traditional boats made of bamboo or wood are used in some regions—not just for transport, but also as tourist attractions.



9.5.2 Effect of temperature on density

Generally, the density of a substance decreases with heating and increases with cooling. This can be explained on the basis of what you have learnt in chapter 'Particulate Nature of Matter'. As temperature increases, the particles of a substance whether, solid, liquid, or gas, tend to move away and spread. This results in an increase in volume but there is no change in mass. Since the Density = Mass/Volume, upon heating, the volume increases and the density decreases. This explains why hot air moves up as it is less dense than the cool air around it. The hot air balloon works on the same principle (Fig. 9.22).



Fig. 9.22: Rising of hot air balloons

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9.5.3 Effect of pressure on density

Pressure affects density differently depending on the state of matter. For gases, increasing pressure causes the particles to move closer together. As a result, the volume of the gas decreases and its density increases. In the case of liquids, pressure has a small effect because they are nearly incompressible. We have learnt in chapter 'Particulate Nature of Matter' that the particles in solids are very close to each other. So, how is the density of solids affected when pressure is applied? Solids are even less affected by pressure than liquids, and changes in their density are usually negligible.

Ever heard of ...

Why does ice float on water? Ice floats on water because it is lighter than liquid water (Fig. 9.23). Water has a special property that its density is highest at 4 °C. It means water is heaviest at 4 °C. As the temperature drops, and water turns into ice at 0 °C, it undergoes a change in structure—the particles arrange themselves in a way that takes up more space. This process is called expansion. Because the same amount of water now occupies a larger volume, its density decreases. As a result, ice becomes lighter than liquid water and floats on its surface.

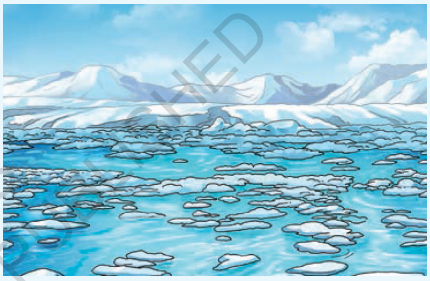


Fig. 9.23: Ice floats on water



This is important for animals living in lakes and oceans because ice floats, it forms a layer on top, keeping the water underneath warm enough for fish and other creatures to survive, even in extremely cold weather.

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Think like a scientist

- Take a glass tumbler and fill it with tap water. Carefully place a raw whole egg into the water and observe what happens. You will notice that the egg sinks to the bottom (Fig. 9.24).
- What change can you make to this setup to make the egg float in water instead of sinking?
- In this chapter, you have learnt the concept of density and how it explains partially why some objects float while others sink.



Fig. 9.24: Raw whole egg sinks in water





Snapshots

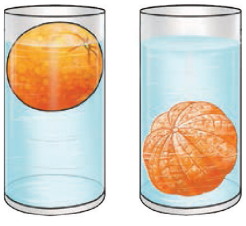
- A solution is said to be formed when two or more substances mix to form a uniform mixture.
- In the solution formed by dissolving a solid in a liquid, the solid component is known as a solute and the liquid component is known as a solvent.
- In a solution formed by mixing two liquids, the component present in less quantity is known as solute and the other component is called solvent.
- In air, nitrogen is considered as a solvent, while oxygen, argon, carbon dioxide, and other gases are considered as solutes.
- A solution in which the maximum amount of solute has been dissolved, and no more of it can be dissolved at that temperature is called a saturated solution.
- A solution in which more solute can be dissolved at a given temperature is called an unsaturated solution.
- Solubility is the maximum amount of solute that can be dissolved in a fixed quantity (100 mL) of a solution or a solvent at a particular temperature.
- Generally, in liquids, the solubility of solids increases and that of gases decreases with an increase in temperature.
- The amount of matter present in an object is known as its mass.
- The space occupied by an object or a substance is known as its volume.
- Devices used to measure mass and volume are a weighing balance and a measuring cylinder, respectively.
- The mass per unit volume of a substance is known as its density (Density = Mass/Volume).
- Generally, density decreases with an increase in temperature and pressure affects density differently depending on the state of matter.

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Keep the curiosity alive

1. State whether the statements given below are True [T] or False [F]. Correct the false statement(s).
   (i) Oxygen gas is more soluble in hot water rather than in cold water.
   (ii) A mixture of sand and water is a solution.
   (iii) The amount of space occupied by any object is called its mass.
   (iv) An unsaturated solution has more solute dissolved than a saturated solution.
   (v) The mixture of different gases in the atmosphere is also a solution.

2. Fill in the blanks.
   (i) The volume of a solid can be measured by the method of displacement, where the solid is _____ in water and the _____ in water level is measured.
   (ii) The maximum amount of _____ dissolved in _____ at a particular temperature is called solubility at that temperature.
   (iii) Generally, the density _____ with increase in temperature.
   (iv) The solution in which glucose has completely dissolved in water, and no more glucose can dissolve at a given temperature, is called a _____ solution of glucose.
3. You pour oil into a glass containing some water. The oil floats on top. What does this tell you?
   (i) Oil is denser than water
   (ii) Water is denser than oil
   (iii) Oil and water have the same density
   (iv) Oil dissolves in water
4. A stone sculpture weighs 225 g and has a volume of 90 cm^3. Calculate its density and predict whether it will float or sink in water.
5. Which one of the following is the most appropriate statement, and why are the other statements not appropriate?
   (i) A saturated solution can still dissolve more solute at a given temperature.
   (ii) An unsaturated solution has dissolved the maximum amount of solute possible at a given temperature.
   (iii) No more solute can be dissolved into the saturated solution at that temperature.
   (iv) A saturated solution forms only at high temperatures.
6. You have a bottle with a volume of 2 litres. You pour 500 mL of water into it. How much more water can the bottle hold?
7. An object has a mass of 400 g and a volume of 40 cm^3. What is its density?
8. Analyse Fig. 9.25a and 9.25b. Why does the unpeeled orange float, while the peeled one sinks? Explain.
9. Object A has a mass of 200 g and a volume of 40 cm^3. Object B has a mass of 240 g and a volume of 60 cm^3. Which object is denser?



(a) *(b)*

Fig. 9.25

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Prepare some questions based on your learnings so far ...

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10. Reema has a piece of modeling clay that weighs 120 g. She first moulds it into a compact cube that has a volume of 60 cm^3. Later, she flattens it into a thin sheet. Predict what will happen to its density.
11. A block of iron has a mass of 600 g and a density of 7.9 g/cm^3. What is its volume?
12. You are provided with an experimental setup as shown in Fig. 9.26a and 9.26b. On keeping the test tube (Fig 9.26b) in a beaker containing hot water (~70 °C), the water level in the glass tube rises. How does it affect the density?

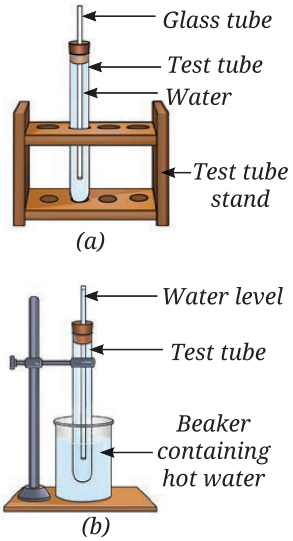
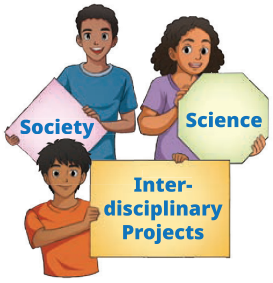


Fig. 9.26

Discover, design, and debate



- Research project on Dead Sea: Why is there no aquatic life in the Dead Sea? Try to find out if there are any other similar water bodies.
- Investigate how well common salt dissolves in different solvents, such as water, vinegar, and oil. Compare the solubility of salt in each solvent and record your observations.
- Debate in class—Is water truly the most versatile solvent?

Our scientific heritage

Ningel village in Manipur's Thoubal district is a place where salt is still produced using traditional methods. The village has a few salt wells, one of which is lined with a 100-year-old tree trunk placed into the ground to draw up salty water. A few families mostly women, continue this sacred practice by collecting the salt solution and boiling it in large metal pans over firewood kilns. Once the water evaporates and salt crystals form, they are shaped into round 'salt cakes' using banana leaves and handmade tools. These cakes are then wrapped in a traditional cloth (*phanek*) to protect them. The salt cakes are believed to have some medicinal value too.

Salt in Ningel is more than just food— it is history, culture, belief, and a beautiful example of India's living heritage.



Reflect on the questions framed by your friends and try to answer ...

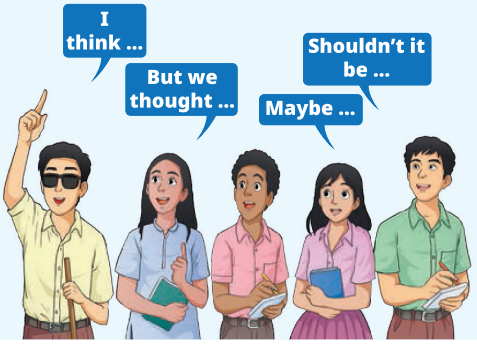
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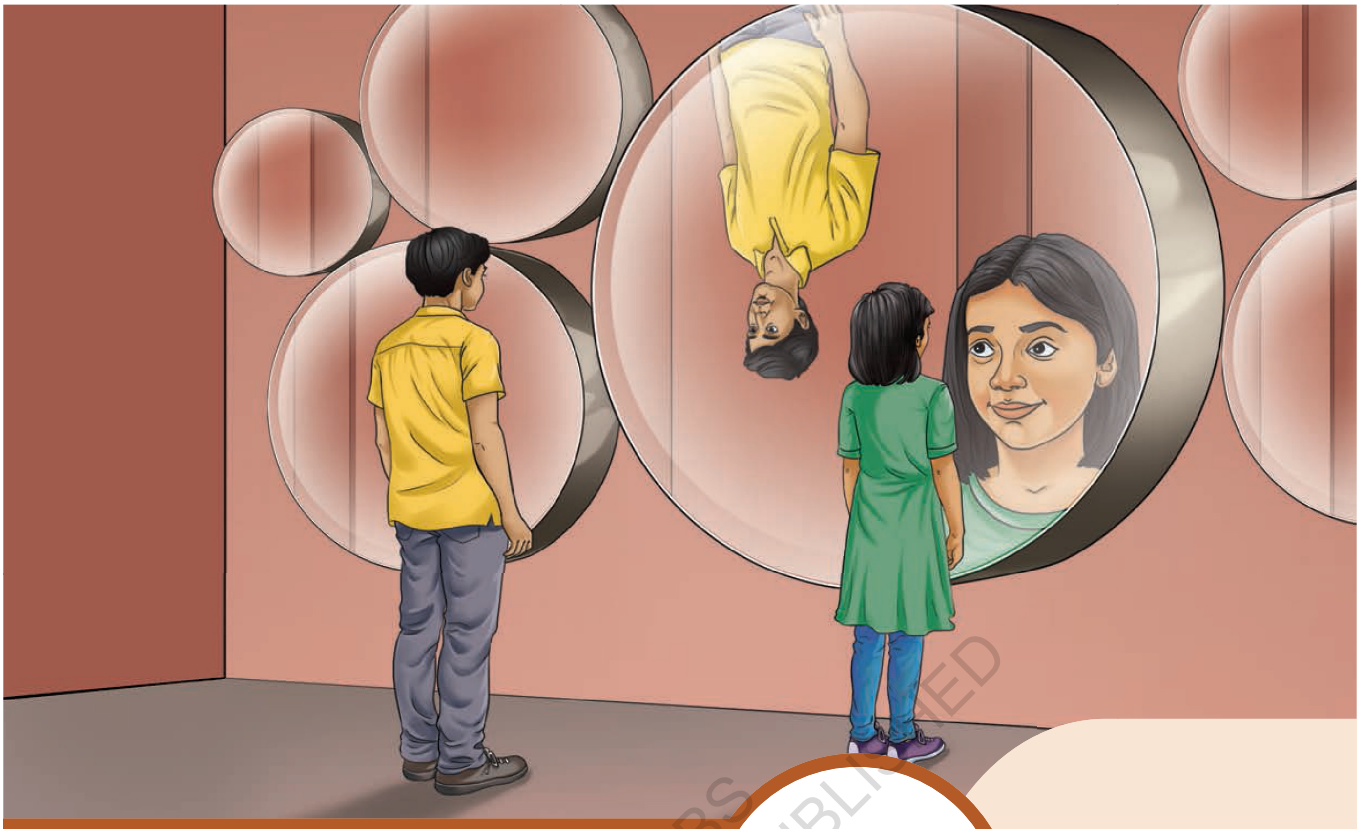
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Light: Mirrors and Lenses

10

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Probe and ponder

- Can we make mirrors which can give enlarged or diminished images?
- On side-view mirrors of vehicles, there is a warning that says "Objects in mirror are closer than they appear". Why is this warning written there?
- Why is there a curved line on some reading glasses?
- Share your questions

_____

_____ ?



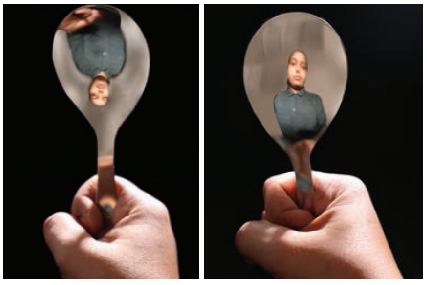
During the summer holidays, Meena went to a science centre with her family. The centre had many fascinating displays on nature, space, and technology. While her parents explored a section on saving water and electricity, Meena and her brother wandered off to look around. In one corner, Meena noticed a row of unusual, curved mirrors. Curious, she stepped closer and looked into one. Her face appeared unusually large, while her brother, standing a little farther away, looked upside down! At another mirror, she saw a tiny version of herself. Meena was puzzled.

She remembered doing activities with a mirror earlier where the image formed by the mirror was of the same size as the object and was erect (in the chapter 'Light: Shadows and Reflections' in *Curiosity*, Grade 7). Seeing her confusion, a guide from the science centre walked up to her and smiled. "These are not plane mirrors," the guide explained. "These are spherical mirrors. When the mirror is curved inward or outward, your image looks different in them!" Meena's curiosity grew and she decided to talk to her teacher about these spherical mirrors.

10.1 What Are Spherical Mirrors?

Activity 10.1: Let us explore

- Take a shiny metallic spoon and hold its curved surface close to your face. Can you see your image in it?
- **Notice** the image of your face. Is it different from the image you see in a plane mirror?
- While **observing** the image, slowly move the spoon away from your face. Do you observe any change in the image?
- Now flip the spoon and repeat the same steps.



(a) *(b)*

Fig. 10.1: Image formed in a shiny metallic spoon from its (a) Inner curved surface; (b) Outer curved surface

Did you notice that the shiny metallic spoon acted like a mirror and you could see your image in it? When you looked at the inner side of the spoon which is curved inwards, you must have observed that the image was inverted (Fig. 10.1a). When you looked at the outer side of the spoon which bulges outwards, the image of your face was erect but smaller in size (Fig. 10.1b).

Curved mirrors, like the spoon, can also be specially made. Spherical mirrors are a common type of curved mirrors which are shaped like a part of a hollow glass sphere. Mirrors, whose reflecting surfaces are spherical are called **spherical mirrors**.

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The reflecting surface of the spherical mirror may be curved inwards or outwards. A spherical mirror, which has a reflecting surface that curves inwards, is called a **concave mirror** (Fig. 10.2a). Its schematic representation is shown in Fig. 10.2b. The outline of the surface of the mirror is circular.



(a) (b)

Fig. 10.2: (a) Concave mirror; (b) Its representation



(a) (b)

Fig. 10.3: (a) Convex mirror; (b) Its representation

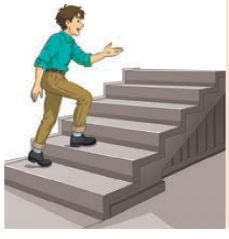
A spherical mirror which has a reflecting surface that curves outwards is called a **convex mirror** (Fig. 10.3a). Its schematic representation is shown in Fig. 10.3b.

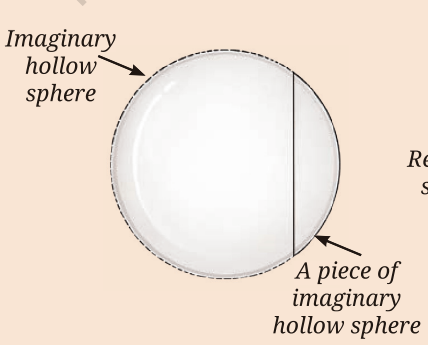
In the representation of both the mirrors, the non-reflecting surface of the mirror is shown as shaded.

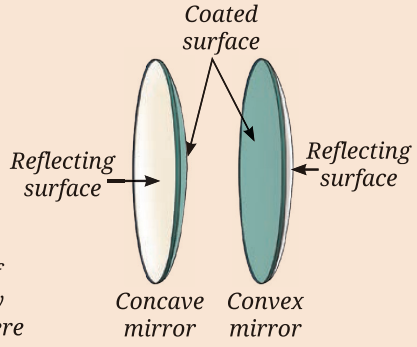
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A step further

The shape of a spherical mirror is such that it can be thought of as a part of an imaginary hollow sphere. However, remember that spherical mirrors are not made by slicing a hollow glass sphere. Instead, they are created by grinding and polishing a flat glass piece into a curved surface. If a reflective coating (like a thin layer of aluminium) is applied on the outer curved surface, it forms a concave mirror. If the coating is applied on the inner curved surface, it forms a convex mirror.







Activity 10.2: Let us distinguish



- Place concave and convex mirrors on a table with their reflecting surfaces facing upwards.
- Now view them from the side, keeping your eye at their level, to **identify** whether the reflecting surface is curved inwards or outwards (Fig. 10.4).

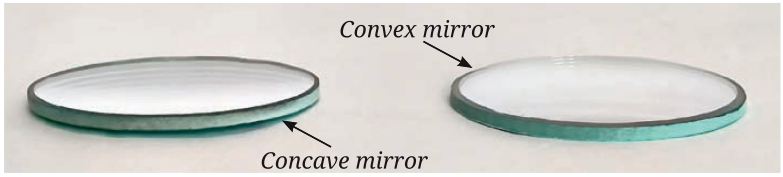


Fig. 10.4: Identifying concave and convex mirrors from their side view

10.2 What Are the Characteristics of Images Formed by Spherical Mirrors?

Activity 10.3: Let us explore

- Take a concave mirror, a convex mirror, two small wooden blocks or something similar to place the mirrors in an upright position, and a small toy or some other object.
- Place the two mirrors side by side in an upright position on a table. Keep the object in front of them at a small distance (3–4 cm away) as shown in Fig. 10.5a. What kind of images do you see in each mirror? Are the images of the same size as the object? Are they erect? Do you see lateral inversion in the images? Write down your observations in your notebook.
- Now slowly move the object away from the mirrors. What changes do you see in the images in both the mirrors? Do the images become smaller or larger? Do they continue to be erect? Again, note down your observations.
- Repeat the steps with each mirror individually.
- **Analyse** your observations and **draw conclusions**.

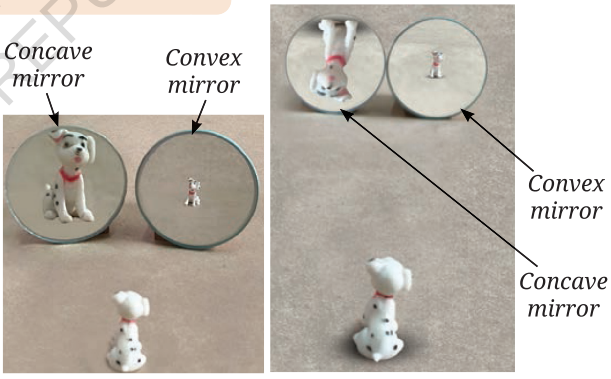


Fig. 10.5: An object placed in front of concave and convex mirrors at (a) Small distance; (b) Large distance

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In the concave mirror, when the object is placed close to the mirror, the image is erect but larger than the object in size, that is, **enlarged**. However, when the object is moved farther away, the image becomes inverted. Initially, the image is enlarged in size and then keeps getting smaller. In case of a convex mirror, the image is always erect and smaller than the object, that is **diminished**. However, the size of the image decreases slightly as the object is moved away from the convex mirror.

This activity shows that spherical mirrors (concave and convex) behave differently from plane mirrors. A plane mirror always forms an erect image of the same size as the object. However, in the concave and convex mirrors, the size of the image changes as the distance of the object from the mirror changes. In addition, in the case of a concave mirror, the image also gets inverted when the object is taken away from the mirror. Lateral inversion of the image is seen in all three types of mirrors.



I just got an idea. We can also identify whether a mirror is plane, or concave, or convex by looking at the images of an object formed in them!

Yes. But where do we find concave and convex mirrors being used in our surroundings?







(a) (b)

Fig. 10.6: Use of concave mirror (a) As a reflector of a torch; (b) By a dentist

The reflectors of torches, headlights of cars and scooters are concave in shape (Fig. 10.6a). Have you ever noticed a dental mirror used by a dentist for inspecting teeth? It is a concave mirror which provides an enlarged view of teeth when held close to the teeth inside the mouth (Fig. 10.6b).



A step further

Do you remember learning about the use of telescope in the chapter 'Beyond Earth' in *Curiosity*, Grade 6? Most modern telescopes are reflecting telescope that use curved mirrors, with the main mirror being a large concave mirror.

Look at the side-view mirrors on vehicles. These mirrors are convex. They always form an erect image of the traffic behind and smaller than the actual vehicles. Also, since the convex mirror is

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(a) (b) (c)

Fig. 10.7: Use of convex mirror as a (a) Side-view mirror; (b) Road safety mirror; (c) Surveillance mirror

curved outside, it provides a much wider area of the road behind. Further, such convex mirrors are installed at road intersections or sharp bends to provide drivers from both sides the visibility of the other side and prevent collisions. Convex mirrors are also installed in big stores to monitor a large area to deter thefts.

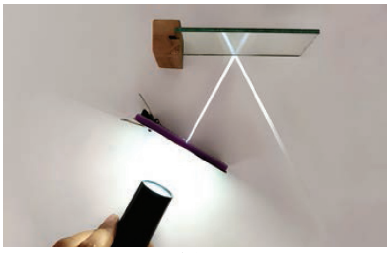


10.3 What Are the Laws of Reflection?

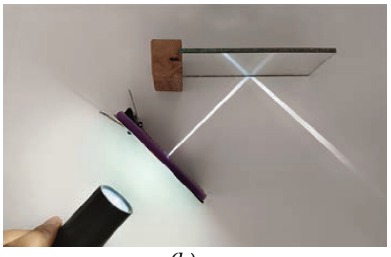
Let us now repeat an activity which we did earlier in grade 7, but this time we will extend it further. Do you remember doing the activity for observing the reflection of a beam of light from a plane mirror?

Activity 10.4: Let us experiment

- Collect a plane mirror with stand, a torch, a comb, a paper clip to hold the comb upright, a sheet of white paper, and a strip of black paper.
- As you did earlier, make a thin slit by covering all openings of the comb using black paper, except for one in the middle.
- Spread a sheet of white paper on a table. Place the plane mirror upright on it.
- Using the thin slit and torch, obtain a thin beam of light along the paper and adjust it to fall upon the mirror as shown in Fig. 10.8a.
- Now, move the slit and torch slightly so that the beam of light falls at a different angle on the mirror (Fig. 10.8b). Does the reflected beam of light also shift?



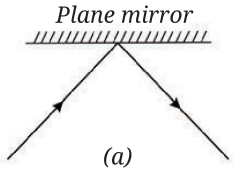
(a)



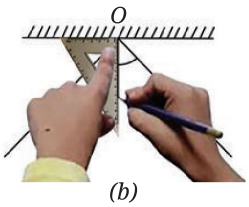
(b)

Fig. 10.8: A beam of light falling on a mirror (a) At one angle; (b) At another angle

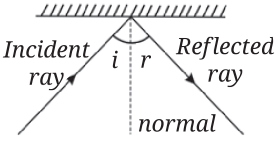
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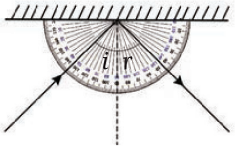
(a)



(b)



(c)



(d)

Fig. 10.9: (a) Drawing incident and reflected rays; (b) Drawing the normal; (c) Angle of incidence and angle of reflection; (d) Measuring angles

- Make the beam of light fall on the mirror at different angles and observe how the direction of the reflected beam changes.

To understand this better, let us **draw** this on a paper, step by step. But before doing that, let us learn how to represent light. We often represent light by straight lines with arrows, or **rays**. Rays indicate the path along which light travels. Do you remember learning earlier that the light travels along a straight line?

- Draw a line showing the position of the plane mirror. Also, draw lines with arrows (rays) indicating the beam of light falling on the mirror and the reflected beam of light as shown in Fig. 10.9a.

The ray of light that falls on the mirror is called the **incident ray**. The ray of light that comes back from the mirror is called the **reflected ray**.

- Now remove the mirror. From the point where the incident ray strikes the mirror, draw a line making an angle of 90° to the line representing the mirror. This line is known as the **normal** to the reflecting surface at the point of incidence, O (Fig. 10.9b).

The angle between the normal and the incident ray is called the **angle of incidence** (*i*) (Fig. 10.9c). The angle between the normal and the reflected ray is known as the **angle of reflection** (*r*) (Fig. 10.9c).

- On your drawing, **measure** the angle of incidence and the angle of reflection and note it in Table 10.1.
- Repeat the activity several times by changing the angle of incidence.
- Finally, let the incident beam fall on the mirror along the normal and observe the direction of the reflected beam. What would be the angle of incidence and angle of reflection in this case? Both the angles would be zero in this case.

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Table 10.1: Measuring angles of incidence and reflection

S.No.	Angle of incidence (*i*)	Angle of reflection (*r*)

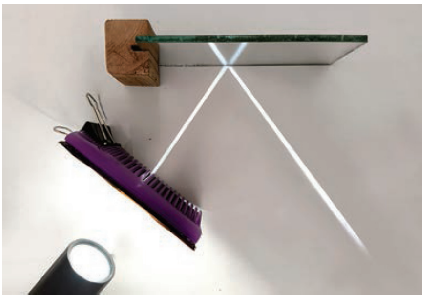
Do you notice that both angles in Table 10.1 are nearly equal? If done carefully, the experiment shows that **the angle of incidence (*i*) is equal to the angle of reflection (*r*)**. This is a law of reflection.

Activity 10.5: Let us experiment

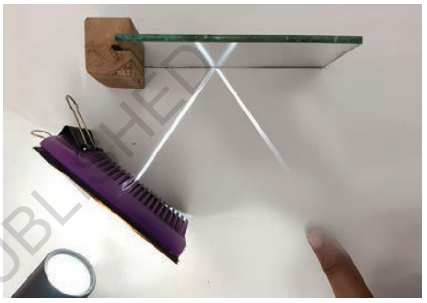
- Use the same setup as in Activity 10.4, but place a stiff sheet of chart paper flat on a table such that part of it extends beyond the edge of the table.
- Shine a beam of light on the mirror placed on the sheet and observe the reflected beam on the extended portion (Fig. 10.10a).
- Now, bend the extended part of the sheet along the edge of the table. Do you still see the reflected beam on the extended portion?
- Flatten the paper again and observe.

The reflected beam disappears when the sheet is bent but reappears when it is flattened again. This shows that the reflected beam lies in the same plane as that of the incident beam. Bending the sheet creates a new plane, breaking this alignment.

The incident ray, the normal to the mirror at the point of incidence, and the reflected ray, all lie in the same plane. This is another law of reflection.



(a)



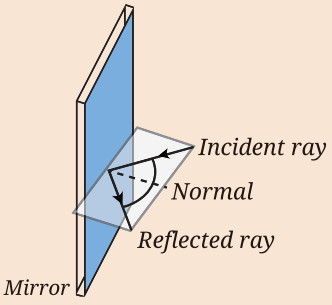
(b)

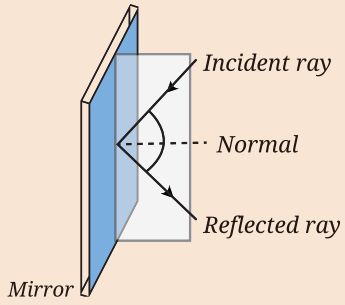
Fig. 10.10: (a) Reflected beam visible along the extended portion of paper; (b) Reflected beam not visible along the bent portion of paper

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A step further

In the two cases, even though the directions of incident rays are different, they fall at the same point on the mirror, and thus, the directions of normal are the same. However, the direction of the reflected ray is such that the incident ray, the normal at the point of incidence, and the reflected ray all lie in the same plane in both cases.









Are laws of reflection applicable to spherical mirrors also?

The laws of reflection are valid for all kinds of mirrors—plane and spherical. But if multiple parallel rays fall on the spherical mirrors, we observe something interesting.



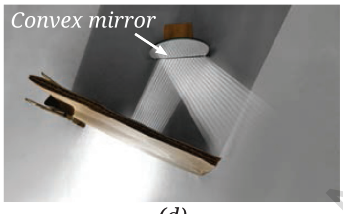
(a)



(b)



(c)



(d)

Fig. 10.11: (a) Multiple slits; Multiple parallel beams of light fall upon — (b) Plane mirror; (c) Concave mirror; (d) Convex mirror

Activity 10.6: Let us explore

- Collect a plane mirror, a concave mirror, a convex mirror, stand for mirrors, a torch, a comb, and a paper clip to hold the comb upright.
- Use the same setup as Activity 10.4 again, but instead of a single slit, leave many openings of the comb uncovered to obtain multiple parallel beams of light (Fig. 10.11a).
- Let the multiple parallel beams of light fall upon the plane mirror, concave mirror, and convex mirror, one by one. Observe the reflected beams. Is your observation similar to what is shown in Fig. 10.11 (b), (c), and (d)?

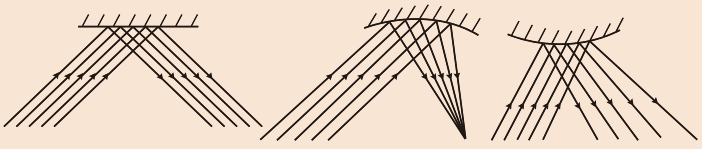
When multiple parallel beams of light fall upon a plane mirror, the multiple reflected beams are also parallel (Fig. 10.11b). However, when multiple beams of light fall upon a concave mirror, the multiple reflected beams get closer, that is, they **converge** (Fig. 10.11c). Whereas, in the case of a convex mirror, the multiple reflected beams spread, that is, they **diverge** (Fig. 10.11d).

In the case of spherical mirrors, even though each ray of light follows the laws of reflection, the curved surface of spherical mirrors causes the parallel beam of rays to either converge (concave) or diverge (convex) on reflection depending on the shape of the mirror.

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A step further

If we draw what we observed in Activity 10.6, we get the figures like those shown below.







So, the concave mirror converges a light beam while the convex mirror diverges it. This is indeed interesting!

Since the concave mirror converges the light beam, wouldn't light get concentrated in a small area?



Activity 10.7: Let us explore

Safety first

Always perform this activity under the supervision of a teacher or an adult. Do not look towards the Sun or into the mirror reflecting the Sun. Focus the reflected light only on a piece of paper, not towards anyone's face or eyes.



- Take a concave mirror and a sheet of thin paper or newspaper.
- Hold the concave mirror with its reflecting surface facing the Sun. Direct the light of the Sun reflected by the mirror on the sheet of paper.
- Adjust the distance of the paper until you get a sharp bright spot on it as shown in Fig. 10.12.
- Hold the mirror and the sheet of paper steady for a few minutes. Does the paper start to burn producing smoke?

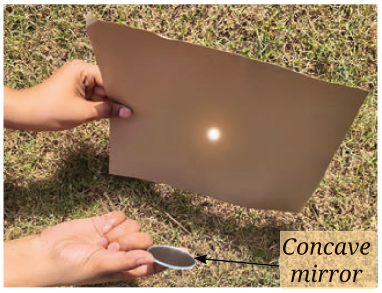


Fig. 10.12: Converging sunlight on paper using a concave mirror

The bright spot is formed on the paper because light from the Sun, after reflection from the mirror, gets concentrated on this point. This produces sufficient heat at this point which can ignite the paper.

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A step further

Devices which concentrate sunlight into a small area, using mirrors and lenses, are called solar concentrators. The concentrated sunlight is used to heat a liquid to produce steam which can be used to generate electricity or for providing heat for various purposes, such as large scale cooking or for solar furnaces. Solar furnaces are even used for melting steel! Do you remember learning in an earlier chapter, about electric furnaces for melting steel?



10.4 What Is a Lens?



We explored the images of an object formed by curved mirrors. But how do objects look when viewed through transparent materials with curved surfaces?

Imagine looking through a flat transparent glass window pane—all objects look the same size and shape. But would those objects continue to look the same if the surface of the transparent material is curved?

Activity 10.8: Let us explore



Fig. 10.13: View of text beneath the water drop

- Collect a flat strip of glass or clear plastic, such as a flat scale, few drops of oil, dropper, water, and a paper or book with some text printed on it.
- Spread a few drops of oil on the surface of glass or plastic strip and rub it to leave a very thin coating. You can also use wax instead of oil.
- Using a dropper or your finger, place a small drop of water on the oiled/waxed spot. (The oil/wax helps the water form a nice round drop.)
- **Examine** the water drop. What is the shape of its surface? Is it flat or curved inward or curved outward?
- Place the paper underneath the glass/plastic strip such that the text is directly under the water drop (see Fig. 10.13).
- Now, look down through the water drop at the text below. Do you find some change in the size of the letters just below the water drop? Do they look enlarged or smaller?

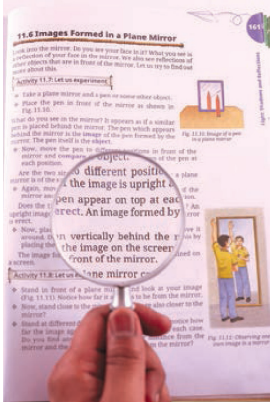
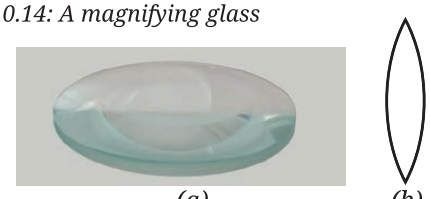


Fig. 10.14: A magnifying glass

The surface of the water drop is curved outside. The letters under the water drop look different— they might appear larger than the letters nearby! The curved surface of the water drop made the size of the text look different. This curved drop of water is acting like a simple lens. Have you seen a magnifying glass as shown in Fig. 10.14? It is also a lens that helps in reading small print by making the letters appear bigger.

A **lens** is a piece of transparent material, usually made of glass or plastic, which has curved surfaces. Like mirrors, lenses can also be convex or concave.

A lens which is thicker at the middle as compared to the edges is called a **convex lens** (Fig. 10.15a).



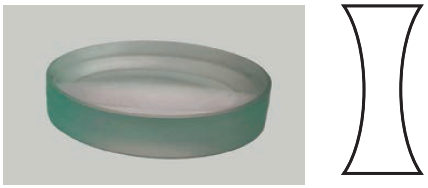
(a) (b)

Fig. 10.15: (a) A convex lens; (b) Its representation

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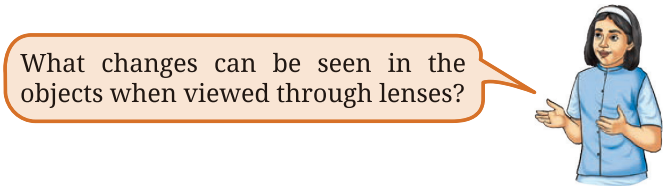
A lens which is thicker at the edges as compared to the middle is called a **concave lens** (Fig. 10.16b).

Unlike mirrors, lenses allow light to pass through them, and we see things through a lens rather than in a lens.



(a) (b)

Fig. 10.16: (a) A concave lens; (b) Its representation



Activity 10.9: Let us experiment

- Collect a convex lens, a concave lens, a lens holder, and a small object.
- Take the convex lens and place it upright using its holder.
- Place the object behind the convex lens (it may also be placed on something to bring it up to the level of the lens).
- Look at the object through the lens from the other side of the lens (Fig. 10.17a) and note your observations in your notebook.
- Now slowly move the object farther from the lens and keep observing how the image changes. How does the distance of the object from the convex lens affect how it looks?
- Now repeat the steps using a concave lens.
- Analyse your observations recorded in your notebook and **compare** the images seen through both lenses. What conclusions do you draw?

When an object is placed behind a convex lens at a small distance from it and seen through the lens, the object appears erect and enlarged in size. As the distance between the object and the convex lens increases, the object appears inverted. It is initially enlarged in size and then diminishes in size. An object placed behind a concave lens and seen through the lens, always appears erect and diminished in size. Its size changes, as its distance from the lens increases.



(a)

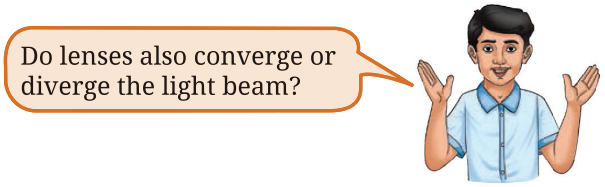


(b)



(c)

Fig. 10.17: An object as seen through a (a) Convex lens placed at small distance; (b) Convex lens placed at large distance; (c) Concave lens



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Activity 10.10: Let us investigate

- Collect a thin transparent glass plate, a convex lens, a concave lens, a torch and a comb to obtain multiple parallel beams of light, a paper clip to hold the comb upright, two identical books, and sheets of white paper.
- Using two books placed adjacent to each other, fix the glass plate or lens upright in between them as shown in Fig. 10.18. Spread paper sheets on both books.
- Now let the multiple parallel beams of light fall upon the thin glass plate, convex lens, and concave lens one by one as shown in Fig. 10.18. Does the parallel beam of light pass through as it is in all three cases?
- **Record** and analyse your observations.

The light beam passes through the thin glass plate as it is. The convex lens converges the light falling on it while the concave lens diverges the light. A convex lens is also called a **converging lens** while a concave lens is called a **diverging lens**.

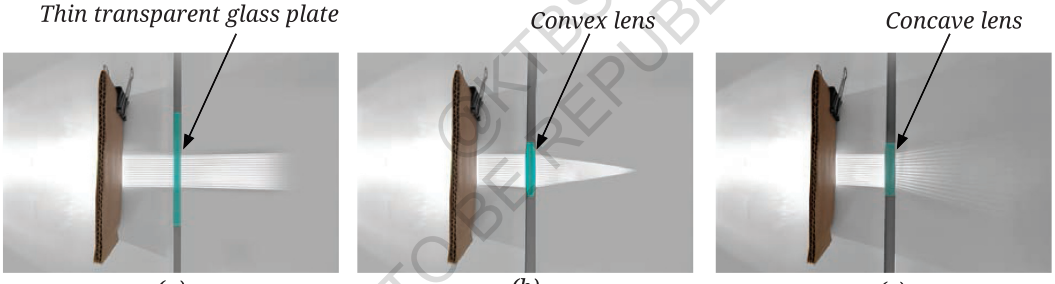


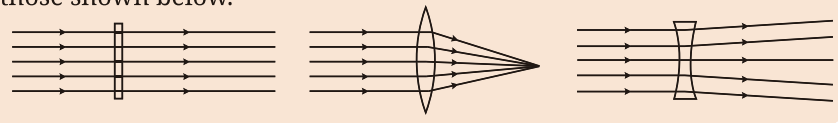
Fig. 10.18: Multiple parallel beams of light fall upon the (a) Thin glass plate; (b) Convex lens; (c) Concave lens

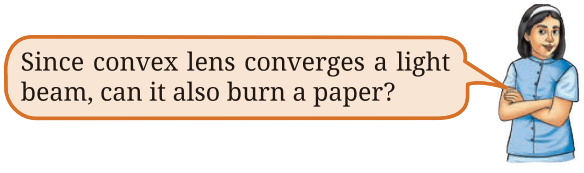
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A step further



If we draw what we observed in Activity 10.10, we get the figures like those shown below.





Activity 10.11: Let us investigate

- Repeat Activity 10.7 by putting a convex lens in the path of sunrays in place of a concave mirror. Could you burn the paper?

Safety first

Do not look at the Sun directly or through the lens as it may damage your eyes.





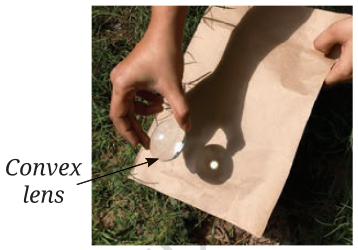


Fig. 10.19: Converging sunlight on paper using a convex lens

Lenses are important and are used everywhere around us. The eyeglasses that people wear to help them see clearly are lenses! Cameras, telescopes, and microscopes all use lenses to work. Even our eye has a convex lens inside it. It is quite an amazing lens that can change its shape, which is what allows us to read a book or see something far away.



(a)



(b)

Fig. 10.20: (a) Eyeglasses; (b) Smartphone camera lenses

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Snapshots



- Image formed by a concave mirror can be enlarged, diminished or of the same size as the object, and it may be erect or inverted, depending upon the distance of the object from the mirror.
- Image formed by a convex mirror is always erect and diminished in size.
- Two laws of reflection are:
  - The angle of incidence is equal to the angle of reflection.
  - The incident ray, the normal to the mirror at the point of incidence, and the reflected ray, all lie in the same plane.
- The laws of reflection are valid for all kinds of mirrors—plane, concave, and convex.
- A concave mirror converges the light beams while a convex mirror diverges it.
- Image formed by a convex lens can be enlarged, diminished or of the same size as the object, and it may be erect or inverted, depending upon the distance of the object from the mirror.
- Image formed by a concave lens is always erect and diminished in size.
- A convex lens converges the light beams while a concave lens diverges it.

Keep the curiosity alive

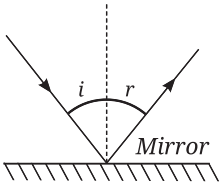


Fig. 10.21

1. A light ray is incident on a mirror and gets reflected by it (Fig. 10.21). The angle made by the incident ray with the normal to the mirror is 40°. What is the angle made by the reflected ray with the mirror?
   (i) 40° (ii) 50° (iii) 45° (iv) 60°
2. Fig. 10.22 shows three different situations where a light ray falls on a mirror:
   (i) The light ray falls along the normal.
   (ii) The mirror is tilted, but the light ray still falls along the normal to the tilted surface.
   (iii) The mirror is tilted, and the light ray falls at an angle of 20° from the normal.

   Draw the reflected ray in each case (Use a ruler and protractor for accurate drawing). What is the angle of reflection in each case?

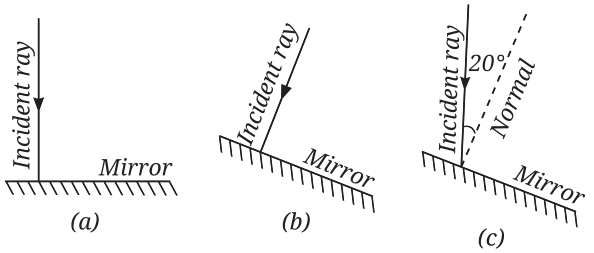


Fig. 10.22

3. In Fig. 10.23, the cap of a sketch pen is placed in front of three types of mirrors.


(i) (ii) (iii)

Fig. 10.23

Match each image with the correct mirror.

Image	Mirror
(i)	Plane mirror
(ii)	Convex mirror
(iii)	Concave mirror

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4. In Fig. 10.24 the cap of a sketch pen is placed behind a convex lens, a concave lens, and a flat transparent glass piece — all at the same distance.
Match each image with the correct type of lens or glass.



(i) (ii) (iii)

Fig. 10.24

Image	Lens/glass type
(i)	Flat transparent glass piece
(ii)	Convex lens
(iii)	Concave lens

5. When the light is incident along the normal on the mirror, which of the following statements is true:
   (i) Angle of incidence is 90°
   (ii) Angle of incidence is 0°
   (iii) Angle of reflection is 90°
   (iv) No reflection of light takes place in this case

6. Three mirrors—plane, concave and convex are placed in Fig. 10.25. On the basis of the images of the graph sheet formed in the mirrors, identify the mirrors and write their names above the mirrors.

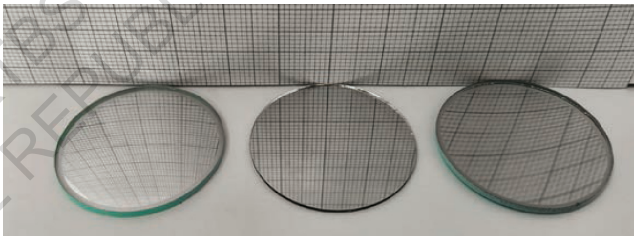


Fig. 10.25

7. In a museum, a woman walks towards a large convex mirror (Fig. 10.26). She will see that:
   (i) her erect image keeps decreasing in size.
   (ii) her inverted image keeps decreasing in size.
   (iii) her inverted image keeps increasing in size and eventually it becomes erect and magnified.
   (iv) her erect image keeps increasing in size.

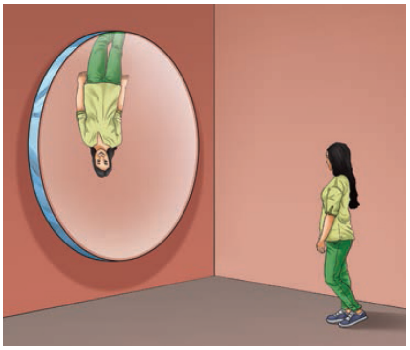


Fig. 10.26

8. Hold a magnifying glass over text and identify the distance where you can see the text bigger than they are written. Now move it away from the text. What do you notice? Which type of lens is a magnifying glass?

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9. Match the entries in Column I with those in Column II.

Column I	Column II
(i) Concave mirror	(a) Spherical mirror with a reflecting surface that curves inwards.
(ii) Convex mirror	(b) It forms an image which is always erect and diminished in size.
(iii) Convex lens	(c) Object placed behind it may appear inverted at some distance.
(iv) Concave lens	(d) Object placed behind it always appears diminished in size.

10. The following question is based on Assertion/Reason.

Assertion: Convex mirrors are preferred for observing the traffic behind us.

Reason: Convex mirrors provide a significantly larger view area than plane mirrors.

Choose the correct option:

(i) Both Assertion and Reason are correct and Reason is the correct explanation for Assertion.

(ii) Both Assertion and Reason are correct but Reason is not the correct explanation for Assertion.

(iii) Assertion is correct but Reason is incorrect.

(iv) Both Assertion and Reason are incorrect.

11. In Fig. 10.27, note that O stands for object, M for mirror, and I for image.

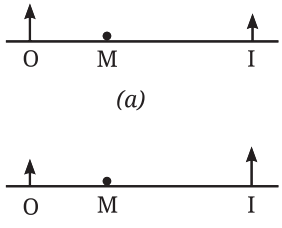
Which of the following statements is true?

(i) Figure (a) indicates a plane mirror and Figure (b) indicates a concave mirror.

(ii) Figure (a) indicates a convex mirror and Figure (b) indicates a concave mirror.

(iii) Figure (a) indicates a concave mirror and Figure (b) indicates a convex mirror.

(iv) Figure (a) indicates a plane mirror and Figure (b) indicates a convex mirror.



(a)

(b)

Fig. 10.27

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Prepare some questions based on your learnings so far ...

.....

.....

.....

.....

.....

12. Place a pencil behind a transparent glass tumbler (Fig. 10.28a). Now fill the tumbler halfway with water (Fig. 10.28b). How does the pencil appear when viewed through the water? **Explain** why its shape appears changed.



(a) *(b)*

Fig. 10.28

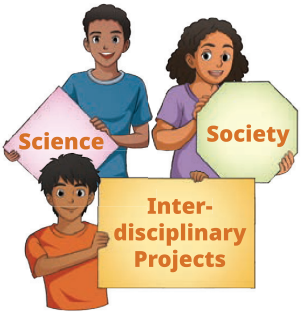
Discover, design, and debate

- Visit a nearby hospital or the clinic of an ENT specialist, or a dentist, with your teacher or parents. Request the doctor to show you the mirrors used for examining ear, nose, throat, and teeth. Identify the kind of mirror used in these instruments.



Fig. 10.29

- Harnessing sunlight is key to solving future energy challenges. In devices like solar cookers (Fig. 10.29), mirrors are used to converge sunlight and generate heat. In India, such designs are used in villages, thus saving electricity and reducing fossil fuel use. Think of a design for a solar cooker for your school or home and prepare a detailed proposal for it including the budget required.



- Use online tools or animation to do virtual experiments with spherical mirrors and lenses. Move objects in the simulation and observe how the image changes.

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Our scientific heritage

More than 800 years ago, during the time of the great Indian mathematician Bhāskara II, astronomers used shallow bowls of water to observe the stars and planets. By carefully looking at their reflected images through tubes placed at appropriate angles, they could measure the positions of stars and planets in the sky. Even though the laws of reflection are not mentioned in literature, their instruments and methods indicate that they might have understood it in practice!



Reflect on the questions framed by your friends and try to answer ...

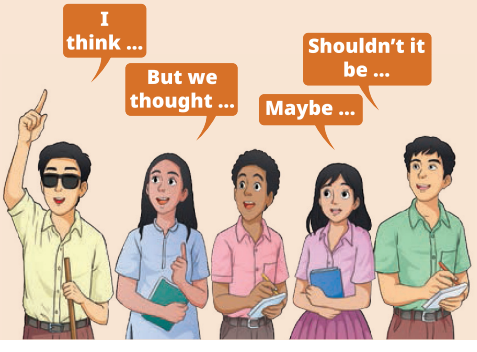
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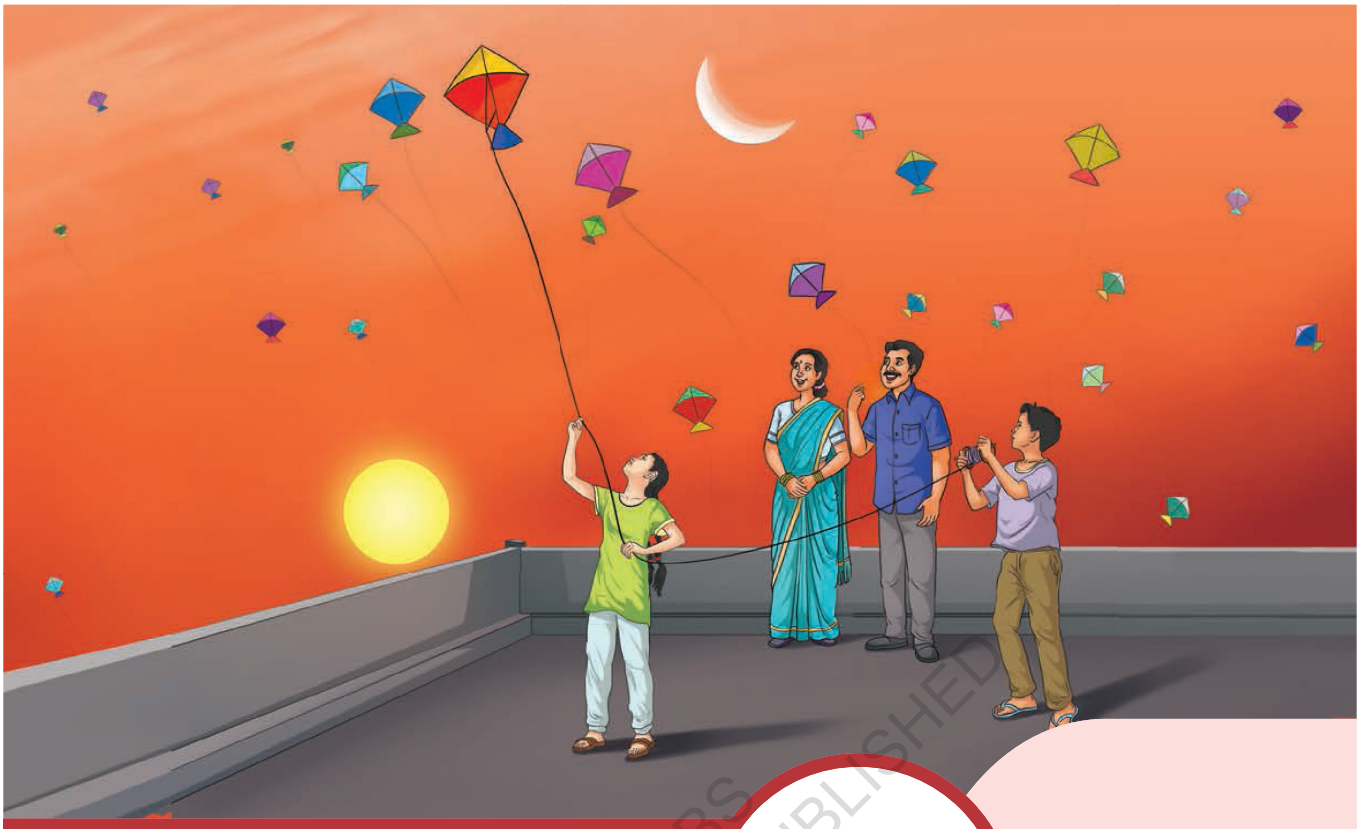
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Keeping Time with the Skies

11

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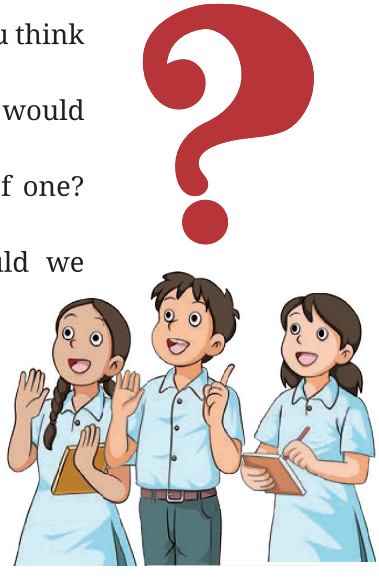
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Probe and ponder

- Have you ever seen the Moon during the day? Why do you think it is sometimes visible when the Sun is up?
- Imagine you lived on the Moon instead of Earth. What would you mean by a day, a month or a year?
- What would happen if Earth had two moons instead of one? How would that change the night sky?
- If we didn't have clocks or calendars, how else could we measure time?
- Share your questions

_____

_____ ?



It was Makar Sankranti, and Meera was in Ahmedabad for the *Patang Mahotsav*, the International Kite Festival. As she looked up at the sky filled with colourful kites, she noticed the Moon shining during the daytime. She was surprised as she had always thought the Moon appeared only at night. Also, the Moon did not appear like a full circle, but that didn't surprise her as much. She knew its shape changed every night. Still, it got her thinking. She remembered learning that the Moon is spherical and shines by reflecting sunlight. Then why isn't the whole Moon visible every night? For a moment, she wondered if it was due to a lunar eclipse. But eclipses are rare and brief. So, what causes the Moon's changing shape?

11.1 How Does the Moon's Appearance Change and Why?

Let us carefully **watch** the Moon to **understand** how its appearance changes over a month. You may have done a similar activity earlier, but let us now do it in more detail. Begin this activity from the sunrise after a full Moon day, that is when it is easiest to spot the Moon in the sky.

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Activity 11.1: Let us explore*

- **Spot** the Moon at sunrise in the western direction on the first day after the full Moon.
- Make a table similar to Table 11.1 in your notebook. Document the following:
  - Date
  - When you saw the Moon (at sunrise or sunset)?
  - Shade the corresponding Circle with pencil to show the bright portion of the Moon as shown in Fig. 11.1.
- From the second day onwards also document the following.
  - Is the size of bright portion of the Moon increasing or decreasing from the previous day.
  - Whether the Moon appears closer to or farther from the Sun in the sky than the day before.
- After about 15 days, you may not be able to see the Moon at sunrise or sunset. For the next 15 days, carry out this activity at sunset.



Fig. 11.1: Shading the dark portion of the Moon

* It is best to begin this activity a month or more before this chapter is scheduled to be learnt.

Table 11.1: Documenting changes in the Moon's appearance

Day	Date	Moon seen at	Appearance of the Moon in the sky	Size of the bright portion compared to the previous day	Moon and Sun separation in the sky compared to the previous day
1.		Sunrise/Sunset	○	—	—
2.		Sunrise/Sunset	○	Increased/ Decreased	Closer/Farther
3.		Sunrise/Sunset	○	Increased/ Decreased	Closer/Farther

Analyse the data recorded by you in Table 11.1. Did the Moon appear different each day? Was the Moon visible on all days? Did the Moon appear at the same position in the sky as on the previous day?

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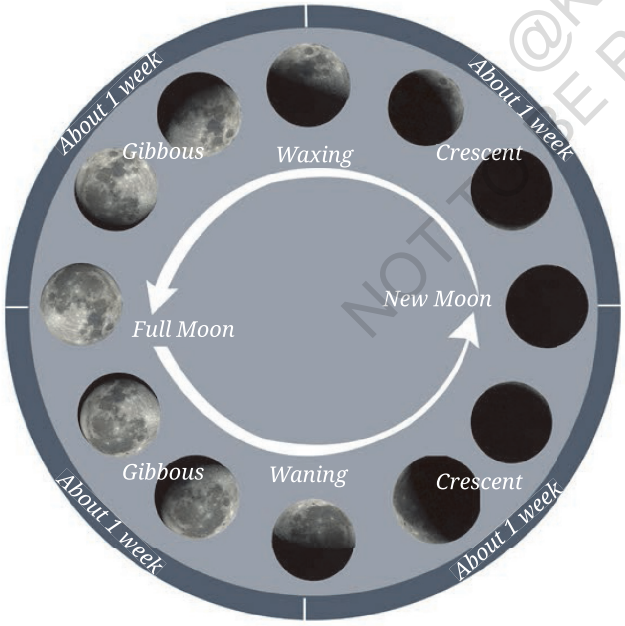


Fig. 11.2: Waxing (Shukla Paksha) and waning period (Krishna Paksha) of the Moon as viewed from the Earth

11.1.1 Phases of the Moon

You may have observed that the bright portion of the Moon decreases from a full circle to a half circle in about a week, as shown in Fig. 11.2. The bright portion continues to shrink for another week until it is no longer visible. This two-week period is called the **waning** period of the Moon. Different names are given to the Moon's visible shapes during this cycle (Fig. 11.2). The day when the Moon appears as a full bright circle is called the **full Moon** day (or *Purnima*), and the day when it is not visible is called the **new Moon** day (or *Amavasya*).

After the new Moon, its bright side grows to a half circle in about a week and to a full circle (full Moon) in another week. The period when the bright part of the Moon increases is called the

waxing period. In India, the waning period of the Moon is generally called the *Krishna Paksha*, while the waxing period is called the *Shukla Paksha*. The Moon goes through a waning period followed by a waxing period in a cyclical manner as shown in Fig. 11.2. The cycle from one full Moon to the next takes about a month.

The changing shapes of the bright portion of the Moon from one day to another as seen from the Earth are called the **phases of the Moon**.

11.1.2 Locating the Moon

When you checked the Moon at the same time on successive days (for example, at sunrise), did you see it in a different part of the sky? On a full Moon day, the Moon is nearly opposite the Sun—when the Sun rises in the East, the Moon is almost setting in the West. On subsequent mornings at sunrise, as its bright part continues to decrease, the Moon appears to move closer in the sky to the Sun. When the bright part of the Moon decreases to a half circle shape, the Moon is overhead at Sunrise. A few days later, the crescent Moon appears even closer to the Sun. Knowing the phase of the Moon and whether it is waxing or waning can thus help us find out where and when to look for the Moon on any given day. A waxing Moon is easiest to spot at sunset, and a waning Moon at sunrise. Because of these shifts, the Moon always rises and sets at different times than the Sun.

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A step further

Many people believe the Moon rises when the Sun sets, but that is not always true. Look in a local newspaper or on the Positional Astronomy Centre (India Meteorological Department) website to find the moonrise time in your area. Check these times for several days in a row and you will see that the Moon rises about 50 minutes later each day. Sometimes moonrise happens in the afternoon (around 2:00–4:00 p.m.), so you can spot the Moon in the eastern sky during daylight. You may need to wait about 30 minutes past the listed moonrise time for the Moon to climb high enough for it to be seen.







The time and position of moonrise changes from one day to the next.

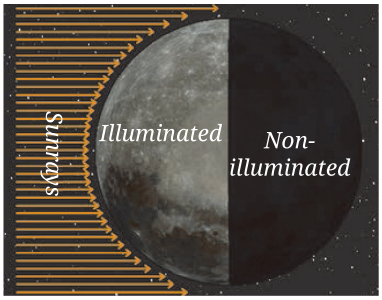


Fig. 11.3: Sunlight falling on the Moon

11.1.3 Making sense of our observations

The shape of the Moon itself does not change, only what we see changes. You may recall learning earlier that the Moon does not emit light of its own, but shines because it reflects sunlight that falls on it. The half of the Moon that faces the Sun receives sunlight and becomes illuminated (Fig. 11.3). The other half facing away from the Sun does not receive sunlight and remains non-illuminated.

The Moon revolves around the Earth and, only one half of the Moon always faces the Earth. However, the portion of the Moon facing the Earth is not always its illuminated part. We can only see the illuminated portion of the Moon from Earth. Sometimes, the entire illuminated portion of the Moon faces the Earth, and at other times only a part of it. At such times the illuminated portion of the Moon that we see is not a full circle. On New Moon day, we do not see the illuminated portion of the Moon at all, as only the non-illuminated portion of the Moon faces the Earth. Therefore, the Moon appears different on different days.



Let us do an activity to understand how the illuminated portion of the Moon, as seen by us, changes when its position changes with respect to the Sun.

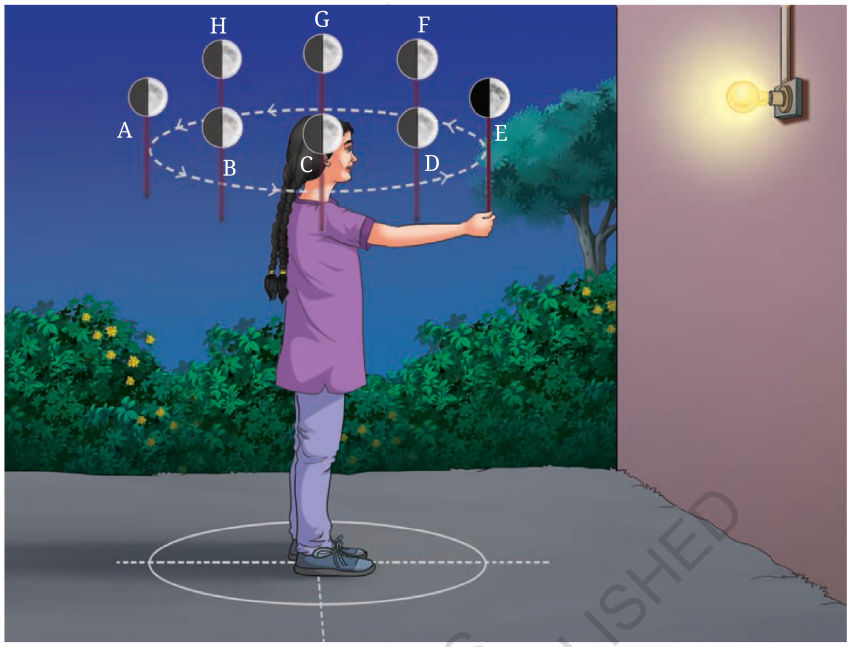
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Activity 11.2: Let us explore

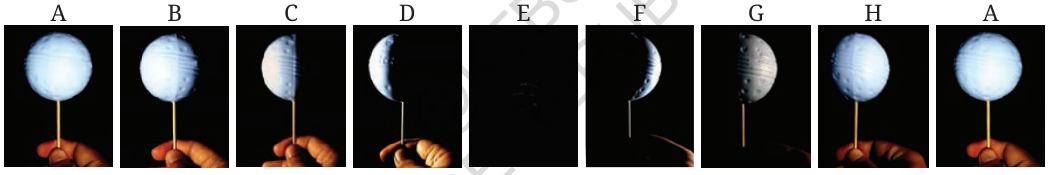


Fig. 11.4: (a) Ball with stick

- Take a small soft ball and insert a stick into it (Fig. 11.4a). This represents the Moon.
- Go to a dark open place (at night), and ask a teacher or guardian to shine a torchlight towards you from about 3 m to represent light coming from the Sun or stand near an electric lamp. Your head represents the Earth.
- Now hold the ball at arm's length in one hand such that it is slightly above your head as shown in Fig. 11.4b. Keep the ball at position E towards the direction of the lamp. Does the portion of the ball facing you appear to be illuminated or not?
- Turn around slowly, in the anti-clockwise direction, with your arm outstretched as shown in Fig. 11.4b and keep looking at the ball. Does the shape of the illuminated portion change? Is the line separating the illuminated and non-illuminated portions of the ball curved?
- Was your observation similar to the changing shape of the illuminated portion of ball shown in Fig. 11.4c? The shape of the illuminated portion of the ball, as seen by you, changes depending on where the ball is with respect to the lamp.



(b)



(c)

Fig. 11.4: (b) A student using a ball and stick to understand phases of Moon; (c) The ball as seen by the student at different positions

When the ball is held opposite to the direction of the lamp (at A), you are facing the entire illuminated portion of the ball, just like the full Moon day. On the other hand, when the ball is held towards the direction of the lamp (at E), you are facing the non-illuminated portion of the ball, and cannot see the illuminated portion of the ball at all. This is similar to the new Moon day. Notice how in other cases, the line separating the illuminated and non-illuminated portions of the ball appears curved (Fig. 11.4c), similar to the shape of the illuminated portion of the Moon viewed from the Earth on other days.

Using our observations of Activity 11.2, let us now try to understand the phases of Moon. Fig. 11.5a shows the positions of the Moon corresponding to the different positions of the ball in Fig. 11.4b. Also shown are the Earth and the sunrays. As shown in Fig. 11.5a, the Moon revolves once around the Earth from position A to H and back to position A in about one month. The side of the Moon that faces the Sun is illuminated.

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The portion of the Moon that faces the Earth is marked by the orange dashed lines and arrows. The illuminated portion of only this part of the Moon can be seen from the Earth. At positions B and H, more than half of the illuminated portion, called the **gibbous phase**, can be seen. At positions D and F, less than half of the illuminated portion, called the **crescent phase**, can be seen. The change in the fraction of the illuminated portion of the Moon seen from Earth causes phases of the Moon.

The phases that will be seen from the Earth at different positions of the Moon are shown in Fig. 11.5b. From A to C to E, we see the waning phase, and from E to G and back to A, we see the waxing phase. Since the rotation period of the Earth of one day is much smaller compared to the revolution period of the Moon which is nearly a month, on a given day, people on different parts of the Earth see nearly the same phase.

As can be seen in Fig. 11.5a, on the New Moon day, the Moon appears closest to the Sun and it appears farthest on the Full Moon day. Is this not what we also observed in Activity 11.1?

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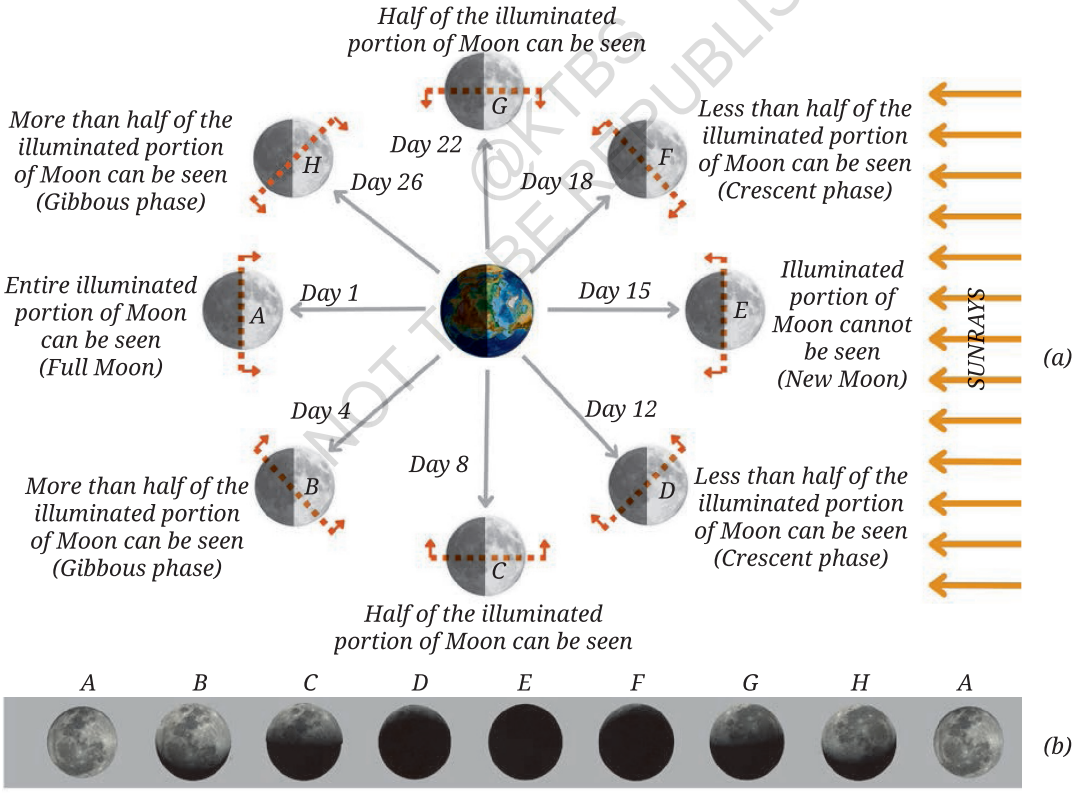


Fig. 11.5: (a) The Moon at different positions in its orbit around the Earth; (b) The corresponding phases of the Moon as seen from the Earth. (The sizes and the distances are not to scale in this figure.)

In Activity 11.1, we also observed that the position of the Moon at sunrise (or sunset) appeared to be shifted on successive days. This happens because, as shown in Fig. 11.6, the Moon moves ahead in its orbit while the Earth completes one rotation about its axis in 24 hours. Earth needs to rotate some more for the Moon to appear in nearly the same spot in the sky.

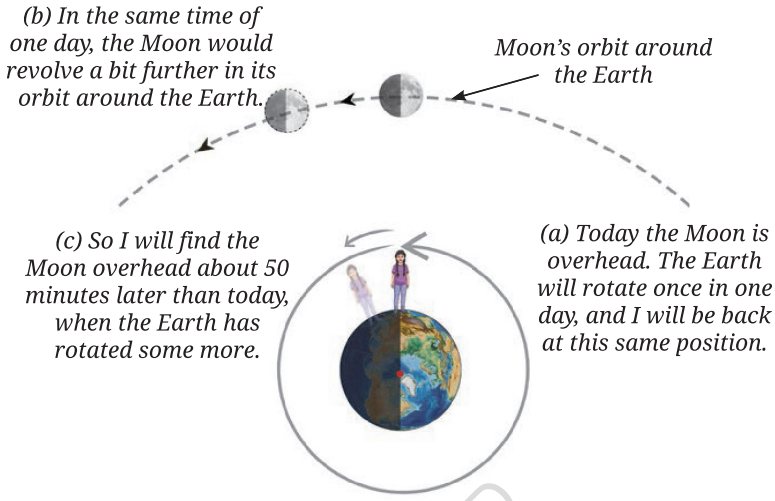


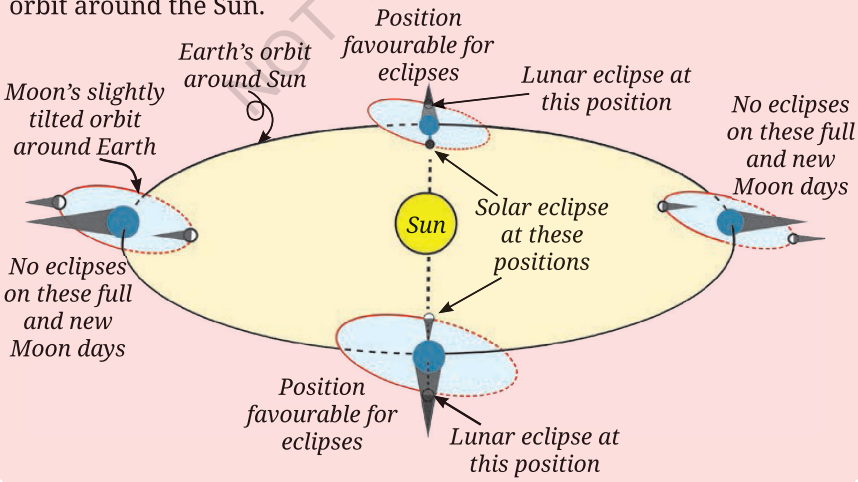
Fig. 11.6: The Moon takes about 50 minutes longer to come back to nearly the same position in the sky.

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A step further

The Moon phases do not happen due to Earth's shadow. It is an incorrect explanation for the Moon's phases that Earth's shadow falls on it. As we have learnt, the phases of the Moon occur due to the relative change in orientation of the Sun, Moon, and Earth as the Moon revolves around the Earth. The Earth's shadow on the Moon causes a lunar eclipse, not the Moon's phases as we learnt earlier (in chapter 'Earth, Moon and the Sun' in the *Curiosity*, Grade 7).

Lunar eclipses can only happen on a full Moon day and solar eclipses can happen only on a new Moon day. But they do not occur every month because of the small tilt of the Moon's orbit with respect to the Earth's orbit around the Sun.







So, changing phases of the Moon is a natural periodic event, with a cycle of almost a month, which can also be used for time keeping.

Yes, along with the natural periodic events of day and night and the changing seasons about which we learnt earlier. But how are these periodic events used for keeping time?



11.2 How Did Calendars Come into Existence?

We have learnt earlier that when viewed from the Earth, the Sun appears to rise in the eastward direction, set in the westward direction every day, and rise again the next day. This apparent periodic motion of the Sun seen by us is primarily due to the rotation of the Earth around its own axis. This natural cycle of the Sun due to the rotation of the Earth, is the foundation of the day, a unit to measure time.

The average time that the Sun takes to go from its highest position in the sky on one day to the highest position in the sky the next day, is 24 hours, and is called the **mean solar day**. The highest position of the Sun in the sky can be found by measuring the length of the shadows cast by an object during the day. The shadow is shortest when the Sun is at the highest point in the sky.

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Activity 11.3: Let us measure a day!

- Find a small flat area in a ground which receives sunlight during the day. Fix a 1 m stick vertically in it as shown in Fig. 11.7.

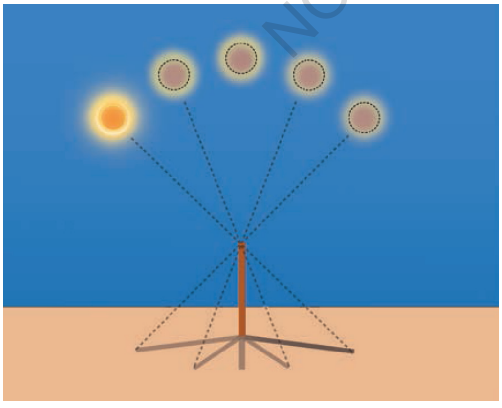


Fig. 11.7: Observing the length of the shadow at different times during the day.

- Start observing at 11:00 a.m. Every minute, mark a dot on the ground at the tip of the stick's shadow. Keep marking dots until around 1:10 p.m.
- **Identify** when the shadow was shortest and find out its time by counting the number of dots. **Record** this time in Table 11.2. Repeat this exercise for the next few days.
- Find the duration of the solar day by finding a difference in time on two consecutive days as shown in Table 11.1.

Table 11.2: Finding the duration of a solar day

Date	Time of shortest shadow (hh:mm)	Duration of day (hh:mm)
22 March 2025	12:20	——
23 March 2025	12:20	24:00
24 March 2025	12:19	23:59

Find the average duration of the day. Is it nearly equal to 24 hours?

The phases of the Moon give us another natural cycle with a duration that is longer than a day. The Moon takes about 29.5 days (nearly a month) to cycle through all its phases. The cycle of the phases of the Moon is the basis for a **month**, another unit to measure time (Fig. 11.8).

The next larger unit to measure time is related to the natural cycle of seasons. Do you remember learning earlier that the Earth revolves around the Sun and takes nearly 365 and a quarter days to complete one revolution around the Sun? The Earth undergoes one cycle of seasons during this time, which can be used to define a **solar year** (Fig. 11.8).

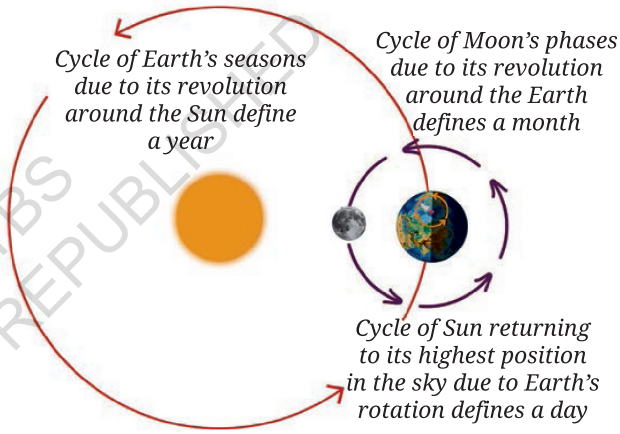


Fig. 11.8: The Earth goes around the Sun, and the Moon revolves around the Earth in regular intervals of time.

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11.2.1 Lunar calendars

In ancient times, people had noticed that during one cycle of seasons, one can fit nearly 12 cycles of the phases of the moon, that is, 12 lunar months. This is how **lunar calendars** came into being, with the day as the shortest unit, a month of nearly 29.5 days, and a lunar year consisting of 12 lunar months. The phases of the Moon thus gave an easy and a perfectly sound way to track the passage of time.

However, in a lunar calendar the seasons do not remain synchronised to the same lunar months in successive lunar years. The reason is that the seasons repeat in approximately 365 days while the lunar year is 354 days long.

11.2.2 Solar calendars

It was important to know the arrival of seasons for agricultural purposes. This need for a year to synchronise with seasons led to the creation of **solar calendars**. The Gregorian calendar, widely used today, is a solar calendar. The months in solar calendars are adjusted to add up to 365 days. That is why in Gregorian calendars, some months have 30 days, others 31, and February has only 28 days.

On top of the 365 days, the Earth takes nearly an extra quarter of a day to complete one revolution around the Sun. These extra hours add up to approximately one day every four years. To adjust for this, solar calendars add an extra day every four years using the concept of a **leap year**. In the Gregorian calendar, if a year is divisible by four, then an extra leap day is added. So in a leap year, February has 29 days, which keeps the calendar well synchronised with the seasons.

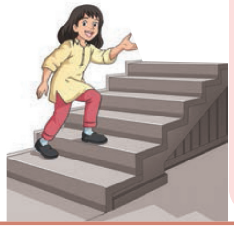
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A step further



The Earth takes slightly less time than 365 and a quarter day to go from one spring equinox to the next spring equinox. Adding a day every four years helps to synchronise with the seasons, but it actually adds a little too much over time. To fix this, leap years are skipped every 100 years—like in 1700, 1800, and 1900. But skipping all of them would make the calendar lag slightly behind. So every 400 years, a leap year is again added back—like in 1600 and 2000. These careful corrections keep the calendar closely matched with the seasons over long periods of time!

A step further

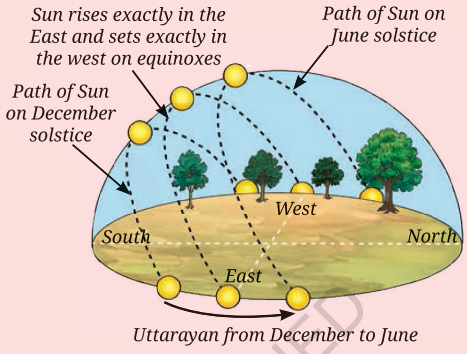


As we learnt earlier, seasons are caused by the Earth's revolution around the Sun and its movement from the spring equinox to winter equinox and back. The time between successive spring equinoxes is called the tropical year. Gregorian calendar is based upon tropical year.

We have also learnt earlier that the stars that rise at sunset change throughout the year due to the Earth's revolution around the Sun. The time duration required for the same stars to rise again at sunset is called the sidereal year, and it can also be used to define a solar calendar. The sidereal year is longer than the tropical year by a mere 20 minutes, and so it takes a long time before the differences between the two calendars become noticeable. In modern times, astronomers use the sidereal year to keep track of the Earth's position in its orbit around the Sun.

Our scientific heritage

For thousands of years, people—including those in India—have been observing the sky and developing calendars. People in ancient times did not know that Earth revolves around the Sun, and lacked modern instruments. Yet through years of careful sky observations, they noticed patterns and cycles in natural events. Hence, they could determine that the length of the year was approximately 365 days allowing them to create calendars.



Uttarayan from December to June

For example, careful observation reveals that the Sun does not always rise exactly in the East. In summer, it rises a little northward of East and in winter a little southward of East. These extremes happen on the solstices, around June 21 and December 21 each year. The Sun's apparent northward movement from December to June is called *Uttarayan*, and its apparent southward movement from June to December is *Dakshinayan*. This cycle repeats every year and is closely linked to the changing seasons. The *Taittirīya Saṁhitā* records it in the verse 6.5.3:

तस्मादादित्यः षण्मासा दक्षिणेनैति षडुत्तरेण ।

"Thus the Sun moves southwards for six months and northwards for six months."

In the past, the equinoxes and solstices were also tracked by identifying the stars that rose at sunset. Ancient Indian texts like the *Surya Siddhanta* noted that the pattern of stars, Capricorn (called *Makar* in India), would be in the background of the Sun around the winter solstice during those ancient times.

भानोर्मकरसंस्ङ्क्रान्तेः षण्मासा उत्तरायणम् ।

कर्क्कादेस्तु तथैव स्यात् षण्मासा दक्षिणायनम् ॥9॥

Translation: From the moment of the Sun's entrance into the constellation of Capricorn, six months make up its northward progress (*Uttarayana*), so likewise from the moment of entrance into the constellation of Cancer, six months are its southward progress (*Dakshinayana*).

Over the years, different types of calendars have evolved based on specific needs. A number of these calendars are used in different parts of India to track time and celebrating festivals.



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11.2.3 Luni-solar calendars

There is another kind of calendar which primarily uses the Moon's phases for counting days and months but also make adjustments to stay in sync with the cycle of seasons.

The 12 lunar months add up to 354 days and thus fall short by nearly 11 days compared to the solar year. Thus every 2–3 years,

the accumulated difference becomes close to a full month. Therefore, every few years, an extra month (called *Adhika Maasa* or intercalary month) is added to the year in some calendars. This keeps the solar year and the lunar cycle in step. Such calendars are called **luni-solar calendars**. They combine elements from both the solar and the lunar calendars and are used in many parts of India.

Ever heard of ...



You may have heard of the names (or similar sounding names) of the months in various Indian luni-solar calendars—*Chaitra, Vaisakha, Jyeshtha, Ashadha, Shravana, Bhadrapada, Ashwin, Kartika, Margashirsha (or Agrahayan), Pausha, Magha, and Phalguna*. In some communities, the new month starts on the first day after the new Moon and ends on the day of the new Moon. Such calendars are called *Amant*. In others, the start of the new month corresponds to the day after the full Moon, and the month ends on the full Moon. Such calendars are called *Purnimant*.

11.2.4 The Indian National Calendar

A national calendar by the Government of India is used along with Gregorian calendar for multiple official purposes.

Shaka Era 1947

Chaitra
(March 22 - April 20, 2025)

SUN	MON	TUE	WED	THU	FRI	SAT
रवि	सोम	मंगल	बुध	गुरू	शुक्र	शनि
						चैत्र 1 22
2 23	3 24	4 25	5 26	6 27	7 28	8 29
9 30	10 31	चैत्र 11 1	12 2	13 3	14 4	15 5
16 6	17 8	18 7	19 9	20 10	21 11	22 12
23 13	24 15	25 14	26 16	27 17	28 18	29 19
30 20						

Vaisakha
(April 21 - May 21, 2025)

SUN	MON	TUE	WED	THU	FRI	SAT
रवि	सोम	मंगल	बुध	गुरू	शुक्र	शनि
	वैशा 1 21	2 22	3 23	4 24	5 25	6 26
7 27	8 28	9 29	10 30	वैशा 11 1	12 2	13 3
14 4	15 5	16 6	17 7	18 8	19 9	20 10
21 11	22 12	23 13	24 14	25 15	26 16	27 17
28 18	29 19	30 20	31 21			

Jyestha
(May 22 - June 21, 2025)

SUN	MON	TUE	WED	THU	FRI	SAT
रवि	सोम	मंगल	बुध	गुरू	शुक्र	शनि
				ज्येष्ठ 1 22	2 23	3 24
4 25	5 26	6 27	7 28	8 29	9 30	10 31
ज्येष्ठ 11 1	12 2	13 3	14 4	15 5	16 6	17 7
18 8	19 9	20 10	21 11	22 12	23 13	24 14
25 15	26 16	27 17	28 18	29 19	30 20	31 21

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Fig. 11.9: Indian National Calendar

It is a solar calendar (Fig. 11.9) consisting of 365 days in a year. The year begins on 22 March, which is the day after the spring equinox. Unlike the Gregorian calendar, months in the Indian National Calendar have either 30 or 31 days. The names of these months were taken from traditional Indian calendars. In a regular year, the second to sixth months have 31 days and the rest have 30 days. The leap years are matched to the Gregorian calendar by adding a day to Chaitra, the first month of the year. In such years, the new year begins on 21 March of the Gregorian calendar.

Ever heard of ...

In 1952, the Government of India set up a Calendar Reform Committee (CRC) to examine all existing calendars which were being followed in the country at that time and to recommend an accurate and uniform calendar for the whole of India. The CRC recommended 'Unified National Calendar' was adopted for use with effect from 21 March 1956 CE, that is, 1 Chaitra 1878 Saka. The Indian National Calendar follows the general principles as that of the *Surya Siddhanta*.



Be a scientist

Meghnad Saha (1893–1956)
Meghnad Saha was a pioneering astrophysicist of India who studied stars and their temperatures and developed a mathematical equation, famously known as the Saha equation. The Saha Institute of Nuclear Physics, in Kolkata, is named after him. He was also the chairperson of the Calendar Reform Committee.





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11.3 Are Festivals Related to Astronomical Phenomena?

Why do most Indian festivals fall on different dates every year?



Many Indian festivals are tied to the phases of the Moon and hence are based on either lunar or luni-solar calendars. For instance, *Diwali* falls on the new Moon of the month of *Kartika*, *Holi* on the full Moon of *Phalguna*, *Buddha Purnima* on the full Moon of *Vaisakha*, *Eid-ul-Fitr* is celebrated after sighting the crescent Moon at the end of the month of *Ramazan*, while *Dussehra* is celebrated on the tenth day in the month of *Ashwina*. Hence, they occur on different dates in the Gregorian calendar in successive years.

For festivals based on luni-solar calendars, the Gregorian calendar dates can shift, but this shift is typically less than a month. This is because the luni-solar calendars add the intercalary month every few years which correct for the difference between the lunar and the solar year. In contrast, purely lunar calendars do not account for this difference. Any festival celebrated according to the phases of the Moon, such as *Eid-ul-fitr*, therefore can occur in different months of the Gregorian calendar year after year.

A step further



A few festivals in India, like *Makar Sankranti*, *Pongal*, *Bihu*, *Vaisakhi*, *Poila Baisakh*, and *Puthandu*, follow a solar sidereal calendar. These festivals happen on almost the same date every year in the Gregorian calendar which is based on the tropical year.

A long time ago, these festivals were tied to either a solstice or an equinox. Due to the small difference in the sidereal and tropical years, the dates of these festivals slowly shift away from the solstices/equinoxes. This shift is due to slow wobble of the Earth's axis, similar to the movement of the axis of a wobbling top.

This causes the dates of festivals based on the sidereal calendar to move ahead in tropical calendar. For example, *Makar Sankranti* moves ahead by one day every 71 years.

Ever heard of ...



The dates of many Indian festivals are based on the exact lunar phase at sunrise. As sunrise occurs earlier in Eastern India and later in Western India, these dates can also shift by a day between these regions even in the same year. To maintain uniformity throughout the country, the Positional Astronomy Center of the Government of India annually publishes the Rashtriya panchang, a detailed calculation of the positions of celestial objects, such as the Moon and the Sun for a central location in India. Based on these calculations, it provides an advance intimation on dates of festivals to Government of India for holiday declaration.

Ever heard of ...

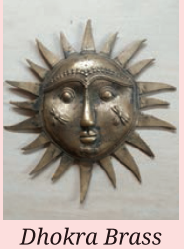


The Moon and moonlight have inspired ragas in Indian classical music. *Chandrakauns*, *Chandranandan*, and *Shubhapantuvarali* (which also means "auspicious moon") are a few ragas that display the moon's imagery in their names and melodic expressions. Similarly, mudras (hand gestures), for example, *Chandrakala*, and *Ardhachandran* relating to the Moon can be found in Indian classical dance Bharatanatyam.

The same is true for other dance forms—Kathak, Odissi, and Kuchipudi. Even the traditional painting styles: Madhubani, Warli, and other forms of art, such as sculpture and pottery among Saura, Gond and other tribes invoke depictions of the Moon and the Sun prominently implying their significance in daily life.



Warli painting

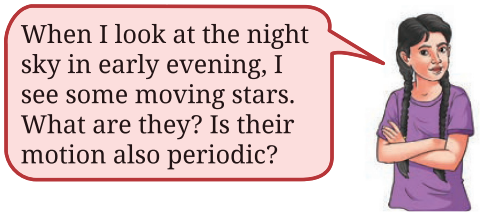


Dhokra Brass sculpture

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11.4 Why Do We Launch Artificial Satellites in Space?

The Moon is Earth's natural satellite, orbiting our planet. Besides the Moon, man-made satellites sent by various countries also orbit the Earth. These **artificial satellites** appear as tiny specks moving in the night sky. Most orbit about 800 km above Earth's surface and take roughly 100 minutes to complete one orbit.



These satellites help us in many ways like communication, navigation, weather monitoring, disaster management, and scientific research. The Indian Space Research Organisation (ISRO) has launched many satellites that support these activities.

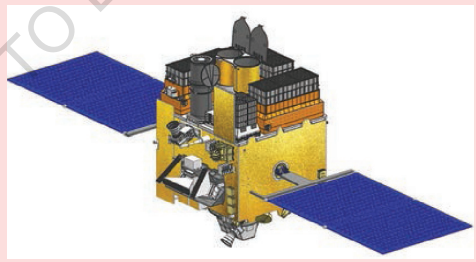
Our scientific heritage

The Cartosat series of satellites, launched by ISRO, capture high-quality images of the Earth to improve maps, plan cities, and handle natural disasters in India. One such mapping platform, Bhuvan, uses these images to show terrain, soil, land use, vegetation, and more.

AstroSat, another ISRO mission, makes scientific observations of stars and other celestial objects. India's other space missions include Chandrayaan 1, 2, and 3 to the Moon; Aditya L1 to study the Sun; and Mangalyaan to Mars. ISRO also lets Indian students build and launch small satellites, such as AzaadiSat, InspireSat-1, and Jugnu.



Cartosat



AstroSat



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Activity 11.4: Let us identify

- Spotting an artificial satellite is a night sky watching activity like we have done previously. Just before sunrise or after sunset, go to a location, accompanied by an adult, that has a clear view of the sky, without any obstruction of trees or tall buildings.

- To identify satellites in the sky, look for any moving object in the sky that appears as a point of light with steady or flickering brightness and is moving very fast across the sky. You can see them with the naked eye or with binoculars.
- You may use mobile apps or websites that provide details of satellites visible in your location and when they will be passing above you in the sky.

A step further



A lot of artificial satellites are being sent up in space by many countries. After their useful life, many of them and their rocket parts become space junk or space debris. This debris crowds space, and could collide with working satellites. While small debris burns up in the atmosphere when it falls towards the Earth, the larger pieces can crash on ground. Countries are now working together to remove this dangerous debris.

Be a scientist



Vikram Ambalal Sarabhai (1919–1971)



Vikram Sarabhai, a researcher in space science and nuclear physics is known as the Father of the Indian Space programme. He pioneered the effort to launch the first artificial satellites. The Vikram Sarabhai Space Centre (VSSC), located in Thiruvananthapuram, the ISRO centre that develops rockets and launch vehicle technology, is named after him.

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Snapshots

- The illuminated part of the Moon changes its shape from day to day through phases, like the new Moon, crescent, and full Moon.
- The phases of the Moon happen because we see different parts of the illuminated portion of the Moon as it moves around the Earth.
- A full cycle of phases of the Moon takes about a month.
- The various cycles observed in nature resulted in the creation of calendars.
- Lunar calendars follow the Moon's cycle, while solar calendars follow the cycle of seasons, which depend upon the position of the Earth in its orbit around the Sun. Luni-solar calendars adapt to both the cycles.
- Artificial satellites are human-made which are launched from the Earth. They provide important information for our well-being and space-science studies.

Keep the curiosity alive

1. State whether the following statements are True or False.
   (i) We can only see that part of the Moon which reflects sunlight towards us.
   (ii) The shadow of Earth blocks sunlight from reaching the Moon causing phases.
   (iii) Calendars are based on various astronomical cycles which repeat in a predictable manner.
   (iv) The Moon can only be seen at night.
2. Amol was born on 6th of May on a full Moon day. Does his birthday fall on the full Moon day every year? Explain your answer.
3. Name two things that are incorrect in Fig. 11.10.



Fig. 11.10

4. Look at the pictures of the Moon in Fig. 11.11, and answer the following questions.



Fig. 11.11

   (i) Write the correct panel number corresponding to the phases of the Moon shown in the pictures above.

Picture label (e.g. A, B, C, etc.)	Phase of Moon
	Three days after New Moon
	Full Moon
	Three days after Full Moon
	A week after Full Moon
	Day of New Moon

   (ii) List the picture labels of the phases of the Moon that are never seen from Earth. Hint: You can use your observations from Activity 11.1 or Fig. 11.2 as reference.
5. Malini saw the Moon overhead in the sky at sunset.
   (i) **Draw** the phase of the Moon that Malini saw.
   (ii) Is the Moon in the waxing or the waning phase?

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6. Ravi said, “I saw a crescent Moon, and it was rising in the East, when the Sun was setting.” Kaushalya said, “Once I saw the gibbous Moon during the afternoon in the East.” Who out of the two is telling the truth?
7. Scientific studies show that the Moon is getting farther away from the Earth and slower in its revolution. Will luni-solar calendars need an intercalary month more often or less often?
8. A total of 37 full Moons happen during 3 years in a solar calendar. Show that at least two of the 37 full moons must happen during the same month of the solar calendar.
9. On a particular night, Vaishali saw the Moon in the sky from sunset to sunrise. What phase of the Moon would she have noticed?
10. If we stopped having leap years, in approximately how many years would the Indian Independence day happen in winter?
11. What is the purpose of launching artificial satellites?
12. On which periodic phenomenon are the following measures of time based: (i) day (ii) month (iii) year?

Discover, design, and debate



Fig. 11.12

- The Moon’s crescent always faces towards the Sun (Fig. 11.12). On days when you see the crescent Moon, point your finger towards the Sun, and slowly move it across the sky towards the Moon taking as short a path as you can. Note how your finger always crosses the illuminated part of the Moon first and clearly shows us that we see sunlight reflected off the Moon. The line joining the tips of the crescent would correspond to the diameter of the Moon.
- Most of the dates in the Indian National Calendar always map to the same dates in the Gregorian calendar. Can you find out which ones may differ for certain years?
- Different states in India celebrate the New Year according to their local cultures. **Find** out the names of the New Year festival celebrated in any 10 states of India. Also find out whether it is

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Prepare some questions based on your learnings so far ...

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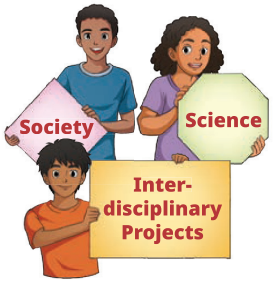
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based on the lunar calendar or the solar calendar or the luni-solar calendar.

- Collect Gregorian calendars (the regular calendar you use every day) for the last five years with the help of your family members or teachers or the internet. For each year, look for the dates on which the festivals *Eid-ul-Fitr* and *Diwali* were celebrated and list them year wise in a tabular form. Do you notice that the date of *Eid-ul-Fitr* moves earlier each year—by about 11 days? If you have a corresponding lunar calendar at home or on the internet, **check** that the month and the day for *Eid-ul-Fitr* according to the lunar calendar remains the same. Does *Diwali* follow the same steady pattern, or are there some sudden jumps? Based on your chart, try to guess which year might have included an intercalary month (*Adhikamaasa*). Obtain a luni-solar calendar and **confirm** if there is an intercalary month between *Diwali* in the previous year and that year.
- Every morning on your way to school, notice the direction in which the Sun rises. Decide on a spot and look towards east, with trees, poles, or buildings acting as markers. **Sketch** the eastern horizon in your notebook. For the next one year, at the start of each month, stand at the same spot and mark the Sun's position on your sketch. **Label** it with the name of the month. At the end of the year analyse your sketch. Do you find that the positions of sunrise shift in particular direction? Can you identify it with the *Uttarayaan* and *Dakshinayaan* that our ancestors noticed? (Refer the 'A step further' box on page 181).



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A step further

If you visit a place near the sea, you may notice that water levels rise and fall. The rise and fall of water levels are called tides. Tides also follow a regular pattern. If there's a low or a high tide at a certain time on one day, a similar tide will come about 50 minutes later the next day. We also learnt that the Moon also rises about 50 minutes later each day. Careful observations show that tide levels are closely related to the Moon's position and phase.



Reflect on the questions framed by your friends and try to answer ...

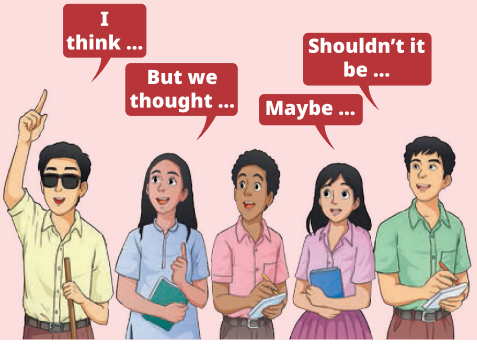
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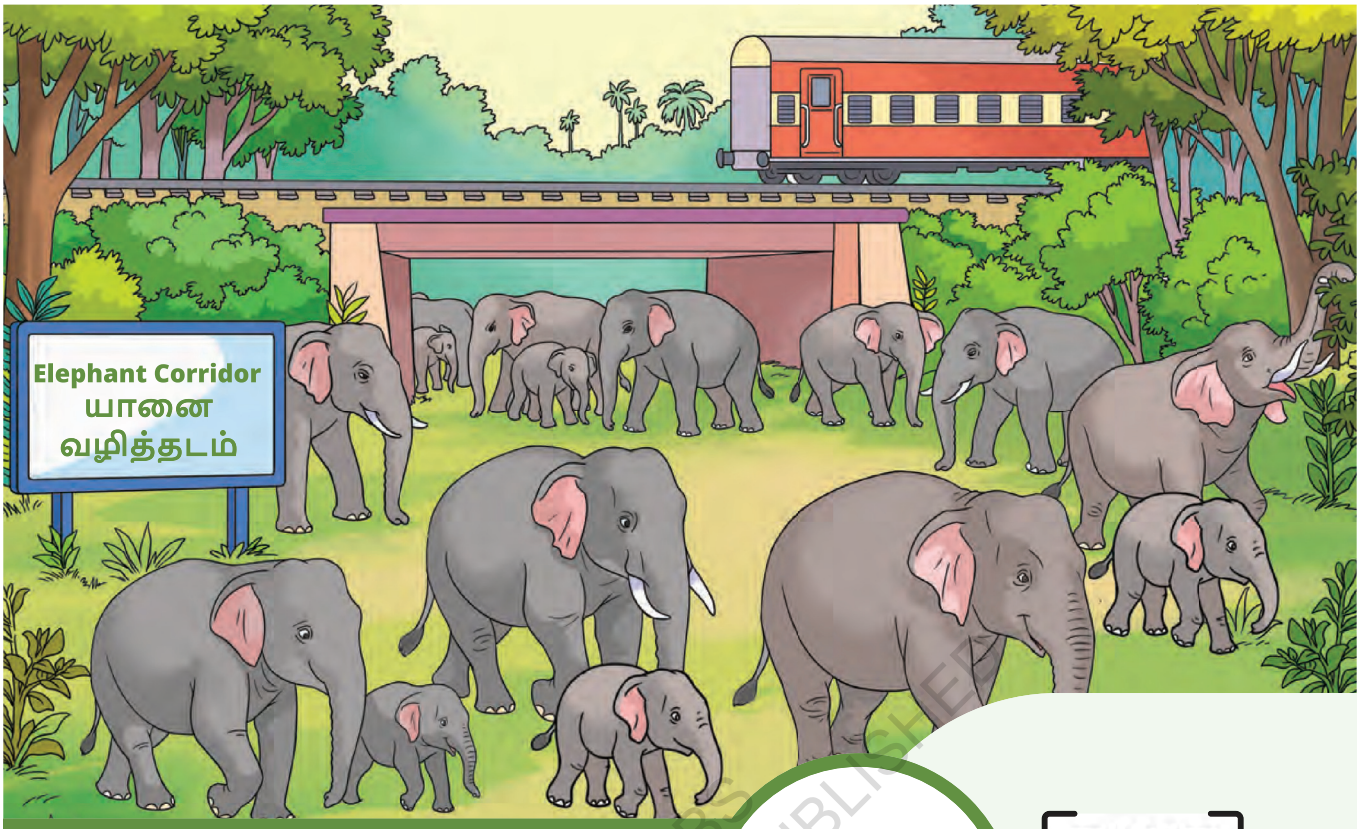
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How Nature Works in Harmony

12

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Probe and ponder

- How might the loss of forest cover and changes in rainfall patterns lead to elephants to enter human farms and villages?
- Imagine you are a tree in a dense forest. What kind of relationships would you have with water, sunlight, other animals, and other components of the forest?
- Do you think the Earth can thrive without humans? Can humans survive without the earth?
- If two kinds of birds compete for the same fruit, how might their way of living change over time?
- Can human actions cause natural disasters?
- Share your questions

_____

_____ ?



In several parts of India, particularly in states like Odisha, Jharkhand, West Bengal, Assam, and Chhattisgarh, elephants often enter farms and villages. When vegetation is scarce and waterholes dry up in their natural habitat, elephants may wander in to nearby farms or plantations in search of food like bananas and sugarcane. This can lead to in crop damage and at times, even harm people and domestic animals.

Changes in rainfall and temperature affect vegetation. Cutting down trees for constructing roads and buildings makes it worse. This leads to the shrinking and drying of forests, the natural home of animals. When forests cannot support wildlife, animals tend to move into human habitats. Elephants are adapted to forest life, but sudden changes make it hard for them to survive. Wildlife ecologists have identified and marked corridors in many parts of the country to allow safe movement of animals. These corridors correct forest habitats, enabling wildlife—such as elephants to travel in need between large forest areas without coming into conflict with human settlements.

This chain of events shows how closely nature's elements are connected. To understand such interconnections, we must study the components of our environment.

12.1 How Do We Experience and Interpret Our Surroundings?

You have learnt in *Curiosity*, Grade 6 chapter 'Diversity in the Living World' that different habitats have different kinds of plants and animals. A habitat is simply place where an organism lives. It could even be just the bark of a tree. The plants and animals interact with each other and adapt to survive in the surrounding conditions they live in. **Explore** two nearby habitats and **identify** both the living organisms and the non-living components in each.

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Activity 12.1: Let us explore

Caution: Explore the habitat in groups with your teacher.

- Identify two habitats in your surroundings.
- These could be any two of the following: a pond, a forest, an agricultural farm, or even a large tree like banyan, mango, or *pilkhan* (white fig) tree.
- List the living beings and non-living things that you **observe** in these habitats.
- **Record** your observations in Table 12.1.

Table 12.1: Different components of two habitats

Pond		Forest	
Living beings	Non-living things	Living beings	Non-living things
Fish	Water	Plants	Soil
		Grass	
		Trees	
		Birds	



(a) Pond habitat



(b) Forest habitat

Fig. 12.1: Two types of habitats

What common characteristics do you observe in the two habitats in Activity 12.1? The similarities are that both habitats have living beings as well as non-living things. However, the types of living beings are different and the non-living things also vary. The living beings you have recorded in Table 12.1 are termed as the **biotic** components and non-living things as the **abiotic** components of a habitat. Have you wondered why some organisms live on land while others live in water? Every organism needs specific conditions to survive. From this activity, you can see that different habitats offer different living conditions.

In Activity 12.1, you listed fish as a biotic component of the pond. How do fish survive in a pond? A pond provides food, oxygen, shelter, and space to grow—conditions essential for survival of organisms. Fish obtain their biotic needs, such as food, from small plants and animals, and abiotic needs, such as oxygen, from water.

Other living beings also inhabit the pond, such as frogs, fresh turtles, snakes, dragonflies, mosquitos, snails, and ducks, along with plants like algae, diatoms, duckweeds, and lotus. They all interact with the other living beings and non-living things present in the places where they grow and thrive.

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Each habitat has its own biotic components and physical conditions—air, sunlight, water, temperature, and soil. Different organisms living in the same habitat may use the resources in different ways. A forest might be warm during the day and cool at night. A snake that comes out at night and a rodent active during the day both live in the same habitat, but they face different conditions. This is how living organisms coexist in harmony in the same habitat.

12.2 Who All Live Together in Nature?

You have observed fish in a pond in Activity 12.1. Did you see only a single fish? Most likely, you may have seen many fish of the same kind. This group of fish of the same kind living together in a pond habitat is called a **population** of that particular fish. In this way, we can observe and record populations of different kinds of organisms in a single habitat.

Activity 12.2: Let us record

We can understand the population of a particular type of plant by counting them at a given place and time.

- Divide students into four to five groups.
- Each group may identify any two organisms, plant(s) or animal(s).
- Mark an area of 1 m × 1 m in your school garden.
- Identify four organisms in this area, and count their numbers.
- Record the number of the organisms in Table 12.2.
- Compile the data from all groups.

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Table 12.2: Number of particular organisms at a given space and time

Name of organism	Population (Number of individual organisms)
Plant 1: _____	20
Plant 2 : _____	05
Animal 1 : _____	
Animal 2 : _____	

In the given example, there is a population of 20 _____ plants and is only 5 _____ plants in the same 1×1 m^2 area.

From Activity 12.2, we can explain that the population is a group of the same type of organisms in a habitat at a given time.

Can a habitat have only one type of living organism? What might happen then? If all organisms are the same, they would have the same requirements—food, water, space—leading to competition and possible scarcity of resources. What else do you think could happen?

In Activities 12.1 and 12.2, you observed that different group of organisms live together in a habitat. A **community** comprises different populations sharing the same habitat. The biotic components of a habitat, such as the plants, animals, and microorganisms together form the community. These organisms interact and depend on one another for survival.

Ever heard of ...



You may have seen brightly coloured flowers blooming around you. Have you ever looked closely at their parts? A flower has a stalk, green leafy structures called **sepals**, coloured **petals** and two reproductive parts. **Carpels** (female) and stamens (male). Stamens burst release yellow dust like **pollen grains**. Wind, 'water insects, bats and birds helps carry pollen from the stamens to the carpels of the same and different flowers. This process is called **pollination** (Fig.12.2). It is essential for the formation of fruits and seeds.

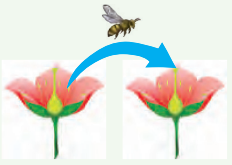


Fig. 12.2: Insect pollination

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12.3 Does Every Organism in a Community Matter?

Let us find out the role of different organisms in a community.

Activity 12.3: Let us read

- Researchers **conducted** a study to see how fish in ponds affect seed production in the plants nearby. They observed



Pond A



Pond B

Fig. 12.3: Pond A with fish and Pond B without fish

two ponds—A with fish and large number of flowering plants around it; B without fish and fewer flowering plants around it (Fig. 12.3). Think of a reason for these observations.

- **Compare** the number of dragonflies, bees, and butterflies in both the ponds. Do you find any relationship between the number of dragonflies and bees/butterflies? We observed that in Pond A (with fish) the number of dragonflies were less as compared to Pond B. Why?
- Fish eat dragonfly larvae, so ponds with fish had fewer dragonflies. Dragonflies usually eat flies, bees and butterflies With fewer dragonflies, more bees, flies, and butterflies were found. These insects help pollinate flowers from nearby areas moving pollen from one flower to another, which helps plants produce seeds. So, flowers near ponds with fish may produce more seeds than those near ponds without fish.
- What does this study show? How does the population of fish in a pond affect the seed production in nearby plants?
- This study shows how biotic components (fish, dragonflies, pollinators, plants) and abiotic components (temperature, water, nutrients) interact with and affect each other (Fig. 12.4). Similarly, can overfishing by humans change this balance? How do you think it may affect the living and non-living parts of the habitat?

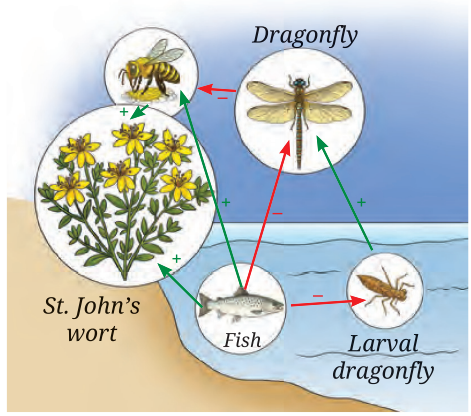


Fig. 12.4: Fish have indirect effect on plants in and around ponds. The solid arrows represent the direct effect, and the dashed arrows represent the indirect effect

12.4 What Are the Different Types of Interactions Among Organisms and their Surroundings?

In *Curiosity*, Grade 7, you learn about how plants and animals need air, water, soil, and sunlight to grow. Living organisms, or the biotic community, depend on non-living things, that is abiotic components for their survival. Plants and animals also depend on each other for nutrition, respiration, and reproduction. These are interactions among the biotic components. Both types of interactions—among biotic components, and between biotic and abiotic components—are important for survival in any habitat.



Fig. 12.5: Biotic and abiotic interactions

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Look at Fig. 12.5, and try to identify interactions among biotic components, and between biotic and abiotic components based on your learnings till now.

Activity 12.4: Let us relate and identify

- Based on the given criteria, **identify** and **describe** the interactions between biotic and abiotic components shown in Fig. 12.5.

  Criterion 1

  Interactions between abiotic and biotic components. These may influence life processes like nutrition, respiration, and reproduction in biotic components.

  Criterion 2

  Interaction between two abiotic components these may influence the physical characteristics of a habitat.

  Criterion 3

  Interaction among the biotic components. These may influence the availability of resources needed for life processes like nutrition, respiration, and reproduction.
- **Relate** your learning with your observations.
- Record your observations in Table 12.3 at the appropriate places. Table 12.3 is filled with examples for your reference.

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Table 12.3: Interaction of biotic and abiotic components in a habitat

Criterion 1: Interactions between biotic and abiotic components	Criterion 2: Interaction between two abiotic components	Criterion 3: Interaction among the biotic components
Earthworms live in moist soil.	The day temperature is high due to the bright sunlight.	A frog eats insects.
Many microbes are present in the pond.	Water is evaporating fast due to the sunlight.	A water snake eats fish.
A fish lays eggs in water.	Air current is blowing slowly on the water surface creating gentle waves.	Frogs and fish may compete for small insects larvae.
	The soil near the pond is moist.	A fish lays eggs in water near vegetation to protect them from other fish or frogs.



Fig. 12.6: Overlap of terrestrial and aquatic ecosystems

In Activity 12.4, you understood different types of interactions occur within a habitat. From this, you can infer that the biotic components (plants, animals, and microorganisms) and the abiotic components (air, water, soil, sunlight, and temperature) in a habitat interact with each other to form an **ecosystem**. Organisms in an ecosystem interact with abiotic components for food, shelter, and protection in an ecosystem. Different communities of living organisms interact with abiotic components in an ecosystems. There are two main types of ecosystems in nature. **Aquatic ecosystems** include ponds, rivers, and lakes while **terrestrial ecosystems** include forests, farms or even large trees like banyan, mango, or *pilkhan*. Hence, ecosystems can be large or small. Can you find overlapping ecosystems in Fig. 12.6?

Fig. 12.6 shows an overlap of different terrestrial and aquatic ecosystems. In this figure, you can see a small river (an aquatic ecosystem) along with mountains, forests, grassland, and farmland, which are examples of terrestrial ecosystems. Farmland is a **human-made ecosystem**. These ecosystems are interacting with each other at any given point.

In Activity 12.4, we have seen the importance of the components and their interactions in an ecosystem. For example, sunlight, carbon dioxide, and water are essential for producing food in plants; soil provides medium and essential nutrients for plant growth; air provides oxygen for respiration in plants as well as animals; water is essential for all living organisms. This shows how living organisms depend on the non-living component of an ecosystem.

Just as biotic components depend on abiotic components, abiotic components also depend on biotic components. For example, plants release oxygen during photosynthesis, roots hold soil in place and prevent erosion, and plants retain soil moisture and help cool the atmosphere.

You can identify and study any ecosystem in your surroundings and observe different types of interactions among the biotic and abiotic components. While studying biotic interactions, notice how organisms depend on each other for food.

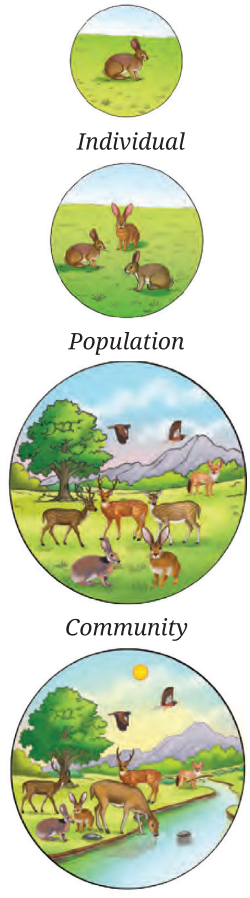


Fig. 12.7: Individual to ecosystem

Activity 12.5: Let us classify

Observe Fig 12.1b, which illustrates a forest ecosystem.

- Study the picture carefully and spot the organisms listed in Table 12.4.

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- Using the internet or your school library, find out what do these organisms eat.
- Record your observations in Table 12.4 by identifying whether each organism feeds only on plants and plant products, only on animals, or on both.

Table 12.4: Eating habits of different organisms

Name of the organism	Performs photosynthesis	Feeds on plants and plant products	Feeds on animals	Feeds on both plants and/or animals
Deer	No	Grass and leaves of plants	No	Only on plants
Horse				
Vulture				
Bengal Fox				
Bird (*Shikra*)				
Squirrel				
Mouse				
Mushroom				
Tree	Yes			

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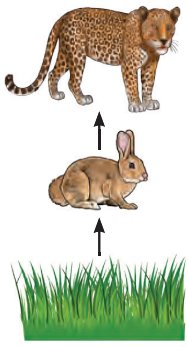


Fig. 12.8: Food chain

How do plants get their food? As you know, plants make their own food by the process of photosynthesis. Thus, they are called **producers** or **autotrophs** (*auto*=self + *troph*=food).

Organisms that cannot produce their own food and depend on other organisms for their food are called **consumers** or **heterotrophs** (*hetero* = other + *troph* = food). List the heterotrophs from Table 12.4.

Organisms that eat only plants are called **herbivores**, such as deer and hare. Those that eat only animals are **carnivores**, such as leopard. Organisms that eat both plants and animals are **omnivores**, such as crows, foxes, and mice.

12.5 Who Eats Whom?

In Activity 12.5, we learn about the feeding relationship among organisms. How can we make linkages with the feeding relationship among organisms in a given ecosystem?

Activity 12.6: Let us link (relate)

- Take an example of a grassland ecosystem.
- Consider the following organisms that we can spot in a grassland ecosystem: grass, frog, hare, fox, grasshopper, snake, and eagle.
- In Fig. 12.8, a relationship of who eats whom is shown among some of the organisms.
- **Draw** the feeding relationships for the remaining organisms by adding arrows, similar to those in Fig. 12.8.

In Fig 12.8, you can see that the grass is eaten by the hare and the hare is eaten by the fox. This is a representation of a food chain in a grassland ecosystem. Which is another food chain that can be drawn for the organisms given in this activity? One example may be as follows:

Grass → Grasshopper → Frog → Snake → Eagle

The interactions between biotic components based on feeding relationships can be represented in the form of a linear chain. A **food chain** is a simple sequence showing 'who eats whom' in an ecosystem. One such example is given in Fig. 12.9.

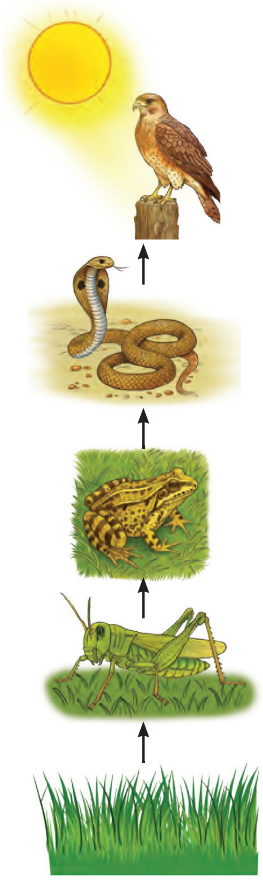


Fig. 12.9: Another food chain in a grassland

Activity 12.7: Let us draw

Fig. 12.10a represents a crop field with millets, mouse, and eagle.

- **Count** the number of each type of organism in Fig. 12.10a.
- Make a table and set a number in the table against each of the organisms.
- Arrange the numbers in the ascending order, consider the highest number at the base and the lowest at the top.
- Place the mouse, millet, and eagle appropriately in Fig. 12.10b.
- What figure do you get? It looks like a pyramid. Complete the pyramid in Fig. 12.10b.

Each organism in a food chain has a specific position, called a **trophic level** (*troph* = food):

- Producers (like green plants) are at the first trophic level.

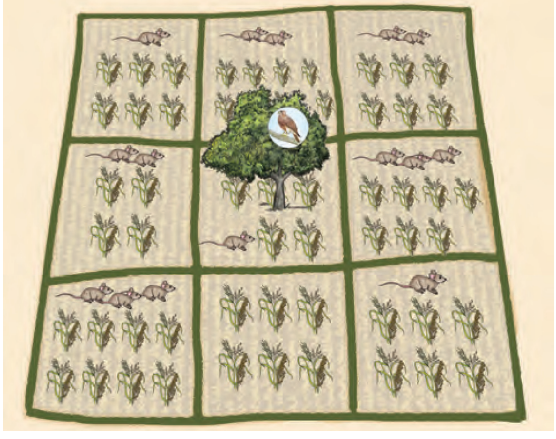


Fig. 12.10: (a) Food chain of millet, mouse, and eagle in a crop field

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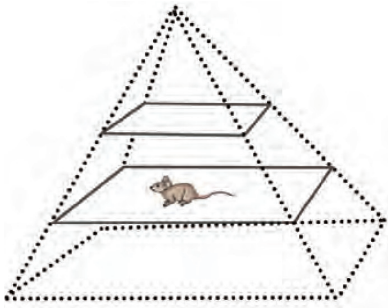


Fig. 12.10: (b) Food chain represented in a pyramid

- Herbivores (like hares and deer) are at the second level.
- Small carnivores (like frogs) are at the third level.
- Large carnivores (like tigers or vultures) occupy the next level.

Activity 12.8: Let us trace and link

- Look at Fig. 12.11.
- Look at the figure and put more arrows for the missing relationship of 'who eats whom'.
- How many other organisms might be connected to one organism through a feeding relationship in an ecosystem?

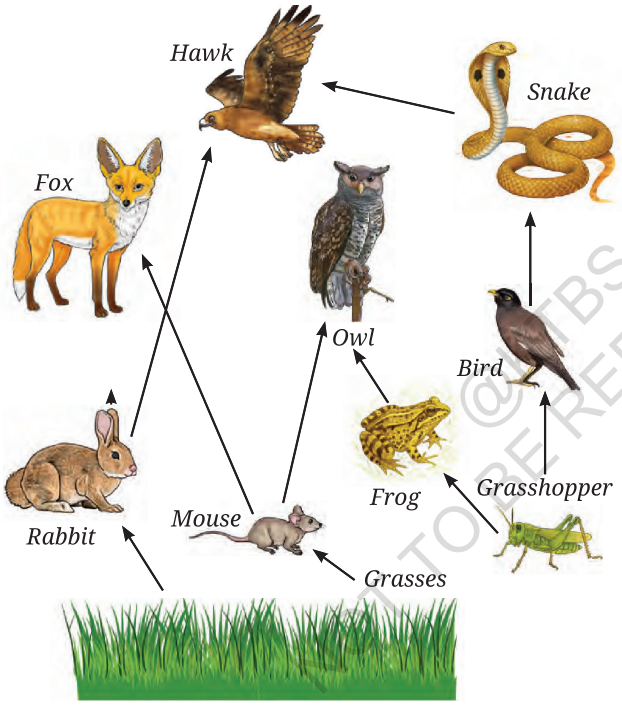


Fig. 12.11: Food web

Look at Fig. 12.11, and observe the relationship between different food chains in an ecosystem. Are these food chains interlinked? Each of the organisms may be eaten by two or more types of organisms. Thus, in an ecosystem, the food chains are interlinked with each other to form a network, called a **food web**.

You know that living organisms grow, perform many functions, develop, and die. During their life cycle, organisms produce a lot of waste, including dead matter and food waste.



Fig. 12.12: Mushroom growing on dead organic matter

12.6 What Happens to Waste in Nature?

You may have seen small umbrella-like structures, mushrooms, growing on dead plants or trees during the rainy season (Fig. 12.12). These are a type of fungi that grow on dead matter. Microorganisms like fungi and bacteria break down complex substances in dead plants and animals into simpler ones. This process returns

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important nutrients to the soil. You can also find tiny insects, such as beetles and flies, on animal droppings—like elephant dung—as they help break it down and recycle nutrients, back into the environment. This process is called **decomposition** and the organisms carrying out the process are called **decomposers** or **saprotrophs** (*sapro*= rotten + *trophs* = food). Plants grow in soil and many of the nutrients in soil come from the decomposition process. Thus, decomposers play an important role in recycling nutrients. In nature, nothing is wasted—everything is reused. Does nature really waste anything?

Ever heard of ...

India is a country with diverse habitats and seasons. Many **migratory birds** fly thousands of miles and reach different habitats in India. They migrate from different parts of the world to avoid harsh climate, and in search for food. Birds not only enhance the aesthetics of those habitats but also play a significant role in keeping the balance in an ecosystem as **pollinators** or seed dispersers along the path they migrate. This way they link two habitats. These birds are **predators** of insect pests and help farmers to control pest populations, and indirectly help in healthy crop growth. Migratory birds, Demoiselle Crane visit the water body of Khichan village in Jodhpur district during the winter months. Do you know which birds in your area are seen only during winter? **Collect** postal stamps and covers of migratory birds released by the Indian Postal Department, and collect information about their place of origin and reasons for their migration to different localities in India and more. **Showcase** the postal stamps in your science laboratory/school library to popularise migratory birds.





12.7 How Does One Change Lead to Another?

Look at Fig. 12.13. It shows how one small change can lead to many others. For example, many plants in a pond start dying because of pollution. With fewer plants less oxygen will be

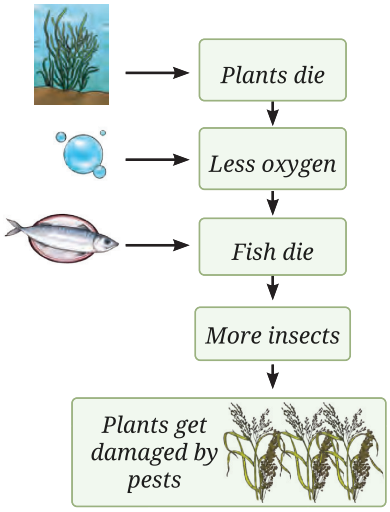


Fig. 12.13: One change leads to another



Fig. 12.14: Indian bullfrog

produced in water which will lead to a drop in the fish population in that water body. Reduction in fish population will have cascading effects and there will be less number of consumers in the pond. As a result, insects will increase in number. These insects will spread to nearby farmlands. This is how farmers will be compelled to use pesticides to grow their crops which may again adversely affect the environment. Further consequences may emerge in the form of other **environmental issues**.

What happens when we intervene in nature?

Activity 12.9: Let us read

In the 1980s, India was a significant exporter of frog legs, especially of the Indian bullfrog (*Hoplobatrachus tigerinus*) (Fig. 12.14). This large-scale harvesting led to a decline in frog populations. Since frogs eat insects, their reduced numbers resulted in a rise in agricultural pests. This forced farmers to use more synthetic pesticides, which harmed the environment, soil and water quality, and affected the overall environmental and human health. The Government of India banned the export of frog legs to prevent further **ecological damage**.

An ecosystem stays in balance when interactions among organisms and their environment keep populations and resources stable. This balance is dynamic, not fixed, and can be disrupted by natural or human-made changes.

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12.8 How Do Interactions Maintain Balance in Ecosystems?



Fig. 12.15: Competition among a community in an ecosystem

Besides feeding relationships, organisms also compete for common resources like food, water, physical space, or sunlight.

This competition helps control population size and keeps the ecosystem balanced. Without it, one species could multiply too much causing an imbalance in the ecosystem (Fig. 12.15).

There are other types of relationships too. Based on the example given in Fig. 12.16, what do you observe?

- **Mutualism:** Both organisms benefit. For example: Honeybees and flowers.
- **Commensalism:** One organism benefits while the other is not affected. For example: Orchids on trees.
- **Parasitism:** One organism benefits while the other is harmed. For example: Ticks on the body of dogs.

These interactions are all part of the complex web of life in an ecosystem.

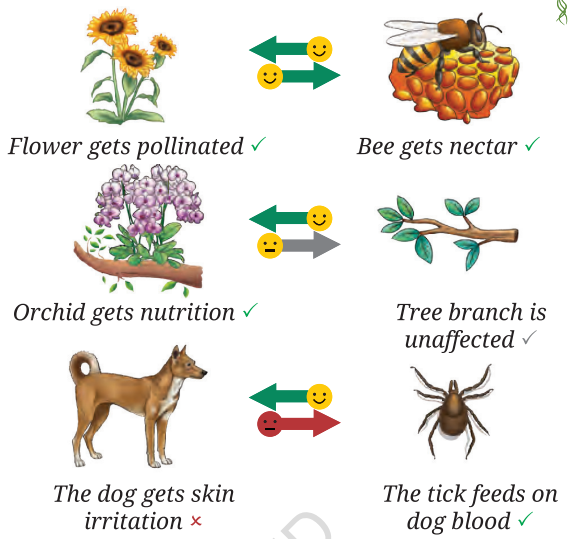


Fig. 12.16: Different types of interactions between organisms

Be a scientist



Asir Jawahar Thomas Johnsingh (A.J.T. Johnsingh) was a famous Indian wildlife biologist who helped us understand forest ecosystems through the eyes of animals. He was a pioneer in studying wildlife through modern tracking system. His research showed how predators like tigers and leopards rely on prey, such as deer and wild boar, while he was working in Bandipur National Park, Karnataka. He proved that a healthy prey population is key to predator survival. He inspired many youngsters to study wildlife and protect the forests and biodiversity of India.



12.9 What Are the Benefits of an Ecosystem?

We have learnt that biotic components and abiotic components of an ecosystem depend on each other and support various life processes. Humans also benefit from ecosystems. For example, forests provide fresh air, fertile soil, food, fibres, timber, and medicines. Similarly, aquatic ecosystems provide water and food. Ecosystems also offer aesthetic and recreational value. This benefits and supports our well-being and shows how closely nature and humans are connected. However, when we overuse or misuse natural resources, we disturb the balance in nature.

Now let us look at a real-life example of a threatened ecosystem — the Sundarbans.

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Fig. 12.17: Mangrove forest in Sundarbans

The Sundarbans have the largest mangrove forests in the world. Located where the Ganges and Brahmaputra Rivers meet between India and Bangladesh, the Sundarbans' forests and rivers are home to various flora and fauna, many of which are endangered. The Sundarbans protect us by slowing down strong winds and waves during storms and floods. The trees also absorb carbon dioxide from the air and release oxygen. Because of its importance, The United Nations Educational, Scientific and Cultural Organization (UNESCO) declared the Sundarbans a World Heritage Site in 1987. However, the Sundarbans (Fig. 12.17) are under a serious threat. Mangrove trees are being cut for fuelwood and farming. Illegal hunting and overuse of forest resources are a threat to the wildlife living there. Pollution from industrial waste and untreated sewage in rivers are also damaging the water and habitat. These human activities disrupt the natural way ecosystems work.

Similarly, other ecosystems across India are also under threat. Problems like deforestation, overuse of natural resources, the spread of invasive species, unsustainable land use, and pollution are damaging forests, rivers, scrublands, wetlands, grasslands, and coastal areas.

How can we stop damaging forests, rivers, and wetlands? Think about what actions you and your community can take to protect these important places.

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Our scientific heritage



Protected areas are parts of land or water set aside to conserve wildlife and their habitats. India has many protected areas like national parks, wildlife sanctuaries, biosphere reserves, and community conserved areas. These places help protect entire habitats including endangered animals, birds, and many rare plants. Famous examples include Jim Corbett National Park (Uttarakhand), Manas National Park (Assam), Nilgiri Biosphere Reserve (Western Ghats), Chilika Lake (Odisha), Eaglenest Wildlife Sanctuary (Arunachal Pradesh), Hemis National Park (Leh), Keibul Lamjao National Park (Manipur), Pirotan Island Marine National Park (Gujarat). Protected areas play a big role in saving nature for future generations.

12.9.1 Human-made ecosystems

Humans have created artificial ecosystems like fish ponds, farms, and parks to meet their needs. When well designed, these can help reduce pollution, support biodiversity, and provide recreational spaces for people. Unlike natural ecosystems, these need human care and management. Can you name any human made ecosystem in your area?

12.9.2 How do healthy ecosystems serve our farms?

Farming, a major livelihood in India, can become unsustainable if not managed well by applying environment friendly farming practices.

Humans have been practising farming for thousands of years to grow food. As the population grew, our dependence on agriculture increased. Between 1950 and 1965, India faced a food crisis due to low crop production. In the mid-20th century, the use of tractors, machines, synthetic fertilisers, and pesticides helped increase food production. This period is known as the **Green Revolution**. However, these farming methods are now considered unsustainable because of the overuse of synthetic chemicals, excessive groundwater extraction, and growing only one type of crop for commercial gain. How do these practices harm both the environment and human health?

Many scientists believe that overusing pesticides and growing the same type of crop repeatedly on the same land leads to soil degradation. Understanding ecosystems can help us adopt better and more sustainable farming practices.

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Activity 12.10: Let us survey

Visit a nearby farm with your parents or teacher/interact with farmers in your community to find out about the farming practices they adopt.

- **Prepare** a list of questions for farmers to find out the pesticides and other farm inputs they use, and whether they reuse or recycle materials to improve their crops. Here are some sample questions:
  - How have your farming practices changed over time? And why?
  - What effects do you notice when using synthetic fertilisers and pesticides?
  - Have you seen any changes in soil health after using these synthetic fertilisers and pesticides?
- **Interact** with farmers based on these questions. Based on your findings, prepare a report.



Fig. 12.18: Natural control of pests by predators—Beetle feeding on pests

What inference do you draw from your interactions with farmers?

Synthetic fertilisers and pesticides have played a vital role in improving crop production and helped countries like India become food secure. However, their long-term use can affect the environment and soil health. Overuse of synthetic fertilisers may reduce soil fertility by decreasing friendly microorganisms in soil and lowering organic matter (humus), which helps bind soil particles. Without enough humus, soil becomes prone to erosion. Also, it reduces the population of natural predators which ultimately increase the population of pests (Fig. 12.18). Heavy irrigation and repeated ploughing can also disturb soil organisms like earthworms and snails, which are important for maintaining ecological balance.

Some pests may develop resistance to pesticides, making them difficult to control. Growing the same crop repeatedly, known as **monoculture**, can reduce crop diversity and affect pollinators, which are crucial for food production.

To make farming more sustainable, some farmers are exploring organic and natural farming methods. These aim to reduce the use of synthetic fertilisers and support sustainable farming, with minimal interference in natural ecosystems. Based on your learning, what practices do you think can help farmers protect the soil, the environment, and our food security for the future?

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Our scientific heritage



The ancient text *Vrikshayurveda* emphasises on soil health and nourishment. The text strongly advocates for the continuous nourishment of the soil through organic manure like *Kunapa Jala* (a liquid fertiliser made from animal and plant waste by the process of fermentation; that breaks complex substances into simpler ones) and other composted materials.



Snapshots

- A habitat is a place that provides the right conditions for an organism to live and grow.

- Habitats have biotic components (plants, animals, microbes) and abiotic components (air, water, soil, temperature).
- The interaction between biotic components and abiotic components in an area forms an ecosystem.
- Ecosystems can be terrestrial (forests, grasslands, deserts) or aquatic (ponds, lakes, sea, oceans).
- Organisms often classified as producers (plants), consumers (herbivores, carnivores, omnivores), and decomposers (bacteria, fungi).
- Producers make their own food, while consumers eat plants or animals. Decomposers break down dead matter and recycle nutrients.
- Food chains depict who eats whom in an ecosystem, and food webs show how these chains are interconnected. The positions that different organisms occupy in a food chain are called trophic levels.
- Some organisms live in relationships, like mutualism (both benefit), commensalism (one benefits, other is unaffected), and parasitism (one benefits, one is harmed).
- The benefits that ecosystems offer are crucial for human survival and well-being. They provide clean air, water, food, medicine, and climate regulation.
- Human activities like pollution, deforestation, habitat loss, climate change, invasive species, and overexploitation of natural resources threaten ecosystems. Protecting them through efforts, such as conservation like national parks and sanctuaries is vital.

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Keep the curiosity alive

1. Refer to the given diagram (Fig. 12.19) and select the wrong statement.
   (i) A community is larger than a population.
   (ii) A community is smaller than an ecosystem.
   (iii) An ecosystem is part of a community.
2. A population is part of a community. If all decomposers suddenly disappear from a forest ecosystem, what changes do you think would occur? Explain why decomposers are essential.
3. Selvam from Cuddalore district, Tamil Nadu, shared that his village was less affected by the 2004 Tsunami compared to nearby villages due to the presence of mangrove forests. This surprised Sarita, Shabnam, and Shijo. They wondered if mangroves were protecting the village. Can you help them understand this?

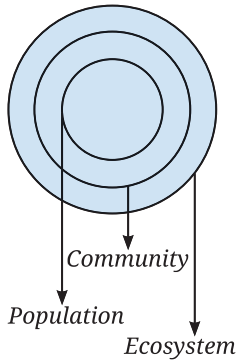


Fig. 12.19: Population, community, and ecosystem

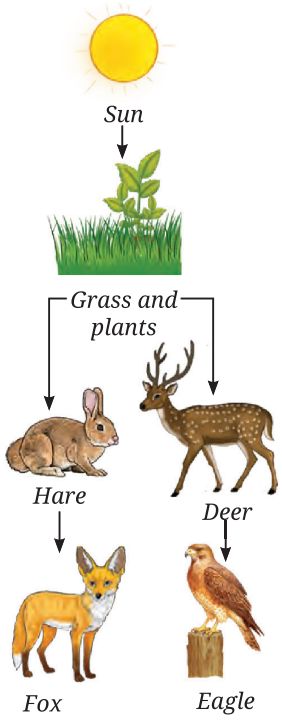


Fig. 12.20: Parts of a food web

4. Look at this food chain:

   Grass → Grasshopper → Frog → Snake

   If frogs disappear from this ecosystem, what will happen to the population of grasshoppers and snakes? Why?
5. In a school garden, students noticed fewer butterflies the previous season. What could be the possible reasons? What steps can students take to have more butterflies on campus?
6. Why is it not possible to have an ecosystem with only producers and no consumers or decomposers?
7. Observe two different places near your home or school (e.g., a park and a roadside). List the living and non-living components you see. How are the two ecosystems different?
8. 'Human-made ecosystems like agricultural fields are necessary, but they must be made sustainable.' Comment on the statement
9. If the Indian hare population (Fig. 12.20) drops because of a disease, how would it affect the number of other organisms?

Discover, design, and debate



- Plan a clean-up day at school or a nearby park. Wearing gloves and using bags, collect the litter you find. Discuss the kinds of waste you found. Which was the most common? How can we reduce such waste?
- In Arunachal Pradesh, the Nyishi and Mishmi tribes treat the Tiger as sacred. In Chhattisgarh, the Baiga tribe worships Bagheshwar or Bagesur Dev and believes the Tiger is the protector of the forest. Find out about another Indian tribe that has a special bond with any animal.
- Pick a tree near your home or school. Observe it once a week for 4 weeks. Note any new leaves, flowers, fruits, or visiting birds and insects. Record your observations. You may even upload your findings to www.seasonwatch.in and become a young citizen scientist.



Prepare some questions based on your learnings so far ...

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- Interact with farmers and record indigenous practices followed by them for sustainable farming. Create a sustainable herbal garden/natural farm at home or at school. It could be a group activity with students from different grades.



Fig. 12.21: Farming Practices

- Look at Fig. 12.21 to understand the different farming practices adopted by farmers or you may also visit a nearby farm with an elderly person to observe the same. List a few suggestions in your notebook to improve farming practices by adopting eco-friendly and sustainable techniques. You can also make posters or model and display while participating in school functions, science fairs or Krishi Mela. The school may also invite agricultural scientists, farmers, and experts to discuss the prevalent farming practices with the students.

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Reflect on the questions framed by your friends and try to answer ...

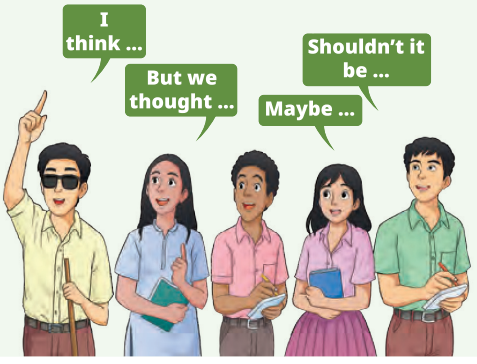
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Our Home: Earth, a Unique Life Sustaining Planet

13

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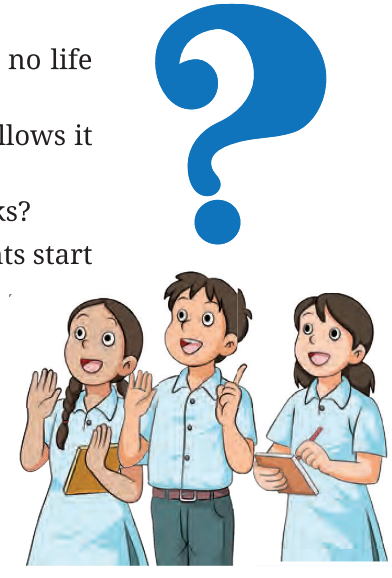
Probe and ponder

- What do you think Earth would look like if there were no life on it at all?
- Life on Earth has survived for billions of years. What allows it to keep going despite major changes and disasters?
- Why don't dogs lay eggs? Or hens give birth to live chicks?
- If a spaceship carried soil and water to Mars, could plants start growing there?

Share your questions

_____

_____ ?



We have now reached the final chapter of this book, the concluding chapter in our scientific journey through the middle stage. It is time to put together all that we have seen and learnt and try to understand why our home, planet Earth, is like no other place in the known universe. As you have learnt in *Curiosity*, Grades 6 and 7, the Earth is a planet orbiting the Sun. However, it is not just any planet. It is a planet that sustains life—full of diverse landscapes, from towering mountains and vast oceans to endless deserts and lush forests. Today, our satellites allow us to take amazing pictures of our planet. The image in the beginning page was taken by an Indian Space Research Organisation (ISRO) Earth Observation Satellite and made by combining nearly 3000 smaller images, like pieces of a mosaic. Although it looks beautiful, it's a false colour image, where scientists use different colours to show different types of information. These satellite images help us study plants on land and tiny organisms in the ocean, and can even detect things like ocean temperature, oil spills, and wind direction. In this chapter, we will uncover the unique conditions that make Earth the perfect home for living beings.

13.1 Why Is Earth a Unique Planet?

What makes the Earth so special? While there are perhaps billions of planets in the universe, Earth is the only one where life, as we know today, exists and thrives in all its forms.

Have you ever wondered where all life on Earth actually exists? All the mountains, rivers, forests, animals, and people are found on just a very thin layer on the surface of our planet. From the tallest mountain to the deepest ocean trench, the crust, where all of life exists, is tiny compared to the size of Earth. If Earth were the size of an apple, the crust would be as thin as the apple's skin as shown in Fig. 13.1. This delicate, life supporting layer is what makes Earth truly special.

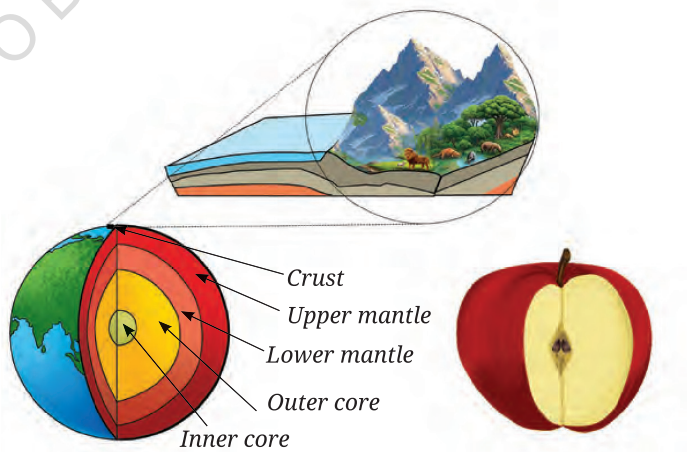


Fig. 13.1: The Earth's crust is like the thin skin of an apple

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I wonder what makes the Earth unique for living beings to grow and survive!

Let us **conduct** an activity to list out some features of the Earth that you think make it special.

Activity 13.1: Let us find out

- List some features of the Earth that we often take for granted, but are interesting and important to us. Write them in Table 13.1. We have filled in a few for you.

Table 13.1: Interesting features about the Earth

S.No.	Interesting features of the Earth
1.	The air we breathe doesn't fly off and disappear into space. (We learnt in Chapter 7 that the particles of a gas move freely, and gases do not have a fixed volume)
2.	We can stand on the ground held by gravity (as we learnt in Chapter 5), but our heart can pump blood up to our head.
3.	
4.	

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Discuss the features you have listed with your teacher and friends. You may realise that the Earth is interesting and important to us in many ways. It provides us with the air that we breathe, the water that we drink, and the soil that helps in growing crops. The Earth also provides us materials like rock and timber with which we build our homes, buildings, and roads. You must be curious to know what makes the Earth a unique planet which not only allows life like us to exist but also sustains it.

13.2 What Do the Planets of Our Solar System Look Like?

In *Curiosity*, Grade 6, you had studied the solar system in the chapter 'Beyond Earth'. Let us recall some of the things we had learnt. Our solar system has eight planets that go around the Sun in nearly circular orbits. In order of their increasing distance from the Sun, they are Mercury, Venus, Earth, Mars, Jupiter,

Saturn, Uranus, and Neptune. Out of all these planets, Mercury, Venus, Earth, and Mars, are relatively small and rocky planets, while Jupiter, Saturn, Uranus, and Neptune are large planets, mostly made of gases.

Let us find out more about the planets in the solar system by **performing** Activity 13.2.

Activity 13.2: Let us find out

- **Collect** information about the temperature and size of the planets in the solar system, and check if they have an atmosphere.
- You may collect this information from books in your school library, trusted websites, or discuss with your teachers.
- Fill out the missing information in Table 13.2.

Table 13.2: Planets in our solar system

S.No.	Planet	Average temperature (°C)	Radius, compared to the Earth	Has an atmosphere?
1.	Mercury	170		No
2.	Venus	450	0.95	Yes
3.	Earth	15	1	Yes
4.				
5.			11	
6.				
7.				
8.		–200	4	

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We know that all planets in the solar system get their energy from the Sun. Thus, when a planet is close to the Sun, it would be very hot. As we move away from the Sun, planets should get colder. Is this what you found in Table 13.2? This is generally correct, except that Venus, the second planet from the Sun has the highest average temperature and is the hottest planet. Why is this so?

Venus is the hottest planet not because it is the closest to the Sun, but because its thick atmosphere traps heat.

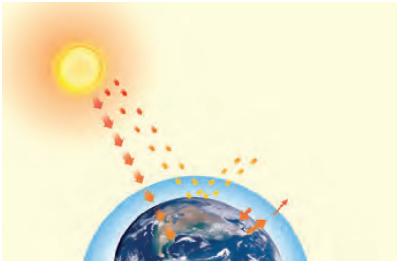


Fig. 13.2: Schematic of greenhouse effect on Earth

The air on Venus is almost entirely made up of carbon dioxide gas, which does not let the heat escape. This is called the **greenhouse effect** (Fig. 13.2), and it makes Venus even hotter than Mercury, which is relatively closer to the Sun. On the Earth also, gases like carbon dioxide in the atmosphere trap heat by absorbing the radiation given off by the Earth, after it gets warmed by the Sun. Thus, greenhouse effect plays an important role in maintaining just the right temperature on Earth.

A step further



The greenhouse effect that causes a planet like Venus and Earth to trap heat does not work the same way as a greenhouse for growing plants in a cool climate. On Venus or Earth, gases like carbon dioxide in the atmosphere trap heat by absorbing the radiation given off by the Earth, after it gets warmed by the Sun. A plant greenhouse, on the other hand, traps warmed air simply because it is a closed space, usually with glass walls (Fig. 13.3). It heats up during the day, but the air stays in and the heat does not escape easily. So while both keep things warm, they do it differently!



Fig. 13.3: Greenhouse for plants

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13.3 What Makes the Earth Suitable for Life to Exist ?

13.3.1 Position of the Earth

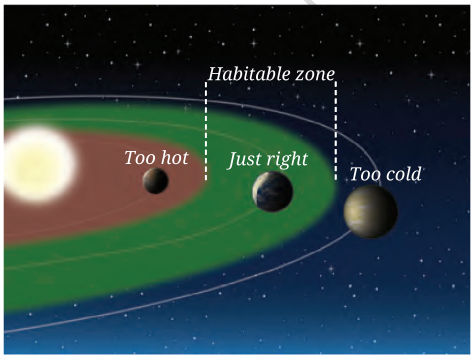


Fig. 13.4: The habitable zone around a star

The most important reason why the Earth can support life is its distance from the Sun. It is just at the right distance, where the temperature allows water to exist in a liquid form. If the Earth were closer to the Sun, it would be too hot and all the water would evaporate; if it were farther away, it would be too cold, and all the water would freeze. In such extreme conditions, it would have been impossible for most life forms—especially plants, animals, and humans—to grow and thrive on Earth. Although some microbes, like certain

bacteria, can survive in frozen environments, from what we know so far, liquid water is essential for life to evolve. Earth's distance from the Sun allows water to remain mostly in liquid form, which is essential for the development and sustenance of life in all its form. The range of distances from the Sun (or another star) over which water remains liquid is called the **habitable zone**, or sometimes also called the '**Goldilocks zone**' (Fig. 13.4).

As you have also studied in Social Science, most of Earth's surface is covered with water. Thus, when seen from space, the Earth looks blue because of the vast amount of water—hence the name Blue Planet (Fig. 13.5).



Fig. 13.5: Earth — The blue planet

A step further

Did Mars ever support life?

Mars lies at the edge of the Sun's habitable zone. Several spacecrafts have been sent to Mars, rovers have landed and explored its surface, but no proof of life has been found yet. However, scientists think that in the past, Mars may have had liquid water—maybe even some lakes—and conditions that could support simple life forms (Fig. 13.6).

This is one reason Mars continues to interest scientists. It also reminds us that science doesn't always have final answers. As we explore more, we may find new clues—or even new kinds of life. Science stays open to change when we learn more.

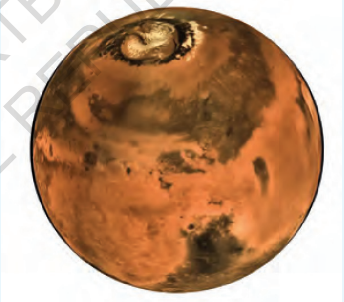


Fig. 13.6: Mars



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Is the temperature or distance from the Sun, the only factor that makes the Earth habitable?

What would happen if the size of the Earth were too small or too big?



13.3.2 Size of the Earth

There are some other important factors that make the Earth habitable. In our solar system, the orbits of most planets, including the Earth are almost circular. This keeps the amount of

sunlight and heat nearly steady throughout the year, preventing extreme summers and winters at most places.

However, moderate temperature due to the right distance from the Sun isn't the only factor that makes the Earth habitable. The planet is also the right size to support an atmosphere. As you learnt earlier, the atmosphere is the layer of gases that surrounds the Earth, and it plays a major role in sustaining life. You also learnt in Chapter 5 that the Earth's gravity pulls objects towards it. If Earth were much smaller (but with the same average density), its gravity would have been too weak to hold on to the gases in our atmosphere, and they would have escaped into space. On Mars, the atmosphere is 100 times thinner than on Earth, and Mercury has no atmosphere at all.

On the other hand, if the planet was too large, and gravity was much stronger, it would perhaps pull us down to the planet with such a large force that our bones could get crushed! Due to the right size of the Earth, it is able to support atmosphere which is essential for life.

The presence of oxygen in the Earth's atmosphere allows us to breathe, and is needed by almost all forms of life on Earth. But oxygen has another important role. Some of the oxygen in our atmosphere, gets converted to another form called ozone (a three-atom oxygen molecule), and forms an important part of the atmosphere called the **ozone layer**. This layer acts like a shield, blocking harmful ultraviolet (UV) rays from the Sun that can damage living cells.

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Our scientific heritage



India's Mangalyaan (Mars Orbiter Mission), launched in 2013 by Indian Space Research Organisation (ISRO), was a big step in exploring Mars (Fig. 13.7). It carried tools to study the planet's atmosphere, surface, and signs of past water. Some of these sensors help scientists ask big questions—like was Mars ever suitable for life? Mangalyaan showed the world that India could do space science with smart, low-cost technology—and it helped bring Mars closer to all of us.

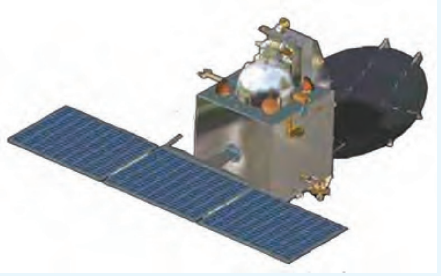
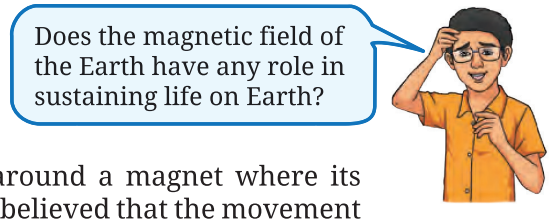


Fig. 13.7: Mangalyaan

13.3.3 Magnetic field of the Earth

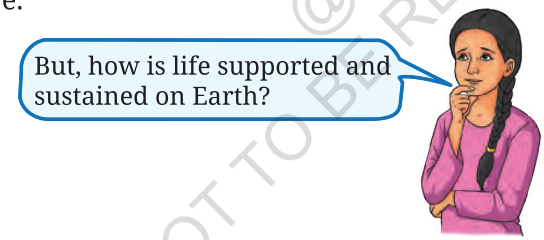


In *Curiosity*, Grade 6, we learnt that a freely suspended magnet always settles in a fixed direction. This is because the Earth itself behaves like a giant magnet. You have also seen in Chapter 4 that the region around a magnet where its effect is felt has a magnetic field. It is believed that the movement of molten iron in Earth's core may be the origin for Earth's magnetic field.

Earth is constantly hit by tiny, high-energy particles that come from space. Some come from far across the universe and are called **cosmic rays**. Other particles come from the Sun and are called the **solar wind**. These particles can be harmful as they can damage the atmosphere, reduce the ozone layer, and let in more harmful UV rays, which can affect life on Earth.

Thankfully, the Earth's magnetic field acts like a protective shield. It pushes many of these harmful particles away from the Earth, keeping our atmosphere, and hence life on our planet safe.

Earth's unique position in the solar system—allows the presence of liquid water—along with its size, atmosphere, and magnetic field, all help make it a planet where life can emerge and thrive.



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13.4 What Allows Life to Be Sustained on Earth?

Earth has the right conditions for life, but it is the beautiful connections between living and non-living things that help life to thrive. In *Curiosity*, Grades 6 and 7, you learnt about key natural resources, such as, air, water, sunlight, soil, and minerals. You also learnt about the important life processes in plants and animals. Now, let us **explore** how all these elements interact to support and sustain life on Earth.

13.4.1 Air, water, and sunlight

We know that the atmosphere contains oxygen, which humans, animals, and plants use for respiration. In the presence of sunlight, plants take carbon dioxide from the air and water from

the soil to prepare food by photosynthesis. In the process, oxygen is released, which is needed for respiration.

We have learnt, radiation from the Sun heats the Earth. Some of this heat is trapped by the atmosphere due to the greenhouse effect. This effect though mild, keeps the temperature just high enough for water to remain in the liquid state. In *Curiosity*, Grade 7, you also learnt about heat transfer by radiation. Without an atmosphere, the Earth would lose heat to space and become too cold. So the greenhouse effect helps keep the Earth warm.

Water is essential for life. You have learnt that it covers about 70 per cent of the Earth's surface and is found in ponds, lakes, rivers, springs, seas, oceans, and groundwater. All this water forms the **hydrosphere**. In Chapter 7, you learnt that water is a good solvent. In *Curiosity*, Grade 7, we learnt how water transports nutrients from soil to leaves in plants. In animals, it regulates body temperature, aids digestion, and ensures hydration, all essential for health and life.



Fig. 13.8: Life in water

Though much of Earth is covered by water, we still know little about what lives deep in the oceans. The hydrosphere is home to millions of life forms, from tiny planktons to giant whales, many still being discovered. Oceans, lakes, and rivers provide rich environments for aquatic life (Fig. 13.8). Freshwater is also needed to grow crops and support people around the world.

Water vapour in the air forms clouds and brings rain or snow. This refills rivers, lakes, and underground water. Rainfall affects the kinds of plants and animals that can live in a place. Moving air also shapes weather and rainfall—which influence farming, water supply, and life on land.

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13.4.2 Soil, rocks, and minerals

Beneath our feet lies something remarkable—the Earth's crust, made of rocks, soil, and minerals. It may seem hard and lifeless, but it provides almost everything life needs to grow and survive. From soil that helps plants grow to minerals that give us salt, coal, oil, and metals like iron and copper—this outer layer support both ecosystems and human life. The solid parts of the Earth, including materials like rocks, soils, and minerals are known as the **geosphere**.

Soil may look like simple dirt, but it is rich in nutrients like nitrogen and potassium that plants need to grow. These nutrients come from the slow breakdown of rocks and the remains of plants and animals.

There are various types of landforms, rocks, soils, etc., on Earth. This variety along with the processes that shape and alter them is called **geodiversity** (Fig. 13.9). It helps create unique habitats where different types of life can thrive. The non-living parts of nature, like soil, rocks, and water, aren't just a background—they help shape the story of life itself.

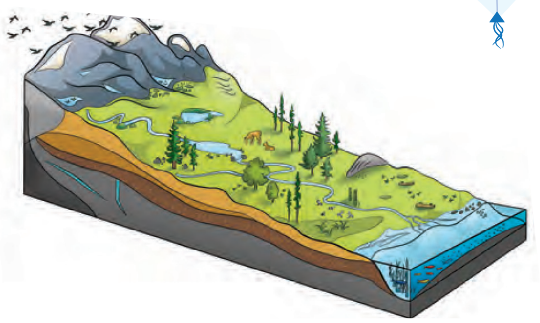


Fig. 13.9: Geodiversity

13.4.3 Plants, animals, and microorganisms

From the chapter on microbes to the chapter on ecology, we have seen that the Earth is full of life—from trees, shrubs, herbs, to animals, insects, and tiny organisms invisible to the naked eye. All living beings, along with the places where they live, make up the **biosphere**. This includes land, water, and air, where life interacts with its surroundings to survive and grow.

As you learnt in Chapter 12, living beings depend on one another and their environment. Plants make food through photosynthesis, animals eat plants or other animals, and decomposers break down dead matter and return nutrients to the soil. Nature works together as a system to support life.

13.4.4 The importance of balance

Have you ever wondered how so many things on Earth stay in balance? Earth is like a giant teamwork project between nature, weather, and life itself. It is a vast, living system where land, air, water, and living things support and affect one another. Even a small change in one part—like cutting down a forest—can impact rainfall, soil, air quality, and the animals that live there. Life on Earth survives not because of just one thing, but because everything works together in balance. It is this balance that keeps our planet habitable. That's why preserving and protecting clean air, water, soil, and all forms of life isn't just important but essential for keeping Earth healthy for the future.

13.5 What Keeps Life from Disappearing?

If plants and animals didn't reproduce, life would eventually disappear from Earth. Reproduction ensures that each type of organism continues to exist, maintaining the continuity of life.

We usually expect that animals will produce young ones that resemble them—cows have calves, and cats have kittens. This happens because parents pass on instructions to their offspring about how to develop from a single cell. These instructions,

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called **genetic material** or **genes**, are stored inside every cell of a living being. You can think of genes as a detailed instruction manual inside each cell. Some instructions tell the cell how to make blood, while others guide the formation of bones, muscles, or skin. Together, these instructions ensure that a calf grows into a cow, or a kitten grows into a cat.

But reproduction does more than just create more of the same kind of living beings. It also allows for small changes in the instructions that are passed down from parents to offpsrings. Sometimes, these changes help a plant or animal survive better in a new environment. For example, over time, camels developed humps to store fat and survive in deserts. Even microbes evolve—some bacteria, as you learnt in the chapter on health, have become resistant to antibiotics, helping them persist. Over many generations, such changes can lead to new features—or even completely new types of living beings. So, reproduction not only keeps each kind continuing, but also helps life adapt change, and continue in new forms (Fig. 13.10).

But how can the same process lead both to similarity (an animal gives birth to similar individual, such as a cow gives birth to a cow) and variation (shows different characteristics like difference in color and height of to individuals of some kind)? That is a fascinating puzzle. There are two types of reproductive processes—one in which the young are almost exactly like their parent and another in which they look slightly different from their parents.



Fig. 13.10: Development of calf to cow

In asexual reproduction, a single parent produces new individuals that are exact copies of itself (exact in terms of the instructions inside the cell). In sexual reproduction, instructions from two parents combine to create offspring that are not exactly like either of the parent. They share some traits with both parents, but also have differences. This mixing helps keep useful features while allowing new ones to appear. Over many generations, these small differences can add up—leading to big differences, and even new life forms.

Let's explore how reproduction takes place in plants and animals, and how it helps living beings develop special features and sometimes change over time.

13.5.1 Asexual reproduction

Many plants can reproduces when any part of the plants—leaf, stem, or root—is planted in soil. This kind of reproduction is called **vegetative propagation.**

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Can you **observe** and list some plants around you that grow this way?



Activity 13.3: Let us find out

- Take some parts of plants like stem cutting of a money plant, the 'eyes' of a sprouted potato, or a piece of ginger (Fig. 13.11b).
- Plant each of them separately in moist soil (not too deep). For money plant, you can just put a cutting in a glass container which makes it easy to observe.
- Make sure they get all the conditions they need to grow—like water, air, and sunlight.
- Watch them every day and note how many days it takes for roots stem and leaves to appear. Also observe when the first new leaf appears.



(a)



(b)

Fig. 13.11: Vegetative propagation — (a) Ginger; (b) Potato

Ever heard of ...

Not just plants—microbes and simple animals also reproduce asexually. For example, single-celled organisms like bacteria and amoeba divide into two identical individuals. Some multicellular organisms like algae can regrow from small cut parts. Hydra, another simple animal, grows tiny buds on its body that breaks off and grow into new individuals.

Planaria (Fig. 13.12), a type of flatworm, can regrow from a fragment of its body! Scientists study this organism to understand regeneration in animals.

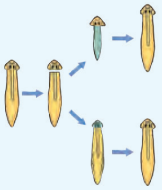


Fig. 13.12: Planaria



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13.5.2 Sexual reproduction

In this type of reproduction, two parents are involved—usually called male and female. This is easy to observe in animals, but did you know even flowering plants have male and female parts? Some microorganisms like bacteria and yeast also have two 'mating types' that act like the two parents.

Special cells for reproduction

You might wonder if both parents pass on their genetic material for making a new organism, won't the child end up with double the amount of instructions? And would not this keep doubling every generation?

This does not happen because each parent makes specialised reproductive cells, called **gametes**. These carry only half of the parent's genetic material . When male and female gametes join, they form a new cell with a complete set of instructions—half from each parent.

Babies do not look exactly like their mother or father. Even brothers and sisters in the same family can look different from each other. This is because every baby gets a mix of genetic information from both parents through gametes. Each gamete carries a different set of instructions for things like eye colour, hair type, and more. These instructions mix in different ways when the sperm and eggs joins to form a baby. These instructions mix in different ways each time, so each child is unique. No wonder one child may 'inherit' a nose similar to mother and another may inherit eyes similar to father. It all depends on which pieces of the parent's 'instruction book set' came together.

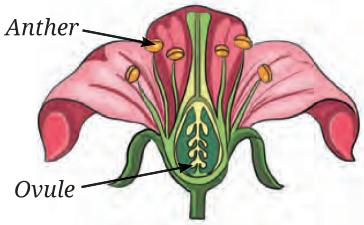


Fig. 13.13: A flower

Sexual reproduction in plants

Plants use different parts of their flowers to produce male and female gametes. Pollen grains found inside the anther of a flower are the male gametes, while ovules, found deep inside the flower, are the female gametes. Pollen is carried to another flower by wind, insects, or animals—this process is called **pollination**. When the male and female gametes combine, it is called **fertilisation**, forming a zygote that becomes the seed. The fleshy part of the flower around the ovule develops into a fruit (Fig. 13.13).

When birds or animals eat the fruit, the seeds often get dropped far from the original plant—a helpful way for plants to spread. That's how a banyan seed, dropped by a bird that ate a fruit and excreted the seed, might sprout in a crack in a wall after the rains. When seeds get water, they use stored nutrients to grow roots and shoots. Remember in Grade 6 you had studied the germination of seeds where you observed tiny shoots and the first leaves appear.

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Sexual reproduction in animals

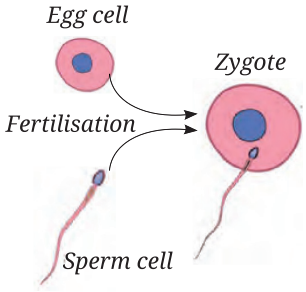


Fig. 13.14: Formation of zygote

In animals, gametes are called sperm (male) and eggs (female). Fertilisation may take place in water, for example, male and female fish or frogs eject sperm and eggs, respectively, into the water where they combine to form the zygote. In these animals, the development of the zygote into an embryo also takes place in water (Fig. 13.14).

In birds and mammals, including humans, sperm are deposited inside the female and fertilisation takes place when the sperm swim towards the egg produced by the female. After this step, birds and mammals follow different processes.

In birds, the fertilised egg (zygote) is 'laid' by the female. The development of the zygote into an embryo happens after the egg is laid during the hatching process. Think about how much 'food' the female parent has to put into each egg—it has to last for the developing embryo until it hatches. This is one strategy to ensures supply of nutrition to the embryo.

In most mammals, the development of the zygote into an embryo takes place inside the body of the female. The mother's body provides all the food and oxygen the baby needs to grow until it is born. This is a different way of giving nutrition to the developing baby, compared to animals like birds that lay eggs. What are the advantages and disadvantages of giving birth to young ones vs. laying eggs? Do you think animals like dogs, cows, or humans could lay eggs like birds? Why or why not?

13.6 What Are the Threats to Life on Earth?

We know that life on Earth depends on a delicate balance of living and non-living things working together. But human actions are disturbing this balance. Even small changes in global temperature, oxygen levels, or the ozone layer can put life at risk.

Today, the biggest environmental challenges that we face are climate change, biodiversity loss, and pollution—together known as the triple planetary crisis.

Burning fossil fuels like coal and oil releases greenhouse gases like carbon dioxide and methane. These trap even more heat in the atmosphere which causes global warming. Normally, Earth keeps a balance since trees, plants, and even tiny ocean planktons absorb carbon dioxide as they grow. But when we burn fossil fuels, we release extra carbon that has been locked underground for millions of years. The Earth cannot absorb this fast enough, so the heat builds up. Even a small increase in temperature can melt ice caps, raise sea levels which could flood many coastal cities, cause extreme weather conditions, and lead to many plants and animals disappearing. These long-term changes in temperature, rainfall, and weather patterns are called **climate change**.

When natural habitats are destroyed, plants and animals may disappear, upsetting ecosystems. For example, as we saw in Chapter 12, if grasses vanish, animals that feed on them like deer or grasshoppers struggle to survive. And without herbivores, predators like tigers or foxes lose their food too. Every type of living thing has a role, and losing even a few weakens nature's ability to support life.

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Fig. 13.15: Air pollution

Pollution adds to the problem. Air pollution from factories, vehicles, and burning fuels harms both people and the nature. It can cause breathing problems, damage crops, and lead to smog and acid rain (Fig. 13.15).

Climate change affects everything—from crop growth and water supply to wildlife habitats and human health. To protect life on Earth, we need to cut pollution, use cleaner energy, and make wiser choices. We have also learnt that life on Earth flourishes within a delicate balance supported by interdependent natural systems. However, this balance is increasingly threatened by human actions. For example, a little less or more of oxygen in air, or a little lower or higher temperature of the Earth, or a little less of ozone in the atmosphere, could endanger life on the Earth.

Ever heard of ...



Countries around the world have made global agreements to protect the environment. The Montreal Protocol (1987) helped reduce harmful chemicals like Chlorofluorocarbons (CFCs), allowing the ozone layer to slowly recover. The Earth Summit (1992) led to international efforts on climate change and biodiversity. Later, the Kyoto Protocol (2005) and Paris Agreement (2015) committed countries to reduce greenhouse gas emissions. The Paris Agreement set a goal to limit global warming to below 1.5 °C, but as of 2025, the world is not on track to meet that goal. Much more action is needed to avoid any more adverse effects of climate change.

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Water and soil pollution are serious threats to life (Fig. 13.16). Factory, farm and plastic waste harm aquatic life and make water unsafe. Excess fertilisers and poor waste disposal pollute soil, reduce crop yield, and spread harmful substances through the food chain. Protecting them requires better waste management and sustainable farming practices.



Fig. 13.16: Water pollution

We have seen above that all the Earth system, such as hydrosphere, biosphere, atmosphere and geosphere are connected—so damage to one can affect the others. Protecting the climate means cutting down on greenhouse gases by using renewable energy like solar and wind, improving energy use, and choosing environmentally friendly ways to travel. At the same time, preserving

biodiversity is key as diverse ecosystems are stronger and more balanced. Local communities can play a big role in using natural resources sustainably.

Everyone can help. Reusing, repairing, and recycling items like clothes and plastic reduce pollution and waste. Small actions like saving energy and water add up. Learning more, sharing ideas, and encouraging others also makes a difference.

In **conclusion**, sustaining life on Earth needs action from all of us—from local communities to global leaders. By working together and living responsibly, we can protect this unique planet and its future.

Snapshots



- Our Earth is a unique planet in the solar system as it supports life.
- Earth orbits the Sun at a distance where the temperature is neither too hot nor too cold, which allows water to exist in liquid form. This region is called the habitable zone or Goldilocks zone.
- Further, the Earth orbits the Sun in a nearly circular orbit ensuring that the Earth is not too hot or too cold during any part of the year.
- The Earth's gravity is just enough to not let atmosphere escape into space. It is also not too high where creatures would be crushed by their own weight.
- Presence of ozone in the atmosphere prevents harmful ultraviolet rays from reaching the surface of the Earth.
- The magnetic field of the Earth shields it from high-energy particles that would otherwise hit the Earth and destroy life.
- The atmosphere (consisting of air), hydrosphere (consisting of water), geosphere (consisting of the solid part of the Earth), and biosphere (consisting of life) interact and together sustain life on the Earth.
- Reproduction is essential to ensure the continuity of life on Earth.
- Reproduction can be either asexual or sexual.
- In asexual reproduction, a single parent produces new individuals that are exact copies of itself.
- Sexual reproduction make it possible for new features to appear in the following generation.
- In different animals, the development of the zygote into an embryo takes place either inside or outside the body.
- Climate change, biodiversity loss, and pollution are threatening life on Earth. Together, these challenges are known as the triple planetary crisis.

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Keep the curiosity alive

1. What is one major reason Mars cannot currently support life like Earth?
   (i) It has too many volcanoes.
   (ii) It is too close to the Sun.
   (iii) It lacks a thick atmosphere and liquid water.
   (iv) Its magnetic field is too strong.
2. Which of these is an example of geodiversity?
   (i) Variety of bird chirping in a forest.
   (ii) Different landforms like mountains, valleys, and deserts.
   (iii) Changing weather during monsoons.
   (iv) Number of different types of fish in a pond.
3. If the Earth were smaller with the same density, what might happen to its atmosphere?
   (i) It would become thicker and hotter.
   (ii) It would escape into space due to weaker gravity.
   (iii) It would become frozen.
   (iv) It would cause stronger winds.
4. In sexual reproduction, why are offspring different from their parents?
   (i) They grow in different climates.
   (ii) They eat different food.
   (iii) They acquire new instructions after birth.
   (iv) They get mixed instructions (genes) from both parents.
5. You notice tiny green plants growing in cracks on your school wall after the monsoon. Where do you think the seeds came from? What conditions helped these plants grow there?
6. A city has recently cut down a large patch of forest to build new roads and buildings. Discuss the possible effects this could have on the local climate and biodiversity? How might this affect water availability or quality in the area?
7. A friend says, "The Earth has always had climate changes in the past, so today's global warming is nothing new." How would you respond using what you've learnt in this and other chapters of your science book?

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Prepare some questions based on your learnings so far ...

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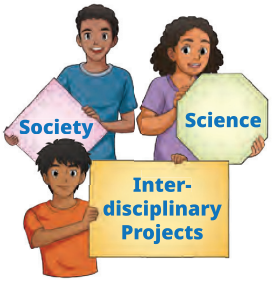
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8. Imagine Earth's magnetic field suddenly disappeared. What kinds of problems could arise for life on Earth? Explain.
9. You are tasked with designing a new settlement for humans on Mars. Name three things you would need to recreate from Earth to support human life there. Which of these do you think is the hardest to replicate, and why?
10. In a village, the temperature has been increasing and rainfall has become unpredictable over the past few years. What could be causing this change? Suggest two ways the village could adapt to these new conditions.
11. If there were no atmosphere on the Earth, would it affect life, temperature, and water on the planet? Explain.
12. Discuss five examples of vegetative propagation.

Discover, design, and debate

- Design an 'Earth Survival Kit'. Imagine you're building a tiny model of Earth for another planet. What must it have to support life, and why?
- India is planning for a challenging lunar mission, Chandrayaan-4, which will bring back samples of soil from the Moon. If the Moon had water, could plants grow in that soil? Think of some experiment that could help you explore whether plant growth is possible on the Moon.
- Flowers are often brightly coloured and have a pleasant smell. How do you think these features help the plant reproduce?
- Why do animals like fish and frogs lay hundreds or even thousands of eggs at a time, while other animals lay only a few? What might be the advantages and disadvantages of laying so many eggs?
- Birds like sparrows build nests and care for their eggs and chicks, while reptiles like snakes usually lay their eggs and leave them without protection. How might this difference in parental care affect the chances of survival for the young ones in each case?



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Reflect on the questions framed by your friends and try to answer ...

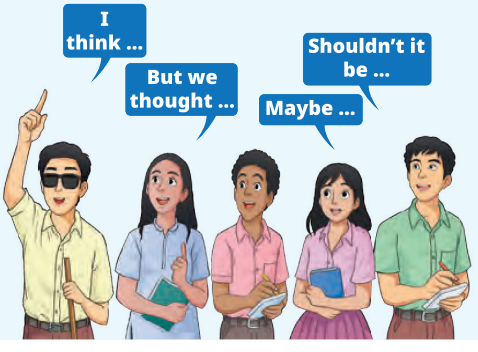
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It's never the end, my friend!

And we have arrived at the final page of our Grade 8 science journey. But remember, this is not the end of your exploration. Throughtout the year, we hope you have learnt to ask deeper questions, design investigations, and think like real scientists do. Whether you wondered about how forces work, explored the remarkable balance of our planet, or investigated how ecosystems are connected, you've already entered the Investigative World of Science.

If you noticed, we left space in every chapter for you to ask your own questions. What are the things around you that puzzled you? Perhaps you noticed how water droplets on a leaf act like a lens, or wondered why different birds have different flight patterns. Things that you notice, and the questions you ask about them are the very beginning of scientific investigation. This textbook has been designed to guide you—rooted in real observations, yet lifting your imagination to fly as high as a kite. But the real adventure belongs to you: keep asking, keep experimenting, keep sharing your findings with your friends and teachers.

As you close this book, remember that next year, you will enter the secondary stage, where we will go deeper into the world of science. The story will continue with more detailed investigations, bigger challenges, and greater discoveries. So never stop wondering, never stop experimenting, and never stop believing that your curiosity can change the world. We'll meet you again on those pages — because in science, it is never the end, my friend!

