Government of Karnataka

Curiosity

Textbook of Science for Grade 8

8

0877

Part - I

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एन.सी.ई.आर.टी.
NCERT

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NATIONAL COUNCIL OF EDUCATIONAL RESEARCH AND TRAINING

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Foreword

The National Education Policy (NEP) 2020 envisages a system of education in the country that is rooted in an Indian ethos and its civilisational accomplishments in all fields of knowledge and human endeavour. At the same time, it aims to prepare students to engage constructively with the opportunities and challenges of the twenty-first century. The basis for this aspirational vision has been well laid out by the National Curriculum Framework for School Education (NCF-SE) 2023 across curricular areas at all stages. By nurturing students' inherent abilities across all five planes of human existence (*pañchakośhas*), the Foundational and Preparatory Stages set the Stage for further learning at the Middle Stage. Spanning Grades 6 to 8, the Middle Stage serves as a critical three-year bridge between the Preparatory and Secondary Stages.

The NCF-SE 2023, at the Middle Stage, aims to equip students with the skills that are needed to grow, as they advance in their lives. It strives to enhance their analytical, descriptive, and narrative capabilities, and to prepare them for the challenges and opportunities that await them. A diverse curriculum, covering nine subjects ranging from three languages—including at least two languages native to India—to Science, Mathematics, Social Sciences, Art Education, Physical Education and Well-being, and Vocational Education promotes their holistic development.

Such a transformative learning culture requires certain essential conditions. One of them is to have appropriate textbooks in different curricular areas, as these textbooks are intended to play a central role in mediating between content and pedagogy—a role that helps strike a judicious balance between direct instruction and opportunities for exploration and inquiry. Among other conditions, classroom arrangement and teacher preparation are crucial to establish conceptual connections both within and across curricular areas.

The National Council of Educational Research and Training, on its part, is committed to providing students with such high-quality textbooks. Various Curricular Area Groups, which have been constituted for this purpose, comprising notable subject-experts, pedagogues, and practising teachers as their members, have made all possible efforts to develop such textbooks. The *Curiosity,* textbook of science for Grade 8 is designed to make learning fun, engaging, and meaningful. Aligned with the NEP 2020 and the NCF-SE 2023, the textbook promotes experiential and inquiry-based learning. It encourages students to ask questions, think critically,

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and understand scientific concepts through real-world contexts. Integrating physics, chemistry, biology, and earth science, the textbook also highlights environmental awareness, ethical values, and insights from India's rich tradition of knowledge. Featuring numerous hands-on activities and relatable examples, the book aims to simplify complex topics and foster deeper understanding. Collaborative learning is encouraged through group work and peer discussions, helping learners develop creativity, logical thinking, and decision-making skills. Rather than simply reading about science, students are guided to explore, question, and experience it actively—making the learning process both enjoyable and impactful.

However, in addition to this textbook, students at this stage should also be encouraged to explore various other learning resources. School libraries play a crucial role in making such resources available. Besides, the role of parents and teachers will also be invaluable in guiding and encouraging students to do so.

With this, I express my gratitude to all those who have been involved in the development of this textbook, and hope that it will meet the expectations of all stakeholders. At the same time, I also invite suggestions and feedback from all its users for further improvement in the coming years.

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Dinesh Prasad Saklani
Director
National Council of Educational
Research and Training

New Delhi
June 2025

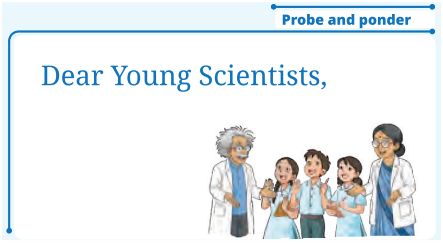
About this Book

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.

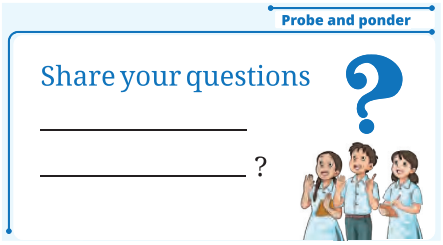
Curiosity, the textbook of science for Grade 8, contains 13 chapters. Each chapter includes engaging activities, thought-provoking questions, and clear illustrations to support your learning. The first chapter is titled **Exploring the Investigative World of Science**. It gives you a quick look at the 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.



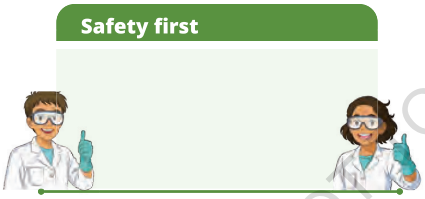
Each chapter begins with a picture linked to the chapter that is designed to spark curiosity, capture your attention, and connect prior knowledge to new concepts. There are a few **Probe and ponder** questions. These are critical thinking questions that are not for evaluation and do not always have simple 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.





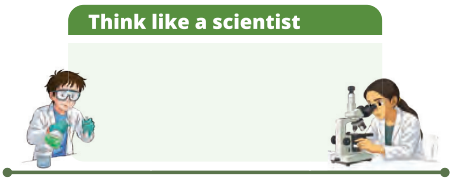
A step further boxes contain advanced concepts that explore the topic in more depth. The information given in these boxes also brings scientific principles and knowledge into real-life

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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'.



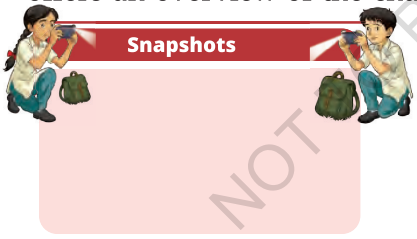


You will find a **Think like a scientist** section in some chapters, where you can explore the experiment further by making modifications or trying different approaches. It will help you to investigate more deeply and allow new questions to emerge in your minds.

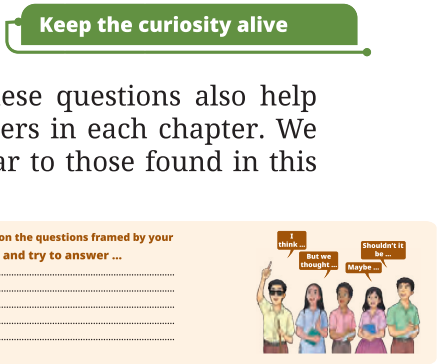
Some chapters also feature a section called **Be a scientist**, where you can learn about the contributions of Indian and international scientists related to the topic. These sections include brief biographies and show how scientists have made a difference. Additionally, an interesting element that has 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.



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.



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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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Constitution of India

Part IV A (Article 51 A)

Fundamental Duties

It shall be the duty of every citizen of India —

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

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

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

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

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

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

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

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

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

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

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

Note: The Article 51A containing Fundamental Duties was inserted by the Constitution (42nd Amendment) Act, 1976 S.11 (with effect from 3 January 1977).

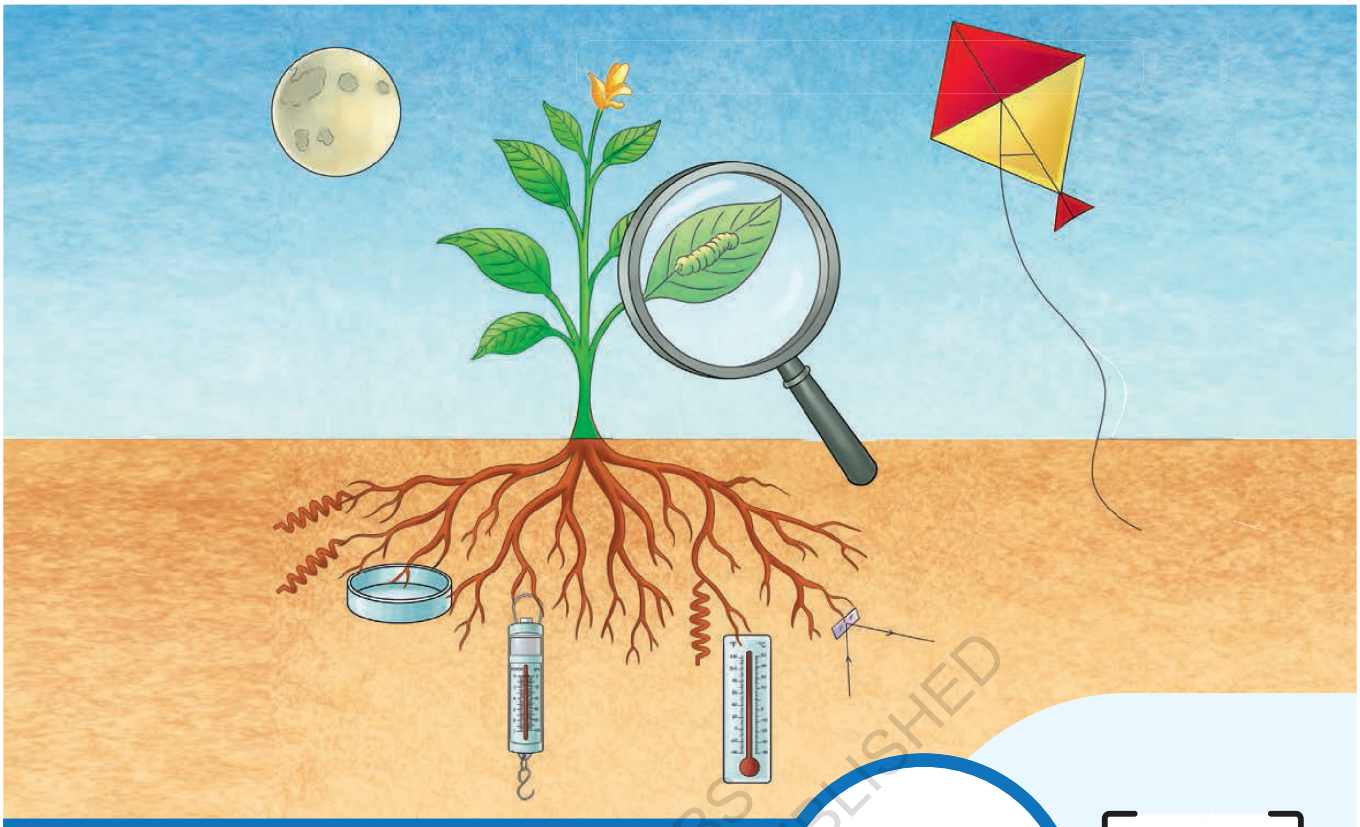
*(k) was inserted by the Constitution (86th Amendment) Act, 2002 S.4 (with effect from 1 April 2010).

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Exploring the Investigative World of Science

1

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Probe and ponder

Dear Young Scientists,

Welcome back! On the first page of each chapter, you will find a set of questions. These are not meant for any exam—they are unique invitations to spark your curiosity to explore the world of science!

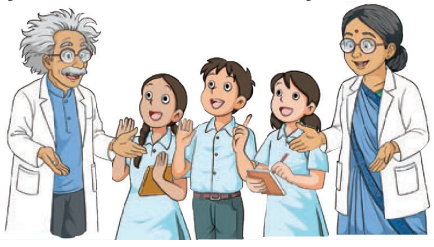
Why is one side of a *puri* thinner than the other?

Are there more grains of sand on all the beaches and deserts of the world, or more stars in our galaxy?

Right from Grade 6, we've observed the incredible diversity of plants and animals around us. From the different shapes of leaves to the many kinds of insects—why has nature created such a vast variety?

Is there such a question that makes you curious about the world?

Write it here! _____



Our journey with *Curiosity*, into the world of science continues in Grade 8. We hope you bring along the spirit of adventure and exploration that has guided us so far. In Grade 6, we discovered how science begins with wonder, with simple "Why?" and "How?" questions about the world around us.

In Grade 7, we learnt that science is always evolving—that each answer opens new questions, and how our ideas can slowly change as we explore deeper. Now, in Grade 8, we take the next step: entering the Investigative World of Science, where wonder and evolution come together to form the heart of how science works.

We don't want you to just learn new facts, we want you to learn how to find new facts. Investigation in science means more than just looking at something and asking only simple questions. Now you can ask more focused questions, and design ways to perhaps do simple experiments to answer those questions, and then use your observations to improve your understanding.

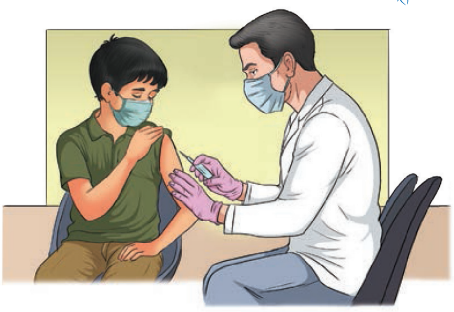
Step by step, we will learn how to use questions as starting points to try to observe carefully, experiment thoughtfully, and explain clearly what we see. In doing so, each of you won't just be learners but also investigators, young scientists, exploring real-world puzzles. These may range from everyday life—like why does dough rise?—to the bigger mysteries of Earth and beyond like is the world getting warmer?

As you turn each page of this book, we hope you notice the interesting design of our page numbers once again. On the left-hand pages, at the bottom, you'll find the image of a root, symbolising the deep, solid foundation of knowledge that keeps us connected to our environment, traditions, and our cultural and natural heritage.

On the right-hand pages, in the top corner, you'll find a kite soaring in the sky, reminding us that curiosity must take flight if we are to explore the unknown. Together, these two symbols—the root and the kite—invite you to stay grounded in real observations, while allowing your ideas to soar towards new horizons. Remember, investigation in science works best only when we balance the solid ground of careful observation with the freedom of creative thinking.

You will also notice some patterns in the lines at the bottom of the page. There are some hidden scientific thoughts in these as well. But don't worry, they are mainly to make the page a little less boring. Let us now take a brief look at the various stops on our journey this year, and see where our curiosity, supported by strong roots and lifted by soaring ideas, might take us!

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This year, our investigative adventure will take us on a journey from the tiny microbes we can't see to planet-wide challenges we can't ignore.

We will start by examining something as small as a single drop of water, and uncover a hidden world of tiny organisms, unseen but deeply linked to us. Some of these are invisible helpers, that help us digest our food or produce medicines, while others can be harmful, causing infections.

But what does our body need to stay healthy? How do we fight these infections? We'll find out how nutritious food, exercise, medicines, and vaccines help us stay healthy and fight infections. But that's just the beginning. In today's world, science does play a major role in improving our lives.





For example, we use electric current in many ways to help make our lives easier. We depend on the heating effect of electric current to keep us warm, while the magnetic effect helps motors run and machines function.

These phenomena depend on fundamental forces. So after watching electricity do work, we move on to study these forces themselves, starting with those that make objects speed up, slow down, or change direction.



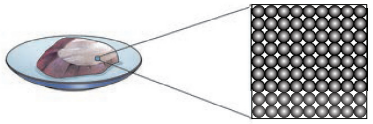
Understanding forces helps explain why a ball thrown up in the air falls back to the ground, or why a car stops when the brakes are applied.

This also leads us to the idea of pressure—how the force is distributed over an object. The same concepts of force and pressure also decide how air moves. A small difference in pressure can result in a gentle breeze while a stronger pressure difference can lead to strong winds, and sometimes even cyclones.

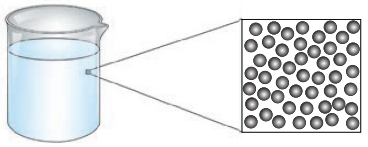




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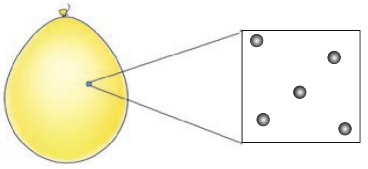


So, these forces are connected to powerful weather events—like storms and cyclones—that affect our daily lives, agriculture, and even our safety.



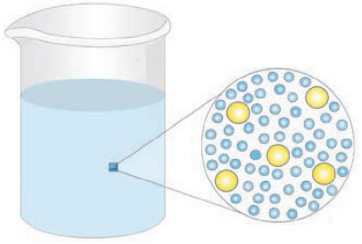
To truly understand how air can exert pressure or why water boils at a certain temperature we need to zoom into these materials and see what kind of particles they are made up of, and how they move around.

Everything around us is made of tiny particles. In materials that are solid these particles cannot move much, while in gases they can move around freely.



Classifying things around us is an important feature of science. We can also classify materials around us into elements (pure substances), compounds (two or more elements bonded together), and mixtures (combinations that can be separated physically).

Once we know how particles combine or mix, we can then understand solutions—for example, how sugar dissolves in tea to make it sweet.



From the world of particles and mixtures, we then move into the world of light. We'll study how light rays reflect off flat and curved mirrors, and bends when passing through lenses and helps us understand the working of many objects around us. The bending of light explains what happens when we see an image in a shiny metal spoon or how corrective glasses help many of us see clearly.





It's not just a polished mirror that reflects light, rough surfaces reflect light as well, and so does the Moon. Depending on the relative positions of the Earth, Moon and Sun, a slightly different part of the Moon is illuminated each night, giving rise to the beautiful phases of the Moon that we see in the sky.



Watching the periodic cycles of the Moon's phases allowed humans to come up with the first calendars. By combining careful observations of sunrises, sunsets, and lunar cycles, various calendars came into being. Isn't it fascinating that the calendars which determine our routines on Earth are linked to the motions of objects far beyond our planet?

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Chaitra
(March 22 - April 20, 2025)

SUN	MON	TUE	WED	THU	FRI	SAT
रवि	सोम	मंगल	बुध	गुरू	शुक्र	शनि
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2 23	3 24	4 25	5 26	6 27	7 28	8 29
9 30	10 31	APR 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						

But it's not just calendars or the movements of the Sun and Moon that are linked. Right here on Earth, there are marvellous and complex patterns of relationships between living organisms and their environments. Every living being—from tiniest insect to the largest whale, from blades of grasses to tall trees—depends on and responds to the air, water, sunlight, and other organisms around them forming the ecosystems that support life on our planet.

In the final chapter of this book, we can put it all together and try to understand what makes Earth 'just right' for life and to recognise the urgent challenges that our planet now faces.

Most importantly, the Earth lies at the perfect distance from the Sun, where water remains liquid, and it has an atmosphere that provides the oxygen we breathe while shielding us from harmful ultraviolet rays. But human activities on the planet can cause small changes in the temperature of the Earth, disrupting climate patterns, with dangerous consequences.

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At the heart of both the problem—and any possible solution—is us. We are the ones influencing Earth's climate. But we are also the ones who can—and must—use science to understand these changes and guide our actions.

The same scientific principles that we have guided our journey through the middle stages—observing, measuring, experimenting—will be key in helping us protect the delicate balance on which life depends. The challenges ahead won't always be easy. We hope some of you will try to solve these difficult problems with *Curiosity* as your guide.

To help you think like a scientist, let us go back to a question we asked on the first page: Why is one side of a *puri* thinner than the other?



Firstly, remember that science is everywhere! You don't need a fancy laboratory to do simple experiments. Even your kitchen at home is a wonderful place to observe and ask questions. All you need is to start with curiosity, careful observation, and asking what happens if...? Have you noticed how a *puri* or a *batura* puffs up when placed in hot oil? Or how a *phulka* swells when put directly on the flame. Why does it puff up like a balloon? And why is one side thinner than the other? These are questions a scientist might ask—and you can too! Let's see how we can investigate this simple everyday phenomenon like a scientist would.

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First, we will try to ask a scientific question. What are the different things that may change the way a *puri* puffs up when fried? To answer this, we may want to do some simple experiments. For that, we try and find out two main things—what all can we change or control when we do the experiment, and what all can we observe to see if these changes made any difference.

In this case, we can perhaps think of the changing the thickness and the size of the rolled dough. We could also try to use different types of flour (atta, *maida*, etc.). While frying the *puri*, we can also change the temperature of the hot oil, or try and drop the rolled dough into the oil in different ways (drop it vertically? slide it at an angle? slide it slowly?) Notice that these are things that we can control.

However, to make sense of the changes, we also need to think of what we can observe or measure. Some of these may have just yes/no answers, in some cases there might be a number we can measure. Maybe we can start by checking whether the *puri* puffs up (yes/no), or we can measure the time it takes to puff up (seconds). We can check whether a very thick layer of dough still gives a thin side to the *puri*. Further, while doing such experiments, it is better to change only one thing at a time while keeping the other conditions same. For example, if we wanted to see the effect of boiling hot, hot, and not very hot oil, we would

use circles of dough of the same thickness, and drop them in the same way. It is also a good idea to keep notes of everything that you see and sense when doing an experiment. Did the oil splatter, smell, or smoke? And after doing one round of experiments, you may think of more questions. Do *puri*s puff better when made fresh or from stored dough? What happens if I prick a hole in the *puri* before frying?

This is exactly how all scientific experiments, from simple to the most complicated are done. This is the idea of systematic investigation. And just so you know, even this simple everyday observation—of a *puri* swelling—is not really completely understood by scientists today!

So, whether it is the swelling of a *puri* or the shrinking bright part of the Moon after *purnima*, let your careful observations guide you along your explorations into the investigate world of science.

Happy investigating!

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The Invisible Living World: Beyond Our Naked Eye

2

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Probe and ponder

- Have you ever wondered what you might see if the invisible world around you became visible?
- How do you think your observation of this hidden world might change the way you think about size, complexity, or even what counts as 'living'?
- Have you thought how these tiny living beings interact with each other?
- Share your questions

_____

_____ ?



The human eye can only see objects that are above a certain size. For a long time, many tiny things around us remained unknown. Long ago, people discovered that a curved piece of glass could make small things look bigger. The piece of glass was shaped like a lentil seed—thick in the middle and thin at the edge—hence they called it a **lens**. Over time, lenses were improved to become more powerful. Each new tool, from simple magnifying glasses to microscopes, helped humans see what their eyes could not. The invention of the microscope opened a fascinating hidden world filled with tiny living creatures. We will **explore** some of these life forms in this chapter.

You have already learnt about the amazing variety of living beings. Just look around—there are so many beautiful plants and animals! They are of all shapes, sizes, and colours. Some living beings are tiny, while others are really big. They differ not only in their structure but also in many other features. All these living beings, whether plants or animals, are called **organisms**. Have you ever noticed the smallest organism around you that is visible to the naked eye? Think about it—how small a thing can your eyes actually see?

You might have seen some people using reading glasses. How does it help them see better? Or what happens when we use a magnifying glass to **observe** something?

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Activity 2.1: Let us observe

- Take a round-bottom flask made up of glass as shown in Fig. 2.1. Fill it with water.
- Close the mouth of the flask with a cork.
- Now, place the flask on an open book and look at the letters through it.

Do you notice something interesting? The letters appear larger when seen through the flask! This happens because the flask filled with water acts like a magnifying glass. Now, use a real magnifying glass to look at small organisms, like an ant. Were you able to see the details of its body more clearly?



Fig. 2.1: Round-bottom flask

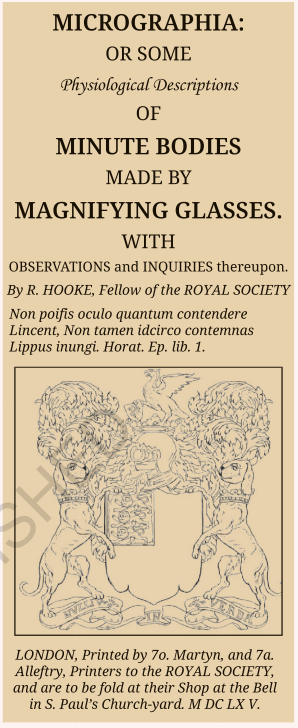
For a long time, people were curious to explore the tiny organisms around them, but they could not see them with their naked eyes. So, how did we finally discover this invisible world? Do you know which scientific discovery helped us see the tiny world for the first time?

Ever heard of ...

In 1665, a scientist named Robert Hooke published a book called *Micrographia*. He was a careful observer, and a skilled artist. In this book, he showed detailed drawings of tiny things that people had never seen before—things he saw using a tool we now call a microscope.

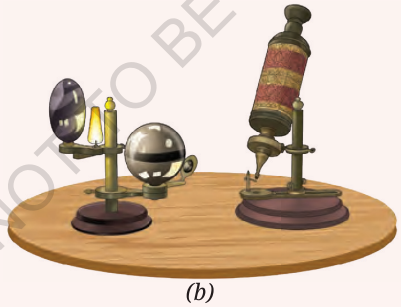
His microscope made things look 200 to 300 times bigger, than what one could see with the unaided eye. One day, he looked at a thin slice of cork and saw it was made of many small, empty spaces. These compartments reminded him of a honeycomb. He drew what he saw and called each small space a cell. This was the first time the word cell was used in science to describe the basic unit of life.

Around the same time in 1660s, Antonie van Leeuwenhoek, a Dutch scientist, made better lenses that allowed him to build more useful microscopes. He was the first person to clearly see and describe tiny living things like bacteria and blood cells. Because of this, he is known as the Father of Microbiology.


MICROGRAPHIA:
OR SOME
Physiological Descriptions
OF
MINUTE BODIES
MADE BY
MAGNIFYING GLASSES.
WITH
OBSERVATIONS and INQUIRIES thereupon.
By R. HOOKE, Fellow of the ROYAL SOCIETY
Non poſſis oculo quantum contendere Lincent, Non tamen idcirco contemnas Lippus inungi. Horat. Ep. lib. 1.
LONDON, Printed by 7o. Martyn, and 7a. Alleftry, Printers to the ROYAL SOCIETY, and are to be fold at their Shop at the Bell in S. Paul's Church-yard. M DC LX V.

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(b)

(a)


(c)

Fig. 2.2: (a) Micrographia book; (b) Microscope of Robert Hooke; (c) Cork cells as published in the Micrographia

2.1 What Is a Cell?

All living beings are made up of **cells**. You might wonder what cells actually look like. Let us take a closer look at the basic structure of a cell using a microscope.

Activity 2.2: Let us study a cell (Teacher demonstration activity)

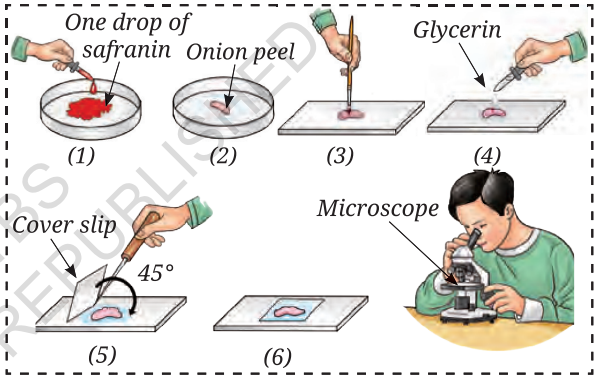




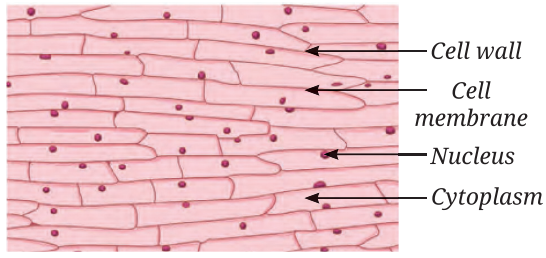
Fig. 2.3: (a) Removing onion peel from an onion bulb

- Take an onion bulb from your kitchen or garden and wash it thoroughly with water.
- Cut the onion bulb vertically into pieces.
- Take one piece of onion and pull out the thin, transparent layer from its inner surface with the help of forceps. This layer is called the onion peel.
- Place the peel in a petri dish containing a few drops of safranin (red-coloured stain) for 30 seconds. This will give a pinkish colour to the cells and help us see them clearly.
- With the help of thin brush transfer the onion peel to another petri dish containing water to rinse the peel and remove extra stain.
- Now, carefully place the stained onion peel on the glass slide using a thin brush, ensuring it does not break or fold.
- Put a drop of glycerin over the onion peel on the slide. The glycerin will prevent drying of the cells and improve clarity for better visualisation of cells.
- Slowly place a coverslip over the peel using a needle, such that no air bubbles get trapped.
- Use blotting paper to gently wipe off any extra glycerin around the edges of the coverslip.
- View the slide under a microscope or a foldscope. **Compare** it with Fig. 2.3c.
- What similarities do you find in Fig. 2.3c and Fig. 2.3d?

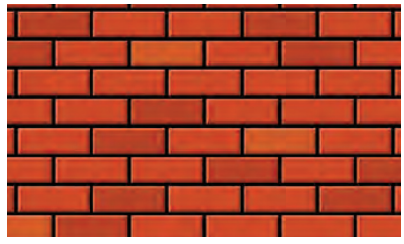
You will observe nearly rectangular structures under the microscope. These are the cells of the onion peel, which are closely arranged without any space between them. Try to observe the peels of the leaves of different plants around you. You will find that all plants are made up of cells. What do you think the body of an animal is made of?



(b)



(c)



(d)

Fig. 2.3: (b) Mounting the onion peel in glycerin using a needle; (c) Structure of onion peel under the microscope; and (d) A wall made of brick

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Activity 2.3: Let us investigate

- Rinse your mouth with clean water.
- Use the blunt end of a clean toothpick, and gently scrape the inside of your cheek.
- Place the scraped material in a drop of water on a clean glass slide and spread it evenly.
- Add a drop of methylene blue (a blue-coloured stain) over the material on slide. Adding stain improves the visibility of the material under the microscope by increasing contrast.
- After one minute, add a drop of glycerin over the material on the slide to prevent the cells from drying.
- Now, carefully place a clean coverslip on the material, and remove the excess glycerin from the edges of the coverslip using blotting paper.
- Observe the slide under a microscope and draw what you see in your notebook.

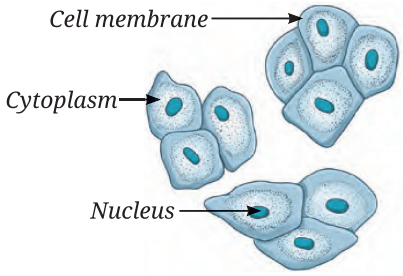


Fig. 2.4: Mount of human cheek cells

What did you observe? You will observe a polygon-shaped structure as shown in Fig. 2.4. These are cheek cells, which form the inner lining of your mouth.

What similarities and differences did you observe between the cells of onion peel in Activity 2.2 and human cheek cells in Activity 2.3?

You have observed that cells have three main parts —a thin outer lining, a central region, and a small round structure inside it. The outer layer is called the **cell membrane**. The round structure in the middle is the nucleus, which is also covered by a thin membrane. The space between the cell membrane and **nucleus** is filled with **cytoplasm**. These three—cell membrane, cytoplasm, and nucleus — are the basic parts of a cell. Some cells, like onion peel cells, have an extra outer layer called the **cell wall**. What is the importance of these structures in a cell? What functions do they perform? Are these functions important for the maintenance of life?

The cell membrane encloses the cytoplasm and nucleus. The cell membrane separates one cell from another. It is porous and allows the entry of materials essential for life processes and the exit of waste material.

Cytoplasm contains other components of the cell and compounds, such as carbohydrates, proteins, fats, and mineral salts. Most of the life processes take place within the cytoplasm.

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The nucleus regulates all activities that occur within the cell. It also regulates growth.

The cell wall in the plant cell provides rigidity and strength to plants. This is why all cells are arranged compactly with each other and look firm in structure.

A step further

Cells in all parts of a plant have tiny rod-shaped structures called **plastids**. Some plastids, like **chloroplasts**, contain chlorophyll, which makes them green and helps in photosynthesis. In non-green parts, they help in the storage of substances. Plant cells also have a large, empty-looking space called a **vacuole**. This helps the plant cell store important substances, get rid of waste, and maintain the shape of the cell. This gives strength and support to the plant. In animal cells, vacuoles are usually not present, if present, they are usually small. These small vacuoles store certain substances dissolved in water (Fig. 2.5). So, a cell is not just a simple bag of liquid—it is a complex structure made up of many different parts, each with its own special function to allow the cell, and in turn the entire organism to work.

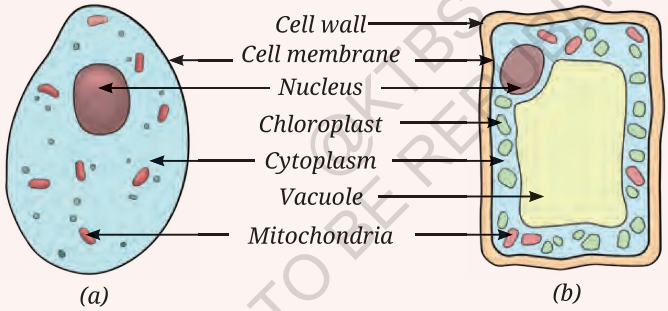


Fig. 2.5: A schematic drawing of (a) An animal cell and (b) A plant cell. (The colours are to show different parts of the cell)



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We have now understood the basic structure of cell. And we now also understand that plant and animal cells differ in shape and structure.

Do different animal cells also vary in their shape and structure?

2.1.1 Variation in shape and structure of cells

The **muscle** cell and the **nerve** cell of a human are shown in Fig. 2.6a and (b). What are the similarities and differences you see in them?

A muscle cell (Fig. 2.6a) is shaped like a spindle, while a nerve cell (Fig. 2.6b) is very long and has branches. Similarly, some cells are round in shape, while others are long and thin. The number of cells also varies in different organisms. Why do cells look so different from each other? Does the shape and structure of a cell relate to its function?



(a) Muscle cell



(b) Nerve cell

Fig. 2.6: Different cells in humans

The unique shape, size, and structure of cells help them carry out their specific functions. But how do these cells help in performing various functions in the body? Let us find out.

You observed in Activity 2.3 that inner cheek cells are thin and flat. They form a protective lining on the inner surface of the cheek. Nerve cells also known as **neurons** carry messages in our body. The elongated shape and branched structure help them reach different parts of the body and pass on messages quickly. Similarly, plant cells also show variation. In plants, too, cells may be rectangular, elongated, oval, or even tube-like. Some plant cells form long tubes that help carry water throughout the plant.

You have already studied the digestive system in Grade 7. Different parts of the digestive system are made up of different types of cells. A group of muscle cells are present in the food pipe. These cells contract and relax in a wave-like manner, pushing the food down to the stomach. This movement is possible because muscle cells are thin, flexible, and spindle-shaped. The stomach also has different types of cells for performing different functions. Muscle cells in the stomach wall help churn the food. Other cells in the inner lining of the stomach produce digestive juices and acid that help break down the food. All these cells work together to make digestion possible.

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2.2 What Are the Levels of Organisation in the Body of a Living Organism?

The body of a living organism is organised in a complex way. Cell (Fig. 2.7a), is the basic unit of life, just like a brick is the basic unit of wall (Fig. 2.3d). A group of similar cells forms a type of **tissue** (Fig. 2.7b). Different tissues are organised to form an **organ** (Fig. 2.7c). Several organs work together to form an **organ system** that performs a major function of the body (Fig. 2.7d). All the organ systems together make up a complete **organism** (Fig. 2.7e)—like a plant or an animal. So, the levels of organisations are:

Cell → Tissue → Organ → Organ system → Organism

These levels of organisation help us understand how simple building blocks like cells come together to form a complex living being.

The life of complex living organisms begins with a single cell—'egg'. The egg of any organism has an amazing ability to divide repeatedly to form a complete living being made up of many cells. Such living beings are called **multicellular organisms**. Animals, including humans, and plants are all examples of multicellular organisms.

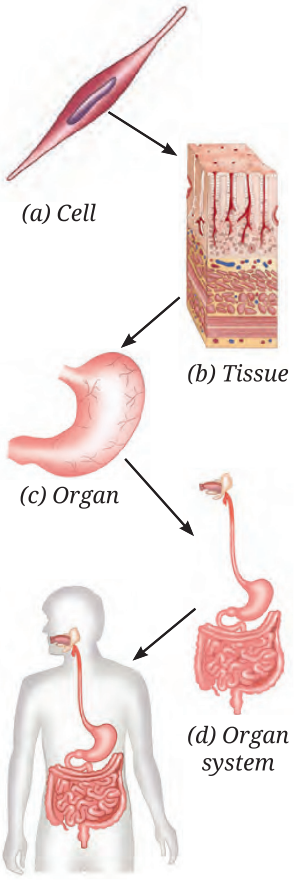
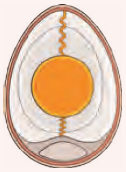


Fig. 2.7: Levels of organisation of life

Ever heard of ...



The yolk (the yellow part of an egg) of an ostrich egg is a single cell—the largest known cell in the living world—measuring about 130 mm to 170 mm in diameter. The egg contains extra non-cellular material: a shell for protection and a white liquid that nourishes the cell during its continued development.





2.3 What Are Microorganisms?

Some living organisms are made up of just one or very few cells. They are so small that they can not be seen with the naked eye. These are called **microorganisms.** Some microorganisms, like bacteria and *Amoeba*, are made of just one cell (unicellular). Others, like some fungi and algae, have many cells (multicellular). They are found all around us—in water, soil, air, and even inside our body! But what do their cells look like? Are they like the plant and animal cells we just learnt about, or are they different? To observe the cells of a microorganism, again, we need to use a microscope which magnifies their size and makes them visible to us. Scientists have also created a low-cost and foldable paper microscope or foldscope. Foldscopes may not provide the same level of details like high-powered laboratory microscopes. However, these make microscopic world accessible to many people.

Let us now take a closer look at the fascinating world of microbes.

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Activity 2.4: Let us observe pond water/ stagnant water

- Take a container and collect pond or stagnant water in it with the help of your teacher or elder(s).
- Use a dropper and place a drop of pond or stagnant water on a microscope or foldscope slide. Put a coverslip and observe it under the microscope or foldscope.
- Observe the tiny organisms found in the pond or stagnant water.

Activity 2.5: Let us observe soil suspension

- Take a beaker and collect some moist soil in it from the nearby field or garden. Do not touch the soil with your bare hands—use a spoon or gloves.

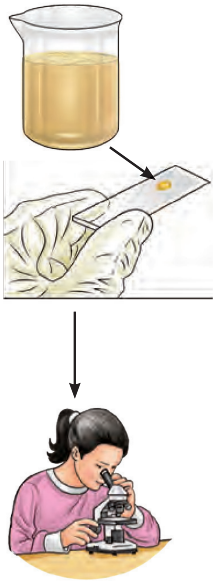


Fig. 2.8: Observation of soil suspension under the microscope

- Pour some water into the beaker and stir it with a glass rod. The liquid, which may look dirty, has very fine particles of soil, and is called soil suspension. Keep it aside for some time and let the mixture settle.
- Use a dropper and take a drop of water from the top layer. Place the drop on a microscope slide.
- Cover it gently with a coverslip and observe it under the microscope (Fig. 2.8).

You may observe small moving organisms similar to those you saw in Activity 2.4. This indicates that even **soil suspension** contains a variety of tiny creatures that cannot be seen with the unaided eye. The tiny creatures that cannot be seen with the naked eye are called microorganisms (micro means very small; organisms means living beings) or **microbes**.

Activity 2.6: Let us study

A group of students studying in Grade 8 performed Activities 2.4 and 2.5. They also collected information from the library and internet. They recorded the data obtained after observing pond water in Table 2.1 and the data obtained after observing soil suspension in Table 2.2. They identified the microorganisms as protozoa, algae, fungi, and bacteria. You can record if you find any of these categories of organisms.

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Table 2.1: Organisms present in pond water

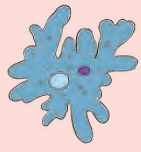
S.No.	Diagram	Remarks
1.	*Amoeba* (Protozoa) 	Single cell, moving, irregular shape
2.	*Paramecium* (Protozoa) 	Single cell, moves from one place to another, movement takes place with the help of specialised structures
3.	Algae 	Single cell, looks green because of the presence of green pigment, movement takes place with the help of specialised structures

Table 2.2: Organisms present in soil suspension

S.No.	Diagram	Remarks
1.	Bread mould (Fungi) 	Branched filament without chlorophyll having sac-like structure
2.	Mould (Fungi) 	Branched filament without chlorophyll having brush-like structure
3.	Algae 	Spherical, presence of chlorophyll—a green pigment
4.	Bacteria 	Spherical, comma, spiral or rod-shaped, one long hair-like structure and many small hair-like projections around the cell

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Did you also observe any of these microorganisms or something different? Record in your notebook and discuss in your class. In Tables 2.1 and 2.2, you have identified a variety of microorganisms. They are everywhere, and we can only see them with a microscope—a device that magnifies them 100 to 400 times. Though microorganisms are small in size, they play an important role in our lives.

Ever heard of ...



Viruses are microscopic and acellular. Viruses multiply when they enter a living cell. They may infect plants, animals, or bacterial cells and may cause a disease.



2.4 How Are We Connected to Microbes?

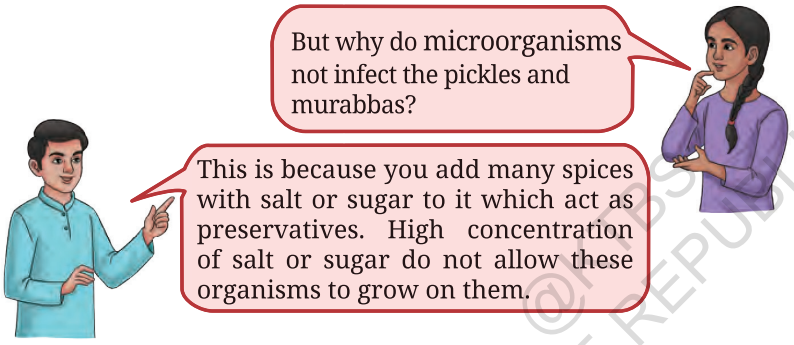


Fig. 2.9: Fruit with microorganism growing on it

Can we find microorganisms in other places, too? Let us have a discussion:

Have you ever seen a lemon, tomato, orange, or any other food item rot after being left outside for some time? If yes, you may have noticed a powdery or cotton-like growth on them (Fig. 2.9). This happens because they have been infected by microbes. But where did these microbes come from? How did they come in contact with the food?

This happens because microorganisms can be found everywhere, be it in water, soil, air, or even in some food items.



You can use a foldscope or a microscope to explore surfaces of leaves, stems, roots, or any other part to see them. Like plants and animals, microorganisms also show great diversity. Some of them can even be found in extreme climatic conditions, such as hot water springs and snow cold zones as well as at moderate temperatures. You already know some of these organisms live inside our bodies, especially in our gut! You have studied in the chapter 'Life Processes in Animals' in *Curiosity*, Grade 7 that our intestine has many bacteria that help in digestion. Like plants and animals, microorganisms vary in shape, size, and structure. In Tables 2.1 and 2.2, you would have observed microorganisms of different shapes—spherical, rod-shape, or irregular.

How does the diversity of microorganisms play a role in our daily life? How do they help clean the environment?

2.4.1 Key players in cleaning the environment

Let us attempt to understand this by doing an activity.

Activity 2.7: Let us do

- Take an empty container and fill it halfway with garden soil.
- Add some fruit and vegetable peels to the container. Thereafter, put a layer of soil on it and leave it aside.

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- After 2–3 weeks, observe the changes that have taken place.
- Do you observe any difference in the contents of the container?

You may find that peels of fruits and vegetables have turned into a dark-coloured material. This is **manure**, which is rich in nutrients and helps increase the fertility of the soil. But how did the peels of fruits and vegetables turn into manure?



Fig. 2.10: Recycling of nutrients by making manure

In Activity 2.6, you saw that soil contains various kinds of microorganisms. Some of these microorganisms, like fungi and bacteria, act on the plant waste and slowly break it down into simpler, nutrient-rich manure. You may have seen gardeners in your school or in a field near your house collecting dry leaves and plant waste and putting them into pits. Do you now understand why they do this? It is to make natural manure.

Our scientific heritage

Ancient Indian texts, particularly the Vedas, have references of the word '*Krimi*' which means different tiny entities including '*Drishya*' (visible) and '*Adrishya*' (invisible). Various Vedic texts mention their beneficial and harmful effects.
Atharvaveda also refers to '*Krimi*'.



If you look around carefully, you might see decaying plants and fallen leaves stored in a container or lying in the garden, disappear after some time from the surroundings. This is because microorganisms breakdown and turn them into simpler substances rich in nutrients. These nutrients go back to the soil and help plants grow better. Microorganisms also decompose bodies of dead animals. So, microbes help recycle the waste and return important nutrients to nature. Manure formation occurs at optimal temperature and appropriate moisture level.

Isn't it interesting? By now, you must have understood that bacteria and some fungi are types of microorganisms that play an important role in our lives. And guess what, these helpful bacteria can also decompose animal wastes like dung!

From Activity 2.7, we can also infer that microorganisms not only help in plant growth, but also clean our environment by breaking down waste.

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Now, think what would have happened if microorganisms did not exist on Earth?

A step further



Microbes as a source of biogas

Many microorganisms, like bacteria and fungi, live in an oxygen-free environment. Some of these bacteria have the ability to decompose plant and animal waste present in the environment or household wastewater. During the process, they release a mixture of gases containing carbon dioxide, and a high proportion of another gas, methane. This gas has been used as a fuel source for cooking, heating, generating electricity, and to even run vehicles.

Be a scientist



Dr. Ananda Mohan Chakrabarty (1938–2020) was a scientist who studied bacteria. In 1971, he developed a special bacterium that could break down oil spills, helping to clean the environment. His discovery received a patent in 1980. **Patent** is a copyright given to a person so that no one else can copy, use or sell his/her invention without permission. His work showed how microorganisms could be used to solve environmental problems like pollution. He is remembered for his contributions to science and for protecting the environment using microbes. What are the other problems which you think can be solved with the help of microorganisms?



How does the diversity of microorganisms help in our kitchen?

2.4.2 Microorganisms and food

Let us try to understand by performing activities in the kitchen.

Activity 2.8: Let us perform



(a) Dough in bowl A



(b) Dough in bowl B

Fig. 2.11: Change in the volume of flour after addition of yeast, sugar, and warm water

- Take two bowls A and B.
- In each, take 200 g of flour (atta or *maida*) and add a pinch of sugar.
- Now, in bowl A, add a small amount of yeast powder and mix it well with the flour.
- In bowl B, do not add any yeast, so that we can compare the results of the two bowls.
- Knead the flour of the two bowls with warm water to make soft dough (Fig. 2.11).

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- Cover the dough with a damp cloth and keep it in a warm place.
- Observe both the bowls after 4–5 hours.

Did you find any change in the volume, smell, or texture of the dough? If not, leave the dough for some more time. After some time, you may notice that the dough in bowl A, where yeast was added, has risen slightly, become fluffy, and has a different smell compared to the dough kneaded without yeast. Why does this happen? What is the role of yeast? Why did we add sugar and warm water to the flour?

Yeast is a type of microorganism. It belongs to a group of microorganisms, called **fungi**. Yeast grows well in warm conditions. You may recall from chapter 'Life Process in Animals' in Grade 7 that, like other organisms, yeast also respires and breaks down food to release energy for their growth and carry out life processes. During this process, carbon dioxide is released, which forms bubbles that makes the dough soft and fluffy. Yeast also produces a small amount of alcohol during this process, which gives the dough a slightly different smell. This special property of yeast is used in the process of making breads, cakes, and more! In addition to yeast, some bacteria, such as *Lactobacillus*, help in fermentation of batter for making idli and dosa, and dough for making *bhatura*.

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Activity 2.9: Let us prepare

- Take two small glass bowls — label them 'A' and 'B'.
- Pour lukewarm milk in bowl A, and cold milk in bowl B.
- Now, add a small spoonful of curd to each bowl and mix well using a spoon.
- Cover both bowls. Keep bowl A in a warm place and bowl B in a cool place (like a refrigerator) for a few hours or overnight.
- Observe the changes in the glass bowls. Write your predictions and observations in Table 2.4.

Table 2.4: Testing for curd formation using milk in different conditions

	Change in the appearance of milk		Change in the colour of milk		Possible reason
	Bowl A	Bowl B	Bowl A	Bowl B	
Prediction					
Observation					

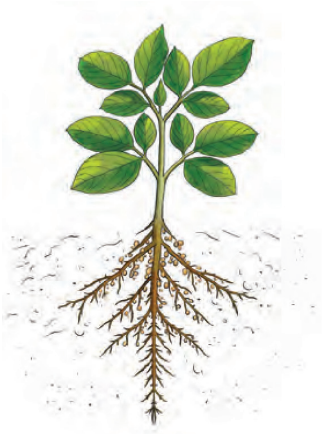


Fig. 2.12: Root nodules of Cowpea plant which contain Rhizobium

You will observe that in bowl A, the milk has turned into curd after a few hours and has become little sour. Whereas in bowl B, the milk has not curdled, but it might be a little sour. Do you know why this happens? The curd contains several types of bacteria. One of them is *Lactobacillus*. This bacterium feeds on the sugar in the milk (lactose), multiplies, and ferments the milk to form curd. Instead of producing alcohol (like yeast), these bacteria produce lactic acid, which makes curd sour. These bacteria grow well in warm conditions. That is why curd is formed in bowl A but not in bowl B.

We can categorise the microorganisms into different categories, such as protozoa, fungi, bacteria, some algae, and more. Some bacteria, such as *Rhizobium*, form the swollen regions called nodules and live in them as shown in Fig. 2.12. Roots of certain legumes, such as beans, peas, and lentils have root nodules that contain *Rhizobium* bacteria. These bacteria trap nitrogen from the air and make it useful for the plants. This helps plants grow better without chemical fertilisers. That is why farmers grow legumes in rotation with other crops. This naturally increases the nitrogen in the soil and keeps it healthy for the next crop.

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2.4.3 Amazing microalgae: tiny helpers in water

Microalgae are microscopic plant-like organisms that live in water, soil, air, and even on trees. They make their own food using sunlight. While doing this, they also release oxygen and produce more than half of the Earth's oxygen supply. They are rich in nutrients and serve as a food source for many aquatic animals. Some, like *Spirulina*, *Chlorella*, and Diatoms, are also used by humans as health supplements and medicines. Microalgae also help in cleaning water and are used to make biofuel.

However, pollution, climate change, and habitat destruction are threatening microalgal diversity and abundance. It is important to conserve these tiny organisms to protect the environment and maintain oxygen balance on Earth.

Ever heard of ...



Spirulina, a microalga, is called a superfood because of its health benefits. *Spirulina* is also a good source of vitamin B12, which is essential for our body. It has a lot of protein—more than 60 per cent of its body weight—and only a small amount of fat and sugar.

Nowadays, farming of *Spirulina* is becoming a feasible livelihood opportunity. You can grow *Spirulina* easily by following these steps:

1. Set a clear glass tank in a bright place away from direct sunlight.
2. Cover the tank with a shade net, or keep the tank at a place with moderate temperature conditions.
3. Fill the tank with pond water.
4. Add living *Spirulina* collected from a pond.
5. Stir the growing *Spirulina* twice a week.
6. After 3–6 weeks, *Spirulina* may be harvested from the tank by filtering it through a fine cloth.





Conservation of microalgae is a good practice for ensuring food security and livelihood development.

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2.5 Why Is Cell Considered to Be a Basic Unit of Life?

The body of all living organisms are made up of tiny building blocks called cells. A single cell contains various components that help organisms perform various functions. The bodies of all plants and animals are made up of many cells. Therefore, they are called **multicellular** (many-celled) organisms. In multicellular organisms, cells carry out specialised functions individually but also cooperate with each other to increase the chance of survival.

Some microorganisms, such as bacteria and protozoa, are made up of just one cell. These are called **unicellular** (single-celled) organisms. They carry out all the functions necessary for their survival in a single cell. Other microbes, like algae and fungi, are made up of one or more cells. For example, yeast is a unicellular fungus while mould is a multicellular fungus.

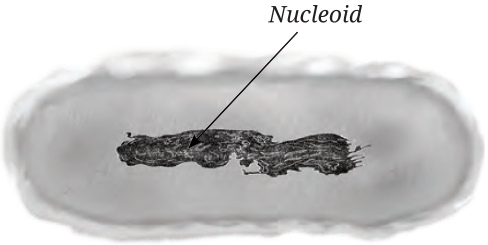


Fig. 2.13: A bacterial cell showing the nucleoid region

Like animal and plant cells, the cells of microorganisms are also surrounded by a cell membrane. Cells of fungi additionally have a cell wall, but they do not have chloroplasts, so they cannot make their own food through photosynthesis. Bacteria do not have a well-defined nucleus and a nuclear membrane. Instead they have a nucleoid. This feature distinguishes them from cells of yeast, protozoa, algae, fungi, plants, and animals.

We have only looked at a few basic cell structures here. The cell has other components about which you will learn in higher classes. For observing subcellular components, we need microscopes with high magnification. An electron microscope magnifies the cell about 10,00,000 times, where we can see more structures present in a cell.

By now, you must have understood that all living beings, including microorganisms, are made up of one or more cells. Their cells differ in size, shape, and structure. Plant and animal cells also have some differences. Understanding these differences helps us learn how these organisms function differently.

In this chapter, we have learnt about the beneficial microorganisms. However, there are some microbes that cause diseases in plants and animals including humans. We will learn about some of the diseases caused by microbes in the next chapter.

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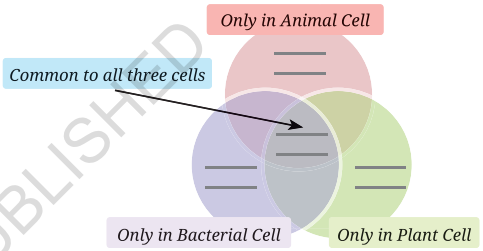
Snapshots

- Microorganisms are small-sized organisms and are not visible to the unaided eye.
- They can live in all kinds of environments, and even in the bodies of plants and animals.
- They are either unicellular or multicellular. Bacteria and protozoans are unicellular; fungi can be unicellular or multicellular, while plants and animals are multicellular.
- The cell is a basic unit of life.
- The body of all living organisms is made up of cells. A cell contains various components which help the organisms perform their functions and survive.
- A typical cell is bounded by a cell membrane, filled with cytoplasm and contains a nucleus. Plant, fungal, and bacterial cells have an extra covering, called a cell wall, around the cell membrane. Bacteria lack a well-defined nucleus.
- Cells differ in shape and size. Their shape is related to the function performed by them.
- Bacteria, fungi, and protozoa are different kinds of microorganisms.
- Viruses are also small in size, but they are different from other microorganisms since they reproduce only inside the host organism.

- Microorganisms can be beneficial or harmful to us.
- Some microorganisms decompose the plant and animal waste into simple substances and clean up the environment.
- Some microorganisms reside in the root nodules of legumes, such as peas, beans, and lentils. They trap nitrogen from the air and increase the soil fertility.
- Yeasts are fungi which are used in the process of making breads, cakes, pastries, idlis, dosas, and bhaturas.
- *Lactobacillus* is used in the curd formation at home and fermentation process in food industry.

Keep the curiosity alive

1. Various parts of a cell are given below. Write them in the appropriate places in the following diagram.



Nucleus	Cytoplasm
Chloroplast	Cell wall
Cell membrane	Nucleoid

2. Aanandi took two test tubes and marked them A and B. She put two spoonfuls of sugar solution in each of the test tubes. In test tube B, she added a spoonful of yeast. Then she attached two incompletely inflated balloons to the mouth of each test tube. She kept the set-up in a warm place, away from sunlight.

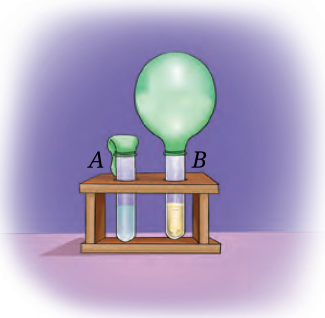


Fig. 2.14: Experimental set-up

(i) What do you predict will happen after 3–4 days? She observed that the balloon attached to testtube B was inflated. What can be a possible explanation for this?

(a) Water evaporated in test tube B and filled the balloon with the water vapour.

(b) The warm atmosphere expanded the air inside the test tube B, which inflated the balloon.

(c) Yeast produced a gas inside the test tube B which inflated the balloon.

(d) Sugar reacted with warm air, which produced gas, eventually inflating the balloon.

(ii) She took another test tube, 1/4 filled with lime water. She removed the balloon from test tube B in such a manner that the gas inside the balloon did not escape. She attached the balloon to the test tube with lime water and shook it well. What do you think she wants to find out?

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3. A farmer was planting wheat crops in his field. He added nitrogen-rich fertiliser to the soil to get a good yield of crops. In the neighbouring field, another farmer was growing bean crops, but she preferred not to add nitrogen fertiliser to get healthy crops. Can you think of the reasons?
4. Snehal dug two pits, A and B, in her garden. In pit A, she put fruit and vegetable peels and mixed it with dried leaves. In pit B, she dumped the same kind of waste without mixing it with dried leaves. She covered both the pits with soil and observed after 3 weeks. What is she trying to test?
5. Identify the following microorganisms:
   (i) I live in every kind of environment, and inside your gut.
   (ii) I make bread and cakes soft and fluffy.
   (iii) I live in the roots of pulse crops and provide nutrients for their growth.
6. Devise an experiment to test that microorganisms need optimal temperature, air, and moisture for their growth.
7. Take 2 slices of bread. Place one slice in a plate near the sink. Place the other slice in the refrigerator. Compare after three days. Note your observations. Give reasons for your observations.
8. A student observes that when curd is left out for a day, it becomes more sour. What can be two possible explanations for this observation?
9. Observe the set-up given in Fig. 2.15 and answer the following questions.
   (i) What happens to the sugar solution in flask A?
   (ii) What do you observe in test tube B after four hours? Why do you think this happened?
   (iii) What would happen if yeast was not added in flask A?

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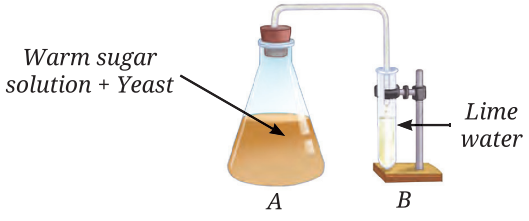


Fig. 2.15 : Experimental set-up



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

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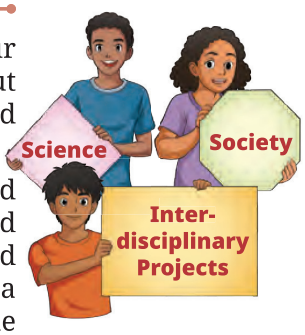
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Discover, design, and debate



- India has a long history of biogas production. One of our oldest biogas plant was set up in late 1850s. Find out about the Biogas Program initiated by the Ministry of New and Renewable Energy, Government of India.
- Fermented food items like fermented soybeans and fermented bamboo shoots are consumed as traditional food in some parts of India. With the help of your parents and teachers, list some traditional food items from your area that utilise the process of fermentation. Investigate the ingredients used in the preparation of these fermented food items; the method of preparing them; the microorganism responsible for the fermentation of the food, and the cultural and nutritional importance of the fermented food.
- Study the different parts of a macro fungus mushroom using a magnifying glass and microscope/foldscope. Take the help of students from senior classes and explore the internal structure of different parts of mushrooms under the microscope/foldscope in your school laboratory.
- Interact with an entrepreneur and learn the steps for cultivation of mushroom.

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

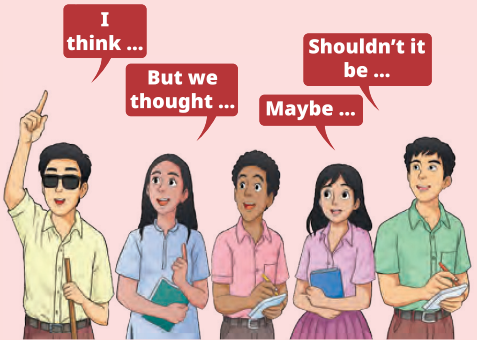
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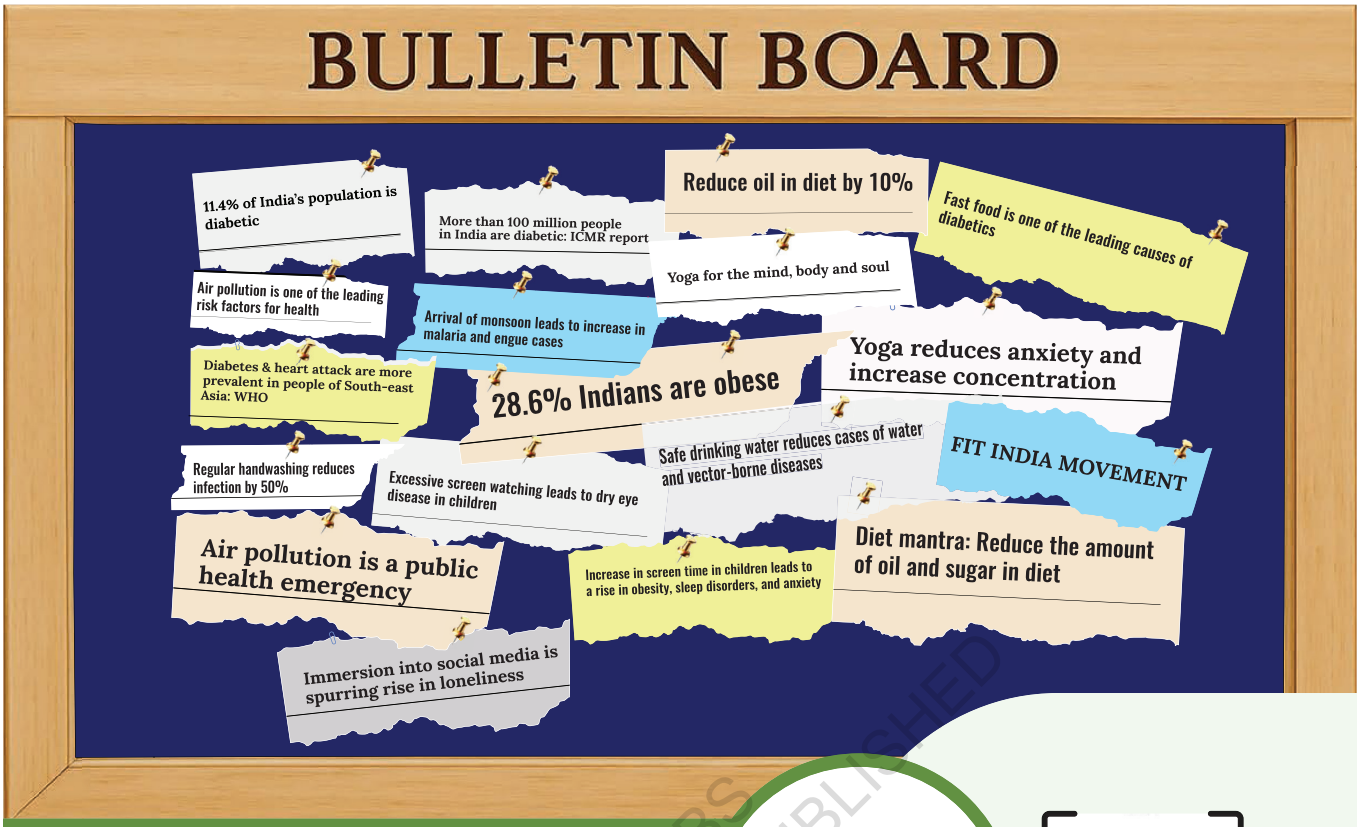
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Health: The Ultimate Treasure

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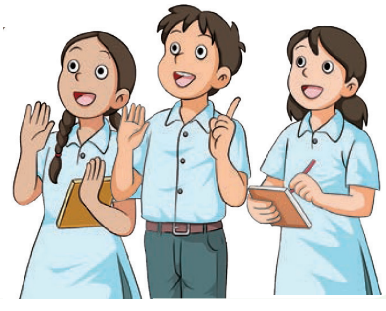
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Probe and ponder

- How does your body respond to an infection such as common cold?
- We rarely see cases of smallpox or polio these days, but diseases like diabetes and heart problems are more common. Why?
- Could climate change lead to new types of diseases?
- How do emotions like stress or worry affect us and make us sick?
- Why do some groups of people get affected more than others during disease outbreaks?
- Share your questions

_____

_____?



3.1 Health: Is It More Than Not Falling Sick?

What do the news clippings on the notice board tell you about people's health in our country? Is being healthy just about not having diseases? Health also includes feeling good physically, staying positive, and having strong relationships. A healthy person takes care of their body, maintains a positive mindset, and enjoys social life. Let us now **explore** what it truly means to be healthy.

Activity 3.1: Let us read

A Grade 8 student moved to a new school in another city. With no friends in his new environment and busy parents, he felt lonely. To cope, he spent more time on his phone and social media, but this made him feel worse. He stopped trying to make friends, had headaches, lost weight, and could not sleep well. A doctor advised less screen time and meeting a counsellor. The school counsellor arranged help to support him in making friends and improving his health.

Think and **Reflect**: What was the cause of the boy's health problems? How did his habits and surroundings affect his well-being?

As per the World Health Organization (WHO), health is defined as a 'state of complete physical, mental, and social well-being, and not merely the absence of disease' (Fig. 3.1). A healthy person can perform various tasks more efficiently and cope well in different and difficult situations. A healthy person can adjust well with peer groups and other members of society. Let us understand more about health.



Fig. 3.1: Aspects of health

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Our scientific heritage

Ayurveda teaches us that true health is a balance of body, mind, and surroundings.

Following *dinacharya* (daily routine) and *ritucharya* (seasonal routine) helps maintain this balance. Eating fresh, wholesome food suited to one's *prakriti* (body constitution) is essential. Regular exercise, cleanliness, restful sleep, and a calm mind support overall well-being. This can also be achieved through practices like yoga, meditation, and mindfulness.



3.2 How Can We Stay Healthy?

Staying healthy means eating nutritious food, maintaining hygiene, staying in a clean place, exercising regularly, getting

proper sleep, spending time with family and friends, and having a positive attitude. What we should do and what should not do to keep ourselves healthy?



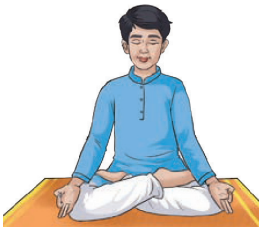
Eat a balanced diet



Stay physically active



Say no to smoking or alcohol



Manage stress



Get enough sleep

Fig. 3.2: How to be healthy

Activity 3.2: Let us list

- List some good habits that your parents, teachers, or elders often encourage you to follow. How many of these are already a part of your daily routine? Which ones would you like to start following? Add to the list below:
  - Keep yourself clean and maintain personal hygiene.
  - Eat a healthy and balanced diet.
  - Exercise regularly.
  - Make time to relax or meditate every day.
- Now, think about habits that are not good for your health. Add more to the list below:
  - Spending too much time on mobile phones or other digital screens.
  - Eating fast food and other junk food every day.
  - Sleeping very late or not getting enough sleep.
  - Skipping meals, especially breakfast.

Taking care of our body and mind is important. Healthy habits support a healthy body as well as a healthy mind.

Discuss your findings with your friends and teacher. From the activity you participated in and the discussions, you may have realised that our health depends on many factors. These factors include our lifestyle (how we live) and our environment (our surroundings).

3.2.1 Maintain a healthy lifestyle

- Eat a balanced diet with plenty of fruits, vegetables, and whole grains.
- Avoid processed, fatty, or sugary food and drinks.
- Stay physically active by playing outdoors, walking, running, cycling, or exercising.
- Limit screen time and spend more time in nature.
- Get enough sleep to help your body and mind rest and recover.
- Practice yoga or simple breathing exercises like pranayama regularly.
- Say 'NO' to harmful substances things like tobacco, alcohol, and addictive drugs (Fig. 3.2).

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3.2.2 Keep the environment clean

Activity 3.3: Let us compare

- Look at Fig. 3.3a and Fig. 3.3b. Which playground would you like to play in, and why?
- Most of us would like to play in the playground shown in Fig. 3.3a as it is clean, well-maintained, and looks beautiful. The playground in Fig. 3.3b is polluted, dirty, unhygienic, and full of flies and mosquitoes. People living in such areas may fall sick more often.
- In addition to inculcating good habits and adopting a healthy lifestyle, we must keep ourselves and our surroundings clean.
- Have you ever found it hard to breathe in a place with a lot of smoke or dust? That is because clean air and water are important for our health. In cities, air pollution from vehicles and factories can cause problems like coughing or asthma. The **Air Quality Index** (AQI) helps us know how clean the air is. A cleaner environment helps us stay healthy and feel better.
- But health is not only about the body. Our feelings and relationships matter too. Even if we eat well and live in a clean place, we may not feel good if we are lonely or upset. Spending time with friends and family, talking, laughing, and having fun help keep our minds healthy too.



(a)

(b)

Fig. 3.3: Two different playgrounds

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3.3 How Do We Know That We Are Unwell?

Our body usually works in a certain way to keep us healthy. When we feel unwell, it means something inside us may not be working as it should. We may have symptoms, such as pain, tiredness, or dizziness, and signs like fever, rash, high blood pressure, or swelling that indicate we are unwell. A symptom is what we feel (like pain), while a sign is something that can be seen or measured (like high body temperature when we have fever). These help doctors understand what might be making us unwell.

3.4 Diseases: What Are the Causes and Types?

A disease is a condition that affects the normal working of the body or mind. It can happen when one or more organs or organ systems stop functioning properly. Some diseases are caused by germs like bacteria, viruses, fungi, worms, or even by protozoa (single-celled organisms). These disease-causing organisms are called **pathogens**. Other diseases may result from poor nutrition or an unhealthy lifestyle. Some diseases last for a short time, while others can continue for a long time and need regular treatment or care. Diseases can be grouped into two major types based on their causes and how they spread:

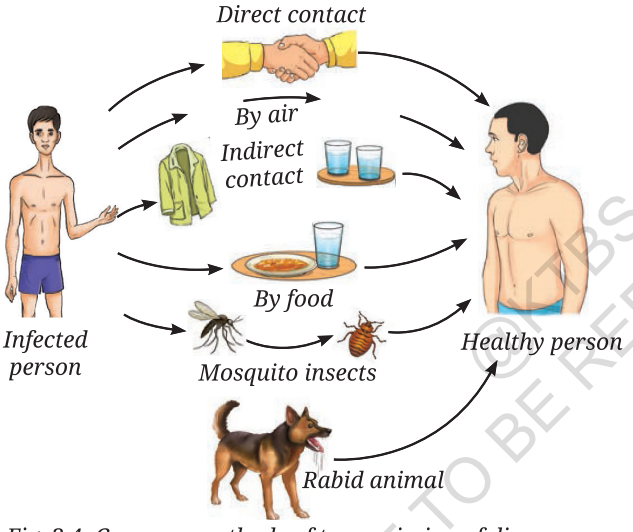


Fig. 3.4: Common methods of transmission of diseases

- **Non-communicable diseases—** Some diseases, like cancer, diabetes, or asthma, are not caused by pathogens and do not spread from one person to another. They are usually linked to lifestyle, diet, and/or environment.
- **Communicable diseases—** Diseases caused by pathogens are called communicable diseases. They can spread from one person to another. Some examples of communicable diseases are typhoid, dengue, flu, chickenpox, and COVID-19.

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In recent years, non-communicable diseases (NCDs) like diabetes, heart disease, and cancer have become more common in India. This is happening because of changes in how people live—such as eating more processed food, getting less exercise, and living longer lives. Today, most deaths in India are caused by NCDs. Understanding the difference between these two types helps us know how diseases spread and how to prevent them.

3.4.1 How are communicable diseases caused and spread?

All communicable diseases are caused by pathogens. These pathogens can enter our body through the air we breathe or by consuming contaminated food or water and more. But how do these pathogens spread from one person to another? One common way is through air, when an infected person coughs or sneezes, or through direct contact like shaking hands, or indirectly by sharing

personal items of an infected person. Some of the communicable diseases spread through contaminated drinking water or food. Some pathogens are also spread by insects like mosquitoes and houseflies—these insects are called **vectors** (Fig. 3.4).

By understanding how diseases spread, we can take simple steps to protect ourselves and others. Let us find out how these communicable diseases spread and how we can prevent them.

Activity 3.4: Let us find out

- Grade 8 students listed some common communicable diseases in Table 3.1 during a community campaign and a library survey.
- Check the information listed by referring to books, trusted websites, or asking your science teacher. Add any missing details.
- Study the table and think about what simple steps can help prevent each disease.

Table 3.1: Some common communicable diseases affecting humans

Diseases	Causal agent	Site of infection	Symptoms	Preventive measures
Diseases spread through the air				
Common cold and influenza 	Virus	Respiratory tract	Nasal congestion and discharge, sore throat, fever, cough, body ache	Washing hands frequently, not sharing personal items, covering the mouth and nose
Chickenpox 	Virus	Respiratory tract, skin	Mild fever, itchy skin, rashes, blisters	Complete isolation of the patient, covering the mouth and nose, vaccination
Measles 	Virus	Skin, respiratory tract	Fever, sore throat, and reddish rashes on the neck, ears and other parts of the skin	Isolation of the patient, covering the mouth and nose, maintaining good hygiene, vaccination

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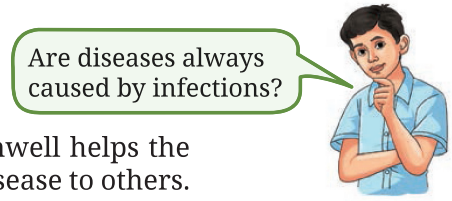
Tuberculosis (TB) 	Bacteria	Lungs	Cough, fever, fatigue, loss of appetite, night sweats	Avoiding close contact with TB-infected people, covering the mouth and nose, maintaining good hygiene, getting vaccinated
Diseases spread through contaminated water and food				
Hepatitis A 	Virus	Liver	Fatigue, fever, loss of appetite, nausea, vomiting, jaundice, pain in the upper right abdomen	Drinking boiled water, vaccination
Cholera 	Bacteria	Intestine	Diarrhoea and dehydration	Maintain personal hygiene and good sanitary habits, consumption of properly cooked food and boiled drinking water, vaccination
Typhoid 	Bacteria	Intestine	Headache, abdominal discomfort, fever, and diarrhoea	Maintain personal hygiene and good sanitary habits, consumption of properly cooked food and boiled drinking water, vaccination
Ascariasis (roundworms) 	Worms	Intestine	Worms in stool, loss of appetite, poor growth, diarrhoea, weight loss, anaemia	Maintain personal hygiene and good sanitary habits, consumption of properly cooked food and boiled drinking water

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Diseases transmitted by insects				
Malaria 	Protozoa	Skin, blood	High fever, profuse sweating, periodic chills	Use of mosquito nets and repellents, wearing long–sleeved clothes, control of mosquito breeding in and around your home
Dengue fever (Break bone fever) 	Virus	Skin, blood	Fever, headache, muscle and joint pain, nausea	Use of mosquito nets and repellents, wearing long-sleeved clothes, control of mosquito breeding in and around your home, avoiding areas with still water

By studying the Table 3.1, we can understand how infectious diseases spread and how to prevent them. Here are some simple but important precautions:

- Keeping ourselves and our surroundings clean.
- Practising basic hygiene every day.
- Washing hands with soap and water to remove pathogens.
- Covering our mouth and nose while coughing or sneezing.
- Wearing a mask in crowded places provides protection.
- Avoid sharing of personal items like towels and handkerchiefs.
- Keeping our home, food, and water clean.
- Staying at home and resting when we are unwell helps the body recover and minimises spreading the disease to others.



Some infectious diseases are caused by worms that live inside our bodies, especially in the digestive system. They feed on nutrients and live as **parasites**—organisms that live in or on another living being. These worms usually spread through contaminated food, water, soil, or contact with infected people or animals.

3.4.2 How are non-communicable diseases caused?

You learnt that non-communicable diseases like cancer, diabetes, and asthma are linked to lifestyle, diet, and/or environment. They are the most common cause of death in India. In Grade 6, you also learnt about diseases like scurvy, anaemia, and goitre,

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which are caused by a lack of specific nutrients in the diet. These are called **deficiency diseases** and are also non-communicable.

Diseases such as cancer, diabetes, and asthma may often persist for a long time (more than 3 months) and are referred to as **chronic diseases**.

Diabetes is a common disease which is becoming more prevalent in adults as well as children. In fact, India now has one of the highest numbers of people with diabetes in the world. It often develops due to a combination of hormonal imbalances, unhealthy eating habits, lack of physical activity, being overweight or obese, and other reasons.

Let us learn more about the causes of non-communicable diseases and their prevention.

Activity 3.5: Let us survey

- Find out the three most common lifestyle-related diseases in your neighbourhood
- Talk to a doctor, nurse, health worker or even a family member who knows about health and what kind of lifestyle changes can help prevent or manage these diseases.
- You can also consult trusted health websites, books, teachers and doctors.
- Fill in Table 3.2 and learn more about lifestyle-related diseases.

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Table 3.2: Non-communicable diseases

S. No.	Name of common lifestyle-related diseases	Signs and symptoms	Suggested lifestyle change(s)
1.	Obesity		Eating a balanced diet and exercising regularly
2.	Diabetes	• Frequent urination • Excessive thirst • Weight loss • Tiredness • Slow healing	
3.	High blood pressure		
4.	.....	.....	.....

Be a scientist



Dr. Kamal Ranadive (1917–2001) was a pioneering biomedical researcher. She studied how hormones and certain viruses are linked to cancer, helping improve its treatment and prevention. Her work also showed how tobacco, diet, and pollution can raise the risk of cancer, highlighting the importance of a healthy lifestyle.



3.5 How to Prevent and Control Diseases?

You might have heard the phrase 'Prevention is better than cure.' It is important to protect ourselves from both communicable and non-communicable diseases.

Activity 3.6: Let us read

Odisha — community-led sanitation campaign

In Bhadrak district, Odisha, a community sanitation campaign helped more people build and use toilets. This reduced open defecation significantly, and improved child health, with fewer cases of diarrhoea and infections.

What do you **infer** from this case study? Simple steps like good sanitation can greatly reduce the spread of communicable diseases. Find about such community campaigns held in your location. Share in your class and discuss with your peers about the impact of such initiatives.

Ability of the body to fight diseases

You would have noticed that some people get sick more frequently than others, although living in a similar environment. Do you know why? The natural ability of our body to fight diseases is known as **immunity**. Our body has a special system called the immune system that helps fight against diseases.

You might have taken some drops or injections in your childhood to protect yourself from certain diseases, such as polio, measles, tetanus, and hepatitis. These are **vaccines** that help prevent serious infections caused by viruses and bacteria.

A vaccine helps our body fight certain diseases by training the immune system to recognise and attack harmful germs. providing what is known as **acquired immunity**—protection developed after exposure to a pathogen or a vaccine. Vaccines can be made in different ways—from weakened or dead pathogens (like viruses or bacteria), or from inactive or harmless parts of the pathogen. Some newer vaccines instruct our own body cells

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to make a harmless part of the germ, which our immune system then learns to fight.

For example, a tetanus shot, often given after an injury protects against infection by the tetanus-causing bacteria. It contains an inactivated bacterial toxin that helps the immune system develop protection without causing the disease.

Do you know when the first vaccine was discovered?

Edward Jenner and the smallpox vaccine

Smallpox was a deadly disease that caused blisters and killed millions. A milder disease called cowpox, seen in cows, could also infect humans. In the late 1700s, English doctor Edward Jenner discovered that people who had cowpox did not get smallpox. This led to the invention of the first vaccine and helped protect people from smallpox.



Our scientific heritage

Long before modern vaccines, India had a traditional method called variolation to protect against smallpox. It involved using material from a smallpox sore to scratch the skin and create a mild infection and build immunity. People who performed this practice were known as *teekedaars*.

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Think like a scientist

Observations

Jenner observed that milkmaids who had cowpox did not catch smallpox, likely because the two viruses are related.



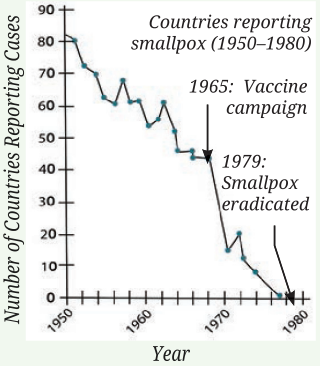
Hypothesis

Content in the pus of cowpox blisters protected people from smallpox.



Experimentation

He tested this by injecting cowpox sap into a boy, who later showed no illness when exposed to smallpox.



Results

He found that people who were infected with cowpox sap were now resistant to smallpox.



Application

Mass vaccination eventually helped eradicate smallpox worldwide.

Vaccines are one of the most effective ways to protect people of all ages—from infants to the elderly—against many serious diseases. They help prevent illnesses, reduce the spread of infections, and save millions of lives every year. It is important to remember that vaccines are preventive, not curative—they can help minimise serious diseases before they happen, but do not treat them once someone is already sick. Some people may fear or doubt vaccines, but scientists and doctors carefully test them for safety. Getting vaccinated not only protects you but also the people around you.

Ever heard of ...



India's Role in Vaccine Production
India is one of the world's largest vaccine producers. It manufactures vaccines on a massive scale and supplies them to many countries. Indian vaccine companies played a key role during the COVID-19 pandemic and continue to support global health efforts.



Be a scientist



Dr. Maharaj Kishan Bhan was a well-known Indian doctor and scientist. As Secretary of the Department of Biotechnology, he helped promote science and innovation in India. He played a key role in developing the Rotavirus vaccine, which protects children from diarrhoea. He believed in using research to create affordable healthcare and made a big difference in India's health and biotechnology sectors.



3.5.1 Treatment of diseases

If our immune system fails to protect us against an infectious disease, we fall ill and need to visit a doctor. The doctor may give us medicines called **antibiotics**, which kill the bacteria that might have caused the disease. Antibiotics work only against bacterial infections because they target parts of bacterial cells that are different from human or other animal cells. They do not work against viruses or diseases caused by protozoa.

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Think like a scientist



Discovery of the first antibiotic, Penicillin

Penicillin was discovered in 1928 by Alexander Fleming, a bacteriologist from London. While studying harmful bacteria, he noticed that a mould on a discarded petri dish stopped the bacteria from growing. He realized the mould released a substance that killed the bacteria. This chance discovery led to the discovery of penicillin, the first antibiotic used to treat bacterial infections.



Though antibiotics are effective in protecting us against bacterial infections and have saved millions of lives since their discovery, their indiscriminate use has led to a decline in their effectiveness (Fig. 3.5a). Nowadays, there are news headlines about **antibiotic resistance**, a phenomenon where bacteria that were earlier killed by a given antibiotic are found to survive and multiply despite treatment with that antibiotic. This makes

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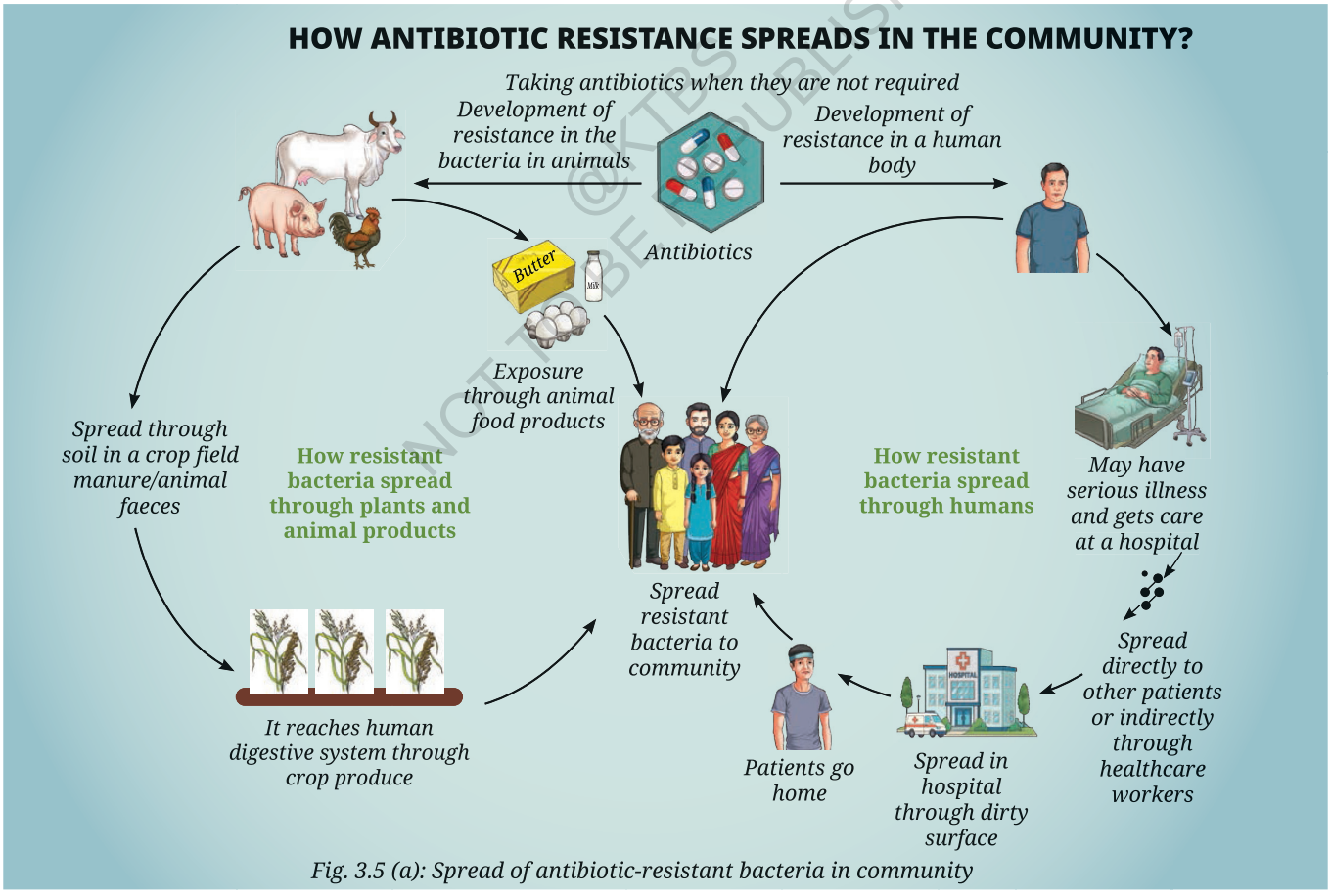


Fig. 3.5 (a): Spread of antibiotic-resistant bacteria in community

common infections harder to treat and increases the risk of complications, prolonged illness, and even death.

Activity 3.7: Let us infer

- Study the infographic given in Fig. 3.5b. How do you think the antibiotic resistance has been developed in bacterial pathogens? What precautions may be taken to reduce antibiotic resistance?
- To tackle the problem of antibiotic resistance, we must use antibiotics wisely—only when prescribed by a doctor, in the correct dose, and for the right duration. Avoiding unnecessary use helps prevent the rise of resistant bacteria and keeps antibiotics effective for future generations.

Traditional medicine systems like Ayurveda, Siddha, and Unani have been used in India for many years to manage common health problems. They use natural substances like herbs, oils,

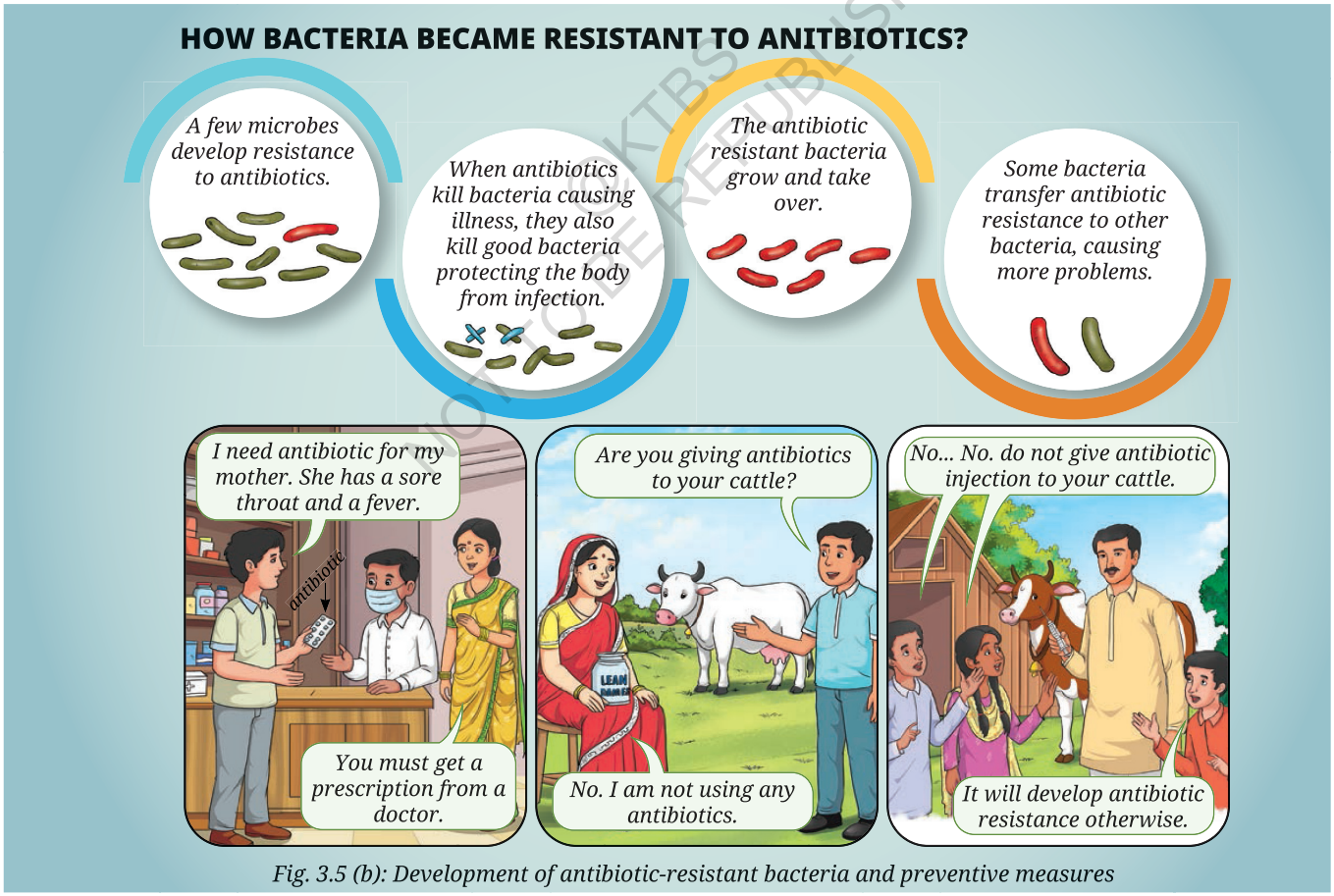


Fig. 3.5 (b): Development of antibiotic-resistant bacteria and preventive measures

and minerals for managing illnesses and promoting recovery, and focus on a healthy lifestyle and balanced diet. While these systems can help with some conditions, and are useful for everyday well-being, they may not be effective for all diseases and at all stages.

Therapies for non-communicable diseases focus on managing symptoms and improving quality of life through medication, lifestyle changes, and rehabilitation. Early diagnosis and continuous care are key to control the disease progression and prevent complications.



Snapshots

- Health means complete physical, mental, and social well-being—not just the absence of disease.
- Being happy helps us stay active and healthy, and good health also improves our mood. Health and happiness are closely related.
- A disease affects the normal working of the body or mind.
- Symptoms are what we feel (like pain or tiredness); signs are what can be seen or measured (like fever or rash).
- Non-communicable diseases like diabetes and heart disease are caused by lifestyle and environmental factors, not germs. They can often be prevented with healthy habits, lifestyle changes, and regular exercise.
- Infectious diseases are caused by pathogens like bacteria, viruses, or worms.
- Our immune system helps protect us from harmful pathogens.
- Vaccines train the immune system using dead, weakened, or harmless parts of a germ to prevent disease.
- Diagnosis and treatment are important for managing and curing diseases.

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Keep the curiosity alive

1. Group the diseases shown in the images as communicable or non-communicable.



Cold and flu



Typhoid



Diabetes



Asthma



Chickenpox

2. Diseases can be broadly grouped into communicable and non-communicable diseases. From the options given below, identify the non-communicable diseases.
   (i) Typhoid (ii) Asthma (iii) Diabetes (iv) Measles
   (a) (i) and (ii) (b) (ii) and (iii) (c) (i) and (iv) (d) (ii) and (iv)
3. There is a flu outbreak in your school. Several classmates are absent, while some are still coming to school coughing and sneezing.
   (i) What immediate actions should the school take to prevent further spread?
   (ii) If your classmate, who shares the bench with you, starts showing symptoms of the flu, how can you respond in a considerate way without being rude or hurtful?
   (iii) How can you protect yourself and others from getting infected in this situation?
4. Your family is planning to travel to another city where malaria is prevalent.
   (i) What precautions should you take before, during, and after the trip?
   (ii) How can you explain the importance of mosquito nets or repellents to your sibling?
   (iii) What could happen if travellers ignore health advisories in such areas?
5. Your uncle has started smoking just to fit in with his friends, even though it is well known that smoking can seriously harm health and even cause death.
   (i) What would you say to him to make him stop, without being rude?
   (ii) What would you do if your friend offers you a cigarette at a party?
   (iii) How can schools help prevent students from indulging in such harmful habits?
6. Saniya claims to her friend Vinita that "Antibiotics can cure any infection, so we don't need to worry about diseases." What question(s) can Vinita ask her to help Saniya understand that her statement is incorrect?

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7. The following table contains information about the number of dengue cases reported in a hospital over a period of one year:

S. No.	1	2	3	4	5	6
Month	January	February	March	April	May	June
No. of dengue cases	10	12	15	18	22	40

S. No.	7	8	9	10	11	12
Month	July	August	September	October	November	December
No. of dengue cases	65	65	65	30	30	20

Make a bar graph of the number of cases on the Y-axis and the month on the X-axis. Critically analyse your findings and answer the following:

(i) In which three months were the dengue cases highest?

(ii) In which month(s) were the cases lowest?

(iii) What natural or environmental factors during the peak months might contribute to the increase in dengue cases?

(iv) Suggest a few preventive steps that the community or government can take before the peak season to reduce the spread of dengue.

8. Imagine you are in charge of a school health campaign. What key messages would you use to reduce communicable and non-communicable diseases?

9. It is recommended that we should not take an antibiotic for a viral infection like a cold, a cough, or flu. Can you provide the possible reason for this recommendation?

10. Which disease(s) among the following may spread if drinking water gets contaminated by the excreta from an infected person?

Hepatitis A, Tuberculosis, Poliomyelitis, Cholera, Chickenpox.

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

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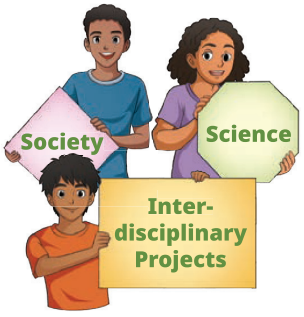
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11. When our body encounters a pathogen for the first time, the immune response is generally low but on exposure to the same pathogen again, the immune response by the body is much more compared to the first exposure. Why is it so?

Discover, design, and debate

- Students maintain a health diary for at least a month to track food, hygiene, exercise, sleep, screen time, and emotional state.
- Read about Indian scientists like Suniti Solomon, Asima Chatterjee, Dr. Yellapragada Subbarao, Dr. Mary Poonen Lukose for their contributions in the field of health and diseases.
- The deadly disease smallpox was eradicated by vaccination. Discover how this was done and why it worked. Debate whether everyone should be required to get vaccinated to protect others.
- According to current guidelines, learn the correct sequence of steps for performing cardiopulmonary resuscitation (CPR) on an adult in case of sudden stoppage of breathing. School may invite a doctor or a professional to demonstrate a mock drill.
- Invite a doctor to the school. Students may be encouraged to interact with the doctor on the issues of malnutrition, under-nutrition, and over-nutrition.
- If you are given an opportunity to create a health card, what all would you like to include in it. Create your own health card and have discussion about it.
- Have a debate on 'Are there ill-effects of fast food on companion animals?



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

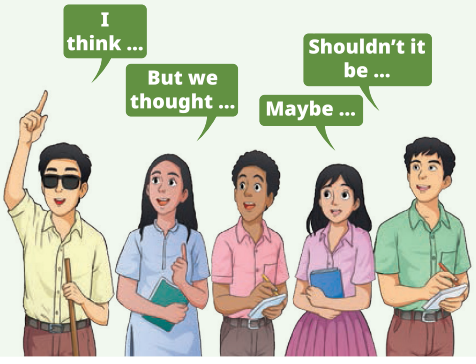
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Electricity: Magnetic and Heating Effects

4

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Probe and ponder

- If we don't have an electric lamp while making an electric circuit with an electric cell, is there any other way through which we can find out if current is flowing in the circuit?
- Is it possible to make temporary magnets? How can these be made?
- We can generate heat by burning fossil fuels and wood; but how is heat generated in various electrical appliances?
- How do we know if a cell or a battery is dead? Can all cells and batteries be recharged?
- Share your questions

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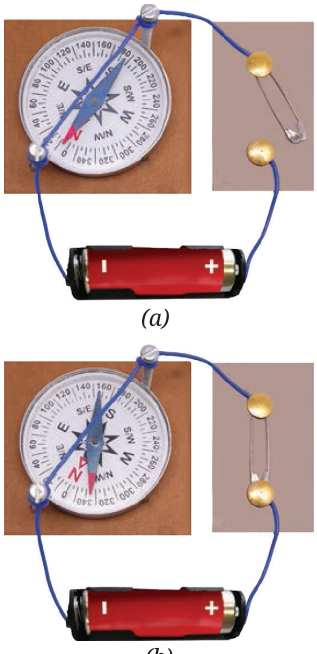


It was the day of the science exhibition, and the school was buzzing with energy. Mohini and Aakarsh, along with their friends, went from one exhibit to another, eagerly exploring different models, asking questions and taking notes. One simple model really fascinated them. It was a working model of a lifting electromagnet which was displayed by their senior, Sumana. In it, instead of a hook like a typical crane, there was an iron nail wrapped with a wire, which was connected to a battery. When Sumana closed the circuit, the nail picked up iron paper clips like a magnet. When she opened the circuit, the clips fell off. Mohini and Aakarsh, were surprised. They remembered learning earlier (in the chapter 'Exploring Magnets', *Curiosity*, Grade 6) that magnetic materials were attracted by magnet and that iron was a magnetic material. But in Sumana's model, there was no magnet, only an electric circuit. They were so excited that they wanted to try it out themselves.

4.1 Does an Electric Current Have a Magnetic Effect?

Activity 4.1: Let us investigate

- Collect a magnetic compass, an electric cell, a cell holder, two drawing pins, a safety pin, two nails, two pieces of connecting wires (one longer and one shorter), and two small pieces of cardboard.
- Using two drawing pins, a safety pin, and a cardboard piece, make a switch (as you made it earlier in the chapter 'Electricity: Circuits and their Components' in *Curiosity*, Grade 7).
- Place the cell in the cell holder.
- Fix two nails to a piece of cardboard as shown in Fig. 4.1a. Fix the middle portion of the longer wire stretched between the nails, such that it is slightly above the surface of the cardboard. Attach one end of that wire to the cell holder and another end to the switch.
- Connect the second wire between the cell holder and the switch.
- Place the magnetic compass beneath the wire between the two nails (Fig. 4.1a).



(a)

(b)

Fig. 4.1: An electric circuit and a magnetic compass

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While watching the compass needle, move the switch to 'ON' position to allow electric current to flow through the wire (Fig. 4.1b). What do you **observe**?

- Now again while watching the compass needle, move the switch to 'OFF' position. What do you observe this time?
- Move the switch between 'ON' and 'OFF' positions a few more times. Carefully observe how the compass needle behaves the each time.

You may have **noticed** that when the current flows, the compass needle gets deflected from its original direction. When the current stops, the needle returns to its original direction.

As we have learnt earlier (in the chapter 'Exploring Magnets' in *Curiosity,* Grade 6), the compass needle is a tiny magnet which deflects when a magnet is brought near it and this magnetic effect can act through any non-magnetic materials kept in between. But why does the compass needle deflect when the current flows through the wire? The deflection indicates that the current carrying wire has a magnetic effect on the compass needle. When the current stops, this magnetic effect disappears and the compass needle returns to its original direction. The region around a magnet or a current carrying wire where its magnetic effect can be felt, such as by the deflection of a compass needle, is said to have a **magnetic field**.



We have learnt about magnets and electric current in earlier grades. I used to think that there was no link between the two. But now we found that electricity and magnetic effect are linked!

When electric current flows through a conductor (like a wire), it produces a magnetic field around it. This phenomenon is known as the **magnetic effect of electric current**. The magnetic field disappears when the current stops flowing.

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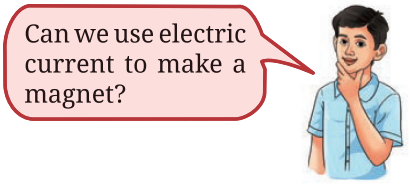
Be a scientist



You have just now made the same discovery which was made by the scientist Hans Christian Oersted (1777–1851) in 1820, that is, the discovery that electricity and magnetism are linked. He was a professor at a university in Denmark. It is said that once while giving a demonstration, he noticed that whenever an electrical circuit was closed or opened, the needle of a magnetic compass, lying nearby, deflected. He investigated this and when he was certain that an electric current indeed produced a magnetic field, he published his findings. This led to other scientists repeating his experiment to check if they got the same results, and further investigating the connection between electricity and magnetism.



The magnetic effect of electric current has many practical applications, such as in devices like electromagnets, electric bells, motors, fans, loudspeakers, and more.



4.1.1 Electromagnets

Activity 4.2: Let us explore

- Take around 50 cm long length of a flexible insulated wire, an iron nail, an electric cell, and few iron paper clips.
- Tightly wrap the wire around the nail in the form of a coil, as shown in Fig. 4.2, and secure it with an adhesive tape.
- Connect the ends of the wire to the cell. Take care to not connect the wires to the cell for more than a few seconds; otherwise, the cell may weaken quickly.
- Bring the nail close to the iron paper clips and lift up. Do the clips hang to the ends of the nail?
- Disconnect the wire from the cell to stop the flow of electric current in the wire. Do the clips fall down?

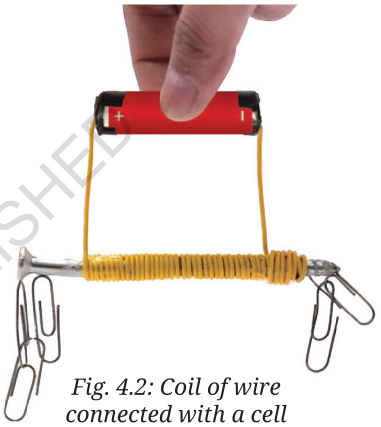


Fig. 4.2: Coil of wire connected with a cell

When electric current flows through the coil, the clips cling to it. But when the current is stopped, the clips no longer cling to it. Let us now try to **investigate** these observations in detail through Activity 4.3.

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Activity 4.3: Let us experiment

- Take around 100 cm long flexible insulated wire, a piece of chart paper, an iron nail, an electric cell, two magnetic compasses, and few iron/steel paper clips.
- Roll a piece of chart paper to make a cylinder of diameter roughly equal to the width of a pencil. Secure it with an adhesive tape.
- Tightly wind around 50 turns of the insulated wire on the cylinder to form a cylindrical coil as shown in Fig. 4.3a. Secure the wire with an adhesive tape.



Fig. 4.3: (a) A coil of insulated wire

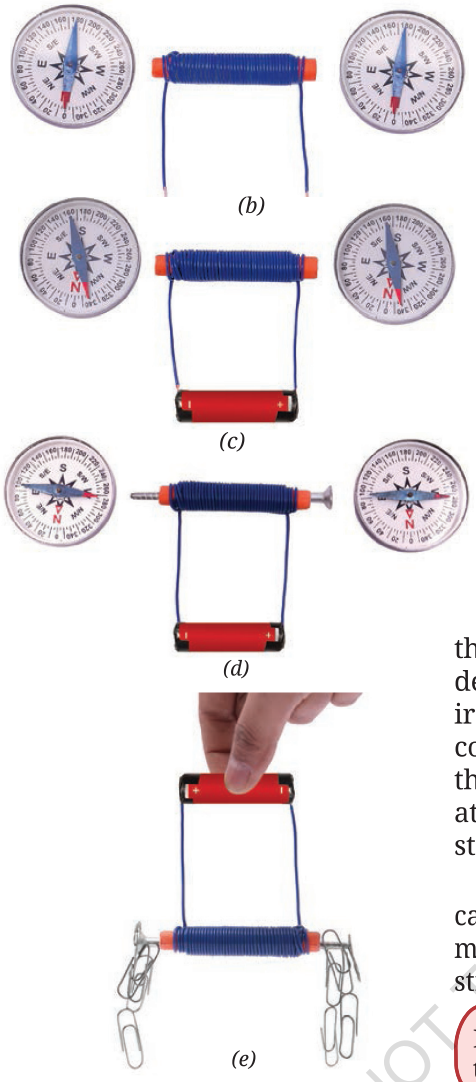
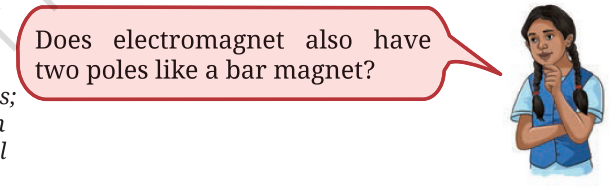


Fig. 4.3: (b) Coil and magnetic compasses; (c) Coil connected to a cell; (d) Coil with iron nail inserted; (e) Coil with iron nail and clips

- Place the compasses near the two ends of the cylindrical coil (Fig. 4.3b).
- Connect the two ends of the coil with the terminals of the cell as shown in Fig. 4.3c and observe the magnetic compasses. Do you find any deflection in the needles of the compasses?
- Disconnect the wire from the cell. Do the needles of the compasses come back to their original positions?
- Insert an iron nail in the paper cylinder (Fig. 4.3d) and repeat the steps. Is there any difference in the deflection of the compass needles?
- Place some iron paper clips near the two ends of the nail. Are the clips attracted to the ends of the nail?

It is observed that when current is passed through the cylindrical coil, it behaves like a magnet and deflects the needle of a magnetic compass. When an iron nail is inserted in the core of the coil, then the coil becomes a stronger magnet and the deflection of the magnetic compass needle is much more. It also attracts iron clips (Fig. 4.3e). When the current is stopped, the cylindrical coil loses its magnetic effect.

A current carrying coil that behaves as a magnet is called an **electromagnet**. For practical applications, most electromagnets have an iron core to make them stronger.



Activity 4.4: Let us investigate

- Take the electromagnet made in Activity 4.3 and a magnetic compass. Label the two ends of the coil as A and B.
- Place the magnetic compass near the end A of the coil as shown in Fig. 4.4a.
- Connect the coil to the cell and observe the compass. Note down which pole of the magnetic compass is attracted to end A.

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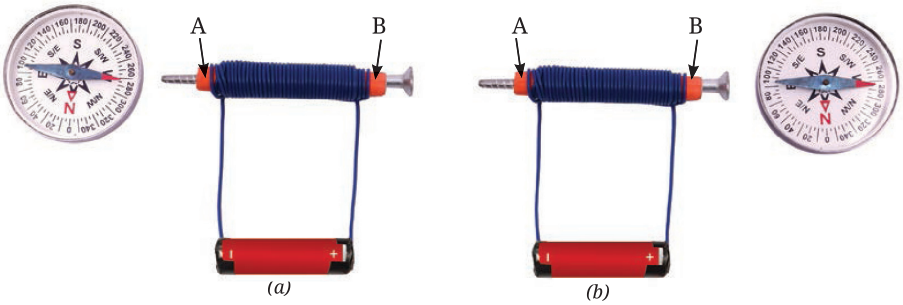


Fig. 4.4: Compass needle near (a) End A; (b) End B of an electromagnet

As we have learnt earlier, when two magnets are brought close to each other, their unlike poles (North–South) attract each other. So, if north pole of the magnetic compass is attracted towards end A of the electromagnet, then end A is south pole.

- Repeat this procedure to find the polarity of end B as well (Fig. 4.4b). Did you find that the polarity of end B is opposite to the polarity of end A?

We learnt in grade 6 that a magnet has two poles. Just like a magnet, an electromagnet also has two poles—North and South.

Think like a scientist

Repeat Activity 4.3 with— (i) 2 and 4 cells with the same coil, (ii) 2 cells but different number of turns of the coil. What do you observe?

A single cell provides only a small amount of current, so the magnetic field is weak. As a result, the deflection of compass needle is less and the coil can only attract a few clips. A battery with more cells gives a larger current as compared to that with a single cell. This creates a stronger magnetic field, so the deflection of the compass needle is more and the coil can attract more clips. The increase in number of turns of the coil also makes the coil a stronger magnet!

Also, repeat Activity 4.4 by changing the direction of the current. So, the strength of an electromagnet can be changed by changing the amount of electric current flowing through the coil or the number of turns of the coil, or both. Also, its poles can be reversed by changing the direction of the current.



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A step further

Do you remember learning earlier (in the chapter 'Exploring Magnets' in *Curiosity*, Grade 6) that a freely suspended magnet rests along the north–south direction because our Earth itself behaves like a giant magnet? But why does Earth behave like a magnet? Deep inside the Earth, the movement of liquid iron in the core creates electric currents, which generate a magnetic field. Many migratory birds, fish, and animals use this field to navigate across continents and oceans. The Earth's magnetic field also acts as a shield, blocking harmful particles from space, and helps protect life on Earth.





Are electromagnets also used in real life, for lifting objects?

4.1.2 Lifting electromagnets

Lifting electromagnets are strong electromagnets, that may be hung to the cranes. The crane operator can control the magnet by switching the current ON and OFF. When the current is turned ON, the electromagnet lifts the iron/steel objects; when the current is switched OFF, magnetic field disappears, and the objects are released. Lifting electromagnets are widely used in factories and scrap yards, to move, lift, and sort heavy metal items efficiently.

A step further



We have learnt that when electric current flows through a conductor (like a wire), it produces a magnetic field around it. In the higher grades, you will learn even more about this wonderful link between electricity and magnetism, including the exciting idea that just as electricity can produce magnetism, a moving magnet can also lead to an electric current. This deep connection between electricity and magnetism is vital to our daily lives, as it forms the basis of many devices, from electric motors to power generators.

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4.2 Does a Current Carrying Wire Get Hot?

Activity 4.5: Let us observe



While doing the activity for electromagnet, did you also notice that the wire ends got warm? Why would that happen?

In this activity, we will use a special kind of wire, called a nichrome wire.

- Take a cardboard piece of about 10 cm length and 10 cm width, two nails, a nichrome wire of thickness about 0.3 mm (26–28 gauge) and length of 10 cm, an electric cell, a cell holder, a switch, and connecting wires.
- Mount the nails on the cardboard about 5 cm apart.
- Tie the nichrome wire between these nails and make the connections as shown in Fig. 4.5 with the switch in OFF position.
- Touch the nichrome wire. What do you feel?
- Move the switch to ON position for about 30 s and then move it back to OFF. Touch the nichrome wire momentarily

(Do not hold the nichrome wire). What difference do you feel?

- Repeat the last two steps to **confirm** the observation.

Safety first

Do not touch the wire for an extended period to avoid any injuries.



You may have observed that nichrome wire feels warm when current is passed through it. This happens because, when electric current flows through any conductor, it faces some opposition or resistance to its flow. Different conductors offer different levels of resistance to the flow of current. A nichrome wire, for example, offers higher resistance compared to a copper wire of the same size and length. This resistance causes some of the electrical energy to be converted into heat energy. When an electric current passes through a conductor, it gets heated. This warming is known as the **heating effect of electric current**.

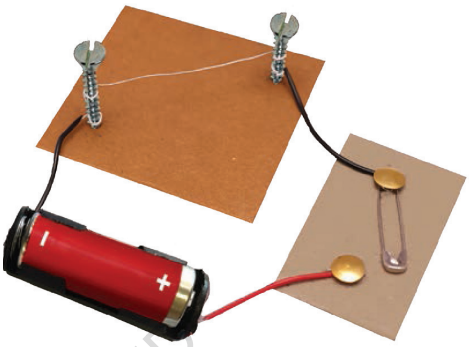


Fig. 4.5: Heating effect in a wire

Think like a scientist

This activity should be carried out strictly under the supervision of a teacher.

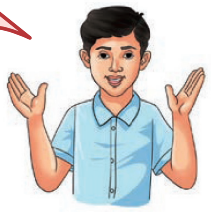
Repeat Activity 4.5 with a battery of 2 cells. What do you notice? For the same duration, does the wire heat up more with one cell or two cells?

The amount of heat generated is more in the experiment with 2 cells. This is due to the fact that the heat generated depends on the magnitude of the electric current. The heat generated in a wire depends on the material, thickness, and length of the wire, and the duration for which the current flows.



In Grade 7, we have learnt that an incandescent lamp glows because its filament is heated by an electric current. Many household appliances, such as electric room heaters, stoves, irons, immersion rods, water heaters, kettles, and hair dryers (Fig. 4.6) work on the same principle of the heating effect of electric current. All these devices contain a rod or a coil of wire, called a heating element. In some appliances where this element is visible, it can be seen glowing red hot.

Oh, now I understand why the incandescent torch lamp sometimes used to get warm when we did the activity of making it glow using an electric cell.



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(a)



(b)



(c)



(d)



(e)



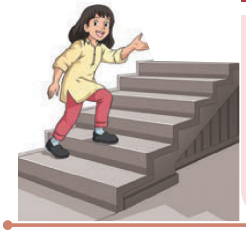
(f)

Fig. 4.6: Simple household electric heating appliances (a) Room heater; (b) Electric stove; (c) Electric kettle; (d) Electric iron; (e) Water heating immersion coil; or (f) Hair dryer

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The heating effect of electric current is useful in many everyday appliances. But sometimes, it can cause problems, like energy loss in wires during transmission. Overheating in appliances may cause damage to plugs and sockets where plastic parts may melt, or even lead to fires. In household circuits, there are safety devices placed in the circuit to minimise such incidents.

A step further



To prevent unnecessary heating in household switchboards, it is important to use appropriate wires, plugs, and sockets that are rated for the specified electric current of the connections.

Ever heard of ...



Beyond household use, heating effect of electric current has several industrial applications. One notable example is in steel manufacturing industries, where a specially designed high-temperature furnace (an enclosed space built to generate heat) uses electric current to produce heat. This is used to melt and recycle scrap steel, converting it into usable steel.



The portable sources of electricity, such as cells and batteries, are so fascinating. Using these, we could light up a small lamp, make a magnet, and heat up a wire.

Yes, but have you ever wondered what is inside these cells and batteries that produces electricity?



4.3 How Does a Battery Generate Electricity?

Let us start with one of the earliest types of electric cells ever made.

4.3.1 Voltaic cell

A Voltaic cell, also known as Galvanic cell, is shown in Fig. 4.7. It contains two metal plates made of different materials and a liquid called an electrolyte, placed in a glass or plastic container. The plates, called electrodes, are partly dipped in the electrolyte, which is usually a weak acid or salt solution. A chemical reaction between the plates and the electrolyte produces electricity. When the circuit is connected, electric current flows from the positive terminal through the circuit to the negative terminal. Over time, the chemicals get used up, and the cell stops working. It is then called 'dead' and cannot supply any more electricity.

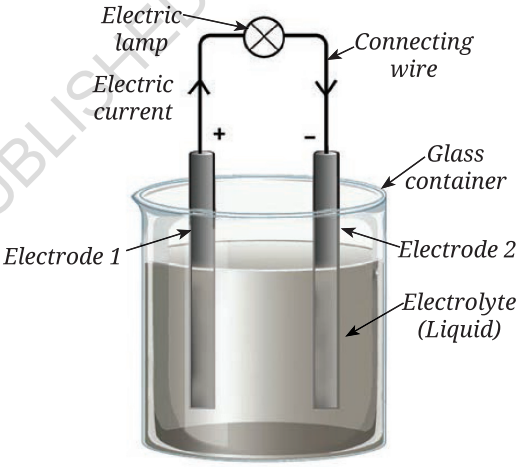


Fig. 4.7: Simple representation of a Voltaic cell

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Ever heard of ...

The Voltaic or Galvanic cells get their names from two Italian scientists, Alessandro Volta and Luigi Galvani. In the late 1700s, Galvani noticed that a dead frog's leg kicked when touched with two different metals—copper and iron. It was already known by then that electricity could stimulate muscular motion and Galvani thought the electricity came from the frog itself. But Volta had a different idea. He believed the electricity came from the metals, and not the frog. To test this, he used saltwater-soaked paper instead of the frog's leg and still got an electric current. This showed that it was the combination of metals and liquid that generated electric current—leading to the invention of the first battery!

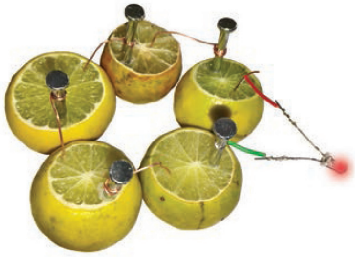


Activity 4.6: Let us construct

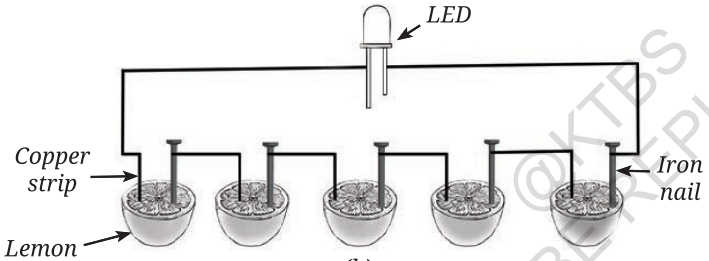


Can we also make our own Voltaic cell using easily available materials?

- Take five or six juicy lemons, copper wires/ strips (1–2 mm thick) and iron nails. Also take one LED and some connecting wires.
- Insert the copper wire and the iron nail in one of the lemons keeping them apart by a small distance as shown in Fig. 4.8a.
- Repeat the above step for all the remaining lemons.
- Join the copper wires and nails as shown in Fig. 4.8b.
- Connect the LED between the copper wire of the first lemon and the iron nail of the last lemon, using connecting wires. What do you observe? Does the LED glow?



(a)



(b)

Fig. 4.8: (a) Electric cell made using lemons; (b) Connections in lemon cell

- If the LED does not glow, reverse its connections. Does the LED glow now? [Remember that we have learnt earlier that current can pass through the LED only when the positive terminal (longer wire) of the LED is connected to the positive terminal of the battery, and negative terminal (shorter wire) of the LED is connected to the negative terminal of the battery].

A glowing LED indicates that your cell is working. In this cell, the metal electrodes are the copper wires and the iron nails. The electrolyte is the lemon juice, which helps conduct electricity. You may also use salt solutions instead of lemon juice.

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A step further



Some common metal pairs for Voltaic cells are zinc/copper, zinc/ silver, aluminium/copper, iron/copper, magnesium/copper, and lead/copper. Some metals—like copper—act as positive electrodes, yet some other metals—like zinc—act as negative electrodes. This is due to their chemical properties. We will learn more about this in the higher grades.

4.3.2 Dry cells

Voltaic cells were an important discovery, but they are not convenient for everyday use. Instead, dry cells are one of the most widely used electric cells today. They are called 'dry' because the electrolyte is not a liquid but a thick moist paste. The structure of a dry cell is shown in Fig. 4.9. It consists of a zinc container which acts as a negative terminal and a carbon rod at the centre covered with metal cap that acts as the positive terminal. The carbon rod is surrounded by the paste-like electrolyte.

The dry cell is a single use cell, meaning once it is used up, it has to be disposed of. For several applications, rechargeable batteries are increasingly being used now.

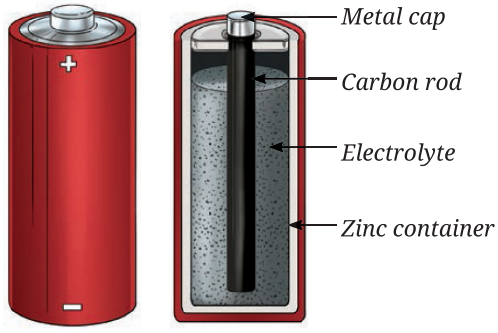


Fig. 4.9: (a) Dry cell; (b) Its internal structure

4.3.3 Rechargeable batteries

Rechargeable batteries can be recharged and reused multiple times. This prevents wastage and saves money over time as well.

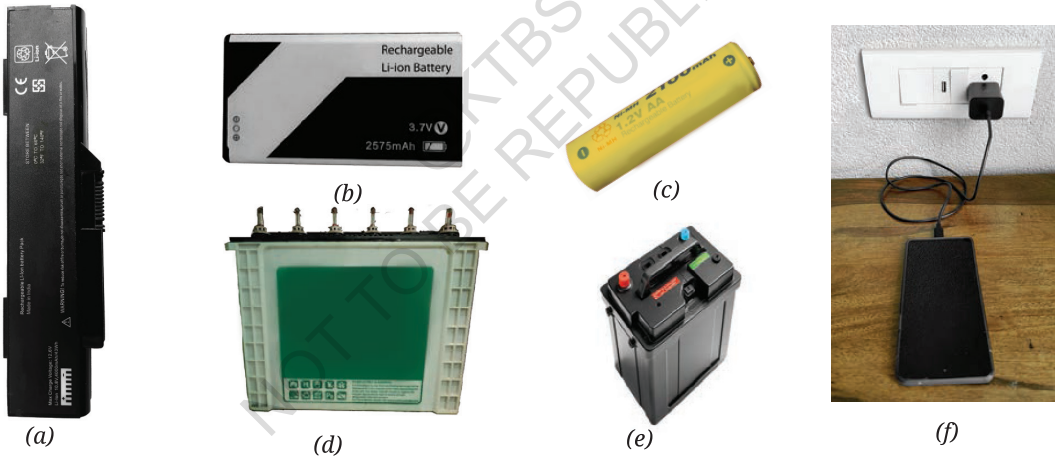
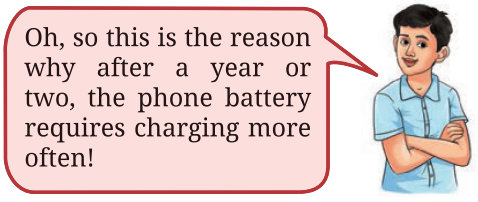


Fig. 4.10: Typical rechargeable batteries used in (a) Laptops; (b) Mobile phones; (c) Camera; (d) Inverter; (e) Vehicles; (f) Charging a mobile phone

There are many different kinds of rechargeable batteries that are used for different applications—from small batteries used in watches and phones to batteries used in laptops and tablet to bigger batteries that run inverters or drive electric vehicles (Fig. 4.10). However, rechargeable batteries also do not last forever. After being charged and used many times, they slowly wear out.



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A step further



Today, the lithium-ion (Li-ion) battery is the most common type of rechargeable battery, found in almost all devices that use batteries. These batteries rely on special metals like lithium and cobalt, which are mined and processed in limited parts of the world. Because of this, countries are now racing to secure supplies, recycle old batteries, and develop new technologies.

Scientists are also working on the next big leap: solid-state batteries, which replace the liquid or paste-like electrolytes with solid materials. These future batteries would be much safer, charge faster and last longer. Improved rechargeable batteries are very important as the world moves to developing environmentally friendly sources of electrical power.



Snapshots

- When electric current flows through a conductor (like a wire), it produces a magnetic field around it. This phenomenon is known as the magnetic effect of electric current.
- A current carrying coil that behaves as a magnet is called an electromagnet. For practical applications, most electromagnets have an iron core to make them stronger.
- Generation of heat in conductors due to flow of electric current is known as the heating effect of electric current.
- A cell or a battery is a device that generates electric current because of chemical reactions taking place inside it.
- Rechargeable batteries can be recharged and reused multiple times.

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Keep the curiosity alive

1. Fill in the blanks:
   (i) The solution used in a Voltaic cell is called _____.
   (ii) A current carrying coil behaves like a _____ .
2. Choose the correct option:
   (i) Dry cells are less portable compared to Voltaic cells. (True/False)
   (ii) A coil becomes an electromagnet only when electric current flows through it. (True/False)
   (iii) An electromagnet, using a single cell, attracts more iron paper clips than the same electromagnet with a battery of 2 cells. (True/False)

3. An electric current flows through a nichrome wire for a short time.
   (i) The wire becomes warm.
   (ii) A magnetic compass placed below the wire is deflected.
   Choose the correct option:
   (a) Only (i) is correct
   (b) Only (ii) is correct
   (c) Both (i) and (ii) are correct
   (d) Both (i) and (ii) are not correct

4. Match the items in Column A with those in Column B.

Column A		Column B	
(i)	Voltaic cell	(a)	Best suited for electric heater
(ii)	Electric iron	(b)	Works on magnetic effect of electric current
(iii)	Nichrome wire	(c)	Works on heating effect of electric current
(iv)	Electromagnet	(d)	Generates electricity by chemical reactions

5. Nichrome wire is commonly used in electrical heating devices because it
   (i) is a good conductor of electricity.
   (ii) generates more heat for a given current.
   (iii) is cheaper than copper.
   (iv) is an insulator of electricity.

6. Electric heating devices (like an electric heater or a stove) are often considered more convenient than traditional heating methods (like burning firewood or charcoal). Give reason(s) to support this statement considering societal impact.

7. Look at the Fig. 4.4a. If the compass placed near the coil deflects: (i) Draw an arrow on the diagram to show the path of the electric current. (ii) Explain why the compass needle moves when current flows. (iii) Predict what would happen to the deflection if you reverse the battery terminals.

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

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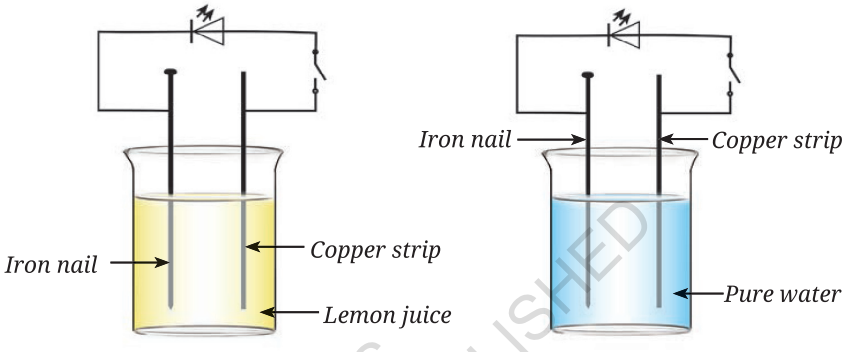
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8. Suppose Sumana forgets to move the switch of her lifting electromagnet model to OFF position (in introduction story). After some time, the iron nail no longer picks up the iron paper clips, but the wire wrapped around the iron nail is still warm. Why did the lifting electromagnet stop lifting the clips? Give possible reasons.

9. In Fig. 4.11, in which case the LED will glow when the switch is closed?



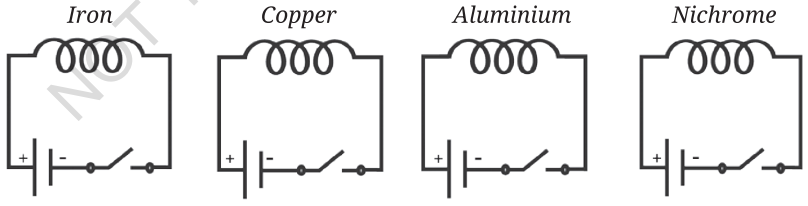
(a) (b)

Fig. 4.11

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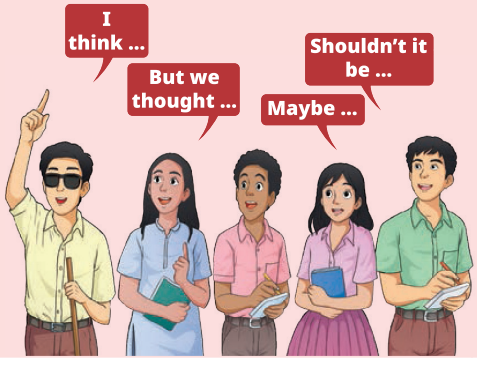
10. Neha keeps the coil exactly the same as in Activity 4.4 but slides the iron nail out, leaving only the coiled wire. Will the coil still deflect the compass? If yes, will the deflection be more or less than before?

11. We have four coils, of similar shape and size, made up from iron, copper, aluminium, and nichrome as shown in Fig. 4.12.



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

Fig. 4.12



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

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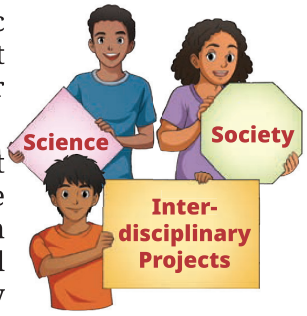
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When current is passed through the coils, compass needles placed near the coils will show deflection.

(i) Only in circuit (a)
(ii) Only in circuits (a) and (b)
(iii) Only in circuits (a), (b), and (c)
(iv) In all four circuits

Discover, design, and debate

- Make coils of turns 25, 50, 75, and 100. Connect them to the same cell one by one. Note the deflection in a magnetic compass placed in the same position in all the cases. Report your observations. Draw conclusion of the effect of number of turns of the coil on the strength of the electromagnet.
- Take two thin nichrome wires of equal length and different thickness (approximately one of these wire thickness to be double of the other, say 0.3 mm and 0.6 mm). Connect them one by one in a circuit which has a switch and a cell, and allow the current to flow for 30 s in each case. Momentarily touch these wires. Which wire heats up more? Now repeat the same activity with two nichrome wires of same diameter but of different lengths. Prepare a brief report of your activity.
- Try to make an electric cell using various fruits and vegetables. Also try with electrodes of different metals. Prepare a brief report.



A step further

Even when a battery stops working, it is not completely 'dead'. It could still contain materials like acids, and metals like lead, cadmium, nickel, or lithium, which may cause fires, or be harmful for the environment if the battery is thrown in regular garbage. Further, many materials used in these batteries are valuable and could be recycled and reused. These days, there are many places with special 'e-waste' recycling facilities, where used batteries can be disposed of. If you are not sure, ask your teacher. Recycling batteries is good for the planet and the people.



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Exploring Forces

5

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Probe and ponder

- Why does it feel harder to pedal a bicycle when going uphill than on flat ground?
- Why is it easier to slip on a wet surface?
- Why do we feel 'light' or like we are 'floating' just after our swing reaches its highest point and begins to come down?
- Share your questions

_____

_____ ?



It was a windy day. Sonali and Ragini were excited to go cycling. Their summer vacation had just begun, and they wanted to **explore** the beautiful landscapes around their village. After pumping air into their bicycle tyres, they set off. As they rode through the village, the wind rushed past them. "Oh no! The wind is pushing me hard!" said Ragini. Smiling, Sonali replied, "We are riding against the wind. We must push our pedals harder to move faster."

Their ride took them up a long path to a hilltop. Some parts of the road were rough where they found it hard to pedal, while other parts were smoother. When they reached the top and were enjoying the view, they heard thunder and saw flashes of lightning at a distance. Even though it looked beautiful, they decided to head back immediately. On the way back, while passing a herd of sheep, they pressed their bicycle bells and turned the handles to change direction.

As they were coming down the slope of the hill, they realised that their bicycles were moving down at a great speed even though they were not pedalling! Sonali yelled, "It's thrilling! It seems something is pulling us downhill, what could it be?"

5.1 What Is a Force?

Let us try to experience the push and the pull.

Activity 5.1: Let us explore

- Take a large cardboard box.
- Try moving the box in as many different ways as you can think of.

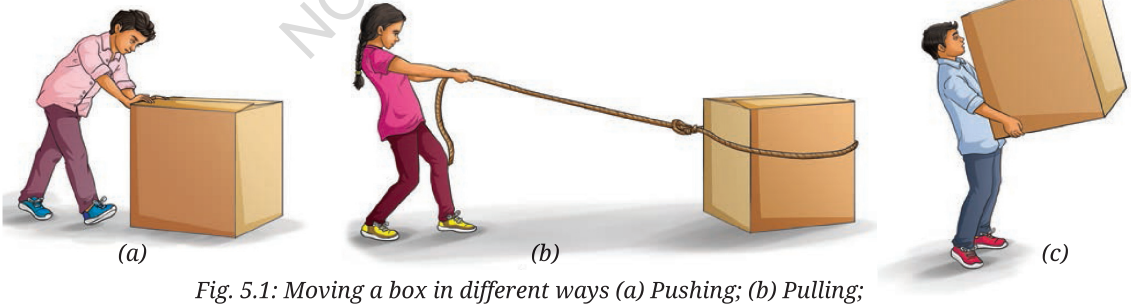


Fig. 5.1: Moving a box in different ways (a) Pushing; (b) Pulling; (c) Lifting (pulling up), and carrying

Did you move the box in any other way than shown in Fig. 5.1? In all the ways that you might have used to move the box, you had to apply a push or pull to the box. Generally, the push or pull applied on an object is called force in science.

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5.2 What Can a Force Do to the Bodies on Which It Is Applied?

We experience push or pull in our daily lives all the time, often without even realising it. Let us recall some of these experiences and **analyse** them.

Activity 5.2: Let us analyse

- **Think** of situations where a force (push or pull) is applied and list them in Table 5.1.
- Analyse each situation and write the effect of the force in Table 5.1. Some situations and their effects are already listed for you.

Table 5.1: Different actions and their effects

S.No.	Action	Push/Pull	Effect
1.	Your friend holding your moving bicycle from behind to stop it	Pull	Stopping or decreasing the speed of the bicycle
2.	Hitting a moving ball with a bat	Push	Changing the direction of a moving ball
3.	Pressing an inflated balloon	Push	Change in shape of the balloon
	.....	.....	.....

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What do you **conclude** from these examples? Does a force cause a moving object to stop? Can it change speed, or direction of motion, or change the shape of an object?

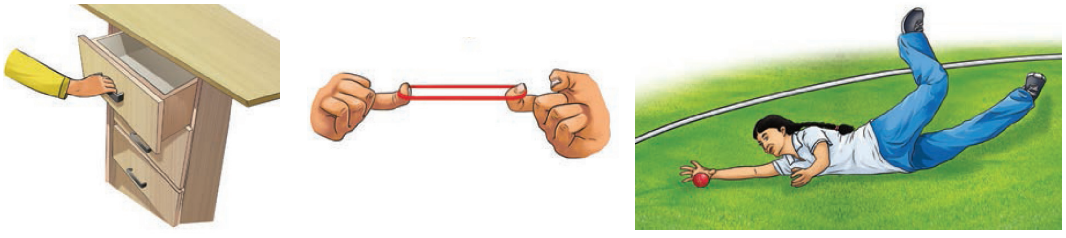


Fig. 5.2: Applying force on objects

In everyday life, we come across many situations where a force is applied, for example, opening a drawer, stretching a rubber band, a fielder stopping a ball, kicking a football, applying brakes on a moving bicycle, rolling a chapati, or turning the steering handle of an autorickshaw. What effect can the application of force have on objects?

The force applied on an object may

- make an object move from rest.
- change the speed of an object if it is moving.
- change the direction of motion of an object.
- bring about a change in the shape of an object.
- cause some or all of these effects.



Does this mean that whenever there is a change in speed or direction, or change in shape, a force is acting on the object?

Yes, none of these take place without the action of force.



A step further

Suppose an object is at rest. Does it mean that no force is acting on this object? It means that the forces acting on the object are balancing one another. You will learn about balanced forces in higher grades.



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5.3 Are Forces an Interaction Between Two or More Objects?

When you push a table, your hand is one object applying force on another object—the table. Here, we say that your hand and the table are two objects interacting with each other.

Think of all the actions listed in Table 5.1. How many objects are involved in each of the actions? Do you **notice** that forces result only when two objects are interacting in some way or the other? From these examples, we can **infer** that at least two objects must interact for a force to come into play.

A **force** is a push or pull on an object resulting from the object's interaction with another object. The **SI unit of force is newton** (written with a small 'n') and its **symbol is N**.



A step further

When you pushed the table with your hand, did you feel a force on your hand too? The moment you stopped pushing, the force on your hand disappeared. Whenever two objects interact, each object experiences a force from the other. As soon as the interaction ceases, the two objects no longer experience the force.

5.4 What Are the Different Types of Forces?

5.4.1 Contact forces

In many situations, we find that to apply a force on an object, physical contact is necessary between our body and the object. This contact can be direct, such as using our hands or other body parts, or indirect, such as using a stick or rope. Forces of this type which act only when there is physical contact between the objects are called **contact forces**.

Muscular force

An example of contact force is muscular force. When we perform any physical activity, such as walking, running, lifting, pushing, jumping, or stretching, the force is caused by the action of muscles in our body. The force resulting due to the action of muscles is known as muscular force. **Muscular force** occurs when muscles contract and elongate while doing any activity.

Animals, birds, fish, and insects use muscular forces for movement and survival.



Fig. 5.3: Use of muscular force by living beings

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Humans used the muscular force of some animals to carry out many tasks for a long time.





Fig. 5.4: Use of muscular force of animals to assist with human tasks

Ever heard of ...

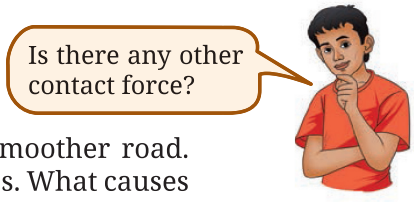
Muscular force plays an important role in many functions inside our body too. This force helps us chew food and push it through the alimentary canal during the process of digestion. The expansion and contraction of our heart muscles allows the blood to circulate in our body—a process essential for survival.



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Friction

A ball rolling on a flat ground stops on its own after some time. If we stop pedalling our bicycle on a flat road, it slows down and comes to a stop. If the road is rough, it stops sooner than on a smoother road. You must have come across many such experiences. What causes the change in the speed of objects in such situations? We have learnt earlier that a force is essential to change the speed of an object. However, in all these situations no force appears to be acting on the objects, yet their speed gradually decreases and they come to a stop after some time. Is it possible that some force is indeed acting on them? Which force is that?



Activity 5.3: Let us investigate

- Take an object with a flat base (such as an empty lunch box/ geometry box/ a notebook) and place it on a table or floor.
- Gently push it and **observe**. Does it stop after travelling some distance? Is there a force acting on it which brings it to rest?
- Now repeat by pushing the object in the opposite direction. Does it stop again after travelling some distance?



Fig. 5.5: Friction acts between two surfaces and opposes the motion of the object.

On pushing, the object stops after sliding a certain distance. This must be due to a force acting between the surfaces of the sliding object and the table or floor which are in contact. This force must be acting on the object in a direction opposite to its direction of motion. This force is what brings the object to a stop.

The force that comes into play when an object moves or tries to move over another surface is called the **force of friction** or simply **friction**. Friction always acts in a direction opposite to the direction in which the object is moving or trying to move. The force of friction is a contact force since it arises due to two surfaces in contact.

Friction arises due to the irregularities in the two surfaces in contact. Even surfaces which appear smooth, have a large number of minute irregularities (Fig. 5.6). When placed in contact, the irregularities of two surfaces lock into each other and oppose any effort to move one surface over the other.



Does this mean that the force of friction will be greater if the surfaces are rough?

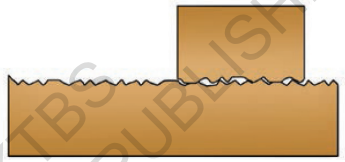


Fig. 5.6: Friction between two surfaces due to irregularities

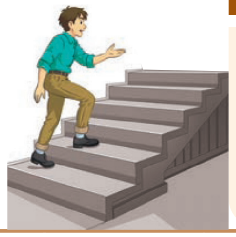
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Activity 5.4: Let us explore

- Try Activity 5.3 again, but this time place the same object on different surfaces, such as glass, cloth, wood, ceramic tile, and sand.
- Does the object stop after travelling the same distance as in Activity 5.3?
- Does the object stop at the same distance on all surfaces?

For different surfaces, the object stops after moving different distances so we can say that the force of friction depends upon the nature of the surfaces in contact. Friction is greater on rough surfaces.

A step further



Does the force or friction act only if the objects are moving on solid surfaces? What about objects moving through liquids and gases? Air, water, and other liquids also exert force of friction on the objects moving through them. Hence the objects, such as aeroplanes, ships, boats, or high-speed trains are designed with specific shapes to reduce the force of friction due to the air or water around them.



Is it essential for an object applying force on another object to always be in contact with it?

5.4.2 Non-contact forces

There are forces whose effect can be experienced even if the objects are not in contact. These forces are called **non-contact forces**. Let us learn about non-contact forces.

Magnetic force

Do you remember learning about magnets in the chapter 'Exploring Magnets' in *Curiosity*, Grade 6? We learnt that a magnet attracts objects made of magnetic materials. When two magnets are brought close to each other, like poles (North–North, South–South) repel each other while unlike poles (North–South) attract each other. In an earlier chapter of this book, we also learnt about electromagnets which behave like magnets. Attraction and repulsion between objects are also a form of push and pull, that is, a force. Can you recall that a magnet could exert force on another magnet or a magnetic material without being in contact with it?

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Activity 5.5: Let us test

- Take two ring magnets and a wooden stick.
- While holding the stick in a vertical position over a wooden table, insert one ring magnet onto the stick (Fig. 5.7).
- Now insert the second ring magnet above it such that the like poles of the two magnets face each other. Does the second magnet stay floating above the first magnet?
- Try pushing the second magnet down gently. Do you feel a force on it?
- Now, reverse the poles of both the magnets. Does the second magnet still remain floating?



Fig. 5.7: Force between two ring magnets

We find that a magnet can exert force on another magnet without being in contact with it.

The force exerted by a magnet on another magnet or a magnetic material is called **magnetic force**. Since a magnet can exert a force from a distance without being in contact it is called a non-contact force.

Are there more such forces which act from a distance?

Activity 5.6: Let us experiment



Fig. 5.8: Charged plastic scale attracting small paper pieces

- Take a plastic scale or a plastic straw, a piece of polythene, and small pieces of paper.
- Rub plastic scale/straw vigorously with polythene.
- Do not touch the rubbed part with your hand or any metal object.
- Now, bring it close to the small pieces of paper placed on a table, taking care not to touch the paper pieces (Fig. 5.8). Do you notice something surprising?

The paper pieces get pulled towards the plastic scale/straw and stick to it when it is brought close to paper pieces. Why does this happen?

When two objects of certain materials are rubbed together, electrical charges build up on their surfaces. These charges are called **static charges** as they do not move by themselves. The object that acquires static charges is said to be a **charged object**. A charged object attracts, that is, exerts a force on uncharged objects made of certain materials, such as small pieces of paper. This force comes into play even when the bodies are not in contact.

Let us do another activity with objects made of different materials.

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Activity 5.7: Let us experiment

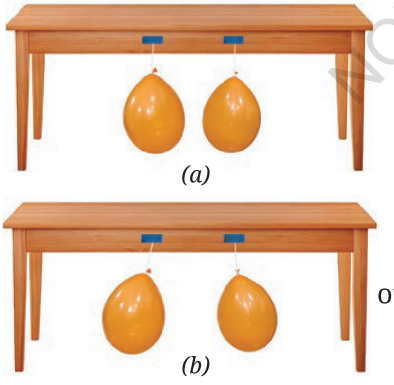


Fig. 5.9: (a) Two uncharged balloons; (b) Two charged balloons repelling each other

- Take two balloons, a length of thread, and a woollen cloth.
- Inflate two balloons and hang them in such a way that they do not touch each other as shown in Fig. 5.9a.
- Rub both balloons with the woollen cloth and release them. Be careful not to touch the rubbed balloons with your fingers. What do you observe?

We observe that the balloons move away from each other as if they are repelling each other (Fig. 5.9b).

- Now bring the woollen cloth used for rubbing the balloons close to one of the rubbed balloons. What happens?

They move towards each other as if they are attracting each other. What do we infer from these observations?



We found that the two similarly charged balloons repel each other whereas a charged balloon and the woollen cloth (with which the balloon was rubbed) attract each other. Does this **indicate** that the charge on the balloon is of a different kind from the charge on the woollen cloth?

Since the balloons were charged in the same way, we can say that they have acquired similar charges. As the similarly charged balloons repelled each other, we can infer that similar (like) charges repel each other. Both the rubbing object and the rubbed object get charged but they acquire opposite kind of charges. Their attraction shows that opposite kind (unlike) of charges attract each other. The two kinds of static charges are said to be 'positive' and 'negative'.

The force exerted by a charged body on another charged body or an uncharged body is called **electrostatic force**. It is a non-contact force.

A step further

When the charges move, they constitute an electric current in an electrical circuit. It is the same current which makes a lamp glow or generates a heating effect or a magnetic effect.



Gravitational force

Activity 5.8: Let us observe

- Take a ball and throw it vertically upwards. Does it come down?
- Now throw it again, but this time harder. Does it still fall back down to the ground?

Think about different situations around you where any object thrown up in any direction, finally falls or comes back to the ground or floor.



Fig. 5.10: Some objects falling towards the Earth

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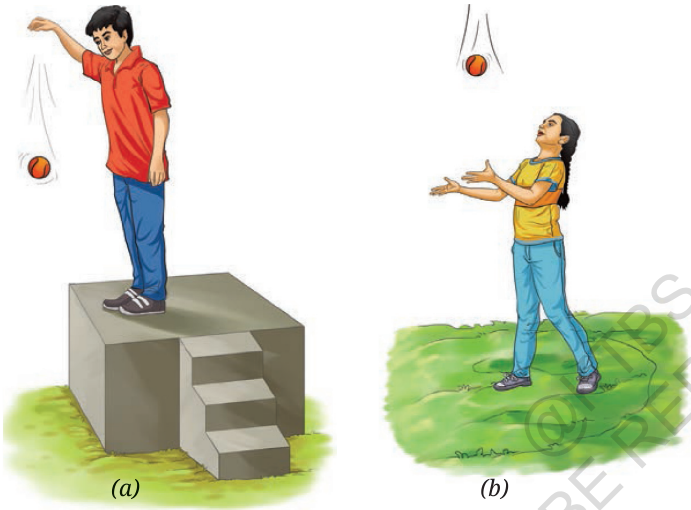


Why do all the objects fall towards the Earth?

Is there any force which acts on them? What exerts this force?



Since all the objects fall towards the Earth, it means the Earth attracts (pulls) them. The force with which the Earth attracts objects towards itself is called the **gravitational force**. The gravitational force exerted by the Earth is also called **force of gravity** or simply **gravity**.



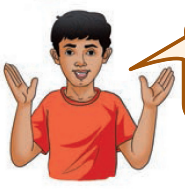
(a) (b)

Fig. 5.11: (a) Dropping an object from a height; (b) Throwing an object vertically upwards

Since the gravitational force acts without contact with the object it attracts, it is a non-contact force. Gravitational force is always an attractive force, unlike magnetic force or electrostatic force, which can either be attractive or repulsive.

You might have noticed that when an object is dropped from a height, it takes a straight vertical path downwards before touching the ground (Fig. 5.11a). When an object is thrown vertically upwards, the object moves up straight, slows down, stops momentarily at the top, and then takes a straight vertical path downwards (Fig. 5.11b).

While going up, the speed of the object goes on decreasing till the object comes to a stop, its direction of motion changes and while coming down the speed goes on increasing. We say that the object undergoes a **vertical motion** when it moves in a vertical direction under the influence of the gravitational force.



Does the Earth pull every object with equal force?

5.5 Weight and Its Measurement

The force with which the Earth pulls an object towards itself is called the **weight** of the object. The weight measures how strongly an object is pulled by the Earth. Since the weight is a force, it is measured in the same unit as that of force. Therefore, **SI unit of weight** is also **newton (N)**.

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Let us now try to find out if the Earth pulls every object with equal force.

Activity 5.9: Let us explore

- Take a spring and a few objects of different masses, such as a pencil box, a tiffin box, and a small stone.
- Hang one end of the spring from a nail. From the other end, hang an object and observe the spring. Does the spring stretch?
- Now hang the other objects, one by one and notice the stretch in the spring each time. Is the stretch caused by each object the same?

When an object is hung from a spring, the spring stretches due to the force applied on the object by the Earth. We find that the stretch caused in the spring is different for different objects. This indicates that the Earth pulls different objects with different forces, that is, the weight of different objects is different. Can we use the spring to measure the weight of an object?

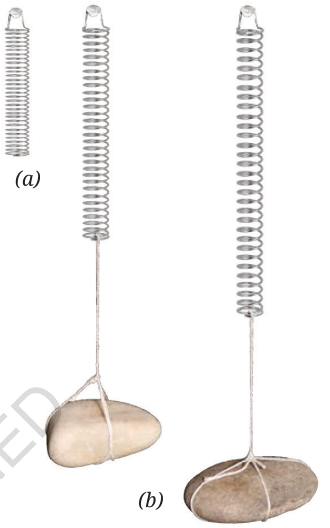


Fig. 5.12: (a) A hanging spring; (b) Two different objects hung from the spring

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A step further

A spring balance is a simple device used to measure weight (force). It consists of a spring fixed at one end, with a hook attached at the other end. When we hang an object from the hook, the spring stretches, and the amount of stretching gives the weight of the object. There is a scale on the balance which is marked to show the weight (force) in newton. Usually, there is also another scale to show the corresponding values of mass in gram (g). These values have been marked with the assumption that the spring balance is used on the Earth, with the Earth's gravitational force attracting the object.



Let us learn to measure the weight using a **spring balance**. But first, let us familiarise ourselves with a spring balance the way we did with thermometer earlier (in the chapter 'Temperature and Its Measurement' in *Curiosity*, Grade 6).

Activity 5.10: Let us observe

- Look at the spring balance shown in Fig. 5.13 carefully. What is the maximum weight it can measure?

The maximum weight it can measure is 10 N. Thus, this scale has a range of 0 to 10 N.

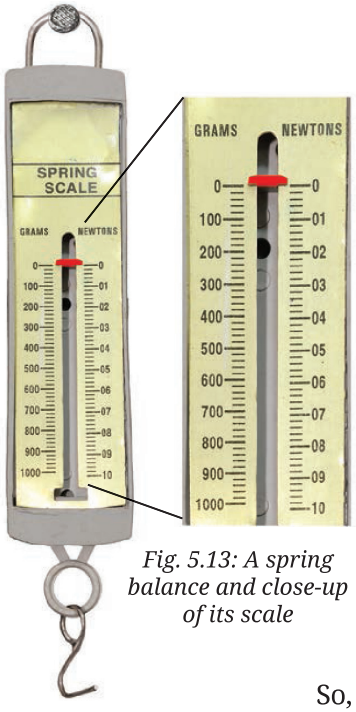


Fig. 5.13: A spring balance and close-up of its scale

Let us now try to find the smallest value of weight that can be measured by the spring balance.

Activity 5.11: Let us calculate

- Look at the spring balance shown in Fig. 5.13 and note down the following:
  - How much is the weight difference indicated between the two bigger marks?

  The weight difference indicated between 0 and 01 N or between 01 N and 02 N is 1 N.
  - How many divisions (shown by smaller marks) are there between these two bigger marks?

  There are 5 divisions between these marks.
  - How much weight does one small division indicate?

  One small division can read $\frac{1\text{ N}}{5} = 0.2$ N.

So, the smallest value that the spring balance can read is 0.2 N.

Now using this method, calculate the smallest value of weight that can be measured with the spring balance given to you. Your school laboratory may have spring balances for which the range and the value of the smallest division may be different. It is, therefore, always necessary to look carefully at the spring balance (or any other instrument) you are about to use.

Let us now learn how to **measure** weight using a spring balance.



Fig. 5.14: Object suspended from a spring balance

Activity 5.12: Let us measure

- Take a spring balance and a few objects. Keep in mind that the objects should not be heavier than the maximum value of weight the spring balance can measure, otherwise it may get damaged.
- Suspend the objects one by one from the hook (Fig. 5.14). Read the scale for weight carefully and record your observations in the Table 5.2.

Table 5.2: Measuring weight using a spring balance

S.No.	Object	Weight (N)
1.	Pencil Box	
2.	Partially filled water bottle	

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You can repeat Activities 5.10 to 5.12 for the mass scale shown on the left side on the spring balance (Fig. 5.13) to measure the mass of an object.

A step further

The mass of an object can be measured indirectly by measuring its weight (using a spring balance) or by comparing its weight with the weight of an object of a known mass (using a beam balance). Since the weight of an object remains almost the same everywhere on the Earth, so for all practical purposes it is acceptable to weigh an object to find its mass.





As we have learnt earlier (in the chapter 'Materials Around Us' in *Curiosity*, Grade 6), mass is the amount of matter in an object and is measured in grams (g) or kilograms (kg). Its value remains the same at every place. Weight, on the other hand, is the gravitational force with which the Earth (or another planet) pulls an object. Since gravitational force can vary very slightly from place to place on the Earth (and can be very different on different planets), weight can change, but mass does not.

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A step further

The gravitational force of different planets on an object is different. Thus, the weight of an object is different on different planets, as shown in the following table, even though its mass remains the same.

Planet	Earth	Moon	Mars	Venus	Jupiter
Mass of the object	1 kg	1 kg	1 kg	1 kg	1 kg
Weight of the object	10 N	1.6 N	3.8 N	9 N	25.4 N



A step further

In everyday life, particularly for the goods we commonly use, we are more interested in the amount of matter in an object (its mass), rather than the force applied by the Earth upon it (its weight). However, though while the units of mass are used, instead of the term mass, the term weight is typically used. For example, it is said that the weight of the wheat bag is 10 kg. But in scientific use, this is not correct and it is important to use the correct terms with their correct units, even if every day language is more casual.



5.6 Floating and Sinking



If we place some objects on water, some of them float, while others fall to the bottom. The gravitational force of the Earth is acting on all objects, then why don't all objects fall to the bottom?

While taking out water from a bucket filled with water using a mug, do you notice that the mug feels lighter when it is inside water? Let us try to **understand** this.

Activity 5.13: Let us investigate

- Take an empty plastic bottle (with its lid closed tightly) and a bucket full of water.
- Push the bottle in the water (Fig. 5.15). Do you feel an upward push? Release the bottle. Does it bounce up?



Fig. 5.15: Plastic bottle in water

You would have felt an upward push and the bottle bounces back to the surface of the water. This indicates that water applies a force on the bottle in the upward direction. In fact, all liquids apply a similar force. The force applied by a liquid on an object in the upward direction is known as **upthrust** or **buoyant force**.

When an object is placed in a liquid, the gravitational force due to the Earth acts on it downwards. But a buoyant force is applied on it by the liquid in the upward direction. If the gravitational force is more than the buoyant force, the object **sinks**, but if the two forces are equal, the object **floats**. One of the factors on which the buoyant force depends upon, is the density of the liquid. You will learn about density in a later chapter of this book.

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A step further

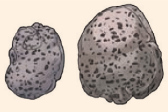


Archimedes, a famous Greek scientist, discovered that when an object is fully or partially immersed in a liquid, it experiences an upward force which is equal to the weight of the liquid it displaces. This is known as Archimedes' Principle. If the weight of a liquid displaced by an object is smaller than the weight of the object, the object will sink in the liquid. If the weight of the liquid displaced is equal to the weight of the object, the object will float in the liquid.

Ever heard of ...



There are some rocks which can float on water. One such rock is Pumice, which is formed during volcanic eruptions. When lava with lots of gas and water vapour cools quickly, it traps tiny bubbles of gas inside. This creates a light, porous rock— filled with air pockets which is less dense than water and floats on it.



Snapshots



- A force is push or pull on an object resulting from the object's interaction with another object.
- The SI unit of force is newton and its symbol is N.
- Forces can act with or without contact.
- Muscular force and frictional force are some of the examples of contact forces.
- Magnetic force, gravitational force, and electrostatic force are non-contact forces.
- Force can change an object's speed, direction of its motion, or both. Force can change the shape of an object.
- The force which comes into play when an object moves or tries to move over another surface, is called force of friction or simply friction. It acts in a direction opposite to the direction in which the object is moving or trying to move.
- The force exerted by a magnet on another magnet or a magnetic material is called magnetic force.
- The force exerted by a charged body on another charged body or uncharged body is called an electrostatic force.
- The force with which the Earth attracts objects towards itself, is called the gravitational force. It is always an attractive force.
- The force with which the Earth pulls an object towards itself is called the weight of the object. The SI unit of weight is newton (N).
- The mass of an object remains unchanged whereas its weight may vary from place to place.
- When an object is placed in a liquid, the force applied by a liquid on an object in the upward direction is known as upthrust or buoyant force.

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Keep the curiosity alive

1. Match items in Column A with the items in Column B.

Column A (Type of force)		Column B (Example)	
(i)	Muscular force	(a)	A cricket ball stopping on its own just before touching the boundary line
(ii)	Magnetic force	(b)	A child lifting a school bag
(iii)	Frictional force	(c)	A fruit falling from a tree
(iv)	Gravitational force	(d)	Balloon rubbed on woollen cloth attracting hair strands
(v)	Electrostatic force	(e)	A compass needle pointing North

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

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2. State whether the following statements are True or False.
   (i) A force is always required to change the speed of motion of an object.
   (ii) Due to friction, the speed of the ball rolling on a flat ground increases.
   (iii) There is no force between two charged objects placed at a small distance apart.
3. Two balloons rubbed with a woollen cloth are brought near each other. What would happen and why?
4. When you drop a coin in a glass of water, it sinks, but when you place a bigger wooden block in water, it floats. Explain.
5. If a ball is thrown upwards, it slows down, stops momentarily, and then falls back to the ground. Name the forces acting on the ball and specify their directions.
   (i) During its upward motion
   (ii) During its downward motion
   (iii) At its topmost position
6. A ball is released from the point P and moves along an inclined plane and then along a horizontal surface as shown in the Fig. 5.16. It comes to stop at the point A on the horizontal surface. Think of a way so that when the ball is released from the same point P, it stops (i) before the point A (ii) after crossing the point A.

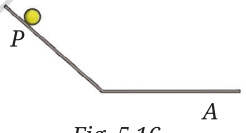
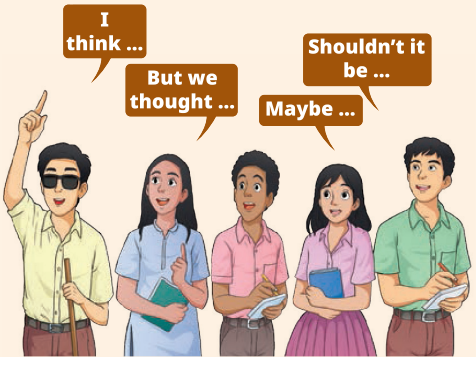


Fig. 5.16

7. Why do we sometimes slip on smooth surfaces like ice or polished floors? Explain.
8. Is any force being applied to an object in a non-uniform motion?
9. The weight of an object on the Moon becomes one-sixth of its weight on the Earth. What causes this change? Does the mass of the object also become one-sixth of its mass on the Earth?

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

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10. Three objects 1, 2, and 3 of the same size and shape but made of different materials are placed in the water. They dip to different depths as shown in Fig. 5.17. If the weights of the three objects 1, 2, and 3 are w_1, w_2, and w_3, respectively, then

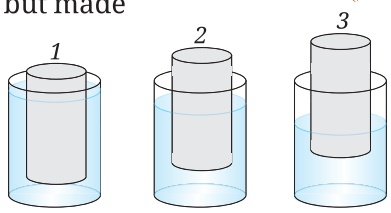
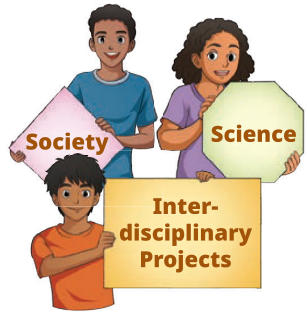


Fig. 5.17

(i) $w_1 = w_2 = w_3$
(ii) $w_1 > w_2 > w_3$
(iii) $w_2 > w_3 > w_1$
(iv) $w_3 > w_1 > w_2$

Discover, design, and debate



- Collect objects made of different materials, such as plastic, wool, silk, rubber, polythene sheet, paper, and metals. Rub one material with another and check if it attracts small pieces of paper or not, that is, whether it gets charged or not. Record your observations in a systematic manner and write a research paper.
- Imagine a scenario where the gravity disappears. Develop a story. Create a cartoon strip to present your story.
- Organise a discussion in your class on the topic: Friction—a necessity or a problem? Make a note of the discussion and state where friction is a necessity and when it is a problem.
- Make your own spring balance with the help of your teacher and calibrate it using standard weights. Now measure the weights of different objects and calculate the ratio of the weight and mass of different objects. Do you observe a pattern?
- An electroscope is a device which can determine whether an object is electrically charged. You can make your own electroscope (Fig. 5.18) in your class with the help of your teacher, test the device. Explore in what other ways you may use this electroscope.

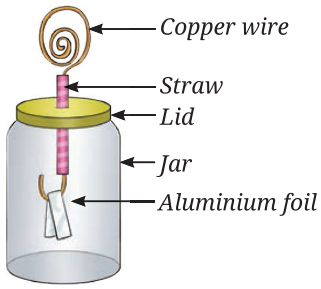


Fig. 5.18

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6

Pressure, Winds, Storms, and Cyclones

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Probe and ponder

- Why are winds stronger on some days than on others?
- Why are water tanks usually placed at a height?
- Can air pressure really crush us?
- What causes storms and cyclones? If the Earth stopped rotating, would cyclones still form?
- Share your questions

_____

_____ ?



You must have observed fallen leaves on the ground swirling in the air or being swept away, and trees swaying or even bending when a strong wind blows. Have you ever wondered why fallen leaves rise in the air or trees sway or bend? Does the wind exert force on fallen leaves to make them rise or on trees to bend? Recall other similar effects of the force exerted by wind like slamming of doors or rattling of windows, or fluttering of clothes? How does the force exerted by wind make this happen? The force exerted by wind creates wind pressure which causes these effects. In this chapter, we will **explore** the relationship between force and pressure, and understand how they shape powerful natural events like thunderstorms and cyclones.

6.1 Pressure

Megha and her brother Pawan are going on a picnic. They walk to the picnic spot, carrying identical items in their bags (Fig. 6.1). On the way, Pawan keeps adjusting his bag, and looks uncomfortable. Megha asks, "Is there a problem with your bag?" Pawan responds, "Yes, it is hurting my shoulders." Megha says, "Both our bags are equally heavy. Why does your bag hurt, and mine doesn't?" Pawan reflects for a minute and says, "Perhaps, it is because of the difference in the straps of our bags. My bag has narrow straps while your bag has broad straps."



Fig. 6.1: Megha and Pawan carrying their bags

Can the shape or size of the straps really make a difference? Let us try to find out.

When we carry a bag, we feel its weight because of the force of gravity acting on our shoulders. The weight of the bag with **narrow straps** acts on a **smaller area** of our shoulders, whereas the weight of the bag with **broad straps** is spread out over a **larger area** of our shoulders. It is due to this reason that we feel more comfortable carrying a bag with broader straps than one with narrow straps, although both bags have the same weight. Since the area over which the force acts is involved, we define a quantity called **pressure**, which is the **force per unit area**.

So,

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$

At this stage, we will consider only those forces which act perpendicular to the surface on which the pressure is to be computed.

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Fig. 6.2: Buckets with broad and narrow handles

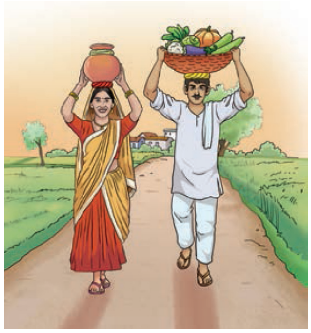


Fig. 6.3: Persons carrying loads

Broad straps reduce the pressure exerted by the bag on our shoulders as compared to narrow straps. Therefore, we feel more comfortable carrying a bag with broad straps.

Can you now understand why it feels easier to lift a water-filled bucket with a broad handle than with a narrow handle (Fig. 6.2)? Similarly, we have seen that when people carry loads like pots or vegetable baskets on their heads, they often place a round piece of cloth under the loads (Fig. 6.3). In both cases, the objective is to reduce pressure by increasing the area over which the weight acts.

Pressure is defined as the force per unit area. The **SI unit** of **force** is **newton** and that of **area** is **metre²**. Therefore, the **SI unit** of **pressure** is **newton/metre²** **(N/m²)**. This unit is also called a **pascal**, denoted by **Pa**.

If a force of 100 N is applied on a cardboard of area 2 m², then the pressure applied on the cardboard will be:

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}} = \frac{100\ \text{N}}{2\ \text{m}^2} = 50\ \text{N/m}^2$$

There are many situations in daily life where pressure plays a role. **Conduct** the activities given in Table 6.1 and **record** your observations. **Explain** how pressure influences the mode of action undertaken for each activity.

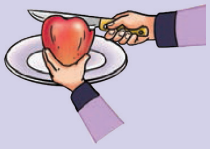
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Safety first

The activities listed in Table 6.1 should be conducted under the supervision of an adult.

Table 6.1: Record your observations

Activity	Modes of action		Easy or difficult to perform? Give reasons.
Driving an iron nail	 By the head of the nail	 By the pointed end of the nail	
Cutting an apple with a knife	 Using the sharp edge of the knife	 Using the blunt edge of the knife	

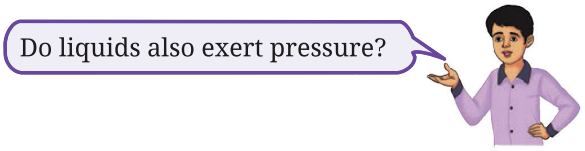
What can you **conclude** from your observations in Table 6.1?

We conclude that when the area over which a force applied is smaller, the resulting pressure is higher, making it easier to do certain tasks. This is why it is easier to drive a nail using its pointed end, and it is easier to cut an apple with the sharp edge of a knife.

You must have seen overhead water tanks (Fig. 6.4) in your locality, or on the rooftops of houses used for water supply. Why are these tanks always placed at a height?



Fig. 6.4: Overhead tank



Let us find out by conducting the following activity.

Activity 6.1: Let us try and find out

- Take two transparent glass or plastic pipes of the same length (about 25 cm), but of different diameters, as shown in Fig. 6.5.
- Take two good-quality rubber balloons. Attach them to one end of each pipe.
- Clamp the pipes on a stand as shown in Fig. 6.5.
- Now, fill both the pipes with water up to the same level about halfway.
- **Observe** what happens to the balloons.
- Do both balloons bulge? Do they bulge to the same extent?

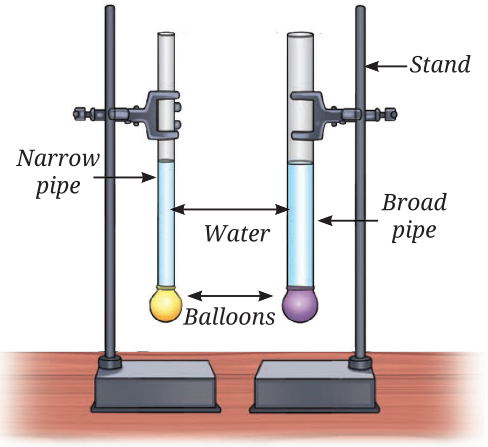


Fig. 6.5: Equal heights of water columns produce same bulge in balloons

What can you **infer** from this activity? You must have observed that the two balloons bulge to the same extent. Why is it so? Notice that because of the different diameters, the weight of water in the two pipes is different. However, the bulge in both the balloons is the same. This means that the weight of water in the pipes could not be responsible for the extent of the bulge of the balloons.

Could it be that the water column is exerting pressure? Yes, it is the pressure exerted by the water column which is responsible for the bulge. That is why equal water column heights produce equal bulges in the balloons, despite their different diameters.

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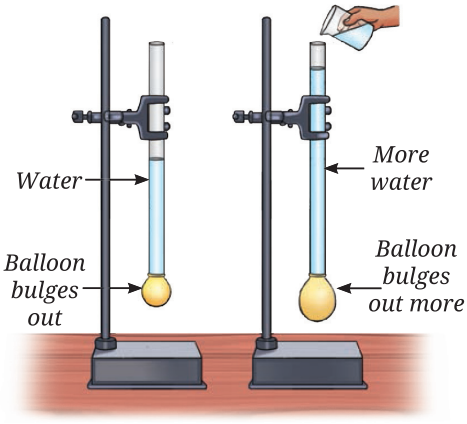


Fig. 6.6: Higher heights of water column produce bigger bulge of the balloon



What will happen to the bulge of the balloon if we increase the height of the water column?

Pour some more water in any one of the pipes used in Fig. 6.5. Observe the bulge of the balloon. Repeat this process a few times, adding more water each time and noting the extent of bulge as shown in Fig. 6.6.

Do you see any relation between the amount of bulge of the rubber balloon and the height of the water column in the pipe? You must have observed that the bulge of the balloon increases as the height of the water column increases.

Thus, as the height of the water column in the pipe increases, the pressure at the bottom of the pipe also increases, which causes the balloon to bulge more. So, we can say that the pressure exerted by a liquid in a vessel depends on the height of its column. This is the reason why overhead tanks are placed at a height so that the pressure in the taps is increased, resulting in a good stream of water from the taps.

Suppose you are living on the second floor of a three-storeyed building and an overhead water tank is placed on the top floor. Will you or your friend on the first floor receive a more powerful stream of tap water? Give reasons.

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Do liquids also exert pressure on the walls of the container? Let us find out by conducting the following activity.

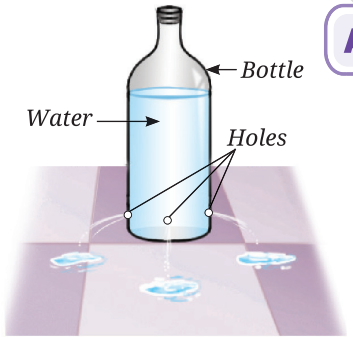


Fig. 6.7: Liquid exerts pressure on the wall of the container

Activity 6.2: Let us find out

- Take a used plastic bottle and remove its cap. Make four small holes near the bottom around the sides using a needle or a nail. Make sure that the holes are at the same height from the bottom as shown in Fig. 6.7. (If you find it difficult to make a hole, you can slightly heat the needle and poke it to make holes.)
- Seal the holes with a tape and fill the bottle with water.
- Now, remove the tape from all holes at the same time.
- What do you observe?

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You observe water flowing out through the holes on the sides of the bottle. What can you infer from this observation? It **indicates** that water also exerts pressure on the sides of a container. Therefore, we can conclude that liquids exert pressure not only at the bottom of the container, but also on its sides. In fact liquids exert pressure in all directions.

You must have seen water spurting out like a fountain from leaking joints or holes in water pipes. Can you explain why this happens? Is it due to the pressure exerted by water on the walls of the pipes?

Ever heard of ...

Do you know that the base of a dam is much broader than the top? This is because a broad base not only supports the structure of the dam, but also withstands the horizontal water pressure near the bottom (Fig. 6.8). The water stored in the dam, exerts pressure horizontally on the side walls of the dam and vertically on the floor due to the height of the water level. The pressure which acts horizontally, is very large near its bottom. Thus, to withstand the pressure, the base of the dam is made broader.

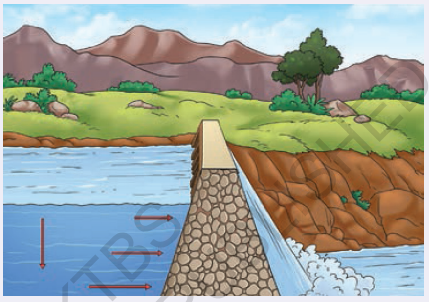


Fig. 6.8: Dam



Let us now try to understand if air also exerts pressure.

6.2 Pressure Exerted by Air

You already know that air is all around us. The envelope of air surrounding the Earth is called **atmosphere**. The atmospheric air contains nitrogen, oxygen, argon, carbon dioxide, and other gases in small quantities. The atmosphere extends up to many kilometres above the surface of the Earth.

Let us find out if the atmosphere exerts pressure by performing the following activity.

Activity 6.3: Let us explore

- Take a paper plate, invert it and attach a stick to it as shown in Fig. 6.9a. Place it on a plain surface.
- Take two identical sheets of chart paper about 70 cm × 56 cm each. Fold one sheet twice and make a hole in the centre of

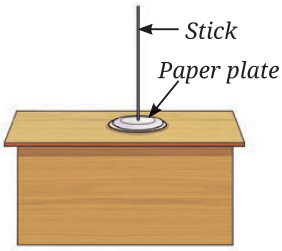


Fig. 6.9: (a) Inverted paper plate setup

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Fig. 6.9: (b) Inverted paper plate with two folds of chart paper



Fig. 6.9: (c) Inverted paper plate with unfolded chart paper

the folded chart paper sheet — big enough for the stick to come out. Place the folded sheet on top of the inverted paper plate as shown in Fig. 6.9b.

- Now, try to lift the paper plate covered with a folded sheet using the stick.
- Observe how much effort is needed to lift it.
- Now, place the second unfolded chart paper sheet in place of the folded sheet. Make a hole at the centre of this chart paper for the stick to pass through. Cover the paper plate with the unfolded chart paper as shown in Fig. 6.9 c.
- Lift the paper plate again and feel the effort needed in doing so.
- In which case is the lifting easier, with the folded or the unfolded chart paper covering the paper plate?

You would have observed that more effort is needed to lift the paper plate when it is covered with the unfolded chart paper, than with the folded chart paper. When we cover the paper plate with unfolded chart paper, the area of the covering sheet increases. The effort needed to lift the paper plate increases. Notice that the weight of the covering sheet has not changed. What can you infer from this? We can infer from these observations that air exerts force on the covering sheet, which makes it difficult to lift the paper plate. Moreover, this force increases with increase in the area of covering sheets. It means that the air is exerting a force on the paper plate, which increases as the area of the sheet covering it increases. As force per unit area is pressure, we can conclude that air exerts pressure on the paper sheet. In fact, air exerts pressure on all objects. The pressure exerted by air around us is known as the **atmospheric pressure**.



Fig. 6.10: A girl blowing a balloon

You must have experienced that when you blow air into a balloon, it gets inflated. Why? This is because the air being filled inside the balloon exerts pressure on the walls of the balloon (Fig 6.10). Can we say that air exerts pressure in all directions? Yes, that is why the balloon expands in all directions. What happens when an inflated balloon is kept without closing its mouth? The air escapes from the balloon. Why does the air escape from the balloon?

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Have you ever wondered how large the atmospheric pressure is? Let us get an idea about its magnitude by performing the following activity.

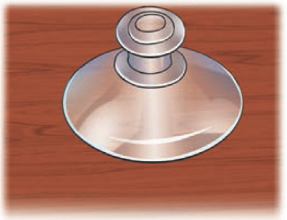


Fig. 6.11: A sucker

Activity 6.4: Let us perform

- Take a good-quality rubber sucker. Press it firmly against a smooth flat surface (Fig. 6.11).
- Do you realise that it sticks to the surface?
- Now, try to pull it off. Do you find it difficult to pull it off?

When we press the sucker, most of the air between its cup and the surface on which it is placed is pushed out and the air pressure inside it is reduced. The sucker sticks to the surface because the pressure of air surrounding the sucker is higher than the pressure exerted by the air inside the sucker. To pull the sucker off the surface, the applied force should be strong enough to overcome the pressure difference between outside the sucker and inside the sucker.

Do you know how large the atmospheric pressure is? The force exerted by the atmospheric air column over an area 15 cm × 15 cm is nearly equal to the force of gravity on an object of mass 225 kg (2250 N). The reason we are not crushed under this weight is that the pressure inside our bodies is also equal to the atmospheric pressure. This balances the pressure exerted from outside. The pressure inside our body is caused by the movement of fluids and gases in tissues and organs of the body.

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A step further

The SI unit of pressure is N/m^2, also known as pascal (Pa). However, the practical unit of air pressure is millibar (mb), which is equal to 100 Pa. Air pressure is also expressed in hectopascal (hPa), which is equal to 100 Pa.



6.3 Formation of Wind

You must have noticed that on some days, the wind blows strongly, whereas on other days, it is calm. Sometimes, wind becomes so strong that it causes damage to life and property.

You must have seen that when an inflated balloon is kept without closing its mouth, the air from the balloon escapes. Recall that when there is a puncture in the bicycle tube, the air escapes and the tube collapses. In both of these cases, does air move from a high pressure region to a low pressure region?



Does the difference in air pressure have anything to do with the formation of winds?

How do winds form?



Let us find out from the following activity.

Activity 6.5: Let us observe

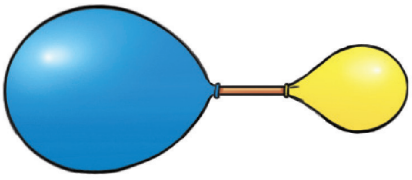


Fig. 6.12: Air moves from a high pressure region to a low pressure region

- Take two similar balloons made of thin rubber, and a drinking straw.
- Insert one end of the straw into one balloon and secure it with a rubber band or thread.
- Now inflate the second balloon and hold its mouth with your fingers, so that air does not escape.
- Insert the free end of the straw into the neck of the inflated balloon and secure it with a rubber band or thread. Make sure that the air does not leak from the balloon as the straw is inserted in it. Now you have one end of the straw inside the inflated balloon and the other end inside the uninflated balloon as shown in Fig. 6.12.
- **Predict** what would happen to the balloons.
- Observe what happens to both the balloons. Did it happen as predicted?
- Do you observe any change in the size of the balloons? Write down your observations.

.....

What can be the reason for the change in the sizes of the balloons? The air pressure in the inflated balloon is higher than that in the uninflated balloon. As a result, some air moves from the inflated balloon to the uninflated balloon, resulting in changes in the size of both the balloons.

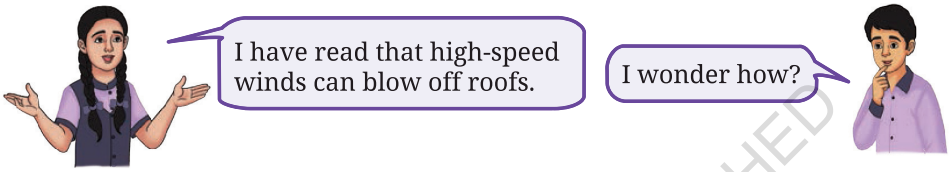
Do you notice that after some time both the balloons attain almost the same size and the flow of air stops? Why does the air flow stop? The flow of air continues till the air pressure in the inflated balloon is higher than the air pressure in the uninflated balloon. The air flow stops when the pressure in both balloons becomes equal. At this stage, both balloons are almost of the same size. Thus, we can conclude that air moves from a region of high air pressure to a region of low air pressure.

You can relate this conclusion to the directions of the sea breeze and land breeze, which you studied in *Curiosity*, Grade 7. As land gets heated faster than water during the day, the air above the land

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becomes warmer and lighter. Hence, it rises, creating an area of low pressure. The air from the high pressure region of the sea blows to the low pressure region which develops on the land, resulting in a sea breeze. At night, the water is warmer than the land. Therefore, a low pressure area develops above the sea. As a result, wind blows from the land to the sea, giving rise to land breeze. Thus, the phenomenon of land breeze and sea breeze is mainly due to the pressure differences over the land and the sea.

If we could measure the speed of the escaping air in Activity 6.5, we would find that the speed of the air is higher if the pressure difference is higher.



6.4 High-Speed Winds Result in Lowering of Air Pressure

Activity 6.6: Let us observe

- Take two balloons of the same size.
- Inflate both balloons and tie strings to them.
- Hang the two balloons from a stick, leaving a gap of 6–10 cm (Fig. 6.13).
- Now, blow air into the narrow space between the balloons.
- What happens to the balloons? Note down your observations.
- Now blow harder and observe.



Fig. 6.13: Blowing between two balloons

When you blow between the two balloons, you observe that they move towards each other. This happens because when you blow air between the balloons, a low pressure area is created between them. The higher air pressure surrounding the balloon pushes them towards each other. You must have observed that blowing harder increases the speed at which the balloons approach each other. What can you infer from this activity? We infer that high speed winds are accompanied by a reduced air pressure.

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Fig. 6.14: (a) Roof of a house blown away

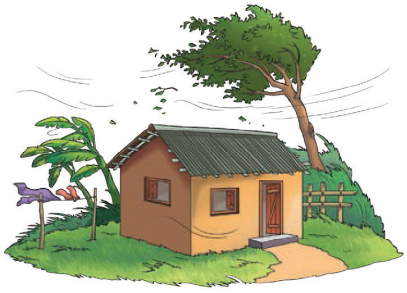


Fig. 6.14: (b) Roof of a house intact

When high-speed winds blow over houses, a low-pressure area is created over them, as high-speed winds are accompanied by a reduced pressure. Therefore, the air pressure above the roofs of the houses is lower than the pressure below them. If the pressure difference is large and the roofs are weak, they may be blown away, as shown in Fig. 6.14a. That is why it is safer to keep doors and windows of the houses open during storms with high-speed winds. When the same wind moves over the roofs, and through the houses, the pressure difference between inside of the houses and over the roofs is reduced to a large extent. This helps prevent the roofs from being blown off as shown in Fig. 6.14b.

You must have experienced that when high-speed winds blow during storms, they are sometimes accompanied by thunder and lightning. Let us learn more about them.

6.5 Storms, Thunderstorms, and Lightning



Have you heard the sound of thunder and seen lightning during the rainy season?

Yes, the sound of thunder is so frightening! Usually there is heavy rainfall too.



When land gets heated, the warm and moist air, being lighter, rises, thereby creating a low pressure area. Cooler air from the surrounding high-pressure areas flows to take its place. This air, in turn, gets heated and rises. This results in a continuous process of wind circulation. As the rising air expands, it cools and moisture in it condenses to form water droplets, creating clouds. The water droplets merge to form heavier drops, which come down as rain, hail, or snow. The strong winds accompanied by rain is called a **storm**. In hot, humid, and tropical regions like India, storms are more frequent. Under certain conditions, warm air rises to great heights that the low temperature there converts water droplets into ice particles.

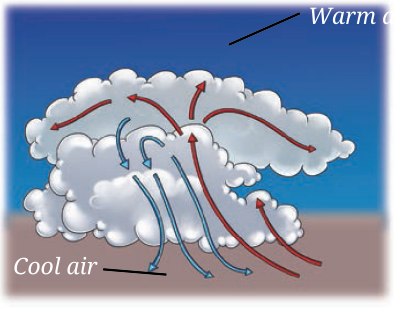


Fig. 6.15: Strong winds going up and down

Strong winds blowing upwards and downwards (Fig. 6.15) facilitate rubbing between water droplets

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and ice particles. You have learnt in the chapter 'Exploring Forces' that when two objects are rubbed against each other, they get charged. In this case, strong winds blowing upwards and downwards and rubbing against each other cause static electric charges to develop within the clouds.



Fig. 6.16: Lightning

The positively charged lighter ice particles move upwards and occupy the upper part of the clouds. The negatively charged heavier water droplets occupy the lower part of the clouds. Thus, a charge separation within the cloud takes place. Also, when the negatively charged lower part of the cloud moves closer to the ground, it causes the ground and nearby objects, such as trees or buildings, to become positively charged (Fig. 6.16).

Normally, air acts as an electrical insulator and does not let opposite charges meet. But when the build up of charges becomes very large, the insulating property of air breaks down. A sudden flow of charges takes place, producing a bright flash of light called **lightning**.

Lightning can occur as opposite charges collide within a cloud, between clouds, or between clouds and the ground. Lightning rapidly heats up the air around it, causing the air to expand and produce a loud sound known as **thunder**. A storm accompanied by lightning and thunder is called a **thunderstorm**.

A step further

Isolated and localised thunderstorms can sometimes occur in various regions of India. These thunderstorms are known by various names such as *Kalboishakhi* in West Bengal, Bihar, and Jharkhand and *Bordoisila* in Assam. They occur before the arrival of the monsoon, thereby helping kharif crops to grow. In Kerala, Karnataka, and Tamil Nadu, they are known as mango showers as they support the ripening of mangoes. Local thunderstorms in Karnataka help in the growth of coffee plants.



Lightning can be dangerous! It can ignite fires, damage buildings, and cause severe burns or death in humans and animals. We must take necessary precautions and protect ourselves from lightning. During lightning, stay away from tall objects, find a low-lying open area and crouch down, and minimise contact with the ground. Do not lie down flat. Avoid using an umbrella with a metallic rod. If you are in water, get out of it. If you are inside a bus or a car, you are comparatively safer.

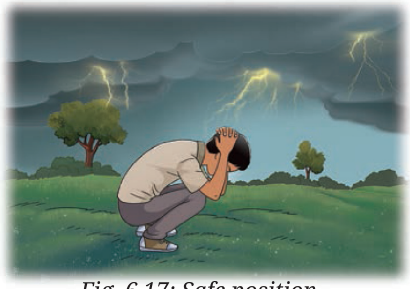


Fig. 6.17: Safe position during lightning

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Ever heard of ...

A lightning conductor is a metallic rod installed along the walls of buildings during their construction. One end of the rod is pointed. This end is kept higher than the highest point of the building (Fig. 6.18). The other end of the rod is buried deep in the ground. The rod provides easy path for the transfer of electric charges into the ground.



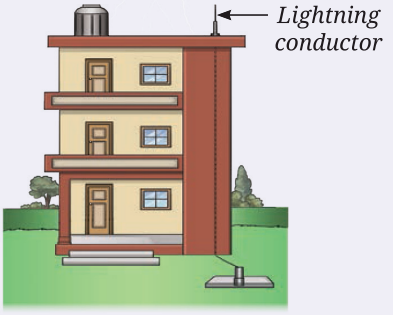


Fig. 6.18: A lightning conductor

6.6 Cyclone

Cyclones are large storms that form over warm ocean waters. As the ocean water gets heated, the warm and moist air above it rises. As the moist air rises, the water vapour condenses to form raindrops. We know that during evaporation, water takes up heat to change into vapour. When this water vapour condenses into raindrops, heat is released back into the atmosphere. This causes further warming of the ascending air leading it to rise even further, creating an even lower pressure. Air from the surrounding regions rushes in and it also starts rising. Earth's rotation causes the moving air to spin (Fig. 6.19). This cycle is repeated, resulting in the creation of a very low-pressure area with high-speed winds revolving around it. This spinning system of clouds, winds, and rain is called a **cyclone**.

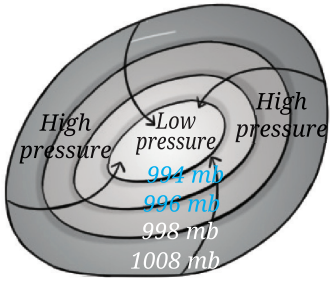


Fig. 6.19: Winds blowing from high pressure areas to low pressure areas

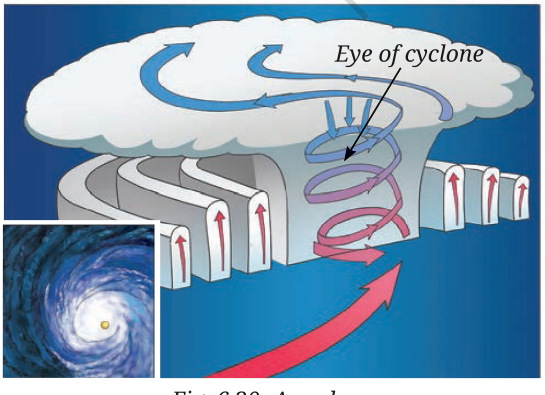


Fig. 6.20: A cyclone

In a cyclone, the region of lowest pressure is at the centre, known as the **eye of the cyclone**. At the eye of the cyclone, the wind is calm, but the surrounding region experiences strong winds and heavy rainfall. As a cyclone moves from the ocean towards the land, it generates higher wind speeds compared to the wind speeds produced by regular thunderstorms. Once the cyclone reaches land, the source of moist air is cut off and it gradually loses its strength.

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Even as a cyclone loses its strength while travelling over land, it leaves behind a trail of destruction that can take months or even years to repair. Cyclones can be extremely destructive. For example, the Amphan cyclone in 2020 had peak wind speeds of 270 km/h.

Strong winds during a cyclone push ocean water towards the shore, creating a wall of water that can be as high as 3–12 metres. This surge of water can flood coastal areas and even areas far from the sea. The heavy rainfall which accompanies a cyclone may cause rivers to overflow and can also trigger landslides.

Seawater that rushes inland can contaminate drinking water sources and damage farmland. The salt in seawater can make soil less fertile, affecting crops. Roads may get blocked due to fallen trees and debris, making it difficult for help to reach the affected areas. Power outages can last for days, disrupting emergency services and daily life.

How can we protect ourselves during cyclones? It is important to stay updated on weather reports and periodic alerts, and warnings issued by the India Meteorological Department (IMD). Thanks to the weather monitoring satellites, today we can track cyclones and predict their path, helping us reduce their impact on life and property. Several national and international organisations work together to monitor cyclone-related disasters. If you live in a cyclone-prone area, keep an emergency kit ready with essential items. During a cyclone, quickly move to a nearby designated cyclone shelter.

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Let us wrap up!

Warm air rises, creating a low-pressure area.

Cool air rushes to occupy the low-pressure area.

Warm air rises, cools, and the water vapour condenses to form clouds.

Bigger water drops in the clouds fall to the ground as rain, hail, or snow.

Positive and negative charges are created in the clouds by strong winds blowing upwards and downwards.

When positive and negative charges meet, they cause lightning. Lightning may occur within a cloud, between clouds, or between a cloud and the ground.

Under certain weather conditions, storms may develop into cyclones.



Snapshots

- Pressure is defined as force per unit area.
- The SI unit of pressure is newton/metre^2 (N/m^2) and is also called pascal denoted by Pa.
- Liquids and gases exert pressure on the walls of a container.
- The pressure exerted by the air around us is known as atmospheric pressure.
- Differences in air pressure cause winds to blow.
- Warm air rises, creating a low-pressure area. Cooler air from surrounding higher-pressure regions moves in to take its place.
- Important requirements for the formation of thunderstorms are moisture and strong winds.
- Strong winds moving upwards and downwards facilitate rubbing of ice particles with water droplets, causing electric charges to develop in clouds.
- Collision of electric charges within a clouds, or between clouds, or between a cloud and the ground causes lightning.
- Lightning strikes can cause destruction to life and property.
- Lightning conductors protect buildings from the effects of lightning.
- The India Meteorological Department (IMD) constantly monitors cyclones and thunderstorms in India.

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Keep the curiosity alive

1. Choose the correct statement.

(i) Look at Fig. 6.21 carefully. Vessel R is filled with water. When pouring of water is stopped, the level of water will be _____.

(a) the highest in vessel P
(b) the highest in vessel Q
(c) the highest in vessel R
(d) equal in all three vessels



Fig. 6.21

(ii) A rubber sucker (M) is pressed on a flat smooth surface and an identical sucker (N) is pressed on a rough surface:

(a) Both M and N will stick to their surfaces.
(b) Both M and N will not stick to their surfaces.
(c) M will stick but N will not stick.
(d) M will not stick but N will stick.

(iii) A water tank is placed on the roof of a building at a height 'H'. To get water with more pressure on the ground floor, one has to

(a) increase the height 'H' at which the tank is placed.

(b) decrease the height 'H' at which the tank is placed.

(c) replace the tank with another tank of the same height that can hold more water.

(d) replace the tank with another tank of the same height that can hold less water.

(iv) Two vessels, A and B contain water up to the same level as shown in Fig. 6.22. P_A and P_B is the pressure at the bottom of the vessels. F_A and F_B is the force exerted by the water at the bottom of the vessels A and B.

(a) $P_A = P_B$, $F_A = F_B$

(b) $P_A = P_B$, $F_A < F_B$

(c) $P_A < P_B$, $F_A = F_B$

(d) $P_A > P_B$, $F_A > F_B$

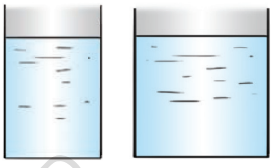


Fig. 6.22

2. State whether the following statements are True [T] or False [F].

(i) Air flows from a region of higher pressure to a region of lower pressure. [ ]

(ii) Liquids exert pressure only at the bottom of a container. [ ]

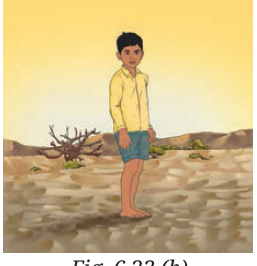
(iii) Weather is stormy at the eye of a cyclone. [ ]

(iv) During a thunderstorm, it is safer to be in a car. [ ]

3. Fig. 6.23 a shows a boy lying horizontally, and Fig. 6.23 b shows the boy standing vertically on a loose sand bed. In which case does the boy sink more in sand? Give reasons.

4. An elephant stands on four feet. If the area covered by one foot is 0.25 m^2, calculate the pressure exerted by the elephant on the ground if its weight is 20000 N.


Fig. 6.23 (a)


Fig. 6.23 (b)

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

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Fig. 6.24

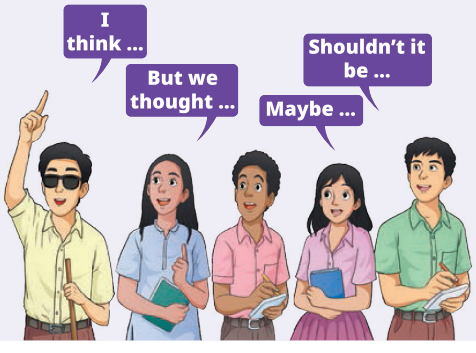
5. There are two boats, A and B. Boat A has a base area of 7 m^2, and 5 persons are seated in it. Boat B has a base area of 3.5 m^2, and 3 persons are seating in it. If each person has a weight of 700 N, find out which boat will experience more pressure on its base and by how much?
6. Would lightning occur if air and clouds were good conductors of electricity? Give reasons for your answer.
7. What will happen to the two identical balloons A and B as shown in Fig. 6.24 when water is filled into the bottle up to a certain height. Will both the balloons bulge? If yes, will they bulge equally? Explain your answer.
8. Explain how a storm becomes a cyclone.
9. Fig. 6.25 shows trees along the sea coast in a summer afternoon. Identify which side is land— A or B. Explain your answer.



Fig. 6.25

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10. Describe an activity to show that air flows from a region of high pressure to a region of low pressure.
11. What is a thunderstorm? Explain the process of its formation.
12. Explain the process that causes lightning.
13. Explain why holes are made in banners and hoardings.



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

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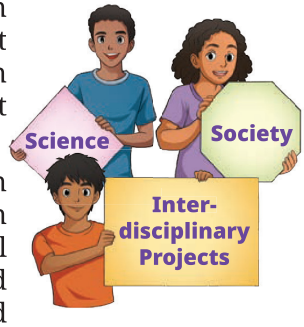
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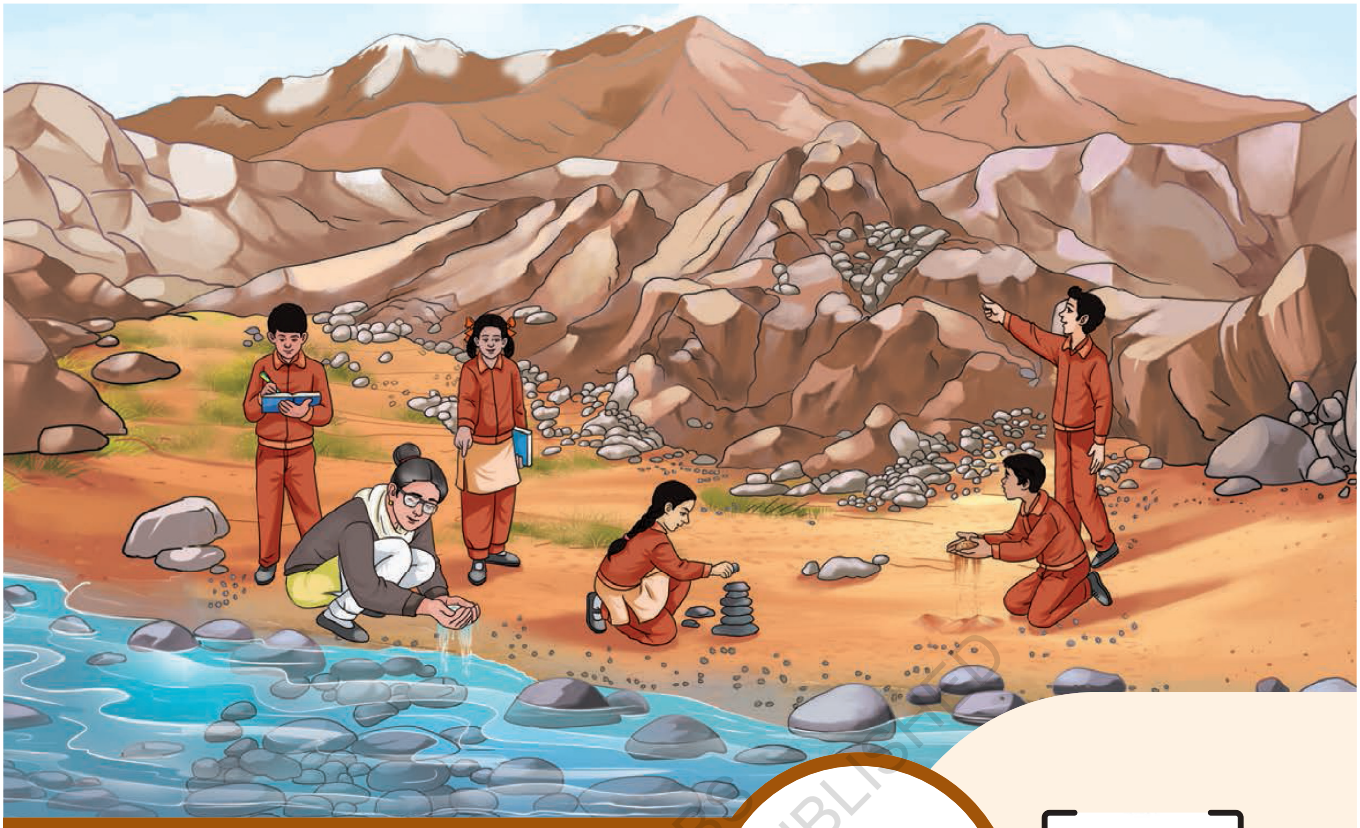
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Discover, design, and debate



- Hold a strip of paper, 18 cm long and 2 cm wide, between your thumb and forefinger so that it hangs freely. Predict what you will observe if you blow over the paper. Perform the activity now. Note down your observations and interpret your results.
- List three major cyclones which have occured in India in the last 20 years. List two major destruction caused by each of the cyclones. What measures were taken by the local government and communities to reduce the loss of life and destruction of property? Mention two suggestions you would like to propose to the local government.
- Collect data on the strength of thunderstorms for various regions of India. Compare your findings and identify which regions are more prone to thunderstorms. Can you give reasons for your findings?

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Particulate Nature of Matter

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Probe and ponder

- Why is it possible to pile up stones or sand, but not a liquid like water?
- Why does water take the shape of folded hands but lose that shape when released?
- We cannot see air, so how does it add weight to an inflated balloon?
- Is the air we breathe today the same that existed thousands of years ago?
- Share your questions

_____

_____ ?



You might have collected pebbles and stones from the sand while playing on a riverbank or a beach. Where do these pebbles, stones, and sand come from?

In the mountains, rocks gradually break down due to erosion. Rivers flowing through these regions carry along the eroded rock pieces. As the rivers flow, they continue to break down the rocks further into pebbles, stones, sand; and transport large quantities of them to the plains.

The bigger rocks are eventually broken down into finer grains of sand and clay. Is this grain the smallest unit of a bigger rock or can these grains of sand and clay be broken down further? Let us find out!

7.1 What Is Matter Composed of?

Activity 7.1: Let us explore

- Take a stick of chalk (Fig. 7.1a) and break it into two pieces (Fig. 7.1b).
- Continue breaking the chalk till it becomes difficult to break it further by hand.
- Grind the small pieces of chalk thus obtained (Fig. 7.1c) using mortar and pestle.
- **Observe** the fine powder of chalk with a magnifying glass (Fig. 7.1d).
- What do you observe?
- Each tiny grain you observe is still a speck of chalk.



Is every speck of this fine chalk powder still composed of the same substance, or has it changed into something else on breaking or grinding?

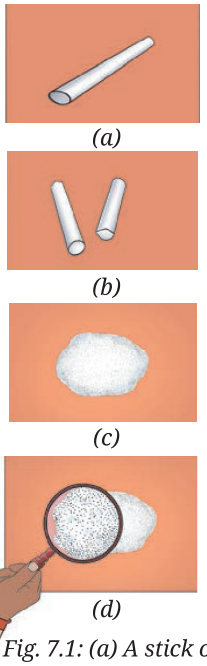
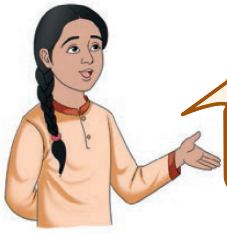


Fig. 7.1: (a) A stick of chalk; (b) The chalk stick broken into two pieces; (c) A piece of chalk ground into fine powder; (d) A close-up view of chalk powder under a magnifying glass

Recall *Curiosity*, Grade 7 chapter 'Changes Around Us: Physical and Chemical'— is grinding chalk a physical change or a chemical change? You learnt that the chalk does not change into a new substance on grinding. It is a physical change in which only the size of each speck of chalk has reduced further.

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These specks of chalk powder can be broken further into smaller particles by further grinding. Let us imagine that this process of grinding continues. Eventually, we would reach a stage where the chalk particles cannot be broken down any further. The tiny units obtained at this stage are the basic building blocks that the chalk was made up of.



This means that one whole piece of chalk was made up of a large number of smaller units. These units are called constituent particles of chalk. A **constituent particle** is the basic unit that makes up a larger piece of a substance or material. Just like chalk, the grains of sand and clay are not the smallest units of bigger rocks. These are also made up of a large number of their constituent particles.

Let us **explore** further!

Recall the dissolution of sugar into water to form a solution. What happens to sugar when it is dissolved in water?

Activity 7.2: Let us perform

Safety first



Perform the activity under the supervision of a teacher or an adult. Never eat or drink anything unless asked to.

- Fill a glass tumbler with drinking water.
- Put two teaspoons of sugar into it.
- Do not stir the water. Taste a small spoonful of water from the top layer of the glass.

Does the water taste sweet?

- Now, stir the water until the sugar dissolves completely (Fig. 7.2).
- Again taste a spoonful of water from the top layer.



Fig. 7.2: Dissolving sugar in water

What difference in taste do you notice? Does it taste sweet?

Since the top layer of water tastes sweet after dissolving sugar, it must be present in the solution. Do you observe any sugar particles in the solution?

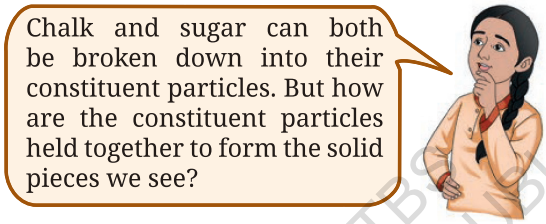
Sugar particles can no longer be observed but their presence can be sensed by taste. When sugar dissolves in water, it breaks up into its constituent particles which cannot be broken down further. Each tiny grain of sugar is made up of millions and millions of such constituent particles.

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Activities 7.1 and 7.2 support the idea that matter is composed of a large number of extremely small particles. These particles are so small that they cannot be seen even through an ordinary microscope.



The tiny sugar particles separate and occupy the available spaces between the water particles. These spaces between the particles are known as **interparticle spaces**.



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7.2 What Decides Different States of Matter?

The constituent particles of matter are held together through forces which are attractive in nature. These forces are called **interparticle attractions**. The strength of these attractions depends on the nature of the substance and the interparticle distance. Even a slight increase in the distance decreases the interparticle forces drastically. The strength of these forces ultimately decides the physical state of the substances.

Our scientific heritage

Do you know that since ancient times, people have been thinking about how far things could be broken down and what is matter made up of?

Acharya Kanad, an ancient Indian philosopher, first spoke about the idea of a *Parmanu* (atom). He believed that matter is made up of tiny, indivisible eternal particles called *Parmanu*. This idea was written in his work called *Vaisheshika Sutras*.



Let us explore how these attractions vary in different states.

7.2.1 Solid state

How are constituent particles held together in **solids**?

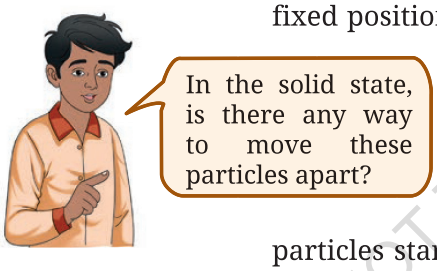
Activity 7.3 : Let us find out



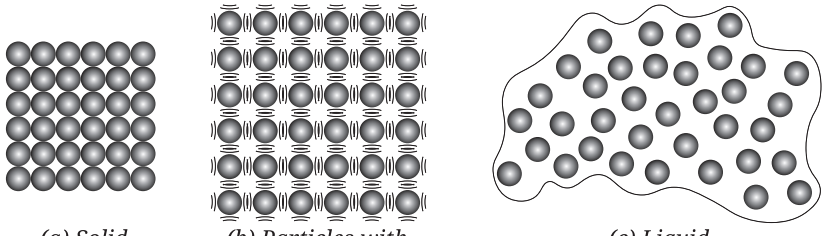
Fig. 7.3: Some solid objects

- **Collect** a few solid objects, such as a piece of iron or an iron nail, a piece of rock salt, a stone, a piece of wood, a key, and a piece of aluminium (Fig. 7.3).
- Observe their shapes and sizes.
- Try hammering them.
- In which of the above six objects do you think particles are strongly held together?

You must have noticed that all these objects are solids. They have a **definite shape** and **volume**. This is due to the fact that in solids, the particles are tightly packed and the interparticle attractions are very strong. These strong forces of attraction hold the particles in fixed positions, preventing them from moving freely (Fig. 7.4a). The particles can only move to and fro about their positions (vibrate or oscillate) but cannot move past each other.



When solids are heated, their particles vibrate more vigorously (Fig. 7.4b). A stage is reached when these vibrations become so vigorous that the particles start leaving their position. The interparticle forces of attraction get weakened and the solid gets converted into the liquid state (Fig. 7.4c). The temperature at which this happens is the melting point of the solid.



(a) Solid *(b) Particles with increased vibrations* *(c) Liquid*

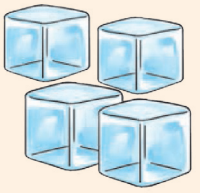
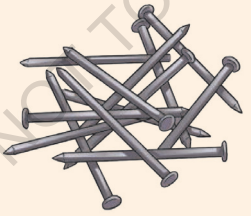
Fig. 7.4: Magnified schematic pictures of melting of a solid

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The minimum temperature at which a solid melts to become a liquid at the atmospheric pressure is called its **melting point**. Generally, in a liquid state, particles are somewhat farther away from each other as compared to those in the solid state (ice is an exception—its particles are farther apart than those in water).

Some solids have weak interparticle forces of attraction, so their melting points are low. While others have strong attractive forces and have high melting points. Some examples of solids and their melting points are shown in Table 7.1.

Table 7.1: Melting points of some solids

S.No.	Material	Melting point
1.	Ice 	0 °C
2.	Urea 	133 °C
3.	Iron 	1538 °C

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Solids have a definite volume; what about liquids and gases?

7.2.2 Liquid state

Activity 7.4: Let us try and find out

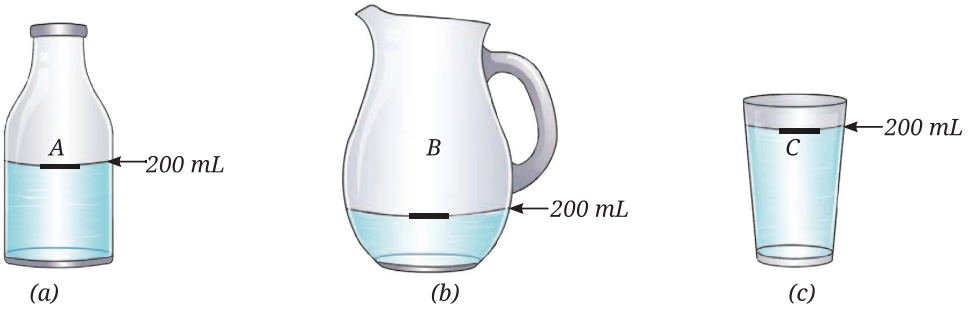


Fig. 7.5: Water placed in containers of different shapes

- Take three clean and dry containers of different shapes. Label them A, B, and C (Fig. 7.5).
- Mark the 200 mL level in each container using a marker or by pasting a thin strip of paper.
- Fill Container A with water up to the marked level.
- Carefully transfer the water from Container A to Container B without spilling, and observe the shape and level of the water.
- Now, transfer the same water from Container B to Container C, carefully, and observe the shape and its level again.

You will notice that the water takes the shape of the container into which it is poured. So, we can say that the **liquids** do not have a fixed shape and take the shape of the container they are kept in. This happens because the particles of liquids are free to move. In all three containers, the water level remains at 200 mL and no change in volume is observed. Hence, we can say that liquids have a **definite volume**. However, if a container is not clean, some water may stick to its walls, causing the water level in the next container to be slightly less than 200 mL after pouring.

Activity 7.4 shows that the particles of liquids can move freely, but only within a limited space. Therefore, we can **infer** that liquids have no fixed shape but have a fixed volume.



Fig. 7.6: Moving finger through water

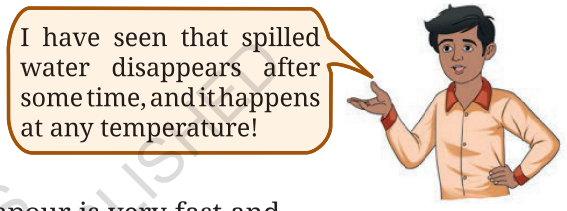
Let us now **compare** interparticle forces of attraction in liquids and solids. Take some water in a shallow vessel and try to move your finger through it (Fig. 7.6).

Are you able to move your finger through the water?

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You can move your finger through water without breaking or cutting it permanently, which cannot be done in the case of solids. When you try this, you are temporarily displacing water. As soon as you remove your finger, the position of the water is restored. We can say that in liquids, the interparticle attractions are slightly weaker than in solids, but still strong enough to keep the particles close together.

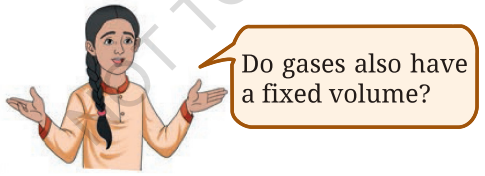
Recall *Curiosity*, Grade 6 chapter 'Temperature and Its Measurement', where you observed the temperature of boiling water (liquid). When a liquid is heated, a stage comes when it starts boiling. The temperature at which a liquid boils and turns into vapour at atmospheric pressure is called its **boiling point**. The movement of particles becomes so vigorous that they move apart from each other, resulting in a decrease in the interparticle forces of attraction. Eventually, the constituent particles can escape from the liquid state. The liquid is converted into vapour or the gaseous state.



At the boiling point, the formation of vapour is very fast and occurs not only at the surface but also within the liquid. This process is observed as bubble formation in the liquid. However, vapour formation occurs at all temperatures, even below the boiling point, though slowly and only at the surface. This slower process is known as evaporation — about which you have learnt in earlier grades.

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7.2.3 Gaseous state



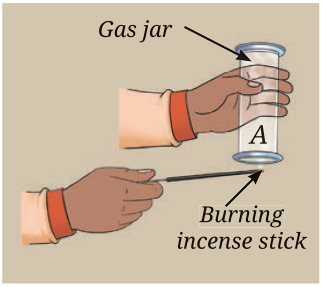
Activity 7.5: Let us investigate

Safety first

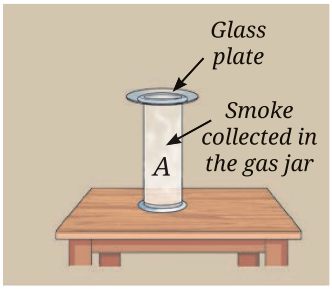
Be careful while burning an incense stick.



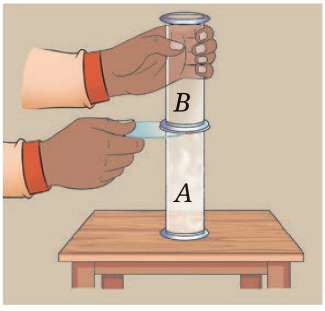
- Take two transparent gas jars or glass tumblers and mark them A and B.
- Create some smoke by burning an incense stick.
- Hold the Gas Jar A upside down over the smoke (Fig. 7.7a).
- The gas jar should trap the smoke inside.
- Turn it over and cover it with a glass plate (Fig. 7.7b).
- Hold another Gas Jar B upside down and gently place it over the glass plate covering the Gas Jar A.



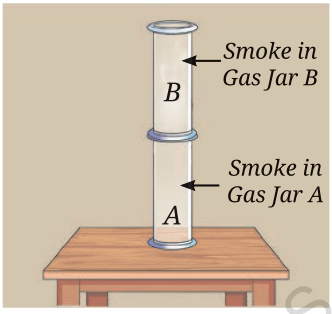
(a) Collecting smoke



(b) Covering the gas jar with a glass plate



(c) Placing the Gas Jar B and removing the glass plate



(d) Spreading the smoke

Fig. 7.7: Smoke spreads freely inside the gas jars

- Remove the glass plate slowly and ensure that both gas jars are close enough and there is no gap for smoke to escape (Fig. 7.7c).
- Observe how the smoke spreads inside the Gas Jar B.
- The smoke fills the entire space in the Gas Jar B, indicating that gases do not have a fixed volume and tend to occupy the entire available space (Fig. 7.7d). Like liquids, they also acquire the shape of the vessel they are in.

This illustrates that the particles in gases move freely in all directions and the interparticle attractions are negligible. As a result, gases do not have a fixed shape or volume.

In this activity, smoke is used to represent the gaseous state. The tiny particles of smoke suspended in the air are constantly hit by invisible particles of gases, and their movement helps us observe the motion of gas particles.

This activity can also be demonstrated by using iodine vapour instead of smoke from incense sticks.



Safety first

Be careful while using solid iodine. Vapours of iodine can cause irritation.

Iodine vapour can be obtained by placing some solid iodine in a closed gas jar for some time, as shown in Fig. 7.8.

Both liquids and gases flow and do not retain a fixed shape. These properties distinguish them from solids and **classify** them as **fluids**.

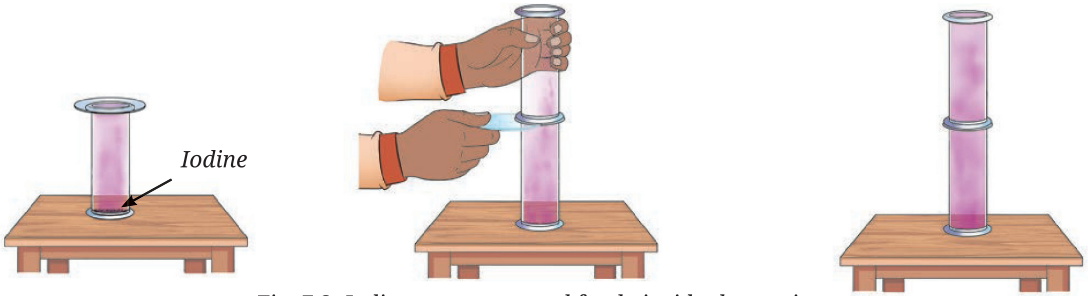


Fig. 7.8: Iodine vapour spread freely inside the gas jar

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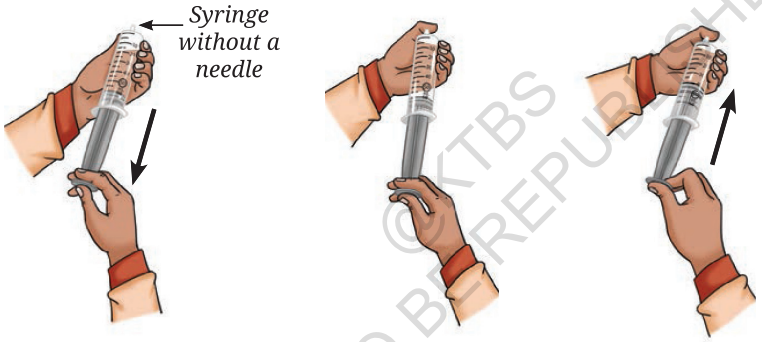
7.3 How Does the Interparticle Spacing Differ in the Three States of Matter?

What role does the interparticle spacing play in determining the properties of each state (solid, liquid, and gas)?

Let us **perform** the following activities to find answers to these questions.

Activity 7.6: Let us experiment

- Take a syringe without a needle. Pull the plunger of the syringe outwards in a fully extended position (Fig. 7.9a).
- Place your thumb over the open end of the syringe to prevent the air present inside the syringe from escaping (Fig. 7.9b).
- Push the plunger slowly and steadily inward (Fig. 7.9c).



(a) Pulling the plunger outwards (b) Placing thumb over the open end (c) Pushing the plunger inwards

Fig. 7.9: The syringe piston in different positions

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- What do you observe?

As you do this, you will notice that the volume of air inside the syringe decreases.

What can we say about the behaviour of gas in the syringe?

When you compress the air by pushing the plunger, the particles are forced to come closer. This shows that the gas particles have a lot of space between them in their natural state, and this space can be reduced by applying external pressure.

If you stop pushing the plunger, the gas particles spread, and the plunger moves back to its original position.

Repeat this activity using water and observe.

You would observe that water is practically incompressible.

Let us perform another activity to learn about the interparticle spaces in liquids.

Activity 7.7: Let us observe

- Take a glass vessel, fill it about half with water, and mark the level of water A (Fig. 7.10a).
- Add two teaspoons of sugar into it.
- Mark the new water level on the glass vessel B (Fig. 7.10b).
- Stir the water with a glass rod to dissolve the sugar (Fig. 7.10c).
- **Predict** whether the water level will increase or decrease with respect to the mark B.
- Mark this water level again as C (Fig. 7.10d).

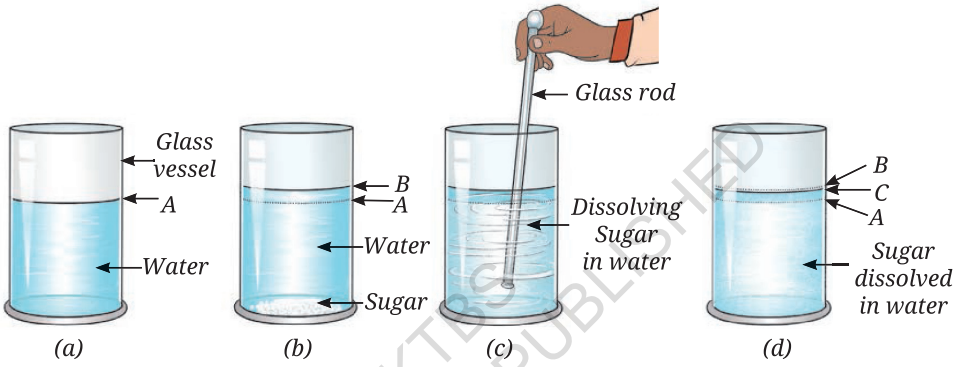


Fig. 7.10: Variation in water levels

What difference do you observe in the water levels?

You will observe that initially, when sugar is added, the level of water increases, but after dissolution, it may decrease to some extent. Since the volume of the solution is less than the sum of the volumes of water and sugar, it indicates that there is some space between the water particles. The particles of the dissolved substance occupy these spaces (Fig. 7.11).

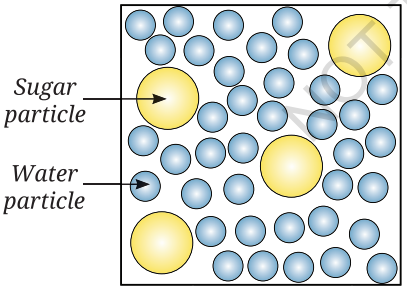


Fig. 7.11: Magnified schematic picture of distribution of sugar particles in water

Repeat the Activity 7.7 with some other soluble solids, such as common salt or glucose, and insoluble solids, like sand and stone pieces.

What do you observe in each case? Do the sand particles dissolve? Does the volume of water in the vessel change after mixing, and why?



Sugar and sand are both solids. Why does sugar dissolve in water but sand does not?

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Sand is a solid that does not dissolve in water. When added to water, the sand particles settle down and occupy some space in the container, causing the total volume to increase.

What do you think about the interparticle spacing in solids?

You learnt earlier that the constituent particles in solids are held together by strong forces of attraction. So, these particles do not move from one place to another and are closely packed. However, despite close packing, some space is left between the particles as shown in Fig. 7.12a. You might assume that the space between particles is filled with air, but this is not the case. They contain nothing at all. Fig. 7.12 summarises the packing of particles and the interparticle spacing in the three states of matter.

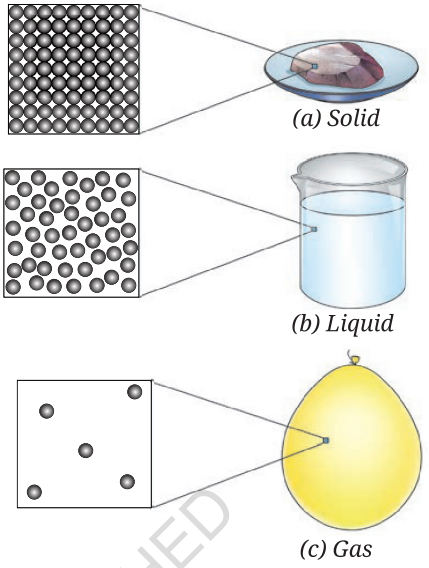


Fig. 7.12: Magnified schematic pictures of interparticle spacing in the three states of matter

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A step further

Often, we use the term 'particle' in different contexts. The meaning of this term changes with the context. For example, while talking about air pollution, the term Suspended Particulate Matter (SPM) is used. This term refers to the tiny dust particles suspended in air and not the constituent particles of matter which are extremely small as compared to the dust particles. In fact, even these tiny dust particles are also made up of a very large number of constituent particles, i.e, atoms and molecules.



7.4 How Particles Move in Different States of Matter?

Let us find out about the movement of particles in the three states of matter.

Activity 7.8: Let us experiment

- Take a glass tumbler containing water and put a few grains of potassium permanganate into it.
- What do you observe?

Safety first

Do not touch potassium permanganate with your hands. Use a spoon or a spatula to handle it.



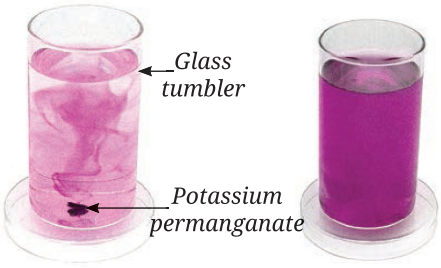


Fig. 7.13: (a) Streaks of pink colour spreading out; (b) Uniform pink colour in glass tumbler

- Initially, you will see some streaks of pink colour spreading out from the grain (Fig. 7.13a).
- With the passage of time, the entire bulk of water will acquire a uniform pink colour (Fig. 7.13b).
- Do you know why this happens?

This happens because the water particles are in constant motion. First they pull out the particles of potassium permanganate from its grain, and later they hit these particles so that they get spread throughout the liquid. In the case of many substances, the constituent particles are held together strongly that the water particles are unable to pull these out. Such substances, like sand, are insoluble in water.

Think like a scientist

Try it yourself!

- Take three clean glass tumblers.
- Pour hot water in one of them, water at room temperature in the second and ice-cold water in the third.
- Drop a small grain of potassium permanganate into each of them.
- Watch carefully and compare. What do you observe?

Water particles move faster in hot water compared to water at room temperature, and even slower in ice-cold water. As a result, the potassium permanganate spreads the fastest in hot water, less quickly in water at room temperature, and the slowest in ice-cold water. Hence, the movement of particles increases when heat is provided.

Try to depict it by **drawing** a diagram.



How can we **demonstrate** the movement of gas particles that cannot be seen with the naked eye?



Activity 7.9: Let us find out

- Light an incense stick in one corner of the room (Fig. 7.14).
- Wait for a few minutes and observe.
- Do you notice the fragrance from a distance?

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Fig. 7.14: Burning of an incense stick

When an incense stick is burnt in one corner of the room, initially, the fragrance is felt only around the incense stick. Shortly, you can smell the fragrance throughout the room. This happens because the particles of the fragrance spread, filling the entire room. This shows that the particles of air are moving constantly. The air particles hit the particles of the fragrance and help them spread throughout the room.



Can you share a few other real-life situations where you have experienced the movement of gas particles?

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Ever heard of ...



Fig. 7.15: Particles of soap help in cleaning

The particulate nature of matter plays a crucial role in many everyday processes. For example, when we wash clothes stained with oil using soap, numerous soap particles surround the oil particles on the fabric. One end of the soap particle attaches to the oil, and the other mixes with water, thus helping lift the oil off and wash it away (Fig. 7.15).

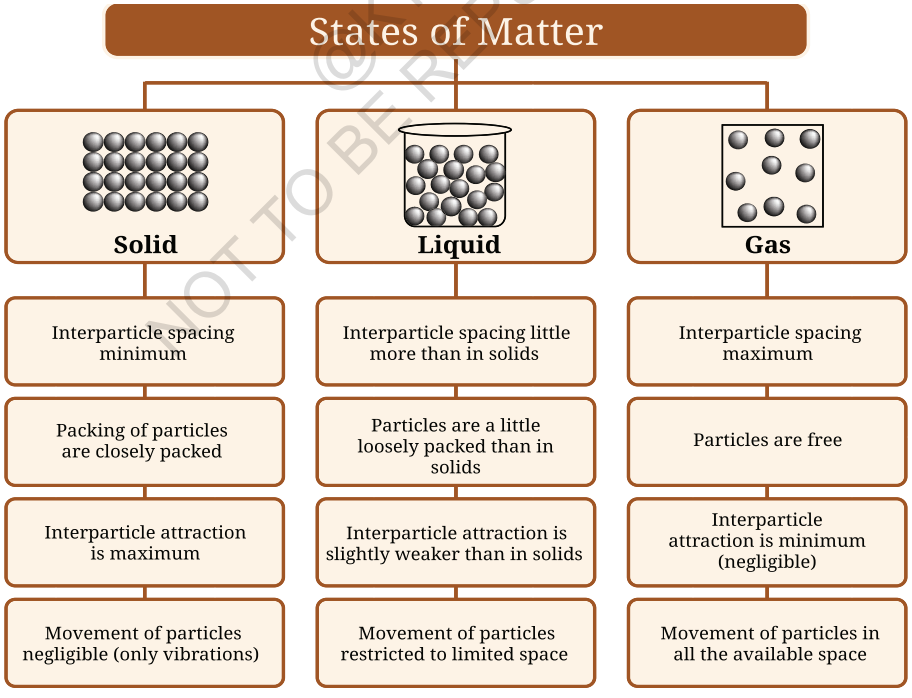


Based on our learnings from the chapter, we can say that matter is made up of small particles which are held together by the force of attraction. The strength of attractive forces between particles depends on the distance between them, which in turn depends on their thermal (heat) energy. Thus, it is the thermal energy of the particles that determines the physical state of matter. In the solid state, the thermal energy of particles is low, so they remain close to each other and experience strong interparticle attractive forces. This restricts their motion to only small vibrations.

At the melting point, the thermal energy is used to overcome the attractive forces between particles, allowing the solid to change into a liquid. At this stage, the particles can move away from their fixed positions. The interparticle distance increases slightly, reducing the strength of the attractive forces to a level that allows the particles to move around, though still within a limited space. In the gaseous state, the particles have enough energy to overcome the forces of attraction between them and move freely in all directions. You will learn more about these particles that constitute matter in higher grades.

Let us wrap up!

Particle nature of the three states of matter–



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Snapshots

- Matter is composed of extremely small particles.
- The particles are held together by interparticle forces of attractions.
- The interparticle attractions are the strongest in solids, a little weaker in liquids, and the weakest in gases.
- Solids have a fixed shape and size due to strong interparticle attraction, minimum interparticle space, and no free movement of the constituent particles.
- The interparticle attraction in liquids is slightly weaker than in solids, enabling the particles to move within a particular space and providing them with a little more interparticle spacing. Therefore, liquids have a definite volume but no fixed shape.
- The interparticle attractions in gases are negligible, making their particles completely free to move from one place to another and resulting in maximum interparticle space. Therefore, gases have no fixed shape and volume.

Keep the curiosity alive

1. Choose the correct option.
   The primary difference between solids and liquids is that the constituent particles are:
   (i) closely packed in solids, while they are stationary in liquids.
   (ii) far apart in solids and have fixed position in liquids.
   (iii) always moving in solids and have fixed position in liquids.
   (iv) closely packed in solids and move past each other in liquids.
2. Which of the following statements are true? Correct the false statements.
   (i) Melting ice into water is an example of the transformation of a solid into a liquid.
   (ii) Melting process involves a decrease in interparticle attractions during the transformation.
   (iii) Solids have a fixed shape and a fixed volume.
   (iv) The interparticle interactions in solids are very strong, and the interparticle spaces are very small.

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

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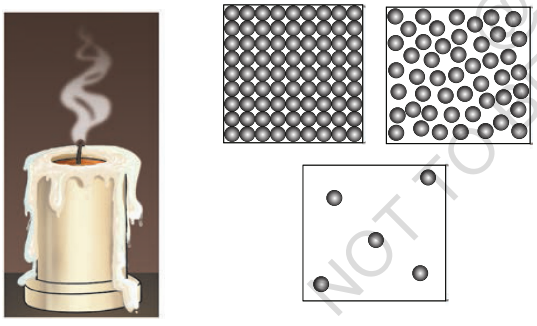
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(v) When we heat camphor in one corner of a room, the fragrance reaches all corners of the room.

(vi) On heating, we are adding energy to the camphor, and the energy is released as a smell.

3. Choose the correct answer with justification. If we could remove all the constituent particles from a chair, what would happen?
   (i) Nothing will change.
   (ii) The chair will weigh less due to lost particles.
   (iii) Nothing of the chair will remain.
4. Why do gases mix easily, while solids do not?
5. When spilled on the table, milk in a glass tumbler, flows and spreads out, but the glass tumbler stays in the same shape. Justify this statement.
6. Represent diagrammatically the changes in the arrangement of particles as ice melts and transforms into water vapour.
7. Draw a picture representing particles present in the following:
   (i) Aluminium foil
   (ii) Glycerin
   (iii) Methane gas

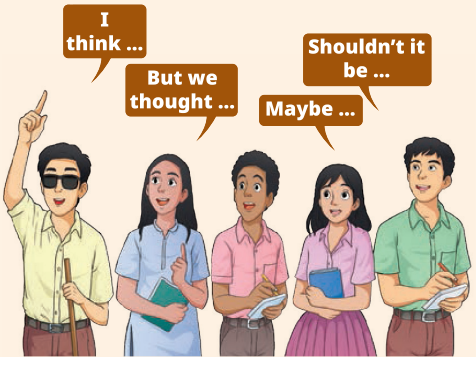


(a) (b)

Fig. 7.16

8. Observe Fig. 7.16a which shows the image of a candle that was just extinguished after burning for some time. Identify the different states of wax in the figure and match them with Fig. 7.16b showing the arrangement of particles.
9. Why does the water in the ocean taste salty, even though the salt is not visible? Explain.
10. Grains of rice and rice flour take the shape of the container when placed in different jars. Are they solids or liquids? Explain.

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

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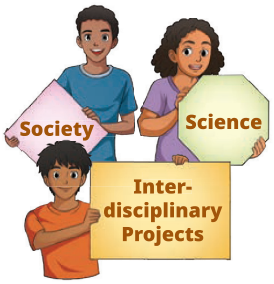
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Discover, design, and debate

- Fix a balloon over the neck of a bottle and put the bottle in hot water. Explore what will happen?
- Design and create simple models to represent particles of solids, liquids, and gases showing interparticle spacing using clay balls, beads, etc.
- Pretend to be particles of solids, liquids, and gases, at different temperatures—create and perform a role-play/ dance showing particles in motion.
- Debate in the class — 'Gases can spread and fill all the available space'. Is this property of gases beneficial or harmful?



A step further

The tiny particles that make up all matter are atoms and molecules. For example, iron is made up of atoms of iron, and gold is made up of atoms of gold. Atoms of many elements like hydrogen, oxygen, and sulfur are not able to exist independently. In such cases, a certain number of atoms of the same element combine to form a molecule. For example, two atoms of hydrogen combine and form a stable particle called a molecule of hydrogen. A water molecule is made up of two hydrogen atoms and one oxygen atom. You will learn about atoms and molecules in higher grades.



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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.

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Right against Exploitation

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

Right to Freedom of Religion

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

Cultural and Educational Rights

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

Right to Constitutional Remedies

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

Sexual Abuse of Children and Punishments under the Protection of Children from Sexual Offences Act, 2012

As per Section 2(d) of the POCSO Act, 2012,
A "Child" means any person below the age of 18 years.

Sexual Offence	Punishment
Penetrative Assault – Any person who commits penetrative sexual assault on a child. (Section 3)	Rigorous imprisonment not less than 10 years, which may extent to life imprisonment, and fine. (Section 4)
Aggravated Penetrative Sexual Assault – Penetrative sexual assault committed under aggravated circumstances. (Section 5)	Rigorous imprisonment not less than 20 years, which may extend to life imprisonment or death, and fine. (Section 6)
Sexual Assault – Touching the private parts of a child or making the child touch any person for sexual intent. (Section 7)	Imprisonment not less than 3 years, which many extents to 5 years, and fine. (Section 8)
Aggravated Sexual Assault – Sexual assault committed under aggravated circumstances. (Section 9)	Imprisonment not less than 5 years, which may extend to 7 years, and fine. (Section 10)
Sexual Harassment of a Child (Section 11)	Imprisonment which may extend to 3 years, and fine. (Section 12)
Use of a Child for Pornographic Purposes (Section 13)	Imprisonment up to 5 years and fine; higher punishment for subsequent offences. (Section 14)
Storage or Possession of Pornographic Material Involving a Child (Section 15)	Imprisonment and fine as prescribed, which may extend to 3 years.
Abetment of an Offence under POCSO (Section 16)	Punishment prescribed for the offence abetted. (Section 17)

Necessary Steps to Be Taken in Case of Sexual Abuse of a Child

- Any person having knowledge of a sexual offence must report the matter immediately to the Special Juvenile Police Unit (SJPU) or the Local Police Station. (Section 19)
- The Child shall be produced before the Child Welfare Committee (CWC) or the Special Court within 24 hours for care and protection.
- The child shall be provided medical examination and treatment immediately, free of cost., at the nearest hospital.
- In case of a girl child, medical examination shall be conducted by a female doctor, as far as possible, in the presence of parents or a trusted person. (Section 27)
- The identity of the child shall not be disclosed through any media, including name, address, photograph, or any identifying details. (Section 23)
- As per Rule 7 of the Protection of Children from Sexual Offences Rules, 2020, where an interim compensation to meet the immediate needs of the child.
- As per Section 44 of the Protection of Children from Sexual Offences Act, 2012, the Karnataka State commission for Protection of Child Rights (KSCPCR) shall monitor the effective implementation of the provisions of the Act.

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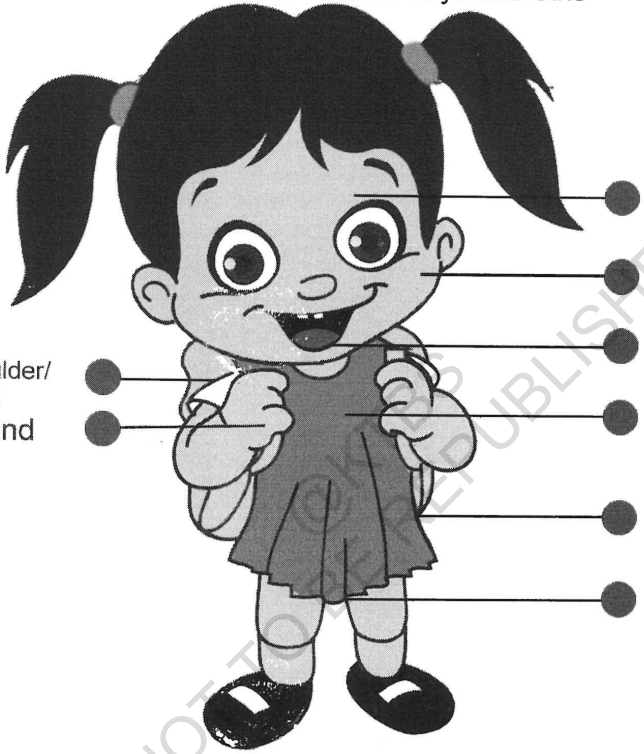
Our Commitment
Towards a Violence-Free and Child-Sate Society

Children be cautious !!! Be alert

Your body belongs only to you,You have all the rights to keep safe and protect it always.
Safe and Unsafe touches on your body

See the picture and understand

this cautious is for Boys and Girls



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Unsafe Touch (BAD TOUCH) - **parts of your body where nobody should touch (except parents and in their presence only doctors can touch)**

Safe touch (GOOD TOUCH) -**can touch only when required**

When you feel Unsafe Touch or any other mischief,please Say loudly NO.. Don't.. Stop it..and Scream, push the person aside and move to a safer place, be brave and inform about it, to your parents & Trusted adult and register a complaint

Published by :Distict Administration -08532-229011, Zilla Panchyat-228448
Department of Police -235635/ 235001 / 235100 / 100 /1091 District Child Protection Unit-280670,
Department of Women and Child Develpoment-226292, Unicef Child Protection Project -230610. Raichur

Be Smart, Be Safe, Be Happy

Picture courtesy : Prajavani, Bhoomika 26-07-2014

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