Exploring the World of Science

1

Probe and Ponder

G3X3A9

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!

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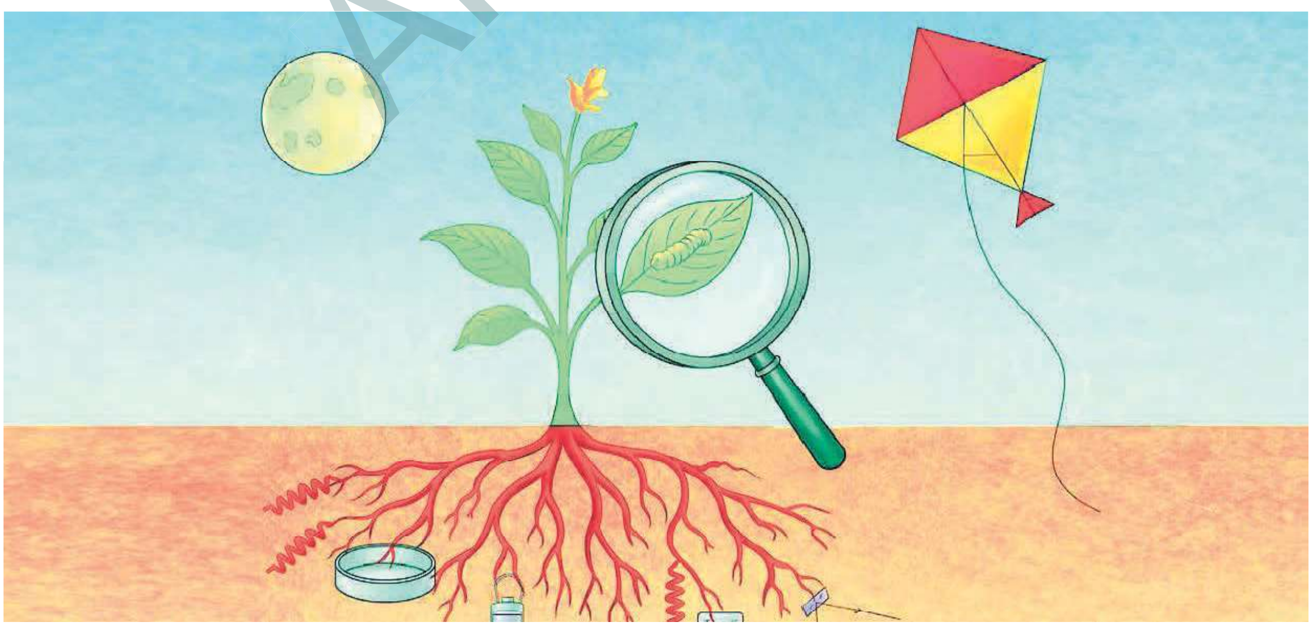


Our journey with Curiosity, into the world of science continues in class 8. We hope you bring along the spirit of adventure and exploration that has guided us so far. In class 6, we discovered how science begins with wonder, with simple "Why?" and "How?" questions about the world around us.

In class 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.

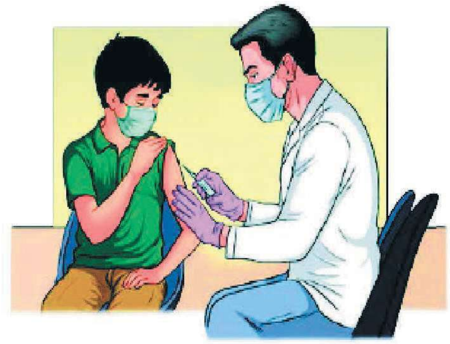
Step by step, we will learn how to use questions as starting points to try to observe carefully, experiment thoughtfully, and explain clearly what we see. In doing so, each of you won't just be learners but also investigators, young scientists, exploring real-world puzzles. These may range from everyday 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!

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.

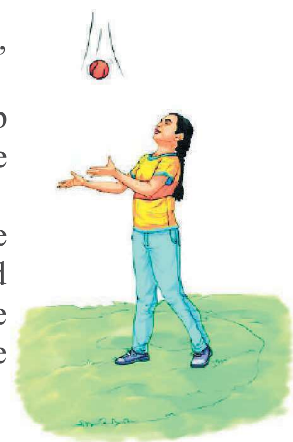


We will start by examining something as small as a single drop of water, and uncover a hidden world of tiny organisms, unseen but deeply linked to us. Some of these are invisible helpers, that help us digest our food or produce medicines, while others can be harmful, causing infections.

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.

Types of Forces

2

Learners will be able to...

- Identify force and its effects in real life events. (CG - 2)
- Classifies forces into contact and non-contact forces. (CG - 2)
- Explains friction as a force that opposes motion and depends on surface nature. (CG - 2)
- Distinguish gravitational force from other non-contact forces as a universal force acting on all masses. (CG - 2)
- Measures weight of an object using a spring balance (CG - 1)

Y4U6G1

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. Swathi and Geetha 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 Geetha Smiling, Swathi 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?"

2.1 What Is a Force?

Let us try to experience the push and the pull.

Activity 2.1 : Let us explore

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

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

Fig. 2.1: 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. 2.1? 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.

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

Let us try to experience the push and the pull.

Activity 2.2: Let us analyse

- Think of situations where a force (push or pull) is applied and list them in Table 2.1.
- Analyse each situation and write the effect of the force in Table 2.1. Some situations and their effects are already listed for you.

Table 2.1: 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
4.	....	....	....

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?

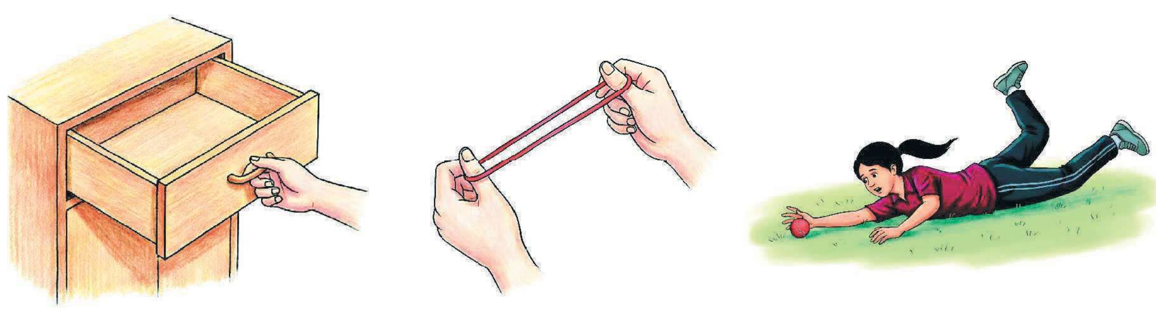


Fig. 2.2: Applying force on objects

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

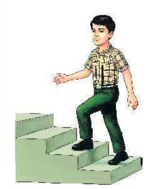
- make an object move from rest.
- change the speed of an object if it is moving.
- change the direction of motion of an object.
- bring about a change in the shape of an object.
- cause some or all of these effects.

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.



2.3 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 2.1. 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.

2.4 What Are the Different Types of Forces?

2.4.1 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. 2.3: Use of muscular force by living beings

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

Fig. 2.4: 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.

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?

Is there any other contact force?

Activity 2.3: 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. 2.5: 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.

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

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. 2.6). When placed in contact, the irregularities of two surfaces lock into each other and oppose any effort to move one surface over the other.

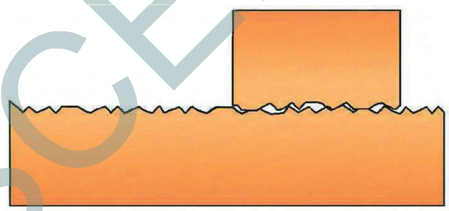


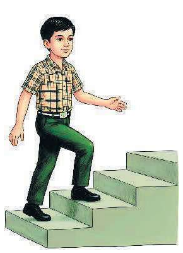
Fig. 2.6: Friction between two surfaces due to irregularities

Activity 2.4: Let us explore

- Try Activity 2.3 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 2.3?
- 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?

2.4.2 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

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?

Activity 2.5: 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. 2.7).
- 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?

  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?

Fig. 2.7: Force between two ring magnets

Activity 2.6: Let us experiment

Fig. 2.8: 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. 2.8). 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.

Activity 2.7: Let us experiment

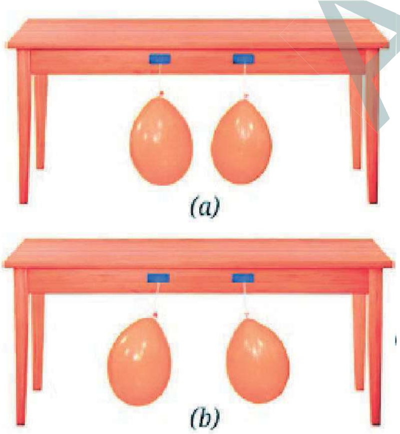


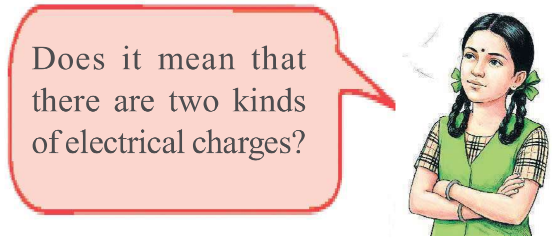
Fig. 2.9: (a) Two uncharged balloons; (b) Two charged balloons repelling each other

- 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. 2.9a.
- 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. 2.9b).
- 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 where as 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 2.8: 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.

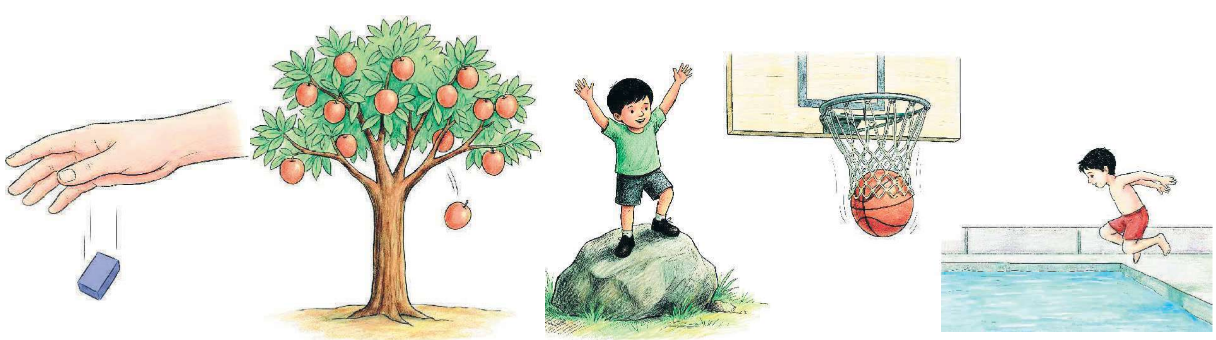
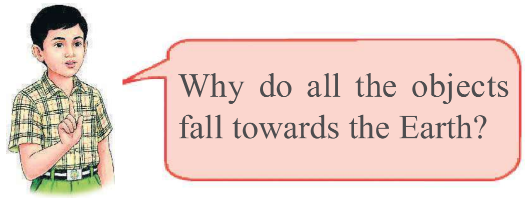
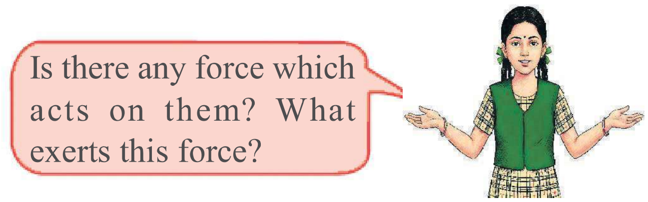


Fig. 2.10: Some objects falling towards the Earth





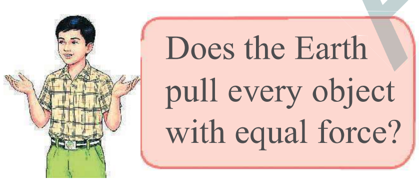
Since all the objects fall towards the Earth, it means the Earth attracts (pulls) them. The force with which the Earth attracts objects towards itself is called the gravitational force. The gravitational force exerted by the Earth is also called force of gravity or simply gravity.

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. 2.11(a)). 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. 2.11(b)).

Fig. 2.11: (a) Dropping an object from a height; (b) Throwing an object vertically upwards

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.



2.5 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).

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

Activity 2.9: Let us explore

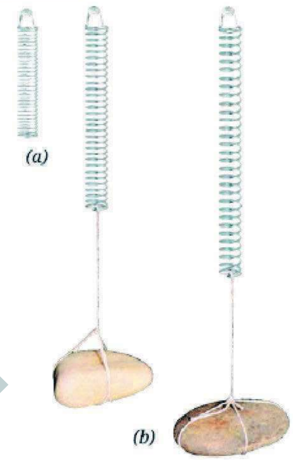


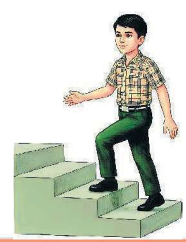
Fig. 2.12: (a) A hanging spring; (b) Two different objects hung from the spring

- 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?

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.

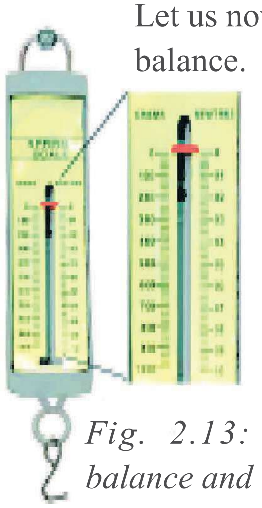


Let us learn to measure the weight using a spring balance.

Activity 2.10: Let us observe

- Look at the spring balance shown in Fig. 2.13 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.



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

Fig. 2.13: A spring balance and its scale

Activity 2.11: Let us calculate

- Look at the spring balance shown in Fig. 2.13 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

  $$\frac{1\text{N}}{5} = 0.2 \text{ N}.$$

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.

Activity 2.12: Let us measure

Fig. 2.14: Object suspended from a spring balance

- 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. 2.14). Read the scale for weight carefully and record your observations in the Table 2.2.

Table 2.2: Measuring weight using a spring balance

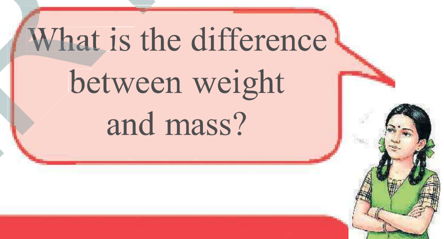
S.No.	Object	Weight (N)
1.	Pencil Box	
2.	Partially filled water bottle	

You can repeat Activities 2.10 to 2.12 for the mass scale shown on the left side on the spring balance (Fig. 2.13) 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.

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.



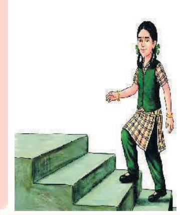
A step further

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	Jupitar
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.



2.6 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 2.13: Let us investigate

Fig. 2.15: Plastic bottle in water

- Take an empty plastic bottle (with its lid closed tightly) and a bucket full of water.
- Push the bottle in the water (Fig. 2.15). Do you feel an upward push? Release the bottle. Does it bounce up?

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.

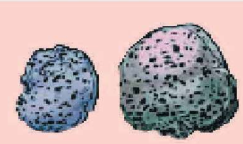
When an object is placed in a liquid, the gravitational force due to the Earth acts on it downwards. But a buoyant force is applied on it by the liquid in the upward direction. If the gravitational force is more than the buoyant force, the object sinks, but if the two forces are equal, the object floats. 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.

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.



Keywords

Force | Contact Force | Non-Contact Force

Muscular Force | Friction | Gravitational Force

Magnetic Force | Electrostatic Force | Mass

Weight

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.

Keep the curisioty alive

1. Define the following.
   A) Force   B) Friction   C) Weight   D) mass   E) buoyant force
2. Which of the following is a non-contact force?
   A) Muscular force   B) Frictional force
   C) Gravitational force   D) Push by hand
3. Match the following 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

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 top most position
6. Why do we sometimes slip on smooth surfaces like ice or polished floors? Explain.
7. Is any force being applied to an object in a non-uniform motion?

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

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8. 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?
9. Read the given statements carefully.
P: The force exerted by a magnet on another magnet is a NON - CONTACT FORCE.
Q: The force exerted by a magnet on a piece of iron is a CONTACT FORCE.
Select the correct option based on the statements given above.
A) P is true; Q is false.
B) P is false; Q is true.
C) Both P and Q are true.
D) Both P and Q are false.
10. In which of the following everyday situations does the applied force cause a change in the shape of an object?
A) Opening a drawer
B) Stopping a moving ball
C) Stretching a rubber band
D) Applying brakes on a bicycle
11. Two balloons rubbed with a woollen cloth are brought near each other. What would happen and why?
12. Ravi rolls two identical balls with the same push—one on a sandy playground and the other on a smooth classroom floor. He observes that the ball on the sand stops much earlier.Why does the ball stop sooner on the sandy surface?
A) Sand attracts the ball
B) Gravitational force is more on sand
C) Friction is greater on sand
D) The ball loses mass while rolling
13. 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. 2.16. If the weights of the three objects 1, 2, and 3 are w_1, w_2 and w_3 respectively, then

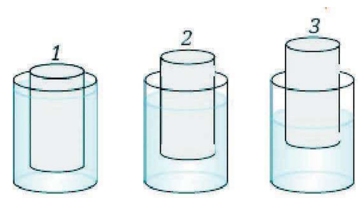

Fig. 2.16

A) $w_1 = w_2 = w_3$
B) $w_1 > w_2 > w_3$
C) $w_2 > w_3 > w_1$
D) $w_3 > w_1 > w_2$

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

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14. 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.

15. 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. 2.17. 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.

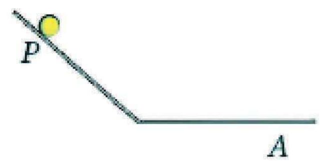


Fig. 2.17

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. 2.18) in your class with the help of your teacher, test the device. Explore in what other ways you may use this electroscope

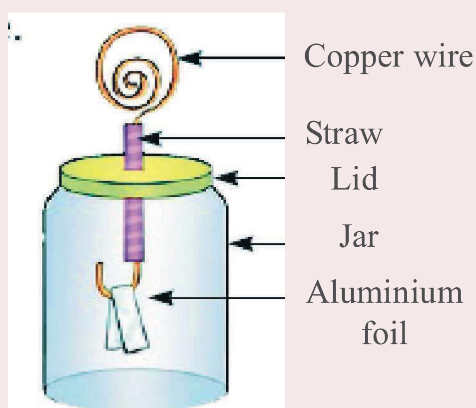


Fig. 2.18

Particulate Nature of Matter

3

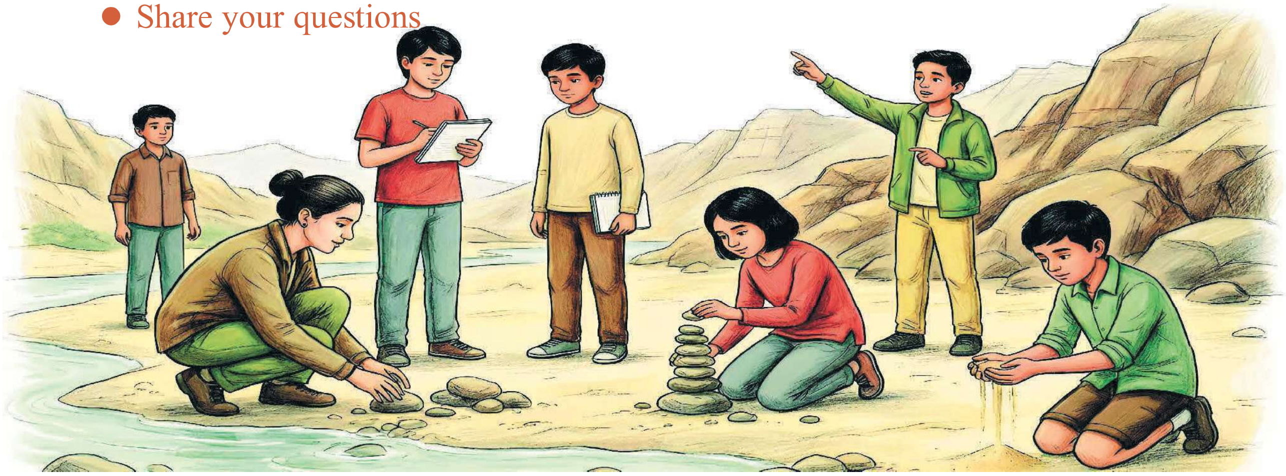
S5R3Y5

Learners will be able to:

- Recognizes that matter is composed of extremely minute particles. (CG-1)
- Understands that the constituent particles of a substance do not change by breaking or melting it. (CG-1)
- Compares solids, liquids, and gases and their state changes based on the differences in the attraction between particles. (CG-1)
- Identifies the differences between boiling and evaporation processes as those in which particles gain energy and move further apart. (CG-1)
- Applies the compressibility of gases to their daily life applications. (CG-1)
- Explains diffusion in liquids and gases as evidence for the continuous motion of particles. (CG-1)

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 year?
- 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.

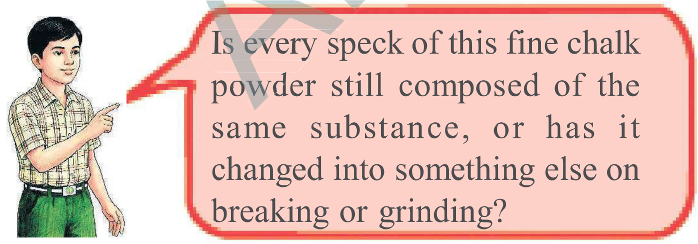
The bigger rocks are eventually broken down into finer grains of sand and clay. Is this grain the smallest unit of a bigger rock or can these grains of sand and clay be broken down further?

Let us find out!

3.1 What Is Matter Composed of?

Activity 3.1: Let us explore

- Take a stick of chalk (Fig. 3.1(a)) and break it into two pieces (Fig. 3.1(b)).
- Continue breaking the chalk till it becomes difficult to break it further by hand.
- Grind the small pieces of chalk thus obtained (Fig. 3.1(c)) using mortar and pestle.
- Observe the fine powder of chalk with a magnifying glass (Fig. 3.1(d)).
- What do you observe?
- Each tiny grain you observe is still a speck of chalk.



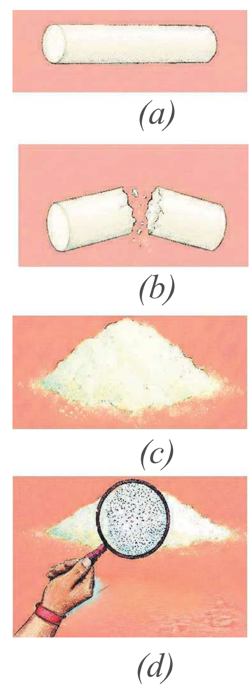
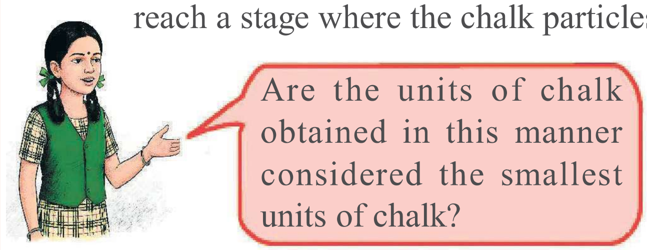


Fig. 3.1: (a) A stick of chalk; (b) The chalk stick broken into two pieces; (c) A piece of chalk ground into fine powder; (d) A close-up view of chalk powder under a magnifying glass

Recall Class 7 chapter "Changes Around Us", 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.

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 3.2: Let us Perform

Saftey 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. 3.2).
- Again taste a spoonful of water from the top layer.

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

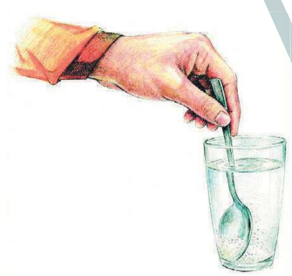


Fig. 3.2: Dissolving sugar in water

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.

Activities 3.1 and 3.2 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.

3.2 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.

3.2.1 Solid state

How are constituent particles held together in solids?

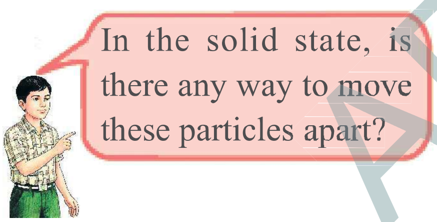
Activity 3.3 : Let us findout

Fig. 3.3: Some solids

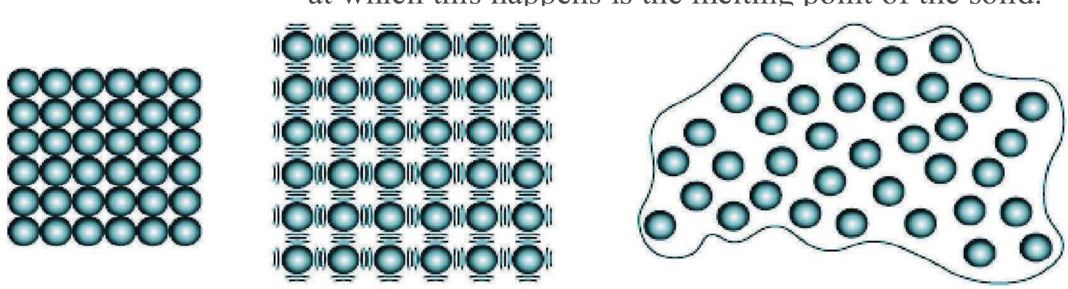
- Collect a few solid objects, such as a piece of iron or an iron nail, a piece of rock salt, a stone, a piece of wood, a key, and a piece of aluminium (Fig. 3.3).
- Observe their shapes and sizes.
- Try hammering them.
- In which of the above six objects do you think particles are strongly held together?

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. 3.4(a)).

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. 3.4(b)). 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. 3.4(c)). The temperature at which this happens is the melting point of the solid.

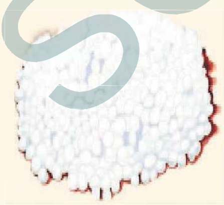
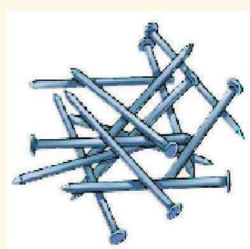


(a) Solid *(b) Particles with increased vibrations* *(c) Liquid*

Fig. 3.4: Magnified schematic pictures of melting of a solid

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 some what 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 3.1.

Table 3.1: Melting points of some solids

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

3.2.2 Liquid state

Activity 3.4: Let us try and find out

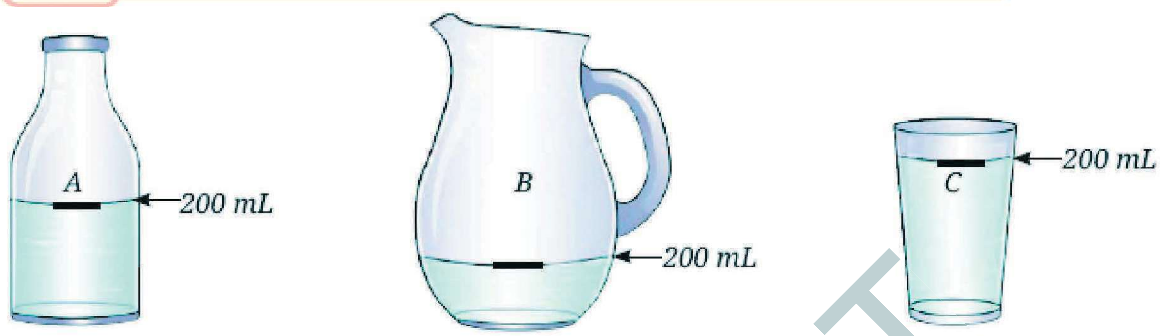
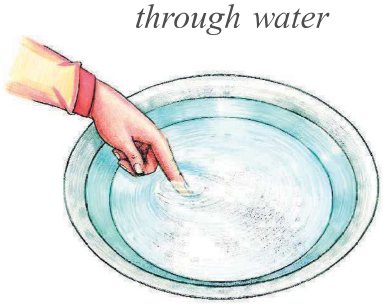


Fig. 3.5: Water placed in containers of different shapes

- Take three clean and dry containers of different shapes. Label them A, B, and C (Fig. 3.5).
- 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.

Fig. 3.6: Moving finger through water



Activity 3.4 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.

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. 3.6).

Are you able to move your finger through the water?

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.

In class 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.

3.2.3 Gaseous state

Activity 3.5: 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. 3.7(a)).
- The gas jar should trap the smoke inside.
- Turn it over and cover it with a glass plate (Fig. 3.7(b)).
- Hold another Gas Jar B upside down and gently place it over the glass plate covering the Gas Jar A.

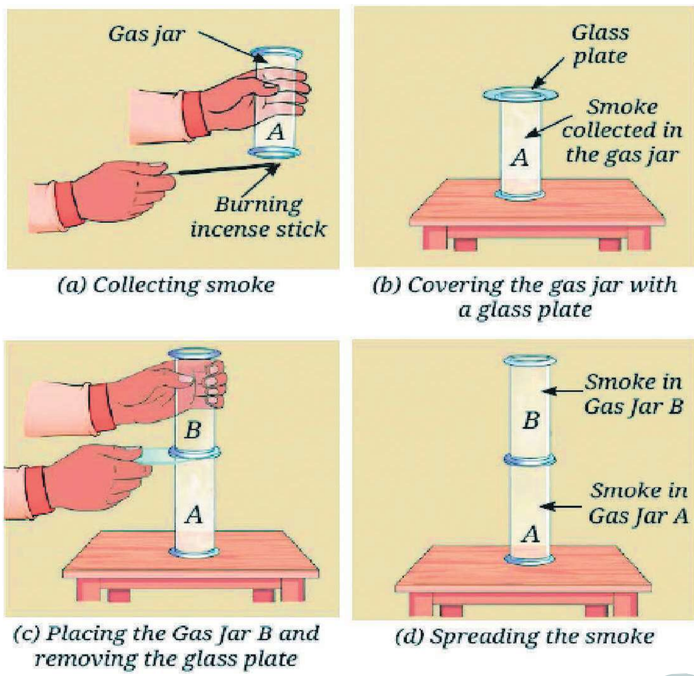


Fig. 3.7: Smoke spreads freely inside the gas jars

- Remove the glass plate slowly and ensure that both gas jars are close enough and there is no gap for smoke to escape (Fig. 3.7(c)).
- 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. 3.7(d)). 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.

Saftey 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. 3.8. Both liquids and gases flow and do not retain a fixed shape. These properties distinguish them from solids and classify them as fluids.

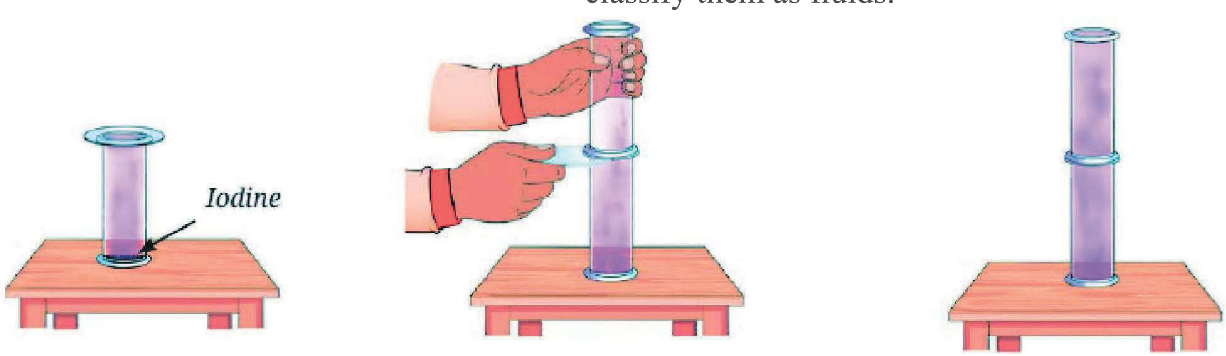


Fig. 3.8: Smoke spreads freely inside the gas jars

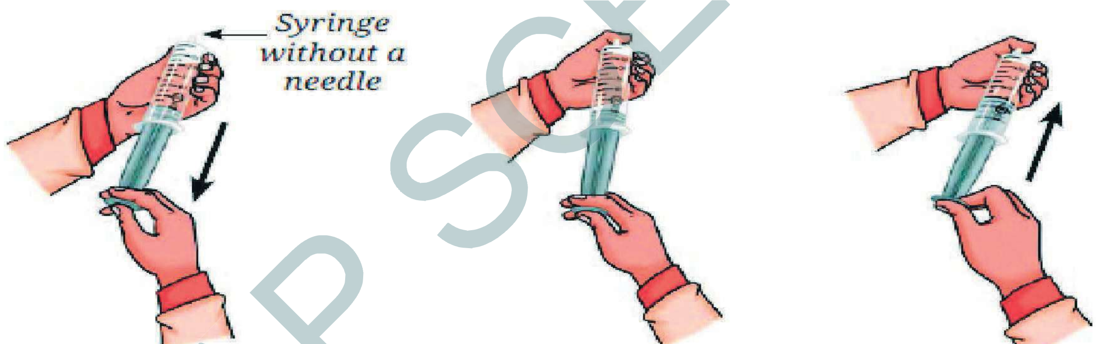
3.3 How Does the Interparticle Spacing Differ in the Three States of Matter?

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 3.6: Let us experiment

- Take a syringe without a needle. Pull the plunger of the syringe outwards in a fully extended position (Fig. 3.9(a)).
- Place your thumb over the open end of the syringe to prevent the air present inside the syringe from escaping (Fig. 3.9(b)).
- Push the plunger slowly and steadily inward (Fig. 3.9(c)).



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

Fig. 3.9: The syringe piston in different positions

- 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 3.7: Let us observe

- Take a glass vessel, fill it about half with water, and mark the level of water A (Fig. 3.10(a)).
- Add two teaspoons of sugar into it.
- Mark the new water level on the glass vessel B (Fig. 3.10(b)).
- Stir the water with a glass rod to dissolve the sugar (Fig. 3.10(c)).
- Predict whether the water level will increase or decrease with respect to the mark B.
- Mark this water level again as C (Fig. 3.10(d)).

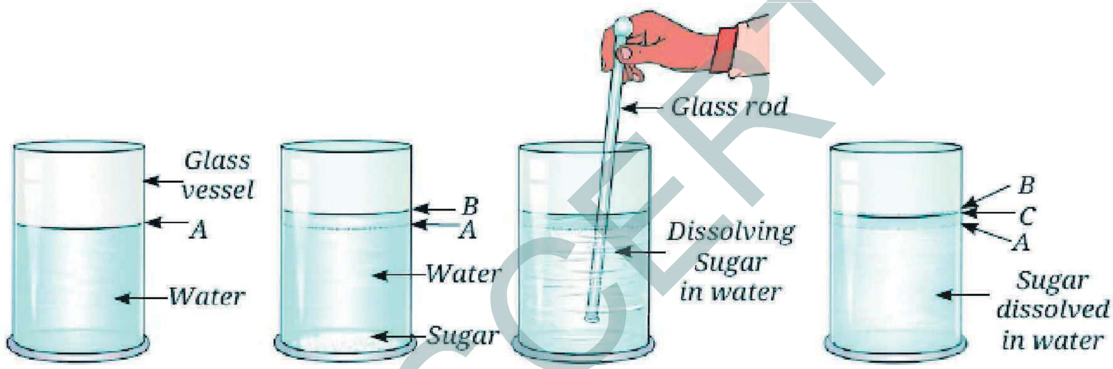


Fig. 3.10: Variation in water levels

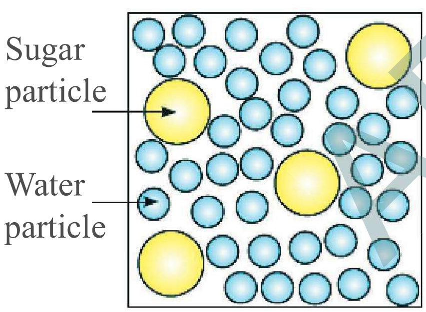


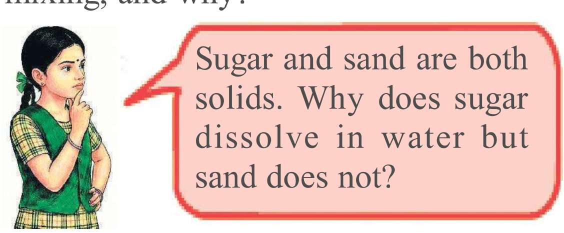
Fig. 3.11: Magnified schematic picture of distribution of sugar particles in water

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. 3.11).

Repeat the Activity 3.7 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?



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. 3.12(a). You might assume that the space between particles is filled with air, but this is not the case. They contain nothing at all. Fig. 3.12 summarises the packing of particles and the interparticle spacing in the three states of matter.

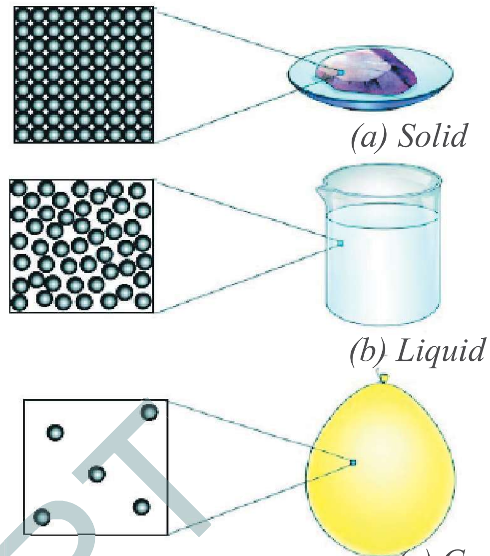


Fig. 3.12: Magnified schematic pictures of interparticle spacing in the three states of matter

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.

3.4 How Particles Move in Different States of Matter?

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

Activity 3.8: Let us experiment

Safety first

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

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

Fig. 3.13: (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. 3.13(a)).
- With the passage of time, the entire bulk of water will acquire a uniform pink colour (Fig. 3.13(b)).
- 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 3.9: Let us find out

- Light an incense stick in one corner of the room (Fig. 3.14).
- Wait for a few minutes and observe.
- Do you notice the fragrance from a distance?

Fig. 3.14: 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?

Ever heard of ...

Fig. 3.15: Particles of soap help in cleaning

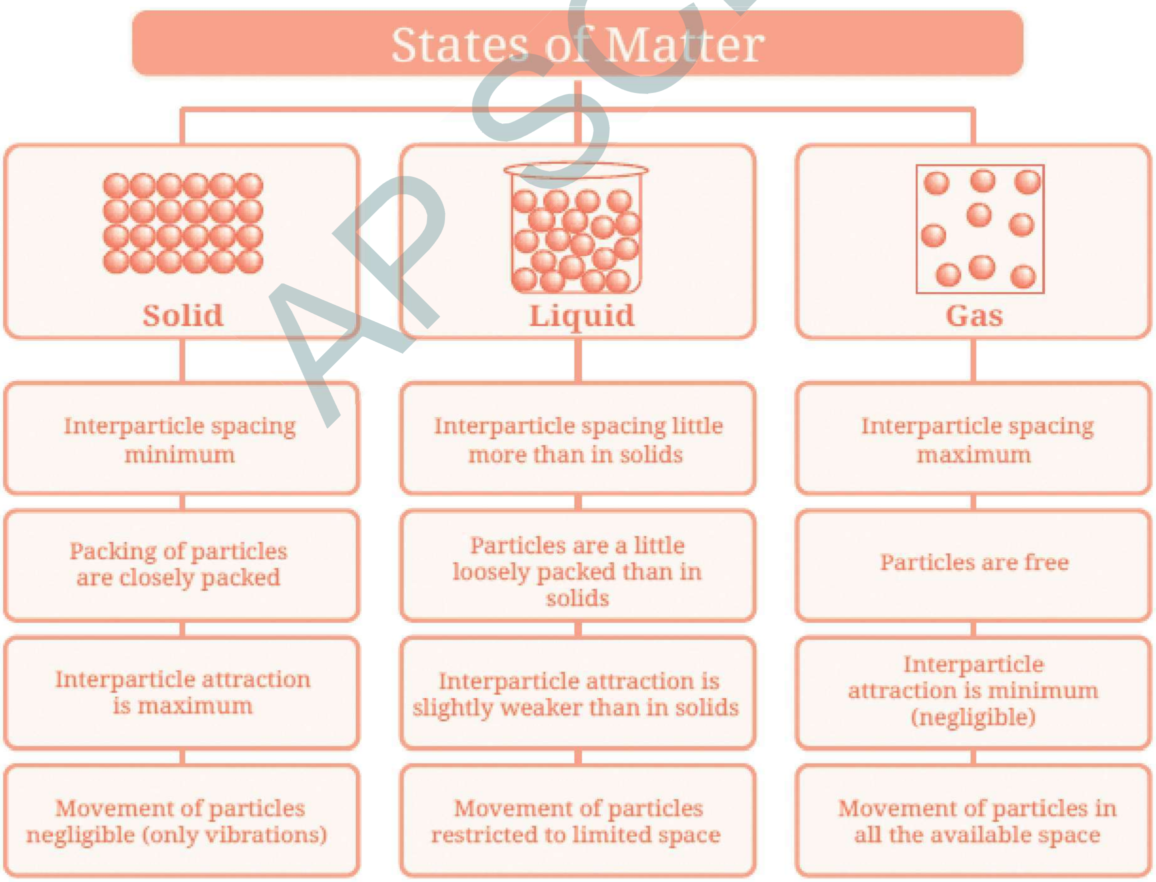
The particulate nature of matter plays a crucial role in many everyday processes. For example, when we wash clothes stained with oil using soap, numerous soap particles surround the oil particles on the fabric. One end of the soap particle attaches to the oil, and the other mixes with water, thus helping lift the oil off and wash it away (Fig. 3.15).

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–



Keywords

Matter | Solution | Melting Point

Boiling Point | Evaporation | Fluids

Atmospheric pressure | Diffusion & Compressiblity

Suspended Particulated Matter (SPM)

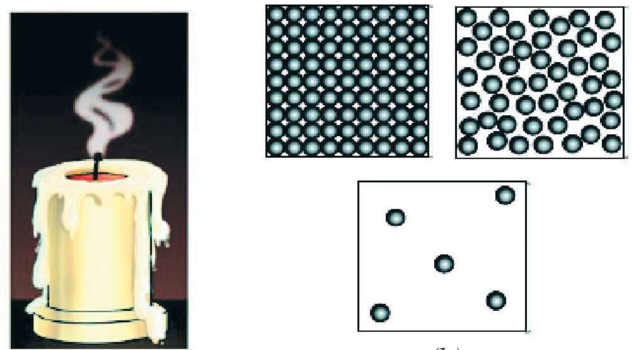
Snapshots

- 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.
   (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

8. Observe Fig. 3.16a 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. 3.16b showing the arrangement of particles.



(a) *(b)*

Fig. 3.16

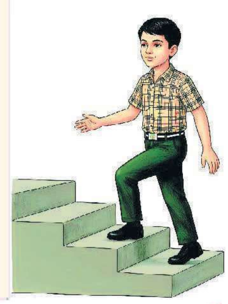
9. Why does the water in the ocean taste salty, even though the salt is not visible? Explain.
10. Grains of rice and rice flour take the shape of the container when placed in different jars. Are they solids or liquids? Explain.

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.



PREASSURE AND ITS EFFECTS

4

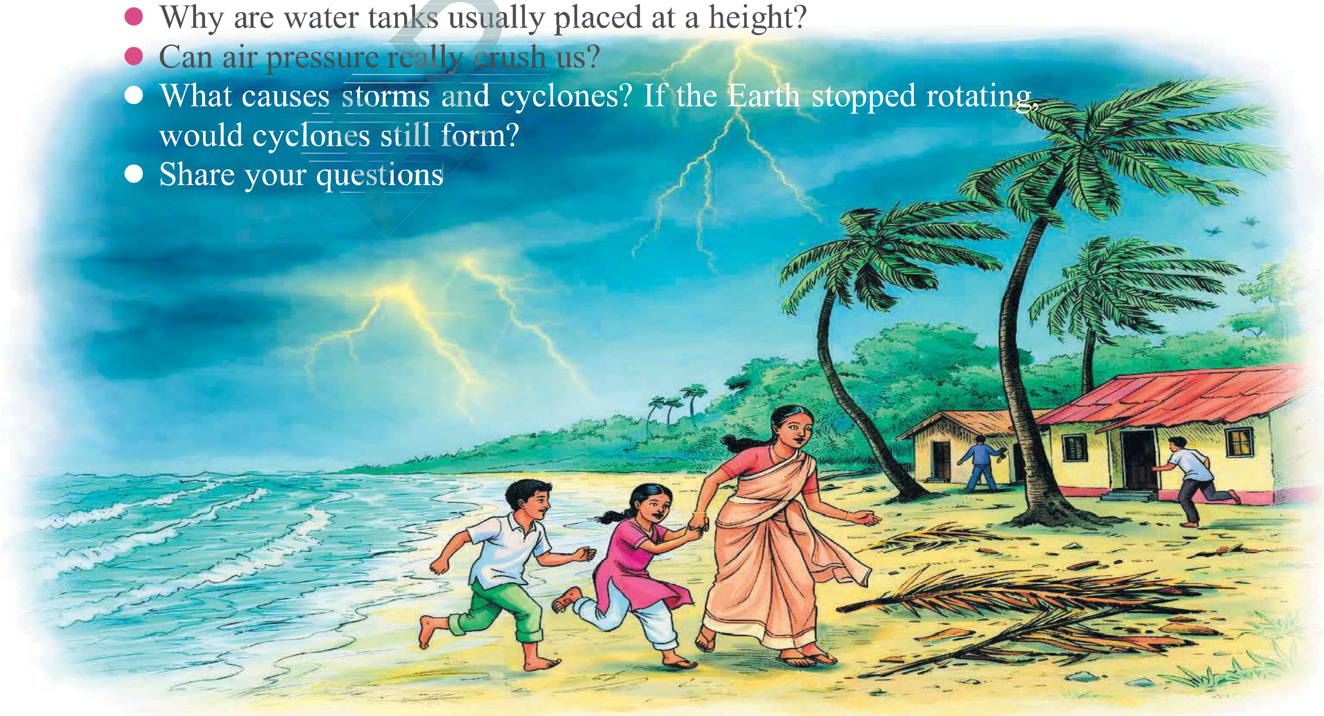
L6N1G9

Learners will be able to...

- Recognise that air exerts pressure in all directions. (CG-1)
- Understand that wind as movement of air from high-pressure regions to low-pressure regions. (CG-1)
- Recognise that unequal heating of land and water creates pressure differences. (CG-1)
- Explain thunderstorms as weather events caused by strong upward movement of warm air. (CG-1)
- Suggest suitable measures to reduce cyclone-related risks. (CG-5)

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.

4.1 Pressure

Megha and her brother Pawan are going on a picnic. They walk to the picnic spot, carrying identical items in their bags (Fig. 4.1). 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."

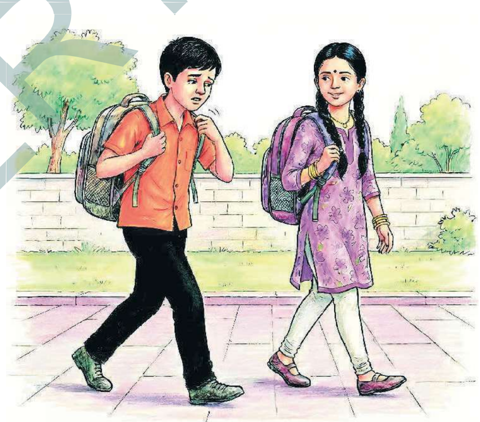


Fig. 4.1: Megha and Pawan carrying their bags

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.

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

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

Fig. 4.2: Buckets with broad and narrow handles

Fig. 4.3: 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. 4.2)? 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. 4.3). 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 m^2, then the pressure applied on the cardboard will be:

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

There are many situations in daily life where pressure plays a role. **Conduct** the activities given in Table 4.1 and **record** your observations. **Explain** how pressure influences the mode of action undertaken for each activity.

Safety first

The activities listed in Table 4.1 should be conducted under the supervision of an adult.

Table 4.1: 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 4.1? 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. 4.4) in your locality, or on the rooftops of houses used for water supply. Why are these tanks always placed at a height?

Fig. 4.4: Overhead tank

Do liquids also exert pressure?

Activity 4.1: Let us try and findout

- Take two transparent glass or plastic pipes of the same length (about 25 cm), but of different diameters, as shown in Fig. 4.5.
- Take two good-quality rubber balloons. Attach them to one end of each pipe.
- Clamp the pipes on a stand as shown in Fig. 4.5.
- 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?

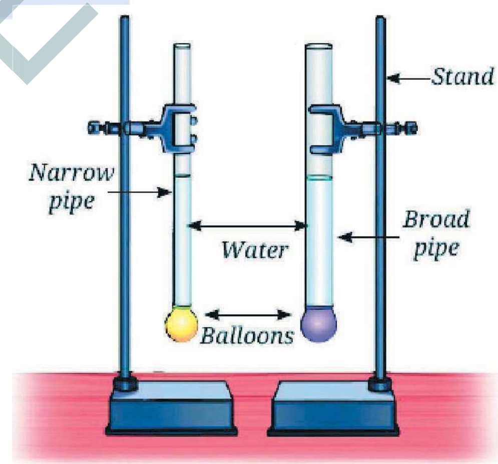


Fig. 4.5: Equal heights of water columns produce same bulge in balloons

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.

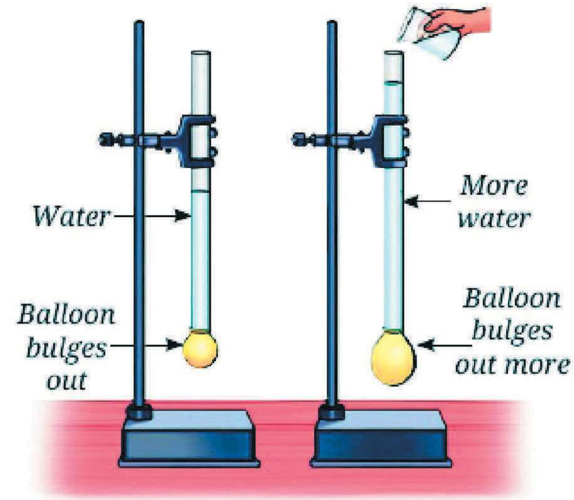


Fig. 4.6: Higher heights of water column produce bigger bulge of the balloon

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. 4.5. 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. 4.6.

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.

Activity 4.2: Let us findout

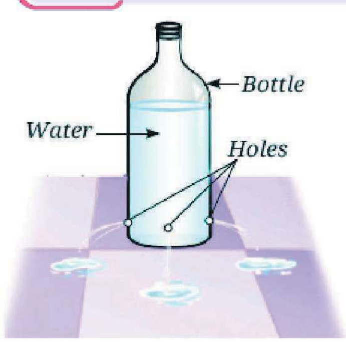


Fig. 4.7: Liquid exerts pressure on the wall of the container

- 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. 4.7. (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?

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?

Activity 4.3 Let us try and findout

- Take a plastic bottle. Punch three holes on its side in the same direction, but at different heights. Now pour some water into it and let it flow through the holes. Observe the flow of water. Water from the lowest hole comes out with the greatest force and the water from the topmost hole comes out with the least force.

This activity confirms that the pressure in a liquid varies with the depth of the point of observation in it.

Fig 4.8: Liquid pressure increases with depth

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. 4.9). 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.

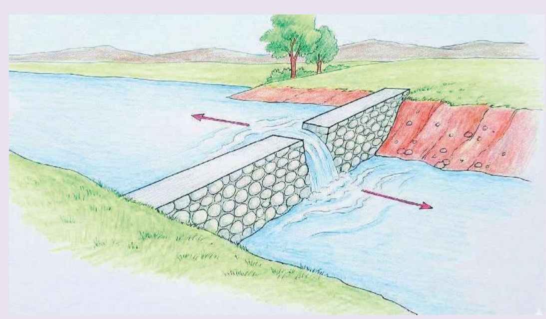


Fig. 4.9: Dam

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

4.2 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 4.4: Let us explore

- Take a paper plate, invert it and attach a stick to it as shown in Fig. 4.10(a). 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 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. 4.10(b).
- 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. 4.10(c).
- Lift the paper plate again and feel the effort needed in doing so.

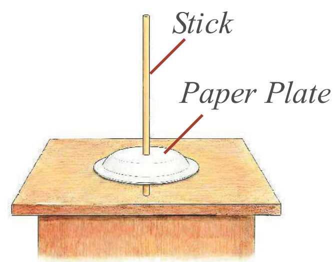


Fig. 4.10: (a) Inverted paper plate setup

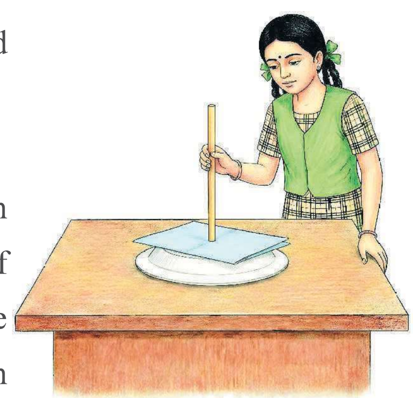


Fig. 4.10: (b) Inverted paper plate with two folds of chart paper

- 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.

Fig. 4.10: (c) Inverted paper plate with unfolded chart paper

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. More over, this force increases with increase in the area of covering sheets. It means indirectly 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. 4.11: 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 4.11). 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?

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

Activity 4.5: Let us Perform

Fig. 4.12: A sucker

- Take a good-quality rubber sucker. Press it firmly against a smooth flat surface (Fig. 4.12).
- 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.

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.

4.3 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?

Let us find out from the following activity.

Activity 4.6: Let us observe

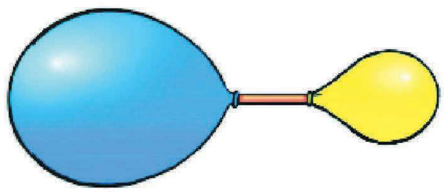


Fig. 4.13: Air moves from a high pressure region to a low pressure region

- 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. 4.13.
- 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.

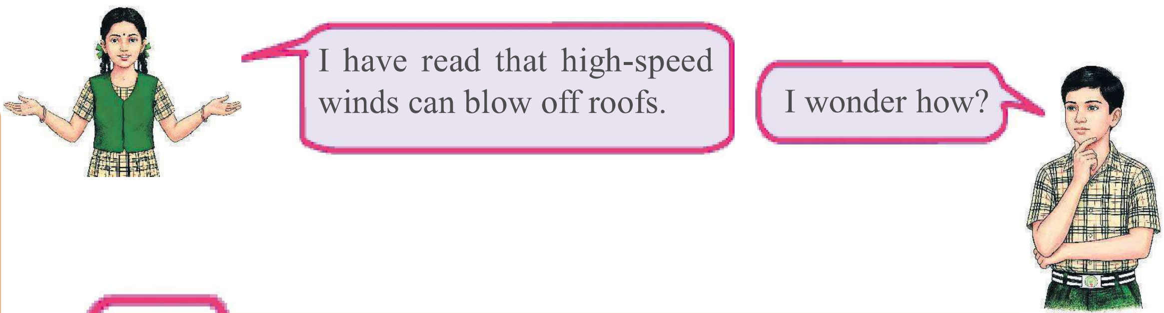
....

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 *Science text book Class 7*. As land gets heated faster than water during the day, the air above the land 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 4.6, we would find that the speed of the air is higher if the pressure difference is higher.



4.4 High-Speed Winds Result in Lowering of Air Pressure

Activity 4.7: 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. 4.14).
- 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. 4.14: 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.

Fig. 4.15: (a) Roof of a house blown away

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. 6.15 a. That is why it is safer to keep doors and windows of the houses open during storms with high-speed winds.

Fig. 4.15: (b) Roof of a house intact

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. 4.15(b).

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.

Scientist

Bernoulli's Principle states that faster moving air has lower pressure and slower moving air has higher pressure. This rule explains many things we see around us! Airplane wings, Flying Birds, Spinning balls, Perfume Sprays and Atomizers.

4.5 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.

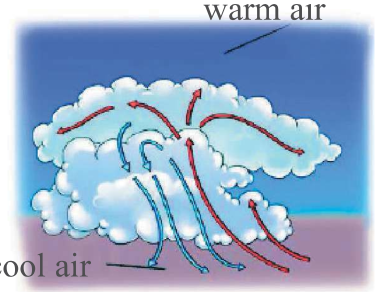


Fig. 4.16: Strong winds going up and down

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. Strong winds blowing upwards and downwards (Fig. 4.16) facilitate rubbing between water droplets and ice particles. 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.

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. 4.17).

Fig. 4.17: Lightning

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

Thunderstorms convert more atmospheric nitrogen into nitrates that fall with rain.These nitrates help the growth of plants. Isolated and localized 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.

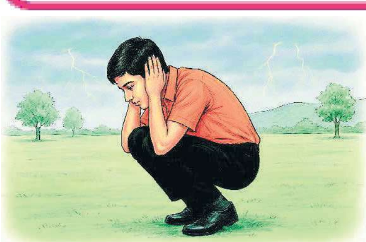


Fig. 4.18: Safe position during lightning

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.

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. 4.19). 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.

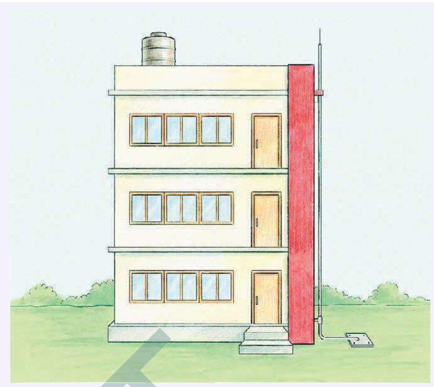


Fig. 4.19: A lightning conductor

4.6 Cyclone

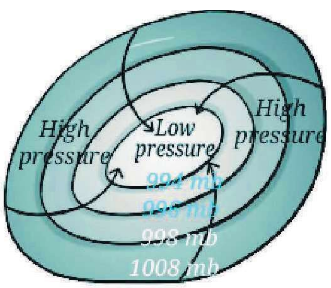


Fig. 4.20: Winds blowing from high pressure areas to low pressure areas

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. 4.20). 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.

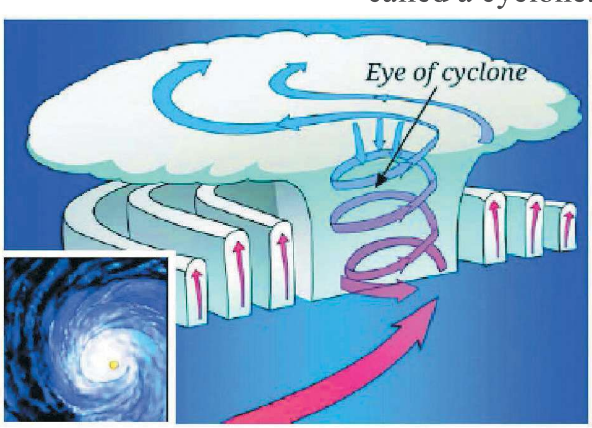


Fig. 4.21: A cyclone

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.

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.

Sea water that rushes inland can contaminate drinking water sources and damage farmland. The salt in sea water 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.

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.

Keywords

Pressure | Atmosphere | Atmospheric pressure

Storm | Lightening | Thunder

Thunder Storm | Cyclone | Satellites

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.

Keep the curiosity alive

1. Define the following

   a. Pressure b. Pascal c. Atmospheric pressure d. Lightning

   e. Lightning conductor

2. Pressure is best described as

   A. The total force acting on an object B. The force acting per unit area

   C. The area over which force is applied D. The weight of an object

3. What will happen to the two identical balloons A and B as shown in Fig. 4.22 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.

Fig. 4.22

4. Fig. 4.23 shows trees along the sea coast in a summer afternoon. Identify which side is land — A or B. Explain your answer.

Fig. 4.23

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

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5. Describe an activity to show that air flows from a region of high pressure to a region of low pressure.
6. What is a thunderstorm? Explain the process of its formation.
7. Explain the process that causes lightning.
8. Explain why holes are made in banners and hoardings.
9. A person finds it easier to carry a schoolbag with wide straps than narrow straps because:
   A) Wide straps reduce the weight of the bag
   B) Wide straps reduce pressure on the shoulders
   C) Wide straps increase force on the shoulders
   D) Narrow straps increase surface area
10. Choose the correct statement.
   i) Look at Fig. 4.24 carefully.
   Vessel R is filled with water.
   When pouring the 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

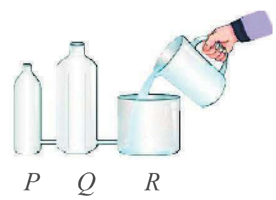

Fig. 4.24

11. 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.

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

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12. 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.

13. Two vessels, A and B contain water up to the same level as shown in Fig. 4.25. PA and PB is the pressure at the bottom of the vessels. FA and FB is the force exerted by the water at the bottom of the vessels A and B.

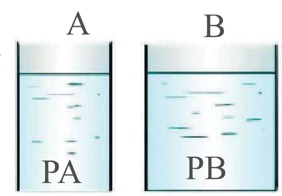


Fig. 4.25

A) PA = PB, FA = FB   B) PA = PB, FA <FB

C) PA < PB, FA = FB   D) PA > PB, FA > FB

14. 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.

15. 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?

16. Would lightning occur if air and clouds were good conductors of electricity? Give reasons for your answer.

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

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

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

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

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

18. Fig. 4.26(a) shows a boy lying horizontally, and Fig. 4.26(b) shows the boy standing vertically on a loose sand bed. In which case does the boy sink more in sand? Give reasons.

Fig. 4.26(a)

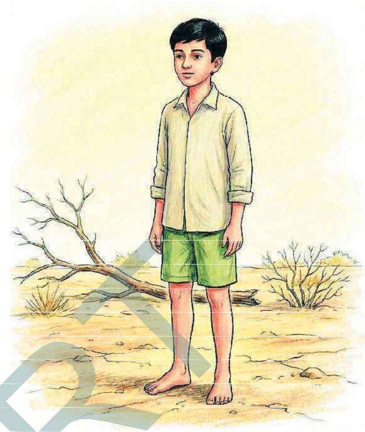


Fig. 4.26(b)

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 occurred 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?

SOLUTIONS

5

P5T8M8

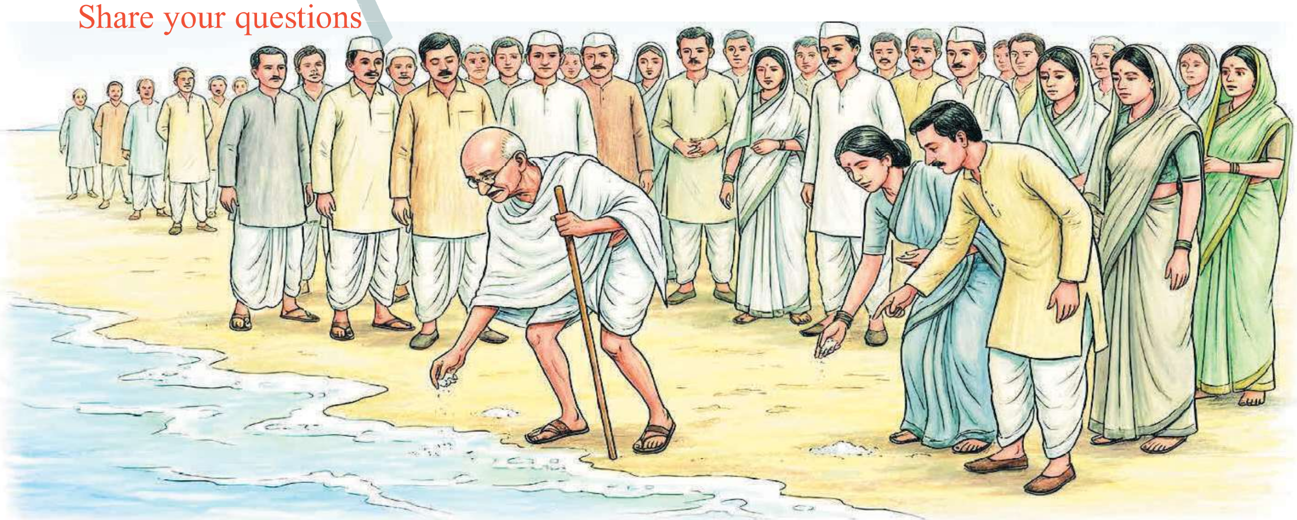
Learners will be able to:

- Recognises solutions as homogeneous mixtures used in daily life. (CG-1)
- Defines the terms solute and solvent. (CG-1)
- Explains that solubility of most solids increases with temperature. (CG-1)
- Identifies a saturated solution as one in which no more solute can dissolve at a given temperature. (CG–1)
- Distinguishes between concentrated and dilute solutions. (CG-1)
- ⅡAnalyses how mass and volume affect the density of a substance. (CG-1)
- Measures Mass,Volume and there by density of substances. (CG-1)

Probe and Ponder

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

Share your questions



You must have taken an Oral Rehydration Solution (ORS) at some time in your life. ORS is used to treat dehydration by keeping your body hydrated. You have learnt to prepare ORS at home in Class 6. You may have wondered why every sip of your homemade ORS tastes the same, no matter how much you drink. Why does it not taste salty in one sip and sweet in another? This is because when you add sugar and salt to water, they form a mixture in which the components are evenly distributed throughout.

Fig. 5.1: Mixture of sugar, salt, and water

Can you predict whether this mixture is uniform or not (Fig. 5.1) ? What happens when chalk powder is mixed with water—does it form a uniform mixture?

When salt and sugar are mixed with water, a uniform mixture is formed, where as when chalk powder or sand, or sawdust is mixed with water, the components are not evenly distributed. Such mixtures are known as non-uniform mixtures (Fig. 5.2(a) and 5.2(b)).

Fig. 5.2: Mixture of (a) Sand and water; (b) Sawdust and water

Example of uniform mixture: Saltwater, Air, Alloy etc.

Example of non-uniform mixture: Salad, oil and water mixture etc.

Let us explore the science of mixing things together.

5.1 What Are Solute, Solvent, and Solution?

A uniform mixture, such as that of salt or sugar, and water, is called a solution. Whenever a solid is mixed with a liquid to form a solution, the solid component is called the solute, and the liquid component is called the solvent. The solute dissolves in the solvent to form a solution (Fig. 5.3).

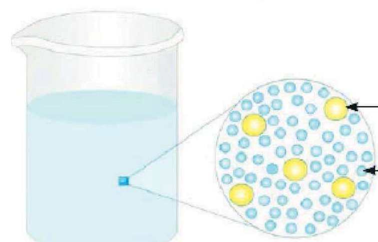
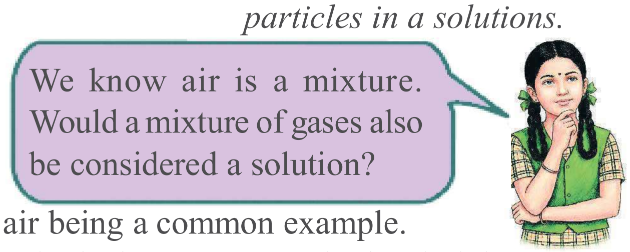


Fig. 5.3: evenly distributed solute particles in a solutions.

Solute + Solvent → Solution

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



Just as water can act as a solvent in liquid solutions, gases can also form solution — with air being a common example. Air is a gaseous solution. Since nitrogen is present in the largest amount in the air, it is considered as the solvent, while oxygen, argon, carbon dioxide, and other gases are considered as solutes.

Solute	Solvent	Name of Solution	Type of Solution
Zinc	Copper	Brass	Solid
Salt	Water	Salt Water	Liquid

Ever heard of ...

The Chashni (sugar syrup) of the Indian sweet Gulab jamun is made of a large amount of sugar (solid) dissolved in a small amount of water (liquid). However, the water is still considered as the solvent and sugar as the solute (Fig. 5.4)!

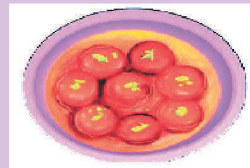


Fig. 5.4: Gulab jamuns dipped in sugar syrup

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

Activity 5.1: Let us investigate

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

- Take a clean glass tumbler and fill it half with water.
- Add one spoon of salt into it and stir well fill it dissolves completely (Fig. 5.5).
- Gradually add a spoonful of salt into the glass tumbler and stir. Observe how many spoons of salt you can add before it stops dissolving completely.
- Record your observations in Table 5.1.

Table 5.1: Dissolution of salt in water

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

Some discussion points

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

You might have observed that, initially, the salt completely dissolves in the water, forming a solution. After adding a few more spoons of salt, a stage comes when the added salt does not dissolve completely and the undissolved salt settles at the bottom. This indicates that the water can no longer dissolve any more salt because it has reached its limit. The solution in which more solute can be dissolved at a given temperature, is called an unsaturated solution (Fig. 5.5). However, when the solute stops dissolving and begins to settle at the bottom, the solution is called a saturated solution at that particular temperature (Fig. 5.6).

Fig. 5.5: Unsaturated solution

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

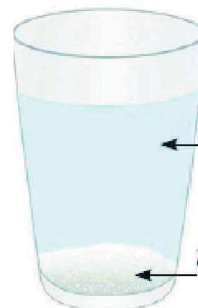


Fig. 5.6: Saturated solution

So, one can say in Activity 5.1, the solution obtained by dissolving one spoon of salt is dilute as compared to that obtained by dissolving two or more spoons of salt.

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

From Activity 5.1, we can say that the maximum amount of solute that dissolves in a fixed quantity of the solvent is called its solubility.

Does temperature affect the solubility of a solute?

Let us find out!

5.2.1 How does temperature affect the solubility of a solute?

Activity 5.1: Let us investigate

- Take about 50 mL of water in a glass beaker and measure its temperature using a laboratory thermometer, say 25 °C.
- Add a spoonful of baking soda (sodium hydrogen carbonate) to the water and stir until it dissolves. Continue adding small amounts of baking soda while stirring, till some solid baking soda is left undissolved at the bottom of the beaker.

Safety first

Be careful while using the heating device.

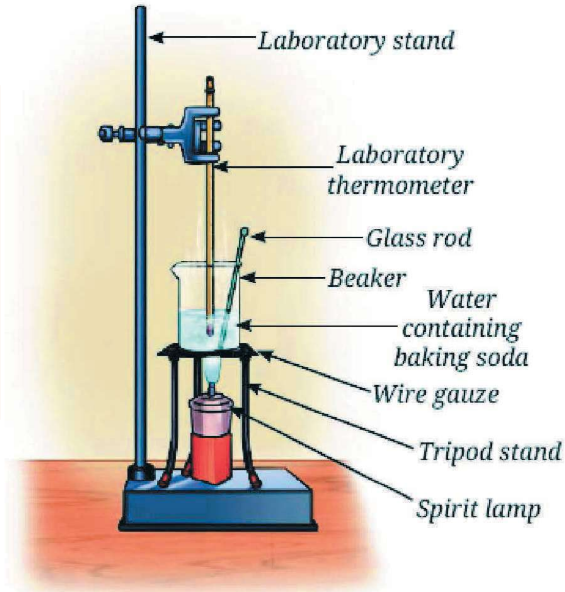


Fig. 5.7: Dissolution of baking soda in water

- Now, heat the contents to 50 °C while stirring (Fig. 5.7).
- What happens to the undissolved baking soda?
- You will observe that it has dissolved.
- Continue adding more baking soda while stirring at this temperature until some solid baking soda remains undissolved.
- Again, heat the contents further to 70 °C while continuing to stir. What do you observe?
- The undissolved baking soda dissolves.
- What do you infer from this experiment?

Water at 70 °C dissolves more baking soda than water at 50 °C. The amount of baking soda dissolved in water at 25 °C is even lesser.

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

Our Scientific heritage

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

Be a scientist

What inspired Asima Chatterjee to work on medicinal plants?

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

Do gases also dissolve in water?

5.3 Solubility of Gases

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

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

It is a uniform mixture because the gases dissolve evenly in water to form a solution. Does temperature affect the solubility of gases in liquids also? If so, how? It has been observed that the solubility of gases generally decreases as temperature increases. More oxygen can dissolve in cold water, ensuring sufficient oxygen for aquatic life (Fig. 5.8). On the other hand, when water warms up, the solubility of oxygen decreases.

Fig. 5.8: Aquatic species in water

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

Ever heard of

Water Soluble gases:

Carbon dioxide
Ammonia
Chlorine
Nitrogen

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

Ever heard of

Uniform mixtures : Homogeneous, consistent composition throughout.

Non-Uniform mixtures : Heterogeneous, visibility distinct parts.

5.4 Why Do Objects Float or Sink in Water?

Fig. 5.9: Some objects float while others sink in water

You must have observed that some objects float while others sink in water (Fig. 5.9). You may have noticed that, while washing rice, husk particles present in the rice float on the surface of water while rice sinks to the bottom of the container. Why does this happen? If you add oil to water, it floats on water. Generally, it is believed that objects that float in a liquid are lighter and others that sink are heavier than the liquid.

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

Note

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

5.5 What Is Density?

Fig. 5.10 (a): Dense forest

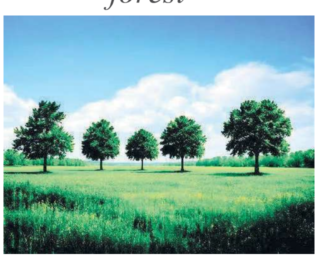


Fig. 5.10 (b): Less dense forest

Imagine a crowded bus where many people are packed together — this is an example of high density whereas, the same bus with only a few people is an example of low density. Similarly, a forest where trees grow close to each other is called a dense forest (Fig. 5.10(a)), but if the trees are far apart (Fig. 5.10(b)), it is considered less dense.

How do scientists define density?

Let us find out.

We have learnt that matter is anything that possesses mass and occupies space (volume). Density is defined as the mass present in a unit volume of that substance. The density of a substance may be expressed mathematically using the formula:

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

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

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

Conversion factor for density

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

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

Suppose the mass of an aluminium block is 27 g and its volume is 10 cm^3, its density is 2.7 g/cm^3. From this, it can be said that aluminium is 2.7 times denser than water. We express this fact by saying that the relative density of aluminium with respect to water is 2.7. It is a number without any units.

Relative density of any substance with respect to water

$$= \frac{\text{Density of that substance}}{\text{Density of water at that temperature}}$$

Fig. 5.11: Packed oil

1. Calculate the density of wooden box, if mass is 2kg and its volume 20cm^3.
2. The density of Carbon is 2.25 g/cm^3. What is relative density of Carbon ?

Think like a scientist

Have you noticed that some packets of ghee or oil are labelled with a volume of 1 litre but a weight of only say 910 grams (Fig. 5.11)? What does this tell us about the density of the oil, and is it less or more than that of water?

5.5.1 Determination of density

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

How to measure mass?

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

You may measure the mass by doing the following activity.

Activity 5.3: Let us investigate

Fig. 5.12(a): Digital weighing balance

Fig. 5.12(b): Tare the balance after placing a watch glass

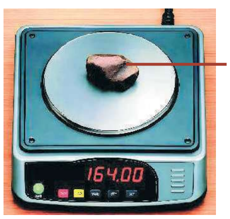


Fig. 5.12(c): Weighing a solid object on digital balance

- Switch ON the digital weighing balance.
- Observe the initial reading on the digital weighing balance display.
- It should show a zero reading. If not, then we must bring it to zero by pressing the tare or reset button (Fig. 5.12(a)).
- Place a dry and clean watch glass or butter paper on the pan.
- Note the reading on the digital weighing balance.
- Reset the digital weighing balance reading to zero by pressing the tare or reset button as shown in Fig. 5.12(b).
- Now, carefully place the solid object, such as stone, on the watch glass (Fig. 5.12(c)).
- Note the reading displayed on the balance, which gives the mass of the stone, say 16.400 g.

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

Note

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

A step further

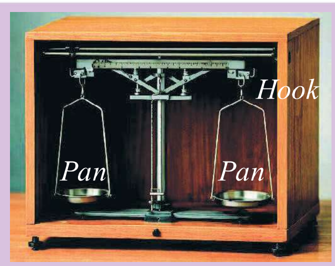


Fig. 5.13: Two-pan balance

The words 'mass' and 'weight' are often used interchangeably in everyday language. But they have different meanings in science, which can sometimes cause confusion. Mass is the quantity of matter present in an object or a substance. Its units are gram (g) and kilogram (kg). On the other hand, weight is the force by which the Earth attracts an object or a substance towards itself, and it is measured in newtons (N). Most balances (except two-pan balances like in Fig. 5.13) actually measure weight, but their scales are marked in mass units, so they show values in grams or kilograms (Fig. 5.12(c)).

How to measure volume?

A tetra pack says it contains 200 mL buttermilk Fig. 5.14). What does that mean?

Fig. 5.14: A pack of buttermilk of 200 mL

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

One of the common apparatuses used to measure the volume of liquids is a measuring cylinder. It is a narrow transparent cylindrical container with one side open and the other side closed as shown in Fig. 5.15. There are markings on the transparent body of the cylinder that indicate the volume of liquid in the measuring cylinder. We can use it to measure the desired amount of a liquid.

Measuring cylinders are available in different sizes to measure volume — 5 mL, 10 mL, 25 mL, 50 mL, 100 mL, 250 mL, etc (Fig. 5.15). How accurately can these measuring cylinders measure? Let us find out!

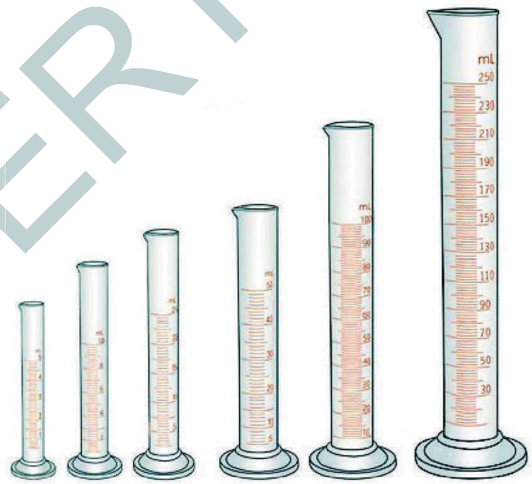


Fig. 5.15: Measuring cylinders of different capacities

Activity 5.4: Let us observe and calculate

In Science, Class 6, chapter 'Temperature and Its Measurement', you learnt how to use the thermometer and to find its smallest reading; you can do the same with a measuring cylinder. Take a measuring cylinder and observe it carefully. Note down the following:

- What is the maximum volume it can measure? Now look at the measuring cylinder (Fig. 5.16) carefully. The cylinder is marked as 100 mL; therefore, it can measure volume up to 100 mL.
  What is the smallest volume it can measure? Look at the measuring cylinder again.
- How much is the volume difference indicated between the two bigger marks? (for example-between 10 mL and 20 mL)

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

The smallest volume that the measuring cylinder can read is__________.

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

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

The number of divisions between these marks is 10.

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

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

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

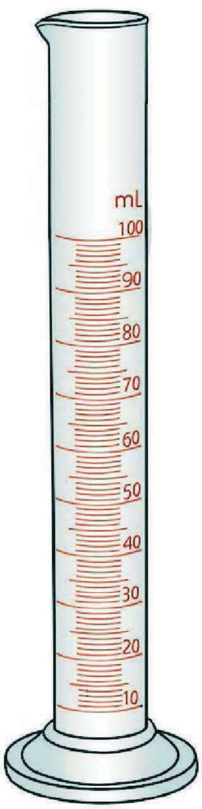


Fig. 5.16: Measuring cylinder of 100 mL

Activity 5.5: Let us measure

- Place a clean, dry measuring cylinder on a flat surface.
- Pour water slowly into the measuring cylinder up to the required mark, as shown in Fig. 5.17.
- If required, adjust the level of water in the measuring cylinder by adding or removing a small amount of water using a dropper.
- On careful observation, you will notice that the water inside the measuring cylinder forms a curved surface. This curved surface is called the meniscus (Fig. 5.18).
- Read the mark on the measuring cylinder that coincides with the bottom of the meniscus for water or other colourless liquids.
- Make sure that the eyes are at level with the bottom of the meniscus while noting the readings as shown in Fig. 5.18.

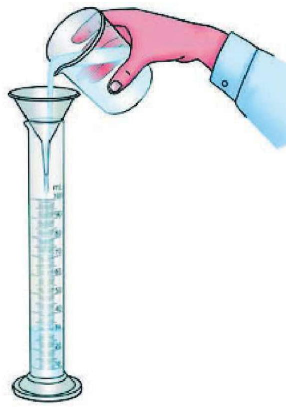


Fig. 5.17: Pouring water into the measuring cylinder

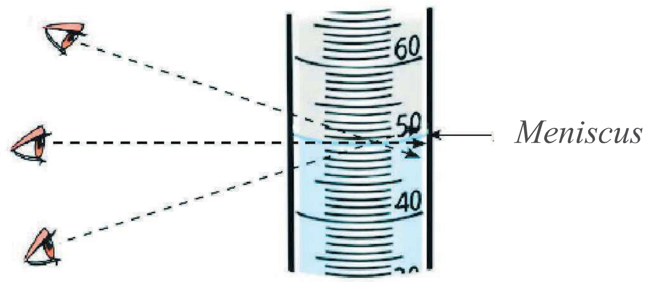


Fig. 5.18: Measuring the reading

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

Ever heard of

It's an important factor in accurately measuring liquid volume. The curvature of the Meniscus can be either concave or convex, depending on the liquid and the material of the container.

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

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

Determining volume of solid objects with regular shapes

Activity 5.6: Let us calculate

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

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

Volume = 25 cm × 18 cm × 2 cm = 900 cm^3

- Record in your notebook.

Determining volume of objects with irregular shapes

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

Activity 5.7: Let us measure

Fig. 5.19: Level of water in the measuring cylinder (a) Without object; (b) With object

- Collect various objects from your surroundings, such as a stone, metal keys, and so on.
- Fill a measuring cylinder with water up to any desired volume, say 50 mL (Fig. 5.19(a)) and record the initial volume taken in Table 5.2.
- Tie the object, say a stone, with a thread and slowly lower it into the measuring cylinder.
- What do you notice?
- Record the final volume after the level rises, say 55 mL, as shown in Fig. 5.19(b).
- Subtract the initial volume from the final volume after the object is put into the measuring cylinder. This is the volume of the object.
- Record your observations in Table 5.2.

Table 5.2: Volume of irregular solids

S.No.	Object	Initial volume of water in the measuring cylinder (mL) (A)	Final volume of water in the measuring cylinder (mL) (B)	Volume of water displaced in the measuring cylinder (mL) (B–A)	Volume of the object (cm^3)
1.	Stone	30 mL	55 mL	5 mL	5 cm^3
2.	Metal key				
3.	Any other				

Note

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

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

Let us calculate the density

Density can be calculated using the following formula:

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

Let us dig deeper!

Did you know that our planet, Earth, is composed of several layers, such as crust, upper mantle, lower mantle, outer core, and inner core, each with its particular range of density? The outermost layer, called the crust, is the lightest and the density of the different layers increases as we move towards the centre (Fig. 5.20). As one moves deeper into the Earth, both the pressure and the temperature rise significantly, making the materials heavier and more compact.

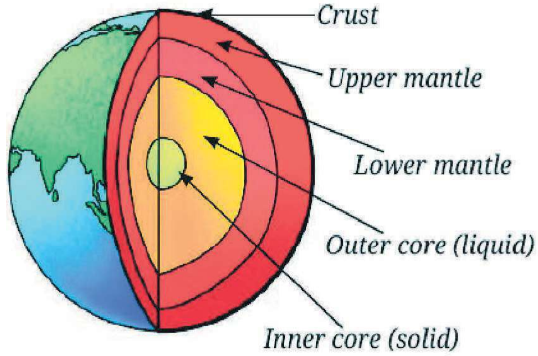


Fig. 5.20: Layers of Earth

Ever heard of ...

Fig. 5.21: Bamboo raft floats on water

In ancient times, before large ships were invented, people used bamboo and wooden logs to travel across rivers and seas (Fig. 5.21). Bamboo was used because it is light, hollow, and floats easily on water. People tied bamboo poles together to make rafts and small boats for fishing, trading, and crossing water bodies. Wooden logs, especially from strong trees were either hollowed out to make boats or used as rafts. These simple boats, made from locally available materials, were important for moving around and connecting different places. Even today, similar traditional boats made of bamboo or wood are used in some regions—not just for transport, but also as tourist attractions.

5.5.2 Effect of temperature on density

Generally, the density of a substance decreases with heating and increases with cooling. This can be explained on the basis of what you have learnt in chapter 'Particulate Nature of Matter'. As temperature increases, the particles of a substance whether, solid, liquid, or gas, tend to move away and spread. This results in an increase in volume but there is no change in mass. Since the Density = Mass/Volume, upon heating, the volume increases and the density decreases. This explains why hot air moves up as it is less dense than the cool air around it. The hot air balloon works on the same principle (Fig. 5.22).

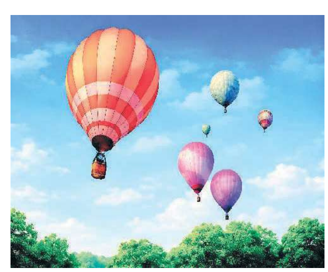


Fig. 5.22: Rising of hot air balloons

9.5.3 Effect of pressure on density

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

Ever heard of ...

Fig. 5.23: Ice floats on water

Why does ice float on water? Ice floats on water because it is lighter than liquid water (Fig. 5.23). Water has a special property that its density is highest at 4 °C. It means water is heaviest at 4 °C. As the temperature drops, and water turns into ice at 0 °C, it undergoes a change in structure—the particles arrange themselves in a way that takes up more space. This process is called expansion. Because the same amount of water now occupies a larger volume, its density decreases. As a result, ice becomes lighter than liquid water and floats on its surface. This is important for animals living in lakes and oceans because ice floats, it forms a layer on top, keeping the water underneath warm enough for fish and other creatures to survive, even in extremely cold weather.

Ever heard of ...

- Take a glass tumbler and fill it with tap water. Carefully place a raw whole egg into the water and observe what happens. You will notice that the egg sinks to the bottom (Fig. 5.24).
- What change can you make to this setup to make the egg float in water instead of sinking?
- In this chapter, you have learnt the concept of density and how it explains partially why some objects float while others sink.

Fig. 5.24: Raw whole egg sinks in water

Keywords

Solute	Solvent	Non-uniform mixture
Solution	Dissolve	Unsaturated solution
Saturated solution	Dilute solution	Concentrated solution
Solubility	Sink	Float
Density	Relative Density	Digital weighing balance
Measuring cylinder	Meniscus	Regular shaped solid

Snapshots

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

Keep the curiosity alive

1. Define the following:
   a) Solution b) Solute c) Solvent
   d) Saturated solution e) Unsaturated solution f) Solubility
   g) Mass h) Volume i) Density
2. Pressure is best described as:
   A. The total force acting on an object B. The force acting per unit area
   C. The area over which force is applied D. The weight of an object
3. Fill in the blanks.
   i) The volume of a solid can be measured by the method of displacement, where the solid is __________ in water and the ____________ in water level is measured.
   ii) The maximum amount of _______________ dissolved in _______________ at a particular temperature is called solubility at that temperature.
   iii) Generally, the density ____________ with increase in temperature.
   iv) The solution in which glucose has completely dissolved in water, and no more glucose can dissolve.
4. You pour oil into a glass containing some water. The oil floats on top. What does this tell you?
   i) Oil is denser than water
   ii) Water is denser than oil
   iii) Oil and water have the same density
   iv) Oil dissolves in water
5. You are provided with an experimental setup as shown in Fig. 5.26(a) and 5.26(b). On keeping the test tube (Fig 5.26b) in a beaker containing hot water (~70 °C), the water level in the glass tube rises. How does it affect the density?

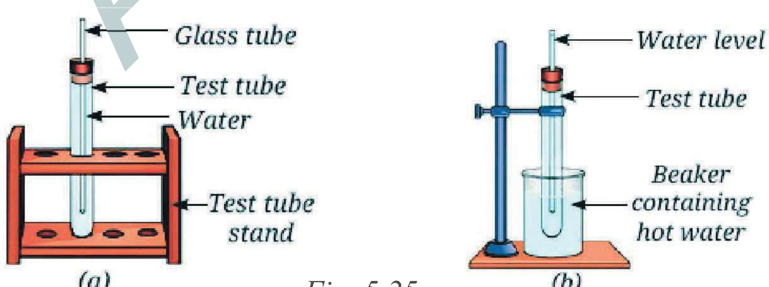


Fig. 5.25

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

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6. A stone sculpture weighs 225 g and has a volume of 90 cm3. Calculate its density and predict whether it will float or sink in water.
7. You have a bottle with a volume of 2 litres. You pour 500 mL of water into it. How much more water can the bottle hold?
8. An object has a mass of 400 g and a volume of 40 cm³. What is its density?
9. Analyse Fig. 5.25(a) and 5.25(b). Why does the unpeeled orange float, while the peeled one sinks? Explain.

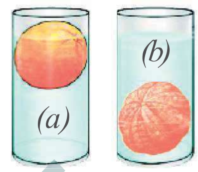

Fig. 5.26

10. Object A has a mass of 200 g and a volume of 40 cm³. Object B has a mass of 240 g and a volume of 60 cm³. Which object is denser?
11. Reema has a piece of modeling clay that weighs 120 g. She first moulds it into a compact cube that has a volume of 60 cm³. Later, she flattens it into a thin sheet. Predict what will happen to its density.
12. A block of iron has a mass of 600 g and a density of 7.9 g/cm³. What is its volume?
13. Ravi lives on the ground floor of an apartment building. His neighbour lives on the first floor. Both flats receive water from the same overhead tank, but Ravi notices that water flows with greater force in his taps than in his neighbour's taps.
    What is the most appropriate reason for this observation?
    A. Water becomes heavier as it flows downward
    B. The water tank contains more water for the ground floor
    C. The length of the pipe connected to the ground floor is longer
    D. The pressure at the tap increases due to a greater height of the water column
14. Which one of the following is the most appropriate statement, and why are the other statements not appropriate?
    i) A saturated solution can still dissolve more solute at a given temperature.
    ii) An unsaturated solution has dissolved the maximum amount of solute possible at a given temperature.
    iii) No more solute can be dissolved into the saturated solution at that temperature.
    iv) A saturated solution forms only at high temperatures.

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

....

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

Discover, design, and debate

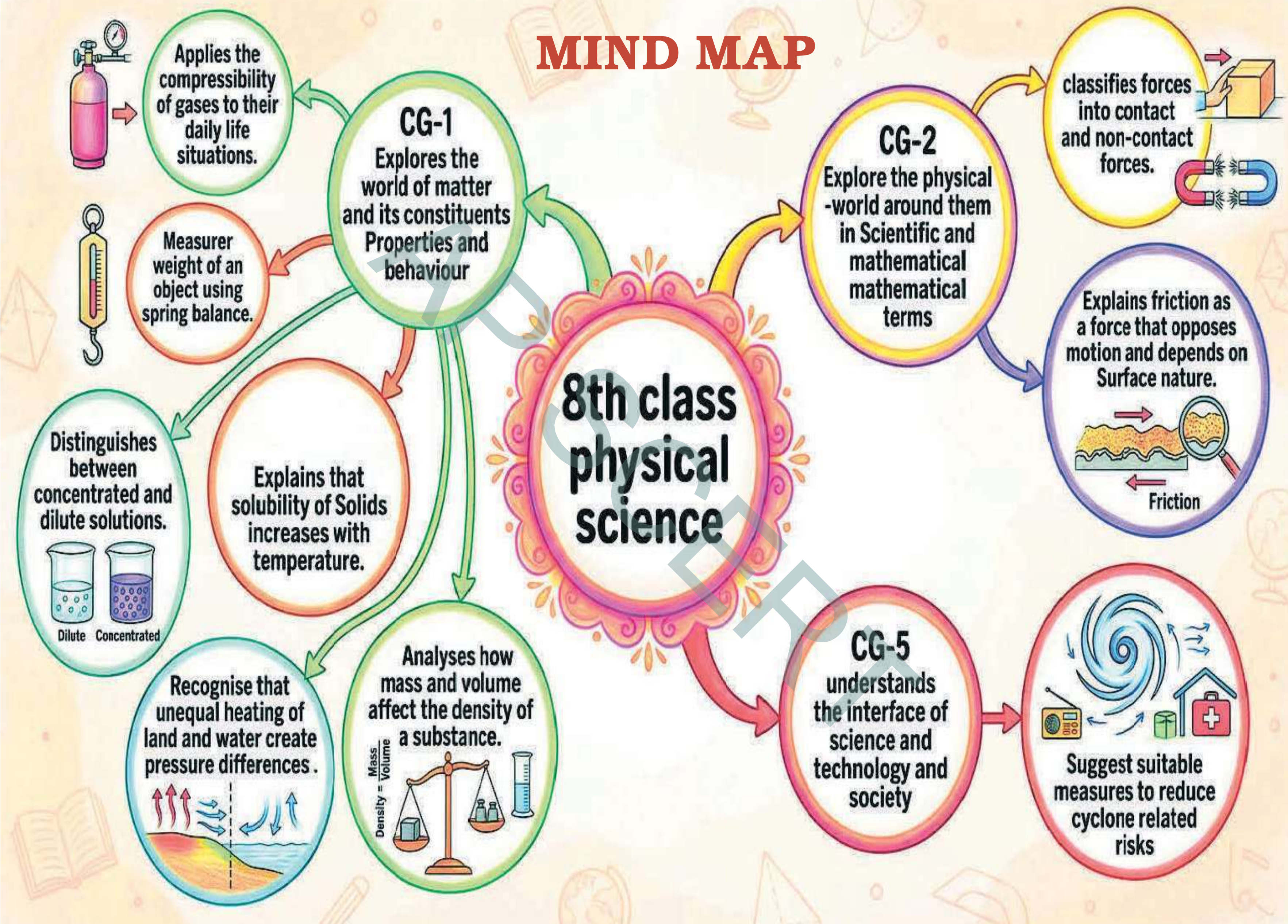
- Research project on Dead Sea: Why is there no aquatic life in the Dead Sea? Try to find out if there are any other similar water bodies.
- Investigate how well common salt dissolves in different solvents, such as water, vinegar, and oil. Compare the solubility of salt in each solvent and record your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

Our scientific heritage

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

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

MIND MAP


8th class physical science
CG-1
Explores the world of matter and its constituents Properties and behaviour
Applies the compressibility of gases to their daily life situations.
Measurer weight of an object using spring balance.
Distinguishes between concentrated and dilute solutions.
Dilute
Concentrated
Explains that solubility of Solids increases with temperature.
Recognise that unequal heating of land and water create pressure differences .
Analyses how mass and volume affect the density of a substance.
Density = Mass / Volume
CG-2
Explore the physical -world around them in Scientific and mathematical mathematical terms
classifies forces into contact and non-contact forces.
Explains friction as a force that opposes motion and depends on Surface nature.
Friction
CG-5
understands the interface of science and technology and society
Suggest suitable measures to reduce cyclone related risks