



## Chapter 1

# Matter and its Composition

### Chapter Objectives

In this chapter, you will learn about:

- ◆ Matter and its properties
- ◆ Composition of matter

- ◆ Characteristics of matter

There are a lot of things, such as water, stones and air, that we see or feel around us. How are they different? Can they be similar in some way? Discuss.

## MATTER

Most of the things that we see or feel around us are matter. What do you think is matter?

*Anything that occupies space and has mass is called matter.* Air, water, soil, stone, wood, pen, paper and fabric are some examples of matter.

*Mass is the amount of matter contained in an object.*

Let us perform a simple activity (Action Time 1) to show that matter occupies space and has mass.

### ACTION TIME 1

**Aim:** To show that matter occupies space and has mass.

**Materials required:** two balloons of equal size, weighing balance made from a stick, thread and pin (to prick the balloon)

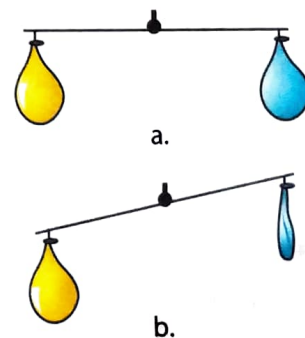
#### Procedure:

1. Take the balloons and observe how they look. Now, inflate air into each balloon and observe the change in their size and shape.
2. Now, tie the balloons on each end of the balance as shown in figure a.
3. Next, prick one balloon with a pin and observe the movement of balance (figure b).

**Observation:** The balloons were flat before the air was filled in them. After inflating, the size of the balloons increased. When the balloons were tied to the balance, it was almost in **equilibrium**. After pricking one of the balloons, the balance got tilted to the side of the other inflated balloon.

**Conclusion:** After inflating, the air occupied the space inside the balloon, and hence the balloon increased in size. This shows air (matter) occupies space.

After pricking, the balance tilted towards the inflated balloon which shows that the inflated balloon was heavier. This shows that air (matter) has mass.



Matter exists in three states—solids, liquids and gases. All these states of matter show the basic characteristics of matter, that is, they all have mass and occupy space.

The characteristics of matter can be summed up as:

- Matter occupies space.
- Matter has mass.
- Matter can be identified through senses such as touch.

Let us explore more about these states of matter and their properties.

## STATES OF MATTER

As discussed, matter exists in three states. All the states of matter may or may not exist naturally. Water exists in all the three states, that is, ice (solid), water (liquid) and water vapour (gas). Most states of matter can be changed from one form to the other through different physical processes.

The process in which the matter changes from one state into another and finally back to the original state is called **interconversion**. This process involves change of matter from one state to another. It is affected by changes in conditions, such as temperature, force and pressure.

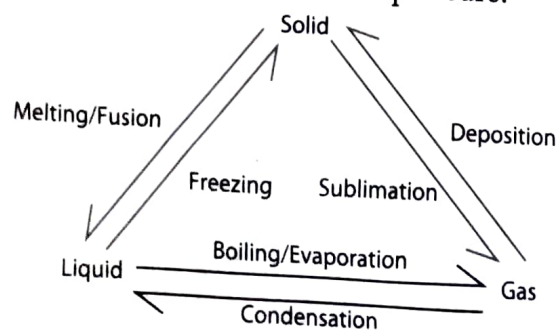


Fig. 1.1 Interconversion of states of matter

## Solids

Substances such as stone, wood, duster, book and pencil are some examples of solid state of matter.

## Characteristics of solids

- Solids have a fixed or definite shape, size and volume.
- They cannot be compressed on application of external force.
- Solids cannot flow.



Fig. 1.2 Solids have a fixed shape and size

Sponge is a solid. Then how can it be compressed? Discuss.

## Liquids

Substances such as water, milk, oil and juice are some examples of liquid state of matter.

## Characteristics of liquids

- Liquids do not have a fixed or definite shape and size, but they have a fixed volume. They take up the shape of the container in which they are kept.
- They can be compressed slightly on application of a large amount of external force.
- They can flow from a higher level to a lower level. This is why most liquids are also called **fluids**.



Fig. 1.3 Liquids do not have a fixed shape

## Gases

Substances such as smoke and air are some examples of gaseous state of matter.

## Characteristics of gases

- Gases neither have fixed shape nor size. They do not have a fixed volume.
- They can be highly compressed on application of external force, as compared to solids and liquids.



- The gases can flow and spread to as far as possible.

## COMPOSITION OF MATTER

What helps the existence of these states of matter? How are these states of matter different from each other?

All matter is made up of tiny particles called **atoms**. An atom is the smallest particle of an element, which may or may not exist on its own. *An atom is the basic unit of matter.* The word atom originated from the Latin word 'atomos', which means 'indivisible.'

Atoms combine together to form larger particles called **molecules**. *A molecule is the smallest particle of a substance, which can normally exist on its own.*

Atoms of either the same element or different elements join together to form larger particles called molecules. For example, two atoms of the same element oxygen (O) combine together to form a molecule of oxygen (O<sub>2</sub>). Similarly, two atoms of hydrogen combine with one atom of oxygen to form one molecule of water.

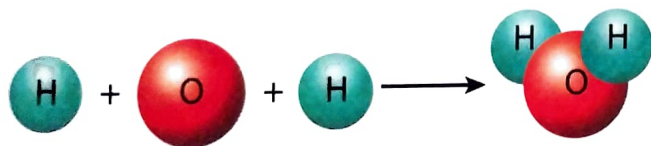


Fig. 1.4 Two atoms of hydrogen and one atom of oxygen combine to form one molecule of water.

the lesser will be the intermolecular spaces. Intermolecular forces and intermolecular spaces help in determining the properties of states of matter.

The **solids** have strong intermolecular forces and almost negligible intermolecular spaces. This is why the solids have a fixed shape and size as they do not have spaces between the particles. Therefore, particles of solids cannot move and hence solids cannot be compressed. Solids cannot diffuse (that is, move from higher to the lower level).

The **liquids** have weaker intermolecular forces and hence, more intermolecular spaces as compared to solids. They do not have a fixed shape. Since particles can flow and move freely, liquids are called fluids. Liquids can diffuse from higher level to the lower level.

The **gases** have the weakest intermolecular forces and maximum intermolecular spaces. This is why the molecules of gases can flow to the available space. Due to more intermolecular spaces, gases can be compressed very easily, even more than liquids. Gases can diffuse from higher level to the lower level.



Fig. 1.5 Gases flow and diffuse

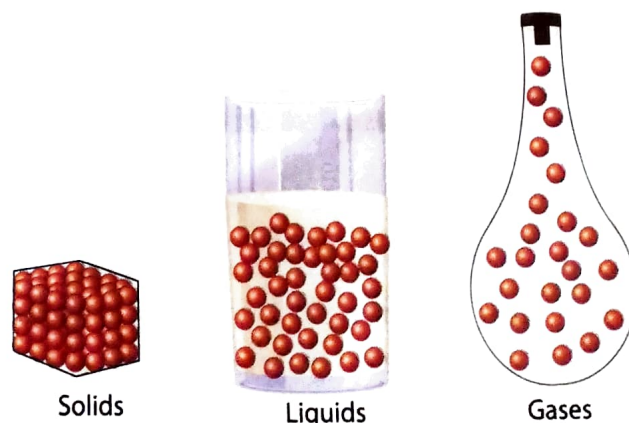


Fig. 1.6 Arrangement of molecules in solids, liquids and gases

## CHARACTERISTICS OF MATTER

According to the particle theory of matter, the particles of matter are in continuous random motion. These *particles are held together by forces of attraction called intermolecular forces.* The *spaces present between the particles are called intermolecular spaces.* The stronger the intermolecular forces between the particles,

**Table 1.1** Differences between solids, liquids and gases

Property	Solids	Liquids	Gases
<b>Intermolecular forces</b>	They have the strongest intermolecular forces.	They have weaker intermolecular forces than solids.	They have the weakest intermolecular forces as compared to solids and liquids.
<b>Intermolecular spaces</b>	They have the least intermolecular spaces as compared to liquids and gases.	They have more intermolecular spaces than solids.	They have the maximum intermolecular spaces as compared to solids and liquids.
<b>Shape</b>	They have definite shape.	They have indefinite shape.	They do not have definite shape.
<b>Size</b>	They have definite size.	They do not have definite size.	They do not have definite size.
<b>Volume</b>	They have definite volume.	They have definite volume.	They have indefinite volume.
<b>Flow</b>	They cannot flow.	They can flow.	They can flow and take up the entire available space.
<b>Compressibility</b>	They cannot be compressed.	They can be slightly compressed but require a great deal of pressure.	They can be compressed very easily.

### Quick Check 1

**State whether the following statements are True or False.**

1. Solids can be compressed.
2. The lesser the intermolecular forces, the lesser is the intermolecular spaces.
3. The gases can be compressed more than liquids.
4. The solids can diffuse from higher level to the lower level.
5. Liquids can be compressed slightly, using great pressure.
6. Matter is anything that occupies space and has mass.
7. Solids have a rigid structure and a fixed volume.
8. Liquids take up the shape of the container.
9. Gases cannot diffuse.
10. Just like liquids, gases can also be called fluids.

### KEY TERMS

**Matter:** Anything that occupies space and has mass

**Fluids:** Substances that can flow conform to the outline of its container

**Intermolecular forces:** The forces of attraction between the atoms or molecules of a matter

**Intermolecular spaces:** The spaces present between the atoms or molecules of a matter



## QUICK NOTES

- \* Matter has mass and occupies space.
- \* Matter can be identified by senses such as touch.
- \* Solids, liquids and gases are the three states of matter.
- \* In solids, the intermolecular force is the strongest and intermolecular space is the least.
- \* In gases, the intermolecular force is the weakest and intermolecular space is the maximum.
- \* Solids have a fixed shape, size and volume. They can neither be diffused nor compressed.
- \* Liquids have a fixed volume but do not have a fixed shape and size. They can diffuse and can be compressed slightly.
- \* Gases do not have a fixed shape, size or volume. They can diffuse and are highly compressible.

## RUN-THROUGH

### I. Very Short Answer Questions.

#### A. Tick (✓) the correct answer.

- Which of the following cannot diffuse?  
 a. Water ☐    b. Milk ☐    c. Smoke ☐    d. Spoon ☒
- Which of the following statements is incorrect?  
 a. Matter occupies space. ☐  
 b. Matter does not have mass. ☒  
 c. Solids are rigid. ☐  
 d. Liquids and gases are fluids. ☐
- Which of the following is the most compressible substance?  
 a. Air ☐    b. Water ☐    c. Juice ☐    d. Wood ☐
- Which of the following has the least intermolecular space?  
 a. Liquids ☐    b. Gases ☐    c. Solids ☐    d. None of these ☐
- Which of the following is not an example of fluid?  
 a. Eraser ☒    b. Water ☐    c. Milk ☐    d. Juice ☐

#### B. Fill in the blanks.

- The solids have maximum intermolecular ..... and least intermolecular ..... (space/force).
- Gases and liquids can ..... (compress/diffuse) from higher level to the lower level.
- The ..... (solids/liquids) can take up the shape of the container.
- The ..... the intermolecular forces, the ..... are the intermolecular spaces (stronger/lesser).
- The solids have ..... shape and ..... (size/fixed).

**C. State whether the following statements are True or False.**

1. Liquids can flow from a higher to lower level.
2. Gases have a fixed volume.
3. Solids have the strongest intermolecular forces.
4. Liquids can be compressed easily.
5. A molecule is the basic unit of matter.

**II. Short Answer Questions.**

**A. Question and Answers.**

1. What is matter? Give examples.
2. How are the molecules in matter held together?
3. How are intermolecular forces and intermolecular spaces related?
4. Define mass of a body.
5. Why do solids have fixed shape whereas liquids do not?
6. State the properties of matter.

**B. Define the following terms.**

1. Matter
2. Mass
3. Interconversion
4. Intermolecular force
5. Fluids

**C. Give reasons for the following:**

1. Although we cannot see air, but it is a form of matter.
2. Air does not have fixed shape and volume.
3. Intermolecular space in solids is negligible.
4. Liquids take up the shape of containers in which they are kept.

**III. Long Answer Questions.**

1. Intermolecular forces and intermolecular spaces define the properties of solids, liquids and gases. Explain the statement with examples.
2. How are the properties of solids, liquids and gases different from each other?
3. Explain with an activity to prove that matter has mass and occupies space.

**IV. Challenge**

1. Diya was reading about matter. She gave shadow as an example of matter. Was she right? Give reasons for your answer.
2. Just like air, we cannot see sound, but we can feel and hear it. So, can sound also be considered as matter? Give reasons for your answer.

**V. Enrichment**

**A. Poster Making**

Make a poster on any social awareness topic. Depict the message by using all the states of matter.

**B. Plasma—What is it? (Read, Research and Report)**

Other than solids, liquids and gases (the three states of matter), that we have studied here in this chapter, there are two more states of matter. One of them is called plasma. Plasma is a state of matter that is often thought of as a subset of gases, but the two states behave very differently. Like gases, plasma has no fixed shape or volume, and is less dense than solids or liquids.

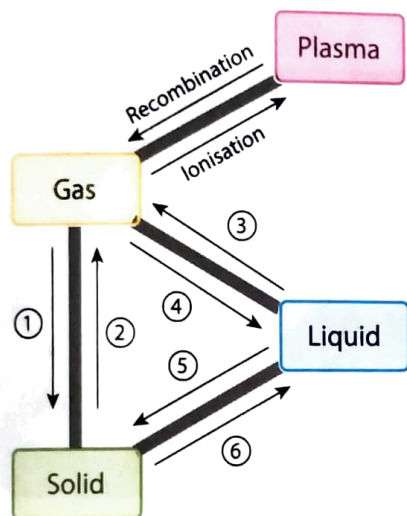
Plasma is a lot like gases, but the atoms are different because they are made up of free electrons and ions of an element such as neon (Ne). You won't find any naturally-occurring plasmas too often when you walk around. They aren't things that are found regularly on the Earth.

Natural plasmas are not found around us that often, but human-made plasmas are everywhere. Have you seen fluorescent light bulbs? They are not just regular light bulbs. When electricity is made to flow in these bulbs, atoms get excited due to energy. This charging and exciting of gases inside fluorescent bulbs due to electricity creates glowing plasma.

You can also see plasma when you look at the stars. Stars are big balls of gases at really high temperatures. The high temperatures charge up the atoms and create plasma.

Research using Internet and books and write a one-page report in your notebook.

**Now, complete the concept map.**



Label the numbers 1 to 6.

1. ....
2. ....
3. ....
4. ....
5. ....
6. ....

**Think and Discuss:**

What do the terms 'recombination' and 'ionisation' mean? Search the Internet and discuss in class.



## SCIENTIFIC QUEST

1. Scientists have been studying two more states of matter other than solids, liquids and gases. They are Plasma and Bose-Einstein Condensate (BEC). Find out about the **Bose-Einstein Condensate** state of matter and explain how it is different from the other states of matter.

2. **The many phases of water.**

Explain what is happening to the water in each picture.



a. ....  
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### Life Connect

b. ....  
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c. ....  
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3. Search the Internet and note down the weather conditions in any five regions of India. Find any two cities where it might be snowing and might be raining. Represent your data in tabular format. Is there any relationship between temperature and weather? Discuss and make a one-page report in your Chemistry notebook.