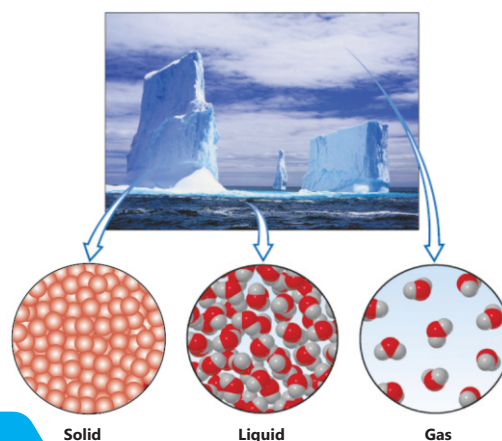


# UNIT 4

## MATTER AND CHANGES IN ITS STATES



### In this unit, we will learn:

- Matter
- Arrangement of particles in solids, liquids and gases
- Effects of heat on arrangement of particles
- Processes involving change in states (Melting, Freezing, Boiling, Evaporation and Condensation)
- Application of condensation and evaporation in nature (Water Cycle)

Things all around us are made up of matter. Matter has mass and occupies space. Different substances are made up of different kinds of matter. The food we eat, the water we drink and the air we breathe in, all are examples of matter. In this unit we shall study properties of different states of matter. The arrangement of particles in different states of matter, the effect of heat on matter, and processes involved in changing the states of matter will also be discussed.

#### Activity 4.1

Hold up your hand close to your mouth and breathe out through your mouth. The warm air you feel on your hand is matter. Touch the tip of your finger to your tongue. Your fingertip becomes wet from the saliva. Saliva is matter. Touch your hair, a fingernail, your nose and teeth. These parts of your body are all composed of matter.

## 4.1 Physical States of Matter

Matter exists in three states, namely, solid, liquid and gas. Table, stone, pen and bag are the examples of solids. Water, milk, oil, blood, etc. are the examples of liquid. Oxygen, carbon dioxide and water vapours are examples of gases. Other examples of solids, liquids and gases are shown in the pictures below (Figure 4.1).



Figure 4.1

We can see and feel many solid, liquid and gaseous things around us. The question is why solids, liquids and gases are different from each other? This is due to the arrangement of particles present in them.

### Arrangement of particles in solids, liquids and gases

Every kind of matter is composed of small particles which are in constant random motion. Let us discuss the arrangement of these particles in three states of matter, i.e., solids, liquids and gases (Figure 4.2).

#### Solids

The particles of solid substances are tightly packed with each other. These are arranged in an order. There are strong attractive forces between them. The particles vibrate only at their mean positions. They cannot be compressed easily. That is why solids have fixed shape and fixed volume.

#### Liquids

The particles of liquid substances are very close to each other, but are not arranged in an order. The attractive forces between them are strong but weaker than solids. Liquids cannot be compressed easily because their particles are quite close to each other. Their particles can move away and

towards each other and thus liquids can flow. Liquids have fixed volume but their shape is not fixed. The liquids take the shape of the vessel in which they are kept.

## Gases

The forces of attraction between the particles of gases are very small. The distances between the gas particles are much greater than those of solids and liquids. Gas particles move freely in all directions. They occupy all available space. They constantly collide with each other and with the walls of the container. In this way, they exert pressure. Gases have no fixed shape and no fixed volume.

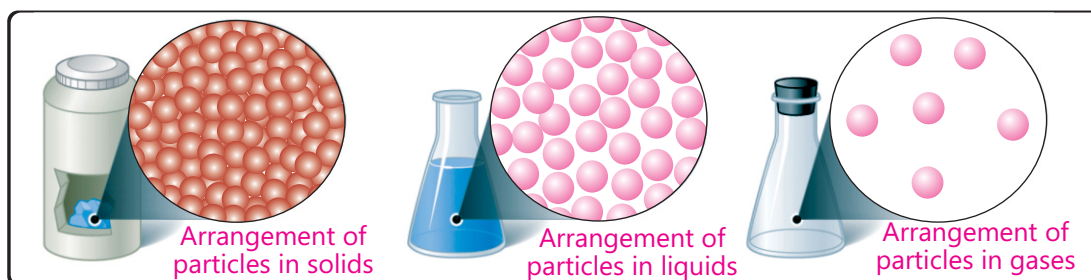


Figure 4.2

### Activity 4.2

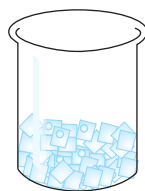
- Take three cardboard pieces and cover them with white paper using transparent insulation tape.
- Take beads of different colours and use them to present as particles of matter.
- Taking help from the diagram above, paste the beads of one colour on one of the boards and make a model showing arrangement of particles in solids.
- Make the models of liquid and gaseous states of matter in the same way on the other boards.

### Interesting information

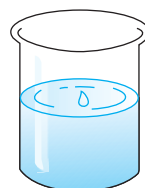
The human body is an interesting example of states of matter. Our bodies have solids (skin, muscles and bones), liquids (blood, saliva, acids, etc.), and gases (oxygen and carbon dioxide in the lungs, etc.).

### Do you know?

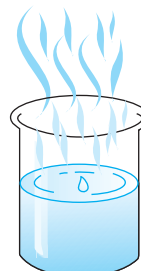
Most of the materials are commonly found in just one or two physical states. Water exists naturally on the Earth in all the three states. It depends on temperature and other conditions such as humidity and air pressure. Water often changes from one state to another.



Ice



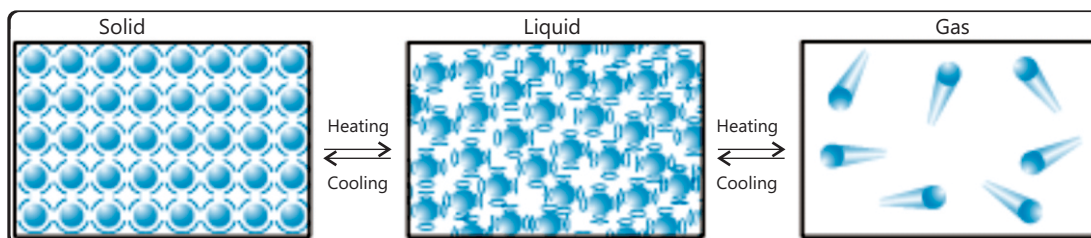
Liquid water



Water vapours

## 4.2 Effect of Heat on the Arrangement of Particles

Properties of matter change with a change in temperature (Figure 4.3). When heated, the particles gain energy, move faster and move away from each other. That is why things expand on heating.



Effect of heat on arrangement of particles in solids, liquids and gases

Figure 4.3

On cooling, the particles lose energy, their motion becomes slower and distances between them are decreased. That is why things contract on cooling.

## 4.3 Processes Involving Change in States of Matter

Physical state of matter can be converted from one form to another on heating or cooling. Melting, freezing, boiling, evaporation and condensation are the processes involved in changing the states of matter.

### Mini Exercise

1. Mercury in the bulb of a thermometer expands when placed under a person's arm pit or tongue. Why?
2. An inflated balloon placed in the Sun bursts after sometime. Why?

## Melting

The change of solid state of matter into its liquid state due to heat is called melting. When ice cubes melt, they change their state. Solid ice becomes liquid water. This is due to the heat energy absorbed by the ice cubes from surroundings.

When a solid is heated, its particles start vibrating faster. Spaces between them increase. On continuous heating, particles of the solid substance vibrate faster and faster. The forces of attraction between them become weaker and they begin to move away from each other. Hence, liquid state is attained by the solid.

### Mini Exercise

What happens to ice cream when it is kept out of the freezer?

## Freezing

The change of liquid state of matter into solid state on cooling is called freezing. When liquid water is kept in the freezer, it freezes. Its state is changed. Liquid water becomes solid ice. In this process, heat energy is lost from liquid water to surroundings. As a result, movement of particles in liquid becomes slower and they come closer to each other. The spaces between the particles are decreased. Finally, the liquid contracts and gets solidified.

### Activity 4.3

- Take a candle and light it.
- Observe and discuss what is happening.
- Some of the wax melts into its liquid state (process of melting).
- The molten wax moves away from the flame and solidifies back into its original solid state (process of freezing).
- The wax melts due to the heat of the burning wick and on cooling, it hardens again.



## Boiling

If we heat a liquid continuously, the movement of its particles becomes faster and faster. Spaces between particles are increased and attractive

forces between them become weaker. Finally, the liquid begins to change into bubbles of vapours or gas. Heating changes the liquid state of matters into its gaseous state, in the form of vapours. This process is called boiling (Figure 4.4).

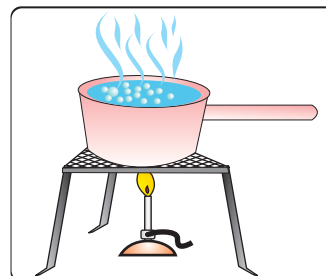
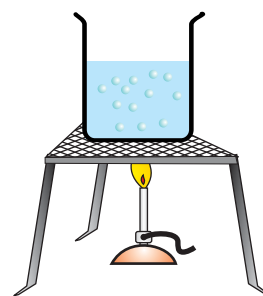


Figure 4.4 Boiling of water

#### Activity 4.4 (Demonstration by the teacher)

- Take a beaker and pour some water in it.
- Place wire gauze over a tripod stand and then place the beaker over it as shown in the figure.
- Heat the water and observe what happens to it?
- After a few minutes, you would observe that water starts boiling.

**Cautions:** (i) Never play with the burner and matches.  
(ii) Do not touch boiling water.



### Evaporation

The change of liquid state of matter into its gaseous state without boiling is called evaporation (Figure 4.5). Wet clothes are dried due to evaporation.

When liquid water evaporates, it changes its state. Liquid water goes into the surrounding air as water vapours. Water can evaporate at any temperature. Evaporation of water takes place from the surfaces of sea, rivers, canals, lakes, etc. It also takes place from the leaves of the plants and from the surface of snow.

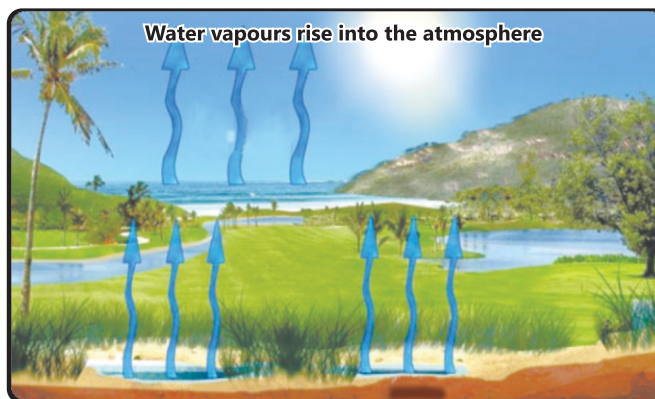


Figure 4.5 Evaporation from a lake

#### Do you know?

Boiling of a liquid requires high temperature. Evaporation can take place at any temperature. However, it is rapid at higher temperatures.

**Activity 4.5**

- Take two shirts of the same stuff. Wash them with water.
- Hang one in the room and the other in the sunny place.
- Note the time of hanging of the shirts.
- Check them after every 10 minutes.
- Note the time of drying of each shirt.
- Which shirt dried faster and why?

**Condensation**

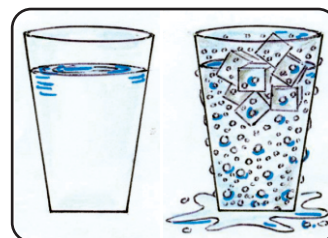
The change of gaseous state of matter into its liquid state is called condensation. When a gas is cooled, its particles lose heat. As a result, their movement slows down. They come closer to each other and attractive forces between them become stronger. Finally the gas changes into liquid. During condensation, heat is given out to the surroundings.

**Information**

Water vapours in the air condense when they meet a colder solid surface. You may see water condensed on the glass of windows on a cold day.

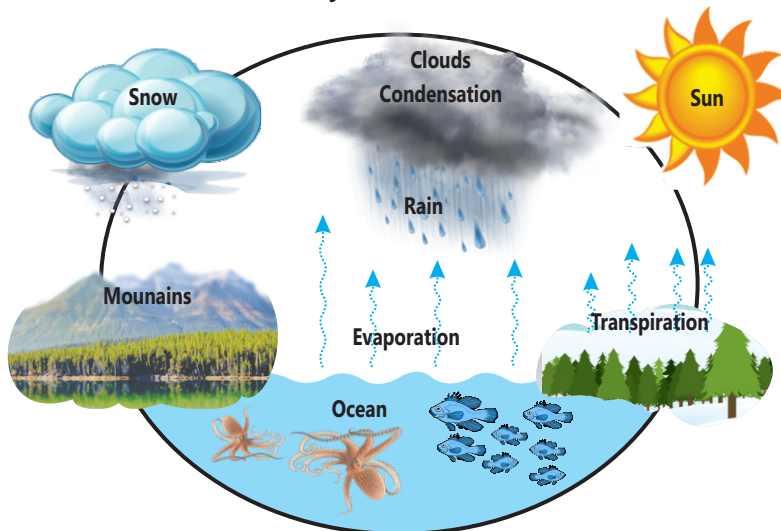
**Activity 4.6**

- Take a glass which is dry from its outside.
- Fill it with ice cold water and place it on the table.
- Look at the outer surface of the glass.
- You would see tiny water droplets over the outer surface of the glass.
- Where have they come from?
- Did water leak out from the glass?
- Is this the condensation of water present in the air in the form of vapours?

**4.4 Role of Evaporation and Condensation in the Water Cycle**

Sea, river, lake, canal, pond, etc. are called water bodies. The transfer of water from water bodies to the atmosphere and its return back is called water cycle (Figure 4.6). The sun shines on water bodies, makes the water evaporate into the atmosphere in the form of vapours. Evaporation also takes place from plants (transpiration) and surface of snow on the

mountains. As these vapours rise up, they lose energy and condense into water droplets. At a certain height, these water droplets gather in the air and form clouds. The water droplets in the clouds get heavier and heavier and the air cannot hold them anymore.

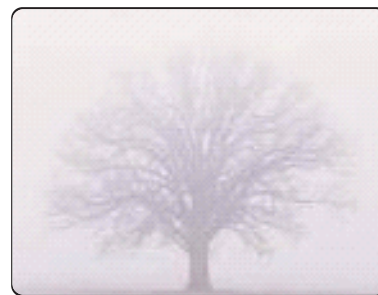


**Figure 4.6 Water Cycle**

The water then falls down in the form of rain and snow. The rain water again flows to the rivers, streams, lakes, canals and sea. In this way, water is always moving in a cycle. The processes of evaporation and condensation are involved in the water cycle. Water goes through its three phases (liquid, solid, gas) as it cycles in the Earth system. It evaporates from plants as well as land and water surfaces into the atmosphere and after condensing in clouds, returns to the Earth as rain and snow.

#### **4.5 Forms of Moisture in the Environment**

- Water is always present in the air in the form of water vapours. When there is smoke and dust in the cold climate, these water vapours appear as fog (Figure 4.7).



**Figure 4.7 Fog**



- Early in the morning, when the temperature falls down, the water vapours present in the air get together to form tiny droplets. These droplets can be seen on leaves and flowers as dew (Figure 4.8).
- Water vapours in the air are the gaseous state of water. At certain height, water vapours in the air condense to form water droplets (liquid state) due to cold. The presence of water droplets in the air forms clouds (Figure 4.9).
- In severe winter, the water present in the atmosphere freezes to form snow on the mountains and a layer of frost on the surface of ponds and lakes (Figures 4.10 and 4.11).



**Figure 4.8 Dew drops**



**Figure 4.9 Clouds**



**Figure 4.10  
Snow on mountain**



**Figure 4.11 Frost**

**Activity 4.7 How to make a cloud? (Demonstration by the teacher)**

1. Boil water in a kettle. Pour about 20mL of boiled water into the jar. Shake the hot water in the jar so that the sides of the jar are heated up.
2. Put a few ice cubes on the lid and put it on the jar.
3. Take the lid off and quickly spray some black colour. Now put the lid along with the ice cubes on the top of the jar. Watch the cloud forming inside the jar. When clouds are fully formed, take the lid off and watch the escape of cloud .

**Science, Technology, Society and Environment**

Evaporation produces cooling. This principle is used in the technology of making refrigerators and air conditioners, etc. The compressors in the AC and refrigerators etc., compress the gases to change them into their liquid state. These liquified gases when allowed to evaporate, absorb energy from the surroundings and produce cooling.

**KEY POINTS**

- All around us are substances that are made of matter.
- Matter has mass and occupies space.
- Matter exists in three states, namely, solid, liquid and gas.
- All matter is composed of small particles.
- The arrangement of the particles determines the state of matter.
- Matter can change its state when the temperature is changed.
- In solid, particles are arranged in an orderly manner and close to one another. Particles vibrate at fixed positions. Solids have a

fixed shape and volume.

- Particles are not arranged in an orderly manner in a liquid. Particles move randomly and slowly in liquids. Liquids do not have a fixed shape.
- In a gas, the spaces between particles are large. The particles are far apart and are randomly arranged.
- Solids melt into liquid state on heating.
- Liquids boil on heating and change into gaseous state.
- Liquids freeze on cooling.
- Gases condense on cooling.
- Freezing is the reverse of melting.
- When liquid water evaporates, it changes its state. Liquid water goes into the surrounding air as water vapours. Water can evaporate at any temperature.
- Condensation is the process by which a gas or vapour changes to liquid state at a certain temperature when it is cooled. When a gas is cooled, the particles lose heat.

## QUESTIONS

4.1 Choose the correct option:

i. Matter has:

- a. no mass but occupies space
- b. mass but occupies no space
- c. mass and occupies space
- d. no mass and occupies no space

ii. A solid has:

- a. maximum spaces between the particles
- b. definite shape but no definite volume
- c. maximum force of attraction between particles
- d. definite volume but no definite shape

- iii. Conversion of gas to liquid is called:
- condensation
  - evaporation
  - freezing
  - boiling
- iv. The process by which wet clothes dry up is called:
- condensation
  - evaporation
  - freezing
  - melting
- v. Matter changes from one state to another with the change in:
- |                |          |
|----------------|----------|
| a. temperature | b. place |
| c. volume      | d. shape |
- vi. Water is always present in the air as:
- |          |            |
|----------|------------|
| a. fog   | b. clouds  |
| c. frost | d. vapours |
- vii. Which of the following is opposite to boiling?
- |                |                 |
|----------------|-----------------|
| a. evaporation | b. freezing     |
| c. melting     | d. condensation |

#### 4.2 Fill in the blanks with suitable words.

- When a liquid changes to a gas, this is called \_\_\_\_\_.
- By adding or removing \_\_\_\_\_, we can change the state of matter.
- In a \_\_\_\_\_ state, the particles are loosely held and the matter takes the shape of the container.
- In a \_\_\_\_\_ state, particles are held together, and the matter cannot easily change its shape.
- is the term used to describe the process when a liquid changes into a solid.

- 4.3 Select the process from the list given below and write it against the phenomenon where it is involved during the change of state. The phenomena may involve more than one processes.

Melting Freezing Boiling Evaporation Condensation

Phenomenon	Process
Drying of clothes	Evaporation
Formation of dew	
Distillation	
Preparation of ice cream	
Burning of candle	
Rain	
Snowfall	
Cooking	
Air conditioning	

- 4.4 Answer the following questions:

- i. What is matter? Mention the states of matter.
- ii. Differentiate between boiling and evaporation of a liquid.
- iii. When does matter change its state?
- iv. How do solids differ from liquids with regard to particle arrangement?
- v. Describe what happens when a solid is heated.
- vi. Why does an ice cube melt at room temperature?
- vii. How are the particles arranged in three states of matter?
- viii. Differentiate between evaporation and condensation.
- ix. Differentiate between melting and freezing.