CHAPTER-6

STATES OF MATTER

You will learn in this chapter about:

* Common states of matter.
* Kinetic description of states of matter.
* Solid state of matter.
* Liquid state of matter.
* Gaseous state of matter.
* Inter conversion of the three states.
* Diffusion in gases and liquids.
* Brownian movement.

6.1 COMMON STATES OF MATTER

Matter is any thing that has mass and occupies space. There are three common states of matter i.e solid, liquid and gas. Solid has definite shape as well as definite volume. Liquid has a definite volume but not definite shape and it takes the shape of vessel in which it is kept. Gas has neither definite shape nor definite volume, it takes the shape of vessel in which it is kept and occupies all the space available to it.

6.1.1. Kinetic Description of States of Matter

According to kinetic molecular theory, matter is composed of very tiny particles, which are called as molecules. These molecules are always in motion and they possess kinetic energy. The three states of matter depend upon the arrangements, motions and forces of attraction between these particles. The difference between solid, liquid and gas is explained as follows:

Solid State: In solid state molecules or particles are tightly packed with one another and they have only back and forth motion (Vibrational motion) about their fixed positions. Therefore particles in solid can not slip or slide over one another and thus they possess definite shape and definite volume.

Liquid State: In liquid state molecules are not tightly packed with one another. Their positions are not fixed and they can move in all direction, hence liquid does not have any definite shape. But in liquid state the kinetic energy of molecules is less than gaseous state. Therefore intermolecular attractive forces are more than gaseous state. Due to these intermolecular attractive forces liquid has a fixed volume.

Gaseous State: In gaseous state molecules are lying away from one another and they can move in all direction easily. The cohesive forces in a gas are negligible and the paritcles are free to move about in all directions. The kinetic energy possessed by these molecules are very high, therefore gases have neither definite shape nor definite volume.

6.1.2 Inter Conversion of Three States

Most of the important properties of liquids, solids and gases depend upon the interconversion of one state into another state. For example when ice is warmed, it melts into liquid state, water. When water is heated and boiled, it changes into vapour (gas) state, some solids upon heating instead of changing into liquid state are converted directly into gaseous (vapour) state. This process is called sublimation. The examples of such substances are iodine, ammonium chloride and napthaline. These chemical substances being in solid state, when heated are sublimed directly in vapour state. In general, each state may be converted into another state is explained as given below:

When a solid is heated, then the kinetic energy of particles increases and it becomes hot. If heating is continued then at certain temperature, the added energy becomes enough to overcome the attractive forces holding particles of solid in their fixed positions and it starts melting. The temperature at which solid starts melting is called melting point. At this point solid particles lose their fixed positions as well as their arrangements and thus solid is converted into liquid. At melting point the temperature of solid and liquid remains same untill all the solid is melted though heat. It means in this condition the rise in temperature is used in change of state from solid to liquid and this change is called **fusion**.

When liquid is heated, the kinetic energy of liquid molecules increases. Due to increase of kinetic energy certain molecules start escaping from

the surface of liquid and this escape of molecules is called ***evaporation***. At certain temperature the vapour pressure of liquid becomes equal to external pressure and at this temperature liquid starts boiling. This temperature is called ***boiling point***. *Actually boiling point is the temperature at which the vapour pressure of a liquid becomes equal to external pressure applied on the liquid.* At this point bubbles of vapours are able to form within the interior of liquid and then rise to the surface, where they burst and release vapours and thus liquid is converted into gas. At boiling point the temperature of liquid remains same until all of the liquid is evaporated or vapourized though heat. It means in this condition the rise in temperature is used in the change of state from liquid to gas, and this change is called ***vapourization.***

6.2. DIFFUSION IN GASES AND LIQUIDS

6.2.1 Diffusion of Gases

It is observed that when a sample of a gas is set free in one part of the closed container, its molecules very quickly spread through out the container. In some cases we can smell a gas as it diffuses throughout the closed room. For example molecule of perfume spread throughout room or smell of H_2S gas spreads in laboratory etc.

The spreading of a substance through medium like air or liquid is called ***diffusion***. The rate of diffusion of a substance depends upon its molar mass or density.

A Scottish chemist, Thomas Graham in 1846 studied the rate of diffusion of different gases and formulated Graham's law. This law states that, the rate of diffusion of a gas is inversely proportional to the square root of its molar mass or density.

In other words, lighter gases can diffuse faster than heavier gases. For example hydrogen gas diffuses four times faster than oxygen gas at similar conditions.

6.2.2 Diffusion of Liquids

Liquid is intermediate between gaseous and solid states. Like gases liquid molecules are able to move and thus flow and diffuse. The rate of movement of liquid molecules is smaller than gases, hence they diffuse slower than gases. For example add two or three drops of blue ink in 200mls of water in a beaker. It is seen that blue colour of ink spreads

slowly in water and the whole water becomes bluish after some time. It means that diffusion also occurs in liquids but the rate of diffusion in liquids is slower than gases.

6.3 BROWNIAN MOVEMENT

This property was first of all observed by British Botanist, Robert Brown in 1827, during the movement of pollen grains in water by microscope.

If a drop of liquid with particles suspended in it, is observed under a microscope, it is seen that the particles are not at rest but they are moving in all directions in zig-zag motion. This motion is called as Brownian movement after the name, who observed it. *"A continuous, rapid, zig-zag motion of suspended particles through the medium is called Brownian motion."*

Example: Mix some powdered sulphur in water and stir it, after stiring filter the suspended sulphur. Some of the sulphur particles are very small and they can pass through the pores of filter paper into filterate. Now put a drop of this filterate on a slide and examine it under high powered microscope. It is observed that sulphur particles perform rapid random zig-zag motion through the medium and this motion is called Brownian motion.

SUMMARY

1. Any thing, that has a mass and occupies space, is called matter.
2. The common states of matter are solid, liquid and gas. Gas has neither definite shape nor volume, liquid has definite volume but no definite shape, whereas solid has definite shape as well as definite volume.
3. Liquid takes the shape of vessel in which it is kept, but does not occupy total volume available, whereas gas takes the shape of vessel as well as occupies all the space available to it.
4. According to kinetic molecular theory, matter is composed of particles, which are called molecules. Molecules are in motion and they possess kinetic energy.
5. The three states of matter depend upon arrangement, motion and forces of attraction between their particles.
6. In solids molecules are tightly packed with one another and they perform only translational motion. Due to this, molecules in solid neither slip nor slide over one another, hence shape and volume of solid is definite.

7. Interconversion of three states of matter are common and they may be seen by us, just like change of ice to water, evaporation of water and sublimation of iodine, ammonium chloride and napthaline.

8. During melting, solids are converted into liquids and in this process movement of particles overcome the intermolecular attractive forces.

9. Certain solids are directly converted into gaseous state during heating and this process is called sublimation.

10. In gaseous state, molecules are widely separated from one another and they move freely in all direction, hence the shape and volume of gas are not fixed.

11. When vapour pressure of a liquid becomes equal to external pressure, then it starts boiling and the temperature is called the boiling point. During boiling bubbles of vapours are able to form within the bulk of liquid and then rise to the surface, where they burst and release vapours. In other words in this way liquid is converted into gas.

12. At boiling point the temperature of liquid remains same until all of the liquid is vapourized to gas. This change is called as vapourization or evaporation.

EXERCISE

1. Fill in the blanks:

(i) There are ..... common states of matter.

(ii) Gas possesses neither definite shape nor definite .....

(iii) All types of matter is usually composed of smallest particles which are always in .....

(iv) The temperature at which liquid starts boiling is called .... Point.

(v) The ..... is the intermediate state between solid and gas.

(vi) ..... is the escape of molecules from the surface of liquid.

2. Tick the correct answers:

(i) The number of common states of matter is:

(a) 5 (b) 4
(c) 3 (d) None of them.

(ii) Neither definite shape nor volume is the property of

(a) Solid (b) Gas
(c) Liquid (d) None of them.

(iii) The temperature at which the vapour pressure of a liquid, becomes equal to its external pressure is called:

(a) Melting point (b) Boiling point
(c) Triple point (d) Freezing point.

(iv) The state of matter in which molecules are tightly packed and possess only transition motion is

(a) Gaseous state (b) Solid state
(c) Liquid state (d) None of them.

(v) The process in which molecules escape from the surface of liquid is called:

(a) Sublimation (b) Evaporation
(c) Boiling (d) Melting

(vi) The process in which solid directly changes to gas is called.

(a) Evaporation (b) Melting
(c) Sublimation (d) None of them

3. Write answer of the following questions:

(i) Define following terms:

(a) Solid (b) Fusion
(c) Evaporation (d) Sublimation

(ii) What do you mean by liquid? Describe the interchange of liquid to gas.

(iii) How solid is converted into liquid? Explain it.

(iv) What is diffusion? Explain on the basis of kinetic molecular theory.

(v) What is Brownian movement? Describe with suitable example.