Matter in Our Surroundings
Introduction of Matters

INTRODUCTION

All the substances around us have different shape, size and texture. Everything in universe is made up of matter. The air we breathe, the food we eat, the water we drink, the pen with which we write, the book we read, are made up of matter. In this chapter, we shall discuss the matter in our surroundings.

IMPORTANT TERMS AND CONCEPTS

1. Classification of Matter: Nowadays scientists have classified matter in the following two ways

(i) The physical classification based on physical properties of matter and

(ii) The chemical classification based on chemical composition of matter.

2. Matter : It is substance which occupies space and has mass. Air, Earth, Fire, Sky and water five basic element, "The Panch Tatva" according to the earlier Indian Philosophers. According to them everything i.e., living or non-living is made up of these five elements.

3. Physical Nature of Matter : Matter is made up small particles and there is space between particles of matter. It can be proved with the help of following experiment

Experiment: To show that there is space between particles of matter.

Materials Required: 100 ml beaker, water, salt, glass rod.

Procedure :

Take a 100 ml beaker and fill it with water and mark the level of water.

Dissolve the given salt with the help of glass rod.

Observe the change in the water level and record your observations.

Observations: The salt gets dissolve in water. The particle of salt have entered the space between water molecules, therefore, the level of water does not change.

Conclusion: The salt consists of large number of small particle which occupy the space between molecules of water.

4. Size of Particles of Matter: The particles of matter are extremely small in size which cannot be seen even with powerful microscope. Their size can be observed with the help of following experiment.

Experiment: To show that matter is made up of very small particles.

Materials Required: Crystals of $KMnO_4$ (potassium permagnate), water, 3 separate beakers.

Procedure : Take 2-3 crystals of $KMnO_4$ and dissolve them in 50ml of water in beaker 1.

Take 5 ml of solution from beaker 1 and put it into 50 ml of water in beaker 2 and observe the colour of solution. Take 5ml of solution from beaker 2 and put it into 50 ml of water in beaker 3 and observe the colour of solution.

Observations: The colour of solution remains purple in all the beakers.

Conclusion: It shows that even 2-3 crystals of $KMnO_4$ consists of millions of small particle which dissolve in water giving purple colour to the solution.

5.Space between Particles of Matter: When we dissolve sugar, salt or KMnO4 in water, particles get evenly distributed in water. Similarly, when we prepare tea or coffee, the particles of one type of matter diffuse into space between particles of the other. This shows that there is enough space between particles of matter.

6.Continuous movement of Particles: Particles of matter are continuously moving, i.e., they possess kinetic energy which increases with increases in temperature.

Experiment : To show the particles of matter are continuously moving.

Materials Required: Incense stick or agarbati, match box.

Procedure: Put an unlit incense stick in a corner of your class.

Go close to the incense stick to smell it.

Now light the incense stick. And try to get the smell from a distance.

Observations : The smell of unlit incense stick can be observed only by going close to it whereas the smell of lighted incense stick can be observed from a distance.

Conclusion : The particles of matter of continuously moving but the speed of particles is very slow. The speed of particles increase with the increase in temperature.

7.Diffusion : The process of intermixing of particles of two or more substance on their own is called diffusion. The rate of diffusion increases on heating that is why an incense stick gives smell only when we come close to it, but on lighting the stick we get smell even far away from it.

8.Attraction between Particles of Matter:

There is force of attraction between particles of matter. It can be explained with the help of following game in the field.

- Make four groups and form human chains as follows.
- The first group should hold each other from back and lock arms like Bihu dancers.
- The second group should hold hands to form human chain.
- The third group should from a chain by touching each other with only their fingertips.
- The fourth group should run around and try to break three human chains one by one into groups as small as possible.

Observations and Conclusions

- The third group is easily to break because of least force of attraction. It is similar to particles in gaseous state.
- The first group is most difficult to break due to maximum force of attraction. It represents particles present in solid state.
- The second group requires little force to break which shows it has force of attraction less than first group but more than third group. It represents particles in the liquid state.
- Even in solids, the force of attraction differs from one substance to another. There is maximum force of attraction between particles of iron nail, less in a piece of chalk and least in rubber band.
- It is difficult to cut a stream of water with the help of fingers due to force of attraction between particle of liquids. Thus, there is force of attraction between particles of matter

which keeps the particles together. The strength of forces varies in different kinds of matter.

9.Classification of Matter on the basis of Physical State : Matter can be classified into Solid, Liquid and Gas.

10.Properties of the Solid State :

- They have fixed shape.
- They have fixed volume.
- They are rigid an have fixed boundaries.
- They are incompressible because intermolecular space is less.
- They have high density as compared to other states of matter.
- They have strong force of attraction between the particles.
- The particles are closely packed in solid, therefore, there is less intermolecular space between the particles.
- The kinetic energy of particles in solid is very less. They vibrate only at their mean position that is why solids have rigid shape. Solid diffuse into solids to very less extent, e.g., it is difficult to rub a blackboard on which something is written in chalk without cleaning for 10-15 days.

11.Volume : The space occupied by a substance is called volume. Its SI unit is cubic metre (m^3). Its common unit is litre. ($1L = 1dm^3$, $1L = 1000$ ml, $1ml = 1cm^3$).

12.Density : The mass per unit volume of a substance is called density.

Density = mass/volume. The SI unit of density is km/m^3 where common unit is g/cm^3. (CGS unit)

13.Kinetic Energy : The energy possessed by particles by virtue of its motion is called kinetic energy.

14.Properties of the Liquid State :

- Liquids do not have fixed shape or boundaries.
- They have fixed volume.

- They can flow, i.e., they have fluidity.
- They have low compressibility but more than solids.
- They have lower density as compared to solids.
- The intermolecular forces of attraction are weaker as compared to solids.
- The intermolecular space is more than that of solids.
- The particles in liquid state can move freely and hence have higher kinetic energy than solids but less than that of gases.
- They shows the property of intermixing and thus they can diffuse. It can be shown by the following experiment.

Experiment : To compare the rate of diffusion of liquids having different densities.

Materials Required : Two beakers filled with water, blue ink, honey.

Procedure : Take two beakers filled with water.

Add a drop of blue ink into first beaker slowly and honey in the second beaker.

Leave them undistributed at you home or in a corner in the class.

Record you observations.

Observations : The blue ink diffuses into water and water become light blue in colour. Honey diffuses very slowly into water, therefore, takes lots of time to diffuse evenly.

Conclusion : Liquids with higher density, diffuse slower than liquids having lower density.

Factor Affecting Rate of Diffusion :

(i) Density : The rate of diffusion depends upon density of liquids. Higher the density, lesser will be the rate of diffusion.

(ii) Temperature : The rate of diffusion depends upon temperature, i.e, the rate of diffusion increase with an increase in temperature which can be shown experimentally.

(iii) Physical State : Solids can diffuse into liquids slowly whereas liquids can diffuse into liquids faster and gases can also diffuse into liquids.

Experiment : To study the variation of rate of diffusion with temperature of solid in liquids.

Materials Required : Copper sulphate, two beakers, cold water and hot water.

Procedure :

- Take 50ml of cold water in a beaker.
- Take 5ml of hot water in another beaker.
- Add a crystal of copper sulphate into the beaker containing 50ml of cold water.
- Add a crystal of copper sulphate into the beaker containing 50ml of hot water.
- Leave them undisturbed.
- Record the observations.

Observations : The colour of solution in first beaker becomes blue slowly whereas the colour becomes blue faster in second beaker.

Conclusion : The rate of diffusion increases with increase in temperature because kinetic energy of molecules increases.

15.Diffusion of Gases in Liquids : Gases can also diffuse in liquids. Oxygen and carbon dioxide get dissolved in water which is essential for growth of aquatic plants and animals.

16.Properties of Gaseous State :

- Gases do not have fixed shape, i.e., they take the shape of container.
- They do not have fixed volume, therefore no definite boundaries.
- They can flow in all directions, hence gases also show fluidity.
- They are highly compressible.
- They have lower densities as compared to liquids and solids.
- They have higher kinetic energy as compared to liquids and solids.
- The rate of diffusion is fastest in gases.
- There is weak intermolecular force of attraction.
- There is large intermolecular space, therefore, gases can be easily compressed.
- Gases can be compressed more easily than liquids which can be shown by following experiment.

Experiment : To show that gases can be compressed more easily than liquids.

Material Required : Two 10ml syringes, rubber cork, vaseline.

Procedure :

Take two 10ml syringes and close their nozzle by inserting them in a rubber cork as shown in figure.

- Remove the piston from both the syringes.
- Allow the air to fill the space inside one syringe and fill water in the other.
- Insert type pistons back into syringes.
- Apply some Vaseline on the piston from smooth movement.
- Now try to compress by pushing piston in the syringe.
- Record your observations.

Observations : In case or air, piston is easily pushed in as compared to syringe filled with water.

Conclusion : The bases can be compressed more easily than liquids. It is because there are weak intermolecular forces of attraction between particles, so the distance between the particles in gaseous state is very large as compared to solids and liquids, e.g., CNG is compressed natural gas which is being used in vehicles. LPG is liquified petroleum gas which is used for cooking.

17.Pressure : It is defined as force exerted per unit area, e.g., gases exert pressure on the walls of the containing. The kinetic energy of the particles in gaseous state i maximum. The particles are in state of constant random motion therefore, they collide with themselves as well as with the walls of the container and exert pressure.

18.Change of state : The state of substance depends upon temperature and pressure, e.g., water exists as solid at 0ºC, as liquid at room temperature whereas in gaseous state at 100ºC. The state of matter will change with change in temperature which is shown by following experiment.

Experiment : To study the effect of temperature on solids and liquids.

Materials Required : Ice, thermometer, beaker.

Procedure :

Take about 50g of ice in a beaker and hang a laboratory thermometer in it so that bulb is in contact with ice.

- Start heating the beaker at low flame.
- Now down the temperature when ice starting melting.
- Note the temperature when all the ice has converted into water.
- Record your observations for conversion of solid into liquid state.
- Now put a glass rod in the beaker and heat while constant stirring till the water starts boiling.
- Keep a close look at the thermometer reading till most of the water has vaporized.
- Record your observations for the conversion of ice into liquid water and then into vapour state.

Observations and Conclusion: When temperature of solid is increased, the kinetic energy of particles increases. Due to increase in kinetic energy, the particle starts vibrating at a greater speed and overcome intermolecular forces of attraction. A stage is reached when intermolecular forces become so less that it changes into liquid. When temperature is further increased, a state comes when liquid changes into vapour.

19.Melting Point: The temperature at which solid changes into liquid completely is called melting point.

Melting point of solids gives indication of the strength of intermolecular forces of attraction. Higher the melting point, more will be intermolecular forces of attraction.

20.Melting : The process in which solid changes into liquid is called melting. It is also called fusion.

21.Kelvin : It is SI unit of temperature. $0^{\circ}C = 273.16$ K.

If we want to change K into ºC, subtract 273.16 from the temperature given in Kelvin. For converting ºC to Kelvin (K), add 273.16 (For convenience we take $0^{\circ}C = 273K$)

22.Latent heat of fusion : The amount of energy that is required to change 1kg of a solid into liquid at atmospheric pressure without any change of temperature at its melting point is called latent heat of fusion.

23Boiling Point : The temperature at which a liquid changes into gas or vapour is known as boiling point. It also indicates strength of intermolecular force of attractions. Greater then intermolecular forces of attractions, higher will be the boiling point. The boiling point of water is 100ºC (373K).

24.Boiling : The process of converting liquid into vapour is called boiling. It is bulk phenomenon, i.e, particles from inside the liquid gain enough energy to change into vapour state. It takes place only at boiling point.

25.Latent Heat of Vapourisation : The amount of energy that is required to change 1kg of liquid into vapours at atmospheric pressure without any change in temperature at its boiling point is called latent heat of vapourisation.

26.Gas : It is stable state as compared to vapours, e.g., O_2, N_2, H_2, CO_2, etc.

27.Vapour : It is unstable state. On cooling, vapours change into liquid state. The work 'vapour' is used to describe those gases which usually exist as liquid at room temperature.

28Vapourisation : It is process in which liquid changes into vapour. It is a surface phenomenon. It takes place at all temperatures. It is a slow process and its rate increase with increase in temperature.

29.Volatile Liquids : Those liquids which can change into vapours easily are called volatile liquids, e.g., petrol, alcohol, acetone, ether, etc. evaporate easily because they have low boiling points due to weak intermolecular forces of attraction. Water has high boiling point due to strong intermolecular forces of attraction.

30.Sublimation : It is a process in which solid directly changes into vapours without changing into liquid state, e.g., camphor, I_2, NH_4Cl, naphthalene can sublime. It can be shown experimentally.

Experiment : To show the process of sublimation experimentally.

Materials Required : Solid iodine, funnel, tripod stands, china dish, wire gauze, burner or spirit lamp, cotton.

Procedure :

Take 2g of iodine in china dish.

Put an inverted funnel over it whose stem is closed by cotton plug and set the apparatus as shown in diagram.

Heat and china dish so that vapours are formed and record the observations.

The vapours of iodine get condensed on the walls of the funnel.

Observations : The violet-coloured vapours of iodine get condensed and change into solid iodine.

Conclusion : Iodine can sublime and can be purified by sublimation.

31.Effect of Pressure on Change in State : When we apply pressure and compress the gas, intermolecular force of attraction increases and molecules come close to each other. It may be change into liquid depending upon temperature and nature of the gas.

32.Liquidification of Gases : Gases can be liquified at low temperature and high pressure, e.g., H_2, N_2 and O_2 can be liquified at low temperature at high pressure. NH_3 can be liquified at room temperature. CO_2 can be solidified at low temperature and high pressure. Solid CO_2 is also called dry ice.

33.Atmosphere (atm) : It is unit of measuring pressure exerted by a gas. The pressure of air in atmosphere is called atmospheric pressure.

34.Pascal (Pa) : It is unit of measuring pressure exerted by a gas. The pressure of air in atmosphere is called atmospheric pressure.

$1 \text{ atm} = 1.01 \times 10^5 \text{ Pa}$

The atmospheric pressure at seal level is 1 atmosphere and is taken as normal atmospheric pressure. As we go higher, atmospheric pressure decreases.

35.Evaporation : It is a process in which liquid changes into vapours e.g., water changes into vapours if left uncovered. Wet clothes dry up because water gets evaporated. The particles of water collide with each as well as with particles of gases in atmosphere. After some time, the particles on the surface gain sufficient energy so as to change into vapours. It is a surface phenomenon.

36.Factor Affecting evaporation :

(a) Surface area : Greater the surface area, more will be the rate of evaporation because it is a surface phenomenon. There will be more number of molecules on the surface which will change into vapour easily.

(b) Humidity : It is amount of water vapours present in air. The air around us cannot hold more than a definite amount of water vapours at a given temperature. If the amount of water in air is already of water is air is already high, the rate of evaporation decreases. Decrease in humidity leads to increase in rate of evaporation.

(c) Temperature : The rate of evaporation increases with increase in temperature because more number of particles gain enough kinetic energy to go to vapour state.

(d) Wind speed : The rate of evaporation increase with increase in wind speed because particles of water vapours are taken away decreasing the amount of water vapours in atmosphere.

37.Effect of Evaporation : Evoparation leads to cooling because high energy molecules leave the surface and average energy of remaining molecules decreases, which results in drop in temperature of the part of liquid that is left. Therefore, evaporation cause cooling.

38.Effect of Temperature on Clothes : Cotton is good absorbed of water, helps in absorption the sweat and exposing it to atmosphere for easy evaporation during summers. It causes cooling of our body.

39.Plasma : It is fourth state of matter. It consists of super energetic and super excited particles which are in the form of ionised gases. The fluorescent tube, neon sign bulbs consist of plasm. Inside the neon bulb, there is neon gas whereas inside the fluorescent tube, there is helium gas or some other gas. The gas gets ionised, i.e., gets charged when electrical energy flows through it. This charging up creates glowing plasma inside the tube or bulb. The plasma glows with a special colour depending upon the nature of the gas. The sun and starts glow because of presence of plasma in them. The plasma is created in stars due to very high temperature.

40.Bose-Einstein Condensate (B.E.C.) is fifth state of matter which is formed from matter that has been cooled to near absolute zero (–273ºC). When a group of atoms is cooled to a very low temperature, the velocity decreases because they have very low energies.
This causes the individual atoms to overlap each other forming a single super atom with all of its constituting atoms sharing a single energy state.
A rotating B.E.C. could be used as model black hole, allowing light to enter but not to escape. Condensate can also be used to 'free' pulses of light, to be released again when condensate break down. Research in this field is going on.