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UNIT-I

MATTER IN OUR SURROUNDINGS

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Chemistry: The branch of science which deals with study of materials (substances), especially about their chemical composition, methods of preparation and their reactions with other substances is called as chemistry.

It is the study of the elements and the compounds they form. Chemistry is mainly concerned with effects that depend on the outer electrons in atoms. Chemistry is divided into three main branches. i.e. Physical, organic and inorganic chemistry.

- i. **Physical Chemistry:** the branch of chemistry concerned with the effect of chemical structure on physical properties. It includes chemical thermodynamics and electrochemistry.
- ii. **Organic Chemistry:** It is the branch of chemistry which deals with the compounds of carbon. i.e., the chemical compounds in which carbon is one of the constituents.
- iii. **Inorganic Chemistry:** it is the branch of chemistry concerned with compounds of elements other than carbon. Certain simple carbon compounds, such as CO, Co₂, CS₂ and carbonates and cyanides, are usually treated as inorganic chemistry.

Matter: Anything that occupies space and has mass is known as matter. e.g., Iron, Copper, water, Air, Sugar, Salt, Oxygen, Hydrogen, Plastic, wood etc. with regard to the modern concept of matter, it is being classified on the basis of its physical and chemical properties. On the basis of physical properties matter is classified as solid, liquid, and gaseous. On the basis of its chemical properties matter is classified as compounds and mixtures. Recently two new states of the matter have been classified as Plasma and Bose-Einstein condensate.

Physical nature of matter: The physical nature or composition of matter shows that matter is made up of particles, and the particles are very small in size.

In order to see that matter is made up of particles, we take some sugar or salt in a spoon and dissolve it in a glass of water homogeneously to make it dissolve in water. After some time we will not find any particles of sugar or salt in water, because the dissolved salt or sugar particles get into the spaces between the particles of water. This proves that matter is made up of particles as the particles of sugar or salt have filled up some empty spaces between the particles of water and hence get dissolved. Now both sugar and water or salt and water are made up of particles of smaller size. These particles are too small to see, even under a microscope. When the sugar or salt dissolves, tiny particles break off from each solid granule of sugar or salt. These sugar or salt particles go with the spaces between the particles of water and mix with them. So, the sugar or salt solution will taste salty or sweet even though we cannot see these particles in the solution.

This shows that the matter is made up of very small particles which are so small that they are beyond our imagination.

Characteristics of particles of matter: After studying the physical nature of matter, it is clear that matter is made up of particles which are very small in size. The important characteristics of particles of matter are:

- i. The particles of matter are very small in size.
- ii. The particles of matter have space between them.
- iii. The particles of matter are constantly moving.
- iv. The particles of matter attract each other.

It is because of these characteristics of particles of matter that matter is classified as solids, liquids and gases on the basis of intermolecular (particle to particle) spaces and intermolecular forces of attraction between the particles of matter.

Classification of matter on the basis of physical properties (states of matter): On the basis of physical properties (nature) of matter, it is classified into three categories. i.e. solids, liquids, and gases.

- i. **Solids:** All those substances in which the particles are closely packed due to the strong intermolecular forces of attraction and the less intermolecular spaces between the particles are known as solids. The particles of solid vibrate about their fixed positions but cannot move and these particles have the minimum kinetic energy. So due to this the solids have following properties.
 1. Solids have definite shape, size and volume.
 2. Solids cannot be compressed much.
 3. Solids have high density and hence cannot flow.
 4. Solids cannot flow and hence cannot fill the container completely.
 5. Solids can be stored without vessel.
- ii. **Liquids:** All those substances in which the particles are loosely packed due to weak intermolecular force of attraction and the larger intermolecular space between their particles are known as liquids. Due to comparatively less interparticle forces, the positions of particles in a liquid are not fixed. The particles of a liquid can move from one position to another within the liquids. Due to this the liquids have the following properties.
 1. Liquids have definite volume, but not definite shape and size.
 2. Liquids take the shape of container and have only one free surface at the top which is always flat
 3. Liquids cannot be compressed much due to their moderate densities as compared to solid.
 4. Liquids generally flow easily, when dropped out of the container.
 5. Liquids can be stored in open containers.
- iii. **Gases:** All those substances in which particles are much farther apart from each other due to the very large interparticle spaces and the negligible intermolecular force of attraction between the particles are known as gases. The particles of gases are free to move in any direction and the positions of particles of a gas as well as the spaces between them are not fixed. Due to this the gases have the following properties.
 1. Gases neither have definite shape, size nor definite volume hence acquire the shape and size of the container.
 2. Gases can be compressed easily due to their very low densities.
 3. Gases fill their containers completely.
 4. Gases can be stored in a closed container only.
 5. Gases can flow in all the directions easily.

Change of states of matter: The matter can exist in three physical states. i.e., solid, liquid and gaseous states. e.g., water exists in all the three states of matter. i.e., in the solid state as ice, in the liquid state as water and in the gaseous state as steam (or water vapor).

The state of matter can be changed by changing the temperature and by changing the pressure. The change of state of matter by changing its temperature means the change of state by heating or cooling while as the change of state of matter by changing the pressure means the change of state by increasing or decreasing its pressure.

So, it is clear that the spaces between the particles, the force of attraction between the particles and the amount of movement (kinetic energy) of particles can be changed by changing the pressure or temperature of a substance. So, depending upon the pressure and temperature of a substance etc. the same substance can exist in all the three states of matter. i.e. Solid, Liquid, and Gaseous state.

- i. **Effect of change of temperature:** by increasing the temperature a solid can be converted into liquid and the liquid can be converted into gaseous state. By decreasing the temperature, a gaseous state can be converted into liquid state and a liquid state into solid state. e.g., conversion of ice into water then to vapor and water vapor back to water and then to ice.
- ii. **Effect of change of pressure:** The physical state of matter can be changed by changing the pressure i.e., by increasing or decreasing pressure. e.g., Gases can be changed into liquids by increasing the pressure (accompanied by lowering of temperature) and some solids like dry ice (solid carbon dioxide) can be changed into gases on decreasing the pressure.

Evaporation: The phenomenon of change of a liquid into vapors at any temperature below its boiling point is called as evaporation. i.e., the process of change of liquid state of a substance into its gaseous state (vapors) at even below its boiling point is called as evaporation. The particles of matter are always moving and are never at rest. At a given temperature in any gas, liquid or solid, there are particles at the surface, having higher kinetic energy is able to break away from the forces of attraction of other particles and gets converted into vapors.

Factors affecting evaporation: The evaporation of a liquid depends upon the following factors

- i. Temperature.
 - ii. Surface area
 - iii. Humidity.
 - iv. Wind
 - v. Speed
- i. The rate of evaporation of a liquid increase on heating when the temperature of a liquid is increased by heating it, more particles of the liquid get enough kinetic energy to go into the vapor state. This increases the rate of evaporation.
 - ii. The rate of evaporation increases on increasing the surface area of the liquid. If the surface area of a liquid exposed to the air is increased gives the particles of water a greater chance of escaping from the liquid. e.g., Spread out of washed clothes while drying increases the surface area of evaporation of water from the wet clothes.
 - iii. The humidity of air indicates the degree of dampness of air. So, when the humidity of air is low, the rate of evaporation is high and water evaporates more readily. When the humidity of air is high then the rate of evaporation is low, and water evaporates very slowly.
 - iv. The rate of evaporation of a liquid increase with increase in wind speed. As the increase in wind speed makes the particles of water vapor move away faster and decreases the amount of water vapor present in the surroundings and hence increases the rate of evaporation of water.

How does evaporation cause cooling: The cooling caused by evaporation is based on the fact that when a liquid evaporates, it draws (or takes out) the latent heat of vaporization from anything which it touches. So, by losing heat that thing gets cooled.

Examples:

- i. If we put a little amount of spirit (ether or petrol) at the back of hand and wave it around, the spirit evaporates rapidly and our hand feels very cold. It is because the change of spirit from liquid to vapor state requires latent heat of vaporization which it gets from our hand. Hence our hand loses heat and gets cooled during this process. Hence proves that evaporation causes cooling.
- ii. It is a common observation that we are able to sip hot tea or milk faster in a saucer than that of a cup, as the large surface area of saucer makes the evaporation of hot tea

or milk faster and cools down the tea or milk making it more convenient for us to drink.

Q1. Which of the following are matter? Chair, air, love, smell, hate, almonds, thought, cold, cold drink, smell of perfume?

Ans. Anything which occupies space, possesses mass and can be felt by any one of our five senses is called matter:

Chair, air, smell, almonds, cold drink and smell of perfume are matter.

Love, hate, thought and cold are not matter.

Q2. Give reasons for the following observations: the smell of hot sizzling food reaches you several meters away, but to get the smell from cold food you have to go close.

Ans. At low temperatures, the kinetic energy is low and particles move very slowly. But as the temperature rises, the kinetic energy increases accordingly and particles move faster. Now since the kinetic energy of the particles of vapours coming out of cold food is low. So they travel slowly and don't reach to us while as the kinetic energy of the particles of hot vapours coming out of hot sizzling food is high so they move faster and reach us several meters away.

Q3. A diver is able to cut through water in a swimming pool. Which property of matter does this observation show?

Ans. The particles of water are held together by forces of attraction. But these forces of attraction are not strong. Therefore, by applying greater force, a diver can cut through water in a swimming pool by overcoming the weaker forces of attraction present among particles of water. This observation shows that particles of matter attract one another.

Q4. What are the characteristics of particles of matter?

Ans. Some important characteristics of the particles of matter are listed below:

- i) Matter consists of tiny particles which cannot be seen individually with the naked eye.
- ii) There exist spaces in between the particles of matter.
- iii) The particles of a matter are not stationary but are continuously moving.
- iv) The particles of matter are held together by forces of attraction. The strength of these forces varies from one kind of matter to another.

Q5. The mass per unit volume of a substance is called density (density = mass/volume). Arrange the following in order of increasing density: air, exhaust from chimneys, honey, water, chalk, cotton and iron?

Ans. The order of increasing density is : air, exhaust from chimneys, cotton, water, honey, chalk and iron.

Q6. a) Tabulate the difference in characteristics of states of matter.

b) Comment upon the following: rigidity, compressibility, fluidity, kinetic energy and density.

Ans.a)

S.No.	Property	Solid	Liquid	Gas
1.	Packing	The constituent particles are very closely packed	The constituent particles are less closely packed	The constituent Particles are free to move about
2.	Interparticle distances	Smallest	Between solids and gases	Largest
3.	Inter particle force of attraction	Strongest	Between solids and gases	Weakest
4.	Shape and Volume	Definite shape and volume	Definite volume But no definite Shape	Neither Definite shape nor definite volume
5.	Compressibility	Completely incompressibility	Almost incompressible	Highly Compressible.
6.	Rigidity/Fluidity	Possess Rigidity	Possess Fluidity	Highest Fluidity
7.	Density	Have high density	Between solids and gases	Have very low densities.
8.	Energy	Minimum Energy	Higher energy than solids	Highest energy than solids and liquids

b) **Rigidity**: - means tendency to maintain shape when some outside force is applied. Due to small interparticle distances and strong interparticle forces of attraction, solids possess high rigidity.

➤ **Compressibility**: - means tendency to decrease volume when some outside forces is applied. Due to large interparticle distances in gases, their volume decreases when some pressure is applied on them.

➤ **Fluidity**: - means tendency to flow. Due to large interparticle distances and weak forces of attraction, gases have the highest fluidity.

➤ **Kinetic energy**: - means energy possessed by particles due to motion. Due to large interparticle distances and weaker forces of attraction, the particles of gas have maximum freedom of movement. Thus, they have highest kinetic energy.

➤ **Density**: - means mass per unit volume. Since the particles of a solid are closely packed, those of liquids are less closely packed while those of gases are loosely packed, therefore, solids have highest density, liquids have lower densities than solids while gases have the lowest densities.

Q7. Give reasons:

(a) A gas fills completely the vessel in which it is kept.

Ans. The particles of gas are constantly moving in all the directions with different speeds. Therefore, they do not have a fixed volume and hence completely fill the vessel in which they are kept.

(b) A gas exerts a pressure on the walls of a container.

Ans. The particles of a gas are constantly moving in all directions with different speeds. As a result of this random motion, the particles of a gas collide with one another and also against the walls of the container. As a result of these collisions, the gas exerts some force on the walls of the container. This force per unit area is called pressure of the gas. Thus, gases exert pressure due to the collisions of the particles of the gas on the walls of the containing vessel.

(c) A wooden table should be called a solid.

Ans. A wooden table has a definite shape, distinct boundaries and a fixed volume, therefore, it should be called a solid.

(d) We can easily move our hand in air but to do the same through a solid block of wood, we need a karate expert.

Ans. We can easily move our hand in air since the forces of attraction between the particles of a gas, i.e., air is very weak and hence can be easily overcome for the movement of the hand. In contrast, the particles of a solid are closely packed and hence the interparticle forces of attraction are very strong. As a result, they cannot be easily overcome for movement of the hand. In other words, we need a karate expert with almost incredible power to separate these particles apart.

Q8. Liquids generally have lower density as compared to solids. But you must have observed that ice floats on water. Find out why?

Ans. Ice has cage like structure, i.e., when water freezes to form ice, a number of empty spaces are created. As a result, volume increases for the same mass of water. In other words, mass per unit volume or density of ice is lower than that of water and hence ice floats over water.

Q9. Convert the following temperatures to the Celsius scale:

(a) 300K

$$300\text{K} = 300 - 273 = 27^{\circ}\text{C}$$

(b) 573K

$$573\text{K} = 573 - 273 = 300^{\circ}\text{C}$$

Q10. What is physical state of water at:

(a) 250°C

Ans. The boiling point of water is 100°C. Therefore, the physical state of water at 250°C, i.e., at a temperature higher than its boiling point is gaseous state.

(b) 100°C

Ans. At 100°C, the boiling point of water, water exists both as a liquid as well as gas.

Q11. For any substance, why does the temperature remain constant during the change of state?

Ans. During the change of state of a substance at its melting point or the boiling point, temperature remains constant because the heat energy supplied to the substance is used up in overcoming

the forces of attraction without increasing their kinetic energy. As a result, the thermometer doesn't show any rise in temperature till the entire substance undergoes change of state.

Q12 Suggest a method to liquefy atmospheric gases?

Ans Atmospheric gases can be liquefied by decreasing the distances and increasing the forces of attraction between the constituent particles. This can be done by cooling the gases under high pressure.

Q13 Why does a desert cooler cool better on a hot dry day?

Ans A hot dry day means the temperature of the atmosphere is high and humidity of air is low. Both these factors increase the rate of evaporation and thus enormous cooling is produced.

Q14 How does the water kept in an earthen pot (matka) become cool during summer?

Ans Due to the small holes or capillaries present in the walls of the earthen pot, the water oozes out slowly. As it comes out on the surface of matka, it evaporates. The heat energy needed for the evaporation is taken from the water kept in the earthen pot. As a result, water kept in the earthen pot becomes cold.

Q15 Why does our palm feel cold when we put some acetone or petrol or perfume on it?

Ans Acetone, petrol or the solvent of the perfume have low boiling points. When these are put on the palm, they quickly evaporate. The energy needed for evaporation is taken from the palm. As a result, the palm feels cold.

Q16 Why are we able to sip hot tea or milk faster from a saucer rather than a cup?

Ans. When hot tea or milk is taken in a cup, the surface area of the liquid in the cup is small. Therefore, evaporation occurs slowly and hence the liquid in the cup remains hot for a sufficient long time. So, we are not able to sip hot tea or milk from a cup.

When hot tea or milk is placed in a saucer, the surface area of the liquid increases. As a result, evaporation occurs faster and the tea or milk becomes little cooler more quickly than when these liquids are kept in a cup. So, we are able to sip hot tea or milk faster from a saucer rather than from a cup.

Q17. What type of clothes should we wear in summer?

Ans. In summer, we perspire more. Therefore, to keep our body cool, we must wear cotton clothes. Since cotton clothes are good absorbers of water, they absorb the sweat quickly and expose it to the atmosphere for easy evaporation. Since evaporation produces cooling, therefore, cotton clothes help us in keeping our body cool.

Exercises:

Q1. Convert the following temperatures to the Celsius scale.

(a) 300k

$$300\text{k} = 300 - 273 = 27^{\circ}\text{C}$$

(b) 573k

$$573\text{k} = 573 - 273 = 300^{\circ}\text{C}$$

Q2. Convert the following temperatures to the Kelvin scale.

(a) 25°C

$$25^{\circ}\text{C} = 273 + 25 = 298\text{k}.$$

(b) 373°C

$$(c) 373^{\circ}\text{C} = 273 + 373 = 646\text{k}$$

Q3. Give reason for the following observations.

(a) Naphthalene balls disappear with time without leaving any solid.

Ans. Naphthalene is a volatile solid. It undergoes sublimation slowly at room temperature. As a result, solid naphthalene gets converted into vapours which become a part of the air around us. Therefore, naphthalene balls disappear without leaving any solid.

(b) We can get the smell of perfume sitting several meters away.

Ans. We get the smell of perfume sitting several metres away due to diffusion. The particles of the perfume mix with the particles of air and due to high speeds of these particles, the smell of perfume reaches us sitting several metres away.

Q4. Arrange the following substances in increasing order of forces of attraction between the particles – water, sugar, oxygen.

Ans. Oxygen, water, sugar.

Q5. What is the physical state of water at:-

(a) 25°C

Liquid

(b) 0°C

Either solid or liquid

(c) 100°C

Either liquid or gas

Q6. Give two reasons to justify: -

(a) Water at room temperature is a liquid.

Ans. Water is a liquid because of the following two reasons:

(i) Liquids do not have a fixed shape.

(ii) Liquids have a fixed volume

(b) An iron almirah is a solid at room temperature.

Ans. Solids have a fixed shape as well as a fixed volume and solids are incompressible so an iron almirah is a solid at room temperature.

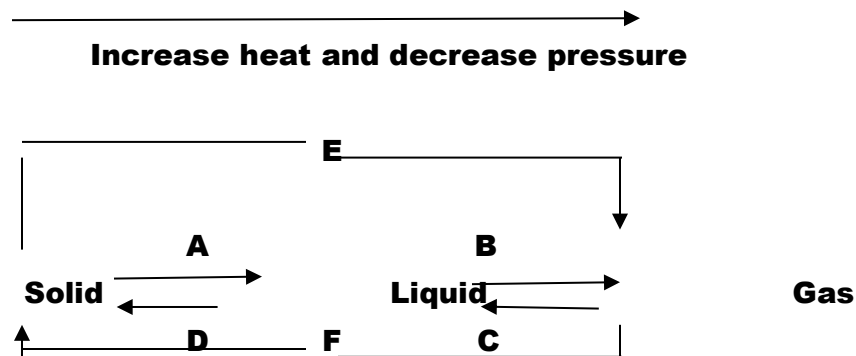
Q7. Why is ice at 273k more effective in cooling than water at the same temperature?

Ans. When ice at 273k melts to form water at 273k, it absorbs heat energy equal to the latent heat of fusion from the surroundings. Thus, ice at 273k and hence ice is more effective in cooling than water at the same temperature.

Q8. What produces more severe burns, boiling water or steam?

Ans. When water at 373k is converted into steam at 373k, it absorbs energy equal to the latent heat vapourisation. Thus, steam at 373k has more heat energy than water at 373k and hence steam produces more severe burns than boiling water.

Q9. Name A, B, C, D, E AND F in the following diagram showing change in its state.



Ans. A = Fusion,

B = Vapourisation

C = Condensation

D = Solidification

E = Sublimation,

F = Sublimation.