Matter in our surrounding

STUDY NOTES

INTRODUCTION :

Matter is defined as anything that occupies space and has mass. It is the stuff our universe is made of, and all thechemicals that make up tangible things, from rocks to pizza to people, are examples of matter.

Early Indian philosophers classified matter in the form of five basic elements – the "Panch Tatva" air, earth, fire,sky and water. According to them everything, living or nonliving, was made up of these five basic elements.

Modern day scientists have evolved two types of classification of matter based on their physical properties andchemical nature.

PHYSICAL NATURE OF MATTER

Evidences for particles in matter : Most of the evidence for the existence of particles in matter and theirmotion comes from the experiments on diffusion and Brownian motion.

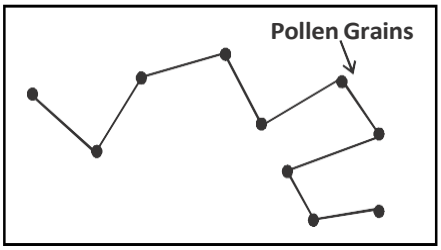
(a) Dissolving a solid in a liquid :

Potassium permanganate is a purple coloured solid substance and water is a liquid. Take 2-3 crystals of potassium permanganate and dissolve them in 100 ml of water. Now take out 10 ml of this solution & put into another 90 ml of clear water.

Keep diluting the solution like this 5 to 8 times. Every time solution will become purple colour. This experiment shows that just a few crystals of potassium permanganate can colour a large volume of water. It means a crystal of $KMnO_4$ is made up of millions of tiny particles. They dividing themselves into smaller &smaller particles.

Particles of $KMnO_4$ and particles of water spread into each other, it means they are moving. This movement of different particles among each other, so they become mixed uniformly, is called **diffusion.**

(b) **Movement of pollen grains in water :** Pollen grains move rapidly through out the water in a very irregular way (zig-zag way). The pollen grains move on the surface of water because they are constantly being hit by fast moving particles of water. This type of zig-zag movement of the small particles suspended in a liquid (or gas) is called Brownian motion. Brownian motion increases on increasing the



temperature.

The existence of Brownian motion gives two conclusions.

(i) Matter is made up of tiny particles. **(ii)** Particles of matter are constantly moving.

Characteristics of Particles of Matter:

(i) The particles of matter are very, very small

(ii) The particles of matter have spaces between them

(iii) The particles of matter are constantly moving

(iv) The particles of matter attract each other

(iii) The Particles of Matter have spaces between them : Is there vacant space between the particles of matter? Let us perform the following experiments –

Experiment (1) – Take a piece of chalk (used for writing on black board) and dip it into water. Some water is absorbed by the chalk. There are vacant spaces or pores in the chalk which are occupied by the water.

Experiment (2) – Take a wide mouthed test tube, almost half filled with water. Now put a sugar cube in the test tube and mark the water label with a glass marking pencil. The sugar cube will dissolve in water and the label of water will go down to a small extent. Why it so happened ? There is vacant space between the particles of water. This vacant space is occupied by the particles of the sugar and water label goes down.

(iv)**The particles of the matter are mobile :**

Let us perform an experiment which will show whether the particles are static or mobile.

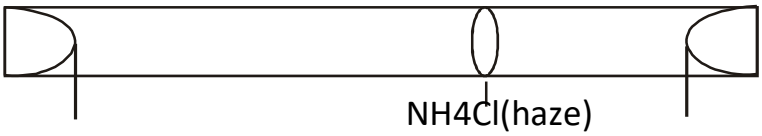
Take one glass test tube, place a small piece of iodine in it and cork tightly. You will find the violet vapour of iodine everywhere in the test tube. Now bring a starch iodide paper near the mouth of the test tube. The starch iodide paper becomes blue. This indicates the presence of iodine at the mouth of the test tube. The iodine particles are mobile and therefore, they move and spread in whole of the test tube.

Cork

Filter paper dipped in starch solution

Particles of matter are mobile

Let us perform another experiment. Take a glass tube of 50 cm length and cotton plug soaked in ammonia at one end and place another cotton plug soaked in concentrated hydrochloric acid at the other end. Now close both ends of the tube with corks. (See Fig)



Cotten plug soaked with ammonia cotten plug soaked with dil HCl

Particles of Matter Attract each other : There are some forces of attraction between the particles of matter which bind them together.

Cohesive Force : The force of attraction between the particles of same substances is called Cohesive Force. **Adhesive force:** The force of attraction between the particles of different substances is called Adhesive Force. **For eg :** If we take a piece of chalk, a cube of ice and an iron nail and beat them with a hammer.

Observation : Chalk will easily break into smaller pieces.

More force is required to break a cube of ice. Iron nail does not break. **Conclusion :** Force of attraction is quite weak in between the chalk particles. Force of attraction in between the particles of ice cube is a bit stronger.

Force of attraction in between the particles of iron is very, very strong.

Chapter-1

Matter in our Surrounding

STUDY NOTES

STATES OF MATTER - There are five main states of matter. Solids, liquids, gases, plasma, and

Bose-Einstein condensates are alldifferent states of matter.

In the solid state, substances are rigid and have definite shapes.

Volumes of solids do not vary much with changes in temperature and pressure. In manysolids,

called **crystalline solids**, the individual particles that make up the solid occupy definite positions

in the crystal structure.

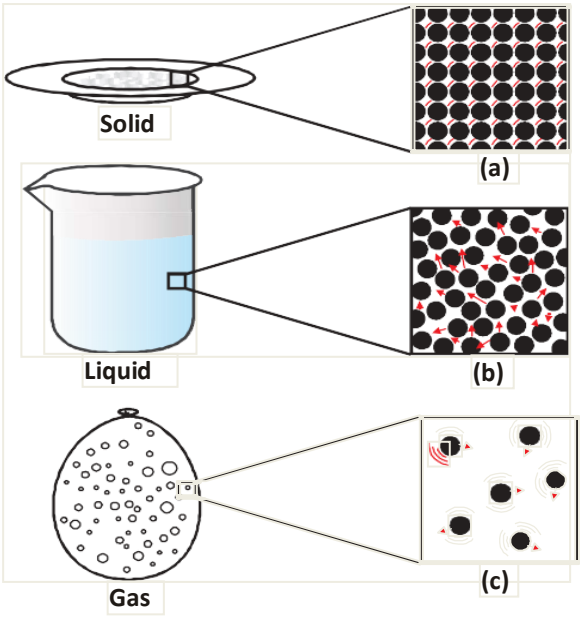


Figure : a, b and c show the magnified schematic pictures of the three states of matter. The motionof the particles can be seen and compared in the three states of matter.

Table : States of Matter

Solids	Liquids	Gases
Particles are very closely packed thus rigid.	Particles are loosely packed thus can flow.	Particles are very loosely packed and can flow.
Voids are extremely small thus incompressible.	Voids are extremely larger thus slightly compressible.	Voids are extremely large thus highly compressible.
Particle motion is restricted to vibratory motion.	Particle motion is very slow.	Particle motion is very rapid and also random.
Inter-particle force is very large thus very dense.	Inter-particle forces are intermediate resulting inlow density.	Inter-particle forces are negligible. Thus imparting very low density.

PLASMA

The state consists of super energetic and super excited particles. These particles are in the form of ionised gases. The fluorescent tube and neon sign bulbs consist of plasma. Inside a neon sign bulb there is neon gas and inside a fluorescent tube there is helium gas or some other gas.

The gas gets ionised, that is, gets charged when electrical energy flows through it. This charging up creates a plasma glowing inside the tube or bulb. The plasma glows with a special colour depending on the nature of gas. The Sun and the stars glow because of the presence of plasma in them. The plasma is created in stars because of very high temperature.

BOSE-EINSTEIN CONDENSATES

In 1920, Indian physicist Satyendra Nath Bose had done some calculations for a fifth state of matter. Building on his calculations, Albert Einstein predicted a new state of matter – the Bose-Einstein Condensate (BEC). In 2001, Eric A. Cornell, Wolfgang Ketterle and Carl E. Wieman of USAreceived the Nobel prize in physics for achieving “Bose-Einstein condensation”. The BEC is formed by cooling a gas of extremely low density, about one-hundred-thousandth the density of normal air, to super low temperatures.

INTERCONVERSION OF MATTER INTO DIFFERENT STATE

The phenomenon of change of matter from one state to another state and back to original state, by altering the condition of temperature and pressure, is called interconversion of matter

The various state of matter can be interchanged into one another by altering the conditions of :

(1) Temperature (2) Pressure.

STUDY NOTES

Latent Heat of Fusion : The amount of heat energy that is required to change 1 kg of solid into liquid at atmospheric pressure at its melting point is known as the latent heat of fusion. (Latent means Hidden) Latentheat of fusion of ice = 3.34×10^5 J/kg.

Particles of water at 0°C (273 K) have more energy as compared to particles in ice at the same temperature.

Interconversion of liquid into gaseous state & vice versa:

Liquids can be converted into gases by heating them. Similarly, gases can be converted into liquids by coolingthem.

Boiling or Vapourisation: The process due to which a liquid changes into gaseous state by absorbing heatenergy is called boiling.

Boiling Point: The constant temperature at which a liquid rapidly changes into gaseous state by absorbing heatenergy at atmospheric pressure is called boiling point.

For water, the vapour pressure reaches the standard sea level atmospheric pressure of 760 mmHg at 100°C. Since the vapour pressure increases with temperature, it follows that for pressure greater than 760 mmHg (e.g., in a pressure cooker), the boiling point is above 100°C and for pressure less than 760 mmHg (e.g., at altitudes above sea level), the boiling point will be lower than 100°C. As long as a vessel of water is boiling at 760 mm Hg, it will remain at 100°C until the phase change is complete. Rapidlyboiling water is not at a higher temperature than slowly boiling water. The stability of the boiling point makes it a convenient calibration temperature fortemperature scales.

Condensation or Liquefaction : The process due to which a gas changes into liquid state by giving out heat energy is called condensation.

Condensation Point : The constant temperature at which a gas changes into liquid state by giving out heat energy at atmospheric pressure. The numerical value of condensation point and boiling point is same.

Water changes into steam at 100°C (273 + 100) = 373 K. Steam changes into water at 100°C.

Explanation : When heat is supplied to water, particles start moving faster. At a certain temperature, a point is reached when the particles have enough energy to break the forces of attraction between the particles. At this temperature the liquid starts changing into gas. Boiling is a bulk phenomena. Condensation is the opposite of evaporation. It takes place when water vapour in the air condenses from a gas, back into a liquid form, andleaves the atmosphere, returning to the surface of the Earth.

You must have seen water droplets on glass containing ice cubes, it is due to condensation.

Latent heat of Vapourisation : The amount of heat which is required to convert 1 kg of the liquid (at its boiling point) to vapo**Latent Heat of Fusion :** The amount of heat energy that is required to change 1 kg of solid into liquid at atmospheric pressure at its melting point is known as the latent heat of fusion. (Latent means Hidden) Latentheat of fusion of ice = 3.34×10^5 J/kg.

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Determination of Melting Point of Ice :

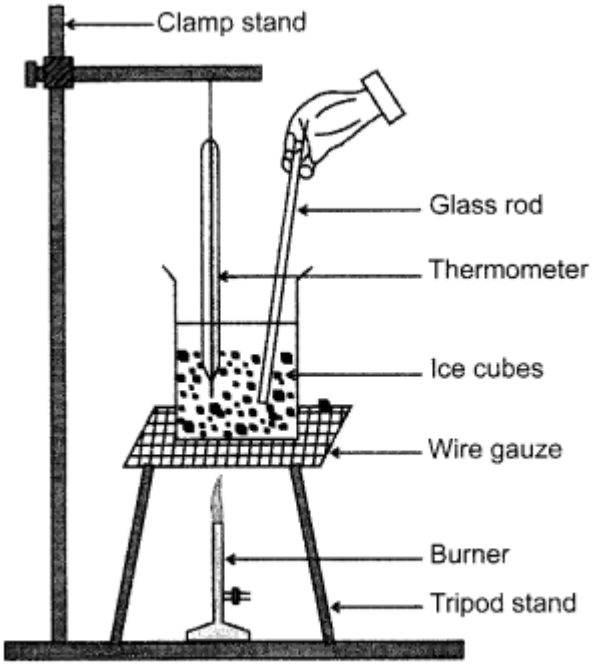

Fig. 8.1. Determination of melting point of ice

Latent heat of Vapourisation : The amount of heat which is required to convert 1 kg of the liquid (at its boiling point) to vapour or gas without any change in temperature.

Latent heat of vapourisation of water 2260 KJ/kg.
Particles in steam, that is water vapour at 373 K have more energy than water at the same temperature. Because steam have absorbed extra energy in the form of latent heat of vapourisation. Steam at 100°C will be more dangerous than water at 100°C

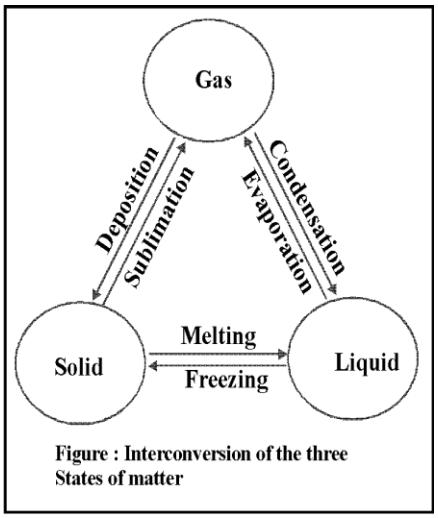

Figure : Interconversion of the three States of matter

Direct interconversion of solid into gaseous state & vice versa

Sublimation: Certain substances when heated, pass directly from the solid state to vapour state without being converted into liquid. The vapours when cooled give back the solid substance. This phenomenon is known as **sublimation** and the substance is called **sublimate.**

$$\text{Solid} \underset{\text{on cooling}}{\overset{\text{on heating}}{\rightleftharpoons}} \text{Vapours}$$

The examples of substances which can easily sublime are camphor, iodine, napthalene, ammonium chloride etc.
The force of attraction is not uniform in the molecules of all the solids. In some solids, the molecules are bonded together with stronger inter-molecules forces and in the other, the molecules are bonded together with comparatively weak inter-molecular forces.
The solids, having weak inter-molecular forces, when heated are directly converted into vapours (gaseous state) without being converted into liquids. Small amount of energy is sufficient to make the inter-molecular force of attraction negligible. This increases the inter molecular distance to a very great extent.
Therefore, the solid is directly converted into vapours.

Experiment : Take ammonium Chloride in a China dish. Cover the dish with a perforated filter paper. Now place an inverted funnel over the dish as shown in Figure. The upper open end of the funnel is plugged with cotton. The vapour rising from the solid pass through the holes of the filter paper and are deposited on the cold walls of the funnel. The substance deposited on the cold walls of upper part of the funnel is nothing but ammonium chloride.
This experiment can be repeated with camphor, iodine, naphthalene etc. These all substance are sublimates.
The perforated filter paper in the above experiment has two functions – (i) It keeps the funnel cool by cutting off the direct heat and (ii) It does not allow the sublimed substance to drop back in the dish. The process of sublimation is very helpful in separating a mixture of solids and also in the purification of the substances.

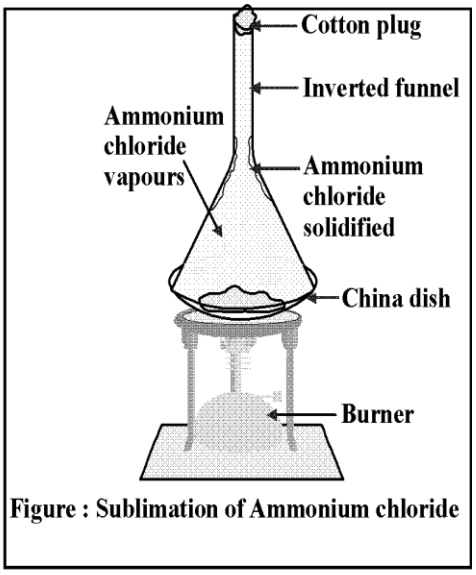

Figure : Sublimation of Ammonium chloride

By Altering Pressure: The difference in various state of matter is due to the different intermolecular spaces between their particles. So when a gas is compressed the intermolecular space between its particles get decreases & ultimately it will converted into liquid. So high pressure & low temperature can liquefy gases.
For eg : Carbon dioxide (CO_2) is gas under normal conditions of temperature and pressure. It can be liquefied by compressing it to a pressure 70 times more than atmospheric pressure.

Applying pressure and reducing temperature can liquefy gases. Solid carbon dioxide (CO_2) is stored under high pressure. Solid CO_2 gets converted directly to gaseous state on decrease of pressure to 1 atmosphere without coming into liquid state. This is the reason that solid carbon dioxide is also known as **dry ice.**

- Pressure & temperature determine the state of a substance.
- Solid CO_2 is extremely cold and used to 'deep freeze' food and to keep ice-cream cold.

When pressure is lowered the boiling point of liquid is lowered. This helps in rapid change of liquid

Into gas.

STUDY NOTES

EVAPORATION

Perhaps one of the most accepted facts of life is that wet things eventually become dry. The liquid water has changed to the gaseous state in a process known as vapourization. When this process occurs below the boiling point, it is known as evaporation. In order for a molecule of a liquid to escape to the vapour state, however, it must overcome the intermolecular forces attracting it to its neighbours in the liquid. Two conditions allow a molecule in a liquid to escape the liquid state to the gaseous state. First, it must be at or near the surface of the liquid. Second, it must have at least the minimum amount of kinetic energyto overcome the intermolecular forces. Evaporation is important to life on Earth. The heat of the sun evaporates water from earth's surface. The evaporated water goes high into the air. Then it cools down, forms clouds, and falls from the sky as rain or snow. Evaporation is important for people too. When we sweat, water on our skin evaporates. The evaporationmakes the skin feel cooler.

Why Evaporation occurs : Molecules in the liquid state are constantly moving, but at different speeds. Faster moving molecules at the surface of a liquid break away from the attraction of the other molecules, and escape into the air. Furthermore, heating makes liquids evaporate faster because there are more fast moving moleculesand, therefore, more molecules can escape.

As faster moving water molecules escape from a cup of water, the temperature of the water in the cup will decrease, and fewer molecules will have sufficient energy to escape, slowing down evaporation. However, this will happen only in a cup of water that is insulated from the rest of the environment. The external environment (i.e., the air, the cup itself, the desk the cup is on, etc.) will continuously provide enough heat to keep the waterat a steady temperature and evaporation will continue.

Factors Affecting Evaporation :

(i) Temperature (ii) Surface Area (iii) Humidity (iv) Wind Speed (v) Pressure

(i) **Temperature:** With the increase in temperature the rate of evaporation increases.

Rate of evaporation □ : Temperature

Reason: On increasing temperature more number of particle

enough kinetic energy to go, into the vapour state.

An increase in heat makes things evaporate faster. For example, if a person put the pan of water on the stove and then turned on the heat, the water would soon begin to boil. The person might see steam rise off he top of the water. Steam is water turning into vapour.

(ii) Surface Area : Rate of evaporation □ Surface area

Since evaporation is a surface phenomena. If the surface area is increased, the rate of evaporation increases.So, white putting clothes for drying up we spread them out.

(iii) Humidity of Air : Rate of evaporation [1

(iv) Humidity is the amount of water-vapour present in air.

When humidity of air is low, the rate of evaporation is high and water evaporates more readily.When humidity of air is high, the rate of evaporation is low and water evaporate very slowly.

(v) Wind Speed : Rate of evaporation □ wind speed

With the increase in wind speed, the particles of water-vapour move away with the wind.So the amount of water-vapour decreases in the surrounding.

(vi) **Pressure :** The rate of evaporation can also increase with adecrease in the gas pressure around a liquid. Molecules like to move from areas of higher pressure to lower pressure.

The molecules are basically sucked into the surrounding area to even out the pressure. Once the vapour pressure of the area increases to a specific level, the rate of evaporation will slow down.

Pressur

STUDY NOTES

Cooling caused by evaporation : When the molecules with the highest kinetic energyof the molecules remaining in the liquid state is lowered. This means that the liquid water will be cooled and the gas above the water will becorrespondingly heated.

The cooling effect of evaporating water is important to health maintenance in warm climates.

Perspiration covers our bodies with a layer of water when it is warm. The evaporation of this liquid cools the water on our bodies and us along with it. The cool feeling after a hot shower is not just a feeling but a reality. Our perspiration cools us but can make life more miserable for the next person in a crowded room. Evaporation cools the liquid but heats the air. If water is allowed to evaporate under a vacuum, the evaporation process occurs faster. Infact, the water cools enough to freeze.

Evaporative coolers : Also called air, swamp, or desert coolers are cooling devices which use simple evaporation of water in air. Evaporative cooling is especially well suited for climates where the air is hot and humidity is low. Residential evaporative coolers use direct evaporation and can be described as an enclosed metal or plastic box with vented sides containing a centrifugal fan or 'blower', electric motor, and a water pump to wet the evaporative cooling pads. The units can be mounted on the roof, or exterior walls or windows of buildings. To cool, the fan draws ambient air through vents on the unit's sides and through the damp pads. Heat in the air evaporates water from the pads which are constantly re-dampened to continue the cooling process. Thus cooled, moist air is then delivered to the building via a vent in the roof or wall.

Difference between boiling and evaporation :

Evaporation and boiling are both examples of liquids changing into gases. Ordinary evaporation is a surface phenomenon - since the vapour pressure is low and since the pressure inside the liquid is equal to atmospheric pressure plus the liquid pressure, bubbles of water vapour cannot form. But at the boiling point, the saturated vapour pressure is equal to atmospheric pressure, bubbles form, and the vapourization becomes a volume

phenomena.

Why should we wear cotton clothes in summer ?

During summer, we perspire more because of the mechanism of our body which keeps us cool.

During evaporating, the particles at the surface of liquid gain energy from the surroundings or body surface. The heat energy equal to latent heat of vapourisation is absorbed from the body leaving the body cool. Cotton, beinga good absorber of water helps in absorbing the sweat.

Why do we see water droplets on the outer surface of a glass containing Ice-cold water ?

If we take some ice-cold water in a tumbler then we observed water droplets on the outer surface of tumbler. **Reason:** The water vapour present in air on coming in contact with cold glass of water, loses energy. So watervapour gets converted to liquid state, which we see as water droplets.

Why is the grass wet early in the morning? Even when it hasn't rained ?

Transpiration : The process by which plants eliminate water drawn through their bodies through their leaves. Covers the surfaces of the leaves in a layer of saturated air. If the temperature falls, the saturated air reaches thedew point and dew condenses on the surface of these plants.

Condensation nuclei : The atmosphere contains bits of dust, particles of smoke, and various other small bitsthat can act as surfaces for condensation.

When water vapour condenses on these nuclei, fog, mist, and clouds are produced.

Evaporation and Smells : Smells are made of molecules of the substance that has escaped and mixed in with the air. This is a form of evaporation. Not all molecules that evaporate from substances are smelly, though. Some students attribute smell to a "scent" that leaves the substance, but don't recognize that the amount of substance decreases as the "scent" leaves it. They most likely do not understand that the "scent" is actuallymolecules of the substance.

Differences between Evaporation and Boiling :

Evaporation	Boiling
-It is a surface phenomenon	- It is bulk phenomenon.
- It is a slow process	- It is a fast process.
- No external heat is required	- External heat is required.
- It causes cooling	- It causes burning.