Matter in Our Surroundings

Matter -

Anything which occupies space and has mass is called matter. In other words, anything which has mass and volume is called matter.
For example: chair, table, computer, mouse, keyboard, dog, cat, cow, pencil, tree, plant, building, mountain, river, etc.

According to their physical and chemical properties, matters can be divided into three types -

(i) Solid
(ii) Liquid
(iii) Gas

Properties of Matter -

- Matter is made up of small particles.
- These particles are very small in size.
- These particles are moving constantly.
- These particles have spaces between them.
- Particles of matter attract each other because of force of attraction.

Experiments -

a. Experiment with Pollen Grains

- If we suspend extremely small pollen grains in water and see through microscope, we found that the tiny particles of water do collisions with pollen grains.
- Due to these collisions, pollen grains move slightly.

b. Mixing of Ink with Water

- If we put a drop of ink in water, we see that initially ink is present in small portion of water and after some time, ink spread up all over in the water.
- This happens because the tiny particles of water collide with tiny particles of ink. Due to these collisions, particles of water and ink mix with each other.

From above two experiments, it is proved that:

(i) Matter is made up of tiny particles.
(ii) Particles do Brownian motion.

Brownian motion of Dust Particles and Smoke -

- Mr. Robert Brown, a Scottish botanist observed the random movement of pollen grains in water in 1827, this movement of particles is called Brownian motion.
- Dust moves randomly because the random moving particles of air collide with dust particles.
- Similarly, smoke also moves randomly because the random moving particles of air collide with smoke particles again and again.

Spreading of Smell -

- When we spread perfume, tiny particles of air collide with tiny particles of perfume which is liquid. Due to these collisions, particles of perfume spread in the air. That's why we feel the smell of perfume.

- Spreading of smell proves that matter is made up of tiny particles moving randomly.

Experiment with Sugar and Water -

- Take a beaker which is filled with water up to certain mark.
- Add some sugar in it.
- We see that marking of water in a beaker increases.
- Keep stirring the solution. After some time sugar dissolved in water and level of the water comes down to original mark.
- This happens because the tiny particles of sugar adjust themselves in the space between the tiny particles of water.
- This experiment proves that:
  (i) Matter is made up of tiny particles.
  (ii) There is a space between these particles.

Mixing Potassium Permanganate or Copper Sulphate with Water -

- Put a small crystal of potassium permanganate in a beaker filled with water.
- Stir the solution.
- You will see that crystals of potassium permanganate dissolve in water and colour of water becomes dark pink.
- Let's take another beaker filled with water and put small amount of dark pink solution in it
- We see that beaker in which only water is present becomes light pink; lighter than previous solution.
- Repeat this activity again. You will find the same result that water turns to pink but lighter than previous one.
- It means that even small amount of solution contains lots of particles of potassium permanganate.
- Or we can say that particles of potassium permanganate are too small that their small amount can change the colour of entire water as we saw in this experiment.
- Similarly, if we do the same experiment with copper sulphate then water becomes blue.

Potassium Permanganate solution

Copper sulphate solution

- This experiment proves that the particles of matter are very small.

Diffusion -

- The process of mixing of two substances due to Brownian motion of particles is called Diffusion.
- As temperature increases, Brownian motion increases and diffusion becomes fast.
- Diffusion takes place from higher concentration to lower concentration.
- It is a natural process.
- It takes place in solid, liquid and gases.

Three States of Matter -

There are three states of matter - solid, liquid and gas.

Solid: Solids have fixed volume and shape. In solids, particles are closely packed and they have very less spacing between them.

In solids, particles only vibrate at their position and they have less kinetic energy. The force of attraction between the particles of solids is very strong.

Example - stone, wood, brick, ice, sugar, salt, coal, etc.

Liquid: Liquids have fixed volume but indefinite shape. In liquids there is a weaker force of attraction and more spacing between the particles.

In liquids, particles can move around and have high kinetic energy. Example - milk, water, petrol, kerosene, alcohol, oil, etc.

Gas: Gases have indefinite shape and volume. Particles of gases have very large spacing and very weak attraction between them. Particles of gases move around very easily and have very high kinetic energy. Example - air, oxygen, hydrogen, nitrogen, carbon-dioxide, etc.

Properties of States of Matter -

1. Filling Container -

- The force of attraction between the tiny particles in gases is very less.

- Due to this, these particles can easily move away from each other and thus filling the container.
- In solids and liquids, attraction force is sufficient enough for not letting the particles move away from each other.

2. Shape and Volume -

Shape: Due to less attraction force between particles, particles of liquid and gas can easily move around. Thus they can take any shape as per the container.

Volume:

- Gases have so little attraction among particles that they can easily change spacing between themselves, so they can easily change their volume.
- In liquids, attraction force is large enough so that spacing between particles does not change easily, so liquid has fixed volume and same with solids.
- Solids can change shape on applying force. Liquids and gases do not need force to be applied for changing shape.
- Some solids have gas inside them. So they can be easily squeezed to change shape.
- Sponges have many small air filled holes, when we squeezed them, air from these holes can come out changing the shape of sponge.

3. Compressibility and Rigidity -

Compressibility: Spacing between particles of gases can be decreased so gases have high compressibility. But spacing between particles of solid or liquid cannot be decreased, so they cannot be compressed.

Applications of Compressed Gas -

- Compressed helium gas is filled in air balloons.
- Compressed natural gas (CNG) is filled in cylinders which are used in vehicles.
- Liquefied petroleum gas (LPG) is filled in cylinders which are used for cooking.

Rigidity: It is the property of a substance to resist any deformation like change in shape, being compressed etc. Solids have high rigidity, liquids have less rigidity and gases have no rigidity.

4. Moving Through -

As we try to move through gases and liquids, their particles move away from our path creating space for us. So we can move through them. Particles of solids cannot move away from our path, so we cannot move though them.

5. Fluidity -

- Fluids are substances which can flow.
- Liquids and gases have fluidity.
- But solids do not have fluidity.

6. Density -

Density = Mass/ Volume

Particles in solids are very closely packed so they have high density. In gases, there is plenty of space between particles due to which density is low.

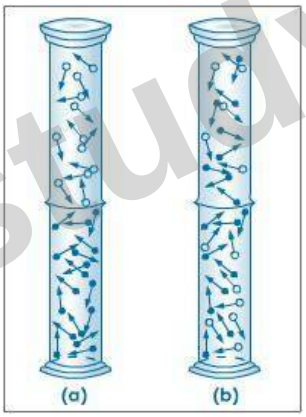
7. Diffusion -

Diffusion is the process of mixing of different substances with each other due to random motion of their particles.

- If a bottle of perfume is opened in one corner of a room, it spreads in the whole room by diffusion.
- If we drop a little ink in a beaker of water, it will spread by itself in the beaker of water and the color spreads uniformly due to diffusion.

Diffusion of Bromine in air -

A gas jar of bromine and a jar of air are placed, separated by a cover plate. The cover plate is removed so that the two open ends of the jars are in contact. The bromine gas spreads (diffuses) rapidly into the air to produce a uniform reddish brown colour in both jars as we can see in fig. (b).



- Aquatic animals take oxygen and carbon dioxide for their survival because of the diffusion phenomenon. Oxygen and carbon dioxide present in air diffuses in water and dissolves in it. Aquatic animals inside water can take these dissolved gases for their survival.

8. Pressure -

- Take a container filled with gas.
- The tiny particles of gas collide with walls of container while doing random motion.
- Due to this pressure is exerted on walls of container. If temperature of gas is high, particles move faster and exert more pressure on walls.
- Particles of liquid can also exert pressure as they can do random motion. As temperature increases, pressure increases.

Measurement of Temperature -

Different units can be used to measure the temperature in different scales. Most known units of measurements are Kelvin and Degree Celsius.

Kelvin -

- Kelvin is the SI unit of temperature. The symbol of Kelvin is 'K'.
- The scale of Kelvin is used widely because of its many advantages over degree Celsius. In Kelvin scale, temperatures are written in positive usually.
- 273 K is defined as the freezing or melting point of ice.
- 373 K is defined as the boiling point of water.
- At Kelvin scale -273 K is considered as the absolute zero temperature.

Degree Celsius -

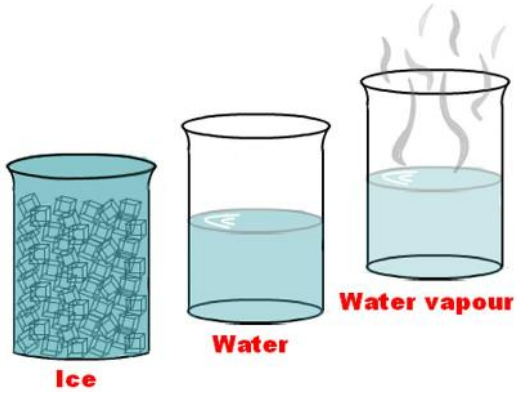
- Degree Celsius is written as "^{o}C" and read as degree Celsius.
- 0 ^{o}C (zero degree Celsius) has been defined for the freezing point of water.
- 100 ^{o}C (hundred degree Celsius) has been defined for the boiling point of water.

$$\text{Temperature in K} = \text{Temperature in } ^{o}\text{C} + 273$$

Change of State of Matter -

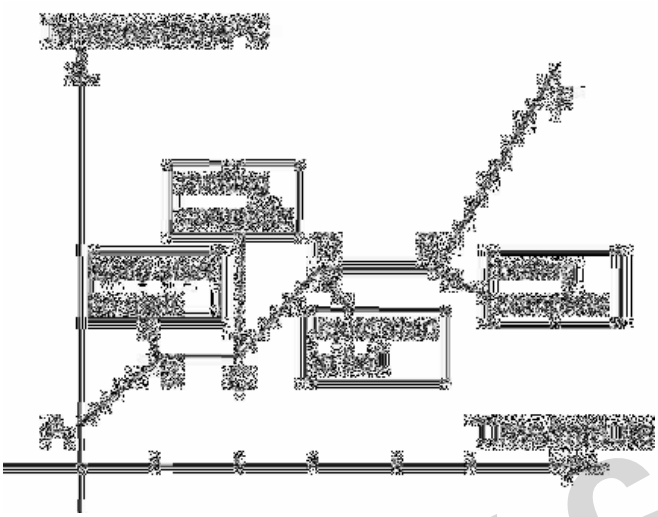
- Matters can be changed from one state to another state. A solid can be changed into liquid and a liquid can be changed into gas.
- Most of the metals, which are solid, turn into liquid on heating and turn into vapor on further heating.
- The change of state of matters mainly depends upon two factors:

  (i) Temperature
  (ii) Pressure



i. Temperature -

- Generally on heating, temperature of substances increases. But during state transformation, temperature remains same.
- **Melting Point:** It is the temperature at which a solid changes to liquid. Different substances have different melting points. Higher melting point means large force of attraction between particles.
- **Boiling Point:** It is the temperature at which a liquid changes to gas.



On heating -

(1) **Temperature increases:** When temperature increases, heat is used to increase the motion of the particles. In other words, heat is used to increase the kinetic energy of the particles.

(2) **State Changes:** When state changes, heat supplied is used by particles to overcome force of attraction.

Latent Heat - Latent heat is the heat supplied to a substance during the change of its state

(i) **Latent Heat of Fusion:** Latent heat of fusion is the amount of heat required to convert 1kg of solid at its melting point to liquid at same temperature.

(ii) **(ii) Latent Heat of Vaporization:** Latent heat of vaporization is the amount of heat required to convert 1kg of liquid at its boiling point to gas at same temperature. Different liquid has different latent heat of vaporization.

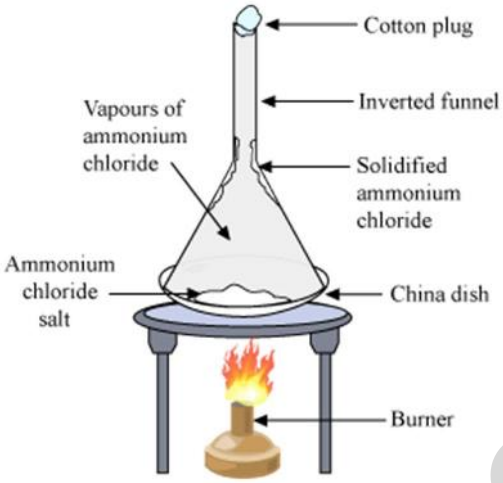
Sublimation -

- Sublimation is a process in which a solid changes directly into gas or vice versa.
- Generally solid first changes into liquid and then changes into gas because of rise in temperature. But there are many substances, which change into gas without changing into liquid. And many other substances which change into solid from gas without changing into liquid. Such substances, which go under sublimation, are known as sublime.

  For example – camphor, naphthalene balls, ammonium chloride, iodine, dry ice, etc.

  Sublimation of ammonium chloride is explained below:

- Take some crushed ammonium chloride (solid) in a china dish.
- There is an inverted funnel over the china dish.
- There is a cotton plug on the stem of the funnel.
- Heat the crushed ammonium chloride, we found that ammonium chloride directly changes into vapours.
- After some time, we see that vapours of ammonium chloride again solidified at the surface of funnel.



ii. Pressure -

Solid -

- There is no effect of pressure on solids.
- Solids are non-compressible, i.e. solids cannot be compressed as there is no space between their particles which could allow compression.
- When the pressure is increased on a solid, it is deformed and finally broken.

Liquid -

- There is no effect of pressure on liquid.
- Liquids are non-compressible, i.e. liquids cannot be compressed since there is not enough space between their particles to get compressed.

Gas -

- The volume of gas decreases with increase in pressure.
- Since there is lot of space between the particles of gas, gas is highly compressible.

Evaporation -

- The process of conversion of liquid to gas due to escaping of particles from liquid surface (even below boiling point) is called evaporation.

- Evaporation takes place only at the surface of liquid. Evaporation takes place even at room temperature also. Evaporation speeds up with rise in temperature.

Factors affecting Evaporation -

1. Temperature
2. Surface area
3. Humidity
4. Wind

1. Temperature -

- Evaporation increases with increase in temperature and decreases with decrease in temperature. This means rate of evaporation is directly proportional to the temperature.
- With increase in temperature, the particles of liquid at surface get required kinetic energy to overcome the force of attraction and escape in air quickly. Hence, the increase in temperature increases the rate of evaporation.

2. Surface Area -

- Evaporation increases with increase in surface area and decreases with decrease in surface area.
- After rain, roads are dried up quickly than pot holes. This happens because of increase in surface area of water. On roads water is spread over a large area, because of that large area of water exposed to atmosphere, and evaporation of water takes place quickly resulting in quickly drying of the roads.
- While in pot holes less water surface is exposed to air because of that less water area could come in contact with air and receives less temperature, resulting in delayed evaporation.
- Wet clothes are spread up over the laundry line to get them dried up quickly. More surface area of water exposes to the air because of spreading of clothes. This speeds up the rate of evaporation and clothes are dried up quickly.
- On the other hand if wet clothes are left even in the sun without spreading, they take more time to get dried because of less surface area exposed to air.

3. Humidity -

- Evaporation decreases with increase in humidity and increases with decrease in humidity present in air. This means rate of evaporation is indirectly proportional to the humidity present in air.
- Because of more water vapors present in air, the water holding capacity of atmosphere decreases; which decrease the rate of evaporation. If air is dry then it can holds more water. Thus in dry air, rate of evaporation increases.
- When we sweat, it evaporates due to large surface area. In coastal region, due to high humidity evaporation is slow. So sweat evaporates slowly. This gives a feeling that we are sweating heavily.

4. Wind -

- Evaporation increases with the increase in wind speed and decreases with decrease in wind speed. This means rate of evaporation is directly proportional to the speed of wind.
- Speedy wind propelled away some of the particles of water with it which speeds up the rate of evaporation.

Cooling Effect of Evaporation -

- Liquid needs latent heat for evaporation. It takes this heat from things in its surroundings. It means things in surrounding loose heat and thus they cool down.
- **Sweating:** When we sweat; water in it; evaporates taking latent heat from our body. This cause cooling.
- When we come out of swimming pool, water on our body surface evaporates. It takes heat from our body for evaporation, so we feel cool.
- Spirit evaporates very fast, when we keep it on our skin it evaporates quickly taking lot of heat from us giving cooling sensation.
- **Earthen Pot (Pitcher):** The earthen pot has minute pores through which water sips out and droplets of water deposit on outer surface of pot. When this water evaporates, it takes latent heat from pot and water inside. So water inside cools down.
- **Tea in Saucer:** When tea is put in saucer, evaporation is faster due to more surface area. This cools tea faster and makes it easier to drink.
- **Cotton Clothes in summer:** Cotton absorbs water and thus sweats very fast. So sweat comes outside clothes in contact with atmosphere. Then it evaporates and gives cooling.
- **Cooler:** Cooler works on the concept of evaporation. When humidity is high, evaporation is very slow and thus cooler is ineffective. But in areas of low humidity, evaporation is fast and thus cooler is effective.

Two more States of Matter -

(1) Bose-Einstein Condensate (BEC)

(2) Plasma

Bose-Einstein Condensate (BEC) -

- In 1920, Indian scientist Satyendra Nath Bose did some calculations, based on which Albert Einstein predicted that a new state of matter should exist.
- This new state was named as Bose-Einstein Condensate (BEC).
- In 2001, Cornell, Ketterie and Wieman of USA received Nobel Prize for actually making this state in laboratory.
- BEC is made by cooling a gas of very low temperature to super low temperature.

Plasma -

- Plasma is found in some glowing substances like sun, stars, fluorescent tube, neon lights etc.
- Plasma consists of super excited ionized particles of gases. For example – Sun : Helium gas and Neon lights :Neon gas.
- These excited ionized particles glow with different colours based on the gas present in them.
- In stars and sun, plasma is formed because of nuclear fusion in stars. In neon lights and fluorescent tubes it is formed due to electricity.
- Plasma does not have a definite shape or a definite volume unless enclosed in a container.
- Plasma may be defined as an electrically neutral medium of positive and negative particles.