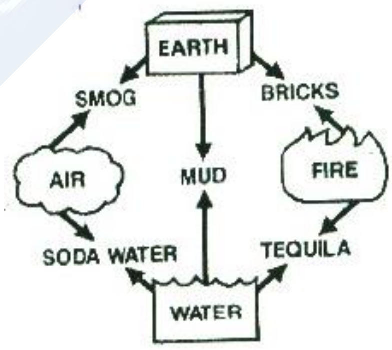
Chapter 1 - Matter in Our Surrounding - Summary Note

SUB- TOPICS

- **Introduction**
- **Composition of Matter**
- **Matter is made up of Particle**
- **Properties of Matter**
- **Diffusion**
- **States of Matter**
- **Rigid & Fluid**
- **Interconversion of the state of Matter**
- **Effect of change of temperature & pressure**
- **Latent Heat**
- **Latent heat of vapourization and Fusion**
- **Sublimation**
- **Evaporation**
- **Cooling Effect**

- **INTRODUCTION**
  - A pencil, a pen, a table, the food we eat, the clothes we wear, the walls of our houses – everything around is made up of matter. But **what is matter?**
    - **Matter is anything that occupies space has mass and can be perceived by out senses**. In other words
    - “**Matter is used to cover all the substances and the materials from which the universe is made.**

- **COMPOSITION OF MATTER**



  - In ancient time, according to the researches carried on our religious books and scriptures, the Indian philosophers stated that matter is made from five constituents or tatvas.

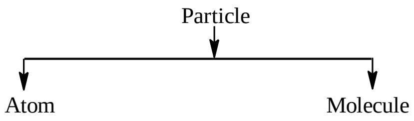
FIVE TATVAS

- Air (Vayu)
- Earth (Prithvi)
- Water (Jal)
- Fire (Agni)
- Sky (Aakash)

Modern scientists have evolved two types of classification of matter

Illustrations –1:	In how many forms did the earlier Indian philosophers classify matter? (A) 2 (B) 6 (C) 7 (D) 5
Solution:	(D)

- **MATTER IS MADE UP OF PARTICLES**
  - Now that we have defined matter let us ask ourselves the question – **What is matter made up of?**
  - All matter comprises of very small particles.
  - All matter can be broken up in a similar manner to get very small particles.
  - Hence we now conclude that all matter is made up of small particles.



Illustrations –2:	Which of the following are matter? Chair, air, love, smell, hate, almonds, thought, cold, cold-drink, smell of perfume.
Solution:	chair, air, almond, cool drink

- **PROPERTIES OF MATTER**

  All matter consists of small particles of matter. These particles have some common characteristics. These characteristics are laid down in a theory called **Kinetic Theory of Matter.**

  Stated very simply The Kinetic Theory of Matter States
  - All matter comprises of small particles.
  - These particles have space in between them.
  - The particles are continuously moving.
  - The particles attract each other.

PARTICLES OF MATTER HAVE SPACE BETWEEN THEM

- Matter is made up of small particles.
- These particles have small spaces between them.
- These spaces are invisible to the naked eye.
- But particles of other matter can get between these spaces without increase in volume.

PARTICLES OF MATTER ARE CONTINUOUSLY MOVING

- Particles present in matter move continuously.
- The particles of matter shown three types of motion.
- **Translatory Motion** – When particles move in straight lines, changing direction without loss of energy on colliding with another particle or the wall of the container, the motion is called **translatory motion**. Translatory motion is maximum in gases and the least in solids when compared to liquids.

- **Rotational Motion –** When particles move around their own axis, the motion is called rotational motion. This motion is similar to the rotation of earth around its axis. Rotational motion will be high in gases and in liquids.
- **Vibrational Motion** – When particles have a to and fro motion about a mean position, the motion is called **Vibrational motion**. This motion is maximum in solids as the particles are held in a rigid structure.

PARTICLES OF MATTER ATTRACT EACH OTHER

- The force with which they attract each other varies from matter to matter.
- In some kinds of matter (waste paper, matchstick) the force is small (as we can tear or break them easily).
- In other kinds of mater (iron nail) the force is large (as we cannot break the nail easily).

Illustrations –3: What happens to the sugar when it dissolves in water? Where does the sugar go? What information do you get about the nature of matter from the dissolution of sugar in water?

Solution:
(a) When sugar dissolves in water, its tiny particles break off from the solid sugar crystals.
(b) the sugar particles go into the spaces between the particles of water and mix with them (to form sugar solution).
(c) The dissolution of sugar in water tells us that:
   i) The matter (here sugar and water) is made up of small particles.
   ii) The particles of matter (here water) have spaces between them.

- **DIFFUSION**
  - ***"The mixing and spreading out of a substance with another substance due to the movement or motion of its particles is called diffusion."***
  - The diffusion of one substance into another substance goes on until a uniform mixture is formed. Let us take one example of it.
  - Take one beaker which is full of water now put a crystal of potassium permanganate (purple colour) in water. Gradually you will see that purple colour crystal starts to diffuse or dissolve into water, after some time you see it becomes purple in colour.

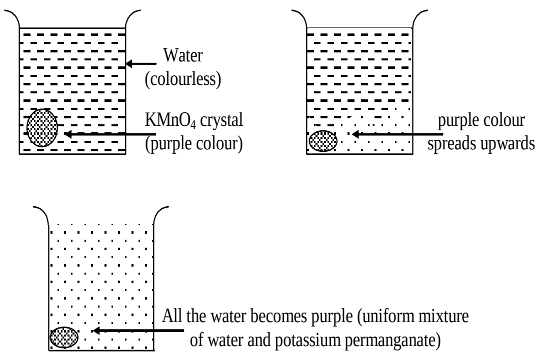


Fig (1.3)

DIFFUSION IN GASES

- Diffusion in gases is very fast. This is because the particles in gases move very quickly in all directions.

Examples – 1:

- The smell of food being cooked in the kitchen reaches us even from a considerable distance.
- The smell of hot sizzling food reaches us even when we are at a considerable distance but to get the smell of cold food, we have to go close to it.
- This is due to the fact that the rate of diffusion of hot gases (released by the hot sizzling food) is much faster than the rate of cold gases released by the cold food.

Example –2:

- When someone opens a bottle of perfume in one corner of a room, its smell spreads in the whole room quickly.
- When the bottle of perfume is opened, then the liquid perfume quickly changes into vapour (or gas).
- The perfume vapours move very rapidly in all directions in air, mix with the air particles and hence spread with air in the whole room.

Example – 3:

- The leakage of cooking gas (LPG) in our homes is detected due to the diffusion of a strong smelling substance (ethyl mercaptan) present in the cooking gas, into air.

DIFFUSION IN LIQUIDS

- Diffusion in liquids is slower than that in gases. This is because the particles in liquids move slower as compared to the particles in gases.

SOLID IN LIQUID

- If a crystal of potassium permanganate is placed at the bottom of water in a beaker, then the purple colour of potassium permanganate spreads into the whole water, slowly.

LIQUID IN LIQUID :

- If a drop of ink is put into a beaker of water, then the colour of ink spreads into the whole water of the beaker.
- The spreading of ink in water, on its own, is due to the diffusion of ink particles into water.
- ***The gases like carbon dioxide and oxygen are essential for the survival of aquatic plants and animals. The carbon dioxide gas and oxygen gas present in air (or atmosphere) diffuse into water (of ponds, lakes, rivers and sea), and dissolve in it. The aquatic plants use the dissolved carbon dioxide for preparing food by photosynthesis and aquantic animals use the dissolved oxygen of water for breathing***

DIFFUSION IN SOLIDS

- Diffusion in solids is a very, very slow process.

Example :

- If we write something on a blackboard and leave it uncleaned for a considerable period of time (say, at least 10 to 15 days), we will find that it becomes quite difficult to clean the blackboard afterwards. This is due to the fact that some of the particles of chalk have diffused into the surface of backboard.
- If two metal blocks are bound together tightly and kept undisturbed for a few years, then the particles of one metal are found to have diffused into the other metal.

Gases diffuses very rapidly. The rate of diffusion of a gas varies inversely as the square root of its density.

Force of Attraction (or Cohesion)

- There is some force of attraction between the particles of the matter which bind them together. This force of attraction between the particles of same substance is known as force of attraction (or cohesion).
- In general, the force of attraction is maximum in the particles of solid matter and minimum in the particles of gaseous matter.

Illustrations –4:	Find the rate of diffusion in various state of matter that is solid, gas, liquid
Solution:	Solid < Liquid < Gases
	Slow fast very fast

- **STATES OF MATTER**

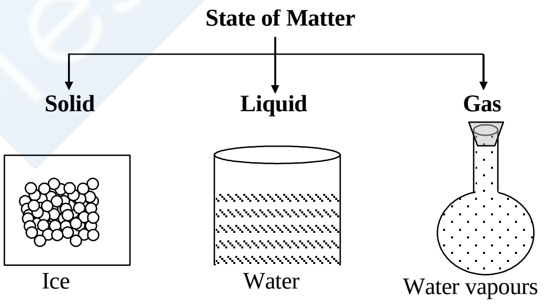


Fig (1.4)

- **Solids** have a definite shape and volume. They are harder than liquid and gases.
- **Liquids** have a definite volume but no definite shape. They take the shape of the container in which they are kept.
- **Gases** have no definite shape or volume. They occupy the entire space available to them and take the shape of the container in which they are stored.
- **Plasma** state is a fused and ionic state of matter that is present at very high temperatures (like the core of the sun, stars). The fused ionic mass is neutral as it consists of positive ions and a pool of electrons. Approximately 99% of the universe is a fused ionic mass.

Comparison of Some Important Characteristics of Solids, Liquid and Gas

S.No.	Solid	Liquid	Gas
1.	Solids have fixed shape and definite volume	Liquids have fixed volume but no definite shape.	Gases have no fixed volume and shape.
2.	Solids have high density	Liquids have high density but less than solids.	Gases have low density.
3.	Solids show only slight expansion on heating.	Liquids show slight expansion on heating but more than solids.	Gases expand considerably on heating.
4.	They have slight or no compressibility.	They have slight compressibility but more than solids.	They have high compressibility.
5.	Solids do not flow.	Liquids generally flow easily.	Gases flow freely.
6.	They have their melting and boiling points above room temperature.	They have their melting point below room temperature.	They have their melting and boiling points both below room temperature.
7.	Intermolecular forces are very strong and constituent particles are closely packed.	Intermolecular forces are strong enough to keep the particles together but not strong enough to keep them in fixed positions.	Intermolecular forces are very weak and the particles are free to move.

Illustrations –5:

(a) Give two reasons for saying that wood is a solid.

(b) ‘A substance has a definite volume but no definite shape’. State whether this substance is a solid, a liquid or a gas.

(c) Name the physical state of matter which can be easily compressed.

(d) ‘A substance has a definite shape as well as a definite volume’. Which physical state is represented by this statement?

(e) A substance has neither a fixed shape nor a fixed volume. State whether it is a solid, a liquid or a gas.

(f) Give two reasons to justify that:
- i) Water is a liquid at room temp.
- ii) An iron almirah is a solid.

Solution:

a) Wood has (i) fixed shape, and (ii) fixed volume

b) Liquid

c) Gas

d) Solid

e) Gas

f) i) Fixed volume but no fixed shape
   ii) Fixed shape and fixed volume.

- **RIGID AND FLUID**
  - Rigid means ‘unbending’ or ‘inflexible’. A stone is rigid because it is unbending or inflexible. Fluid means ‘a material which can flow easily’ and requires a vessel (or container) to keep it.
  - A solid is a rigid form of matter. Due to their rigidity, solids have a tendency to maintain their shape when subjected to outside force. Thus, the main identifying characteristic of solids is their rigidity. Solids do not require a container to keep them. A brick and a log of wood are two common solids.
  - A liquid is a fluid form of matter which occupies the lower part of the container. Being fluids, liquids require a container to keep them. A liquid has a well-defined surface, so a liquid can be kept in an open container. The liquid will not escape from the open container by itself. Water and milk are two common liquids around us.
  - A gas is a fluid from of matter which fills the whole container in which it is kept. Being fluids, gases also require a container to keep them. A gas does not have a free surface, so a gas has to be kept in a closed container. A gas will escape if kept in an open container. **This is why gases are usually kept in air-tight gas cylinders.** For example, cooking gas (LPG) is kept in air-tight metal cylinders. From this discussion we conclude that both, liquids and gases are known as fluids. Characteristic of liquids and gases of ‘flowing’ easily is called ‘fluidity’. Due to fluidity, liquids and gases change their shapes readily when subjected to outside force.

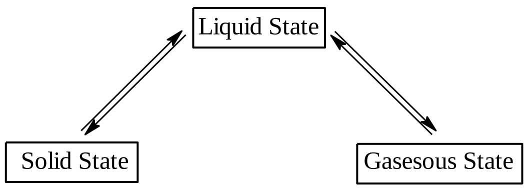
Illustrations –6:	Which of the following is rigid form of matter			
	(A) alcohol	(B) ether	(C) love	(D) pen
Solution:	ether and alcohol			

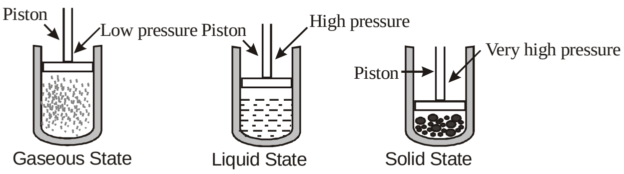
- **INTER CONVERSION OF THE STATE OF MATTER**

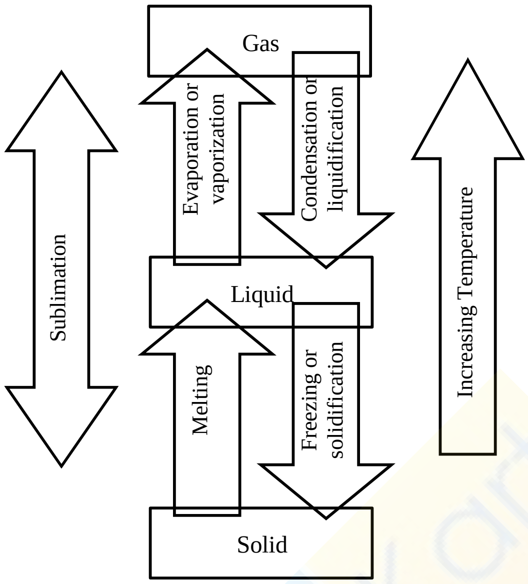
Changing temperature, pressure or both can change matter from one physical state to another.

Changing a solid to a liquid is called melting.
Changing a liquid to solid is called solidification.
Changing a liquid to gas is called vaporization.
Changing a gas to liquid is called condensation.
Changing a solid to gas directly is called sublimation.

Note: While pressure will not have an effect to change the physical state of a solid but increasing pressure in a gas can bring the particles closer together so as to liquefy the gas. Decreasing pressure over the surface of a liquid helps in vaporizing a liquid.







Effect of temperature on the physical state of a substance

Fig (1.7)

Illustrations –7: Which of the following factors are responsible for the change in state of solid carbon dioxide when kept exposed to air?

(a) Increase in pressure
(b) Decrease in pressure
(c) Increase in temperature
(d) Decrease in temperature

Solution: (a) Decrease in pressure; Increase in temperature

- **EFFECT OF CHANGE OF TEMPERATURE AND PRESSURE**

We can change the physical state of matter in two ways:—

i) By changing the temperature
ii) By changing the pressure

➢ By increasing the temperature, a solid can be converted into liquid state; and liquid can be converted into gaseous state and by decreasing the temperature is vice-versa.

MELTING (FUSION)

➢ The process in which a solid substance changes into a liquid on heating is called **melting** (or **fusion**).

➢ The point of temperature at which solid melts and changes into a liquid at atmospheric pressure is called melting of the substance.

➢ When a solid substance is heated the heat energy makes its particles vibrate more vigorously. At the melting point the particles of a solid have sufficient kinetic energy to overcome the strong forces of attraction holding them in fixed positions and break to form small groups of particles. And the solid melts to form a liquid.

- Higher the melting point of a solid substance, greater will be the force of attraction between its particles. For example, the melting point of iron metal is very high (1535°C) which tells us that the force of attraction between the particles of iron is very strong.

BOILING (VAPORISATION)

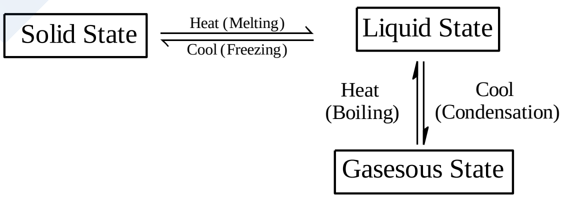
- The process in which a liquid substance changes into a gas rapidly on heating is called boiling
- The point of temperature at which a liquid boils and changes rapidly into a gas atmospheric pressure is known as boiling point of a liquid.

CONDENSATION

- The process of changing a gas (or vapour) to a liquid by cooling is called condensation where a gas is cooled enough.
- So, when steam (or water vapour) changes into water on cooling, it is called condensation of steam (or condensation of water vapour).
- It is the reverse of vaporization. (Boiling)

FREEZING

- The process of changing a liquid (solidification) into a solid by cooling is called freezing.
- When a liquid is cooled, its particles lose energy due to which they move slowly.
- If the liquid is cooled enough (upto freezing point) its each particle stops moving and vibrates about a fixed position. At this stage the liquid freezes and becomes a solid.
- Freezing is the reverse of melting.
- Freezing means solidification from above discussion, we conclude that state of matter can be changed by changing the temperature.



EFFECT OF CHANGE IN PRESSURE ON THE STATE OF MATTER

- Matter consists of small particles separated by small distances.
- In the solid state the inter particle distances are very small.
- In the liquid state the inter particles distances are a little more than in solids.
- In the gaseous state the inter particle distances are he largest when compared to liquids or solids.
- It can thus be seen that when pressure is exerted on matter, the effect of the pressure on solids will be negligible as the particles are very close together.
- The effect of pressure in liquids will be small.

- The effect of pressure on gases will be the largest as the inter particle distances are large.
- Thus, when ever pressure is exerted on gases, the particles move closer together.
- As the particles move closer together, the attractive forces between the particles increases.
- This increase in attractive forces helps in the change of state of the gas. If the pressure exerted is sufficiently large he attractive forces increase to such an extent that the physical state changes from gaseous to liquid.
- The reverse can be expected to happen if the pressure on a gas is deceased.

Illustrations –8:	***Define melting process***
Solution:	The process in which a solid substance changes into a liquid on heating is called **melting .**

- **LATENT HEAT**
  - **Heat which required by substance to change its state without rise of its temperature**. It is called **latent** heat **(hidden** heat) because it becomes hidden in the substance undergoing the change of state and does not show its presence by raising the temperature.
  - ***"the latent heat is that heat which is used up in overcoming the force of attraction between the particles of substance during the change of state. It does not increase the kinetic energy of the particle of the substance. And since there is no rise in temperature of the substance."***

Illustrations –9:	***What is the latent heat of fusion of ice***
Solution:	3.34×10^5 j/kg

- **LATENT HEAT OF VAPOURIZATION AND FUSION**

There are two types of latent heat:

i) Latent heat of fusion

ii) Latent heat of vaporization

LATENT HEAT OF VAPORISATION

- The amount of heat in Joules which is required to convert unit mass or 1 kg liquid in vapours form without rise in temperature is known as latent heat of vaporization.
- It has been found by experiments that 22.5×10^5 joules of heat is required to change 1 kilogram of water (at its boiling point, 100°C) to steam at the same temperature of 100°C. so, the latent heat of vaporization of water is 22.5×10^5 joules per kilogram (or 22.5×10^5 J/kg).
- ***"If the liquid freezes to form a solid and steam condenses to form water, an equal amount of latent heat of fusion and vaporization respectively will be given out by the substance."***
- ***Different substances have different Latent Heat of vaporization.***

LATENT HEAT OF FUSION (SOLID TO LIQUID)

It is quantity of heat in Joules which is required to convert unit mass or 1 kg solid into liquid form without rise in temperature.

It has been found by experiments that 3.34×10^5 J of heat is required to convert 1 kg of ice in water at same temperature (0°C).

So, latent heat of fusion of ice is 3.34×10^5 J/ Kg.

Different substances have different **Latent Heat of Fusion**.

Illustration : 10	Why the temperature of melting ice does not rise even though heat is being supplied continuously.
Solution:	Ice is a solid substance, so the particles of ice attract one another with strong forces. These forces of attraction hold the particles closely packed in solid ice. The heat which we supply to ice during melting is all used up to overcome the forces of attraction between ice particles so that they become somewhat loose and form liquid water. This heat does not increase the kinetic energy of particles and hence no rise in temperature takes place during the melting of ice. But when all the ice has melted to form water, further heating increases the kinetic energy of water particles due to which the temperature of water starts rising sharply.

- **SUBLIMATION**

"The changing of a solid directly into vapours on heating, and of vapours into solid on cooling is known as sublimation."

$$\text{Solid} \underset{\text{Cooling}}{\overset{\text{Heating}}{\rightleftarrows}} \text{Vapour(or Gas)}$$

- ➢ The common substance which undergo sublimation are : Ammonium chloride, Iodine, Comphor, Naphthalene and Anthracene etc.
- ➢ Another example of sublimation is provided by solid carbon dioxide (which is commonly known as dry ice).
- ➢ ***Solid carbon dioxide (or dry ice) sublimes to form carbon dioxide gas.***

Illustration – 11:	(a) Which of the following solids undergo sublimation upon heating: (i) Sugar (ii)Urea (iii) Ice (iv) Camphor (v) Sodium chloride (vi) Iodine? (b) What happens to the heat energy supplied when a solid has already melted? (c) The melting point of a substance is below the room temperature. Predict its physical state. (d) Is it proper to regard the gaseous state of ammonia as vapours? (e) What is the name of the process in which a solid directly changes into a gas? (f) Which of the following energy is absorbed during change of state of a substance? (i) Specific heat (ii) Latent heat (iii) Heat of solution.

	(g)	Name one common substance which can undergo a change in state upon heating or cooling.
Solution:	(a)	Camphor and iodine
	(b)	It is converted into latent heat of fusion
	(c)	It is a liquid.
	(d)	No, it is not
	(e)	It is called sublimation
	(f)	Latent heat
	(g)	Water

- **EVAPORATION**
  - **Evaporation** is the phenomenon in which a liquid changes to gaseous state below its boiling point.
  - Water molecules are attracted by other water molecules in all directions.
  - But at the surface of water, the water molecules are pulled only inward that is below the surface of water.

Vapour: A substance that can exist in the gaseous state at a temperature at which normally it is a solid or liquid is called vapour.
Examples of solids that can exist as vapour: camphor, naphthalene
Factors Affecting Evaporation
Evaporation depends on temperature, surface area and weather conditions

a) Evaporation increases if the surface area of the water is large as the number of water molecules at the surface increases. This increases the probability of more water molecules breaking free on acquiring sufficient kinetic energy.
b) Evaporation is more as the temperature approaches the boiling point of water. As the temperature increases the kinetic energy of the molecules increases. This decreases the extra kinetic energy the surface molecules require to break free or evaporate. So evaporation increases.
c) In highly humid weather, evaporation decreases, as the air is highly-saturated with water molecules.
d) As evaporation takes place, the air immediately above the surface of the water becomes saturated with water molecules.

Illustration – 12:	How does evaporation depend upon temperature and surface area ?
Solution:	When we increase the temperature and surface area evaporation increases.

- **COOLING EFFECT**

How Does Evaporation Cause Cooling?

- When a liquid evaporates it draws the energy from the liquid itself. Hence it keeps cooling. The liquid draws on the energy lost from the surroundings that in turn become cooler.
- One such usage can be seen in the forced cooling by air coolers during summer.

Illustration – 13:	Write down the mechanism of cooling?
Solution:	On the cooling the energy of gas particle decreases, and so the moment of the particle is slowed down. The particles also come much closer to each other leading to the intermolecular force of attraction. This causes the gas to contract.