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S1 New Curriculum Physics

Theme: Mechanics and properties of matter

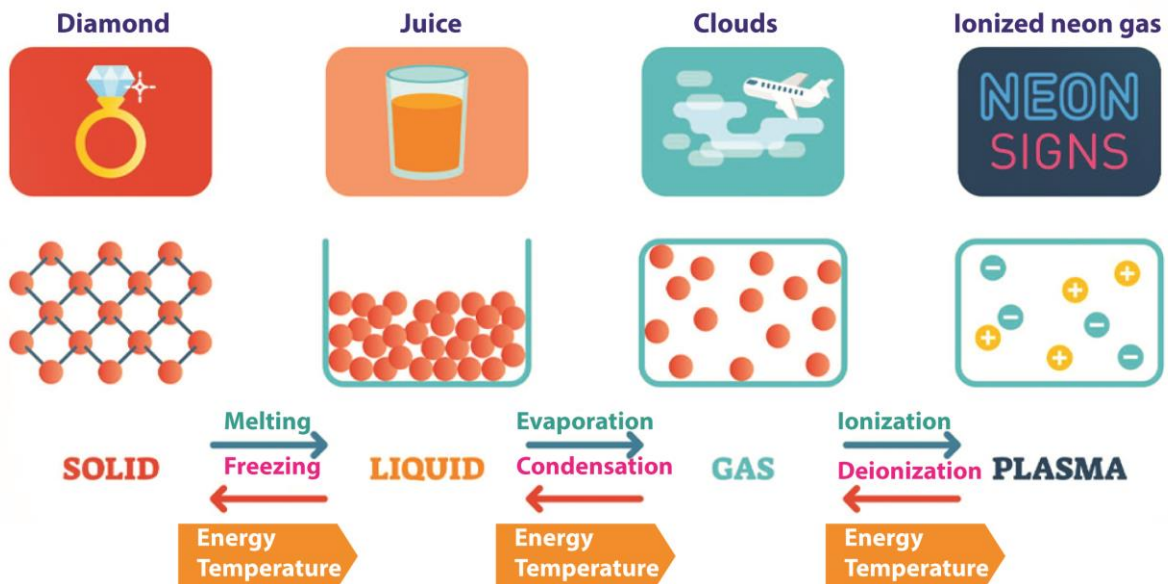
Chapter 3 – States of matter

Matter

Matter is anything that occupies space and has weight. Matter is made up of particles that are too small. These tiny particles cannot be seen by the naked eye. The tiny particles are called molecules. The molecules consist of more tiny particles called atoms. Atoms are made of small particles called protons, electrons and neutrons

Examples are stone, clouds, water etc.

States of matter



There are majorly four states of matter

- (i) **Solids** e.g. chairs, tables, stone wall etc. Here the molecules are closely packed together and are vibrating within fixed positions, but are not free to move due to the strong forces of attraction between the molecules. Solid state has a definite shape and volume.

- (ii) **Liquids** e.g. water, paraffin, cooking oil. In liquids, molecules are further apart compared to solids. The particles are free to move and are in constant random motion but within the surface of the liquid. The forces of attraction between the particles are weaker compared to solid state. Liquids take up the shape of the container in which they are put. So liquids do not have a definite shape but have definite volume.
- (iii) **Gas** e.g. air. The particles are much further apart compared to liquids and solids. These particles can move independently and at a high speed compared to solids and liquids. The intermolecular forces of attraction are almost negligible. Gases have no particular shape and volume.
- (iv) **Plasma**: it is made of gaseous positive ions and electrons only at very high temperatures. That is, plasma is an ionized gas, a good conductor of electricity with indefinite shape and indefinite volume.

Summary table

Properties	Solid	Liquid	Gas	Plasma
Distance of separation	Least	Closer	Large	Largest
Intermolecular forces	Strongest	Strong	Weak	weakest
Potential energy	Highest	Low	Lower	Lowest
Kinetic energy	Lowest	High	Higher	Highest

Effect of heat on matter

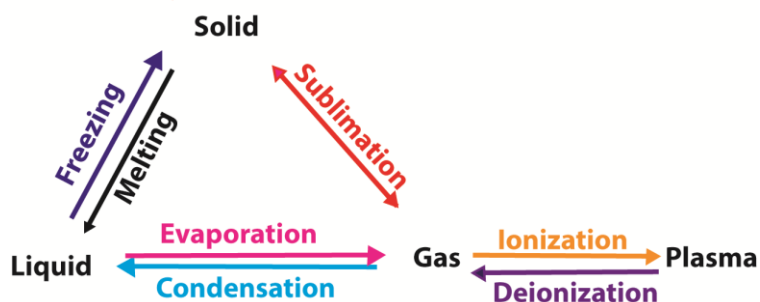
- (a) Increases the speed of movement of particle or kinetic energy of particles
- (b) Lead to change from solid to liquid to gas and finally to plasma.

When a solid is heated, the particles gain kinetic energy and turns into a liquid by a process called **melting** or into a gas by the process called **sublimation**.

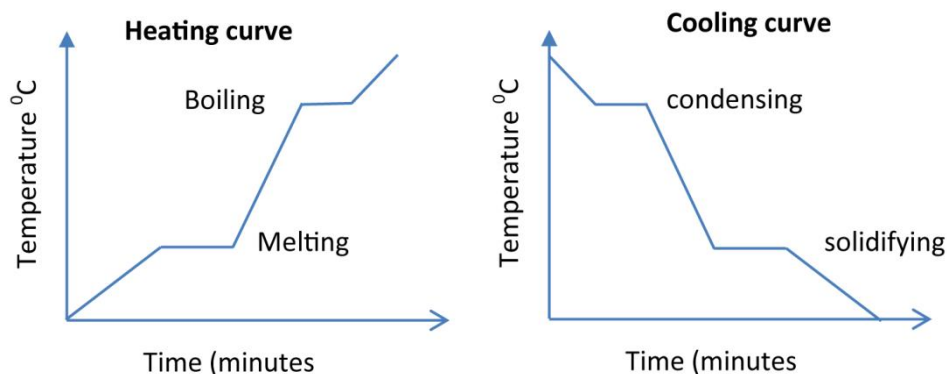
Heating a liquid turns it into a gas by the process called **evaporation**.

Cooling a gas turns into a solid by the process of **sublimation** or into a liquid by **condensation** and a liquid turns into a solid by **freezing** or **solidification**.

The summary for interconversion of phase of matter



Note that melting/solidification and boiling/condensing occur at constant temperatures. The characteristic heating and cooling curves are shown below;



Note that boiling and condensing occur at the same temperature

Also, melting and solidification/freezing occur at same temperature

The cooling effect of evaporation

Evaporation causes cooling because it removes heat from a surface or substance i.e.

- **Energy Absorption:** When a liquid evaporates, its molecules gain energy from their surroundings to escape into the air as vapor.
- **Loss of High-Energy Molecules:** The fastest-moving (hottest) molecules leave first, reducing the average energy of the remaining liquid.
- **Lower Temperature:** With fewer high-energy molecules, the temperature of the liquid and the surface it touches drops.

Uses of evaporation in daily life

- Wet clothes dry due to evaporation
- Preservation of food such as fish by drying is through evaporation
- Sweating causes cooling through evaporation of sweat from the skin.
- Rain forms through a process of evaporation.
- Distillation is used for production of alcohols

Evidences for the motion of particles in matter

- Diffusion of gases.

This is the movement of particles from areas of high concentration to a region of low concentration. For instance, when a person wearing a perfume enters a room, the whole room is filled by the scent.

Factors that affect the rate of diffusion

The rate of **diffusion** depends on several factors that influence how fast particles move and spread.

(a) Temperature

Higher temperature → Faster diffusion because heat gives particles more **kinetic energy**, making them move and spread more quickly.

(b) Concentration Gradient

Greater difference in concentration → Faster diffusion because the larger the gap between high and low concentration areas, the stronger the driving force for diffusion.

(c) Surface Area

Larger surface area → Faster diffusion because more space allows more particles to move across at the same time, speeding up the process.

(d) Particle Size (Molecular Mass)

Smaller, lighter particles → Faster diffusion because heavier molecules move more slowly because they require more energy.

(e) Diffusion Medium

Gases diffuse faster than liquids, and liquids diffuse faster than solids. In gases, particles are widely spaced and move freely, while in liquids and solids, they experience more resistance.

(f) Distance of Diffusion

Shorter distance → Faster diffusion because the shorter the distance molecules need to travel, the quicker they reach equilibrium.

(g) Nature of the Membrane (for Biological Diffusion)

More permeable membranes → Faster diffusion. For instance, biological membranes that have pores allow easier passage of certain molecules.

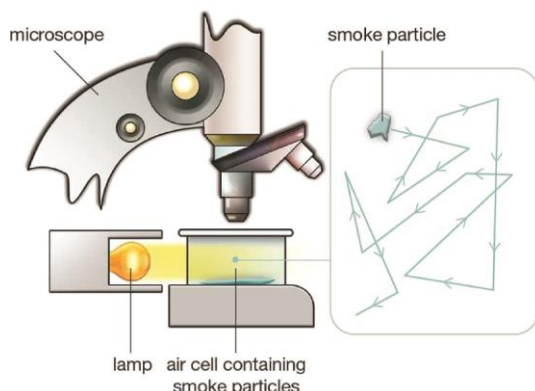
Experiment to demonstrate diffusion

When a drop of potassium permanganate solution is dropped slowly in calm water it quickly spreads causing all water to turn pink



2. Brownian motion

This is the random movement of smoke particles in a glass cell as seen through a microscope.



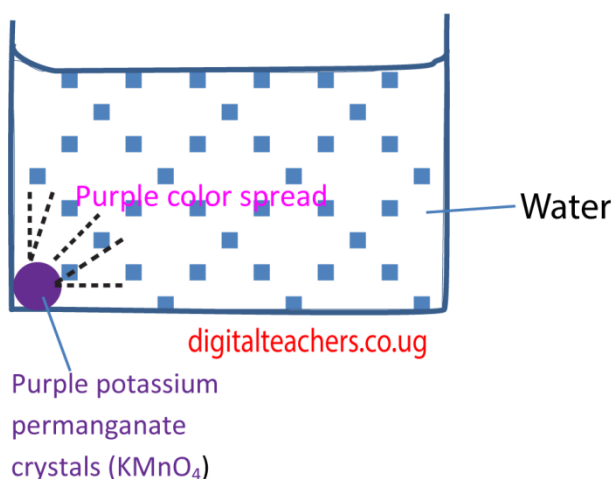
Explanation

Air particles are in random movement; these collide with smoke particles and cause them to move randomly.

When temperature is increased, the kinetic energy of the air particles increase which increases the speed of smoke particles.

The Brownian motion can be observed by the dust particles through light rays i

3. Presence and movement of particles in liquids is demonstrated by diffusion of purple permanganate color in water



Revision question

1. What is matter
2. List states of matter
3. How can we show that matter is made of particles?
4. Arranges the states of matter starting from the state with least energy.
5. In terms of kinetic theory, explain condensation and melting.

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Thanks

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