Matter in our Surroundings

Concepts & Notes **CHEMISTRY**

Chemistry can be defined as the study of matter and the changes it undergoes.

Matter

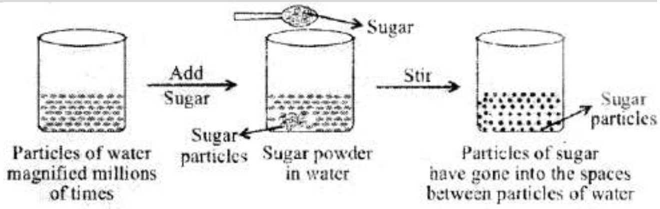
Matter may be defined as anything that occupies space and possesses mass. All the things which we see or feel around us like air, water, plants, animals, stones, sand, ice, steel, etc. are termed as matter.

- **Physical Nature of Matter**
  - Matter is made up of particles.
  - The particles of matter have space between them.
  - The particles of matter are continuously moving.
  - The particles of matter are very small.
  - The particles of matter attract each other.
  - The above characteristics can be established by the following activities:

ACTIVITY CORNER

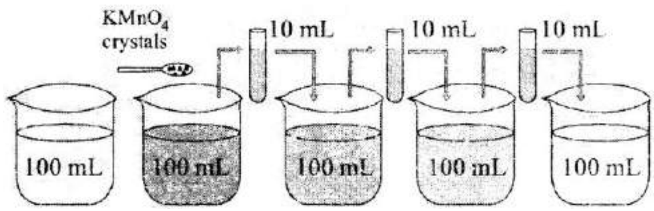
To demonstrate that particles of matter have spaces between them

- Take a beaker and fill it half with water.
- Mark the level of water.
- Dissolve some salt or sugar in it.
- **Observation:** Water level remains the same as earlier.
- **Conclusion:** When sugar or salt is dissolved in water, the particles of sugar or salt get into the spaces between particles of water.

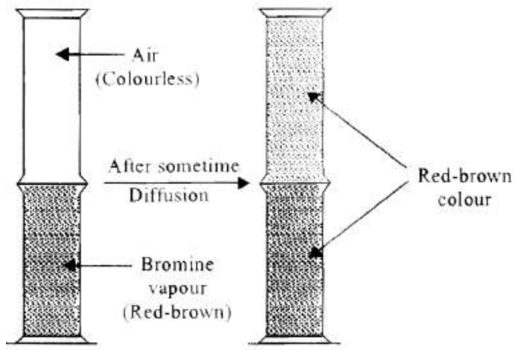


To demonstrate that the particles of matter are very small

- Take 2-3 crystals of potassium permanganate and dissolve in 100 mL of water.
- Take 10 mL of this purple solution and mix with 90 mL of fresh water in second beaker.
- Take 10 mL of this second solution and mix with 90 mL of fresh water in third beaker.
- Take 10 mL of this third solution and mix with 90 mL of fresh water in fourth beaker.
- Dilute the solution five to six times.
- Observation: The water in the last beaker is still coloured and is light pink now.
- Conclusion: Just 2-3 crystals of potassium permanganate impart colour to a large volume of water. It shows that the particles of matter are very very small.



- **Diffusion**
  - The intermixing of particles of two substances on their own is called diffusion.
  - The rate of diffusion increases on heating, since with increase in temperature kinetic energy of the particles increases and they move faster.
  - Diffusion occurs in gases, liquids and solids. The diffusion is fastest in gases because the particles in gases move very rapidly. The diffusion is slowest in solids because the particle in solids do not move much. The diffusion in liquids is, however, much faster than that ill solids and slower than that in gases.



Diffusion of bromine vapour (or bromine gas) into air

ACTIVITY CORNER

To demonstrate that particles of matter are continuously moving

Experiment-I

- Light an agarbatti in one corner of a room.
- **Observation:** The fragrance spreads in the whole room quickly.

- Conclusion: The vapours of agrabatti are mixed with air and move rapidly in the room. Thus particles of matter are in continuous motion (Diffusion).

Experiment-II

- Put a few crystals of copper sulphate in a beaker containing water.
- Do not stir.
- **Observation:** The water of the whole beaker turns blue after sometime.
- **Conclusion:** The spreading of blue colour of copper sulphate is due to the movement of copper sulphate and water particles (Diffusion).

To demonstrate the strength of attractive forces between particles of different kinds of matter

- Take an iron nail, a piece of chalk and a cube of ice.
- Try to break each of them by beating with a hammer.
- Observation: It is very easy to break the piece of chalk into smaller particles. It requires more force to break a cube of ice whereas the iron nail does not break at all.
- Conclusion: The force of attraction between particles of chalk is weaker than ice while the force of attraction between particles of iron is very strong.

ILLUSTRATION

1. When we smell the odour of a rose our olfactory nerves are sensing molecules of the scent. Explain how smelling a rose demonstrates that molecules are always moving.

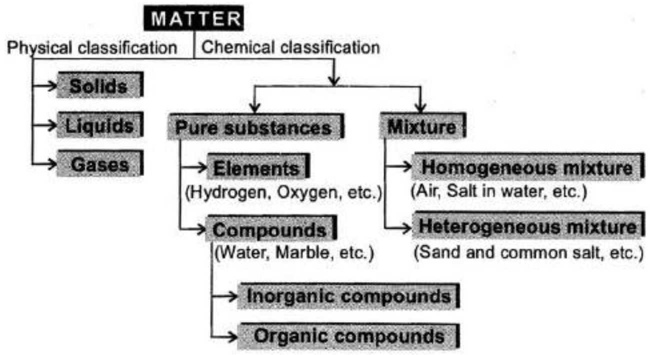
Sol. The molecules that give roses their aroma evaporate from the surface of the flower. Once in the gas phase, they collide countless times with other gas molecules, moving slowly away from the rose, when they reach a nose, they are sensed by the olfactory sensors.

2. Even one or two crystals of potassium permanganate can impart colour to a very large volume of water. Which characteristic of matter is illustrated by this observation?

Sol. From this observation we conclude that each potassium permanganate crystal is made up of millions of small particles which keep on separating and imparting colour to more and more water. Hence we can say that matter is made up of very very small particles.

Classification of Matter

Matter can be classified into different categories depending upon their physical or chemical nature.



States of Matter

On the basis of physical state, matter can be classified into three groups- Solids, Liquids and Gases.
In general, this classification arises due to variation in characteristics of the particles of matter.

- **The Solid State**
  - Solids have fixed shape and fixed volume.
  - Solids possess rigidity hence cannot be compressed.
  - Solids do not flow or diffuse into each other.
  - Solids have high density.

Do You Know

- A rubber band can change its shape by stretching but regains its shape when force is removed.
- A sponge can be compressed due to presence of small holes in it, in which air is trapped, when a sponge is pressed the air is released.

- **The Liquid State**
  - Liquids have fixed volume but no fixed shape.
  - Liquids have fixed volume but no fixed shape.
  - Liquids cannot be compressed much.
  - Liquids flow from a higher to lower level.
  - Liquids have lesser density than solids.
  - Solids, liquids and gases can diffuse into liquids.
- **The Gaseous State**
  - Gases are highly compressible.
  - Gases have very low density.
  - Gases flow easily and diffuse into one another.

- Gases do not have fixed shape and volume and can thus fill the entire space of the container.

Do You Know

Due to high compressibility large amount of gas can be filled in a small container, e.g.. Liquefied Petroleum Gas (LPG) used for cooking or Compressed Natural Gas (CNG) used as fuel in vehicles are compressed gases. The oxygen gas supplied to hospitals in cylinders is also in compressed form.

- **Two More States of Matter**
  - **Plasma**

    This state consists of super energetic and super excited particles. These particles are in the form of ionised gases and free electrons.

    A fluorescent light bulb or a neon sign bulb is an example of plasma state. As electricity flows through helium or neon filled in the bulb or the sign bulb, the atoms of these gases break into charged electrons and ions, consequently plasma is formed which glows with a specific colour.

    The sun and the stars glow due to presence of natural plasma created by the high temperature.
  - **Bose-Einstein Condensate**

    This state is called fifth state of matter and is the main work of the scientists Satyendra Nath Bose and Albert Einstein. But this was actually shown to exist by three American scientists, Eric A. Comell, Wolfgang Ketterle and Carl E. Wieman in 2001 by cooling certain gases of extremely low density to a very low temperature called super low temperature.

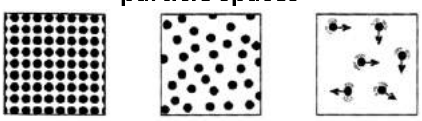
Particle Mode of Three States

Particle Mode of Three States

Following properties of particles decide the state of matter:

- Intermolecular distance
- Force of attraction between the particles
- Kinetic energy of the particles

Comparison of the three states in terms of inter particle spaces



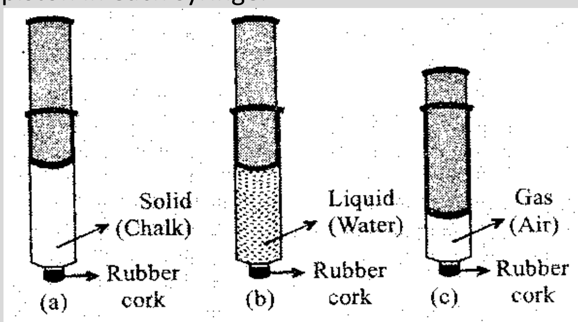
(Solid) (Liquid) (Gas)

- **Explanation of States of Matter on the Basis of Molecular Structure**
  - In case of solids, the intermolecular spaces are very large. The molecules can vibrate about their mean position, but cannot change their positions. Hence the solids have definite shape, definite volume and are incompressible.
  - In case of liquids, the intermolecular spaces are somewhat large and intermolecular forces fairly small as compared to the solids. The molecules of liquid have more kinetic energy than the solids. Due to large intermolecular spaces and kinetic energy, the molecules can interchange their position. Hence liquids take the shape of the vessel and flow from higher to lower level, and they require a container to keep.
  - In case of gases, the intermolecular spaces are about 1000 times more than the liquids and intermolecular forces of almost negligible magnitude. The molecules are free to move in any direction hence gases have no definite shape or volume. The kinetic energy of molecules of gases is maximum and they move randomly at a high speed. These moving molecules hit the sides of the vessel and exert pressure on the walls of container.

Activity Corner

To show that solids are completely incompressible, liquids are only slightly compressible while gases are highly compressible.

- Take three 100 mL glass syringes having pistons.
- Remove the pistons from all the syringes.
- In first syringe (a) fill chalk powder, in second syringe (b) fill water and in third syringe (c) fill nothing (air is already present in it).
- Put the pistons back on all the syringes.
- Try to compress the contents by pushing the piston in each syringe.



- **Observations:**
- The piston of first syringe does not move.
- The piston of second syringe move in slightly.
- The piston of third syringe move considerably.
- **Conclusions:**
- Solids cannot be compressed by applying pressure.
- Liquids are slightly compressed by applying pressure.
- Gases can be compressed easily by applying pressure.

Rigidity and Fluidity

- Rigid means inflexible. A solid is a rigid form of matter, hence it does not require a container to keep it.
- Fluid is a material which can flow easily and requires a vessel to keep it. A liquid is a fluid form of matter which takes the shape of container while a gas is a fluid form of matter which fills the container.

Comparison of three states of matter

	Property	Solid State	Liquid State	Gaseous State
1.	Inter particle space	Very small, particles are closely packed	Comparatively large, particles are loosely packed	Very large, particles are very loosely packed
2.	Inter particle force	Very strong	Weak	Very weak
3.	Nature	Very hard and rigid	Fluid	Highly fluid
4.	Compressibility	Negligible	Very small	Highly compressible
5.	Shape and Volume	Definite shape and volume	Indefinite shape but definite volume	Indefinite shape as well as volume
6.	Density (Mass/Volume)	High	Less than the density of solid state	Very low density
7.	Molecular motion or kinetic energy	Low	Comparatively high	Very high
8.	Diffusion	Negligible	Slow	Very fast

ILLUSTRATION

3. Out of solid, liquid and gas which has
(a) maximum inter particle space?
(b) maximum particle motion?
(c) definite volume but no definite shape?
(d) least diffusion of the particles?

Soln. (a) Gas, (b) Gas, (c) Liquid, (d) Solid.

4. Carbon dioxide gas is heavier than both nitrogen and oxygen. Why does not it form lower layer in the atmosphere?

Soln. The diffusion of a gas is not affected by gravity. This means that carbon dioxide (CO_2) remains uniform ally mixed in air. Therefore, the carbon dioxide gas does not form the lower layer in the atmosphere.

5. Liquids generally have low density as compared to solids, but you must have observed that ice floats on water. Find out why?

Soln. Ice is solid, hence it is supposed to be heavier than water which is liquid. But ice has lesser density than water due to its cage like structure with vacant spaces between the molecules while density of water is more, hence ice floats on water.

6. Why does a gas completely fill the container while liquid or solid does not?

Soln. The molecules of a gas have large intermolecular spaces and very less intermolecular forces of attraction. Hence the molecules of gas move away from each other and spread in the entire space available to them.

Volume

- The space coupled by a substance is called volume.
- The SI unit of volume is cubic metre (m^3). The common unit is litre (L).
These units are related as: 1 L = 1 dm^3; 1L = 1000 mL; 1 mL = 1 cm^3, where dm $\Rightarrow$ decimeter = 10^{-1} m

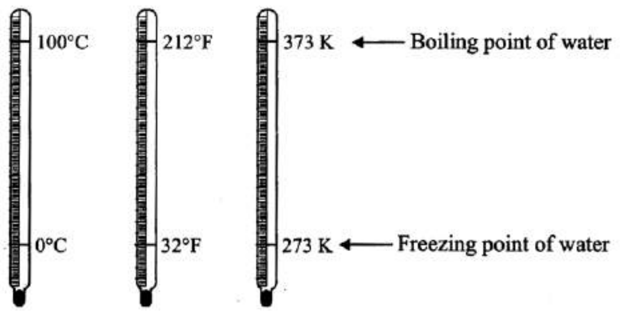
Density

- The mass per unit volume of a substance is called density.
  Density = Mass/Volume. Units of density are kg/m^3 or g/cm^3.

Scales of Measuring Temperature

Three scales are used to measure the temperature.

- **Celsius scale (°C)**
  Freezing point of water is taken as 0°C and boiling point is taken as 100°C.
- **Fahrenheit scale (°F)**
  Freezing point of water is taken as 32°F and boiling point is taken as 212°F.
  Celsius and Fahrenheit scales are related to each other by the relation, $^{o}\text{F}=\frac{9}{5}(^{o}\text{C})+32$
- **Kelvin scale (K) or Absolute scale**
  It is SI unit of temperature.
  Freezing point of water is taken as 273.15 K or 273 K approx. and boiling point is taken as 373 K.
  Celsius and kelvin scales are related to each other by the relation, K = 273 + **°C**

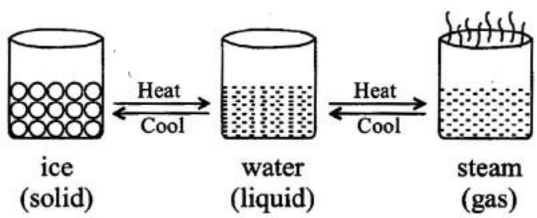


Three scales of measuring temperatures

Change of State

Inter conversion of states of matter can be achieved
- by changing the temperature.
- by changing the pressure.

Effect of Change of Temperature on States



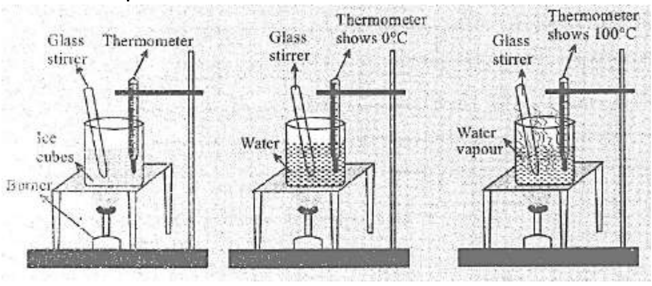
- **Solid to Liquid Change: Melting**
  - The process in which a solid changes into a liquid on heating is called melting or fusion.
  - The temperature at which a solid changes into liquid at atmospheric pressure is called melting point of the substance.
  - Higher the melting point, stronger are the forces of attraction between the particles.
- **Liquid to Gas Change: Boiling or Vaporization**
  - The process in which a liquid substance changes into a gas on heating is called boiling or vaporization.
  - The temperature at which a liquid boils and changes into gas at atmospheric pressure is called boiling point of the liquid.
  - Impurities increase the boiling point of liquids.
  - If pressure is increased, the boiling point increases. Boiling point of water is taken as 373 K at 1 atm pressure.
  - Higher the boiling point, stronger are the forces of attraction between the particles.
- **Gas to Liquid Change : Condensation**
  - The process of changing a gas to a liquid on cooling is called condensation.
  - Condensation is the reverse of vaporization.
- **Liquid to Solid Change : Freezing**
  - The process of changing a liquid into solid by cooling is called freezing.
  - Freezing is also called solidification and is reverse of melting.
  - The temperature at which a liquid freezes to become a solid at atmospheric pressure is called the freezing point.
  - Impurities lower the freezing point of liquids.

ACTIVITY CORNER

To demonstrate that the temperature remains constant during the change of state

- Take about 100 g of ice in a beaker.
- Hang a laboratory thermometer in it so that its bulb is in contact with ice.
- Note down the initial temperature and start heating the beaker.
- Note the temperature when ice starts changing to water.
- Note the temperature when the complete ice is converted to water.

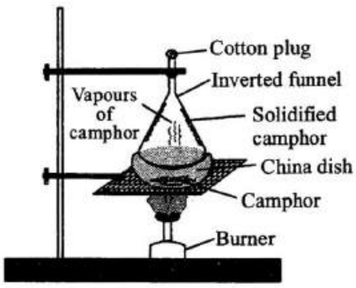
- Continue heating and note the temperature when water starts changing to vapours.
- Note the temperature when most of the water has vaporized.



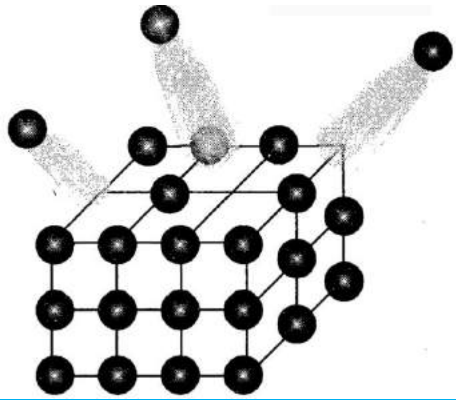
- **Observations:**
  There is no change in temperature till all the ice melts though heating continues. Temperature remains constant at 0°C.
  Once the ice is converted to water, the temperature starts rising till the water begins to boil.
  Once the ice is converted to water, boiling, the temperature remains constant at $100^{o}C$ till all the water has changed into vapors.
- **Conclusion:** During the change of state from solid to liquid or from liquid to gas, the temperature remains constant till all the solid has melted or all the liquid has vaporized. The heat energy supplied is used up in overcoming the forces of attraction and hence the thermometer does not show any rise in temperature.
- **Sublimation (Solid to Gas or Gas to Solid Change)**
  - The process of change of a solid state directly to gaseous state on heating, and vice-versa on cooling without passing through the intervening liquid state is called sublimation.

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

  - Few examples of the substances which sublime are camphor, ammonium chloride, naphthalene, iodine, solid carbon dioxide, etc.



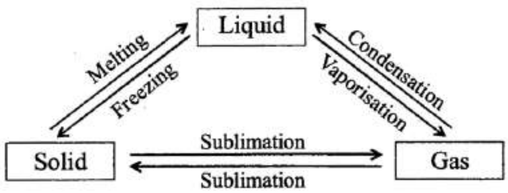
- **Applications of Sublimation**
  The solids, having weak inter-molecular forces, when heated are directly converted into vapours (gaseous state) without being converted into liquids. Small amount of energy is sufficient to make the intermolecular force of attraction negligible. This increases the intermolecular distance to a very great extent. Therefore, the solid is directly converted
  (1) Process of sublimation is very useful in the purification of solids which sublime on heating and contain non-volatile impurities.
  (2) Freeze-dried foods prepared by sublimation can be stored for long times.
  (3) In very cold places, the snow does not melt but sublimes directly to vapours.



Effect of Change of Pressure

- The process of conversion of a gas into liquid by increasing pressure and decreasing temperature is called liquefaction of gases.
- On applying pressure, the intermolecular space in gases decreases and the molecules come closer.
- On reducing pressure the reverse process takes place.
- Solid carbon dioxide which is also called dry ice is converted directly to carbon dioxide gas by decrease in pressure upto 1 atm without coming into liquid state.
- The pressure exerted by a gas is measured in atmosphere. Atmospheric pressure at sea level is taken as 1 atmosphere which is also normal atmospheric pressure.
  1 atm = 1.01 x 10^5 Pa (Pa = Pascal, SI unit of pressure).

The interchange of states of matter can be shown as below:



Latent Heat

The heat which is given to the system during a phase change and which is not used in raising the temperature -s called latent heat (hidden). The latent heat is used up in changing the state by breaking the intermolecular forces of attraction hence there is no increase in temperature till one state changes to other.

- **Latent Heat of Fusion**
  - It is defined as the amount of heat energy required to change 1 kg of a solid into liquid at atmospheric pressure without any change in temperature at its melting point.
  - It is observed that latent heat of fusion of ice is 3.34 x 10^5 J/kg or 80 kcal/kg.
  - Ice at 273 K is more effective in cooling than water at 273 K. This is due to the reason that for melting, each kilogram of ice absorbs latent heat of 3.347 x $l0^5$ joules from the substance and hence cools the substance more effectively.
- **Latent Heat of Vaporization**
  - It is defined as the amount of heat energy required to change 1 kg of the liquid into vapour at its boiling point without any change in temperature.
  - Latent heat of vaporization of water is 22.5 x 10^5 J/kg or 540 kcal/kg.
  - Steam contains more heat in the form of latent heat than boiling water.

ILLUSTRATION

7. The burns caused by steam are much more severe than those caused by boiling water though both have same temperature of 100^oC.Why?

Sol. The steam at 100^oC has more heat (latent heat of vaporization which is equal to $22.5\times10^5 J/kg$) than boiling water at 100^oC. Hence steam when comes in contact with skin gives out $22.5\times10^5 J/kg$ more heat than boiling water and causes more severe burns.

8. Convert the temperature of 373^oC to Kelvin and 573 K to Celsius scale.

Sol. $K={}^oC+273$

Hence, K = 373 + 273 = 646 or $373^oC=646K$.

Similarly, $K={}^o C+273$

Hence, $573={}^o C+273$ or ${}^oC=573-273=300$

or $573K=300^oC$.

Evaporation

The process of conversion of a liquid into vapours at any temperature below its boiling point is called evaporation.

At any given temperature the kinetic energy of some particles on the surface of liquid is high enough to overcome the forces of attraction by other particles, hence they leave the liquid and are converted into vapours.

- **Evaporation is an Endothermic Process**
  During evaporation, a liquid absorbs heat energy from any other body in contact with it or from the surroundings.
- **Factors Affecting Evaporation**
  Surface area: - Greater the surface area, more is the rate of evaporation.
  Temperature: - Higher the temperature, faster is the evaporation.
  Humidity: - Lesser the humidity (dampness) in air, more is the rate of evaporation.
  Wind speed: - Higher is the speed of wind, more is the rate of evaporation.
- **Cooling Effect of Evaporation**
  During evaporation, the liquid particles having high kinetic energy leave the surface of the liquid and are converted to vapours. As a result the average kinetic energy of the remaining system decreases resulting in decrease in temperature. The particles absorb energy from the surroundings to regain the energy lost, making the surroundings cool.

Do You Know

- The air from the fan causes rapid evaporation of sweat. During evaporation the seat takes away heat from the body. As a result, we feel relief under a fan.
- As water vapour molecules present in air, come in contact with the cold glass of water, the molecules loose energy, slow down and get condensed into liquid state which we see as water droplets.
- Evaporation of water from the leaves is called transpiration. Transpiration helps plants/trees to keep cool. During summer, when the temperature is high, a tree must transpire more to keep itself cool. More transpiration requires more leaves. So, tress acquire more leaves during summers.
- Light coloured or white coloured clothes absorb less heat in summer, however dark coloured

clothes absorb more heat making the person feel more hot and sweaty, as a result light coloured clothes are preferred in summer as they make the person feel cool and comfortable.

Difference between Boiling and Evaporation

Boiling	Evaporation
1. Boiling occurs only when the liquid is heated.	Evaporation of a liquid takes place on its own.
2. Boiling takes place at a specific temperature known as the boiling point of the liquid.	Evaporation takes place at all temperatures below the boiling point of liquid.
3. Boiling occurs from the surface as well as from the bulk of the liquid.	Evaporation is a surface phenomenon and occurs from the surface of the liquid.
4. No cooling is caused during boiling.	Cooling is always caused during evaporation.

ILLUSTRATION

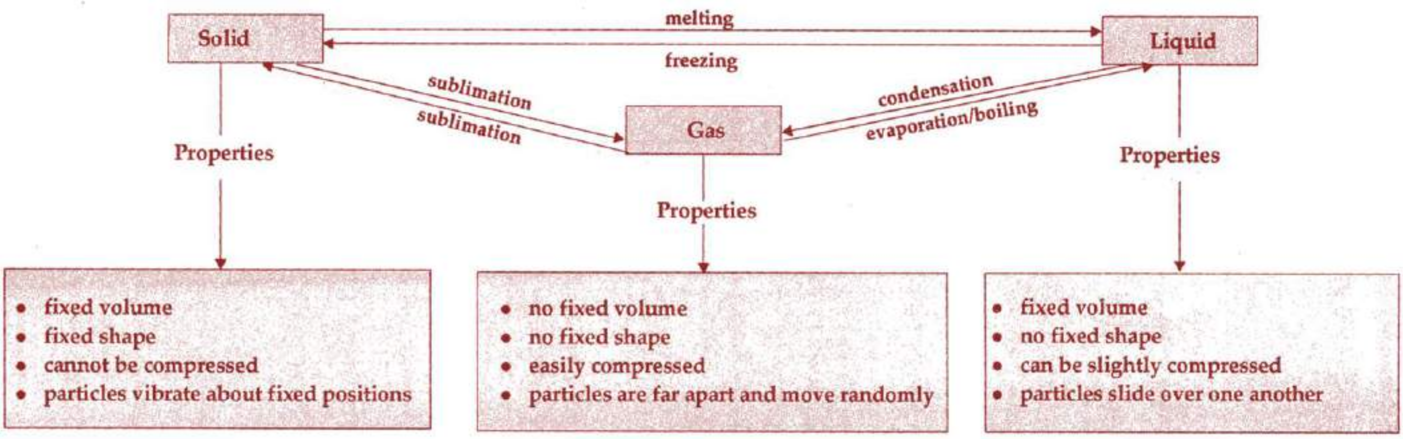
9. Why do we sprinkle water on the roof or open ground in summer?

Sol. The sprinkling of water on the open ground or roof causes the water molecules to absorb energy from the open ground roof and surroundings and to get evaporated. The evaporation of water causes a cooling effect since it makes use of the very large latent heat of vaporization of water $(22.6 \times 10^5 \, \text{J kg}^{-1})$.

10. Why do we perspire more during summer?

Sol. During summer or after a heavy exercise, the temperature of our body rises. Due to increase in temperature the body gives out more sweat.
When the sweat evaporates, it takes large amount of energy (equal to latent heat of vaporization of water) from our body. Due to loss of heat the body feels cool.

Concept Map



ESSENTIAL POINTS For COMPETITIVE EXAMS

Simultaneous Effect of Temperature and Pressure on the Physical State of a Substance

The decrease in temperature brings the particles of a substance closer while increase in pressure can have the same effect. At low temperature and under high pressure a gas can be liquefied easily. The effect of temperature is more important than pressure. For every gas there is a certain temperature above which the gas cannot be liquefied however large be the pressure applied. The temperature above which a gas cannot be liquefied is called critical temperature and the corresponding pressure is called critical pressure.

Difference between Gas and Vapour

A substance is said to be a gas if its boiling point is below room temperature. For example, oxygen, nitrogen, carbon dioxide, etc.
If the normal physical state of a substance is either a solid or a liquid but gets converted into the gaseous state either on its own or by absorbing energy, the gaseous state is called the vapour state. For example, vapours of water in air.

SI units for Some Measurable Quantities

Quantity	Unit	Symbol
Length Mass Time	metre kilogram second	M Kg s
Temperature Volume	kelvin cubic metre	K m^3
Density Pressure	kilogram per cubic metre pascal	kg m^{-3} Pa

Some more Units of Mass, Volume, Pressure and Temperature

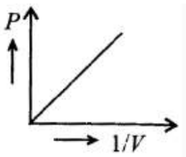
- **Mass :** kg or g ; 1 kg = 10^3 g
- **Volume :** L, mL, cm^3, m^3
  1 m^3 = 10^3 dm^3 = 10^6 cm^3; 1 L = 10^3 cm^3 = 10^{-3} m^3 = 1 dm^3
- **Pressure :** atm, cm of Hg, mm of Hg, Pa, Torr 1 atm = 76 cm of Hg = 760 mm of Hg 760 mm of Hg = 760 Torr
  1 Nm^{-2} = 1 Pa ; 1 atm = 101.325 x 10^3 Nm^{-2}
  1 atm = 1.01325 bar = 1.01325 x 10^5 Pa
- **Temperature:** K, °C K = °C + 273.15

Sublime and Sublimate

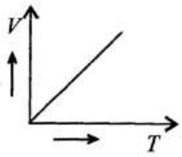
A gaseous state directly formed from a solid on heating is known as sublime. A solid state of matter formed directly from its gaseous state on cooling is known as sublimate.

Gas Laws

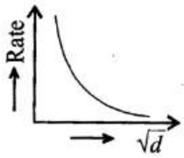
- **Boyle's Law**
  At constant temperature, the volume of fixed mass of gas is inversely proportional to the pressure.
  Mathematically, $V \propto \frac{1}{P}$ PV = constant or $P_1V_1 = P_2V_2$.
  The graph between P and 1/V as shown is a straight line.



- **Charles' Law**
  At constant pressure, the volume of a fixed mass of gas is directly proportional to its temperature.
  Mathematically, $V \propto T$ constant or $\frac{V_1}{T_1} = \frac{V_2}{T_2}$
  The graph between V and T as shown is a straight line.



- **Avogadro's Law**
  Equal volumes of all gases under similar conditions of temperature and pressure contain equal number of molecules. Mathematically $V \propto n$.
- **Graham's Law of Diffusion**
  The rate of diffusion or effusion (the process of diffusion through a small aperture) is inversely proportional to the square root of its density or molar mass at constant temperature and pressure.
  Rate of diffusion $\propto \sqrt{\frac{1}{d}}$ or Rate $\propto \sqrt{\frac{1}{M}}$
  For comparison of rates of diffusion the law can be put as $\frac{r_1}{r_2} = \sqrt{\frac{d_2}{d_1}} = \sqrt{\frac{M_2}{M_1}}$ where two gases with densities d_1, d_2 and molar masses M_1, M_2 have rate of diffusion as r_1 and r_2 respectively.



  The relation can be graphically represented as shown in the graph.
  A gas which obeys Boyle's law and Charles' law is called an ideal gas.
- **Ideal gas equation**
  PV = RT (for one mole of gas) = nRT (for n moles of gas)
  R is universal gas constant $= 8.314 \text{ Jmol}^{-1} \text{ K}^{-1} \approx 2 \text{ cal mol}^{-1}\text{K}^{-1}$.

Comparison of Ideal and Real Gases

Ideal gas	Real gas
(a) Obeys gas equation PV = RT	(a) Obeys van der Waals equation. $\left(p + \frac{a}{V^2}\right)(V - b) = RT$
(b) Molecules are point particles which do not occupy any volume. Free volume available to molecules is V.	(b) Molecules have finite size. The free volume available for molecules is less than V, it is (V-b).
	(c) Intermolecular forces

(c) No force of interaction between the molecules. (d) Obeys Boyle's and Charles' law for all pressures and temperatures. (e) Internal energy depends on temperature only. (f) Specific heat does not depend on temperature.	exist. (d) Do not obey Boyle's and Charles' law. (e) Internal energy depends on temperature as well as volume. (f) Specific heat depends on temperature.

Properties of Liquids

- **Vapour Pressure**
  - When a liquid is heated in a closed vessel, it is converted to vapours and after some time an equilibrium is established between vapours and the liquid.
  - The pressure exerted by the vapours on the liquid at equilibrium is called vapour pressure, it increases with increase in temperature. When vapour pressure of a liquid is equal to atmospheric pressure, the liquid starts boiling.
- **Viscosity**

  The internal friction or resistance which resists the relative motion of the layers of liquids or the resistance in the flow of liquids is called viscosity. Glycerine is said to have more viscosity than water since glycerine does not flow as easily as water.
- **Surface Tension**

  Due to unequal forces on the surface of a liquid, the surface feels stretched. This tension on the surface of the liquid is known as surface tension. Due to surface tension, liquids tend to minimize the surface area to reduce tension. Hence a drop of water always acquires a spherical shape and water rises in a capillary.

Types of Solids

- **Amorphous Solid**

  An amorphous solid is a substance in which atoms, molecules or ions have a random and non-uniform arrangement. They melt over a range of temperature. The amorphous solids do not have a fixed geometry or a sharp melting point, e.g., glass, plastic, rubber, etc.
- **Crystalline Solid**

  Crystalline solid is a substance in which the atoms, molecules or ions have a characteristic, regular and fixed arrangement. They have a sharp melting point. Crystalline solids have a definite geometric shape such as cube, octahedron, tetrahedron, etc. e.g., sodium chloride, sugar, diamond, copper sulphate, etc.

Types of crystalline solids: On the basis of their structural unit such as atoms, ions or molecules the crystalline solids can be classified as

(i) Ionic solids: They consist of anions and cations held together by electrostatic forces.
e.g., NaCI, KCI, ZnS, etc.

(ii) Molecular solids: They are made up of neutral molecules held by weak van der Waals forces, e.g., ice, solid carbon dioxide, etc.

(iii) Covalent solids: They consist of atoms held by strong covalent bonds, e.g., diamond, graphite, etc.

(iv) Metallic solids: They are made up positive metal ions dispersed in sea of electrons, e.g., Cu, Fe, Zn, etc.