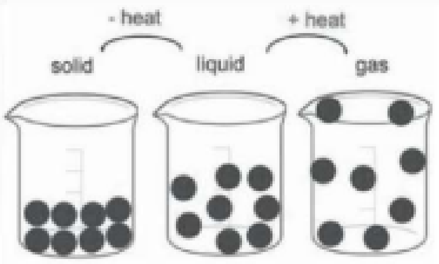


CHAPTER 5

PHYSICAL STATES OF MATTER

SUBJECTIVE PART

LONG QUESTION ANSWERS

Matter: *Anything that has mass and occupies space is called matter.*

Examples: Air, water, table, book etc.

Physical states of matter:

Matter exists in three physical states i.e. gas, liquid and solid. The simplest form of matter is the gaseous state. Liquids are less common and most of the matter exists as solid. These states are classified by means of two properties

(i) Shape **(ii)** Volume

5.1 GASEOUS STATE

Q.1 Write down the general properties of Gaseous state.

Ans: Gases:

The state of matter that has indefinite shape and indefinite volume is called gas.

Examples:

Hydrogen (H_2), oxygen (O_2), carbon dioxide (CO_2) etc

Typical properties of gases:

i. Diffusion

The spontaneous mixing up of molecules by random motion and collisions to form a homogeneous mixture is called diffusion.

Examples:

a. Spreading of fragrance of flower

b. Spreading of fragrance of perfume

Dependence:

Rate of diffusion depends upon the molecular mass of the gases. Lighter gases diffuse rapidly than heavier ones. e.g. H_2 diffuses four times faster than O_2 gas.

ii. Effusion:

It is escaping of gas molecules through a tiny hole into a space with lesser pressure.

Example:

When a tyre gets punctured, air effuses out.

Dependence:

Effusion depends upon molecular masses of the gases. Lighter gases effuse faster than heavier gases.

iii. Pressure

Gas molecules are always in continuous state of motion. Hence when molecules strike with the walls of the container or any other surface, they exert pressure.

The force (F) exerted per unit surface area (A) is called pressure.

$$P = \frac{F}{A}$$

SI unit of Pressure:

The SI unit of force is Newton and that of area is m^2. Hence pressure has SI unit of Nm^{-2}. It is also called Pascal (Pa)

One Pascal (Pa) = 1 Nm^{-2}

Pressure Measuring Devices:

i. Barometer is used to measure atmospheric pressure

ii. Manometer is used to measure pressure in the laboratory.

Standard Atmospheric Pressure:

It is the pressure exerted by the atmosphere at the sea level.

Definition:

It is defined as the pressure exerted by a mercury column of 760 mm height at sea level.
It is sufficient pressure to support a column of mercury 760m in height of sea level.

Different units of Pressure:

1 atm =760 mm of Hg = 760 torr (1 mm of Hg = one torr)
101325 Nm^{-2} = 101325 Pa

iv. Compressibility:

Gases are highly compressible due to empty spaces between their molecules. When the gases are compressed, the molecules come closer to one another and occupy less volume as compared to the volume in uncompressed state.

v. Mobility:

The ease of flow of liquids is called mobility.

a. Gas molecules are always in state of continuous motion.

b. They can move from one place to another because gas molecules possess very high kinetic energy.

c. They move through empty spaces that are available for the molecules to move freely.

d. The mobility or random motion results in mixing" up of gas molecules to produce a homogeneous mixture.

vi. Density of Gases:

The mass per unit volume of a substance is called density.

Units of Measurement:

Gases have low density than liquids and solids. It is due to light mass and more volume occupied by the gas molecules. Gas density is expressed in grams per dm^3, whereas, liquid and solid densities are expressed in grams per cm^3 i.e. liquids and solids are 1000 times denser than gases.

Effect of Temperature:

The density of gases increases by cooling because their volume decreases.

Example:

At normal atmospheric pressure, the density of oxygen gas is 1.4gdm^{-3} at 20°C and 1.5gdm^{-3} at 0°C.

5.2 LAWS RELATED TO GASES

Q.2 State Boyle's Law. Give the experimental verification of Boyle's law.

Ans: Boyle's Law

Introduction:

In 1662 Robert Boyle studied the relationship between the volume and pressure of a gas at constant temperature. Robert Boyle (1627-1691) was natural philosopher, chemist, physicist and inventor. He is famous for 'Boyle's law of gases.

Statement 1:

The volume of a given mass of a gas is inversely proportional to its pressure provided the temperature remains constant.

Mathematical Expression:

According to this law the volume (V) of a given mass of a gas decreases with the increase of pressure (P) and vice versa.

It can be written as:

$$V \times \frac{1}{\text{Pressure}} \qquad V = \frac{K}{P}$$

OR

$$PV = k = \text{constant}$$

Where, k is proportionality constant. The value of k is same for the same amount of a given mass.

Another form of Boyle's Law:

Boyle's Law can also be stated as:

The product of pressure and volume of a fixed mass of a gas is constant at a constant temperature.

	P_1V_1	= K, then	P_2V_2	= K
Where	P_1	=Initial pressure	P_2	= Final pressure
	V_1	= Initial volume	V_2	= Final volume

As both equations have same constant, therefore their variables are also equal to each other P_1V_2-P_2V_2. This equation establishes the relationship between pressure and volume of the gas.

Experimental Verification of Boyle's law:

The relationship between volume and pressure can be verified experimentally by the following series of experiments. Let us take some mass of a gas in a cylinder having a movable piston and observe the effect of increase of pressure on its volume. The phenomenon is represented when the pressure of 2 atmosphere (atm) is applied, the volume of the gas reads as 1 dm^3 when pressure is increased equivalent to 4 atm, the volume of the gas reduces to 0.5 dm^3, again when pressure is increased three times i.e. 6 atm, the volume reduces to 0.33 dm^3, Similarly, when pressure is increased up to 8 atm on the piston, volume of the gas decreases to 0.25 dm^3 where 'k' is proportionality constant. The value of k is same for the same amount of a given gas.

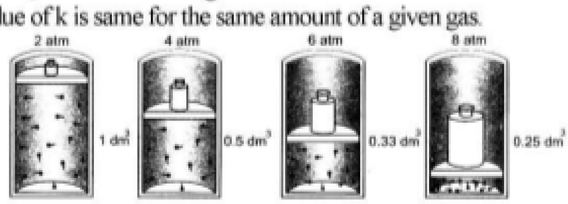


Fig. 5.1 The decrease of volume with increase of pressure.

Result

When we calculate the product of volume and pressure for this experiment, the product of all these experiments is constant i.e 2 atm dm^3. It proves the Boyle's law

$$P_1V_1 = 2atm \times 1dm^3 = 2atmdm^3$$

$$P_2V_2 = 4atm \times 0.5dm^3 = 2atmdm^3$$

$P_3V_3 = 6atm \times 0.33dm^3 = 2atmdm^3$
$P_4V_4 = 8atm \times 0.25dm^3 = 2atmdm^3$

Q.3 State Charle's Law. Give the experimental verification of Boyle's law.

Ans: Charle's Law:

Introduction

The relationship between volume and temperature keeping the pressure constant was also studied by French scientist J. Charles in 1787. J. Charles (1746-1823) was a French inventor scientist, mathematician and balloonist. He described in 1802 how gases tend to expand when heated.

Statement-1:

"The volume of a given mass of a gas is directly proportional to the absolute temperature if the pressure is kept constant"

Mathematical Expression:

When pressure P is constant, the volume V of a given mass of a gas is proportional to absolute temperature T.

Mathematically

It is represented as

$$V \times T$$

$$V = kT \quad \text{Or} \quad \frac{V}{T} = k$$

Where *k* is proportionality constant

Another form of Charle's Laws:

If temperature of the gas is increased its volume also increases. When temperature is changed from T_1 to T_2, the volume will change from V_1 to V_2. The mathematical form of Charles' Law will be:

$$\frac{V_1}{T_1} = k, \quad \frac{V_2}{T_2} = k$$

As both equations have same value of constant, therefore their variables are also equal to each other.

So

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

Experimental Verification of Charles' Law:

Let us take a certain amount of gas enclosed in a cylinder having a movable piston. If the initial volume of the gas V_1 is 50 cm^3 and initial temperature T_1 is 25°C on heating the cylinder up to 100 °C its new volume V_2 is about 62.5 cm^3. The increase in temperature increases the volume that can be observed as elaborated.

Representation of increase of volume with the increase of temperature:

According to Charle's Law:

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

$$\frac{50}{25+273} = \frac{62.5}{100+273}$$

$$\frac{50}{298} = \frac{62.5}{373}$$

$$0.167 = 0.167$$

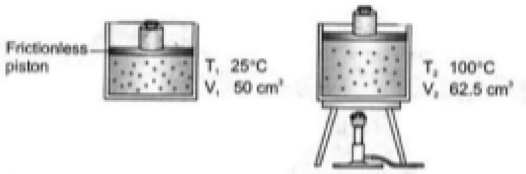


Fig. 5.2: Representation of increase of volume with the increase in temperature.

Q.4 Explain the absolute temperature scale with example.

Ans: Absolute Temperature Scale:

Introduction:

Lord Kelvin introduced absolute temperature scale or Kelvin scale. This scale of temperature starts from 0 K or $-273.15°C$, which is given the name of absolute zero.

Absolute Zero:

It is the temperature at which an ideal gas would have zero volume.

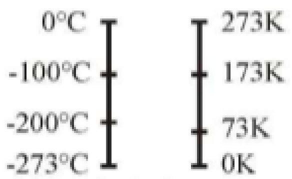
Absolute temperature scale or Kelvin scale:

A scale of temperature that starts from zero Kelvin or –273.25°C is called absolute temperature scale or Kelvin scale.

As both scales have equal degree range, therefore, when 0K is equ... then 273 K is equal to 0°C as shown in the scales

Conversion of Kelvin temperature to Celsius temperature and vice versa ... out as follows:

$$T(K) = T(°C) + 273$$
$$T(°C) = T(K) - 273$$



Remember

Always convert temperature scale from °C to K scale while solving problems.

$K = 273 + °C$

Q.5 In which units body temperatures is measured?

Ans: Body temperature is measured in Fahrenheit scale. Normal body temperature is 98.6F, it is equivalent to 37°C.

i. This temperature is close to average normal atmospheric temperature.

ii. In winter atmospheric temperature falls lower than that of our body temperature.

iii. According to principle of heat flow, heat flows out from our body and we feel cold.

iv. To control this outward flow of heat, we wear black and warm clothes.

v. To maintain body temperature we use dry fruits, tea, coffee and meats etc.

Q.6 Explain the Physical States of Matter and Role of Intermolecular Forces.

Ans: Physical States of Matter and Role of Intermolecular Forces:

Matter exists in three physical states; gas, liquid and solid.

Gaseous state of matter:

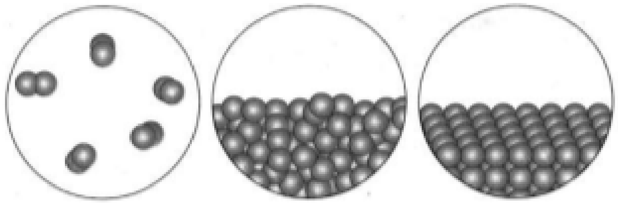
In the gaseous state, the molecules are far apart from each other. Therefore, intermolecular forces are very weak in them.

Liquid state of matter:

In the liquid state molecules are much closer to each other as compared to gases. As a result liquid molecules develop stronger intermolecular forces, which affect their physical properties like diffusion, evaporation, vapour pressure and boiling point. Compounds having stronger intermolecular forces have higher boiling points.

Solid State of Matter

The intermolecular forces become so dominant in solid state that the molecules look motionless. They arrange in a regular pattern therefore they are denser than molecules of liquids.



A. Gas molecules B. Liquids molecules C. Solid molecules

Fig 5.3 Three states of matter showing intermolecular forces.

Q.7 What are liquids? Name some important properties of liquids.

Ans: Liquid State

The state of matter that has indefinite shape but definite volume is called liquid.

Typical Properties of liquids:

i. Evoporation
ii. Vapour pressure
iii. Boiling point
iv. Freezing point
v. Diffusion
vi. Density

Liquids have a definite volume but their shape is not definite. A liquid attains shape of the container in which it is put. A few typical properties of the liquids are given below.

Q.8 Explain the Evaporation. Write down the factor effecting evaporation.

Ans: Evaporation:

The process of changing of a liquid into a gas phase is called evaporation.

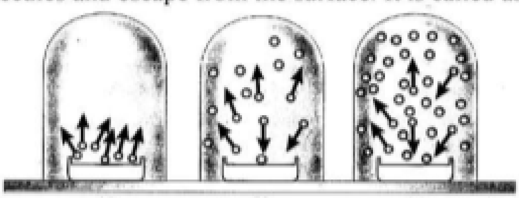
The molecules having more than average kinetic energy over come the attractive forces among the molecules and escape from the surface is called as evaporation.

It is reverse to condensation in which a gas changes into liquid. Evaporation is an endothermic process. Evaporation is an endothermic process (heat is absorbed). Such as when one mole of water in liquid state is converted into vapour form, it requires 40.7 kJ of energy.

$$H_2O_{(l)} \longrightarrow H_2O_{(g)} \qquad \Delta H^{\circ}_{vap} = 40.7\ Kj/mol$$

Mechanism of evaporation:

In the liquid state, molecules are in a continuous state of motion. They possess kinetic energy but all the molecules do not have same kinetic energy. Majority of the molecules have average kinetic energy and a few have more than average kinetic energy. The molecules having more than average kinetic energy, overcome the attractive forces among the molecules and escape from the surface. It is called as evaporation.



(a) (b) (c)

Fig. 5.4 A state of Dynamic Equilibrium between liquid and its vapours

Evaporation and Temperature:

Evaporation is a continuous process taking place at all temperatures. The rate of evaporation is directly proportional to temperature. It increases with the increase in temperature because of increase in kinetic energy of the molecules.

Evaporation is a cooling process:

When the high kinetic energy molecules vaporize, the temperature of remaining molecules falls down. To compensate this deficiency of energy, the molecules of liquid absorb energy from the surroundings. As a result the temperature of surroundings decreases and we feel cooling.

Example:

When we put a drop of alcohol on palm, the alcohol evaporates and we feel cooling ffect.

Factors affecting evaporations:

Evaporation depends upon following factors:

i. Surface area:

Evaporation is a surface phenomenon. Greater is surface area, greater is evaporation and vice verse. Example, sometimes a saucer is used if tea is to be cooled quickly. This is because evaporation from the larger surface area of saucer is more than that from the smaller surface area of a tea cup.

ii. Temperature:

At high temperature, rate of evaporation is high because at high temperature kinetic energy of the molecules increases so high that they over- come the intermolecular forces and evaporate rapidly.

For example:

Hot water will evaporate faster than the cold water in containers of same capacity.

iii. Intermolecular forces:

The stronger the inter molecular attractive forces, the lower is the evaporation.

For Example, water has stronger intermolecular forces than alcohol, therefore, alcohol evaporates faster than water.

Temp	Vapour Pressure	Temp	Vapour Pressure
°C	mmHg	°C	mmHg
0	4.58	60	149.4
20	17.5	80	355.1
40	55.3	100	760.0

Q.9 What is vapour pressure and how it is affected by inter molecular forces? Ex. Q. 3

Ans: Vapour Pressure:

The pressure exerted by the vapours of a liquid at equilibrium with the liquid at a particular temperature is called vapour pressure of a liquid.

State of equilibrium:

The equilibrium is a state when rate of vaporization and rate of condensation is equal to each other but in opposite directions.

Dynamic Equilibrium:

The state at which two processes take places in the opposite direction at equal rates simultaneously is called dynamic equilibrium.

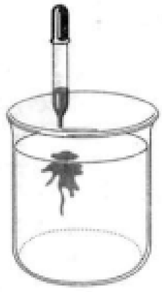
The number of molecules evaporating will be equal to the number of molecules coming back (condensing) to liquid. This state is called dynamic equilibrium.

Explanation:

$$\text{liquid} \underset{\text{condense}}{\overset{\text{vapourize}}{\rightleftharpoons}} \text{vapours}$$

From the open surface of a liquid, molecules evaporate and mix up with the air but when we close a system, evaporated molecules start gathering over the liquid surface. Initially the vapours condense slowly to return to liquid. After sometime condensation process increases and a stage reaches when the rate of evaporation become equal to rate of condensation. This is called Factors affect in vapour pressure.

A state of Dynamic Equilibrium between liquid and its vapors Vapour pressure of a liquid depends upon the following factors.


. 5.6 Diffusion in liquids

i. Nature of liquid:

Vapors pressure depends upon the nature of liquid.

Polar liquids have low vapour pressure than non-polar liquids at. the same temperature.

This is because of strong intermolecular forces between the polar molecules of liquids.

Example:

Water has less vapour pressure than that of alcohol at same temperature.

ii. Size of molecules

Small size molecules can easily evaporate than big size molecules. Hence small size molecules exert more pressure.

Examples:

Hexane (C_6H_{14}) is a small sized molecule as compared to decane ($C_{10}H_{22}$).

C_6H_{14} evaporates rapidly and exerts more pressure than $C_{10}H_{22}$).

iii. Temperature

At high temperature, vapour pressure is higher than at low temperature. At elevated temperature, the kinetic energy of the molecules increases enough to enable them to vaporize and exert pressure.

Example:

Vapour pressure of water at 0°C is 4.58 mmHg and at 100°C it is 760 mmHg.

Q.10 Define boiling point and also explain how it is affected by different functions?

Ans: Boiling Point:

The temperature at which the vapour pressure of a liquid becomes equal to the atmospheric pressure or any external pressure is called boiling point.

Mechanism of boiling:

When a liquid is heated, its molecules gain energy and the number of molecules which have more than average kinetic energy increases. More and more molecules become energetic, enough to overcome the intermolecular forces. Due to this, rate of evaporation increases which results in increase of vapour pressure until a stage reaches where the vapour pressure of a liquid becomes equal to atmospheric pressure. At this stage the liquid starts boiling.

Relationship between boiling point and vapour pressure:

Let's describe the increase of vapour pressure of diethyl ether, ethyl alcohol and water with the increase of temperature. At O°C the vapour pressure of diethyl ether is 200 mm Hg, of ethyl alcohol 25 mm Hg while that of water is about 5 mm Hg. When they are heated, vapour pressure of diethyl ether increases rapidly and becomes equal to atmospheric pressure at 34.6°C, while vapour pressure of water increases slowly because intermolecular forces of water are stronger.

The figure shows the vapour pressure increases very rapidly when the liquids are near to boiling point.

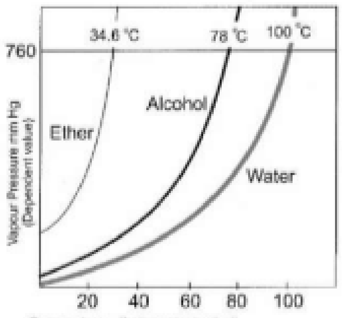


Fig.5.5 Boiling point curves of Ether Alcohol and water.

Factors Affecting Boiling Point:

The boiling point of the liquid depends upon the following factors.

i. Nature of liquid:

The polar liquids have high boiling points than that of non-polar liquids because polar liquids have strong intermolecular forces.

Example:

Boiling point of water (polar) is 100°C while that of ethyl alcohol (non polar) is 78°C.

ii. Intermolecular forces:

The stronger the inter molecular forces, the higher is the boiling point of liquid.

Intermolecular forces play a very important role on the boiling point of liquids.

Substances having stronger intermolecular forces have high boiling points, because such liquids attain a level of vapour pressure equal to external pressure at high temperature.

Example:

Boiling point of water (100°C) is greater than that of alcohol (78°C) due to stronger inter molecular forces of attraction.

iii. External pressure:

Boiling point of a liquid depends upon external pressure. Boiling point of a liquid is controlled by external pressure in such a way, that it can be increased by increasing external pressure and vice versa. This principle is used in the working of 'Pressure Cooker'.

Q.11 What is meant by freezing point?

Ans: Freezing Point:

The temperature at which vapour pressure of a liquid state becomes equal to the vapour pressure of the solid state and liquid and solid coexist in dynamic equilibrium is called freezing point.

Explanation:

When liquids are cooled the vapour pressure of liquid decreases and when vapour pressure of a liquid state becomes equal to the vapour pressure of the solid state. At this temperature liquid and solid coexist in dynamic equilibrium with one another and this is called the freezing point of a liquid.

Examples: Freezing point of water is 0°C and that of acetic acid is 16.6°C. Due to attractive force respectively.

Q.12 Describe the phenomenon of diffusion in liquids along with factors which influence it.

Ans: Diffusion:

A spontaneous mixing up of molecules by random motion and collisions to form homogenous mixture is called diffusion.

Ultimate goal:

The liquid molecules are always in a state of continuous motion. They move from higher concentration to lower concentration. They mix up with the molecules of other liquids, so that they form a homogeneous mixture.

Example:

When a few drops of ink are added in a beaker of water, ink molecules move around and after a while spread in whole of the beaker. Thus diffusion has taken place.

Comparison of rate of diffusion of liquids and gases:

Liquids diffuse like gases but the rate of diffusion of liquid is very slow.

Factors affecting diffusion:

The diffusion of liquids depends upon the following factors.

i. Intermolecular force:

Liquids having weak intermolecular forces diffuse faster than those of solids having strong intermolecular forces.

Example:

Rate of diffusion of alcohol is greater than that of water.

ii. Size of molecules:

Big size molecules diffuse slowly. For example, honey diffuses slowly in water than that of alcohol in water.

iii. Shapes of molecules:

Regular shaped molecules diffuse faster than irregular shaped molecules because they can easily slip over and move faster.

iv. Temperature:

Diffusion increases by increasing temperature because at high temperature the intermolecular forces are weak.

Example:

Rate of diffusion of water is higher at 25°C than that of 0°C.

Q.13 Explain comparison between densities of gases and liquids.

Ans: Density

"The mass per unit volume of a substance is called density."

Dependence of Density of liquids:

The density of liquid depends upon its mass and volume.

Comparison between densities of gases and liquids:

Liquids are denser than gases because molecules of liquid are closely packed and the spaces between their molecules are negligible. As the liquid molecules have strong intermolecular forces hence they cannot expand freely and have a fixed volume. Like gases, they cannot occupy all the available volume of the container that is the reason why densities of liquids are high.

Examples:

Density of water is 1.0 g cm^{-3} while that of air is 0.001 g cm^{-3} that is the reason why drops of rain fall downward.

Variation in densities of liquids:

The densities of liquids also vary. You can observe kerosene oil floats over water while honey settles down in the water.

Q.14 Explain typical properties of solid state.

Ans: Solid State:

The state of matter which has definite shape and definite volume is called solid.

Examples:

Sugar, common salt, iron, gold etc

In solid state the molecules are very close to one another and they are closely packed. The intermolecular forces are so strong that particles motionless. Hence they cannot diffuse. Solid particles possess only vibrational motion.

Typical Properties of Solids:

Some typical properties of solids are as follows:

i. Melting Point:

The temperature at which the solid starts melting and coexists in dynamic equilibrium with liquid state is called melting point.

Examples:

Melting point of sodium chloride is 801°C.

Explanation:

The solid particles possess only vibrational kinetic energy. When solids are heated, their vibrational energies increase and particles vibrate at their mean position with a higher speed. If the heat is supplied continuously, a stage reaches at which the particles leave their fixed positions and then become mobile. At this temperature solid melts.

$$solid \rightleftharpoons liquid$$

Melting points of Ionic and Covalent solids:

The ionic and covalent solids make network structure to form macromolecules so all such solids have very high melting points.

ii. Rigidity:

The particles of solids are not mobile. They have fixed position. Therefore solids are rigid in their structure.

iii. Density

Mass per unit volume of a substance is called density.

Comparison between densities of solids, liquids and gases:

Solids are denser than liquids and gases because solid particles are closely packed and do not have empty spaces between their particles. Therefore, they have the highest densities among the three states of matter.

Examples:

Density of aluminum is 2.70 g cm^{-3}, iron is 7.86 g cm^{-3} and gold is 19.3 g cm^{-3}.

Q.15 Differentiate between crystalline and amorphous solids

OR

Explain the types of solids in detail?

Ans: Types of Solids: (Greek word amorphous means without shape or shapeless)

According to their general appearance solids can be classified into two types:

i. Amorphous solids **ii.** Crystalline solids

i. Amorphous Solids:

"Solids in which the particles are not arranged in a regular repeating pattern are called amorphous solids".

They do not have sharp melting points. They do not form crystals.

Examples: Plastic rubber, glass, coal tar etc.

ii. Crystalline Solids:

Solids in which particles are arranged in a definite three-dimensional pattern are called crystalline solids.

Properties:

i. They have definite surfaces or faces.

ii. Each face has definite angle with the other.

iii. They have sharp melting points.

Examples: Diamond, sodium chloride, sugar, ammonium chloride etc

Q.16 Define Allotropy. Explain its condition and properties.

Ans: Allotropy:

The existence of an element in more than one form, in same physical state is called allotropy.

OR

Different forms of same element having same chemical properties but different physical properties are called allotropes or allotropic forms and this phenomenon is called allotropy.

Reasons:

i. Different number of atoms OR in a molecule:

Different forms of an element which have same chemical properties but different physical properties are called allotropes or allotropic forms and this phenomenon is called allotropy.

The existence of two or more kinds of molecules of an element each having different number of atoms such as allotropes of oxygen are oxygen (O_2) and ozone (O_3).

ii. Different arrangement of atoms in a molecule:

Different arrangement of two or more atoms or molecules in a crystal of the element

Examples:

a. Sulphur shows allotropy due to different arrangement of molecules (S_8) in the crystals.

b. Due to different arrangement of carbon (c) atoms in the crystals carbon has three allotropes.

Diamond, Graphite, Bucky balls

c. Due to different arrangement of P_4 molecules in the crystals, phosphorous exists in the three allotropes i.e. White, Red, Black

Properties of allotropes:

They always show different physical properties but may have same or different chemical properties.

Effect of temperature:

Allotropes of solids have different arrangement of atoms in space at a given temperature.

The arrangement of atoms also changes with the change of temperature and new allotropic form is produced.

Transition temperature:

The temperature at which one allotrope changes into another is called transition temperature.

Examples:

i. Transition temperature of sulphur is 96°C, below this temperature rhombic form is stable. If rhombic form is heated up to 96 °C, its molecules rearrange themselves to give monoclinic form.

$$S_8(\text{rhombic}) \rightleftharpoons^{96^\circ C} S_8\ (\text{monoclinic})$$

ii. Transition temperature for allotropic forms of phosphorous is 250°C.

$$P_4(white) \rightleftharpoons^{250^\circ C} (P_4)_4(\text{red})$$

White Phosphorous:

Is a very reactive, poisonous and waxy, soft solids. It exists as tetra-atomic molecules.

Red Phosphorous:

Is less reactive, non poisonous and brittle powder

iii. Transition temperature for allotropic forms of tin is 13.2°C.

$$Sn_{(Grey)} \rightleftharpoons^{13.2^\circ C} Sn_{(white)}$$

(cubic) (white)

Q.17 Explain change of instrumentation as the science progresses.

Ans: Change of instrumentation as the science progresses

There are many aspects to be considered about the functioning of instruments. Scientific observation is determined by the human sensory system. It generally relies on instruments that serve as mediators between the world and the senses. Thus, instruments can be considered as a reinforcement of the senses. They provide a great capacity for increasing the power of observation and making induction processes easier. Furthermore, scientific instruments constitute a major factor in checking, refuting or changing previously established theories.