CHAPTER: No.5
Physical States of Matter

Diffusion:-

The movement of molecules from a higher concentration to a lower concentration is called diffusion. The process of diffusion takes place in all directions.

Example:-

1. The smell of a perfume spread in a room is a an example of diffusion.

2. The smell of a rotten egg spreads all over the room by the process of diffusion.

Effusion:-

The escape of gas molecules through the hole one after the other without collision is called effusion.

Example:-

The escape of a gas molecule from a punctured tyre is an example of effusion.

Pressure:-

The force exerted by the molecules of the gas on unit area of a container is called pressure.

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$

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

Unit of Pressure:-

The unit of pressure is pascal.

One Atmosphere:-

At sea level at OC^0 temperature the atmospheric pressure is 760 mm of Hg or 760 torr. This pressure is called one atmosphere.

1 Atmosphere = 760 mm of Hg

Or

1 Atmosphere = 760 Torr

Also

1 Atmosphere = 101.325 Kpa

1 Atmosphere = 1.01325×10^5 Pa

Compressibility:-

There are large empty spaces between the molecules of a gas. On applying pressure the distance between the gas molecules decreases. As a result the volume of the gas also decreases. This property of the gas is called compressibility.

Mobility:-

There are large number of empty spaces between the molecules of a gas. Due to these large spaces the molecules of the gas can move easily from one place to another place. This property of the gas molecules is called mobility.

Due to this property a gas can be transported through pipes over long distance.

Density:-

The flow of mass per unit volume is called density. There are a large number of empty spaces between the molecules of the gas. Therefore gases have low density. But when a gas is cooled then its density increases.

Effect of volume of a gas by change in pressure and Temperature

(Question)

What is the effect of change in pressure and change in temperature on volume of the gas?

Ans **Effect of Change in Pressure:-**

There are large number of empty spaces between the molecules of a gas. If the pressure of a gas increases then the distance between the molecules of the gas decreases the volume of the gas also decreases.

Effect of Change in Temperature:-

If the temperature of a gas increases then the average kinetic energy of the gas molecules also increase. Due to this increase in kinetic energy the molecules of the gas move more frequently and as a result the volume of the gas increases.

Boyle's Law

Statement:-

The volume of a fixed amount of a gas is inversely proportional to the applied pressure if temperature is kept constant.

Explanation:-

If 'v' is the volume of the gas and p is the pressure and T is the constant temperature then according to Bolye's Law.

$$P \propto \frac{1}{v}$$

$$P = (\text{constant}) \frac{1}{V}$$

$$Pv = \text{constant}$$

Charles Law:-

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

Explanation:-

If 'V' is volume of a gas and T is its temperature and 'P' is the constant pressure then according to Charles Law.

$$V \propto T$$
$$V = (\text{constant})\, T$$
$$\frac{V}{T} = \text{constant}$$
$$\frac{V}{T} = \text{constant}$$

Similarly $\frac{v_1}{T_1} = \frac{v_2}{T_2}$

Evaporation:-

Conversion of a liquid to a gas or a vapour at all temperature is called evaporation or vaporization.

Page No 111 Self Assessment Exercise 5.3

Qno. 1 When you put nail polish remover on your palm, you fell a sensation of coldness.

Ans The nail polish remover contains a chemical acetone. We know that acetone is a volatile liquid. It evaporates very quickly. The molecules of aceton absorb heat from our palm as a result of this we feel a sensation of coldness because evaporation is a cooling process.

Qno. 2 What clothes are dry quickly in summer than in winter.

Ans We know that wet clothes dry due to process of evaporation at high temperature the rate of evaporation increases. Since the temperature in summer is higher than temperature in winter therefore the wet clothes dry quickly in summer than in winter.

Condensation:-

The process in which gas molecules are converted into liquid molecules is called condensation.

Vapour Pressure:-

The pressure exerted by the vapours of a liquid in equilibrium state is called vapour pressure.

Equilibrium State:-

During the process of evaporation and condensation when the number of molecules evaporating becomes equal to the number of molecules condensing then this state is called equilibrium state liquid evaporation.

Effect of Temperature on vapour pressure.

Question

How vapour pressure is affected by change in temperature?

Ans. The vapour pressure of a liquid changes with change in temperature. This is because when the temperature of a liquid increases then the kinetic energy of the molecules also increases. As a result of this increase in kinetic energy the rate of the molecules comping out of the liquid we can say that vapour pressure of a liquid increases due to increases in temperature.

Boiling Point:-

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

Effect of External Pressure on Boiling Point:-

A liquid boils when its vapour pressure becomes equal to the external pressure. The normal boiling point of water is $100C^o$ and in normal conditions the external pressure or atmospheric pressure is 1 atm.

But at mountains the atmospheric pressure is less than $100\ C^o$. Hence we can say that if atmospheric pressure is less than 1 atm then boiling point of water is less than $100C^o$. Similarly if atmospheric pressure is greater than 1 atm then boiling point of water is also greater than $100C^o$.

Question

Why water boils at 120^o in a pressure cooker?

Ans. We know that a liquid boils when its vapour pressure becomes equal to atmospheric pressure. If the atmospheric pressure is 1 atm then boiling point of water is $100C^o$.

In a pressure cooker there is a value that controls the pressure inside the pot. General this value exerts a pressure of 2 atm. Due to this value the vapour pressure of water also becomes 2 ATM. Therefore at this high vapour pressure water boils = at $120C^o$ in a pressure cooker.

Page No. 114 Self Assessment Exercise 5.5

Q1. The boiling point of water on the top of Mount Everest is 70C^o while at Murree 98C^o.?

Ans. We know that a liquid boils when its vapour pressure becomes equal to atmospheric pressure. At sea level the atmospheric pressure is 1 atm or 101.325 kpa so water boils at 100Co but at mount everest at a height of about 8850m above sea level the atmospheric pressure becomes less than 1 atm and its value is about 34 kpa. Therefore at this low pressure the water boils at 70^{o}C Muree is at lesser height than mount Everest. So at Murree the atmospheric pressure is greater than mount Everest. Therefore water boils at 98^{o}C at murree.

Q2. If you try to cook an egg in boiling water while cmping atam elevation of 0.5km in the mountain you will find that it takes longer than it does at home why?

Ans. We know that at sea level when the atmospheric pressure is 1 atm or 101.325 kpa then water boils at 100C$^{o.}$ But at height of 0.5 km on the mountain the atmospheric pressure becomes low so due to this low atmospheric pressure egg takes longer time to cook than it does at home.

Distillation:-

The process in which a liquid is heated to vapourize it and the vapours are cooled to condence them back to the liquid in a different container is called distillation.

Melting Point:-

The temperature at which a solid turns into a liquid is called melting point.

Freezing Point:-

The temperature at which a liquid changes into the solid is called freezing point.

Solid $\underset{\text{freezing}}{\overset{\text{melting}}{\rightleftharpoons}}$ liquid

Sublimation:-

The process in which a solid directly changes in to vapours without passing through the liquid state is called sublimation.

Example:-

When iodine is heated then it directly changes into vapours without passing through liquid.

Page No. 117 Self Assessment Exercise 5.6

Sodium chloride, an ionic compound has a high melting point of 801C^o. Whereas molecular solid such as ice has relatively low melting point of 0^{o}C.

Ans. Sodium chloride is an ionic compound and we know that very strong forces of attraction are present between the ions of an ionic compound. Therefore the melting point of ionic compounds such as sodium chloride is very high. Whereas ice is a molecular solid and we know that very weak forces of attraction are present in molecular solids. Therefore melting point of ice is very low.

Types of Solids:-

There are two main types of solid

1. Crystaline Solids
2. Amorphous Solids

1. Crystaline Solids:-

Those solids in which atoms are arranged in a regular and repeating three dimensional patter are called crystalline solids.

Example:-

Sodium chloride (NaCl) is a crystalline solid.

Properties:-

1. A crystalline solid has well defined shape because of regular arrangement of atoms.

2. Crystalline solids have sharp melting solid points.

2. Amorphous Solids:-

Those solids in which there is no regular arrangement of particles are called amorphous solids.

Example:-

Glass and plastics are amorphous solids.

Properties:-

1. Amorphous solids do not have a fix melting point.

Allo Tropes:-

The different forms of an element in the same physical state and phase are called allotropic forms or allotropes. And this process is called allotropy.

Allotropic Forms of Carbon:-

There are three allotropic forms of carbon.

1. Diamond.
2. Graphite

1. Diamond:-

Diamond is the first allotropic form of carbon. In diamond each carbon atoms is bonded to four other carbon atoms by a covalent bond. Diamond is very hard substance and it has very strong forces of attraction between its atoms. It is very beautiful and transparent in nature.

2. Graphite:-

Graphite is the second allotropic form of carbon. In graphite carbon atoms are arranged in layer's of hexagonal arrays. A very weak bond exists between each layer of carbon atoms. Due to presence of weak bond graphite is soft and slippery in nature.

3. Bucky Ball:-

Bucky Ball is third allotropic form of carbon. In bucky ball sixty carbon atoms joined together and form a ball shaped molecule. The new molecule looks just like a football.

Allotropic Forms of Phosphorus:-

Phosphorus is a non-metal it has two allotropic forms.

1. White phosphorus
2. Red phosphorus

1. White Phosphorus:-

White phosphorus consist of tetra-atomic molecules (p_4). These molecules are not bonded to each other.

2. Red Phosphorus:-

Red phosphorus consist of tetra-atomic molecules (p_4). But these molecules are bonded to each other in long chains.

Allotropic Forms of Sulphur:-

Sulphur is a non-metal and sulphur molecule consist of eight sulphur atoms. It has three allotropic forms.

1. Rhombic sulphur
2. Monoclinic sulphur
3. Plastic sulphur

Comparison between physical states of Matter:-

There are three basic states of Matter.

1. Gas
2. Liquid
3. Solid

1. Gases:-

There are large empty spaces between the molecules of gas. The gas molecules have no attraction forces between them. The gas molecules have no attraction forces between them. Te molecules of the gas move freely in all directions. Therefore a gas has n fix shape and volume.

2. Liquids:-

The molecules of the liquid have small distance between them. Due to this small distance the molecule of the liquid have same forces of attraction between them but these forces are not strong enough to hold the molecule of the liquid in affix position. Therefore a liquid has no definite shape but a liquid has definite volume.

3. Solids:-

The molecules of the solids are closely packed with each other. Therefore very strong forces of attraction are present between the molecules if the solid held together in a fixed position. Therefore a solid has definite shape and definite volume.

Page No. 128

Exercise Question

Explain why volume of the gas decreases on applying pressure on it at constant temperature?

Ans.

There are large empty spaces between the molecules of the gas. When pressure is increased then the distance between the molecules decreases. As a result the volume of the gas also decreases.

Also According to Boyle's Law

"The volume of a fixed mass of a gas is inversely proportional to the applied pressure if temperature is kept constant.

$$v \propto \frac{1}{p}$$

Therefore volume of a gas decrease if pressure is applied at constant temperature.

2. How does temperature effect vapour pressure of a liquid?

Ans.

As a temperature of a liquid increases then vapour pressure also increases. Because due to increase in temperature the kinetic energy of the molecules also increases. As a result of this increase in energy more molecules start to escape from liquid surface. Hence vapour pressure increases due to increase in temperature.

3. Water boils at $120C^o$ in pressuer cooker why?

Ans.

We know that a liquid boils when its vapour pressure becomes equal to atmospheric pressure. If the atmospheric pressure is 1 atm then boiling point of water is $100C^o$.

In a pressure cooker there is a value that exerts the pressure inside the pot. Generally this value exerts a pressure of 2 atm. Due to this value vapour pressure of water also becomes 2 ATM. Therefore at this high vapour pressure water boils at $120C^o$ in a pressure cooker.

4. Is evaporation a cooling process?

Ans.

During the process of evaporation the high energy molecules starts to escape from liquid surface. As a result the average kinetic energy of the remaining molecules decreases. Due to decrease in kinetic energy the temperature of the liquid energy the temperature of the liquid also decreases. Hence we can say that evaporation is a cooling process.

5. Can you make water boil at $70C^o$?

Ans.

Yes water can be boiled at 70^oC because we know at sealeved the atmospheric pressure is 1 atm or 101.325 kpa. At this pressure the boiling point of water is $100C^o$. But if atmospheric pressure becomes less than 1 atm then boiling point of water also becomes less than $100C^o$. At mount Everest at a height of about 8850m above sea level the atmospheric pressure becomes less than 1 atm and its value is about 34 kpa. So at this law pressure water boils at $70C^o$.

6. Express the pressure 400 mmHg in kpa?

Ans.

We know that

1 atm = 101.325 kpa

Also

1 atm = 760 mmHg (1)

Also

From (1) and (2)

760 mm Hg = 101.325kpa

1 mmHg = 101.325

1 mmHg = 0.1333kpa

Now

400mmHg = 400 x 0.1333kpa

400 mm Hg = 53.32kpa

Qno. 3

Explain the effect on the volume of a gas by a change in the?

a. Pressure b. Temperature

Ans. (a) Effect of Pressure:-

We know that there are large empty spaces between the molecules of gas. If the pressure of a gas increases then the distance between the molecules of the gas decreased. Due to this decreases in distance the volume of the gas also decreases.

b. Effect of Temperature?

If the temperature of a gas increases then the kinetic energy of the molecules of the gas also increase. Due to this increase in kinetic energy the molecules of the gas move more frequently and as a result the volume of the gas increases.

Question No. 6

Q. Explain the effect of external pressure on boiling point?

Ans.

We know that a liquid boils boils when its vapour pressure becomes equal to the external pressure. If external pressure is 1 atm then boiling point of water is $100C^{o}$.

In the mountains the external pressure is less than 1 atm therefore boiling point of water is also less than $100C^{o}$. In a pressure cooker the vapour pressure is greater than 1 atm therefore boiling point of water is also greater than $100C^{o}$.

Question No. 11

Q. Why does evaporation lower the temperature of a liquid?

Ans.

Evaporation is a process in which a liquid changes in to vapours. During the process of evaporation the high energy molecules starts to escape from liquid surface. As a result the everage kinetic energy of the remaining molecules decreases. Due to this decease in kinetic energy the temperature of the liquid also decreases. Hence we can say that temperature of a liquid.

Question No. 12

The air in a perfectly elastic balloon occupies $885cm^3$, during the fall when the temperature is 20o C. During the winter the temperature on a particular day is -10Co. The balloon occupies 794.39 cm^3. If the pressure remains constant. Show that the given data proves the volume temperature relation according to charl's Law?

Solution.

Initial volume = V_1 = 885cm3

$V_1 = \frac{885}{1000}$ dm3, $V_1 = 0.885dm3$

Initial temperature = T_1 = 20Co

T_1 = 20 + 273

T_1 = 293 K

Final volume = v2 = 794.39 cm3

V_2 = 794.39 dm3

1000

V_2 = 0.79439 dm3

Final temperature = T2 = -10Co

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

$\frac{0.885}{293} = \frac{0.79439}{263}$

0.00302020.003020

L.H.S = R.H.S

So

Charle's law is verified

Page No. 129 Qno. 14

In automobile engine the gaseous air fuel mixture enters the cylinder and is compressed by a moving position before it is ignited. If the initial cylinder volume is 990 cm^3 . after the piston moves up, the volume is 90 cm^3. The fuel air mixture initially has a pressure of 1.0 atm and final pressure 11.0 atm. Do you think this change occure according to the boyle's law?

Initial volume = V_1 = 990cm^3

$V_1 = \frac{990}{1000} = 0.990dm^3$

Final volume = V_2 = 90cm^3

$V_2 = \frac{90}{1000} = 0.090dm^3$

Initial pressure = P_1 = 1atm

Final pressure = P_2 = 11atm

According to boyle's law

$P_1V_1 = P_2V_2$

(1)(0.990) = (0.090)(11)

0.990 = 0.990

L.H.S = R.H.S

So

boyle's law is verified

Q No. 15

A sample of neon that is used in aneon that is used in a neon sign has a volume of 1500cm^3 at a pressure of 636torr. The volume of the gas after it is pumped into the glass tube of the sign is 1213.74cm^3, when it shows a pressure of 786torr. Show that this data obeys boyle's law?

Initial volume = V_1 = 1500cm^3

$V_1 = \frac{1500}{1000} = 1.5dm^3$

Initial pressure = P_1 = 636torr

$P_1 = \frac{636}{760} = 0.8368torr$

Final volume = V_2 = 1213.74cm^3

$V_2 = \frac{1213.74}{1000} = 1.21374dm^3$

Final pressure = P_2 = 786torr

$P_2 = \frac{786}{760} = 1.0342atm$

According to boyle's law

$P_1V_1 = P_2V_2$

$(0.8368)(1.5) = (1.0342)(1.21374)$

$1.2552 = 1.2552$

L.H.S = R.H.S

So

boyle's law is verified