PHYSICAL STATES OF MATTER

5

MULTIPLE CHOICE QUESTIONS

GASEOUS STATE

1. **Which of the following expand or compressed easily**
(a) liquid (b) gases (c) solids (d) water

2. **Diffusion is faster in:**
(a) liquid (b) solids (c) gases (d) plasma

3. **Gases exerts pressure in all directions**
(a) uniformly (b) randomly (c) alternately (d) constantly

4. **The SI unit of a pressure is**
(a) kJ/mole (b) kJ
(c) Mole (d) Pascal

5. **Standard atmospheric pressure is;**
(a) 760 torr (b) 101.325 k pa
(c) 101325 kJ/mole (d) None of these

6. **How many times liquids one denser than gases?**
(a) 100 times (b) 1000 times
(c) 10,000 times (d) 100, 000 times

7. **Gases are the lightest form of matter and their densities are expressed in terms of**
(a) mg cm^{-3} (b) g cm^{3}
(c) gdm^{-3} (d) kg dm^{3}

8. **Ammonia gas is used as**
(a) Refrigerant (b) Air conditioner
(c) Both a and b (d) None of these

LAW'S RELATED TO GASES

9. **What is the mathematical form of charles law:**
(a) $\frac{V}{T}$ = Constant (b) $P_1V_1 = P_2V_2$
(c) $V \times P$ = Constant (d) $P \propto \frac{1}{V}$.

10. **Charles describe, how gases tend to expand when heal**
(a) 1882 (b) 1802
(c) 1820 (d) 1828

11. **Robert Boyles was**
(a) Philosopher (b) Chemist
(c) Physicist (d) All of these

LIQUID STATE

12. **Conversion of a liquid to a gas at all temperature is called**
(a) Evaporation (b) Charles law
(c) Boyles law (d) None of these

13. The presence exerted by the vapour of a liquid is equilibrium with its liquid is called
(a) Vapour pressure (b) Evaporation
(c) Vaporization (d) Both a and b

14. Evaporation is a _____ process
(a) Cooling (b) Suffocating
(c) Heating (d) One

15. Solid have _____ intermolecular forces
(a) Weak (b) Strong
(c) Very weak (d) None

16. Evaporation is _____ process
(a) Continues (b) Both a, c
(c) Slow (d) None

17. The temperature at which vapour pressure of a liquid becomes equal to the external or atmospheric pressure is called
(a) Freezing point (b) Boiling point
(c) Melting point (d) None of these

SOLID STATE

18. The temperature at which a solid turns into liquid is called
(a) Melting point (b) Freezing point
(c) Both a and b (d) None of these

19. It depends upon the nature of liquid intermolecular forces and external pressure.
(a) Melting point (b) Freezing point
(c) Boiling point (d) None of these

20. The conversion of a liquid onto vapours at all temperature is called
(a) Evaporation (b) Boiling point
(c) Cooling process (d) Both a and c

21. Quartz is the crystalline form of
(a) SiO_2 (b) Si (c) SiO (d) None of these

22. Diamonds is the example of
(a) Allotropes (b) Sublimation (c) Solids (d) None of these

23. Red phosphorous is
(a) Less reactive (b) Non poisonous (c) Brittle (d) All of these

24. Oxygen has two allotropic forms
(a) O_2 and O_4 (b) O_2 and O_3 (c) O and O_3 (d) O_2 and O

ANSWER KEY

Q.	Ans	Q.	Ans	Q.	Ans	Q.	Ans
1	b	7	c	13	a	19	c
2	c	8	a	14	a	20	a
3	d	9	a	15	b	21	a
4	d	10	b	16	a	22	a
5	a	11	d	17	b	23	b
6	b	12	a	18	a	24	b

SHORT QUESTIONS

GASEOUS STATE

Q.1 Define pressure.

Ans: Forcer exerted by a gas on unit arca of container is called its pressure.

$$P=F/A$$

Q.2 Discuss Compressibility of gasses.

Ans: Compressibility:

Gasses are highly compressible. This is due to the presence of large empty spaces between the gas molecules.

Q.3 What do you mean by Pascal? How many Pascals are equal to 1 atm?

Ans. Pascal: "The pressure equal to one Newton per square meter is called Pascal."

1 atm = 101325 Pa

Q.4 Convert the following

(a) 70 cm Hg to atm:

760 cm Hg = 1 atm

$$1 \text{ cm Hg} = \frac{1}{760}$$

$$70 \text{ cm Hg} = \frac{1}{760} \times 70 = 0.0921 \text{ atm}$$

Ans. 70 cm Hg = 0.0921 atm

(b) 3.5 atm to torr:

1 atm = 760 torr

3.5 atm = 760 × 3.5

= 2660

Ans. 3.5 atm equal to 2660 torr

(c) 1.5 atm to Pa

1 atm = 101325 Pa

1.5 atm = 101325 × 1.5

= 151987.5

Ans. 1.5 atm is equal to 151987.5 Pa

Q.5 Whether the densities of a gas decrease on cooling?

Ans. No, the density of a gas does not decrease on cooling, it increases on cooling because on cooling their volume decrease and density is inverse to volume.

As $$d = \frac{m}{v}$$

Q.6 Write few properties of gaseous state.

Ans: No fix shape.

- No fix volume.
- Particles are not closely packed no intermolecular forces, etc.

Q.7 Discuss effect of pressure and temperature on volume.

Ans: Effect on the volume of a gas by a change in pressure and temperatures.

On increasing pressure on the gas, the distance between molecules decreases. So, the volume of the gas decreases.

On the other hand when pressure of a gas is kept constant and temperature is increased the average kinetic energy of a gas molecules increases so , volume increases.

Q.8 Discuss pressure of gases

Pressure:

Force exerted by a gas an unit area of a container is called its pressure.
At sea level at 0°C the atmospheric pressure is 160 mm of Hg or 760 torr. This pressure is referred as one atmosphere.

1 atm = 760 mm Hg
= 760 torr

Unit:

The S.I unit of pressure is pascal (Pa).

1am = 101. 325 kPa
= 1.01325×10^5 Pa

Q.9 Write a note on properties of gases

Ans: Diffusion
Effusion
Pressure
Density etc.

LAW'S RELATED TO GASES

Q.10 Define Boy's law?

Ans: Boyles law states that the volume of a fixed amount of a gas at a given temperature is inversely proportional to the applied pressure.

Mathematical form:

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

$$P = \frac{1}{V} \times \text{Constant}$$

$$V \times P = \text{Constant}$$

Q.11 Define Charles's law?

Ans: The volume of a given mass of a gas varies directly with the temperature at constant pressure.

Mathematically:

$$V \propto T$$

$$V = \text{Constant} \times T$$

$$\frac{V}{T} = \text{Constant}$$

Q.12 Is the Boyle law valid at very high temperature?

Ans: No, Boyles law is not valid at very high temperature because at this temperature K.E. increases that may effect pressure.

LIQUID STATE

Q.13 Is evaporation a cooling process?

Ans: **Evaporation is a cooling process:**

Only those molecules which have greater kinetic energy than average can break away from the surface. This means the molecules with the highest kinetic energy escape first than the molecules in liquid have a lower average kinetic energy. Therefore, liquid's temperature will decrease. To compensate this system will absorb energy from surrounding. Due to this evaporation is a cooling process.

Q.14 Define vapour pressure?

Ans: Vapour Pressure

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

Q.15 What do you mean by dynamic equilibrium?

Ans: It is that stage at which number of molecules evaporation will be equal to the number of molecules coming back condensing to liquid. This state is called dynamic equilibrium.

Q.16 Why are the rates of diffusion in liquids so slower than that of gases?

Ans: liquid diffuse like gases but the state of diffusion of liquid to slower than gases because liquids have stronger intermolecular forces then gases. The size of liquid molecules is larger than gases that is why. They diffuse slowly.

SOLID STATE

Q.17 Define sublimation?

Ans: Sublimation:

Some solids on heating change to vapours without passing through the liquid state. This process is called sublimation.

Example:

I_2 , Benzoic Acid etc

Q.18 Define freezing point?

Ans: Melting of Freezing:

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

$$\text{Solid} \underset{\text{Freezing}}{\overset{\text{Melting}}{\rightleftharpoons}} \text{Liquid}$$

Q.19 Why is the boiling point of water higher than that of alcohol?

Ans: Boiling point of water is higher than that of alcohol because water is a polar liquid and it also have high intermolecular force i.e. hydrogen bonding because of these reason water high boiling point than alcohol.

Q.20 Define allotropes?

Ans: The different form of an element in the same physical state and phase are called allotropic form or allotropes.

Q.21 Define amorphous solid?

Ans: Amorphous solid is one that lacks ordered arrangement of its particles.

e.g. Quartz glass results.

Q.22 Which allotropic form of carbon is stable at room temperature (25 °C)?

Ans. Three allotropic forms of carbon are:

(a) Diamond

(b) Graphite

(c) Bucky Balls

Among these allotropic forms graphite is energetically slightly more stable than diamond.

Q.23 State whether allotropy is shown by elements or compounds or both?

Ans. Allotropy is shown by elements not by compounds.

For example: Allotropic forms of carbon are diamond, bucky balls, graphite. And allotropes of oxygen are O_2 and O_3.

LONG QUESTIONS

Q.1 Define the following terms:
(i) Diffusion (ii) Effusion

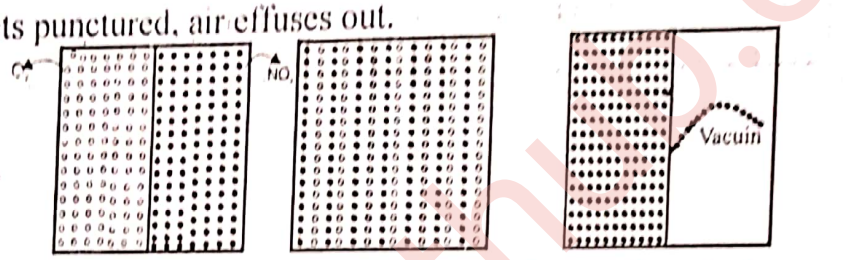
Ans. **(i) Diffusion:**
"It is defined as "The moment of molecules from a higher concentration to a lower concentration to form a homogeneous mixture is called diffusion .

Example:
Thomas Graham observed that molecules with smaller masses diffused faster than heavy molecules. H_2 diffuses four (4) times faster than O_2 gas.

(ii) Effusion:
It is defined as "the escape of gas molecules through the hole one after the other without collosion into a region of low pressure or vacuum is known as effusion."

Dependence:
The rate of effusion of a gas depends on the molecular mass of the gas.

Example:
When a tyre gets punctured, air effuses out.



Mixing of O_2 and No_2 by diffusion process

Escaping of gas molecules through a hole by effusion process

Q.2 Define Gaseous state of matter. Discuss the Typical properties of Gases.

Gaseous State:
A gas is that physical state of matter is which molecules are in constant random motion independent of each other. Therefore, gases have no definite volume or shape. They acquire the volume and shape of their container. The gaseous state is the most disorderly but also the simplest of the three states of matter

TYPICAL PROPERTIES
The following properties are common to all gases.

1. **Diffusion**
   The process of diffusion property concerned both gases and liquids but it is more significant in gases. Molecules of gases are widely separated and they don't have any attractive or repulsive forces. E.g. the characteristics smell of rotten egg spreads throughout the room because of the movement of Hydrogen Sulphide gas molecules from higher concentration to a lower concentration.
2. **Effusion**
   The escape of gas molecules through the hole one after the other without collision is called Effusion. The escaping of molecules is not because of collision. Instead, they have a tendency to escape one by one. Effusion depends upon molecular masses, light gases ($O2 = 32g$) effuses than heavier gases ($Cl_2 = 71_g$)

3. **Pressure**
A gas exerts pressure on the walls of its container due to collision of the molecules. At any point inside the container, a gas exerts n equal pressure in all directions. Hence force exerted by a gas on unit area of a container is called its pressure.

4. **Compressibility**
The presence of large empty spaces among the gas molecules shows highly compressible nature. By increasing pressure, the distance between the gas molecules decreases, therefore their volume decreases.

5. **Mobility**
At high pressure, Gases can flow like liquids and can be transported through pipes over long distance. The tendency of a gas to expand and fill the entire available space can be observed when it leak out from small hole of container.

6. **Density**
Mass per unit volume is called Density I,e density = mass / volume. The density of gases is relatively low because of huge distance among the gas molecules. When a gas is cooled its density increases because of decrease of volume.
For Example, density of oxygen at 20°C is 1.4g/dm3 but at 0.°C its density increase to 1.5g/dm.

Q.3 State and explain Boyle's Law experimentally?

1. **Statement # 1**
Boyle's Law state that the volume of a fixed amount of a gas at a constant temperature is inversely proportional to the applied pressure.

2. **Mathematical Explanation**
The volume of a give mass of a gas at constant temperature is inversely proportional to the pressure applied to the gas.

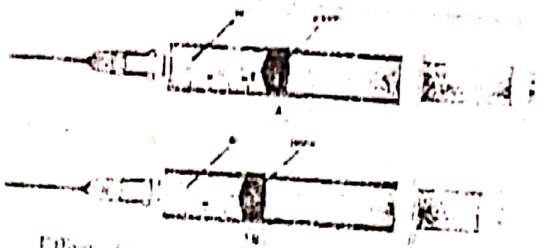
$V \times \frac{1}{p}$ (When the temperature and number of moles are constant)

$V \times k\frac{1}{p}$

$PV = k$ (When T and n are constant)
"K" is proportionality constant. The value of K is different for the different amounts of the same gas.)

3. **Statement # 2**
According to PV = K, Boyle's Law can also be defined as, "The product of pressure and volume of a fixed amount of a gas at a constant temperature is a constant quantity"
So $P_1V_1 = K$ and $P_2V_2 = K$
Hence $P_1V_1 = P_2V_2$
P_1V_1 are the Initial values of pressure and volume while P2V2 are the final values of pressure and volume.

4. **Experimental verification of Boyle's Law**
Figure below shows a syringe filled with air.



Effect of pressure change on the volume of air

Seal needle's tip with alfe, when pressure is increased on piston, it moves from position A to B as a result of which volume reduces. A student obtained data of volume and pressure for a given mass of gas at constant temperature with the help of this experiment. The data is shown in the table below.

Table: Volume-pressure data of a gas at constant temperature

Experiment No.	Pressure (atm)	Volume (dm^3)
1	0.500	4.00
2	1.00	2.00
3	2.00	1.00
4	4.00	0.500

This table clearly indicates that pressure and volume relationship is inversely proportional to each other.

The second statement of Boyle's Law is clearly verified in the table below.

Table: Volume-pressure data of a gas at constant temperature

Experiment No.	Pressure (atm)	Volume (dm^3)	VP (dm^3.atm)
1	0.50	4.00	2.00
2	1.00	2.00	2.00
3	2.00	1.00	2.00
4	4.00	0.50	2.00

This table is clearly shows that the product of volume and pressure is constant therefore we can write V×P = constant

Q.4 Ethene is used as anaesthetic gas. The pressure on 2.5 dm3 of ethane changes from 1.05 to 2.10 atm. The volume of ethane becomes 1.25dm3 if the temperature remains constant. Justify Boyle's Law by using this change?

Ans. Problem Solving Strategy

According to Boyle's Law

i) Product of pressure and volume is constant at any two sets of conditions.

ii) Calculate PxV for the two sets of condition

Solution

$P_1 = 1.05$ atm. $V_1 = 2.5\ dm^3$

So before changes of pressure-volume relation

$P_1 = 1.05\ atm \times 1.05atm \times 2.5\ dm3$

$P_1 = 2.625\ atm.dm^3$

After change of pressure-volume relation

$P_2 = 2.1$ atm $V_2 = 1.25$ dm^3

$P_2 V_2 = 2.1$ atm$\times 1.25$ dm^3

$P2V2 = 2.625$ atm. dm^3

$P_1 V_1 = P^2 V_2$

Thus the calculated result agrees with the pressure-volume relationship according to the Boyle's Law.

Q.5 State and Explain Charle's Law Experimentally and Graphically?

Ans. 1) Statement # 1

This law states that the volume of given mass of gas is directly proportional to the absolute Kelvin temperature at constant pressure.

2) Mathematical Form:

Mathematically, it can be written as

$V \propto T \therefore$ p and n are constant

$V = \text{Constant} \times T$

$\frac{V}{T} = \text{constant}$

e by
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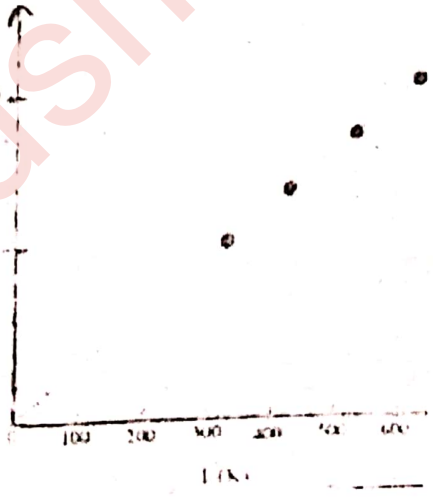
3) Statement # 2.

Since $\frac{V}{T}$ =constant, charle is law can also be defined as "The ratio of volume of a fixed amount of a gas and temperature is a constant quantity at a constant pressure". So,

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

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



This law can also be explained graphically. First temperature Co Converted into Kelvin temperature by adding 273 to it. Place values of volume on the y-axis and value of temperature in Kelvin on x-axis. A straight line is obtained from above data. This straight line suggests that there is a direct relationship between volume and temperature at Kelvin Scale at constant pressure.

i.e $\frac{V}{F}$ = Constant

Q.6 The table shows data of volume of a gas and its temperature for the given mass of a gas at 900 mm Hg.

Ans. Table: Temperature-volume data for a gas at 900 mm Hg

Temperature (°C)	Volume (Cm^3)
0	107.9
5	109.7
10	111.7
15	113.6
20	115.5

Explain volume-temperature relationship using Charles Law.

Answer

Problem Solving Strategy:

1. According to the Charles law, ratio of volume to absolute temperature is constant for any set of conditions.
2. Convert °C temperature of Kelvin temperature by adding 273.
3. Find $\frac{V}{T}$ for each set of conditions and compare.

Solution

Table given can be expanded into another table as mentioned below.

Temp. (°C)	Vol. (cm^3)	Temp. (K)	
0	107.9	273	$\frac{107.9}{273} = 0.3952$
5	109.7	278	$\frac{109.9}{278} = 0.3948$
10	111.7	283	$\frac{111.7}{283} = 0.3947$
15	113.6	288	$\frac{113.6}{288} = 0.3944$
20	115.5	293	$\frac{115.5}{293} = 0.3942$

The ratio $\frac{V}{T}$ is fairly constant. Thus volume of the gas varies directly with the absolute Kelvin temperature as stated by the Charles law.

Q.7 Define Liquid State of Matter. Mentioned the Typical properties of Liquids

Ans. Liquid State

It is a state of matter in which the constituent particles are loosely bound by intermolecular forces. Liquid change their shape with a fixed volume.

Typical Properties of Liquids

Some typical properties of liquids are given below:

1) Evaporation 2) Vapour Pressure 3) Boiling Point
4) Viscosity 5) Surface Tension 6) Diffusion
7) Freezing Point 8) Mobility 9) Density etc.

Q.8 Define and Explain Evaporation Experimentally.

Ans. Evaporation

It refers to the conversion of a liquid to a gas or vapour at all temperatures but less than the Boiling point of the liquids is called Evaporation or vaporization.

Experimental Verification

In evaporation, we have to examine the movement of molecules in liquid. the molecules of a liquid are not motionless. The energy of molecules are not equally distributed. The molecules which have low kinetic Energy move slowly, while others with. K.E more faster. This is clearly observed in an open container of ether of Acetone. The volume of the liquid gradually decreases and finally no more liquid is left behind. This is because of eraporation. Thus this spontaneous change of liquid into its vapours is called evaporation, its continues at all temperature.

Evaporation in an open container

Q.No.1 Justify the following with reason:

i) **Evaporation is a Cooling Process**
ii) **Liquids Evaporate faster when heated**

Ans: (i) Evaporation Causes Cooling

Evaporation Causes Cooling reason is that when high energy molecules leave the liquid and low energy molecules are left behind, the temperature of the liquid falls and heat moves from surrounding to liquid as a result temperature of surrounding also decreases. Hence Evaporation is a cooling process and lower the temperature process of liquid.

(ii) Liquids Evaporate faster

Higher the temperature, faster is the rate of evaporation and vice verse. This is because added heat increases the Kinetic Energy of the molecules. Hence liquids Evaporate faster when heated.

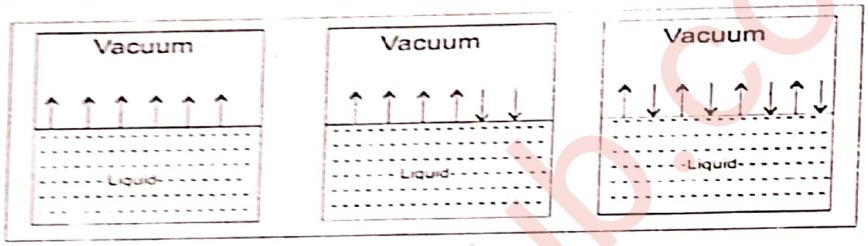
Q.No.2Define and Explain vapour Pressure Experimentally.

Ans: Vapour Pressure

The pressure exerted by the vapours of a liquid in equilibrium ($Liquid \underset{Condensation}{\overset{Evaporation}{\rightleftharpoons}} Vapours$) with its liquid at a given temperature is called vapour Pressure.

Explanation

Let us consider a liquid enclosed in a container. Air is evacuated and the vessel is sealed. The liquid then starts evaporating and its molecules collide with each other. Some of the molecules are recaptured by the liquid phase. This process is called Condensation. When two opposing process proceed exactly the same rate then the system is said to be in a dynamic state of equilibrium and the number of molecules in the vapour phase exerts a definite pressure which is called the vapour pressure of the liquid as shown in the figures.



Q.No.3 What is the Effect of temperature on Vapour Pressure?

Ans: Effect of Temperature on Vapour Pressure

Table below shows vapour pressure of some liquid at various temperatures.

Table: Vapour pressure of some liquids at various temperatures

Vapour Pressure (kPa) of Several Substances at Various Temperature						
	0°C	20°C	40°C	60°C	80°C	100°C
Water	0.61	2.33	7.37	19.92	47.34	101.33
Ethanol	1.63	5.85	18.04	47.02	108.34	225.75
Diethyl Ether	24.70	58.96	122.80	230.65	399.11	647.87

We conclude from the table that the V.P of liquids changes with temperature. This is because an increase in temperature of a liquid increases the K.E of the molecules and as a result vapour pressure increases.

Q.No.4 Define and Explain Boiling Point Graphically.

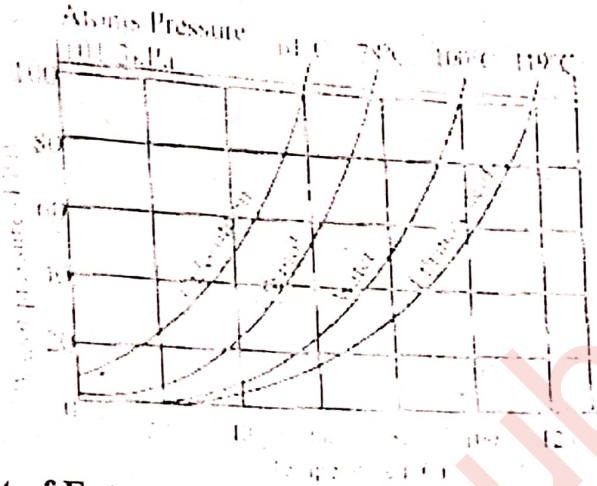
Ans: Boiling Point

The temperature at which vapour Pressure of a liquid becomes equal to the external or atmospheric Pressure I,e 760mm Hg or 101.325 KPa at sea level is called Boiling Point. The B.P of some of the liquids are given below:

Liquid →	Water	Chloroform	Ether	Acetone	Ethanol	Ethanoic
B.P(C°)	100	61	35	56	78	119
B.P(K)	273	334	308	329	351	392

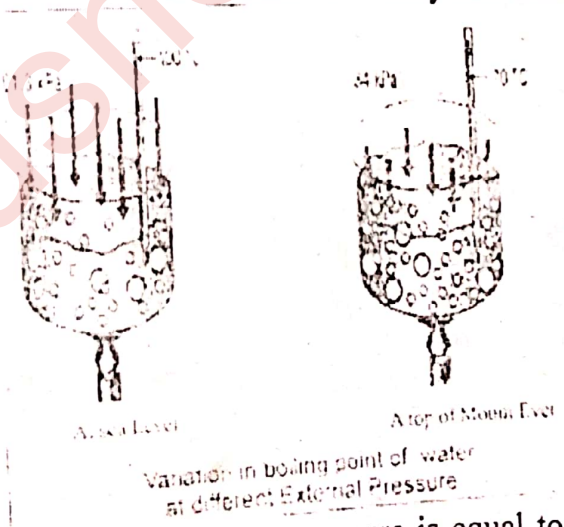
Graphical Explanation

When a liquid is heated in an open container, average K.E of the molecules, increases and atmosphere exerts pressure on the liquid surface. Therefore, the temperature of the liquid gradually increases. This heating process overcome the attractive forces and increases the V.P of the liquids. At a certain temp, the V.P of the liquid becomes equal to the external or atmospheric Pressure. At this stage, bubbles of vapours from throughout the liquid, rise to surface and escape into air and liquid starts boiling. This is called B.P of the liquids. The Graph clearly shows the variation in vapour Pressures at 101.325 KPa of four liquids with Boiling Points.



Q.No.5 What is the Effect of External Pressure on Boiling Point?

Ans: Boiling Points depend upon the External Pressure over the surface of the liquid. At Sea level, External Pressure is 1atm = 760mm Hg = 101.325 K.Pa. As we go at higher altitude i.e a top of Mount Everest, the external pressure decreases to 34 K. pa. So at sea level, the normal B.P of water is 100°C at 101.325K. Pa while at higher altitude 21°C at Mount Everest, water boils at 70°C with 34 K.Pa External Pressure Hence B.P is high at high External Pressure and vice versa which is clearly shown in the figures below.



Variation in boiling point of water at different External Pressure

Hence, "A liquid boils when its vapour pressure is equal to the pressure exerted on the liquids by its surroundings".

Pressure cooker is equipped with a valve that controls the pressure inside the pot. This valve generally exerts a pressure of 2 atm. Therefore, the valve does not allow water vapours to escape until the pressure inside the pot reaches 2 atm. Because vapour pressure of water becomes 2 atm when the temperature reacher120°C so water boils at 120°C in a pressure coolker

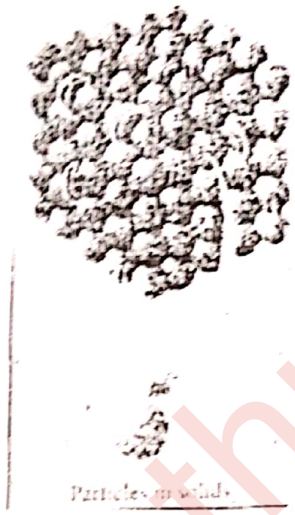
Q.No.6 Define Solid State of Matter Mentioned typical Properties of Solids

Ans: Solid State

In Solid State atoms, molecules or ions are very closely packed having definite shape and volume. They are in compressible and do not flow but vibrate about their fixed positions as shown in the figure.

The typical properties of solids are:

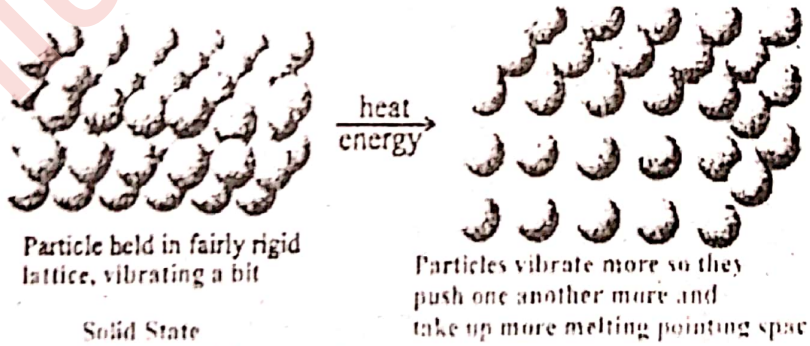
1. Melting point/melting
2. Freezing Point/Freezing
3. Sublimation etc.



Q.No.7 Describe melting and Freezing Processes with reference to Melting Point and Freezing Points.

Ans: Melting and Freezing

During heating, the particles of a solid start vibrating with greater Kinetic Energy. This makes the molecules a little bit apart from each other. This process increases the volume of solids. On future heating a statge reaches when the particles leave their fixed positions and start moving in the form of a liquid state as shown in the figure. This is called melting.



The temperature at which a solid turns into a liquid is called melting point. On cooling the liquid freezes. Thus freezing of a liquid is the reverse of melting. So the temperature at which a liquid changes into the solid is called Freezing Point. The melting and freezing of a substances occurs at the same temperature. At this temperature, the liquid and solid substances are in equilibrium each other.

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

The melting Point of a solid depends on the strength of attractive forces that hold particles together in the fixed positions. Stronger the forces higher will be the melting point. Ionic solids comparatively having high M.P than covalent solids.

Q.No.8 Define sublimation. Explain the Sublimation of Iodine molecules.

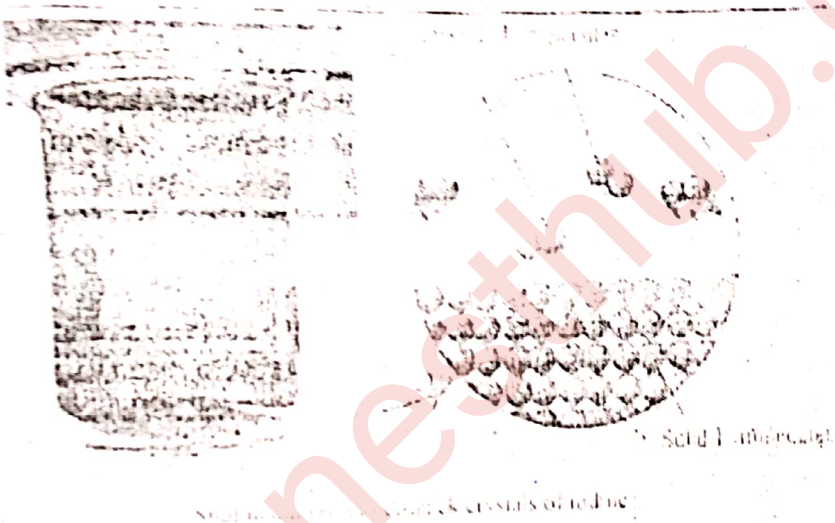
Ans: **Sublimation**

The volatilization of a solid substance into the vapour phase without passing through the liquid phase is called SUBLIMATION.

e.g. iodine molecule, Benzoic Acid, Ammonium Chloride, naphthalene etc. Sublimes.

Explanation

When impure sample of Iodine molecule is heated on sand bath. After some time dark violent black crystals of Iodine deposit the underside of the glass water placed on the top of a beaker containing Solid Iodine. The iodine vapour Sublimates from Iodine crystals in the bottom of the beaker and Condenses to form crystals on the glass watch as shown in the figure.



Q.No.9 Based on the structure of Solids, name and explain the two types of Solids.

Ans: **Types of Solids**

Bases on their structural feature, the solids have been divided into two classes based on their macroscopic appearance.

a) Amorphous Solids b) Crystalline Solids

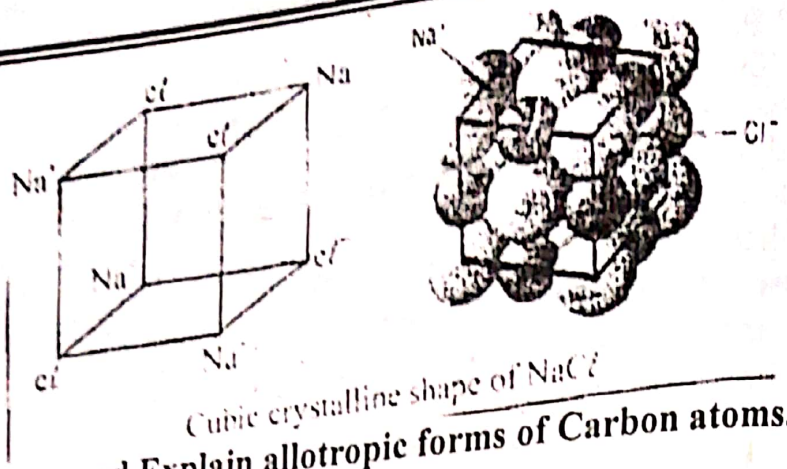
A) Amorphous Solids

Amorphous is derived from Greek and "Amorphous" which means without shape. Hence Amorphous Solids are those in which atoms, ions or molecules are not arranged in a definite pattern. E.g. glass, Plastics, rubber etc..

Amorphous solids do not melt at a definite temperature but gradually soften when heated.

B) Crystalline Solids

The solids in which atoms, molecules or ions are arranged in a regular repeating three dimensional well- ordered pattern is called as crystalline solids. Crystals have regular shape. Particles forming the crystals are packed in a very exact and ordered pattern as shown in figure below.



Cubic crystalline shape of NaCl

Q.No.10 A. Define Allotropy and Explain allotropic forms of Carbon atoms.
B. Discuss white and Red Phosphorous.
C. Write the Allotropic forms of Sulphur.

Ans: Allotropy

The phenomenon of the existence of an element in different forms which have different physical properties but same chemical properties is known as ALLOTROPY and different forms will be called ALLOTROPES or ALLOTROPIC FORMS.

Two Classes of Allotropes of Carbon

Carbon has many Allotropic forms which are divided into two classes.

1) Crystalline Allotropic forms: Diamond Graphite and Bucky Ball
2) Non-crystalline Allotropic forms e.g: coal, coke, charcoal, Lamp black etc only explanation of crystalline allotropes is given.

Crystalline Allotropes of Carbon

Carbon has three crystalline allotropes. The arrangements and properties are given below:

1. **Diamond**

It is the hardest known substance in diamond, each carbon atom is covalently bonded to four other C-atoms which are arranged in the form of tetrahedron. Diamond are used for cutting glass and polishing hard surface because of rigid compact array as shown in the figure.

Structure of Diamond

2. **Graphite**

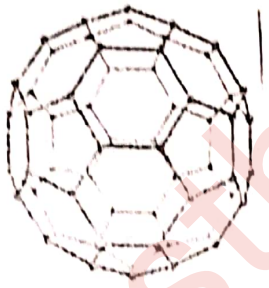
In Graphite, Carbon atoms are arranged in layers of hexagonal arrays. In these layers, each C-atoms is joined covalently by weak each Vender Waal's forces. These layers slip over each other and makes Graphite Soft. Graphite is used as electrodes, lubricant in machines, and black pigment. The structure of Graphite is shown below:

This allotrope way named bulk minister fullerene in the honour of architect R. Buckminster Fuller who used similar ring arrangements in designing a type of structure called a Geodesic Dome.

Structure of Graphite

3. Bucky Ball

It is new allotropic form which consist of forty to hundred carbon atoms. These atoms are arranged in a hollow cage like structure. Simplest molecule of Bucky Ball is made up of sixty C-atoms. Carbon atoms are arranged in Pentagons (Five member ring) and Hexagons (six member ring) just like a soccer Balls shown in the structure with the formula C60.



Structure of Bucky Ball

b. Allotropes of Phosphorus

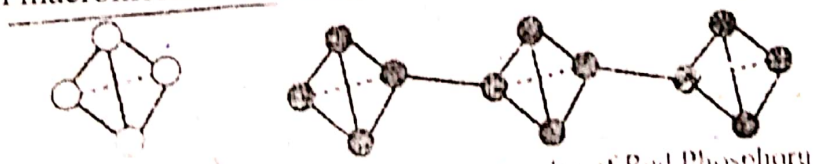
Phosphours can exist in at least six different solid allotropic forms, three are common I,e. white, Red and black, phosphorus is a non-metal but here two are given.

(i) White Phosphorus

It is a very reactive, poisonous, volatile, waxy allotrope which is soluble in benzene and carbon disulphide. It exist in the form of tetra atomic molecules (P_4) and form a tetrahedral structure as shown below:

(ii) Red Phosphorus

It is much less reactive and poisonous than white Phosphorus. It can be prepared by heating white Phosphorus upto 250°C in vacuum in the presence of Iodine or Sulphur as catalyst. The tetra atomic molecules of red Phosphorus combine to form macromolecules in long chains.



(i) White Phosphorus (ii) Macromolecules of Red Phosphorus

Allotropes of Sulphur

Sulphur consists of molecules that contain eight atoms, S_8 covalently bonded with each other. Sulphur exist two crystalline allotropes i.e. Rhombic and monoclinic sulphurs while one non crystalline (Amorphous) Sulphur i.e. Plastic sulphur.

Q.No.11 **Compare the three Physical States of Matter.**

Ans: We can differentiate the three states of matter with regard to intermolecular forces present between their particles.

Distinction between the three states of matter on the basis of particle model

	Property	Solids	Liquids	Gases
1.	Shape and volume	Solids posses definite shape and definite volume	Liquid do not have definite shape but definite volume.	Gases have neither a definite shape nor a definite volume.
2.	Compressibility	Solids are least compressible. It is due to the presence of small empty space between their molecules	It is slightly more that in solids.	Gases are highly compressible.
3.	Energy	Molecules possess least energy	Molecules possess moderate values of energies.	These molecules are highly energetic and have lot of energy in them.
4.	Molecular Motion	The molecules possess vibratory motion.	Molecules have linear as well as vibratory motion and are restricted to the boundary of the liquid	Molecules have complete freedom of motion. They move in all directions.
5.	Intermolecular forces	Mutual forces of attraction between the molecules are maximum.	Forces of attraction between the molecules are small.	Forces of attraction between molecules are almost negligible
6.	Packing of particles	The molecules are very closely packed	The molecules loosely held.	The molecules are at a very large distance apart.
7.	Diffusion	No tendency to diffuse	Slow tendency to diffuse	High tendency to diffuse
8.	Density D = m/v	High	Less than that of solids	Very low densities

SOCIETY, TECHNOLOGY AND SCIENCE

1) Scientists use the power of reasoning to explain their observation. For instance when a balloon is filled with air, it expands. A scientist would explain it by saying that air molecules are free to move inside their container. There is no attractive or repulsive force between the molecules. As a result gas expands until it takes the shape of its container. Therefore, air expands to fill the interior of the balloon evenly.
2) In early 1600s, Galileo argued that suction pumps were able to draw water from a well because of the force of vacuum" inside the pump. After Galileo's death, the Italian mathematician and physicist E. Torricelli proposed another explanation. He suggested that the air in the atmosphere has weight. The force of atmosphere pushing down on the surface of water drives the water into the suction pump when it is evacuated. In 1946 Torricelli invented a device called barometer. He measured atmospheric pressure is 760mm Hg. Torricelli's work soon caught the attention of

British scientist Robert Boyle. He modified barometric tube into a J-shaped tube. By adding mercury to the open end of the tube, he trapped a small volume of air in the sealed end. He studied what happened to the volume of the air as he added more mercury to the open end. Boyle's from the studies discovered the pressure-volume relationship. J-tube was further modified and another device known as manometer was developed that can measure the pressure of any gas. This means instrumentation improves as science progress.

3) Freeze-dried foods are light-weight and conveniently re-constituted by adding water. When salt is applied on meat it draws out considerable amount of water from the meat. After this meat is frozen and placed in a chamber attached to a vacuum pump. By lowering the pressure below the vapour pressure of ice, the ice crystals sublimate and the meat is dried without the loss of its flavor. Dried meat needs no refrigerator because bacteria such as salmonella which cause food poisoning cannot grow on salt and in the absence of moisture. Thus curing with the salt helps preserve meat.

KEY POINTS

- Diffusion is the movement of molecules from a higher to lower concentration.
- The escape of gas molecules through a hole one after the other without collisions is called effusion.
- Force exerted by a gas on unit area of a container is called its pressure.
- The SI unit of pressure is Pascal. One Pascal is the force of one Newton exerted on an area of one square meter.
- Compressibility of gases is due to the presence of large empty spaces between the gas molecules.
- Gases have tendency to expand and fill the entire available space.
- Boyles law states that the volume of a fixed amount of a gas at a given temperature is inversely proportional to the applied pressure.
- Charles law states that the given volume of a gas varies directly with absolute temperature at constant pressure.
- Conversion of a liquid to vapours is called vapourization or evaporation.
- The pressure exerted by vapours of a liquid in equilibrium with its liquid is called vapour pressure.
- A liquid boils when its vapour pressure is equal to the external pressure.
- Distillation is the process in which a liquid is heated to vapourize it and the vapour is cooled to condense it back to the liquid in a different container.
- Melting point is the temperature at which a solid turns in to a liquid.
- Sublimation is the process in which a solid changes into vapours without passing through the liquid state with or without heating.
- A crystalline solid is made up of orderly, repeating three dimensional arrangement of particles.
- The different forms of an element in the same physical state and phase are called allotropes.

TEXTBOOK EXERCISE

Q.No.1 **Encircle the correct answer.**

(i) Which statement about the particles of a solid is not correct?

(a) They move at great speeds

(b) They are arranged in regular patterns

(c) There is a very little space between the particles

(d) The forces of attraction between the particles are strong

(ii) The boiling points of some elements are given below:

	B.P in Kelvin
(a) Argon → -186°C	87
(b) Nitrogen → -196°C	77
(c) Oxygen → - 183°C	90
(d) Xenon → - 108°C	165

A mixture of the above gases at -210°C was heated by 20°C. Which of the element will still be in the liquid state?

(a) Oxygen only

(b) Argon, oxygen and xenon

(c) Argon, Nitrogen and xenon

(d) Only Xenon

(e) Oxygen and Xenon

Temp Range in Kelvin

-210°C + 20° = - 190°C = 83k

>83K will be in liquid state

(iii) The following table show the melting and boiling points of four substances. Which substance is a solid at room temperature?

Substances	Melting point (0°C)	Boiling Point (0°)
A	-186	-183
B	-6	120
C	0	100
D	**36**	**130**

(vi) In which of the following processes speed of the particles decreases?

(a) Melting

(b) Sublimation

(c) Evaporation

(d) Boiling

(e) Condensation

(v) Consider the following table:

Sr. No.	X	Y	X/Y
A	1.00	273	0.0037
B	1.37	373	0.0037
C	1.73	473	0.0037
D	2.10	573	0.0037

Which of the following relationships does this table represent?

(a) $x \alpha y$ (b) $x = y$

(c..) $x \alpha \frac{1}{y}$ (d) $x = \frac{1}{y}$

(vi) A liquid boils when its vapour pressure becomes equal to:

(a..) 760 cmHg (b) IPa

(c) 101.325kPa (d) 0.1atm

(vii) Aceton has characteristic fragrant odour and is used to make finger nail polish. It melts at -94°C and boils at 56°C. What is the physical state of acetone at 25°C and 1 atm?

(a) Gas (b) Liquid

(c..) Solid (d) Cannot be predicated

(viii) Water normally boils at 100°C, but it is possible for water to boil at room temperature. What variable would you have to change to do this?

(a) Increase external pressure

(b) Decrease external pressure

(c) Decrease temperature

(d) None of these

(ix) Bromine has a melting point of -7°C and a boiling point of 59°C. What is the physical state of bromine at 100C°.

(a) Gas (b) Liquid

(c..) Solid (d) Cannot be predicted

(x) Which is not the property of crystalline solids?

(a) Have well defined shape

(b) Have orderly arrangements of particles

(c) Have repeating three dimensional arrangement of particles

(d) Are generally soft

EXERCISE QUESTIONS

Q.No.2

(i) **Explain why volume of a gas decreases on increasing pressure on it at constant temperature?**

Ans: According to Boyles Law volume and pressure are inversely proportional to each other at constant temp. High pressure on gas molecules increases the intermolecular forces as a result of which volume of a gas molecules decreases.

(ii) **How does temperature effect vapour pressure of a liquid?**

Ans: See question 16.

(iii) **Water boils at 120°C in a pressure cooker, why?**

Ans: Pressure Cooker is a closed container in which on heating B.P of water increases which help to increase the external pressure. A liquid can be made to boil at any temperature by changing the external pressure. So water boils at 120°C in a pressure Cooker because inside the pressure Cooker. external pressure increases.

(iv) **Is evaporation a cooling process?**

Ans: Yes, evaporation is a cooling process. For more detail see question 14(i)

(v) **Can you make water boil at 70°C?**

Ans: Yes, a liquid can be made to boil at any temperature by changing the external pressure. Lower the external pressure, lower, will be the boiling point of water. Water boil at 100°C with 532mm Hg Pressure.

(vi) **Express the pressure 400mm Hg in kPa?**

Ans: As we know that

$$760\text{mmHg} = 101.325\text{Kpa}$$

$$400\,\text{mmHg} = \frac{101.325}{760\text{mmHg}}\,\text{KPa} \times 400\,\text{mmHg}$$

$$= 53.33\ \text{KPa}$$

Hence 400 mmHg = 53.33Kpa

Q.No.3 **Explain the effect on the volume of a gas by a change in the**
(a) Pressure (b) Temperature

Ans: See Question.4

Q.No.4 **Explain the following properties of gases**
(a) Diffusion (b) Effusion

Ans: See Question.1

Q.No.5 **Explain the terms:**
(a) evaporation (b) vapour pressure
(c) boiling point

Ans: See Question. 13, 15, 17.

Q.No.6 **Explain the effect of external pressure on boiling point.**

Ans: See Question.18.

Q.No.7 **Differentiate between amorphous and crystalline solids.**

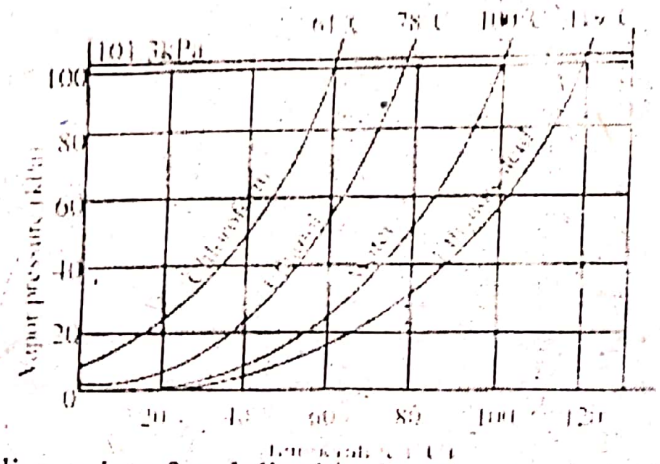
Ans: See Question.22.

Q.No.8 **Explain the allotropic form of any two solids.**

Ans: See Question.23 (a) 23 (b)

Q.No.9 **Plots of vapour pressure versus temperature of four liquids are given in the following figure:**

Ans:



a) Find the boiling point of each liquid when the atmospheric pressure is 1 atm.
b).At what temperature ethanol will boil when the atmospheric pressure is 51KPa.
c).How can you make water to boil at 80°C?
d).At what temperature chloroform will boil when the external pressure is 50kPa.

e).Can you boil chloroform at 0°C.

f).Predict the boiling point of chloroform at 600mm Hg.

Ans:

a) See question 17 for more detail.

b) According to the Graph

101.3 kPa Pressure = Ethanol boil 78°C

But at 51kPa Pressure $= \frac{78°C}{101.3KPa} x51KPa$

$= 31.274°C$

So, Ethanol will boil at 31.27° when the atmospheric pressure is 51 KPa

c) The boiling point of water is 100°C when pressure is 760 mm Hg or one atoms. Pressure but can be water boil at 80°C when pressure will be 608mm Hg or 0.8 atoms.

Pressure

i.e,

$100°C = 760mm\ Hg$

$80° = \frac{760mmHg}{100°C}$

d) According to the Graph situation

When external pressure is 101.3 Kpa = B.P chloroform

But when external pressure become

$50\ Kpa = \frac{61°}{101.3KPa} x50Kpa$

$= 30.11°C$

So, chloroform will boil at 30.11°C when the external pressure is 50 Kpa.

e) Yes, when temperature in °C can be changed into Kelvin Scale.

e.g: Chloroform boil 61°C = 334K, 0°C = 273K

At 334K temp(B.P of chloroform) = Pressure is 101.3KPa

But at 273K temp (B.P of chloroform) $= \frac{101.3KPa}{334K} x273K$

$= 82.80KPa$

Thus when pressure reduces to 82.80KPa, chloroform can boil at 273K (°C)

f) According to the graph,

760mm Hg pressure = B.P of chloroform 61°C

600mm Hg pressure $= \frac{61°C}{760mmHg} x600mmHg$

The B.P. of chloroform at 600mmHg will be 48.16°C

Q.No.10 **Why does Evaporation lower the temperature of a liquid?**

Ans: See Question No 14-i

Q.No.11 **The air in a perfectly elastic balloon occupies 855cm^3, during the fall when the temperature is 20°C. During the winter, the temperature on a particular day is -10°C, the balloon occupies 794.39cm^3. if the pressure remains constant. Show that the given data proves the volume temperature relation according to the Charles Law.**

Ans:

$V_1 = 885cm^3$ $T_1 = 20°C + 273 = 293K$

$V_2 = 794.39cm^3$ $T_2 = -10°C + 273 = 263K$

According to Charles Law

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

P.anel-are constant

By putting the values

$$\frac{885cm^3}{293K} = \frac{794.39cm^3}{263K}$$

$3.02cm^3\ k^{-1} = 3.02\ cm^3\ K^{-1}$

Thus the given data proves the volume temperature relation according to the Charles's Law.

Q.No.12 **In the past, gas volume was used as a way to measure temperature using devices called gas thermometers. An experimenter obtains following data from gas thermometer.**

Volume (dm^3)	Temperature (°C)
2.7	0°C
3.7	100°C
5.7	300°C

Show that gas thermometer obtained results according to Charles Law.

Ans: When we compare given volume temperature relation of three gases According to Charles Law, the following results will be obtained

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} = \frac{V_3}{T_3}$$

$V_1 = 2.7dm^3$ $T_1 = 0°C + 273 = 273K$

$V_2 = 3.7dm^3$ $T_2 = 100°C + 273 = 373K$

$V_3 = 5.7dm^3$ $T_3 = 300°C + 273 = 573K$

By putting the values

$$\frac{2.7dm^3}{273K} = \frac{3.7dm^3}{373K} = \frac{5.7dm^3}{573K}$$

$0.00989\ dm^3\ K^{-1} = 0.00992dm^3K^{-1} = 0.00994\ dm^3K$

$9.89\ cm^3\ K^{-1} = 9.92cm^3K^{-1} = 9.94cm^3\ K^{-1}$

Thus the given data show that gas thermometer obtained result are according to Charles's Law.

Q.No.13 **In automobile engine the gaseous fuel-air mixture enters the cylinder and is compressed by a moving piston before it is ignited. If the initial cylinder volume is 990cm^3. After the piston moves up the volume is 90cm^3. The fuel-air mixture initially has a pressure of 1.0at. and final pressure 11.0atm. Do you think this change occurs according to the Boyles law.**

Ans:

$V_1 = 990cm^3$ $V_2 = 90cm^3$

$P_1 = 1.0atm$ $P_2 = 11.0atm$

According to Boyles Law

$P_1 V_1 = P_2 V_2$ $\therefore$ T, n are constant

Putting the values $1.0 \text{ atm} \times 990cm^3 = 11.0 \text{ atm} \times 90cm^3$

$990atm\ cm^3 = 990\ atm.cm^3$

$990atm\ cm^3 = 990\ atm.cm^3$

Thus the given data proves the statement of Boyles's law and this change occurs accordingly.

Q.No.14 **A sample of neon that is used in a neon sign has a volume of 1500cm^3 at a pressure of 636 torr. 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 786 torr. Show that this data obeys Boyles's Law?**

Ans:

$V_1 = 1500cm^3$ $P_1 = 636$ torr

$V_2 = 1213.74cm^3$ $P_2 = 786$ toor

According to Boyel's Law

$P_1V_1 = P_2V_2$ T, n are constant

Putting the values

$636 \text{ toor} \times 1500cm^3 = 786 \text{ toor} \times 1213.74\ cm^3$

$954000\ toor.cm^3 = 954000\ toor.\ Cm^3$

Hence the given data obeys Boyle's Law.

Q.No.15 **Instrumentation changes as science progresses, comment on it?**

Ans: The search of man for collecting knowledge and integrating it is called Science. So true knowledge and its integration can be progressed more with the help of instruments.

Some examples will prove the truth.

1. Exact heat changes during chemical reaction can be measured with the help of digital thermometer.
2. PH of solution, urine and blood can be measured exactly by PH-meter not by PH papers.
3. Stethoscope uses doctor to listen heart beats and breathing
4. Barometer used for measuring air pressure easily
5. Mass spectrometer used to find out the atomic mass of an atom
6. Geologist easily detect the presence of oil and gas under earth with the help of instruments.
7. Micro organism easily seem by micro scope for better analysis
8. 1st date moon easily seen by powerful telescope
9. In medicine, use of instruments plays a vital role in the micro analysis of blood, urine, cancer, breaking bones etc. In short, Instrumentation changes as science progress.

ELF ASSESSMENT EXERCISE 5.1

Related To Gaseous State

1. **A student obtained following data in an experiment at 20 C° Explain pressure volume relationship using this data according to Boyle's Law.**

P (atm)	V (dm^3)
0.350	0.707
0.551	0.450
0.762	0.325
0.951	0.261
1.210	0.205

Solution

According to Boyles Law

Pressure x Volume = Constant

So in first case 0.350 atm x 0.707dm^3 = 0.248 atm. dm^3

Second case 0.551 atm x 0.450dm^3 = 0.248 atm. dm^3

Third Case 0.762 atm x 0.325 dm^3 = 0.248 atm. dm^3

Fourth Case 0.951 atm x 0.261 dm^3 = 0.248 atm. dm^3

Fifth Case 1.210 atm x 0.205 dm^3 = 0.248 atm. dm^3

Thus the calculated results agrees with the Pressure- Volume relationship according to the Boyles Law.

2. **Ammonia gas is used as refrigerant 0.474 atm (P1) pressure is required to change 2000 cm^3 (V1 = 2 dm^3) sample of ammonia initially at 1.0 atm (P2) to 4.22 dm^3 (V2) at constant temperature. Show that this data satisfies Boyle's Law?**

Solution

According to Boyles Law

$P_1V_1 = P_2V_2$

So

P_1 = 0.474 atm

V_1 = 2000Cm^3 = 2dm^3

P_2 = 1.000 atm

V_2 = 4.22dm^3

Putting all the values in above equation

$P_1V_1 = P_2V_2$

0.474 atm x 2 dm^3 = 1.000 atm x 4.22 dm^3

0.948 atm . dm^3 ≠ 4.22 atm. dm^3

The given data does not satisfied the Boyles Law.

Exercise 5.2:

1. **A chemist obtained data shown in the table in an experiment at 1 atm pressure. Explain Volume-Temperature relationship using Charles Law**

Temp (C°)	Volume(Cm^3)
25	117.5
30	119.4
35	121.3
40	123.2

Solution

According to Charle's Law

$V \alpha T$ or $V = T$ Constant

or $\frac{V}{T}$ = Constant $\therefore$ P,n are Constant

So fi t Temperature C° is Converted into Temperature. Kelvin and then find in each case $\frac{V}{T}$ ratio i.e.,

T(C°)	T(K) °C + 273	V,cm³	V/T
25	298	117.5	2.54
30	303	119.4	2.54
35	308	121.3	2.54
40	313	123.2	2.54

Thus the Calculated V/T ratio satisfies the Charles Law

2. A bacterial culture isolated from sewage produce 36.4 cm^3 of methane (CH_4) gas at 27C° and 760 mm Hg. This gas occupies 33.124 cm^3 at 0C° and same pressure. Explain volume-temperature relationship from this data.

Solution

According to Charle's Law by Comparison

$V_1 = 36.4\ cm^3$ $T_1 = 27c° + 273 = 300K$

$V_2 = 33.124\ cm^3$ $T_2 = 0°C + 273 = 273K$

Provided pressure constant, so

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

$$\frac{36.4cm^3}{300K} = \frac{33.124cm^3}{273K}$$

$0.121\ cm^3\ K^{-1} = 0.121\ cm^3\ K^{-1}$

Hence the given data satisfies the Charle's Law

3. A perfect elastic balloon filled with Helium gas has a volume of $1.25 \times 10^3\ dm^3$ at 1.00 atm and 25C° on ascending to a certain altitude where temperature is 15c°, the volume of balloon becomes $1.208 \times 10^3\ dm^3$ at the same pressure show that this data satisfies Charle's Law.

Solution

$V_1 = 1.25 \times 10^3\ dm^3 = 1250dm^3$

$T_1 = 25c° + 273 = 298K$

$V_2 = 1.208 \times 10^3 dm^3 = 1208dm^3$

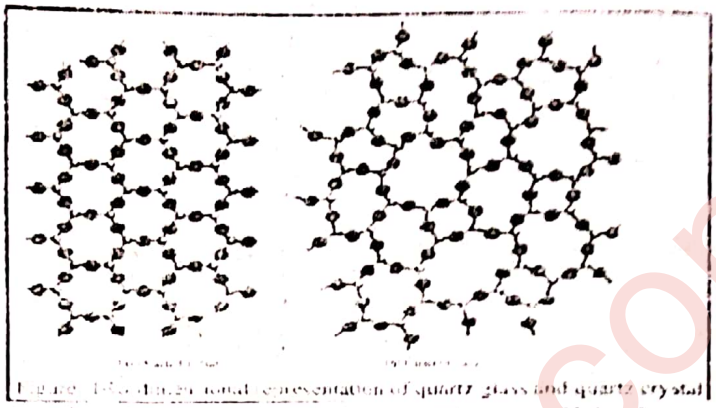
$T_2 = 15c° + 273 = 288K$

According to Charles Law

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

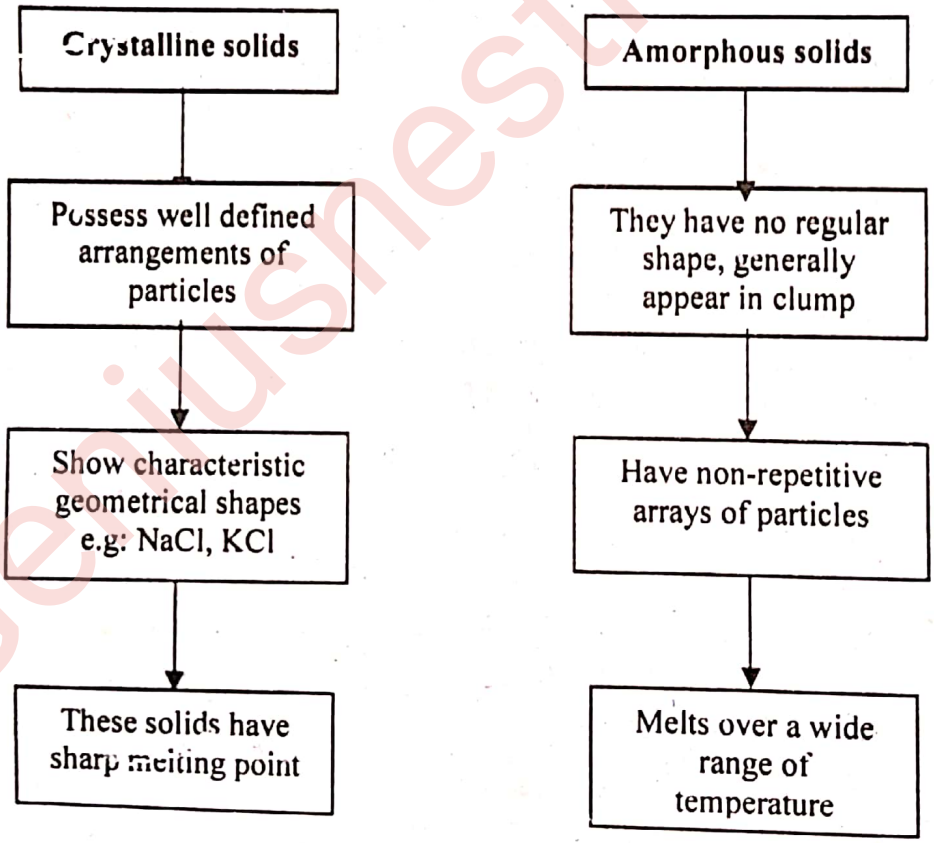
SELF ASSESSMENT EXERCISE 5.7

1. Quartz is the crystalline form of silicon dioxide (SiO_2). It is a hard, brittle and colourless solid. When quartz is heated above its melting point (about 1600°C) and cooled rapidly, an amorphous solid called quartz glass results. Figure below shows two-dimensional representation of quartz glass and quartz crystal. Identify each?
Give reasons.



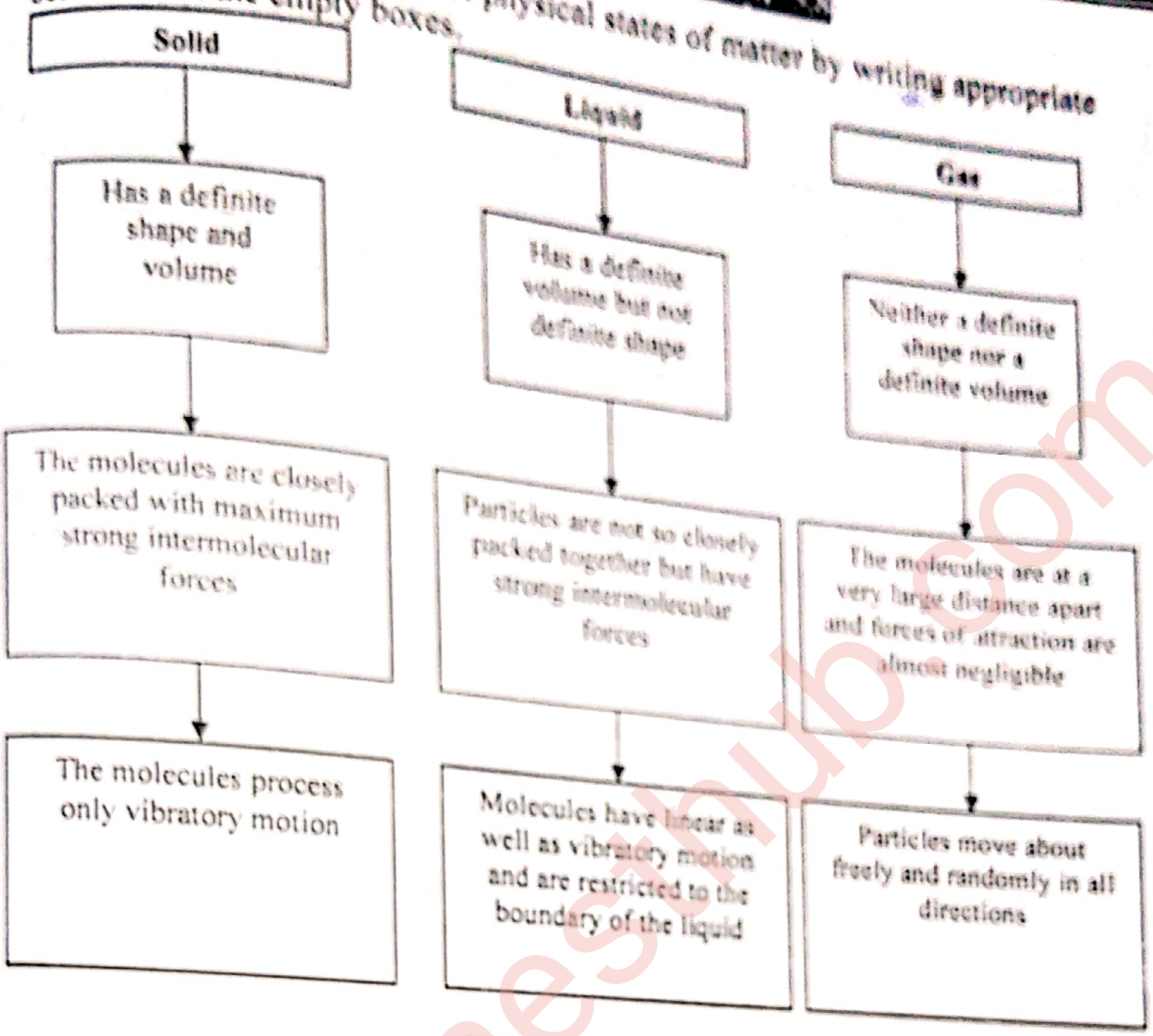
2. Differentiate between amorphous and crystalline solids by writing appropriate sentences in the empty boxes.

1. Fig. a) is Quartz crystal because it is well defined arrangements of particles and show characteristic geometrical shapes.
Fig. b) is Quartz Glass because it has no regular shape and have non-repetitive arrays of particles.



SELF ASSESSMENT EXERCISE 3.5

Copy and make comparison of physical states of matter by writing appropriate sentences in the empty boxes.



THINK - TANK

1) Following table shows data collected from an experiment by a student

Volume (dm^3)	Pressure (mm Hg)
400	353.5
320	442
240	589
200	707

Do you think that the student collected data carefully or carelessly? Explain

2) The water level in an aquarium decreases slowly even thought the tank does not lake. What change of state is occurring?

3) What types of attractive forces do you expect between the molecules of HF and HCl?

4) Name two substances that are solids at 25°C. Name two substances that are liquid at 25°C.

5) Identify the process occurring in each of the following:

a) Mothballs slowly disappear

b) A cold windshield becomes covered with ice when struck by raindrops.

6) An autoclave is used to sterilize surgical equipment. It is far more effective to produce steam by autoclave than steam produced from boiling water in the open

atmosphere, because it generates steam at a pressure of two atmospheres. Explain why an autoclave is such an efficient sterilization device.

7) The following table shows the melting points and boiling points of four substances.

Substance	Melting point (°C)	Boiling point (°C)
A	-123	-79
B	-17	58
C	52	305
D	-6	120

a) Write the physical state of each substance at room temperature and 1 atm.
b) Which substance exists as a liquid for the longest range of temperature.
c) Describe what will happen to the substance B when it is heated from 0°C to 100°C.
d) Describe what will happen to the substance D when it is cooled from 100°C to -10°C.

Solution

1) The given data can be analyse by Boyle's Law
$P_1V_1 : P_2V_2 : P_3V_3 : P_4V_4$
353.5x400 : 442x320 :589x240 : 707x200
141400 : 141440 : 141360 : 141400
141.4mm Hg. Cm^3 = 141.4mm Hg.Cm^3 = 141.4mm Hg = 141.4mmHg.Cm^3
Thus from the given data we conclude that the student collected data carefully because the data satisfies the truth of Boyle's Law.

2) The water level in aquarium gradually decreases due to the evaporation of water because evaporation occurs at all temperatures.

3) The attractive forces are of two types i.e. Ionic and covalent forces. In H-F and HCl, strong Hydrogen bonding (covalent forces) is present. These forces are much stronger in HF than HCl because of Electro negativity difference.

4) Two substances that are solids at 25c° are sodium chloride (NaCl) and sugar ($C_{12}H_{22}O_{11}$) two substances that are liquid at 25c° are water (H_2O) and Ethanol (C_2H_5OH)

5) a) Sublimation
b) Condensation/ Freezing

6) An auto clave is a closed container like a pressure cooker. Inside the auto clave during heating, external pressure increase as inside gradually which generate steam and thus becomes better sterilizer surgical equipment.

7) a) Substance A: Gas
Substance B: Liquid
Substance C: Solid
Substance D: Liquid

b.) D substance because from melting to boiling the temp difference in Kelvin is 267-393

c) The substance B (Liquid) will boil, when heated

d) The substance D (Liquid) from 0°C to 100°C will freeze when cooled from 100°C to -10°C.