Chapter 5. States of Matter

Question-1

What will be the minimum pressure required to compress 500 dm^3 of air at 1 bar to 200 dm^3 at 30^0 c?

Solution:

P_1 = 1 bar

P_2 = ?

V_1 = 500 dm^3

V_2 = 200dm^3

$P_1V_1 = P_2v_2$

$1 \times 500 = P_2 \times 200$ or

$P_2 = \frac{1 \times 500}{200} = 2.5$ bar.

Question-2

A vessel of 120 mL capacity contains a certain amount of gas at 35 °C and 1.2 bar pressure. The gas is transferred to another vessel of volume 180 mL at 35 °C. What would be its pressure?

Solution:

Let V_1 = 120 ml

V_2 = 180 ml

P_1 = 1.2 bar

P_2 = ?

$P_1V_1 = P_2V_2$

$1.2 \times 120 = P_2 \times 180$

$P_2 = \frac{120}{180} \times 1.2$

P_2 = 0.8 bar.

Question-3

Using the equation of state PV = nRT, show that at a given temperature density of a gas is proportional to gas pressure, P.

Solution:

PV = nRT

(or) P (Pressure of gas) = $\frac{n.RT}{V}$

We know $\frac{1}{V}$ = ρ (density)

∴ P = n. ρ RT

∴ Pressure of gas (P) α density of the gas (d).

Question-4

At 0^0 C, the density of a gaseous oxide at 2 bar is same as that of nitrogen at 5 bar. What is the molecule mass of the oxide?

Solution:

Density of nitrogen, $\rho = \frac{Pm}{RT}$

$= P = 5 \times 0.987$ atm, m = 28

$= \rho = \frac{5 \times 0.987 \times 28}{0.0821 \times 273}$

Density of gaseous oxide

$\frac{5 \times 0.987 \times 28}{0.0821 \times 273} = \frac{2 \times 0.987 \times x}{0.0821 \times 273}$

$x = \frac{0.0821 \times 273 \times 5 \times 0.987 \times 28}{0.0821 \times 273 \times 2 \times 0.987}$

or $x = \frac{5 \times 28}{2}$ = 70 g/mol.

Question-5

Pressure of 1g of an ideal gas A at 27^0 C is found to be 2 bar when 2 g of another ideal gas B is introduced in the same flask at same temperature the pressure becomes 3 bar. Find a relationship between their molecular masses

Solution:

Amount of ideal gas, A = W_A = 1 g

Its pressure, P_A = 2bar

Amount of another gas, B = W_B = 2 g

Total pressure of the flask = 3 bar

∴ Partial Pressure of gas B in the gas mixture = 3-2 = 1 bar

PV = nRT

$= \frac{W.RT}{M}$

For gas A, $P_A = \frac{W_A.R.T}{M_A V}$

$2 = \frac{1g.RT}{M_A.V}$ ....(i)

For gas B,

$P_B = \frac{W_B \times RT}{M_B.V}$

$1 = \frac{2gR.T}{M_A.V}$ --------(ii)

Divide equation (i) by (ii)

$\frac{2g}{1g} = \frac{1g.RT}{M_A \times V} \times \frac{M_B.V}{2g.R_T}$

or $\frac{M_B}{2 \times M_A} = 2$

$4M_A = M_B$

The molecular mass of M_b is four times of M_a.

Question-6

The drain cleaner, Drainex contains small bits of aluminium which react with caustic soda to produce hydrogen. What volume of hydrogen at 20^0c and one bar will be released when 0.15 g of aluminium reacts?

Solution:

$2Al + 2NaOH + 2H_2O \rightarrow 2NaAlO_2 + 3H_2$

2×27 g of Al $\quad$ 3×22.4 litre of H_2

= 54 g

54g Al gives = 3×22.4 litre H_2 at N.T.P.

0.15 g Al gives = $\frac{0.15 \times 3 \times 22.4}{54}$ = 0.186 litre at N.T.P.

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

Normal Pressure P_1 = 1 atm

P_2 = 1 bar = 0.987 atm

V_1 = 0.186L

V_2 =?

T_1 = 273K

T_2 = 273 + 20 = 293K

$\frac{1 \times 0.186}{273} = \frac{0.987 \times V_2}{293}$

$V_2 = \frac{1 \times 0.186 \times 293}{0.987 \times 273}$ = 0.202 litre = 202 ml.

Question-7

What will be the pressure exerted by a mixture of 3.2 g of methane and 4.4 g of carbon dioxide contained in a 9 dm^3 flask at 27^0C?

Solution:

w_{CH_4} = 3.2 g

Mol. Weight of CH_4 = 16

Moles of CH_4 = $\frac{3.2}{16}$=0.2

w_{CO_2} = 4.4 g

Mol. Weight of CO_2 = 44

Moles of CO_2 = $\frac{4.4}{44}$ = 0.1 mol

Total moles present in mixture = 0.2 + 0.1 = 0.3 mol

Volume of flask = 9 dm^3 = 9 L

Temperature = 273 + 27 = 300 K

Now for pressure of mixture = $P \times V = nRT$

$P \times 9 = 0.3 \times 0.0821 \times 300$

$P = \frac{0.3 \times 0.0821 \times 300}{9}$=0.821 atom

$0.821 \times 1.01 \times 10^5\ P_a = 8.29 \times 10^4\ P_a$.

Question-8

What will be the pressure of the gas mixture when 0.5 L of H_2 at 0.8 bars and 2.0 L of oxygen at 0.7 bar are introduced in a 1 L vessel are 27^0C?

Solution:

Volume of H_2, (V_1) 0.5 l

Pressure of H_2, (P_1) = 0.8 bar

Volume of oxygen, (V_2) = 2.0 l

Pressure of O_2, (P_2) = 0.7 bar

Total Volume of the flask $(V_1 + V_2)$ = 1l

Total pressure of the gaseous mixture is P

$P (V_1 + V_2) = P_1V_1 + P_2V_2$

$P \times 1 = (0.8 \times 0.5) + (0.7 \times 2.0)$

$P \times 1 = (0.4 + 1.4)$

Total Pressure of the mixture of gases , P = 1.8/1 = 1.8 bar.

Question-9

Density of a gas is found to be 5.46 g/dm^3 at 27°C at 2 bar pressure. What will be its density at STP?

Solution:

$$\frac{d_1T_1}{P_1} = \frac{d_2T_2}{P_2}$$

$d_1 = 5.46\ g/dm^3$ $\quad\quad d_2 = ?$

$T_1 = 273 + 27 = 300\ K$ $\quad\quad T_2 = 273\ K$

$P_1 = 2$ bar

$$\frac{5.46 \times 300}{2} = \frac{d_2 \times 273}{1}$$

$d_2 = \frac{5.46 \times 300}{2 \times 273} = 3 g/dm^3$.

Question-10

34.05 mL of phosphorous vapour weighs 0.00625 g at 546° C and 0.1 bar pressure. What is the molar mass of phosphorous?

Solution:

P = 0.1 bar , V = 34.05 mL = 0.03405

R = 0.0821 litre-atm K^{-1} mol^{-1}

T = 273 + 546 = 819 K

PV = nRT

$n = \frac{PV}{RT} = \frac{0.1 \times 0.03405}{.0821 \times 819}$

$= 0.00005\ mol^{-1}$

Weight of phosphorous vapour = 0.00625g

Molar mass of phosphorus = $\frac{0.00625g}{0.00005 mol^{-1}}$ = 125 g.

Question-11

A student forgot to add the reaction mixture to the round bottomed flask at 27°C but put it on the flame. After a lapse of time, he realized his mistake, using a pyrometer he found the temperature of the flask was 477°C. What fraction of air would have been expelled out?

Solution:

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

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

T_1 = 27+273=300 K

T_2 = 477 + 273 = 750 K

$\frac{V_1}{300} = \frac{V_2}{750}$

$\frac{V_1}{V_2} = \frac{300}{750} = \frac{2}{5}$

If the total volume of flask is taken as 1

Fraction of air expelled = 1 - $\frac{2}{5} = \frac{3}{5}$.

Question-12

Calculate the temperature of 4.0 moles of a gas occupying 5 dm^3 at 3.32 bar ($R=0.083$ bar dm^3 K^{-1} mol^{-1}).

Solution:

PV = nRT

P = 3.32 bar, V = 5dm^3

n = 4 moles

R = 0.083 bar dm^3 K^{-1} mol^{-1}

$\therefore 3.32 \times 5 = 4 \times 0.083 \times T$

$T = \frac{3.32 \times 5}{4 \times 0.083} = 50K.$

Question-13

Calculate the total number of electrons present in 1.4g of Nitrogen gas.

Solution:

Atomic weight of Nitrogen = 14 g

weight of Nitrogen gas = 1.4 g

Number of gram Moles of Nitrogen atoms = $\frac{W}{M} = \frac{1.4}{14}$ = 0.1 mol.

No. of atoms of Nitrogen, present in 1 mol of Nitrogen gas = 6.022×10^{23} atoms

1 atom of Nitrogen contains = 7 electrons

No. of electrons, present in 1 mol of Nitrogen atoms = $7 \times 6.022 \times 10^{23}$

No. of electrons in 0.1 mol = $0.1 \times 7 \times 6.02 \times 10^{23} = 4.22 \times 10^{23}$.

Question-14

How much time it would take to distribute one Avogadro number of wheat grains if 10^{10} grains are distributed each second?

Solution:

10^{10} grains are distributed I s Time in seconds, taken to distribute 6.023×10^{23} grains = $\frac{6.023 \times 10^{23}}{10^{10}}$ s = $\frac{6.023 \times 10^{23}}{10^{10} \times 60 \times 60 \times 24 \times 365}$ years = 1,90,800 years.

Question-15

Calculate the total pressure in a mixture of 8 g of oxygen and 4 g of hydrogen confined in a vessel of 1 dm^3 at 27°C, R = 0.083 bar dm^3 K^{-1} mol^{-1}.

Solution:

Weight of oxygen W_{O_2} = 8 g

Moles of O_2 = $\frac{8}{32} = \frac{1}{4}$

W_{H_3} = 4 g

Moles of H_2 = $\frac{4}{2} = 2$

Total moles present in mixture = $\frac{1}{4} + 2 = \frac{9}{4}$

Volume of vessel = 1 dm^3 = 1 L

Temperature = 27°C = 27 + 273 = 300 K

Now for pressure of mixture = P × V = n × RT

P × 1 = $\frac{9}{4} \times 0.083 \times 300$

P = 56.025 bar.

Question-16

Pay load is defined as the difference between the mass of displaced air and the mass of the balloon. Calculate the pay load when a balloon of radius 10m, mass 100kg is filled with helium at 1.66 bar at 27°C. (Density of air 1.2 kg m^{-3} and R = 0.083 bar dm^3 K^{-1} mol^{-1}).

Solution:

Volume of balloon, V = $\frac{4}{3}\pi r^3$

r = 10 m

V = $\frac{4}{3} \times 3.14 \times 1(10)^3 = 4187 m^3$

Volume of air displaced = Volume of balloon = 4187 m^3

M = Vol × Density

Mass of displaced air = 4187 m^3 × 1.2 kg m^{-3} = 5024. 4 kg

Temp, T = 27+273=300 K

Moles of gas present, n = $\frac{PV}{RT}$

= $\frac{1.66 \times 4187}{0.083 \times 300} = 279.1 \times 10^3$mol.

Mass = No. of moles × Molecular weight

Mass of He present = 279 × 10^3 × 4

= 1116.4 × 10^3 g

= 1116.4 kg

Mass of filled balloon = 100 + 1116.4 = 1216.4 Kg

Pay load = Mass of displaced air - Mass of balloon

= 5024.4 - 1216.4

= 3808 kg.

Question-17

Calculate the volume occupied by 8.8 g of CO_2 at 31.1°C and 1 bar pressure. R = 0.083 bar 1 K^{-1} mol^{-1}.

Solution:

P = 1 bar , T = 31.1 + 273 = 304.1K

Mol. wt of CO_2 = 44

Weight of CO_2 = 8.8 g

PV = (W/m)RT

$I \times V = \frac{8.8}{44} \times 0.083 \times 304.1$

V = 5.05 L.

Question-18

2.9 g of a gas at 95°C occupied the same volume as 0.184 g of hydrogen at 17°C at the same pressure. What is the molar mass of the gas?

Solution:

Ideal gas equation, PV = nRT

1st Case

Let the molar mass of gas (M) = M(g mol^{-1})

Mass of gas (m) = 2.9 g

No. of moles (m) = $\frac{\text{Mass}}{\text{Molarmass}} = \frac{2.9}{M}$ mol

T = 273 + 95 = 368

Pressure = P, Volume = V

PV = nRT

PV = $\frac{2.9}{M} \times R \times 368$ ....(i)

2nd Case

Mass of hydrogen = 0.184 g

Number of moles of H_2 = $\frac{0.184}{2}$ mol

T = 273 + 17 = 290

PV = $\frac{0.184}{2} \times R \times 290$ ....(ii)

In both gases PV is same

From (i) and (ii)

$$\frac{2.9}{M} \times 368 = \frac{0.184 \times 290}{2}$$

M = $\frac{2.9 \times 368 \times 2}{0.184 \times 290}$ = 40 g mol^{-1}.

Question-19

A mixture of dihydrogen and dioxygen at one bar pressure contains 20% by weight of dihydrogen. Calculate the partial pressure of dihydrogen.

Solution:

Percentage of H_2 = 20%, say 20g

No. of moles of H_2 = $\frac{20}{2}$ = 10 moles

Mass of oxygen = (100-20) = 80 g)

No. of moles of O_2 = $\frac{80}{32}$ = 2.5 moles

Mole fraction of H_2 = $\frac{10}{(10+2.5)}$ = $\frac{10}{(12.5)}$

Partial pressure of H_2 =Total Pressure × Mole fraction of H_2

Total Pressure = 1 bar

$= 1 \times \frac{10}{12.5}$ = 0.8 bar.

Question-20

What would be the SI unit for the quantity pV^2T 2/n ?

Solution:

S.I. unit = $\frac{Pa \times (m^3)^2 K^2}{mol}$ = Pa $m^6K^2mol^{-1}$.

Question-21

In terms of Charles' law explain why −273°C is the lowest possible temperature.

Solution:

Charles law states that Pressure, remaining constant the volume of a given mass of gas increases or decreases by 1/273 of its volume at 0^0c for every 1^0c rise or fall in temperature .

$V_t = V_0\,(1 + \frac{t}{273})$

If t = -273^0c

$V_t = V_0\,(1 - \frac{273}{273})$

$= 0$

Thus at -273^0c any volume of a given mass of gas becomes zero. Thus -273^0c is said to be limiting temperature and it is equal to OK (absolute scale).

Question-22

Critical temperature for carbon dioxide and methane are 31.1°C and –81.9°C respectively. Which of these has stronger intermolecular forces and why?

Solution:

CO_2 can more easily be liquified than Methane which shows that intermolecular forces in CO_2 are more stronger than in Methane, because in CO_2 polarity exists.

Question-23

Explain the physical significance of van der Waals parameters.

Solution:

Vander Waals equation of state for mol of gas = $\left(P + \frac{a}{v^2}\right)$(v-b) = RT

For n moles of gas = $\left(P + \frac{n^2 a}{v^2}\right)$(v-nb) = RT

The constant 'a' tells the magnitude of attractive forces between the molecules of the gas. In other words larger the value of 'a', greater the intermolecular attraction.

The constant 'b' relates to non compressible volume of gas, as gas molecules occupy some volume, however small may be, at high pressures and low temperatures.∴Actual volume of gas = Available volume - Non compressible volume = (V - b).

CBSE Class 11 Chemistry

Important Questions

Chapter 5

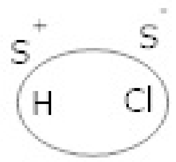
States of Matter

1 Marks Questions

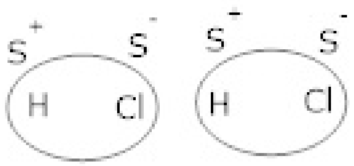
1.Define Van der waal's forces.

Ans. Attractive intermolecular forces between molecules is known as Van der waals forces.

2.Give an example to show dipole-dipole forces.



(a) electron cloud in HCl molecule



(b) dipole - dipole interaction between two HCl molecule.

Ans. Dipole-dipole forces act between the molecules possessing permanent dipole. Ends of the dipoles possess partial charges which are responsible for the interaction eg. The interaction between two HCl molecules.

3.What type of bond exists between H_2O ,HF, NH_3, C_2H_5 OH molecule.?

Ans. In H_2O, HF, NH_3, C_2H_5OH molecule, hydrogen bond exists between hydrogen and the other electronegative atom attached to it.

4.Define Boyle's law.

Ans. At constant temperature, the pressure of a fixed amount (i.e; number of moles n) of gas varies inversely with its volume.

Mathematically,

$p \propto \frac{1}{v}$ (at constant T and n)

=> $p = k_1 \frac{1}{v}$

Or, $pv = K_1$

5.Why helium and hydrogen gases not liquefied at room temperature by applying very high pressure?

Ans. Because their critical temperature is lower than room temperature and gases cannot be liquefied above the critical temperature even by applying very high pressure.

6.How is the pressure of a given sample of a gas related to temperature at volume?

Ans. Pressure is directly proportional to the temperature , i.e; P $\propto$ T.

7.Define absolute zero temperature.

Ans. The lowest hypothetical or imaginary temperature at which gases are supposed to occupy zero volume is called Absolute zero.

8.Define an ideal gas.

Ans.A gas which obeys the ideal gas equation (PV = nRT) at all temperature and pressure is called an ideal gas.

9.What is aqueous tension?

Ans. Pressure exerted by saturated water vapors is called aqueous tension.

10.What is the value of R at STP?

Ans. At S. T. P, R = 8.20578 x 10^{-2} L at m k^{-1} mol^{-1}.

11.Molecule A is twice as heavy as the molecule B. which of these has higher kinetic energy at any temperature?

Ans. Kinetic energy of a molecule is directly proportional to temperature and independent of mass so both the molecules will have the same kinetic energy.

12.Write Van der waal's equation for n moles of a gas.

Ans. $\left(p+\frac{an^2}{V^2}\right)(V-nb)=nRT$ is Van der waal's equation for n moles of a gas.

13.Out of NH_3 and N_2, which will have (i) larger value of 'a' and (ii) larger value of 'b'?

Ans. (i) NH_3 will have larger value of 'a' because of hydrogen bonding.

(ii)N_2 should have large value 'b' because of larger molecular size.

14.What property of molecules of real gases is indicated by van der waal's constant 'a'?

Ans. Intermolecular attraction

15.Under what conditions do real gases tend to show ideal gas behaviour?

Ans. When the pressure of the gas is very low and the temperature is very high.

16.How are Van der waal's constants 'a' and 'b' related to the tendency to liquefy?

Ans. The Van der waal's constant 'a' is a measure of intermolecular attractions. Therefore, the value of 'a' reflects the tendency of the gas to liquefy. The gas having larger value of 'a' will liquefy more easily.

17.When does a gas show ideal behaivour in terms of volume?

Ans. The gases show ideal behaviors when the volume of the gas occupied is large so that the volume of the molecules can be neglected in comparison to it.

18.Define Boyle point.

Ans. The temperature at which a real gas obeys ideal gas law over an appreciable range of pressure is called Boyle temperature or Boyle point.

19.Define standard boiling point.

Ans. If the pressure is 1 bar then the boiling point is called standard boiling point of the liquid.

20.What is surface energy?

Ans. The energy required to increase the surface area of the liquid by one unit is defined as surface energy.

21.What is surface tension? What is its S.I unit?

Ans. Surface tension is defined as the force acting per unit length perpendicular to the line drawn on the surface of liquid S.I unit is expressed as Nm^{-1}.

22.How does surface tension change when temperature is raised?

Ans. Surface tension decreases as the temperature is raised.

23.Why is glycerol highly viscous?

Ans. Glycerol has three hydrogen bonds which results in an extensive hydrogen bonding. That is why glycerol is highly viscous.

24.Some tiny light hollow spheres are placed in a flask. What would happen to these

spheres, if temperature is raised?

Ans. The spheres would start moving faster randomly and colliding with each other.

25.The boiling points of a liquid rises on increasing pressure. Give reason.

Ans. A liquid boils when its vapors pressure becomes equal to the atmospheric pressure. An increase in pressure on liquid, causes a rise in the boiling temperature of the Liquid.

CBSE Class 12 Chemistry
Important Questions
Chapter 5
States of Matter

2 Marks Questions

1.Ice has lower density than water. Give reason.

Ans. Hydrogen bonding affect the physical properties of compounds. Ice is H-bonded molecular solid having open type structure with wide holes whereas liquid water has H-bonding having closed type structure that is why ice has lower density than water.

2.Water has maximum density at 4^0C. Give reason.

Ans. Water has maximum density at 4^0C because when temperature is increased from o to 4^0C, some of the H-bonds break and molecules come closer and density increases till 4^0C because volume decreases. But, above 4^0C, the kinetic energy of molecules increases which leads to increase in volume and density decreases.

3.Define thermal energy

Ans. Thermal energy is the energy of a body arising from motion of its atoms or molecules. It is directly proportional to the temperature of the substance.

4.What are the factors responsible for the strength of hydrogen bonds?

Ans. Strength of the hydrogen bond is determined by the coulombic interaction between the lone-pair electrons of the electronegative atom of one molecule and the hydrogen atom of other molecule.

5.At what temperature will the volume of a gas at 0^0 c double itself, pressure remaining constant?

Ans. Let the volume of the gas at 0^0C = Vml.

Thus,

V_1 = Vml, V_2 = 2Vml

T_1 = o + 273 T_2 = ?

= 273k

By applying Charle's law

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

$$=> \frac{V}{273} = \frac{2V}{T_2}$$

$$=> T_2 = \frac{2Vx273}{V} = 546k$$

T_2 = 546 - 273 = **273^0C**

6. 50 cm^3 of hydrogen gas enclosed in a vessel maintained under a pressure of 1400 Tor, is allowed to expand to 125 cm^3 under constant temperature conditions. What would be its pressure?

Ans. Since, temperature is constant, we have

PV = constant

$\therefore P_1 V_1 = P_2 V_2$

P_1 = 1400 ; P_2 = ?

$V_1 = 50cm^3$; $V_2 = 125\ cm^3$

$\therefore P_2 = \frac{P_1V_1}{V_2} = \frac{1400x50}{125} = 560 Torr$

The final pressure of the gas after expansion would be 560 Torr.

7.State the law depicting the volume-temperature relationship.

Ans. The law is known Charle's law.

"Pressure remaining constant the volume of a given mass of a gas increases or decreases by 1/273 of its volume at 0^0C for every one degree centigrade or fall in temperature.

Mathematically, $V_t = V_o + \frac{V_o}{273}t$

$= V_o (1+\frac{t}{273})$

$V_t = V_o(\frac{273+t}{273)})$

Where V_t is the volume of the gas at t^0C and V_o is its volume at 0^0C.

8.State Avogadro's Law. Is the converse of Avogadro's law true?

Ans. Avogadro's Hypothesis: This law was given by Avogadro in 1811. According to this law, "Equal volumes of all gases under the same conditions of temperature and pressure contain the same number of molecules."

Volume = a constant X Number of Moles (Temperature and pressure constant).

The converse of Avogadro's law is also true. Equal number of molecules of all gases occupy equal volume's under the same conditions of temperature and pressure. It follows that one gram molecular mass of any gas (containing $6.023x10^{23}$ molecules) will occupy the same volume under the same conditions. The volume occupied by one gram molecular mass of any gas at 0^0C and 760 mm of Hg is 22.4 dm^3 (liters) is called the gram molecular volume or simply molar volume.

9.Deduce the relation pv = nRT where R is a constant called universal.

Ans. According to Boyle's law,

$V \alpha \frac{1}{p}$ (at constant T and n)

According to charle's law,

$V \alpha T$ (at constant p and n)

According to Avogadro's law,

$V \alpha n$ (at constant T and p)

By combining the three laws,

$V \alpha n \times \frac{1}{p} \times T$

$or, V \alpha \frac{nT}{p}$

or $pV = nRT$

Where R is a constant called universal gas constant.

10.At 25^0C and 760 mm of Hg pressure a gas occupies 600ml volume. What will be its pressure at a height where temperature is 10^0C and volume of the gas is 640mL. Calculate the volume occupied by 5.0 g of acetylene gas at 50^0C and 740mm pressure.

Ans. P_1 = 760mm Hg, V_1 = 600mL

T_1 = 25 + 273 = 298 k

V_2 = 640 mL and T_2 = 10 = 273 = 283 k

According to combined gas law,

$$\frac{p_1V_1}{T_1} = \frac{p_2V_2}{T_2}$$

=> $$p_2 = \frac{p_1T_2V_1}{T_1V_2}$$

= $$\frac{760x283x600}{640 \text{ x } 298}$$

P_2 = $\underline{\underline{676.6mm}}$ of Hg

11.Explain how the function pv/RT can be used to show gases behave non-ideally at high pressure.

Ans. The ratio pv/RT is equal to the number of moles of an ideal gas in the sample. This number should be constant for all pressure, volume and temperature conditions. If the value of this ratio changes with increasing pressure, the gas sample is not behaving ideally.

12.Mention the two assumptions of kinetic theory of gases that do not hold good.

Ans. The two assumptions of the kinetic theory that do not hold good are –
(i) There is no force of attraction between the molecules of a gas.
(ii) Volume of the molecules of a gas is negligibly small in comparison to the space occupied by the gas.

13.Calculate the pressure exerted by one mole of CO_2 at 273 k if the Van der waal's constant a = 3.592 dm^6 at m mol^{-1}. Assume that the volume occupied by CO_2 molecules is negligible.

Ans. According to Van der waal's equation

$$\left[P+\frac{a}{v^2}\right]\left[v-b\right]=RT$$ (for 1 mole of the gas)

Since, the volume occupied by CO_2 molecules is negligible, therefore, b =o

$$V\left(P+\frac{a}{v^2}\right)=RT$$

a = 3.592 dm^6 at m mol^{-1}

V = 22.4 dm^3

R = o.o82 L at m k^- mol^{-1}

T = 273 k.

$$\therefore P=\frac{RT}{V}-\frac{a}{V^2}=\frac{o.082 \text{ x } 273}{22.4}-\frac{3.592}{(22.4)^2}$$

= 0.9993 – 0.0071

$$p \underline{\underline{= 0.9922 atm.}}$$

14.Why does viscosity of liquids decrease as the temperature is raised?

Ans. Viscosity of liquids decreases as the temperature rises because at high temperatures molecules have high kinetic energy and can overcome the intermolecular forces to slip over one another between the layers.

15.What is the effect of temperature on
(i) density
(ii) vapors pressure of a liquid?

Ans.(i) $D=\frac{M}{V}$ The volume increases, with the increase of temperature. Therefore, density decreases with the rise of temperature.
(ii) As the temperature of a liquid is increased, the vapors pressure increases.

States Of Matter Gases & Liquids

Short Answer Type Questions

1. If 1 gram of each of the following gases are taken at STP, which of the gases will occupy (a) greatest volume and (b) smallest volume? CO, H_2O, CH_4, NO
2. Physical properties of ice, water and steam are very different. What is the chemical composition of water in all the three states.
3. The behaviour of matter in different states is governed by various physical laws. According to you what are the factors that determine the state of matter?
4. Use the information and data given below to answer the questions (a) to (c):
   - Stronger intermolecular forces result in higher boiling point.
   - Strength of London forces increases with the number of electrons in the molecule.
   - Boiling point of HF, HCl, HBr and HI are 293 K, 189 K, 206 K and 238 K respectively.
     - (a) Which type of intermolecular forces are present in the molecules HF, HCl, HBr and HI?
     - (b) Looking at the trend of boiling points of HCl, HBr and HI, explain out of dipole-dipole interaction and London interaction, which one is predominant here.
     - (c) Why is boiling point of hydrogen fluoride highest while that of hydrogen chloride lowest?

5. What will be the molar volume of nitrogen and argon at 273.15K and 1 atm?
6. A gas that follows Boyle's law, Charle's law and Avogadro's law is called an ideal gas. Under what conditions a real gas would behave ideally?
7. Two different gases 'A' and 'B' are filled in separate containers of equal capacity under the same conditions of temperature and pressure. On increasing the pressure slightly the gas 'A' liquefies but gas B does not liquify even on applying high pressure until it is cooled. Explain this phenomenon.
8. Value of universal gas constant (R) is same for all gases. What is its physical significance?
9. One of the assumptions of kinetic theory of gases states that "there is no force of attraction between the molecules of a gas." How far is this statement correct?
   Is it possible to liquefy an ideal gas? Explain.

10. The magnitude of surface tension of liquid depends on the attractive forces between the molecules. Arrange the following in increasing order of surface tension :
water, alcohol (C_2H_5OH) and hexane [$CH_3(CH_2)_4CH_3$)].
11. Pressure exerted by saturated water vapour is called aqueous tension. What correction term will you apply to the total pressure to obtain pressure of dry gas?
12. Name the energy which arises due to motion of atoms or molecules in a body. How is this energy affected when the temperature is increased?
13. Name two intermolecular forces that exist between HF molecules in liquid state.
14. One of the assumptions of kinetic theory of gases is that there is no force of attraction between the molecules of a gas.
State and explain the evidence that shows that the assumption is not applicable for real gases.
15. Compressibility factor, Z, of a gas is given as
Z = (pV/nRT)
(i) What is the value of Z for an ideal gas?
(ii) For real gas what will be the effect on value of Z above Boyle's temperature?
16. The critical temperature (Tc) and critical pressure (pc) of CO_2 are 30.98°C and 73 atm respectively. Can CO_2 (g) be liquefied at 32°C and 80 atm pressure?
17. For real gases the relation between p, V and T is given by van der Waals equation:

$$\left(p+\frac{an^2}{V^2}\right)(V-nb)=nRT$$

where 'a' and 'b' are van der Waals constants, 'nb' is approximately equal to the total volume of the molecules of a gas.
'a' is the measure of magnitude of intermolecular attraction.
(i) Arrange the following gases in the increasing order of 'b'. Give reason.
O_2, CO_2, H_2, He
(ii) Arrange the following gases in the decreasing order of magnitude of 'a'.
Give reason.

CH_4, O_2, H_2

18. The relation between pressure exerted by an ideal gas (pideal) and observed pressure (preal) is given by the equation

    $P_{ideal} = P_{real} + (an^2/V^2)$

    If pressure is taken in Nm−2, number of moles in mol and volume in m^3, Calculate the unit of 'a'.

    What will be the unit of 'a' when pressure is in atmosphere and volume in dm^3?
19. Name two phenomena that can be explained on the basis of surface tension.
20. Viscosity of a liquid arises due to strong intermolecular forces existing between the molecules. Stronger the intermolecular forces, greater is the viscosity. Name the intermolecular forces existing in the following liquids and arrange them in the increasing order of their viscosities. Also give reason for the assigned order in one line.

    Water, hexane ($CH_3CH_2CH_2CH_2CH_2CH_3$), glycerine ($CH_2OH\ CH(OH)\ CH_2OH$)
21. Explain the effect of increasing the temperature of a liquid, on intermolecular forces operating between its particles, what will happen to the viscosity of a liquid if its temperature is increased?
22. The variation of pressure with volume of the gas at different temperatures can be graphically represented as shown in Fig. 5.3.

    On the basis of this graph answer the following questions.

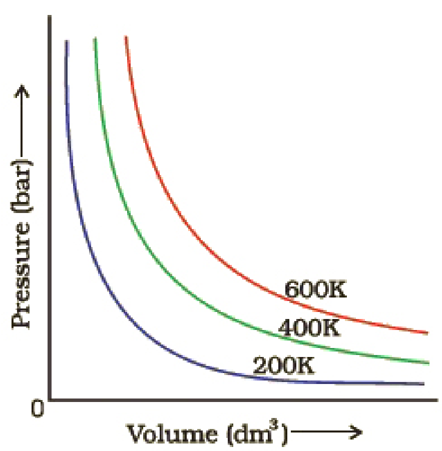


Fig. *5.3*

- (i) How will the volume of a gas change if its pressure is increased at constant temperature?
- (ii) At a constant pressure, how will the volume of a gas change if the temperature is increased from 200K to 400K?

23. Pressure versus volume graph for a real gas and an ideal gas are shown in Fig. 5.4. Answer the following questions on the basis of this graph.

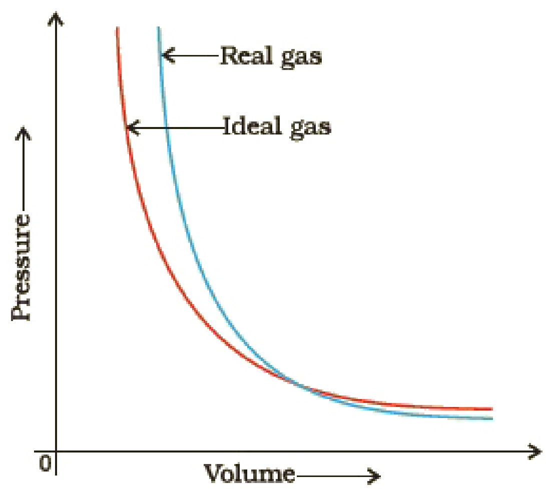


Fig. *5.4*

- (i) Interpret the behaviour of real gas with respect to ideal gas at low pressure.
- (ii) Interpret the behaviour of real gas with respect to ideal gas at high pressure.
- (iii) Mark the pressure and volume by drawing a line at the point where real gas behaves as an ideal gas.

Long Answer Type Questions

1. Isotherms of carbon dioxide at various temperatures are represented in Fig. 5.5. Answer the following questions based on this figure.

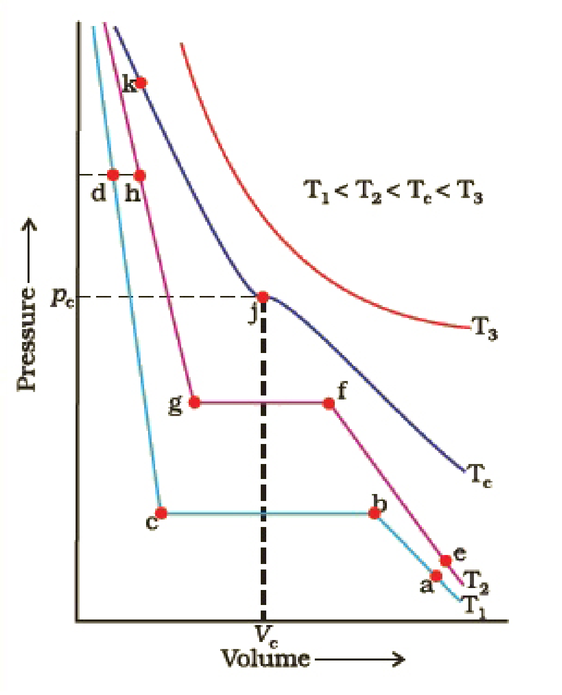


Fig. 5.5

- (i) In which state will CO_2 exist between the points a and b at temperature T_1?
- (ii) At what point will CO_2 start liquefying when temperature is T_1?
- (iii) At what point will CO_2 be completely liquefied when temperature is T_2.
- (iv) Will condensation take place when the temperature is T_3.
- (v) What portion of the isotherm at T_1 represent liquid and gaseous CO_2 at equilibrium?

2. The variation of vapour pressure of different liquids with temperature is shown in Fig. 5.6.

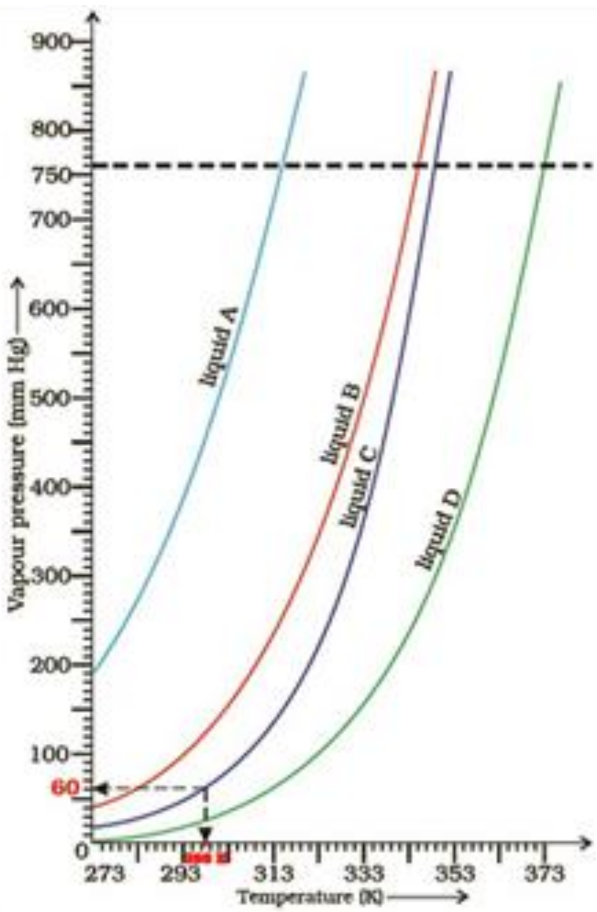


Fig. 5.6

- (i) Calculate graphically boiling points of liquids A and B.
- (ii) If we take liquid C in a closed vessel and heat it continuously. At what temperature will it boil?
- (iii) At high altitude, atmospheric pressure is low (say 60 mm Hg). At what temperature liquid D boils?
- (iv) Pressure cooker is used for cooking food at hill station. Explain in terms of vapour pressure why is it so?

3. Why does the boundary between liquid phase and gaseous phase disappear on heating a liquid upto critical temperature in a closed vessel? In this situation what will be the state of

the substance?

4. Why does sharp glass edge become smooth on heating it upto its melting point in a flame? Explain which property of liquids is responsible for this phenomenon.
5. Explain the term 'laminar flow'. Is the velocity of molecules same in all the layers in laminar flow? Explain your answer.
6. Isotherms of carbon dioxide gas are shown in Fig. 5.7. Mark a path for changing gas into liquid such that only one phase (i.e., either a gas or a liquid) exists at any time during the change. Explain how the temperature, volume and pressure should be changed to carry out the change.

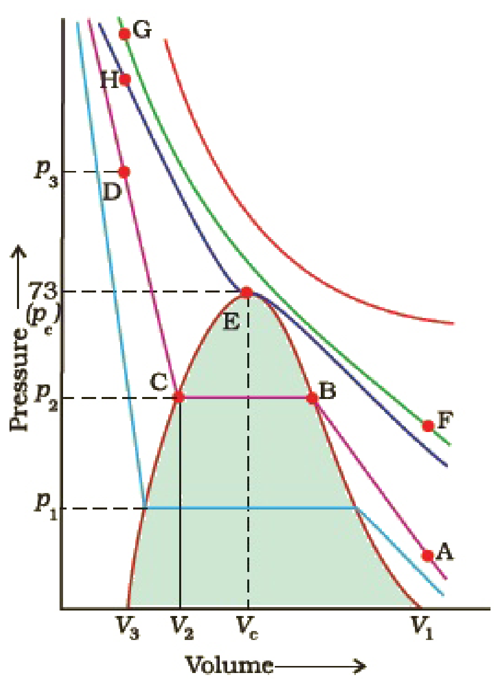


Fig. 5.7