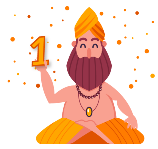

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TEXTBOOK QUESTIONS SOLVED

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°C?
Answer:
P_1 = 1 bar, P_2 = ?
V_1= 500 dm^3, V_2=200 dm^3
As temperature remains constant at 30°C,
$P_1V_1=P_2V_2$
1 bar x 500 dm^3 = P_2 x 200 dm^3 or P_2=500/200 bar=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?
Answer:
V_1= 120 mL, P_1=1.2 bar,
V_2 = 180 mL, P_2 = ?
As temperature remains constant, $P_1V_1 = P_2V_2$
(1.2 bar) (120 mL) = P_2 (180mL)

Question 3. Using the equation of state PV = nRT, show that at a given temperature, density of a gas is proportional to the gas pressure P.
Answer:
According to ideal gas equation
PV = nRT or PV = nRT/V

$$n = \frac{\text{Constant Mass of gas}}{\text{Molar mass of gas}}$$

$$P = \frac{mRT}{MV} \qquad \left[\because \rho\,(density) = \frac{m}{V}\right]$$

$$P = \frac{\rho RT}{M}$$

$$P \propto \rho \quad \text{at constant temperature}$$

Question 4. At 0°C, the density of a gaseous oxide at 2 bar is same as that of dinitrogen at 5 bar. What is the molecular mass of the oxide?
Answer:
Using the expression, d =MP/RT, at the same temperature and for same density,
$M_1P_1 = M_2P_2$ (as R is constant)
(Gaseous oxide) (N_2)
or
M_1 x 2 = 28 x 5 (Molecular mass of N_2 = 28 u)
or M_1 = 70u

Question 5. Pressure of l g of an ideal gas A at 27°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 the

relationship between their molecular masses.
Answer: Suppose molecular masses of A and B are M_A and M_B respectively. Then their number of moles will be

$$n_A = \frac{1}{M_A}, \qquad n_B = \frac{2}{M_B}$$

$P_A = 2$ bar, $\quad P_A + P_B = 3$ bar, *i.e.,* $P_B = 1$ bar
Applying the relation $PV = nRT$

$$P_AV = n_ART, \qquad P_BV = n_BRT \quad \therefore \quad \frac{P_A}{P_B} = \frac{n_A}{n_B} = \frac{1/M_A}{2/M_B} = \frac{M_B}{2M_A}$$

or $$\frac{M_B}{M_A} = 2\times\frac{P_A}{P_B} = 2\times\frac{2}{1} = 4 \quad \text{or} \quad \mathbf{M_B = 4\,M_A}.$$

Question 6. The drain cleaner, Drainex contains small bits of aluminium which react with caustic soda to produce dihydrogen. What volume of dihydrogen at 20 °C and one bar will be released when 0.15g of aluminium reacts?
Answer:
The chemical equation for the reaction is
$2\ Al + 2\ NaOH + H_2O \rightarrow 2\ NaAlO_2 + 3H_2$ (3 x 22400 mL At N.T.P)
2 x 27 = 54 g.
54 g of Al at N.T.P release
H_2 gas = 3 x 22400 0.15 g of Al at N.T.P release

$$H_2 \text{ gas} = \frac{3\times 22400\times 0.15}{54} = 186.7 \text{ mL}$$

N.T.P condition. $V_1 = 186.7$ mL, $P_1 = 1.013$ bar, $T_1 = 0 + 273 = 273$ K; $V_2 = ?$, $P_2 = 1$ bar, $T_2 = 20 + 273 = 293$ K

According to Gas equation

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \quad \text{or} \quad V_2 = \frac{P_1V_1T_2}{P_2T_1}$$

$$V_2 = \frac{1.013 \text{ bar}\times 186.7\text{mL}\times 293\text{K}}{1 \text{ bar}\times 273\text{K}}$$

$$= \mathbf{203\ mL}$$

Question 7. What will be the pressure exerted by a mixture of 3.2g of methane and 4.4g of carbon dioxide contained in a 9 dm^3 flask at 27 °C?
Answer:

$$p = \frac{n}{V}RT = \frac{m}{M}\frac{RT}{V}$$

$$p_{CH_4} = \left(\frac{3.2}{16}\text{mol}\right)\frac{0.0821 \text{ dm}^3\text{atm K}^{-1}\text{mol}^{-1}\times 300 \text{ K}}{9 \text{ dm}^3} = 0.55 \text{ atm}$$

$$p_{CO_2} = \left(\frac{4.4}{44}\text{mol}\right)\frac{0.0821 \text{ dm}^3\text{atm K}^{-1}\text{mol}^{-1}\times 300 \text{ K}}{9 \text{ dm}^3} = 0.27 \text{ atm}$$

$$p_{total} = 0.55 + 0.27 = \mathbf{0.82\ atm}$$

In terms of SI units, $R = 8.314\, p\, m^3\, K^{-1}\, mol^{-1}$, $V = 9 \times 10^{-3}\, m^3$
$P = 5.543 \times 10^4$ Pa + 2.771×10^4 Pa = $\mathbf{8.314 \times 10^4}$ **Pa.**

Question 8. What will be the pressure of the gas mixture when 0.5 L of H_2 at 0.8 bar and 2.0 L of dioxygen at 0.7 bar are introduced in all vessel at 27 °C?
Answer:
Calculation of partial pressure of H_2 in 1L vessel P_1= 0.8 bar,
P_2= ?, V_1= 0.5 L, V_2 = 1.0 L
As temperature remains constant, $P_1V_1 = P_2V_2$
(0.8 bar) (0.5 L) = P_2 (1.0 L) or P_2 = 0.40 bar, i.e., PH_2 = 0.40 bar
Calculation of partial pressure of 02 in 1 L vessel
$P_1' V_1 = P_2' V_2'$

(0.7 bar) (2.0 L) = P_2 (1L) or P_2' = 1.4 bar, i.e.,P_{O_2}= 1.4 bar
Total pressure =P_{Hz} + P_{Q2} = 0.4 bar + 1.4 bar = 1.8 bar

Question 9. Density of a gas is found to be 5.46 g/dm^3 at 27 °C and at 2 bar pressure. What will be its density at STP?
Answer:

$d = \frac{MP}{RT}$. For the same gas at different temperatures and pressures, $\frac{d_1}{d_2} = \frac{P_1}{T_1} \times \frac{T_2}{P_2}$.

Here, d_1 = 5.46 g dm^{-3}, T_1 = 27 °C = 300 K, P_1 = 2 bar.
At STP, d_2 = ?, T_2 = 0 °C = 273 K, P_2 = 1 bar

$$\therefore \quad \frac{5.46\text{g dm}^{-3}}{d_2} = \frac{2 \text{ bar}}{300 \text{ K}} \times \frac{273\ K}{1 \text{ bar}} \text{ or } d_2 = 3 \text{ g dm}^{-3}$$

Question 10. 34.05 mL of phosphorus vapour weighs 0.0625 g at 546°C and 1.0 bar pressure. What is the molar mass of phosphorus?
Answer:

Step I. Calculation of volume at 0°C and 1 bar pressure

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \text{ i.e., } \frac{1 \times 34.05}{546+273} = \frac{1 \times V_2}{273} \text{ or } V_2 = 11.35 \text{ mL}$$

11.35 mL of vapour at 0°C and 1 bar pressure weigh = 0.0625 g
∴ 22700 mL of vapour at 0°C and 1 bar pressure will weigh

$$= \frac{0.0625}{11.35} \times 22700 = 125 \text{ g}$$

∴ Molar mass = **125 g mol^{-1}**

Alternatively, using

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

$$PV = nRT, \text{ i.e., } n = \frac{PV}{RT} - \frac{1.0 \text{ bar} \times (34.05 \times 10^{-3} \text{ dm}^3)}{0.083 \text{ bar dm}^3 \text{ K}^{-1} \text{ Mol}^{-1} \times 819 \text{ K}}$$

$$= 5 \times 10^{-4} \text{ mol}$$

$$\therefore \quad \text{Mass of 1 mole} = \frac{0.0625}{5 \times 10^{-4}} g = 125 \text{ g}$$

∴ Molar mass = **125 g mol^{-1}**

*********** END **********