



DPP 04

Solution

1. According to Charles' law, $V \propto T$ or $\frac{V}{T} = \text{constant} = \frac{1}{P}$

As in graph, slope at P_2 is more than slope at P_1 .

$$\therefore P_1 > P_2$$

2. RMS speed,

$$v_{\text{rms}} = \sqrt{\frac{3RT}{M}}$$

$$\text{Most probable speed, } v_p = \sqrt{\frac{2RT}{M}}$$

$$\text{So, } \frac{v_{\text{rms}}}{v_p} = \sqrt{\frac{3}{2}}; \text{ Hence, } v_{\text{rms}} = \sqrt{\frac{3}{2} v_p}$$

3. For 2 moles Helium, n moles Hydrogen

$$v_{\text{rms}} = \sqrt{2}v$$

$$\Rightarrow \sqrt{\frac{3RT}{M_{\text{mix}}}} = \sqrt{2} \sqrt{\frac{\gamma_{\text{mix}} RT}{M_{\text{mix}}}}$$

$$\Rightarrow \sqrt{3} = \sqrt{2} \sqrt{\gamma_{\text{mix}}} \Rightarrow 3 = 2\gamma_{\text{mix}} \quad \dots (\text{i})$$

$$\text{As, } \gamma_{\text{mix}} = \frac{n_1 C_{p1} + n_2 C_{p2}}{n_1 C_{v1} + n_2 C_{v2}}$$

$$\Rightarrow \frac{3}{2} = \frac{\frac{5}{2} \cdot R \times 2 + n \times \frac{7R}{2}}{2 \times \frac{3R}{2} + n \times \frac{5R}{2}} \quad (\text{Using (i)})$$

$$\Rightarrow \frac{3}{2} = \frac{10R + 7nR}{6R + 5nR}$$

$$\Rightarrow 18R + 15nR = 20R + 14nR$$

$$\Rightarrow nR = 2R; n = 2$$

4. Mass, $m = 5 \times 10^{-17} \text{ kg}$, $T = 273 \text{ K}$

$$K = 1.38 \times 10^{-23} \text{ JK}^{-1}$$

$$V_{\text{rms}} = \sqrt{\frac{3KT}{m}} = \sqrt{\frac{3 \times 1.38 \times 10^{-23} \times 273}{5 \times 10^{-17}}}$$

$$\Rightarrow V_{\text{rms}} = 15 \text{ mm s}^{-1}$$



5. Ratio of number of molecules is 1: 4.

As per ideal gas equation, $PV = nRT$

V and T are same in both vessels.

$$\therefore \frac{P_1}{P_2} = \frac{n_1}{n_2} = \frac{1}{4}$$

$$\text{Ratio of rms velocities } \frac{v_{rms1}}{v_{rms2}} = \sqrt{\frac{T_1}{T_2}} = 1$$

6. For ideal gas, $PV = nRT$. So, the graph for $PV \propto T$ is a straight line with positive slope.

7. $v_{RMS} = \sqrt{\frac{3RT}{M}}$

So, $m_A < m_B < m_C$ and $v_A > v_B > v_C$,

$$\text{or } \frac{1}{v_A} < \frac{1}{v_B} < \frac{1}{v_C}$$

8. For adiabatic expansion of an ideal gas; $PV^\gamma = \text{constant} \Rightarrow \ln P + \gamma \ln V = \text{constant}$

On differentiating both sides

$$\left(\frac{dP}{P}\right) + \gamma \left(\frac{dV}{V}\right) = 0$$

So, fractional change in pressure,

$$\therefore \frac{dP}{P} = -\gamma \frac{dV}{V}$$

9. Number of moles of O_2 ,

$$n_1 = \frac{16}{32} = 0.5 \text{ mole}$$

Number of moles of N_2 is $n_2 = \frac{28}{28} = 1 \text{ mole}$

Number of moles of CO_2 ,

$$n_3 = \frac{44}{44} = 1 \text{ mole}$$

Total number of moles, $n = n_1 + n_2 + n_3$

$$\therefore \text{Now } n = 0.5 + 1 + 1 = \frac{5}{2} \text{ moles}$$

$$\text{Now, } PV = nRT, P = \frac{nRT}{V} = \left(\frac{5}{2}\right) \left(\frac{RT}{V}\right)$$

10. $V = 500 \text{ cm}^3, T = 300 \text{ K}, P = 400 \text{ kPa}$

Say total number of moles is n . By using ideal gas equation, $PV = nRT$

$$400 \times 10^3 \times 500 \times 10^{-6} = n \times 8.314 \times 300$$

$$n = \frac{2}{25}, n = n_O + n_H, \frac{2}{25} = \frac{M_O}{32} + \frac{M_H}{2}$$

$$M_O + M_H = 0.76 \quad (\text{Given})$$

$$\therefore \frac{M_O}{M_H} = \frac{16}{3}$$

11. $U = 3PV + 4, \frac{nFRT}{2} = 3PV + 4$

$$\frac{F}{2}PV = 3PV + 4 \quad (\because PV = nRT)$$

$$F = 6 + \frac{8}{PV}$$

Since degree of freedom is more than 6, so gas is polyatomic.

12. Ideal gas equation, $PV = nRT$

As temperature is constant.

$$PV = \text{constant} \Rightarrow P \frac{m}{\rho} = \text{constant}$$

$$P \propto \rho \quad (\text{for given } m)$$

13. $v_{rms} = \sqrt{\frac{3RT}{m}}$

$$\Rightarrow \frac{(v_{rms})_{He}}{(v_{rms})_{Ar}} = \sqrt{\frac{40}{4}} = \sqrt{10} = 3.16$$

14. The final temperature of the mixture is

$$T_{\text{mixture}} = \frac{T_1 n_1 + n_2 T_2 + n_3 T_3}{n_1 + n_2 + n_3}$$

15. $PV = nRT = \frac{m}{M}RT \Rightarrow PM = \rho RT$

$$\frac{\rho_1}{\rho_2} = \frac{P_1 M_1}{P_2 M_2} = \left(\frac{P_1}{P_2}\right) \times \left(\frac{M_1}{M_2}\right) = \frac{4}{3} \times \frac{2}{3} = \frac{8}{9}$$

Here ρ_1 and ρ_2 are the densities of gases in the vessel containing the mixture.