| Daily Tutorial Sheet-1 | JEE Advanced (Archive) |
|---|---|

**1.(3.42 g/L)**

The ideal gas equation: $pV = nRT = \dfrac{w}{M}RT$

$\Rightarrow \quad pM = \dfrac{w}{V}RT = dRT$ where, 'd' is density $\Rightarrow \quad d = \dfrac{pM}{RT} = \dfrac{5\times 17}{0.082\times 303} = 3.42 \text{ g L}^{-1}$

**2.(12.15)**

Moles of $CO_2$ can be calculated using ideal gas equation as :

$$n = \frac{pV}{RT} = \left(\frac{700}{760}\right)\left(\frac{1336}{1000}\right)\times\frac{1}{0.082\times 300} = 0.05$$

Also, the decomposition reaction is: $\underset{0.05\text{ mol}}{MCO_3} \longrightarrow \underset{0.05\text{ mol}}{MO + CO_2}$

$\because \quad$ 0.05 mole $MCO_3 = 4.215$ g

$\therefore \quad$ 1.0 mole $MCO_3 = \dfrac{4.215}{0.05} = 84.3$ g(molar mass)

$\Rightarrow \quad$ 84.3 = MW of M + 12 + 48 $\quad \Rightarrow \quad$ Molecular weight of metal = 24.3

$\because \quad$ Metal is bivalent, equivalent weight $= \dfrac{\text{Molecular weight}}{2} = 12.15$

**3.(41.32 g)**

For same p and V, $n \propto \dfrac{1}{T}$

$\Rightarrow \quad \dfrac{n(\text{gas})}{n(H_2)} = \dfrac{T(H_2)}{T(\text{gas})} \quad \Rightarrow \quad n(H_2) = \dfrac{0.184}{2} = 0.092 \quad \Rightarrow \quad n(\text{gas}) = \dfrac{290}{298}\times 0.092 = 0.0895$

$\because \quad$ 0.0895 mole of gas weigh 3.7 g

$\therefore \quad$ 1 mole of gas will weigh $\dfrac{3.7}{0.0895} = 41.32$ g

**4.($C_7H_8$)** First we determine empirical formula as

| | C | H |
|---|---|---|
| Weight | 10.5 | 1 |
| Mole | $\dfrac{10.5}{12} = 0.875$ | 1 |
| Simple ratio | 1 | 1/0.875 = 1.14 |
| Whole no. | 7 | 8 |

$\Rightarrow \quad$ Empirical formula $C_7H_8$

From gas equation: $pV = \left(\dfrac{w}{M}\right)RT$

$$M = \frac{wRT}{pV} = \frac{2.8\times 0.082\times 400}{1\times 1} = 91.84 \approx 92$$

$\because \quad$ Molar mass (M) is same as empirical formula weight.

Molecular formula = Empirical formula $= C_7H_8$

**5.(1 : 1.18)**

Rate of effusion is expressed as $-\frac{dp}{dt} = \frac{kp}{\sqrt{M}}$

K = constant, p = instantaneous pressure $\Rightarrow$ $-\frac{dp}{p} = \frac{k\,dt}{\sqrt{M}}$

Integration of above equation gives $\ln\left(\frac{p_o}{p}\right) = \frac{kt}{\sqrt{M}}$

Using first information : in $\left(\frac{2000}{1500}\right) = \frac{k47}{\sqrt{32}}$ $\Rightarrow$ $k = \frac{\sqrt{32}}{47}\ln\left(\frac{4}{3}\right)$ ...(i)

Now in mixture, initially gases are taken in equal mole ratio, hence they have same initial partial pressure of 2000 mm of Hg each.

After 74 min:

For $O_2$ $\ln\left(\frac{2000}{p_{O_2}}\right) = \frac{74k}{\sqrt{32}}$

Substituting k from Eq. (i) gives

$$\ln\left(\frac{2000}{p_{O_2}}\right) = \frac{74}{\sqrt{32}} \times \frac{\sqrt{32}}{47}\ln\left(\frac{4}{3}\right)$$

$$\ln\left(\frac{2000}{p_{O_2}}\right) = \frac{74}{47}\ln\left(\frac{4}{3}\right)$$

Solving k from Eq. (i) gives $\ln\left(\frac{2000}{p_g}\right) = \frac{74}{\sqrt{79}} \times \frac{\sqrt{32}}{47}\ln\left(\frac{4}{3}\right)$

Solving gives : $p_g = 1500$ mm $\Rightarrow$ After 74 min, $p(O_2) : p(g) = 1271.5 : 1500$

Also, in a mixture, partial pressure $\propto$ number of moles

$\Rightarrow$ $n(O_2) : n(g) = 1 : 1.18$

**6.(A)** $V_{rms} = \sqrt{\frac{3RT}{M}}$ ; $V_{avg} = \sqrt{\frac{8RT}{\pi M}} = \sqrt{\frac{8RT}{\pi M}}$

**7.(B)** It is the Boyle temperature $T_B$. At Boyle temperature, the first virial coefficient (B) vanishes and real gas approaches ideal behaviour.

$$T_B = \frac{a}{Rb}$$

Here, a and b are van der Waal's constants.

**8.** ($6.21 \times 10^{-21}$ J/molecule)

$Ke = \frac{3}{2}k_BT : k_B$ = Boltzmann's constant $= \frac{3}{2} \times 1.38 \times 10^{-23} \times 300$ J $= 6.21 \times 10^{-21}$ J/molecule.

**9.(B)** $V_{avg} = \sqrt{\frac{8RT}{\pi M}}$

**10.(F)** In a close container, gas exerts uniform pressure everywhere in the container.

**11.(Subjective)**

**(i)** According to Avogadro's hypothesis, "Under identical conditions of pressure and temperature, equal volume of ideal gases contains equal number of molecules."

**(ii)** $NH_3$ ($l$) is highly volatile, a closed bottle of $NH_3$ (l) contains large number of molecules in vapor phase maintaining high pressure inside the bottle. When the bottle is opened, there is chances of bumping of stopper. To avoid bumping, bottle should be cooled that lowers the pressure inside.

**12.(1 : 3)**

From the given information, it can be easily deduced that in the final mixture,
Partial pressure of A = 1.0 atm, Partial pressure of B = 0.5 atm

Also, $n_A = \frac{p_A V}{RT} = \frac{V}{RT}$, $n_B = \frac{p_B V}{RT} = \frac{0.5V}{RT}$

$$\Rightarrow \quad \frac{n_B}{n_A} = \frac{1}{2}\frac{w_B}{M_B} \times \frac{M_A}{w_A} = \frac{3}{2} \times \left(\frac{M_A}{M_B}\right) \quad \Rightarrow \quad M_A : M_B = 1:3$$

**13.(2.7 × 10[10])**

$$nN_A = \frac{pv}{RT}$$

$2.7 \times 10^{10}$ molecules

**14.(B)** According to KTG, there is no intermolecular forces of attraction or repulsion between the molecules of ideal gases.

**15.** (390.2 ms)

$$u_{rms} = \sqrt{\frac{3RT}{\pi}} = \sqrt{\frac{3 \times 8.314 \times 293}{48 \times 10^{-3}}} = 390.2\,ms^{-1} \quad \Rightarrow \quad C_{rms} = 390.2\ ms^{-1}$$