HINT & SOLUTIONS : IDEAL GAS

EXERCISE # S-I

1. $2NaN_3 \longrightarrow 2Na + 3N_2$

Mole : 2 3

Volume of N_2 formed = $\frac{3 \times 0\cdot0821 \times 300}{1}$ = 73.9 lits.

2. Case-I : P.V. = $\frac{3.6}{36} \times 0.0821 \times T$ ...(1)

Case-II : P.V. = $\frac{3}{36} \times 0.0821 \times (T + 15)$ ...(2)

Equating (1) & (2),

We get, $\boxed{T = 75k}$

From equation (1)

$P \times 8.21 = \frac{3.6}{36} \times 0.0821 \times 75$

$\Rightarrow$ P = 0.075 atm

3. $P\cdot V_1 = \frac{1}{4} RT$ ...(1)

$P\cdot V_2 = \frac{0.125}{4} RT$ ...(2)

Now, (1) ÷ (2),

$\frac{V_1}{V_2} = 8 \Rightarrow V_2 = \frac{1}{8} V_1$

or $\frac{4}{3}\pi r_2^3 = \frac{1}{8} \times \frac{4}{3}\pi r_1^3$

$\Rightarrow r_2^3 = \left(\frac{10}{2}\right)^3$

$\Rightarrow \boxed{r_1 = 5\ cm}$

4. $C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O$

$n_{O_2} = \frac{1 \times 0\cdot2 \times 10^{-3}}{0\cdot08 \times 300}$

$\simeq 8\cdot3 \times 10^{-6}$ mole

$\therefore$ mass of glucose required for hour by a resting mole having mass 60 kg

$\simeq \frac{8\cdot3 \times 10^{-6}}{6} \times 180 \times 60$

$\simeq$ 15 gm.

Also, volume of CO_2 product = $\frac{8\cdot3 \times 10^{-6} \times 0\cdot08 \times 300}{1} \times 60$

$\simeq 12\ dm^3$.

5. $n^2 = \left(\frac{P}{RT}\right)^2 \times V^2$

$\Rightarrow$ slope $= \left(\frac{P}{RT}\right)^2$

$\Rightarrow$ slope $= \frac{(8\cdot21)^2}{(0\cdot0821\times200)^2}$

$\simeq 0{\cdot}25$

or $\frac{1}{4}$

6. As, $M = \frac{dRT}{P}$

$\Rightarrow$ $M = \frac{0\cdot8\times0\cdot082\times300}{2\cdot46}$

$\Rightarrow$ M = 8 gm/mole

7. By using equation of state,

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

$\Rightarrow$ $\frac{P\cdot V}{T_1} = \frac{4P\times2V}{T_2}$

$\Rightarrow$ $\boxed{T_2 = 8T_1}$

8. As, $P^2 = (nRT)^2 \times \frac{1}{V^2}$

$\Rightarrow$ slope $= (nRT)^2$

$\Rightarrow$ slope $= (1 \times 0{\cdot}08 \times 400)^2$

$= (32)^2$

$= (1024)$

9. $P_f\,(100 + V) = (n_1 + n_2)RT$ ...(1)

$P_A\,(100) = n_3 \cdot RT$ ...(2)

Now, (1) ÷ (2),

$\frac{P_f}{P_A}\times\frac{100+V}{100} = \frac{(n_1+n_2)RT}{n_3\,RT} \quad \left(\frac{P_f}{P_A} = \frac{40}{100}\ \&\ n_1+n_2 = n_3\right)$

$\Rightarrow$ V = 150 ml

10. $n_{He} = \dfrac{0\cdot3\times1}{0\cdot0821\times300}$

$= 0{\cdot}012$

Now, $\dfrac{0\cdot4\times3}{0\cdot0821\times300} = n_T$

$\Rightarrow\quad n_T = 0{\cdot}048$

$\Rightarrow\quad n_{Ne} = 0{\cdot}048 - 0{\cdot}012$

$= 0{\cdot}036$

$\Rightarrow\quad \dfrac{n_{He}}{n_{He}} = \dfrac{0\cdot036}{0\cdot012}$

$\simeq 3$

11. $2NH_3 \longrightarrow N_2 + 3H_2$

76	0	0
$76 - x$	$\dfrac{x}{2}$	$\dfrac{3x}{2}$

As, $x = 19$

$\Rightarrow$ % dissociation $= \dfrac{19}{76}\times 100$

$= 25\%$

12. (i) $P = \dfrac{nRT}{V}$

$= \dfrac{16\times0\cdot0821\times300}{32\times8\cdot21}$

$= 1{\cdot}5$

(ii) $3O_2 \longrightarrow 2O_3$

mole :	$\cdot5$	0
	$0{\cdot}5 - \cdot25$	$0{\cdot}25\times\dfrac{2}{3}$

Now, $P_{O_2} = x_O \times P_T$

$= \dfrac{0\cdot25}{\cdot5}\times1\cdot5$

$\simeq 0{\cdot}75$

& $P_{O_3} = \dfrac{0\cdot16}{\cdot5}\times1\cdot5$

$\simeq 0{\cdot}50$

(iii) $P_T = \dfrac{n_T\times RT}{V}$

$= \dfrac{0\cdot42\times0\cdot0821\times50}{8\cdot21}$

$\simeq 0{\cdot}208$ atm.

13. Total pressure of mixture = $P_{H_2} + P_{O_2}$

$\Rightarrow$ $P_T = \dfrac{10^{-2} \times 10^3 \times 0\cdot 0821 \times 473}{2 \times 10} + \dfrac{6\cdot 4 \times 10^{-2} \times 10^3 \times 0\cdot 0821 \times 473}{32 \times 10}$

$\Rightarrow$ $P_T \simeq 27\cdot 17$ atm

or

$27{\cdot}54 \times 10^5$ N/m^2

Where spark ignites the mixture,

$$H_{2(g)} + \frac{1}{2}O_{2(g)} \longrightarrow H_2O(g)$$

mole :	5	2	0
	1	0	4

$\Rightarrow$ moles total $\simeq$ 5

$\Rightarrow$ $P_{(final)} = \left(\dfrac{5 \times 0\cdot 0821 \times 473}{10} \times 1\cdot 013 \times 10^5\right)$

$= 19{\cdot}66 \times 10^5$ N/m^2

14. $P_T = P_{N_2} + P_{O_2}$

$\Rightarrow$ $P_{N_2} = 90 - 63$

i.e. P_{N_2} = 27 mm of Hg

Now, $P_{N_2} = x_{N_2} \times P_T$

$\Rightarrow$ $x_{N_2} = \dfrac{27}{90}$. $\Rightarrow$ $x_{N_2} = 0\cdot 3$

$\Rightarrow$ Answer is ($0{\cdot}3 \times 10$) i.e. 3

15. $\dfrac{r_{H_2}}{r_{O_2}} = \dfrac{P_{H_2}}{P_{O_2}}\sqrt{\dfrac{M_{O_2}}{M_{H_2}}}$

$= \dfrac{1 \times 32}{2 \times 8}\sqrt{\dfrac{32}{2}}$

$= 8$

16. $\dfrac{r_{mix}}{r_x} = \sqrt{\dfrac{M_x}{M_{mix}}}$

$\dfrac{600}{200} = \sqrt{\dfrac{M_x}{20/3}}$

$9 = \dfrac{M_x}{20/3}$

$M_x = 9 \times \dfrac{20}{3}$

$M_x = 60g$

17. (i) $\frac{r_{SO_2}}{r_{CH_4}} = \sqrt{\frac{M_{CH_4}}{M_{SO_2}}} = \sqrt{\frac{16}{64}}$

$\Rightarrow \quad \frac{r_{SO_2}}{r_{CH_4}} = \frac{1}{2}$

(ii) $\frac{r_{SO_2}}{r_{CH_4}} = \frac{3\times16}{64\times2}\sqrt{\frac{1}{4}}$

$= \frac{3}{16}$

(iii) $\frac{r_{SO_2}}{r_{CH_4}} = 1\times\sqrt{\frac{1}{4}}$

$\Rightarrow \quad \frac{r_{SO_2}}{r_{CH_4}} = \frac{1}{2}$

18. $\frac{r_{N_2}}{r_{SF_6}} = \sqrt{\frac{M_{SF_6}}{M_{N_2}}}$

$(dn)_{N_2} = \sqrt{\frac{146}{28}} \times (dn)_{SF_6}$

$= 2\cdot28 \times 100$

$= 228$

No. of molecules of N_2 present in the product gas for every 100 molecules of SF_6 is 228.

19. $\text{No} \rightarrow |\leftarrow x \rightarrow|\leftarrow 100-x \rightarrow| \leftarrow O_2$

$\frac{r_{NO_2}}{r_{O_2}} = \sqrt{\frac{M_{O_2}}{M_{NO}}}$

$\frac{x}{100-x} = \sqrt{\frac{32}{30}}$

$\Rightarrow \quad x = 50\cdot8$ cm

20. At constant volume & temperature

$P \,\alpha\, W$

Thus, for N_2 : $P_1 = 2$ atm, $P_2 = 1/2$ atm. at t = 1 hr.

$\frac{P_1}{P_2} = \frac{W_1}{W_2}$

$\Rightarrow \quad W_2 = \frac{14\times1/2}{2}$

$\Rightarrow \quad W_2 = \frac{14}{4}$

$\therefore$ wt. of N_2 diffused = $14-\frac{14}{4}$

$= \frac{21}{4}$ kg.

For H_2 : P_1 = 2 atm, $P_2 = \frac{1}{2}$ at t = t hrs.

w_1 = 1 kg $w_2 \rightarrow$?

$\Rightarrow$ $w_2 = \frac{1}{4}$ kg

Hence, wt. of H_2 diffused = $1-\frac{1}{4}=\frac{3}{4}$ kg.

Now, $\frac{r_A}{r_B}=\frac{\rho_B}{\rho_4}$

or, $\frac{V_A \times t_B}{V_B \times t_A}=\frac{\rho_B}{\rho_A}\sqrt{\frac{\rho_A}{\rho_B}}$

$\frac{W_A \times t_B}{W_B \times t_A} = \frac{\rho_B}{\rho_A}\sqrt{\frac{\rho_A}{\rho_B}}$

For our problem,

$\frac{W_{H_2} \times t_{N_2}}{W_{N_2} \times t_{H_2}} = \sqrt{\frac{M_{H_2}}{M_{N_2}}}$

$\frac{\frac{3}{4}\times 1}{\frac{21}{2}\times t} = \sqrt{\frac{2}{28}}$

$\Rightarrow t = \frac{60}{14}$ mins

$\Rightarrow$ t = 16 mins

21. $\frac{r_{O_2}}{r_{mix.}} = \sqrt{\frac{M_{mix}}{M_{O_2}}}$

$\frac{336}{224} = \sqrt{\frac{M_{mix}}{32}}$ $\Rightarrow$ $M_{mix.} = 72$

Now, Let molecular weight of unknown gas be x g

$\Rightarrow$ $72 = \frac{3}{4} \times 32 + \frac{1}{4} \times x$

$\Rightarrow$ x = 192 gm

22. using, Pv = nRT

$n_T = \dfrac{24.6\times 3}{0.0821\times 300}$

$\Rightarrow \quad n_T = 3$

$\Rightarrow \quad n_{H_2} = 2 \quad \& \quad n_{D_2} = 1$

Now,

$$\frac{\left(\dfrac{n_{H_2}}{n_{B_2}}\right)_f}{\left(\dfrac{n_{H_2}}{n_{D_2}}\right)_i} = \left(\frac{M_{D_2}}{M_{H_2}}\right)^{\frac{n}{2}} \qquad \Rightarrow \qquad \frac{\left(\dfrac{1\times 4}{4\times 2}\right)}{\left(\dfrac{2}{1}\right)} = \left(\frac{1}{2}\right)^{\frac{n}{2}}$$

$$\Rightarrow \quad \frac{1}{4} = \left(\frac{1}{2}\right)^{\frac{n}{2}} \qquad \Rightarrow \qquad \frac{1}{16} = \left(\frac{1}{2}\right)^{n}$$

$$\Rightarrow \quad \left(\frac{1}{2}\right)^{4} = \left(\frac{1}{2}\right)^{n} \qquad \Rightarrow \qquad n = 4$$

23. $P_f \,.\, V_f = n_T \,.\, R \times T$

$\Rightarrow \quad \dfrac{7}{6} \times 10 \times 2.4 = n_T \times 25$

$\Rightarrow \quad n_T = 1.12$

Now, $\quad n_T = n_1 + n_2$

As, $\quad n_2 = \dfrac{20\times .4}{25} = \dfrac{8}{25}$

$\Rightarrow \quad n_1 = 1.12 - \dfrac{8}{25} \qquad = 0.8$

Now, $\quad n_1 = \dfrac{P_1V_1}{RT}$

$\Rightarrow \quad P_1 = \dfrac{.8\times 25}{2}$

$\Rightarrow \quad P_1 = 10$ atm or 1 MPa

24. As, $\quad n_i = n_f$

$\Rightarrow \quad \dfrac{(P.V)\times n}{RT} = \dfrac{P_f \times V(1+2+3......n)}{RT}$

$\Rightarrow \quad P = \dfrac{P_f\,(n+1)}{2}$

$\Rightarrow \quad P_f = \left(\dfrac{2P}{n+1}\right)$

25. As, $\frac{P_1}{T_1} = \frac{P_2}{T_2}$

$\Rightarrow \quad \frac{250\times10^3}{300} = \frac{10^6}{T_2}$

$\Rightarrow \quad T_2 = 1200k$

Yes, the cylinder will blow up.

26. $n_1 = \frac{2.463\times2}{25}$ & $n_2 = \frac{4.926\times1}{25}$

$\Rightarrow \quad P_f \times 3 = \frac{9.852}{25}\times25$

$\Rightarrow \quad P_f = 3.284$ atm

27. $\left(U_{r.m.s}\right)_{SO_2}$ at TK = $\left(U_{Arg.}\right)_{O_2}$ at 300K

$\left(\sqrt{\frac{3RT}{M}}\right)_{SO_2} = \left(\sqrt{\frac{8RT}{\pi M}}\right)_{O_2}$ at 300 K

$\Rightarrow \quad \frac{3\times T}{64} = \frac{8\times300}{\pi\times32}$

$\Rightarrow \quad T = 509.554$ K Or 236.3°C.

28. $U_{r.m.s} = \sqrt{\frac{3P}{P}}$

$= \sqrt{\frac{3\times10^5\times10^{-6}}{3\times10^{-4}\times10^{-3}}}$

$= \sqrt{10^6} \quad = 1000$ m/s

29. As, $K.E = \frac{3}{2}\ KT$

$= \frac{3}{2}\times\frac{1.38\times10^{-23}\times300}{1.6\times10^{-19}}$ ev

$= 3.88 \times 10^{-2}$ ev

$\Rightarrow x = 2$

30. $\lambda = \dfrac{1}{\sqrt{2}\pi r^2 N^+}$ or $\dfrac{1 \times KT}{\sqrt{2}\pi r^2 \times P}$

$\Rightarrow \quad \dfrac{\lambda_2}{\lambda_1} = \dfrac{1}{5}$

$\Rightarrow \quad \lambda_2 = \dfrac{1}{5} \times \lambda_1$ or $\dfrac{1}{5} \times 10$

$\Rightarrow \quad \lambda_2 = 2$ cm

31. $\lambda = \dfrac{KT}{\sqrt{2}\pi r^2 \times P}$

on substituting the values, we get

$\lambda = 3.3 \times 10^3$ cm.

32. As, $Z_1 = \sqrt{2}\pi r^2 \; U_{avg} \, N^*$

$\left(U_{Avg.}\right)_{Ne} < \left(U_{Avg.}\right)H_2$

$\Rightarrow \quad N^*_{He} > N^*_{H_2}$

$\Rightarrow$ He has higher concentration.

EXERCISE # S-II

1. $P_{(glycerine)} = \dfrac{2.75\times5}{13.6} + 76 = 176$ cm of Hg

$\Rightarrow \quad n_{gas} = \dfrac{\dfrac{176}{76}\times10}{0.0821\times300} \quad \Rightarrow \quad n_{gas} = 0.94$

2. $10 \times 4 = P_1 \times 8$

$P_1 = 5$

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

$\dfrac{8}{300} = \dfrac{V_1}{600}$

$V_1 = 16L$

$\dfrac{P_1}{T_1} = \dfrac{P_2}{T_2}$

$\dfrac{5}{600} = \dfrac{3}{T_3}$

$T_3 = \dfrac{600\times3}{5} = 360$ K

$\dfrac{5}{300} = \dfrac{P_2}{T_4}$

3. $P \propto d$

So $P = kd$

it $P_1 = 1$ atm $\quad d_1 = 1$ m $\quad \Rightarrow \quad K = 1$ atm m^{-1}

(a) $\dfrac{P_1V_1}{n_1} = \dfrac{P_2V_2}{n_2}$

$\dfrac{P_1\times\frac{4}{3}\pi r_1^3}{n_1} = \dfrac{P_2\times\frac{4}{3}\pi r_2^3}{n_2}$

$\dfrac{1\times1}{1} = \dfrac{3\times(3)^3}{n_2}$

$n_2 = 81$

So moles of gas added = 81 – 1 = 80

(b) at 7 atm pressure d = 7 m

$V_{balloon} = 57.1\pi\ m^3$

So balloon will burst is its volume becomes $36\pi m^3$

$\frac{4}{3}\pi r^3 = 36\pi \quad \Rightarrow r = 3\text{ m}$

$D = 6\text{ m}$

$P = 6\text{ atm}$

$$\frac{P_1V_1}{n_1} = \frac{P_2V_2}{n_2}$$

$$\frac{1\times\frac{4}{3}\pi\times\frac{1}{8}}{1} = \frac{6\times 36\pi}{n_2}$$

$n_2 = 1296$

moles added = 1296 – 1 = 1295

4. $\frac{r_{mix}}{r_{kr}} = \sqrt{\frac{M_{kr}}{M_{mix}}}$

$1.16 = \sqrt{\frac{84}{M_{mix}}}$

$M_{mix} = 62.42$

$62.42 = \frac{71}{1+\propto}$

$1 + \propto = \frac{71}{62.42} = = 1.137$

$\propto = 0.137$

5. $NH_4Cl(s) \longrightarrow NH_3(g) + HCl(g)$

	$NH_4Cl(s)$	$NH_3(g)$	$HCl(g)$
n_i	1	0	0
n_f	0	1	1

$P_{gas} = \frac{2\times 0.0821\times 600}{24.63} = 4\text{ atm}$

6. T_{max} at P_{max}

$PV = nRT$

$\frac{1}{8.21} \quad P \times 8.21 \times P = 1 \times 0.0821 \times T$

At $\quad P = 10\text{ atm}$

$100 \times 8.21 = 1 \times 0.0821 \times T$

$T = 10000\text{ K}$

7.

	A_2	$\longrightarrow$	$2A$
n_i	1		0
n_f	0.5		1

$PV = nRT$

$P \times 33.6 = 1.5 \times 0.0821 \times 546$

$P = 2$ atm

8. (a) $m_{rms} = \sqrt{\frac{3RT}{M}}$

$= \sqrt{\frac{3 \times 8.314 \times 300}{2 \times 10^{-3}}} = 1934.24\ ms^{-1}$

(b) $\mu_{rms} = \sqrt{\frac{3RT}{M}} = \sqrt{\frac{3PV}{nM}}$

$= \sqrt{\frac{3 \times 10^5 \times 5 \times 10^{-3}}{3 \times 2 \times 10^{-3}}} = 500$ m/sec

(c) $\mu_{rms} = \sqrt{\frac{3RT}{M}} = \sqrt{\frac{3P}{d}}$

$= \sqrt{\frac{3 \times 10^5}{10^3}}$

$= \sqrt{300} = 17.32$ m/sec

9. (i) $P = \frac{nRT}{V}$

$= \frac{10^{-3} \times 0.08 \times 300}{2} = 0.012$ atm

(ii) $\frac{P_1}{n_1 T_1} = \frac{P_2}{n_2 T_2}$

$\frac{0.012}{10^{-3} \times 300} = \frac{1}{n_2 \times 600}$

$n_2 = \frac{1}{24}$

$N = \frac{6 \times 10^{23}}{24} = 2.5 \times 10^{22}$

(iii) KE total $= \frac{3}{2}$ RT × n

$= \frac{3}{2} \times 8 \times 300 \times 10^{-3}$

(vi) KE total = $\frac{3}{2} \times 8 \times 6000 \times \frac{1}{24}$

= 300 J

(v) $\frac{\mu_{mps}, A}{m_{mps}, B} = \sqrt{\frac{T_A}{T_B}} = \frac{1}{\sqrt{2}}$

(vi) $Z_{11} = \frac{1}{\sqrt{2}} \pi\sigma^2 \mu_{avg} (N)^2$

$z_{11} \propto \frac{P^2}{T^{\frac{3}{2}}}$

$\frac{z_{11}, A}{z_{11}, B} = \left(\frac{12\times10^{-3}}{1}\right) 2\times\left(\frac{600}{300}\right)^{3/2} = 0.4 \times 10^{-3} : 1$

10. (a) $\lambda = \frac{1}{\sqrt{2}\pi\sigma^2 N^*}$

$N^* = \frac{1}{\sqrt{2}\times3.14\times(0.26\times10^{-9})^2\times2.6\times10^{-5}}$

$N^* = 1281\times10^{20}\ M^{-3}$

(b) $N^* = \frac{P}{KT}$

$1281\times10^{20} = \frac{P\times6\times10^{23}}{8.314\times300}$

P = 530.6 Pa

EXERCISE # O-I

1. (C)

Sol. By equation of state, $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$\Rightarrow \quad \frac{P \cdot V_1}{273} = \frac{P \cdot 2V_1}{T_2}$

$\Rightarrow \quad T_2 = 546$ K or 273°C

2. (B)

Sol. At constant temperature, $P \propto \frac{1}{V}$

$\Rightarrow \quad P_1 < P_2$

3. (D)

Sol. Mass of liquid = 50 gm

$\Rightarrow$ volume of container = $\frac{50}{25} = 2\ dm^3$

4. (C)

Sol. $d_A = 2d_B$ & $M_B = 3M_A$

As, $P = \frac{dRT}{M}$

$\Rightarrow \quad P_A = \frac{d_ART}{M_A}$ .....(1)

& $\quad P_B = \frac{d_BRT}{M_B}$ .....(2)

(1) ÷ (2)

$\frac{P_A}{P_B} = \frac{d_A}{d_B} \times \frac{M_B}{M_A}$

$= \frac{2d_B}{d_B} \times \frac{3M_A}{M_A} = 6 \quad \Rightarrow \quad P_A : P_B = 6 : 1$

5. (C)

Sol. $(nRT)_1 = (nRT)_2$

$\frac{4}{18} \times R \times T = \frac{3.2}{18} \times R \times (T+50)$

$\Rightarrow \quad T = 200K$

6. (C)

Sol. V.D = 70 $\Rightarrow$ molar mass = 140

$\Rightarrow$ $12x + 16x = 140$

$\Rightarrow$ $28x = 140$

$\Rightarrow$ $x = \dfrac{140}{28}$ $\Rightarrow$ $x = 5$

7. (C)

Sol. Vapour pressure depends on temperature only, so, as the temperature remains constant, V.P. will remain unchanged.

8. (C)

Sol. Assuming volume remaining constant

$$\frac{W_1T_1}{P_1} = \frac{W_2T_2}{P_2}$$

$\Rightarrow$ $\dfrac{10\times T}{P} = \dfrac{W_2\times 2T\times 2}{3\times P}$

$\Rightarrow$ $W_2 = 7.5$ gm

$\Rightarrow$ mass of gas escaped = $W_1 - W_2$

$= 10 - 7.5 = 2.5$ gm

9. (D)

Sol. This statement is in accordance to Dalton's Law.

10. (B)

Sol. $NH_3 + HCl \longrightarrow NH_4Cl$

Dalton's Law is applicable for non-reacting gas.

11. (C)

Sol.

	He : 0
Number of ratio of atoms	1 : 1
Ratio of mole of atoms	$\dfrac{1}{N_A}$: $\dfrac{1}{N_A}$
Ratio of mole of molecules	$\dfrac{1}{N_A}$: $\dfrac{1}{3N_A}$

Now, $\dfrac{1}{N_A} + \dfrac{1}{3N_A} = P$

$\Rightarrow$ $\dfrac{4}{3N_A} = P$ $\Rightarrow$ $\dfrac{1}{N_A} = \dfrac{3P}{4}$

If Helium is removed from the vessel,

Let pressure of system be P'

$\Rightarrow \quad P' = \dfrac{1}{3N_A} \quad = \dfrac{1}{3}\times\dfrac{3P}{4}$

$\Rightarrow \quad P' = \dfrac{P}{4}$ or $0.25\,P$

12. (D)

Sol. Rate of diffusion of gas is inversely proportional to the square root of its molecular weight.

13. (A)

Sol. rate $\propto \dfrac{1}{\sqrt{M}}$

14. (C)

Sol. $r \propto \dfrac{1}{\sqrt{M}}$

15. (D)

Sol. rate $\propto \dfrac{1}{\sqrt{M}}$

Increasing order of effusion is ($CO_2 < O_2 < NH_3 < H_2$)

16. (B)

Sol. As, $\dfrac{r_1}{r_2} = \sqrt{\dfrac{M_2}{M_2}}$

$\Rightarrow$ Relative rates of effusion are, $a < c < b$.

17. (B)

Sol. Rate of diffusion of Hydrogen is about

$$\frac{r_{H_2}}{r_{H_e}} = \sqrt{\frac{M_{He}}{M_{H_2}}} = \sqrt{2} = 1.4$$

$\Rightarrow \quad r_{H_2} = 1.4 \times r_{He}$

18. (A)

Sol. $\dfrac{W_{H_2}}{W_{O_2}} = \sqrt{\dfrac{M_{H_2}}{M_{O_2}}}$

$= \sqrt{\dfrac{2}{32}} \qquad = \sqrt{\dfrac{1}{16}} \qquad = \dfrac{1}{4}$

19. (A)

Sol. $\dfrac{r_{CH_4}}{r_X} = \sqrt{\dfrac{M_X}{M_{CH_4}}}$

$1 = \sqrt{\dfrac{MX}{16}}$

$4 \times 16 = M_X$

$\Rightarrow \quad M_X = 64$ gm

20. (A)

Sol. $\dfrac{n'_{He}}{n'_{CH_4}} = \dfrac{4}{1} \times \sqrt{\dfrac{16}{4}} \quad = 8 : 1$

21. (B)

Sol. $\dfrac{r_x}{r_y} = 3 = \sqrt{\dfrac{D_y}{D_x}}$

$\dfrac{D_y}{D_x} = \dfrac{9}{1}$

$\Rightarrow \quad D_x : D_y = 1 : 9$

22. (A)

Sol. $\dfrac{r_{O_2}}{r_{H_2}} = \dfrac{16\times 2}{32\times 2}\sqrt{\dfrac{2}{32}}$

$= \dfrac{1}{2}\times\dfrac{1}{4} = \dfrac{1}{8}$

23. (C)

Sol. $\dfrac{\left(\dfrac{n_A}{n_B}\right)_f}{\left(\dfrac{n_B}{n_B}\right)_i} = \left(\dfrac{M_B}{M_A}\right)^{n/2}$

$\dfrac{3072}{20}\times\dfrac{1600}{240} = \left(\dfrac{32}{2}\right)^{n/2}$

$(4)^5 \quad = (4)^n$

$\Rightarrow \quad n = 5$

24. (D)

Sol. $P_{(final)} = \dfrac{P_1V_1 + P_2V_2}{V_T}$

$= \left(\dfrac{720\times 200 + 750\times 400}{1000}\right) = \left(\dfrac{444000}{1000}\right)$

$= 444$ mm

25. (C)

Sol. $\frac{r_{mix}}{r_{SO_2}} = \sqrt{\frac{M_{SO_2}}{M_{mix}}}$

$2 = \sqrt{\frac{64}{M_{mix}}}$

$\Rightarrow \quad M_{max.} = 16$

Now, $16 = \frac{17}{1+\propto}$

$\Rightarrow \quad \propto = 6.25\%$

26. (A)

Sol.

	$2NH_3 \longrightarrow$	N_2 +	$3H_2$
At. T$\rightarrow$	P	0	0
At. 2T$\rightarrow$	2P	0	0
	–	P	3P

$\Rightarrow$ Ratio of final pressure to initial pressure = $\frac{4P}{P}$

i.e. 4

27. (B)

Sol.

$2A_{(g)} \longrightarrow$	$3B_{(g)}$ +	$2C_{(g)}$
1	0	0
(1–0.4)	$\frac{0.4\times3}{2}$	$\frac{0.4\times2}{2}$
= 0.6	= 0.6	= 0.4

$P = \frac{nR}{V}\times T$

$\Rightarrow$ Slope = $\tan\theta = \frac{nR}{V} = \frac{1.6\times0.08}{0.16} = 0.8$

$\Rightarrow \quad \theta = \tan^{-1}(0.8)$

28. (B)

Sol.

$3A \longrightarrow$	$2B$
1	0
$1-\propto$	$\frac{2\propto}{3}$

$n_T = 1 - \propto + \frac{2\propto}{3} = 0.8$

$\Rightarrow \quad \propto = 0.6$

29. (A)

Sol. As $M_{Avg.}$ remains same

$\Rightarrow$ Total pressure will remain same

30. (A)

Sol.

$$U_{m.p.s} : U_{Avg} : U_{r.m.s}$$

$$\sqrt{\frac{2RT}{M}} : \sqrt{\frac{8RT}{\pi - M}} : \sqrt{\frac{3RT}{M}}$$

$$\sqrt{2} : \sqrt{\frac{8}{\pi}} : \sqrt{3}$$

OR, $1 : 1.128 : 1.224$

31. (D)

Sol. $(U_{avg.})_X = 2(U_{avg.})_Y$

$$\left(\sqrt{\frac{8PV}{\pi M}}\right)_X = 2\left(\sqrt{\frac{8PV}{\pi M}}\right)_Y$$

$\Rightarrow$ $P_XV_X = 4 \times P_YV_Y$

$\Rightarrow$ $\frac{P_X}{P_Y} = \frac{4\times 2}{1}$

$\Rightarrow$ $P_X = 8P_Y$

32. (A)

Sol. $U_{r.m.s} \propto \frac{1}{\sqrt{M}}$

33. (D)

Sol. $$U_{r.m.s} = \sqrt{\frac{V_1^2 + V_2^2 + V_3^2 + V_4^2}{4}}$$

$$= \sqrt{\frac{4+9+16+25}{4}} = \frac{\sqrt{54}}{2}\,\text{cm/s}$$

34. (B)

Sol. $$S = \sqrt{\frac{(7)^2 \times 4 + 6 \times x^2}{10}}$$

$$2S = \frac{49\times 4 + 6x^2}{10} \quad \Rightarrow x = 3$$

35. (D)

Sol. $$\frac{1}{N}\left(\frac{dN}{dU}\right) \propto M$$

36. (D)

Sol. $(V_{Avg.})_{N2} = 0.3$ m/s at 27°C

$$\sqrt{\frac{8RT}{\pi M}} = 0.3$$

$$\Rightarrow \quad \frac{8R}{\pi M} = \frac{(0.3)^2}{300} \qquad .....(1)$$

Now, $\sqrt{\frac{8RT}{\pi M}} = 0.6$

$$\frac{8R}{\pi M} \times T = 0.6 \times 0.6$$

$$\Rightarrow \quad T = \frac{0.6 \times 0.6 \times 300}{(0.3)^2}$$

$$\Rightarrow \quad T = 1200 \text{ K}$$

37. (B)

Sol. $U_{r.m.s} = \sqrt{\frac{3RT}{M}} = \sqrt{\frac{3PV}{n\,M}} = \sqrt{\frac{3P}{D}}$

38. (D)

Sol. $U_{r.m.s} \propto \frac{1}{\sqrt{M}}$

39. (B)

Sol. $(U_{r.m.s})_T = 2 \times (U_{r.m.s})_{373k}$

$$\Rightarrow \quad \frac{3RT}{M} = 4 \times \frac{3R \times 373}{M}$$

$$\Rightarrow \quad T = 4 \times 373$$

$$\Rightarrow \quad T = 1492 \text{ K}$$

40. (A)

Sol. K.E $= \frac{3}{2}RT$

$= \frac{3}{2} \times 2 \times 300$

$= 900$ cal/mole

41. (B)

Sol. K.E $= \frac{3}{2}KT$

$= \frac{3}{2} \times 1.3807 \times 10^{-23} \times 298$

$= 6.17 \times 10^{-21}$ J

42. (C)

Sol. $(K.E)_{He}$ at TK = $(K.E.)_{Ar}$ at 400 K

$\Rightarrow \frac{3}{2} \times 0.30 \times R \times T = \frac{3}{2} \times 0.40 \times R \times 400$

$\Rightarrow$ $T = \frac{1600}{3} = 533\ K$

43. (A)

Sol. As, K.E depends on T only

$\Rightarrow$ It will remain same

44. (B)

Sol. $(U_{m.p.s})_{O_2} = (U_{r.m.s})_{N_2}$

$\left(\sqrt{\frac{2RT}{M}}\right)_{O_2} = \left(\sqrt{\frac{3RT}{M}}\right)_{N_2}$

$\frac{2 \times T}{32} = \frac{3 \times 700}{28}$

$\Rightarrow$ T = 1200 K

45. (C)

Sol. K.E depends on Temperature only

So, K.E. remain same

46. **(A)**

Sol. As, $N^* = \frac{P}{KT}$

$= \frac{10^5}{1.38 \times 10^{-23} \times 300}$

$\Rightarrow$ $N^* = 2.4 \times 10^{25}\ m^{-3}$

47. (A)

Sol. At. Constant volume,

$Z_{11} \propto \sqrt{P}$

$\Rightarrow$ Correct option is (A)

EXERCISE # O-II

1. (A, B)

Sol. Slope of P-T curve gives volume.

2. (A, B)

3. (C, D)

Sol. K.E $\propto$ T

4. (D)

5. (A, B, D)

Sol. $r \propto \frac{1}{\sqrt{M}}$

6. (A, B, C, D)

7. (A, C)

Sol. $U_{mps} \propto \sqrt{\frac{T}{M}}$

8. For untainer-1 before opening the value,

$P = \frac{nRT}{V} = \frac{2\times0.082\times300}{16.42} = 3$ atm.

Pressure in each compartment is same after opening the value, as total moles remains conserved.

9.

$$2A(g) \longrightarrow 3B(g) + 2C(g)$$

$P_i \rightarrow$ 1 0 0

$P_f \rightarrow$ 0.8 $\left(\frac{3}{2}\times.2\right)$ 0.2

Total final pressure = (0.8 + 0.3 + 0.2) = 1.3 atm

$\Rightarrow$ Total pressure increases by 0.3 atm

As, $P_{gas} > P_{atm.}$

$\Rightarrow$ difference in mercury level is 22.8 cm or 228 mm.

10. $y = \frac{1}{V^2}$ or $\sqrt{y} = \frac{1}{V}$

$P = X$ & $P = \text{constant}/V$

$A \longrightarrow R\ (X = K\sqrt{y} \Rightarrow y = K^1x^2)$

$B \longrightarrow S\ (V = KT,\ y = V\ \&\ \frac{1}{T} = x \quad \therefore y = \frac{K}{x})$

$C \longrightarrow P\ (P = RT;\ PT = RT^2$ or $y = kx)$

$D \longrightarrow Q\ (V = \frac{C}{P} \Rightarrow y = c\sqrt{x};\ y^2 = cx)$

11. (B)

Sol. $P.e^{v/2} = nCT$

At $P = 1$ atm, $V = 0$

$\Rightarrow$ i.e° $= 2 \times C \times 500$

$\Rightarrow C = \frac{1}{1000}$

$\Rightarrow C = 10^{-3}$ or 0.001

12. (D)

Sol. For P.T. curve, slope $= \frac{nc}{e^{v/2}}$

$= \frac{2 \times 0.001}{e} = \frac{2}{1000\,e}$

13. (A)

Sol. $n = \frac{PV}{RT}$

$= \frac{1 \times 200}{0.0821 \times 200} = 12.18$

As, $P = \frac{nCT}{e^{v/2}}$

$= \frac{12.18 \times 0.001 \times 821}{e^{200/2}}$

$= \frac{10}{e^{100}}$

14. $\frac{r_1}{r_2} = \frac{P_1}{P_2}\sqrt{\frac{M_2}{M_1}} = \frac{\ell_1 / t}{\ell_2 / t}$

$\frac{\ell_1}{\ell_2} = \frac{1}{x} = \frac{1}{2}\sqrt{\frac{64}{4}}$

$x = \frac{1}{2}$ m $= 50$ cm

15. $\frac{r_1}{r_2} = \frac{n_1}{n_2} = \sqrt{\frac{M_2}{M_1}}$

$\frac{4/2}{x/32} = \sqrt{\frac{32}{2}}$

$\frac{64}{x} = 4$

$x = 16$

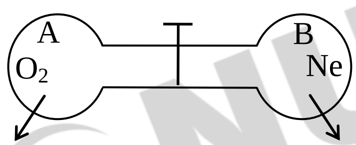
16. $P\,V = n\,R\,T$

$\frac{4.1\times3}{300\times0.0821} = n_x = 0.5 = n_{He} + n_x$

$n_x = 0.1$

$\frac{r_1}{r_2} = \frac{n_1}{n_2} = \sqrt{\frac{M_2}{M_1}}$

$\frac{0.4}{0.1} = \sqrt{\frac{M}{4}}$ $\quad\quad M = 64$

17. 

$P_1 = 950$ mm $\quad\quad P_2 = 900$ mm

$n_T = n_1 + n_2$

$\frac{\frac{910}{760}\times(V_A + V_B)}{R\,T} = \frac{\frac{950}{760}V_A}{R\,T} = \frac{\frac{900}{760}V_B}{R\,T}$

$V_B = 4V_A$

18. $n_T = \frac{\frac{910}{760}\times\left(\frac{5}{4}\times304\right)}{0.08\times300}$

$= 18.95$

$\frac{n_A}{n_B} = \frac{V_A}{V_B} = \frac{1}{4}$

$n_B = \frac{4}{5}\times n_T$

$n_B = 15.16$

$n_A = \frac{1}{5}\times n_T$

$= 3.790$

EXERCISE # JEE-MAINS

1. (1)

Sol. Factual

2. (4)

Sol. $2BCl_3 + 3H_2 \longrightarrow 2B + 6HCl$

mole : $\left(\frac{21.6}{10.8}\right) = 2$

$n_{H_2} = 3$

$\Rightarrow$ Volume of H_2 at 273K & 1 atm

$= 3 \times 22.4$

$= 67.2$ L

3. (3)

Sol. K. E $\propto$ T

$$\Rightarrow \frac{(K.E)_{40°C}}{(L.E)_{20°C}} = \frac{313}{293}$$

4. (3)

Sol. P $\propto$ n

$$\Rightarrow \frac{P_{CH_4}}{P_{O_2}} = \frac{w \times 32}{16 \times w} = \frac{2}{1}$$

Fraction of total pressure excreted by O_2 is $\frac{1}{3}$

5. (4)

Sol. $u \propto \sqrt{T}$

6. (3)

Sol. u > v > a

7. (3)

Sol. As, V remains constant

$$n \propto \frac{1}{T}$$

i.e. $n_1T_1 = n_2T_2$

$\Rightarrow n_1 \times 300 = \frac{3}{5} n_1 \times T_2$

$\Rightarrow T_2 = \frac{300 \times 5}{3}$

$\Rightarrow T_2 = 500$ k

8. (3)

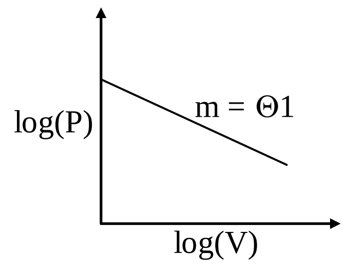
Sol. As $P = \frac{nRT}{V}$

$\Rightarrow$ $\log(P) = \log(nRT) + \log\left(\frac{1}{V}\right)$

or, $\log(P) = \log(nRT) - \log(V)$

For, 1 mole ideal gas,

$\log(P) = \log(RT) - \log(V)$



9. (1)

Sol. $\sqrt{2} : \sqrt{\frac{8}{\pi}} : \sqrt{3}$

10. (1)

Sol. Factual

11. (1)

Sol. $U_{rms} = \sqrt{\frac{3RT}{m}}$

i.e. $U_{rms} \propto \sqrt{T}$

$\frac{5\times10^4}{10\times10^4} = \sqrt{\frac{T_1}{T_2}}$

$\frac{1}{4} = \frac{T_1}{T_2}$

$\Rightarrow (T_2 = 4T_1)$

12. (3)

Sol. $U_{mps} = C = \sqrt{\frac{2RT}{m}}$

$V_{Avg} = \bar{C} = \sqrt{\frac{8RT}{\pi m}}$ & $U_{rms} = C = \sqrt{\frac{3RT}{m}}$

$\Rightarrow C : \bar{C} : C = 1 : 1.128 : 1.225$

13. (4)

Sol.

Element	% (by mass)	relation no. of moles	Simplest atomic ratio
N	87.5	$\frac{87.5}{14} = 6.25$	$\frac{6.25}{6.25} = 1$
H	12.5	$\frac{12.5}{1} = 12.5$	$\frac{12.5}{6.25} = 2$

Empirical formula = NH_2
Molar mass of compound = 32
As, molecular formula = n × empirical formula

$\Rightarrow n = \frac{32}{16} = 2$

$\Rightarrow$ (m.f = N_2H_4)

14. (1)

Sol. $P_1V_1 = P_2V_2$

$840 \times 750 = 360 \times V_2$

$\Rightarrow V_2 = \frac{840\times750}{360}$

$\Rightarrow V_2 = 1750$ ml or 1.750 L

15. (4)

Sol. $(U_{rms})_{O_2} = (U_{rms})_{He}$

$$\sqrt{\frac{3R\times T}{32}} = \sqrt{\frac{3R\times300}{4}}$$

$$\Rightarrow \frac{T}{32} = \frac{300}{4}$$

$$\Rightarrow T = \frac{32\times300}{4}$$

$\Rightarrow T = 2400$ K

16. (3) Factual

17. $V_{rms} \times \sqrt{\frac{T}{M}}$

T is doubled
M is lalfed

$V_{rms}^{'} = \sqrt{4}\ V_{rms}$

$V_{rms}^{'} = 2\ V_{rms}$

$= 2\ \mu$

18. (4)

Sol. $(n_i)_T = (n_f)_T$

$$\frac{P_1V}{RT_1}+\frac{P_1V}{RT_1} = \frac{P_fV}{RT_1}+\frac{P_fV}{RT_2}$$

$$\frac{2P_1V}{RT_1} = \frac{P_fV}{R}\left(\frac{1}{T_1}+\frac{1}{T_2}\right)$$

$$\Rightarrow P_f = 2P_1\left(\frac{T_2}{T_1+T_2}\right)$$

19. (2)

Sol. $V_1 = V_2$, $n_2 = \frac{3}{5}n_1$

$n_1T_1 = n_2T_2$

$n_1(300) = n_2(T_2)$

$300 = \frac{3}{5}T_2$

$T_2 = 500$ K

20. (3)

Sol. $V_A = 2V_B$

$Z_A = 3Z_B$

$$\frac{Z_A}{Z_B} = \frac{P_A}{P_B}\frac{V_A}{V_B}$$

$$3 = \frac{P_A}{P_B}\times 2 \quad\Rightarrow\quad 2P_A = 3P_B$$

21. (3)

Sol. $n_A = 0.5$ $n_B = x$ mole

For the container

$P = 200$ Pa

$V = 10\ m^3$

$T = 1000$ K

$PV = nRT$

$200 \times 10 = (0.5 + x)R \times 1000$

$0.5 + x = \frac{2}{R}$

$$x = \frac{2}{R} - 0.5 \quad\Rightarrow\quad \frac{4-R}{2R}$$

22. (4)

Sol. V_{MPS} is proportional to $\sqrt{\frac{T}{M}}$

EXERCISE # JEE-ADVANCED

1. $n_{He} = \frac{.4}{4} = 0.1$

$n_{O_2} = \frac{1.6}{32} = 0.05$

$n_{N_2} = \frac{1.4}{28} = 0.05$

$P_T = \frac{0.2 \times 0.0821 \times 300}{10}$

$P_T = 0.492$ atm

$P_{He} = \frac{0.1}{0.2} \times 0.492$

$\Rightarrow P_{He} = 0.246$ atm

2. (C)

Sol. According to Graham's Law,

$$\frac{r_A}{r_B} \propto \frac{P_A}{P_B}\left(\frac{M_B}{M_A}\right)^{1/2}$$

3. Mass of liquid = 148 – 50 = 98g

Volume of liquid = $\frac{98}{0.98}$ = 100 ml = volume of flask

Mass of gas = 50.5 – 50 = 0.50 g

Using, PV = nRT, we get

$M = \frac{wRT}{PV} = \frac{0.5 \times 0.082 \times 300}{1 \times 0.1}$

$\Rightarrow M = 123 \text{ g mol}^{-1}$

4. For a fixed amount of gas at constant volume,

$P \propto T$

$\frac{1}{1.1} = \frac{T}{T+10}$

$\Rightarrow T = 100$ K or Θ 173°C

Also, $V = \frac{nRT}{P} = \frac{12}{120} \times \frac{0.0821 \times 100}{1}$

$\Rightarrow V = 0.82$ L

5. For the same amount of gas being diffused,

$$\frac{r_1}{r_2} = \frac{t_2}{t_1} = \frac{P_1}{P_2}\sqrt{\frac{M_2}{M_1}}$$

$\frac{57}{38} = \frac{0.8}{1.6}\sqrt{\frac{M_2}{28}}$

$\Rightarrow M_2 = 252 \text{ g mol}^{-1}$

The formula of compound can be considered to be XeF_n

$\Rightarrow 131 + 19n = 252$

$\Rightarrow n = 6$

$\Rightarrow$ The unknown gas is XeF_6.

6. (C)

Sol. $(U_{rms})_{H_2} = \sqrt{7}(U_{rms})_{N_2}$

$\frac{T_{(H_2)}}{2} = 7 \times \frac{T_{(N_2)}}{28}$

$\Rightarrow T_{(H_2)} = \frac{T_{(N_2)}}{2}$

$\Rightarrow T_{(H_2)} < T_{(N_2)}$

7. **Statement-1:** False, Besides amount, pressure also depends on volume.
Statement-2: True as $u_{rms} \propto \sqrt{T}$

8. (D)

Sol. $U_{rms} = \sqrt{\frac{3RT}{m}} = \sqrt{\frac{3P}{d}}$

$\Rightarrow U_{rms} \propto \left(\frac{1}{d}\right)^{1/2}$

9. For an ideal gas, $V_m = 22.4$ lit at 273 K & 1 atm.
In option (C), at the initial point, the volume is 22.4 lit. as required by the ideal gas equation & $\left(\frac{V}{T}\right)$ have the same value at both initial & final points.

10. $\frac{V_{Avg}}{U_{rms}} = \sqrt{\frac{8RT}{\pi m}} \div \sqrt{\frac{3RT}{m}}$

$= \sqrt{\frac{8}{3\pi}}$

$\Rightarrow U_{rms} = \sqrt{\frac{3\pi}{8}} \times 400$

$= \sqrt{\frac{3 \times 3.14}{8}} \times 400$

$\Rightarrow U_{rms} = 434.17$ m/s.

11. $U_{rms} = \sqrt{\frac{3RT}{M}}$ …….(1)

The average kinetic energy (E) of the gas is given by the following expression.

$E = \frac{3}{2}RT$

$RT = \frac{2}{3}E$ ……(2)

Substitute (2) into (1)

$U_{rms} = \sqrt{\frac{3\times\frac{2}{3}E}{M}}$

$U_{rms} = \sqrt{\frac{2E}{M}}$

12. (B)

Sol. $\frac{r_{He}}{r_{CH_4}} = \sqrt{\frac{16}{4}} = 2$

13. $(U_{rms})_x$ at 400 K = $(U_{mps})_y$ at 60 K

$\Rightarrow \sqrt{\frac{3R\times 400}{40}} = \sqrt{\frac{2R\times 60}{m_y}}$

$\Rightarrow \frac{3\times 400}{40} = \frac{2\times 60}{m_y}$

$\Rightarrow m_y = \frac{2\times 60\times 40}{3\times 400}$

$\Rightarrow m_y = 4$

14. Partial pressure of He = 1 – 0.68 = 0.32

$V = \frac{n_{He}.R_T}{P_{He}}$

$= \frac{0.1\times 0.082\times 273}{0.32}$

$\Rightarrow$ V = 7 lit.

$\Rightarrow$ Volume of container = volume of He.

15. (C)

Sol. Let distance covered by X is d, then distance covered by Y is (24 – d)

If r_x & r_y are the rate of diffusion of gases X & Y

$\frac{r_x}{r_y} = \frac{d}{24-d} = \sqrt{\frac{40}{10}} = 2$

$\Rightarrow$ d = 16 cm

16. The experimental value of d is found to smaller than the estimated value obtained using Graham's law. This is due to increased collision frequency of Y with the inert gas as compared to that of X with the inert gas. ($\because$ As, the collision frequency increases, the molecular speed decreases much more than expected.)

17. (DC) Diffusion coefficient $\propto \lambda$ (mean free path) $\propto U_{mean}$

Thus (DC) $\propto \lambda\, U_{mean}$

But $\lambda = \dfrac{RT}{\sqrt{2}\, N_0 \sigma p} \Rightarrow \lambda \propto \dfrac{T}{p}$

and $U_{mean} = \sqrt{\dfrac{8RT}{\pi M}}$

$U_{mean} \propto \sqrt{T}$

$\therefore$ $DC \propto \dfrac{(T)^{3/2}}{p}$

$$\frac{(DC)_2}{(DC)_1}(x) = \left(\frac{p_1}{p_2}\right)\left(\frac{T_2}{T_1}\right)^{3/2} = \left(\frac{p_1}{2p_1}\right)\left(\frac{4T_1}{T_1}\right)^{3/2}$$

$$= \left(\frac{1}{2}\right)(8) = 4$$

18. Finally, $P_A = P_B$ & $T_A = T_B$

So, $\dfrac{n_A}{n_B} = \dfrac{V_A}{V_B}$

$$\frac{\dfrac{5}{400R}}{\dfrac{3}{300R}} = \frac{V_A}{V_B}$$

$\Rightarrow \dfrac{V_A}{V_B} = \dfrac{5}{4}$ $\Rightarrow V_A = \dfrac{5}{9} \times 4 = \dfrac{20}{9} = 2.22$

19. The root mean square speed (U_{rms}) and average translational kinetic energy ($\in_{av}$) has following relation with temperature and molecular mass

$\in_{av} = \dfrac{3}{2}RT$, $U_{rms} = \sqrt{\dfrac{3RT}{M}}$ and $U_{rms} \propto \dfrac{1}{\sqrt{M}}$

$\therefore$ $\in_{av}$ doesn't depend on its molecular mass.

According to the relation given above $\in_{av}$ gets doubled when the temperature is increased 2 times. Thus option B is incorrect.