# States of Matter and Eudiometry

## SOLUTIONS

### EXERCISE - O

**1. Ans. (C)**

Gases do not have definite shape and volume. Their volume is equal to the volume of the container.

**2. Ans. (A)**

In gases, molecular attraction is very less and intermolecular spaces are large hence kinetic energy of gases is highest.

**3. Ans. (B)**

Barometer is used to measure atmospheric pressure of mixture of gases. Staglometer is used to measure surface tension. Only manometer is used to measure pressure of pure gas in a vessel.

**4. Ans. (D)**

The mass of gas can be determined by weighing the container, filled with gas and again weighing this container after removing the gas. The difference between the two weights gives the mass of the gas.

**5. Ans. (C)**

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

$\frac{22.4}{273}=\frac{30.6}{373}$

**6. Ans. (B)**

Using Charle's law

The correct order of pressure is

$P_1 > P_2 > P_3$

**7. Ans. (A)**

$V_2=\frac{T_2}{T_1}.V_1=\frac{270\,K}{300\,K}.400\,cm^3 = 360\ cm^3$

contraction = $V_1 - V_2 = 400 - 360 = 40\ cm^3$

**8. Ans. (A)**

$P=\frac{Constant}{V}$

**9. Ans. (C)**

At constant volume

$P_I > P_{II} > P_{III} \Rightarrow T_I > T_{II} > T_{III}$

**10. Ans. (B)**

(A) PV = nRT

At constant temperature

PV = K (T = constant)

Higher the value of PV, higher the temperature.

So, $T_3 > T_2 > T_1$

Since, $P_1 = P_2 = P_3$

So, $V \propto T \Rightarrow V_3 > V_2 > V_1$

$d = \frac{PM}{RT}$

Since, $P_1 = P_2 = P_3$

$d \propto \frac{1}{T} \Rightarrow d_1 > d_2 > d_3$

(B) From Graph,

$V_3 > V_2 > V_1$ and $T_1 = T_2 = T_3$

Higher the volume, lesser the pressure because temperature is same for all.

$P_1 > P_2 > P_3$

$d = \frac{PM}{RT}$

Since, $T_1 = T_2 = T_3$

So, $d \propto P \Rightarrow d_1 > d_2 > d_3$

(C) From the graph,

$P_3 > P_2 > P_1$ and $T_1 = T_2 = T_3$

Higher the pressure, lesser the volume because temperature is same for all.

$V_1 > V_2 > V_3$

$d = \frac{PM}{RT}$

Since, $T_1 = T_2 = T_3$

So, $d \propto P \Rightarrow d_3 > d_2 > d_1$

(D) From the graph,

$d_3 > d_2 > d_1$ and $P_1 = P_2 = P_3$

$d = \frac{PM}{RT} \Rightarrow d \propto \frac{1}{T}$

So, $T_1 > T_2 > T_3$

$PV = nRT$

Since, $P_1 = P_2 = P_3$

$V \propto T$

So, $V_1 > V_2 > V_3$

**11. Ans. (D)**

$$P_{N_2} = \frac{\text{mol of } N_2}{\text{total mol}} \times \text{total pressure}$$

$$P_{N_2} = \frac{\frac{56}{28}}{\frac{56}{28}+\frac{96}{32}} \times 10 = \frac{2}{2+3} \times 10 = 4 \text{ atm}$$

$P_{O_2} = 10 - 4 = 6$ atm

**12. Ans. (A)**

Initially $0.63 \times 1.2 = n_{He} RT$

after opening valve

$P_{He} \times (1.2 + 3.4) = n_{He} RT$

$P_{He} = \frac{0.63 \times 1.2}{4.6} = 0.164$ atm.

**13. Ans. (D)**

$\text{Rate of diffusion} \propto \frac{1}{\sqrt{\text{Molar mass}}}$

$CH_4$ has lowest molar mass among all so its rate of diffusion faster.

**14. Ans. (B)**

$r_{Diffusion} \propto \frac{1}{\sqrt{\text{Molar mass}}}$ ; $r_{Diffusion} \propto \frac{1}{\sqrt{\text{density}}}$

$r_x = 3r_y$

$\frac{r_x}{r_y} = \sqrt{\frac{d_y}{d_x}}$

$\frac{3r_y}{r_y} = \sqrt{\frac{d_y}{d_x}} = \frac{d_x}{d_y} = \frac{1}{9}$

**15. Ans. (A)**

$r_{Diffusion} \propto \frac{n}{\sqrt{M}}$

- Rate of diffusion in term of diffused mol

$\frac{n_{diffusion}}{dt} \propto \frac{n}{\sqrt{M}}$

$\frac{\left(\frac{n_{diffusion}}{dt}\right)_{He}}{\left(\frac{n_{diffusion}}{dt}\right)_{CH_4}} = \frac{n_{He}}{n_{CH_4}} \times \sqrt{\frac{M_{CH_4}}{M_{He}}}$

$\frac{(n_{diffusion})_{He}}{(n_{diffusion})_{CH_4}} = \frac{4}{1} \times \sqrt{\frac{16}{4}} = \frac{8}{1}$

**16. Ans. (D)**

$\frac{r_{O_2}}{r_H} = \sqrt{\frac{M_{H_2}}{M_{O_2}}} = \sqrt{\frac{2}{32}} = \frac{1}{4}$

$\frac{n_{O_2}}{n_H} = \frac{1}{4} \quad \therefore \quad n_H = 1$ mole

$n_{O_2} = \frac{1}{4}$ mole

Mass of $O_2 = \frac{1}{4} \times 32 = 8$ gm

**17. Ans. (A)**

$U_{mp} = \sqrt{\frac{2RT}{M}}$ ; $U_{avg} = \sqrt{\frac{8RT}{\pi M}}$ ; $U_{rms} = \sqrt{\frac{3RT}{M}}$

$U_{mp} : U_{rms} : U_{avg}$ $\sqrt{2}$ ; $U_{avg} = \sqrt{\frac{8}{\pi}}$ ; $U_{rms} = \sqrt{3} = 1 : 1.128 : 1.225$

$\frac{U_{rms}}{U_{av}} = 1.08$

$\frac{U_{av}}{U_{mp}} = 1.13$

$\frac{U_{rms}}{U_{mp}} = 1.225$

**18. Ans. (C)**

At constant temperature KE remains constant.

**19. Ans. (A)**

At similar temperature KE of two gas are same.

**20. Ans. (D)**

$$U_{rms} = \sqrt{\frac{U_1^2 + U_2^2 + U_3^2 + U_4^2}{N}}$$

$$= \sqrt{\frac{2^2 + 3^2 + 4^2 + 5^2}{4}}$$

$$= \sqrt{\frac{54}{4}} = 3.67 \text{ cm/s}$$

**21. Ans. (B)**

$$(U_{mp})_{O_2} = (U_{rms})_{N_2}$$

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

$$\sqrt{\frac{2RT}{32}} = \sqrt{\frac{3R \times 700}{28}}$$

T = 1200K

**22. Ans. (C)**

$$U_{rms} = \sqrt{\frac{3P}{d}}$$

$$\frac{(U_{rms})_{O_2}}{(U_{rms})_{H_2}} = \sqrt{\frac{d_{H_2}}{d_{O2}}} = \sqrt{\frac{1}{16}} = \frac{1}{4}$$

**23. Ans. (A)**

$$U_{avg} = \sqrt{\frac{8RT}{\pi M}}$$

$$\frac{U_1}{U_2} = \sqrt{\frac{T_1}{T_2}}$$

$$\frac{0.3}{U_2} = \sqrt{\frac{300}{1200}}$$

$U_2$ = 0.6 m/sec.

**24. Ans. (A)**

Collision frequency (Z) of a gas at a particular pressure decreases with the rise in temperature.

$Z \propto \frac{1}{T^{3/2}}$

**25. Ans. (A)**

$Z_{11} = \frac{\sigma^2 \pi \bar{U}}{\sqrt{2}}\left(\frac{N}{V}\right)^2 = \frac{\sigma^2 \pi}{\sqrt{2}}\left(\frac{N}{V}\right)^2 \sqrt{\frac{8RT}{\pi M}}$

$Z_{11} = \frac{\sigma^2 \pi}{\sqrt{2}}\left(\frac{N}{V}\right)^2 \sqrt{\frac{8}{\pi}\frac{P}{d}}$ ; for constant volume $N^* = \frac{N}{V}$ = constant

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

**26. Ans. (C)**

$\lambda = \frac{1}{\sqrt{2}\pi\sigma^2\left(\frac{N}{V}\right)}$

$\Rightarrow \frac{N}{V} = \frac{P \times N_A}{RT} = \frac{10^{-9} \times 6 \times 10^{23}}{1.01325 \times 0.0821 \times 300}$ = 2.4 × $10^{13}$ molecules/L

$\Rightarrow$ 2.4 × $10^{10}$ molecules/ml

$\Rightarrow \lambda = \frac{1}{1.44 \times \frac{22}{7} \times [500 \times 10^{-10}]^2 \times 2.4 \times 10^{10}}$ = 3.78 × $10^3$ cm

**27. Ans. (B)**

$C_2H_6 + \frac{7}{2}O_2 \rightarrow 2CO_2(g) + 3H_2O(\ell)$

V Ltr. 2V Ltr.

$C_3H_8 + 5O_2 \rightarrow 3CO_2(g) + 4H_2O(\ell)$

(3–V) 3(3–V)Ltr.

2V + 9 – 3V = 8 Ltr.

V = 1Ltr.

**28. Ans. (D)**

$C_xH_y + \left(\frac{4x+y}{4}\right)O_2 \rightarrow xCO_2 + \frac{y}{2}H_2O$

10 ml 10 x $\frac{10y}{2}$

10x = 40 $\frac{10y}{2}$ = 50

x = 4 y = 10

The hydrocarbon is $C_4H_{10}$

**29. Ans. (B)**

$O_2 \xrightarrow{\Delta}$ No reaction

x ml

$2O_3 \xrightarrow{\Delta} 3O_2$

(20 – x)ml $\frac{3}{2}$ (20 – x)ml

On passing from alkaline pyrogallol solution all the $O_2$ disappears.

$\frac{3}{2}(20 - x) + x = 29$

$60 - 3x + 2x = 58$

$x = 2$

% $O_2$ in original mixture = $\frac{2}{20} \times 100 = 10\%$

**30. Ans. (D)**

$CO(g) + \frac{1}{2}O_2(g) \rightarrow CO_2(g)$

x ml $\frac{x}{2}$ ml x ml

$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$

(20 – x)ml $\left(\frac{20-x}{2}\right)$ ml —

Volume concentration = 23

$\left(x + \frac{x}{2} + 20 - x + \frac{20-x}{2}\right) - x = 23$

$\left(\frac{3x}{2} + 20 - x + 10 - \frac{x}{2}\right) - x = 23$

$30 - x = 23$

$x = 7$ ml

$V_{CO} = 7$ ml

$V_{H_2} = 13$ ml

$V_{CO} : V_{H_2} = 7 : 13$

**31. Ans. (A)**

$C_nH_{2n}(g) + \frac{3n}{2}O_2(g) \rightarrow nCO_2(g) + nH_2O(g)$

if there no volume changes i.e. $\Delta n_g = 0$

$(n + n) - \left(1 + \frac{3n}{2}\right) = 0 \Rightarrow n = 2$

**32. Ans. (D)**

'a' is related to attractive forces and 'b' to the volume of the molecules.

**33. Ans. (C)**

Greater the attractive force between molecules greater the value of 'a'

**34. Ans. (C)**

b is excluded volume or covolume = b = $4 \times \frac{4}{3}pr^3.N_A$

**35. Ans. (D)**

In an ideal gas there are no attractive or repulsive forces present. In real gas molecules intermolecular attractive forces are present.

**36. Ans. (D)**

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

**37. Ans. (C)**

At high pressure a ≃ 0

P(V – b) = RT

PV = Pb + RT

**38. Ans. (D)**

At low pressure and high temperature 'a' factor & 'b' factor become ≃ 0

**39. Ans. (A)**

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

**40. Ans. (A)**

$b = 4N_AV$

**41. Ans. (A)**

At low pressure attractive force dominant, 'a' dominant and 'b' become negligible

Hence $\left(p+\frac{a}{V^2}\right)(V-b)=RT$

$b \simeq 0$

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

$$pV+\frac{a}{V}=RT \Rightarrow pV_m+\frac{a}{V_m}=RT$$

$$Z=\frac{pV_m}{RT}=1-\frac{a}{V_mRT}$$

$$\Rightarrow Z=\frac{pV_m}{RT}=1-\frac{a}{V_mRT}$$

**42. Ans. (D)**

(I) P(V – b) = RT

$$P=\frac{R}{(V-b)}.T \Rightarrow \text{slope}=\frac{R}{V-b}$$

(II) PV – Pb = RT

$$V=\frac{RT}{P}+b \quad \text{slope} = \frac{R}{P} \text{ and intercept b}$$

(III) $Z=\frac{PV}{RT}=1+\frac{Pb}{RT}$; Z > 1

i.e., repulsive forces predominate.

**43.** **Ans. (C)**

$Z = \frac{V_{real}}{V_{ideal}}$ ;

If $Z > V$, $V_{real} > V_{ideal}$

$Z = \frac{V_{m,real}}{V_{m,ideal}}$ ;

If $z > 1$

$\Rightarrow V_{m,\,real} > V_{m,\,ideal}$

repulsive forces are dominant and gases are difficult to compress.

If $Z < 1$, $V_{real} < V_{ideal}$ ;

If $z < 1$

$\Rightarrow V_{m,\,real} > V_{m,ideal}$

attractive forces are dominant and gases are easy to compress.

**44.** **Ans. (D)**

Vander Waal's equation in virial form

$$Z = 1 + \frac{1}{V_m}\left(b - \frac{a}{RT}\right) + \frac{b^2}{V_m^2} + \frac{b^3}{V_m^3} \ldots..$$

Third virial coefficient $C = b^2$

$$b^2 = 4 \times 10^{-2}$$

$$b = \frac{0.2l}{mol} = 0.2 \text{ lit/mol}$$

As $T > T_B$, so repulsive forces are dominant and $a \simeq 0$

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

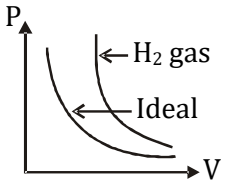
become $P(v - nb) = nRT$

$1(V - 2 \times 0.2) = 2 \times 0.0821 \times 273$

$V = 45.3$ l

**45.** **Ans. (A)**

For $H_2$ gas $+Z > 1$




**46.** **Ans. (A)**

$$z = \frac{PV}{nRT} \Rightarrow \frac{Z_A}{Z_B} = \frac{P_A V_A}{P_B V_B} \Rightarrow \frac{3Z_B}{Z_B} = \frac{P_A \times 2V_B}{P_B \times V_B}$$

$2P_A = 3P_B$

**47.** **Ans. (D)**

At low pressure when $T < T_b \Rightarrow Z < 1$

**48. Ans. (C)**

Greater the attractive force between gaseous molecules, greater the 'a', greater the liquification of gas.

**49. Ans. (A)**

$T_C = \frac{8a}{27Rb}$

Greater the $T_C$, greater the attractive force and greater the liquification of gas.

**50. Ans. (A)**

$T_C = \frac{8a}{27Rb}$

Due to very small size, attractive force between $H_2$ and He is negligible hence very small value of 'a' factor and critical temperature too.

**51. Ans. (C)**

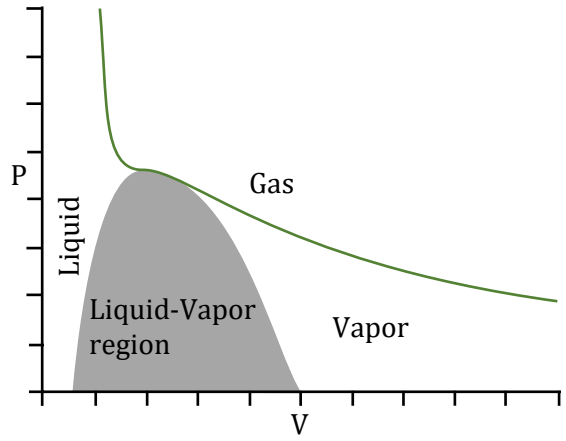
Greater the attractive force between gaseous molecules, greater the 'a' greater the liquification of gas.

**52. Ans. (B)**

I. Slope of isotherm below critical point < 0.
Slope of isotherm above critical point < 0.
Slope of isotherm at critical point = 0.
So, slope of isotherm at critical point is maximum

II. $T_C = \frac{8a}{27Rb}$
$T_C \propto a$
Larger value of $T_C$ It means less decreases in temperature is required to liquifly the gas. Gas will liquify at higher temperature. So, easier 'II be liquification.

III. When gas is below critical temperature. It is 'liquid' so Vander Waal equation of state is not valid.
So, Answer (B)




**53. Ans. (D)**

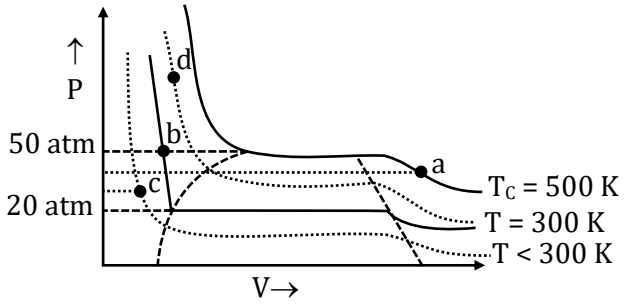
$P_C$, $V_C$ and $T_C$ are given hence 'a' and 'b' should be calculated using $P_C$ and $T_C$ as it is more reliable.

$P_C = \frac{a}{27b^2}$, $T_C = \frac{8a}{27Rb}$

$$\frac{P_C}{T_C}=\frac{R}{8b}\Rightarrow b=\frac{300\times1/12}{8\times50}=\frac{1}{16}$$

$$4\times\frac{4}{3}\pi r^3.N_A=\frac{1}{16}\Rightarrow r=\left(\frac{3}{256\pi Na}\right)^{1/3}$$

**54. Ans. (D)**




(a) at T = 500 K, P = 40 atm corresponds to 'a' substance – gas
(B) at T = 300 K, P = 50 atm corresponds to 'b' substance – liquid
(C) at T < 300 K, P > 20 atm corresponds to 'c' substance – liquid
(D) at T < 500 K, P > 50 atm corresponds to 'd' substance - liquid
So, Answer (D)

**55. Ans. (A,B,C)**
For Boyle's law

**56. Ans. (A,C,D)**
$n_A = 3, n_B = 1, n_C = 1$

$$(P_A)_i=\frac{n_ART}{V}=\frac{3RT}{V},\ (P_B)_i=\frac{n_BRT}{V}=\frac{1\times RT}{V}$$

$$(P_A)_f=\frac{3RT}{V},\ (P_B)_f=\frac{1\times RT}{V}$$

$$(P_T)_i=\frac{(3+1)RT}{V}\Rightarrow(P_T)_f=\frac{5RT}{V}\Rightarrow\frac{(P_T)_i}{(P_T)_f}=\frac{4}{5}.$$

$$\frac{P_1}{n_1}=\frac{P_2}{n_2}\Rightarrow\frac{20}{4}=\frac{P_2}{5}$$

$P_2$ = 25 atm (V = constant as container is rigid)

Partial pressure of C = $X_C \times P_T = \frac{1}{5} \times 25 = 5$ atm.

**57. Ans. (C,D)**

$$\lambda=\frac{1}{\sqrt{2}\pi\sigma^2N^*}$$

$$N^*=\frac{N}{V}=\frac{PN_A}{RT}$$

$$\lambda=\frac{V}{\sqrt{2}\pi\sigma^2N}=\frac{RT}{\sqrt{2}\pi\sigma^2PN_A}$$

**58. Ans. (B,C,D)**
Liquefaction of gas not possible for $T > Te$

$$T_b=\frac{a}{Rb};T_C=\frac{8a}{27Rb}$$

## EXERCISE - S

### *Ideal Gas*

**1.** **Ans. (2)**

At bottom,

$P_A = P_{atm} + P_{Hg}$

$= 1 + 1 = 2$ atm

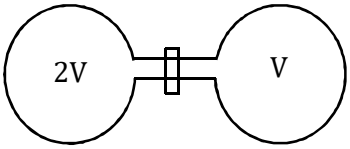
**2.** **Ans. (–111.5)**

Since P is constant, From Charles law,

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

$\frac{100}{323} = \frac{50}{T_2} = 161.5\ K \Rightarrow T_2 = -111.5°C.$

**3.** **Ans. (2)**




$P_A$ 2500 mm  $P_B$ 1000 mm

$P_A \times 2V = (P_{final})_A \times (3V)$

$\frac{2}{3} \times 2500 = (P_{final})_A$

$P_B \times V = (P_{final})_B \times 3V$

$\frac{1000}{3} = (P_{final})_B$

$P_{total} = \frac{5000}{3} + \frac{1000}{3} = 2000$ mm or $= 2m$

**4.** **Ans. (0.028)**

$P_{H_2O} = X_{H_2O} \times P_{total} = 0.0287 \times 0.977 = 0.028$ bar

**5.** **Ans. (1460)**

(Aqueous tension of $H_2O$ = 20 mmHg)

$P_{Total} = P_{O_2} + P_{H_2O}$

$P_{O_2}$ (initial) = 740 – 20 = 720 mmHg

$(P_{O_2} V_{O_2})_{initial} = (P_{O_2} V_{O_2})_{final}$ (Boyle's law)

$720 \times V = P_{O_2} \times \frac{V}{2}$

$P_{O_2} = 1440 mm$

$P_T = P_{O_2} + P_{aq.}$

$= 1440 + 20 = 1460$ mm

**6.** **Ans. (100)**

$P = \frac{nR}{V}.T \Rightarrow \log P = \log \frac{nR}{V} + \log T$

$Y = C + mx$

Intercept = $\log\frac{nR}{V} = 1$

$\frac{nR}{V} = 10$

$n = 10\times\frac{V}{R} = \frac{10\times0.084}{0.084} = 100$ mol

**7. Ans. (0.347)**

$\frac{r_A}{r_B} = \frac{n_A}{n_B}\cdot\sqrt{\frac{M_B}{M_A}} = \frac{w_A}{w_B}\left(\frac{M_B}{M_A}\right)^{3/2}$

$\Rightarrow \quad \frac{r_A}{r_B} = \frac{1}{4} = \frac{2}{3}\left(\frac{M_B}{M_A}\right)^{3/2}$

$\left(\frac{M_A}{M_B}\right) = \left(\frac{8}{3}\right)^{\frac{2}{3}}$

$\frac{M_A}{M_B} = \frac{4}{(3)^{2/3}} = \frac{4}{(9)^{1/3}} = \frac{4}{2.08}$

Let mass of gas A in the mixture be 2x and gas B be 3x

$\frac{X_A}{X_B} = \frac{n_A}{n_B} = \frac{\frac{2X}{M_A}}{\frac{3X}{M_B}} = \frac{2}{3}\times\frac{2.08}{4} = 0.347$

**8. Ans. (6)**

$C_xH_y + \left(x+\frac{y}{4}\right)O_2 \rightarrow xCO_2(g) + \frac{y}{2}H_2O(l)$

V $\left(x+\frac{y}{4}\right)V$

— — Vx

Volume contraction = $V_i - V_f$

$V_i = V + V\left(x+\frac{y}{4}\right)$

$V_f = Vx$

$2.5\ V = V\left(1+\frac{y}{4}\right)$

y = 6

Number of H-atom in 1 molecule of hydrocarbon is 6.

**9. Ans. (9)**

$Z_{11} \propto P^2$ (at constant temperature)

So, if pressure is tripled, $Z_{11}$ increases by nine times.

**10. Ans. (1.256)**

$Z = 1 - \frac{a}{V_m RT}$

$Z = \frac{PV_m}{RT} \Rightarrow V_m = \frac{RTZ}{P}$

$$Z = 1 - \frac{a}{(RT)^2} \times \frac{P}{Z}$$

$$0.5 = 1 - \frac{a \times 100}{(273 \times 0.0821)^2 \times .5}$$

$a = 1.256$ atm $L^2$ $mol^{-2}$

**11. Ans. (500)**

At Boyle temperature real gas behave ideally

$$T_B = \frac{a}{Rb} = \frac{1.642}{0.0821 \times 0.04} = 500$$

**12. Ans. (2)**

$$4N \frac{4}{3}\pi r^3 = 3.2 \times \pi \times 10^{-6}$$

$$4 \times 6 \times 10^{23} \times \frac{4}{3}\pi r^3 = 3.2\pi \times 10^{-6}$$

$r^3 = 10^{-30}$ m

$r = 0.1$ nm

$d = 2r = 0.2$ nm

**13. Ans. (9)**

$\therefore \quad Z_C = \frac{3}{8}; \frac{3}{8} = \frac{x}{24}; x = 3 \times 3; x = 9.$

**14. Ans. (0.36 & 0.00428)**

$T_C = 273 + 31 = 304$ K, $P_C = 728$ atm

$$T_C = \frac{8a}{27Rb} \text{ and } P_C = \frac{a}{27b^2}$$

$$\therefore \quad \frac{T_C}{P_C} = \frac{8a}{27Rb} \times \frac{27b^2}{a} = \frac{8b}{R}$$

On substitution $\frac{304}{728} = \frac{8b}{0.082}$

$$\therefore \quad b = \frac{304 \times 0.082}{728 \times 8} = 4.28 \times 10^{-3} \text{ litre/mole}$$

Now, $T_C = \frac{8a}{27Rb}$

$$\therefore \quad a = \frac{27RbT_C}{8} = \frac{27 \times 0.082 \times 4.28 \times 10^{-3} \times 304}{8} = 0.36 \text{ atm litre}^2 \text{ mole}^{-2}$$

**15. Ans. (4.00)**

$$d_{Mixture} = \frac{PM_{mixture}}{RT}$$

| | $2HI$ | $\rightleftharpoons$ | $H_2$ | + | $I_2$ |
|---|---|---|---|---|---|
| t=0 | 1 | | | | |
| | $1-\alpha$ | | $\frac{\alpha}{2}$ | | $\frac{\alpha}{2}$ |

Total moles = $1 - \alpha + \frac{\alpha}{2} + \frac{\alpha}{2} = 1$

$M_{mixture} = \frac{\text{Total mass}}{\text{Total moles}} = \frac{128}{1}$

$d = \frac{1 \times 128}{0.08 \times 400} = 4 g/ml$

**16. Ans. ($T_3 = 360.00$, $T_4 = 90.00$, $P_1 = 5.00$, $P_2 = 1.50$, $V_1 = 16.00$)**

At point B $T_1 = 300$ K

so, A to B is isothermal process

hence $(PV)_A = (PV)_B$

$10 \times 4 = P_1 \times 8$

$P_1 = 5$ atm

Point B to C is isobaric process

hence $\left(\frac{V}{T}\right)_B = \left(\frac{V}{T}\right)_C$

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

$V_1 = 16$ liter

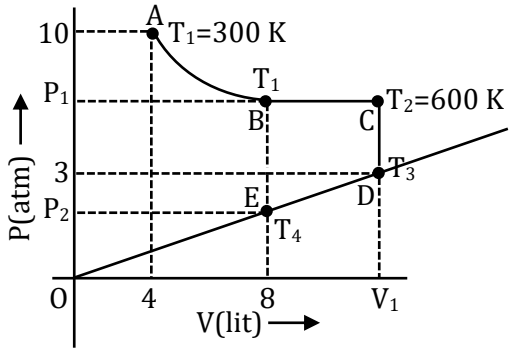
Point C to D is isochoric process

hence $\left(\frac{P}{T}\right)_C = \left(\frac{P}{T}\right)_D$

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

$T_3 = 360$ k

At point E




observe that line joining D & E is straight & passing through origin slope of "OD" & ED are same

so slope of $OD = ED = \frac{y_2 - y_1}{x_2 - x_1}$

considering OD we get $\frac{V_1 - 0}{3 - 0} = m$

considering OE we get $\frac{8 - 0}{P_2 - 0} = m$

so $\frac{16}{3} = \frac{8}{P_2} \Rightarrow \boxed{P_2 = 1.5 \text{ atm}}$ ($V_1 = 16$ liter)

point B & E are isochoric hence

$$\left(\frac{P}{T}\right)_B = \left(\frac{P}{T}\right)_E$$

$$\frac{5}{300} = \frac{1.5}{T_4}$$

$T_4 = 90$ k

**17. Ans. (a. (80.00), b. (1295.00))**

(a) Given $P \propto r$ P = Pressure, r = radius

so $\frac{P_1}{r_1} = \frac{P_2}{r_2}$

given $P_1 = 1$ atm & $d_1 = 1$ m so $r_1 = 1/2$ m

$P_2 = 3$ atm hence

$$\frac{P_1}{P_2} = \frac{r_1}{r_2} \Rightarrow r_2 = r_1 \times \frac{P_2}{P_1}$$

$$r_2 = \frac{1}{2} \times \frac{3}{1} = \frac{3}{2} m \quad \left[\frac{r_2}{r_1} = 3\right]$$

Assuming temperature to be constant as nothing is given about it.

so $P_1V_1 = n_1RT$

& $P_2V_2 = n_2RT$

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

Taking ballon to be perfect sphere

$V_1 = \frac{4}{3}\pi r_1^3$ $V_2 = \frac{4}{3}\pi r_2^3$

$P_1 = 1$ atm $P_2 = 3$ atm

$n_1 = 1$ mole $n_2 = ?$

so $1 \times \frac{4}{3}\pi r_1^3 = 3 \times \frac{4}{3}\frac{\pi r_2^3}{n_2}$

or $n_2 = 3\left(\frac{r_2}{r_1}\right)^3$

putting $\frac{r_2}{r_1} = 3$

$n_2 = 3 \times (3)^3$

$= 81$ moles

so number of moles to be added

$= n_2 - n_1 = 80$ moles

(b) If volume = $36\pi$ then

$$36\pi = \frac{4}{3}\pi r^3$$

or $\Rightarrow r^3 = 27$

$r = 3$ m

now using the reaction

$\frac{P_1}{r_1} = \frac{P_2}{r_2}$ calculated above

$P_2 = \frac{r_2}{r_1} \times P_1$ Given $r_1 = 1/2$

$= 3 \times 2 \times 1$ $r_2 = 3$

$P_2 = 6$ atm $P_1 = 1$

so when pressure reaches 6 atm volume will become $36\pi m^3$; furture filling the gas, will increases the volume, and balloon will get burst.

so again using

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

where $P_1 = 1$ $V_1 = \frac{4}{3}\pi r_1^3$

$n_1 = 1$

$P_2 = 6$ $V_2 = 36\pi m^3$

$n_2 = ?$

$$\frac{1 \times \frac{4}{3} \times \pi \times \left(\frac{1}{2}\right)^3}{1} = \frac{6 \times 36\pi}{n_2}$$

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

$= 54 \times 24$

$n_2 = 1296$

so, no. of moles to be added

$= n_2 - n_1 = 1295$ moles

**18. Ans. (i. (6.00), ii. (No))**

| | $NH_4Cl(s)$ | $\rightarrow$ | $NH_3(g)$ | + | $HCl(g)$ |
|---|---|---|---|---|---|
| at t=0 | 1 moles | | × | | × |
| after complete decomposition | | | | | |
| t = t | × | | 1 | | 1 |

so total gaseous moles will be = 2 (coming from $NH_4Cl(s)$)

$V = 24.63$ $T = 600$ $n = 2$

$R = 0.082$ $\frac{\text{liter atm}}{\text{mol K}}$

using ideal gas equation

$P = \frac{nRT}{V}$

$= \frac{2\times0.082\times600}{24.63}$

$P_{(NH_3+HCl)} = 4$ atm

Now lid was initially open so vessel has air at 1 atm & 300 k, when heated on closing the lid, the moles of air will remain same at T = 600 k

$\left(\frac{P_1}{T_1}\right)_{air} = \left(\frac{P_2}{T_2}\right)_{air}$ [as Vessel volume is const.]

so $(P_2)_{air} = \frac{600\times1}{300} = 2$ atm

hence $P_{Total} = p_{air} + p_{(NH_3+HCl)}$

= 4 + 2 = 6 atm

Now $P_{Inside}$ = 6 atm

$P_{outside}$ = 1 atm

$\Delta P$ = 5 atm ; so lid will not blow

**19. Ans. (627.00)**

n = 1 mol

$P = \frac{1}{8.2}V$

V = 8.2 P

$P_{final}$ = 3 atm

$T_f = \left(\frac{PV}{nR}\right)_f = \frac{P_f\times8.2\times P_f}{nR}$

$= \frac{3\times8.2\times3}{1\times0.082} = 900$ k

= 900 – 273 = 627°C

**20. Ans. (2.00)**

$A \rightleftharpoons A_2$

Given Total mass = 96 g

T = 273°C = 546 k

V = 33.6L

mass of dimer = 48g (50%)

$n_{A_2} = \frac{48}{96} = \frac{1}{2}$ mole

$n_A = \frac{48}{48} = 1$ mole

Total gaseous mole = 1 + 0.5 = 1.5

Now from

$$P = \frac{nRT}{V}$$

$$= \frac{1.5 \times 0.082 \times 546}{33.6} = 2 \text{ atm}$$

**21. Ans. (6.00)**

Temperature & total moles of gas are constant so

$(PV)_i = (PV)_f$

$30 \times 2 = P_f \times 5$

$P_f = 12$ atm

Now partial press of C

$P_C$ = Mole fraction of C × $P_{Total}$

$$= \frac{3}{6} \times 12 = 6 \text{ atm}$$

**22. Ans. (2.00)**

As gases are non-reacting

$$(n_{He})_{initial} + (n_{Ne})_{initial} + (n_{xe})_{initial} = (n_{He})_{final} + (n_{Ne})_{final} + (n_{xe})_{final}$$

$$\frac{1.5 \times 2}{RT} + \frac{4 \times 2.5}{RT} + \frac{1 \times 1}{RT} = \frac{P_f.(2+4+1)}{RT} \qquad \left(n = \frac{PV}{RT}\right)$$

$3 + 10 + 1 = P_f \times 7$

$P_{final} = 2$ atm

**23. Ans. (380.00)**

mole ratio of $N_2$ and $O_2$ is 75 : 25

final Total pressure = 1560 torr

final total pressure is due to $N_{2(g)}$, $O_{2(g)}$ & vapour of $H_2O$

$$\therefore \quad p_{N_2} + p_{O_2} + (p_{H_2O})_{vap.} = 1560$$

$$p_{N_2} + p_{O_2} + 40 = 1560$$

$$p_{N_2} + p_{O_2} = 1520 \text{ torr}$$

pressure ratio or $N_2$ and $O_2$ is same as mole ratio

$$\therefore \quad p_{O_2} = \left(\frac{25}{25+75}\right) \times 1520 = 380 \text{ torr}$$

**24. Ans. (i. (1.50), ii. (1.25), iii. (0.20 or 0.21))**

(i) $\frac{16}{32} = \frac{1}{2}$ mole of $O_2$

By PV = nRT

$$P \times 8.2 = \frac{16}{32} \times 0.082 \times 300$$

= P = 1.5 atm

(ii) $O_2 \rightarrow \frac{2}{3}O_3$

$t=0 \quad \frac{1}{2}$ mole $\quad -$

$t=t \quad \left(\frac{1}{2}-\frac{1}{4}\right) \quad \frac{2}{3}\times\frac{1}{4}$ mole [50% converted]

$=\frac{1}{4}$ mole $\quad =\frac{1}{6}$ mol

By PV = nRT

$P_{Total}=\frac{n_{Total}RT}{V}$

$=\frac{5}{12}\times\frac{0.082\times300}{8.2}=1.25$ atm

(iii) At 50 k and 50% conversion

$P_{Total}\times8.2=\left(\frac{1}{4}+\frac{1}{6}\right)\times0.082\times50$

$P_{Total}$ = 0.208 atm

**25. Ans. (7.00)**

$V_{Total}=\frac{n_{Total}RT}{P}$

$n_{Total}=n_{He}+n_{H_2O}$

$n_{H_2O}=\left(\frac{PV_{Total}}{RT}\right)_{H_2O}=\frac{0.68\times V_{Total}}{0.082\times273}$

$n_{Total}=0.1+\frac{0.68\times V_{Total}}{0.082\times273}$

$n_{Total}=\left(0.1+\frac{0.68V_{Total}}{0.082\times273}\right)\times\frac{0.082\times273}{1}$

$V_{Total}$ = 2.24 + 0.68 $V_{Total}$

0.32 $V_{Total}$ = 2.24

$V_{Total}=\frac{2.24}{0.32}=7$ liter

**26. Ans. (4.00)**

Initially PV = nRT

$3\times24.6=(n_{D_2}+n_{H_2})\times0.082\times300$

$3=1+n_{H_2}\Rightarrow(n_{H_2})_i=2$ moles

Final mass ratio = $\frac{w_{D_2}}{w_{H_2}}=\frac{1}{4}$

$\left(\frac{n_{D_2}}{n_{H_2}}\right)=\frac{1/4}{4/2}=\frac{1}{8}$

We know $\left(\frac{n_{D_2}}{n_{H_2}}\right)_f = \left(\frac{n_{D_2}}{n_{H_2}}\right).\left(\sqrt{\frac{M_{H_2}}{M_{D_2}}}\right)^n$

$\frac{1}{8} = \frac{1}{2}\left(\sqrt{\frac{2}{4}}\right)^n \Rightarrow \frac{1}{4} = \left(\frac{1}{2}\right)^{\frac{n}{2}}$

$\Rightarrow$ n = 4 steps

**27. Ans. (8.00)**

$u_{av} = \sqrt{\frac{8RT}{\pi M}}$ $\quad$ $u_{rms} = \sqrt{\frac{3RT}{M}}$ $\quad$ $u_{av}$ = 1.84 × 104 cm/sec

= 184 m/sec

$\frac{u_{av}}{u_{rms}} = \sqrt{\frac{8}{3\pi}} = 0.92$

$u_{rms} = \left(\frac{184}{0.92}\right)$

$KE = \frac{1}{2}m.(u_{rms})^2$ $\quad$ (per molecule)

$= \frac{1}{2} \times \frac{48\times10^{-3}}{6\times10^{23}} \times \left(\frac{184}{0.92}\right)^2$

KE = $1.6 \times 10^{-21}$ J = x

$\therefore \quad \left(\frac{x}{2}\times10^{22}\right) = 8$

**28. Ans. (i. (0.012 atm), ii. ($2.50 \times 10^{22}$), iii. (3.60 J), iv. (300.00 J), v. (1 : $\sqrt{2}$), vi. (1 : 2500))**

(i) For container A

$P = \frac{nRT}{V} = \frac{N}{N_A}.\frac{RT}{V}$

$= \frac{6\times10^{20}}{6\times10^{23}} \times \frac{8\times300}{2\times10^{-3}} = 1200 \text{ Pa} = 0.012 \text{ atm}$

(ii) For container B

$P = \frac{nRT}{V} = \frac{N}{N_A}.\frac{RT}{V}$

$N = \frac{PN_AV}{RT}$

$= \frac{10^5 \times 6\times10^{23} \times 2\times10^{-3}}{8\times600}$

= $2.5 \times 10^{22}$

(iii) For container A

$KE_{Total} = \frac{3}{2}RT \times$ No. of moles of ideal gas

$= \frac{3}{2}\times8\times300\times\frac{6\times10^{20}}{6\times10^{23}} = 3.6\text{J}$

(iv) For container B

$$KE_{Total} = \frac{3}{2}RT \times \text{No. of moles of ideal gas}$$

$$= \frac{3}{2} \times 8 \times 600 \times \frac{2.5 \times 10^{22}}{6 \times 10^{23}} = 300 \text{ J}$$

(v) $$\frac{(U_{MPS})_A}{(U_{MPS})_B} = \frac{\left(\sqrt{\frac{2RT}{M}}\right)_A}{\left(\sqrt{\frac{2RT}{M}}\right)_B} = \sqrt{\frac{T_A}{T_B}} = \sqrt{\frac{300}{600}} = \frac{1}{\sqrt{2}}$$

(vi) $$z_{11} = \frac{1}{\sqrt{2}}\pi\sigma^2 u_{avg} N^{*2}$$

$$z_{11} = \frac{1}{\sqrt{2}}\pi\sigma^2 \sqrt{\frac{8RT}{\pi M}} \cdot \left(\frac{N}{V}\right)^2$$

$$z_{11} \propto \sqrt{T}.(N)^2$$

$$\frac{(z_{11})_A}{(z_{11})_B} = \sqrt{\frac{300}{600}} \times \left(\frac{6 \times 10^{20}}{2.5 \times 10^{22}}\right)^2$$

$$= \frac{1}{\sqrt{2}} \times \frac{36}{6.25 \times 10^4}$$

$$= \frac{1}{2.45 \times 10^3} \simeq \frac{1}{2.5 \times 10^3} = \frac{1}{2500}$$

## *Real Gas*

**29. Ans. (58.82)**

Molar volume of mercury = $\frac{200}{13.6}\text{cm}^3$

So, value of b = $\frac{200}{13.6} \times 4 = 58.82$

**30. Ans. (0.50)**

PV = ZnRT

P = $Z\frac{n}{V}RT$

P = ZCRT

72 = Z(6)(.08 × 300)

Z = 0.5

**31. Ans. (222.22)**

P(V –nb) = nRT

240 (10 – .08n) = n (.08) (300)

240 (10 – .08n) = 24 n

100 – 0.8n = n

$n = \frac{100}{1.8} \Rightarrow$ mass of He = $\frac{100}{1.8} \times 4 = 222.22$ gm

**32. Ans. (1.68 or 1.69)**

Critical volume $V_C = \frac{\text{Molar mass}}{\text{Density}}$

$V_C = \frac{30}{0.4} cm^3$

$V_C = 75\ cm^3$

$3b = 75$

$b = 25 \frac{cm^3}{mol} = .025 \frac{Litre}{mol}$

$T_C = \frac{10^4}{41}$

$\frac{8a}{27Rb} = \frac{10^4}{41}$

$\frac{8a}{27 \times .0821 \times .025} = \frac{10^4}{41}$

$a = 1.6875\ atm\ L^2\ mol^{-2}$

**33. Ans. (60.00)**

$T_b = \frac{a}{Rb} = \frac{4.10}{(.0821)\left(\frac{1}{6}\right)} = 300\ K$

So at 300 K this gas will behave like a ideal gas.

$PV = nRT$

$(.0821)\ V = 0.2\ (.0821)\ (300)$

$V = 60$ Litre

**34. Ans. (1.62)**

Mass of 1 litre gas = 1.6 g = $\frac{1.6}{32} = \frac{1}{20} mol$

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

$\left(P + \frac{4\left(1/20\right)^2}{1^2}\right)\left(1 - \frac{1}{20} \times 0.4\right) = \frac{1}{20} \times .08 \times 400$

$\left(P + \frac{1}{100}\right)(0.98) = 1.6$

$P = 1.62\ atm$

## EXERCISE - JEE (Advanced) PYQ

**1. Ans. (B)**

**TIPS/Formulae :**

Compressibility factor of ideal gas (Z) = $\frac{PV}{nRT}$

For one mole of ideal gas at STP

$Z = \frac{P \times 22.4}{RT}$

For other gases Z < 1 and $Z = \frac{P \times V_m}{RT}$

$\therefore \quad V_m < 22.4$ litres

**Alternate solutions**

$(PV)_{Observed}/(PV)_{Ideal} < 1$

$\Rightarrow \quad V_{obs} < V_{ideal}, V_{obs} < 22.4$ litre.

**2. Ans. (C)**

**TIPS/Formulae :**

$U_{rms} = \sqrt{\frac{3RT}{M}}$

$\sqrt{\frac{3RT_{H_2}}{2}} = \sqrt{7}\sqrt{\frac{3RT_{N_2}}{28}}$ ;

$\therefore \quad T_{N_2} = 2T_{H_2}$ or $T_{N_2} > T_{H_2}$

**3. Ans. (T)**

$\rightarrow \quad P \propto T$

$\rightarrow$ collision frequency $\propto U_{avg.} \propto \sqrt{T}$

**4. Ans. (D)**

$U_{RMS} = \sqrt{\frac{3RT}{M}}$

Using ideal gas equation

$PV = RT = \frac{W}{M}RT \qquad \frac{RT}{M} = \frac{PV}{w} = \frac{P}{d}$

Where d is the density of the gas

$\therefore \quad U_{RMS} = \sqrt{\frac{3p}{d}}$ at constant pressure

$U_{RMS} \propto \frac{1}{\sqrt{d}}$

option (d) is correct

**5. Ans. (434.17)**

**IPS/Formulae :**

$C_{rms} = \sqrt{\frac{3RT}{M}}$ , $C_{av} = \sqrt{\frac{8RT}{\pi M}}$

$$\frac{C_{rms}}{C_{av}} = \sqrt{\frac{3RT}{M}} \times \sqrt{\frac{\pi M}{8RT}} = \sqrt{\frac{3\pi}{8}} = 1.085$$

$C_{rms} = 1.085 \times C_{av} = 1.085 \times 400 = 434\ ms^{-1}$

**6. Ans. (C)**

For positive deviation : PV = nRT + nPb

$$\Rightarrow \frac{PV}{nRT} = 1 + \frac{Pb}{RT}$$

Thus, the factor nPb is responsible for increasing the PV value, above ideal value, b is actually the effective volume of molecule. So, it is the finite size of molecules that leads to the origin of b and hence positive deviation at high pressure.

**7. Ans. (B)**

**TIPS/Formulae :**

Use Grahams' law of diffusion

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

**8. Ans. (RT)**

The Vander Waal equation (for one mole) of a real gas is

$$\left(P + \frac{a}{V_m^2}\right)(V_m - b) = RT$$

$$PV_m - Pb + \frac{a}{V_m} - \frac{ab}{V_m^2} = RT$$

$$PV_m = RT + Pb - \frac{a}{V_m} + \frac{ab}{V_m^2} \qquad ...(i)$$

**Note This step :** To calculate the intercept $P \to 0$, hence $V_m \to \infty$ due to which the last two terms on the right side of the equation (can be neglected.

$\therefore \quad PV_m = RT + Pb$

When P = 0, intercept = RT

**9. Ans. (B)**

For gas A, a = 0, $Z = 1 + \frac{Pb}{RT}$ implies Z varies linearly with pressure.

For gas B, b = 0, $Z = 1 - \frac{a}{VRT}$. Hence, Z does not vary linearly with pressure.

**10. Ans. (D)**

Matching

(A) $\to$ (P), (S)

[Because 200 atm pressure is very large for $H_2$ gas, at very high pressure Z > 1]

(B) $\to$ (R)

[Since p ~ 0 it means very low pressure so ideal behaviour is observed]

(C) $\to$ (P) & (Q)

[Since P is 1 atm, Z for $CO_2$ would be less than 1]

(D) $\to$ (R)

In real gas with very high molar volume, molecules will be very far apart from each other due to which Vander Waals forces as well as actual vol. occupied by molecule will be negligible.

**11. Ans. (A,C,D)**

(A), (C), (D) are correct

$\left(P+\frac{n^2a}{v^2}\right)(v-nb)=nRT$

At low pressure, when the sample occupies a large volume, the molecule are so far apart for most of the time that intermolecular forces play no significant role, and the gas behaves virtually ideal perfectly a & b are characteristic of a gas are independent of temp. The term $\left(P+\frac{n^2a}{v^2}\right)$ represents the pressure exerted by an ideal gas while P represents the pressure exerted by a real gas.

**12. Ans. (B)**

Correction factor for attractive force for n moles of real gas is given by the term mentioned in (b)

**13. Ans. (4)**

$V_{rms}$ of x = $\sqrt{\frac{3RT_x}{M_x}}$

$V_{mp}$ of y = $\sqrt{\frac{2RT_y}{M_y}}$

Given $V_{rms} = V_{mp}$

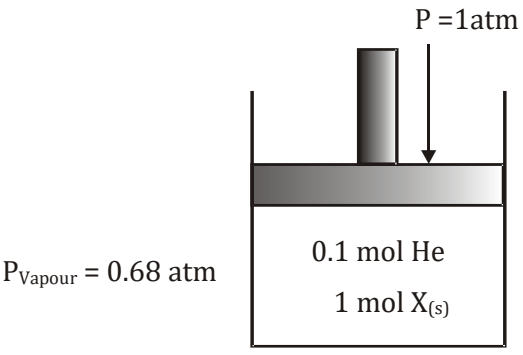
$\Rightarrow \sqrt{\frac{3RT_x}{M_x}}=\frac{\sqrt{2RT_y}}{M_y}$

$\Rightarrow M_y = \frac{2RT_yMx}{3RT_x}=\frac{2\times60\times40}{3\times400}$

$M_y = 4$

**14. Ans. (7)**

Since external pressure is 1 atm




$P_{Vapour} + P_{He} = 1$

$\Rightarrow P_{He} = 1 - 0.68 = 0.32$ atm

Now from ideal gas equation $\Rightarrow PV = nRT$

$\Rightarrow 0.32 \times V = 0.1 \times (R \times 273)$

$\Rightarrow V = 7$ litre.

**15. Ans. (C)**

$\left(P+\frac{a}{V^2}\right)(V-0)=RT$ as (n = 1)

$PV = RT - \frac{a}{V}$

On comparing slope from graph

$-a = \frac{20.1-21.6}{3-2}$

$-a = \frac{-1.5}{1} = a = 1.5$

**16. Ans. (C)**

$\left[\frac{d_x/t}{d_y/t}\right] = \sqrt{\frac{M_y}{M_x}}$

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

$d = 48 - 2d$

$d = 16$ cm

**17. Ans. (D)**

The experimental value of d is found to be smaller than the estimated, this is due to increased collision frequency of X with the inert gas as compared to that of Y with inert gas.

With increase in collision frequency, the molecular speed decreases then the expected so the distance converted will be less.

**18. Ans. (2.22)**

Finally

$P_A = P_B$, $T_A = T_B$

($\because$ Heat flow take place until temp. become equal)

$\text{hence} = \frac{n_A}{V_A} = \frac{n_B}{V_B}$

$= \frac{\frac{5\times1}{R\times400}}{V_A} = \frac{\frac{3\times1}{R\times300}}{V_B}$

$\frac{V_A}{V_B} = \frac{5}{4}$

$V_A = \frac{5}{9} \times 4 = 2.22$

($\because$ total value = 4l)

**19. Ans. (ABC)**

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

$KE_{avg} \propto T$

**20. Ans. (B)**

Graph represents symmetrical distribution of speed and hence, the most probable and the average speed should be same. But the root mean square speed must be greater than the average speed.

## JEE (Advanced) Practice Paper

**1.** **Ans. (B)**

$V_1 = 5L$ $V_2 = 1L$

$P_1 = 1$ bar $P_2 = ?$

$P_1V_1 = P_2V_2$

$1 \times 5 = P_2 \times 1$

$P_2 = 5$

% increase = 400%

**2.** **Ans. (B)**

$3A \rightarrow 2B$

$1-\alpha \quad \frac{2}{3}\alpha$

Total moles = $1-\frac{\alpha}{3}$

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

y = m x

$\downarrow$

slope

As per given data tan 42.95 = 0.8

$\therefore \frac{nR}{V} = 0.8$

$\therefore \ n = \frac{0.8 \times 0.082}{0.082}$

n = 0.8

$\therefore \ 1-\frac{\alpha}{3} = 0.8$

$\therefore \ \alpha = 0.6$

**3.** **Ans. (C)**

Let the distance travelled by gas X at the point of meeting be "x"

Distance travelled by gas Y = "150 –x"

Applying Rate of diffusion equation.

$\frac{r_X}{r_Y} = \frac{n_X}{n_Y}\sqrt{\frac{M_Y}{M_X}}$

$\Rightarrow \frac{\frac{x}{t}}{\frac{(150-x)}{t}} = \frac{3}{2}\sqrt{\frac{80}{20}}$

$\frac{x}{150-x} = 3$

$x = 450 - 3x \Rightarrow 4x = 450$

x = 112.5 cm

Distance of A from Q = 150 – x = 37.5 cm

**4.** **Ans. (C)**

$Z = \frac{PV}{nRT}$

$V = 0.064$ L

**5.** **Ans. (A)**

Critical temperature = $\frac{8}{27}\frac{a}{Rb}$

$\frac{8}{27}\frac{a}{Rb} < 300$ $\quad [200 < T_C < 300]$

$\frac{a}{b} < 81$

$\frac{8a}{27Rb} > 200$

$\boxed{\frac{a}{b} > 54}$

$\left[54 < \frac{a}{b} < 81\right]$

**6.** **Ans. (C)**

**$C_4H_{10}$, $CH_4$ & CO mixture** $\rightarrow$ **$C_4H_{10}$** 40% by volume

$\therefore$ **Volume of $C_4H_{10}$** = 80 ml

& **$CH_4$** & CO volume = 120 ml

If **$CH_4$** volume = x ml

Volume of CO = 120 – x ml

$$C_4H_{10} + \frac{13}{2}O_2 \longrightarrow 4CO_2 + 5H_2O$$

80 ml $\qquad$ 4 × 80 = 320 ml

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$$

x ml $\qquad$ x ml

$$CO + \frac{1}{2}O_2 \longrightarrow CO_2$$

120 – x $\qquad$ 120 – x ml

Total **$CO_2$** = 320 + 120 – x + x = 440 ml

**7.** **Ans. (B,D)**

Since initially manometer shown no difference in mercury level therefore initial pressure of gas A = 76 cm of Hg = 1 atm

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

initial pressure (atm) 1 $\qquad$ 0 $\qquad$ 0

It is given that after sparking pressure of gas 'A' is decreased to 0.8 atm. It means 0.2 atm of 'A' is converted into B and C.

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

pressure after sparking (atm) 1–0.2=0.8 $\qquad \left(\frac{3}{2}\times 0.2 = 0.3\right) \qquad$ 0.2

$\therefore$ After sparking $P_{total}$ = 0.8 + 0.3 = 0.2 = 1.3 atm.

initially total pressure was 1 atm

$\therefore$ Differecne is Hg level = 0.3 atm = 22.8 cm of Hg

= 228 mm of Hg

**8. Ans. (A,B,C,D)**

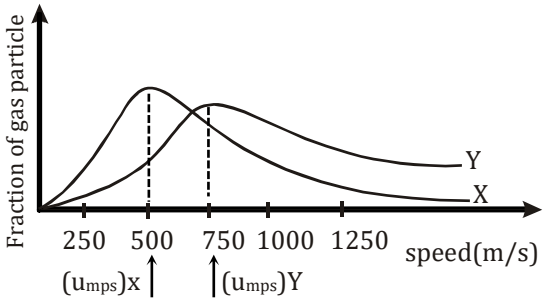
$$V = \frac{nRT}{P} : V_{H_2} = \frac{\left(\frac{1}{2}\right)\times 0.0821\times(273+273)}{1} = 22.4\ell$$

$$V_{He} = \frac{\left(\frac{2}{4}\right)\times 0.0821\times(273+273)}{1} = 22.4\ell$$

$$V_{CH_4} = \frac{\left(\frac{3}{16}\right)\times 0.0821\times(273+273)}{1} = 8.4\ell$$

$$V_{SO_2} = \frac{\left(\frac{4}{64}\right)\times 0.0821\times(273+273)}{1} = 2.8\ell$$

**9. Ans. (C,D)**




**For option (A)** From Fig (i), if is clear that $(u_{mps})Y > (u_{mps})X$

or, $\sqrt{\frac{2RT}{M_Y}} > \sqrt{\frac{2RT}{M_X}}$

since both X and Y are at same temp.

$\therefore$ $\boxed{M_Y < M_X}$ ...(1)

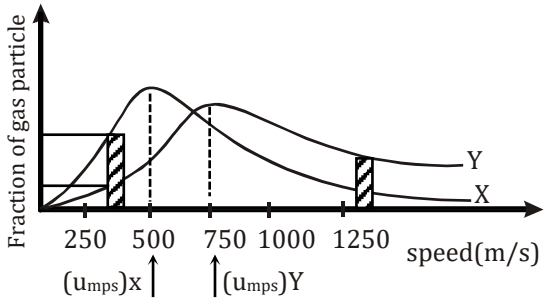
since X is $CH_4$ whose molar wass is 16.

$\therefore$ Y can't be $CO_2$ because. $M_{CO_2} = 44$

$\therefore$ (A) is wrong.

**for option (B)**, see Fig (ii)

(ii)




in lower speed region shaded area in figure, fraction of molecules of X > fraction of molecules of Y. As shaded area is greater for X as compared to Y. In higher speed region, shaded area in fig. fraction of molecules of Y > fraction of molecules of X. Therefore (B) is wrong.

**for option 'C'**

under identical conditions of P & T.

rate of effusion $\propto \frac{1}{\sqrt{M}}$

$\therefore$ $M_Y < X_X$ (from (i))

$\therefore$ rate of effusion of Y > X.

$\therefore$ (C) is correct.

**for option 'D'**

Molar KE = $\frac{3}{2}RT$

$\therefore$ Both X and Y are at same tempt. = 200k

$\therefore$ Molar $(KE)_X$ = Molar$(KE)_Y$.

$\therefore$ (D) is correct.

**10. Ans. (A,B,C)**

$V_C = 3b = 3 \times \frac{16}{3} \pi r^3 = \frac{48}{3} \pi r^3 \times N_A$

Theoretical fact of Andrew's Isotherm.

**11. Ans. (A, B)**

$\mathbf{C_3H_8 + O_2} \rightarrow 100$ ml

Case-I :-

Let assume $\mathbf{C_3H_8}$ is L.R.

$$\mathbf{C_3H_{8(g)} + 5O_{2(g)} \longrightarrow 3CO_{2(g)} + 4H_2O\ (l)}$$

| | | | | |
|---|---|---|---|---|
| initial | $\mathbf{V_1}$ | | $\mathbf{V_2}$ | |
| final | 0 | | $\mathbf{V_2 - 5V_1}$ | $3V_1$ |

Vol. contraction = $\mathbf{V_i - V_f}$

$V_C = (\mathbf{V_1 + V_2}) - (\mathbf{V_2 - 5V_1 + 3V_1})$

$45 = \mathbf{3V_1}$

$\mathbf{V_1 = 15\ ml\ (C_3H_8)}$

$\mathbf{V_2 = 85\ ml\ (O_2)}$

Case-II :-

Let assume $\mathbf{O_2}$ is L.R.

$$\mathbf{C_3H_8 + 5O_2 \longrightarrow 3CO_2 + 4H_2O\ (\ell)}$$

| | | | | |
|---|---|---|---|---|
| Initial | $\mathbf{V_1}$ | | $\mathbf{V_2}$ | |
| final | $\mathbf{V_1 - \frac{V_2}{5}}$ | | $\mathbf{0}$ | $\mathbf{\frac{3}{5}V_2}$ |

Vol. contraction = $\mathbf{V_i + V_f}$

$V_C = (\mathbf{V_1 + V_2}) - \left(\mathbf{V_1 - \frac{V_2}{5} + \frac{3}{5}V_2}\right)$

$45 = \mathbf{\frac{3}{5}V_2}$

$\mathbf{V_2}$ = 75 ml

$\mathbf{V_1}$ = 25 ml

**12.** **Ans. (A,B,D)**

$CO + \mathbf{CO_2} = 100$ ml

$x + y = 100$ ml

$$CO + \frac{1}{2}\mathbf{O_2} \rightarrow \mathbf{CO_2}$$

| | | | |
|---|---|---|---|
| Initial | x | | 30 |
| Final | x – 60 | 0 | 60 |

Residual gas shout be CO = 10 ml

$\Rightarrow$ x – 60 = 10

x = 70 ml CO

y = 30 ml $CO_2$

absorbed $\mathbf{CO_2}$ = y + 60 = 90 ml

**13.** **Ans. (B)**

(P) PV = nRT

$A \rightarrow B$ $P \propto T$, (n & V constant), T increases, P increase

$B \rightarrow C$ P = constant, T increases, n decreases

(Q) $\frac{P}{T} = \frac{nR}{V}$

$\frac{P^2}{T} = \frac{nR}{V}.P$

$A \rightarrow B$ $\frac{P^2}{T}$ = constant

P increases, n decreases

$B \rightarrow C$ P = constant

$\frac{P^2}{T}$ increases, n increases

(R) $T = \frac{PV}{nR}$

$A \rightarrow B$ P = constant

T decreases, n increases

$B \rightarrow C$ T = constant

P increases, n increases

(S) $P = \frac{nR}{V}.T$

$PT = \frac{nR}{V}.T^2$

$A \rightarrow B$ PT = constant

$T^2$ increases, n decreases

$B \rightarrow C$ $\frac{nR}{V}$ = constant

PT increases, $T^2$ increases, n constant

**14.** **Ans. (A)**

Experimental values only.

**15.** **Ans. (D)**

Gas having highest a can be liquified easily.

**16.** **Ans. (A)**

$T_C = \frac{8a}{27Rb}$

**17.** **Ans. (D)**

$3NH_3 + H_3PO_4 \longrightarrow (NH_4)_3PO_4$

$n_{NH_3} = 3n_{H_3PO_4}$

Let x moles of $NH_3$ is produced

$\therefore \quad x \times 1 = 0.5 \times \frac{2}{3} \times 3 \Rightarrow x = 1 \text{ mole}$

$\therefore \quad CO_2 = \frac{1}{2} \text{ mole} = 0.50 \text{ mole}$

**18.** **Ans. (A)**

$3NH_3 + H_3PO_4 \longrightarrow (NH_4)_3PO_4$

$n_{NH_3} = 3n_{H_3PO_4}$

Let x moles of $NH_3$ is produced

$\therefore \quad x \times 1 = 0.5 \times \frac{2}{3} \times 3 \Rightarrow x = 1 \text{ mole}$

$\therefore \quad CO_2 = \frac{1}{2} \text{ mole}$

$P = \frac{nRT}{V} = \frac{1.5 \times 0.08 \times 300}{36} = 1 \text{ atm}$

$\therefore \quad P_{total} = P_{initial} + P_{NH_3+CO_2} = 1 + 1 = 2 \text{ atm}$

$\therefore \quad \Delta P = 1 \text{ atm} \Rightarrow 760 \text{ mm}$

**19.** **Ans. (2.00)**

| | ER | | LR | | |
|---|---|---|---|---|---|
| | $2NO$ | + | $O_2$ | $\longrightarrow$ | $2NO_2$ |
| t = 0 | 2 mole | | 0.5 mole | | |
| After reaction | 1 mole | | – | | 1 mole |

$n_i = 2.5$ mole; $n_f = 2$ mole

$\Delta P = \frac{\Delta nRT}{V} = \frac{0.5 \times R \times T}{V} = \frac{0.5 \times \frac{1}{12} \times 300}{6.25} = 2$

**20.** **Ans. (820.00)**

$P_A = P_B + 100$

$P_B = P_{atm} - 40$

$P_B = 720$

$P_A = 720 + 100 = 820 \text{ mmHg}$