# **SOLVED EXAMPLES**

**Ex.1** A gas column is trapped between closed end of a tube and a mercury column of length (h) when this tube is placed with its open end upwards the length of gas column is  $(\bullet_1)$ , the length of gas column becomes  $(\bullet_2)$  when open end of tube is held downwards. Find atmospheric pressure in terms of height of Hg column.



**Ex.2** The diameter of a bubble at the surface of a lake is 4 mm and at the bottom of the lake is 1 mm. If atmospheric pressure is 1 atm and the temperature of the lake water and the atmosphere are equal. what is the depth of the lake? (The density of the lake water and mercury are 1 g/ml and 13.6 g/ml respectively. Also neglect the contribution of the pressure due to surface tension)

P<sub>1</sub>V<sub>1</sub>=P<sub>2</sub>V<sub>2</sub>  
∴ (760 mm × 13.6 × g) 
$$\frac{4}{3}\pi (4 \text{ mm/2})^3 = (760 \text{ mm} × 13.6 × g + h × 1 × g) \frac{4}{3}\pi (1 \text{ mm/2})^3$$
  
760 × 13.6 × 64 = (760 × 13.6 + h)  
h=64 × 760 × 13.6 - 760 × 13.6  
h=63 × 760 × 13.6 mm  
h= $\frac{63 × 760 × 13.6}{1000 × 1000}$  km = 0.6511 km = 651.1 m Ans.

- **Ex.3**
- A gas is initially at 1 atm pressure. To compress it to 1/4 th of initial volume, what will be the pressure required ? Sol.  $P_1 = 1$  atm V<sub>1</sub>=V





## **CHEMISTRY FOR JEE MAIN & ADVANCED**

**Ex.4** Find the lifting power of a 100 litre balloon filled with He at 730 mm and  $25^{\circ}$ C. (Density of air = 1.25 g/L). PV = nRTSol. Since,  $PV = \frac{W}{M} RT$ :.  $W = \frac{PVM}{RT} = \frac{730}{760} \times \frac{100 \times 4}{0.082 \times 298} g$ i.e., Wt. of He = 15.72 g Wt. of air displaced =  $100 \times 1.25$  g/L = 125 g Lifting power of the balloon = 125 g - 15.72 g = 109.28 g Ans.... A weather balloon filled with hydrogen at 1 atm and 300 K has volume equal to 12000 litres. On ascending it reaches **Ex.5** a place where temperature is 250 K and pressure is 0.5 atm. The volume of the balloon is : (A) 24000 litres **(B)** 20000 litres (C) 10000 litres **(D)** 12000 litres Using  $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$ ;  $\frac{1 \operatorname{atm} \times 12000 \operatorname{L}}{300 \operatorname{K}} = \frac{0.5 \operatorname{atm} \times V_2}{250 \operatorname{K}}$ Sol. :.  $V_2 = 20,000 L$ Hence Ans. (B) **Ex.6** If water is used in place of mercury then what should be minimum length of Barometer tube to measure normal atmospheric pressure. Sol.  $P_{H_g} = P_{H_2O} = P_{atm}$  $0.76\ m \times 13.6 \times g \ = h_{\text{H}_{2}\text{O}} \ \times 1 \times g$  $h_{H_{2}O} = 0.76 \times 13.6 = 10.336 \text{ m Ans.}$ A car tyre has a volume of 10 litre when inflated. The tyre is inflated to a pressure of 3 atm at 17°C with air. Due to **Ex.**7 driving the temperature of tyre increases to 47°C. (a) What would be pressure at this temperature? (b) How many litres of air measured at 47°C and pressure of 1 atm should be left out to restore the tyre to 3 atm at 47°C

**Sol.** 
$$V = 10L$$
 P, = 3 atm T, = 17°C = 290K

$$T_2 = 47^{\circ}C = 320K$$

(a) → Here v & n are constant

: Using 
$$\frac{P_1}{T_1} = \frac{P_2}{T_2} \implies P_2 = \frac{P_1 T_2}{T_1} = \frac{3 \times 320}{290}$$
 atm

i.e.  $P_2 = 3.3103$  atm

i.e. Pressuse at 47°C = **3.3103 atm** Ans. (b) Now,  $P_1 = 3 \text{ atm}$ ;  $V_1 = 10L$ ;  $T_1 = 17°C = 290K$ Final  $P_2 = 3 \text{ atm}$ ;  $V_2 = ?$ ;  $T_2 = 47°C = 320 \text{ K}$ 

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} \therefore V_2 = \frac{V_2 \times T_2}{T_1} = \frac{10L \times 320K}{290K} = 11.035L$$

∴ Volume of gas should be removed at 47°C & 3atm = (11.035 – 10) L = 1.035L
 Now this vol at 1atm be v' then
 1.0351 × 3atm = v' × 1atm
 ∴ v' = 3.105L
 ∴ Reqd vol = 3.105 L Ans.



- Ex. 8 A tube of length 50 cm is initially in open atmosphere at a pressure 75 cm of Hg. This tube is dipped in a Hg container upto half of its length. Find the level of mercury column in side the tube.
- **Sol.** If after dipping the tube, the length of air column be x cm (situation shown in the adjoining figure).

Then by using,  $P_i V_i = P_f V_f$ We have.  $75 \text{ cm Hg} \times \bullet A = P_f \times x \times A \dots (1)$  ( $\bullet = 50 \text{ cm}$ ) & also,  $P_f = 75 \text{ cm Hg} + (x - \frac{1}{2}) \dots (2)$ (2) & (1)  $\Rightarrow [75 + (x - 25)] \times x = 75 \times 50$   $\Rightarrow x^2 + 50 x - 3750 = 0$   $\therefore x = 41.14 \text{ or} -91.14$ But, x can't be - ve  $\therefore x = 41.14$ 



Ex.9 An open container of volume V contains air at temperature 27°C or 300 K.The container is heated to such a temperature so that amount of gas coming out is 2/3 of
(a) amount of gas initially present in the container
(b) amount of gas finally remaining in the container

mercury column inside the tube = (50 - 41.14) cm = 8.86 cm Ans.

(a) amount of gas initially present in the container.(b) amount of gas finally remaining in the container.Find the temperature to which the container should be heated.

Sol. (a) Here, P & V are constant, n & T are changing. Let, initially the amount of gas present be n & temp is 27°C

or 300K. Finally amount of gas present in container =  $n - \frac{2}{3} n = \left(\frac{1}{3} \times n\right)$  & final temp. be T. Then using

 $n_1 T_1 = n_2 T_2$ , we have,

$$n \times 300 = \frac{n}{3} \times T_2 \Longrightarrow T_2 = 900K$$

i.e., final temp = 900K Ans.

Sol. (b) Let there be x moles of gas remaining in the container,  $\frac{2}{3}$  of x come out  $\therefore \qquad (x + \frac{2}{3}x) = n \Rightarrow \frac{5x}{3} = n \qquad \therefore x = \frac{3n}{3}$ 

$$(x + \frac{1}{3}x) = n \implies \frac{1}{3} = n \qquad \therefore x = \frac{1}{5}$$
Using  $n_1 T_1 = n_2 T_2$ 
 $n \times 300 \text{ K} = \frac{3n}{5} \times T_2$ 
 $T_2 = 500 \text{ K}$ 
final temperature = 500 K Ans.

**Ex. 10** Four one litre flasks are separately filled with the gases,  $O_2$ ,  $F_2$ ,  $CH_4$  and  $CO_2$  under the same conditions. The ratio of number of molecules in these gases :

(A) 2:2:4:3 (B) 1:1:1:1 (C) 1:2:3:4 (D) 2:2:3:4Sol. According to avogadro's hypothesis. All the flasks contains same no. of molecules  $\therefore$  Ratio of no. of molecules of  $O_2$ ,  $F_2$ ,  $CH_4 \& CO_2$ 

= 1:1:1:1 **Ans (B)** 



...

**Ex. 11** A sample of water gas has a composition by volume of 50% H<sub>2</sub>, 45% CO and 5% CO<sub>2</sub>. Calculate the volume in litres at STP at which water gas which on treatment with excess of steam will produce 5 litre of H<sub>2</sub>. The equation for the reaction is :

2

$$CO + H_2O \longrightarrow CO_2 + H_2O$$

**Sol.** If 
$$x \perp CO$$
 in needed then

volume of H<sub>2</sub> in water gas = 
$$\left(\frac{x}{0.45} \times 50\%\right) L$$

$$= \left(\frac{x}{0.45} \times \frac{1}{2}\right) L = \frac{x}{0.9} L$$

But, from equation :  $CO + H_2O \longrightarrow CO_2 + H_2$ & Gay-Lussac's law, we get, that the volume of  $H_2$ produced = volume of CO taken.

 $\therefore$  Volume of H<sub>2</sub> due to reaction = x L

$$\therefore \qquad \text{Total volume of H}_2 = \left(\frac{x}{0.9} + x\right) L = 5 L$$

$$\Rightarrow \qquad \frac{1.9x}{0.9} = 5I$$
$$0.9 \times 3$$

$$X = \frac{0.15}{1.0}$$

:. Volume of water gas = 
$$\frac{x}{0.45}L = \frac{0.9 \times 5}{1.9 \times 0.45}L = 5.263 L$$
 Ans.

Ex. 12 5 ml of  $H_2$  gas diffuses out in 1 sec from a hole. Find the volume of  $O_2$  that will diffuse out from the same hole under identical conditions in 2 sec.

**Sol.** Rate of diffusion of 
$$H_2 = \frac{5ml}{1 \sec} = 5ml/s = r_{H_2}$$
 (say)

 $\therefore \mathbf{r}_{\mathbf{o}_2} = \mathbf{r}_{\mathbf{H}_2} \times \frac{1}{4} = 5 \mathrm{ml/s} \times \frac{1}{4}$ 

 $\therefore$  Volume of O<sub>2</sub> diffused in 2.0 seconds

$$=\frac{5}{4}\times 2\,\mathrm{ml}=2.5\,\mathrm{ml}\,\mathrm{Ans.}$$

- Ex.13 The partial pressure of hydrogen in a flask containing two grams of hydrogen and 32 gm of sulphur dioxide is :
  - (A) 1/16th of the total pressure
  - (B) 1/9th of the total pressure
  - (C) 2/3 of the total pressure
  - (D) 1/8th of the total pressure (C)
- Ans.

Sol. 
$$n_{H_2} = \frac{2g}{2g / mol} = 1 \text{mol.}$$
  $n_{SO_2} = \frac{32g}{64g / mol} = 0.5 \text{ mol}$   
 $\therefore P_{H_2} = \frac{n_{H_2}}{(n_{H_2} + n_{SO_2})} \times P_T = \frac{1}{(1+0.5)} \times P_T = \frac{2}{3} P_T.$   
 $\therefore$  (C)



**Ex. 14** Equal volume of two gases which do not react together are enclosed in separate vessels. Their pressures are 10 mm and 400 mm respectively. If the two vessels are joined together, then what will be the pressure of the resulting mixture (temperature remaining constant) :

(A) 120 mm (B) 500 mm (C) 1000 mm (D) 205 mm Ans. (D) Sol. Let, vol of containers be V & temperature be T  $P_1 = 10 \text{mm}$   $P_2 = 400 \text{mm}$   $\therefore n_1 = \frac{P_1 V}{RT}$  &  $n_2 = \frac{P_2 V}{RT}$   $\therefore n_1 + n_2 = \frac{(P_1 + P_2) \times V}{RT}$ After joining two containers final vol = (V+V) = 2V(for gases)  $\therefore P_{\text{final}} = \frac{(n_1 + n_2)RT}{V_{\text{final}}} = \frac{(P_1 + P_2) \times V}{RT} \times \frac{RT}{2V} = \frac{(P_1 + P_2)}{2}$  $= \frac{(10 + 400) \text{ mm}}{2} = 205 \text{ mm}.$ 

**Ex. 15** A vessel contains 
$$H_2 \& O_2$$
 in the molar ratio of 8 : 1 respectively. This mixture of gases is allowed to diffuse through a hole, find composition of the mixture coming out of the hole.

Sol. Here, 
$$n_{H_2} : n_{O_2} = 8 : 1$$
 &  $\frac{r_{H_2}}{r_{O_2}} = \frac{n_{H_2}}{n_{O_2}} \sqrt{\frac{M_{O_2}}{M_{H_2}}}$ 

$$\Rightarrow \frac{\mathbf{r}_{\mathrm{H}_2}}{\mathbf{r}_{\mathrm{O}_2}} = \frac{8}{1} \times \sqrt{\frac{32}{2}} = \frac{32}{1}$$

 $\Rightarrow \frac{(\text{no. of moles of H}_2 \text{ coming out})/\Delta t}{(\text{no. of moles of O}_2 \text{ coming out})/\Delta t} = \frac{32}{1}$ 

- :. Required composition of  $H_2$ :  $O_2$  coming out = 32 : 1 Ans.
- Ex. 16 (i) Calculate the pressure exerted by  $10^{23}$  gas molecules, each mass  $10^{-22}$  g in a container of volume one litre. The rms velocity is  $10^5$  cm/sec.
  - (ii) What is the total kinetic energy (in cal) of these particles ?
  - (iii) What must be the temperature ?
- Sol. (i) Here  $N = 10^{23}$  molecules  $m = 10^{-22}$ g, V = 1L = 1000 cm<sup>3</sup>

rms velocity =  $10^5$  cm/second

$$\therefore PV = \frac{1}{3} \text{ Nm } \overline{U^2}$$
$$\therefore P = \frac{1}{2} \text{ Nm } \overline{U^2}$$

$$= \frac{1}{3 \times 1000 \text{ cm}^3} \times 10^{23} \times 10^{-22} \text{g} \times (10^5)^2 \text{cm}^2/\text{s}^2$$
  
= 3.33 × 10<sup>7</sup> dyne/cm<sup>2</sup> Ans.

(ii) Total  $K \cdot E$  of the molecules

$$= \frac{1}{2} \operatorname{Nm} \overline{U^{2}}$$

$$= \frac{1}{2} \times 10^{23} \times 10^{-25} \operatorname{kg} \times (10^{3} \operatorname{m/s})^{2}$$

$$= \frac{10000J}{2} = 5000 \operatorname{J} \approx 1195.0 \operatorname{Cal} \operatorname{Ans.}$$
(iii) Avg K · E of one molecule =  $\frac{1}{2} \operatorname{m} \overline{U^{2}} = \frac{3}{2} \operatorname{kT}$ 

$$\therefore \operatorname{T} = \frac{1}{3} \times \frac{\operatorname{m} \overline{U^{2}}}{\operatorname{k}}$$

$$= \frac{1}{3} \times \frac{10^{-25} \operatorname{Kg} \times (10^{3} \operatorname{m/s})^{2} \times 6.023 \times 10^{23}}{8.314} \operatorname{K}$$

$$= 2414.8 \operatorname{K} \operatorname{Ans.}$$

Ex. 17 The rate of diffusion of a sample of a ozonized oxygen is 0.98 times than that of oxygen. Find the % (by volume of ozone in the ozonized sample).

 $\left( Q k = \frac{R}{NA} \right)$ 

Sol. Let, rate of diffusion of ozonized oxygen be  $r_g$ 

& Let, reat of diffusion of oxygen be  $r_{O_2}$ 

:. 
$$\frac{r_g}{r_{O_2}} = 0.98 \text{ (given)}$$
 ......(1)

but 
$$\frac{r_g}{r_{O_2}} = \left(\frac{M_{O_2}}{M_g}\right)^{1/2}$$
 (mean molar mass of ozonized oxygen = M<sub>g</sub>)

Form (1) 
$$\Rightarrow$$
 0.98 =  $\sqrt{\frac{32}{M_g}}$ 

$$\Rightarrow (0.98)^2 = \frac{32}{M_g}$$
 :  $M_g = \frac{32}{(0.98)^2} = 33.32$ 

Let % of  $O_3$  be x  $\therefore$  %  $O_2 = (100 - x)$  in ozonized oxygen.

$$\frac{48x + (100 - x) \times 32}{100} = 33.32$$

⇒ 
$$3200 + 16x = 33.32$$
 :  $x = \frac{132}{16} = 8.25\%$ 



**Ex. 18** A gaseous mixture containing CO, methane  $CH_4 \& N_2$  gas has total volume of 40 ml. This mixture is exploded with excess of oxygen on cooling this mixture a contraction of 30 ml is observed & when this mixture is exposed to aqueous KOH a further contraction of 30 ml is observed .find the composition of the mixture.

Sol. Let vol of CO be x mL vol of  $CH_4$  be y mL vol of N<sub>2</sub> be z mL On explosion with excess of oxygen the following reactions takes place  $CO(g) + \frac{1}{2} O_2(g) \longrightarrow CO_2(g)$ (By Gaylussac's law of combing volume) xmL xmL  $CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(g)$ ymL 2 ymL vmL N<sub>2</sub> remains unreacted On cooling  $H_2O(g)$  liquifies hence volume reduction of 30 mL is observed  $\therefore 2y = 30$  $\therefore y = 15$ But, vol of CO<sub>2</sub> obtained = (x + y) mL This is absorbed in KOH & vol reduction of 30 mL is observed. x + y = 30 $\Rightarrow$  x = 30 - y = (30 - 15) = 15 ...  $x+y+z=40 \implies z=40-x-y=40-15-15=10$ and, ... Composition of mixture is vol of CO = 15 mL Ans. vol of  $CH_4 = 15 \text{ mL}$  Ans. vol of  $N_2 = 10 \text{ mL}$  Ans.

**Ex.19** Under critical states of a gas for one mole of a gas, compressibility factor is :

(A) 
$$\frac{3}{8}$$
 (B)  $\frac{8}{3}$  (C) 1 (D)  $\frac{1}{4}$ 

Sol. For 1 mole of gas 
$$Z = \frac{P_C V_C}{RT_C}$$
 (Under critical condition)  
But,  $P_C = \frac{a}{27b^2}$ ,  $V_C = 3b$ ,  $T_C = \frac{8a}{27Rb}$   
 $\therefore Z = \left(\frac{a}{27b^2}\right) \times \frac{3b}{R} \times \frac{27Rb}{8a} = \frac{3}{8}$   
Ans. (A)

- **Ex. 20** One litre of oxygen gas is passed through a ozonizer & the final volume of the mixture becomes 820 ml. If this mixture is passed through oil of turpentine. Find the final volume of gas remaining.
- **Sol.** The reaction that takes place in ozonizer as  $3O_2 \longrightarrow 2O_3$ .

= 460 mL Ans.

If Vml of O<sub>2</sub> out of 1000 ml is ozonized then vol of O<sub>3</sub> obtained =  $\frac{2}{3}$  V  $\therefore$  Final vol of ozonized oxygen = $(1000 - V + \frac{2}{3} V)$  mL = 820 mL

 $\therefore V = 540$ 

$$1000 - \frac{1}{3}$$
 V = 82

=180

 $O_2$  remaining = (1000 - 540) mL ( $\Rightarrow$   $O_3$  is absorbed in oil of turpentine)



Sol.

**Ex.21** If for two gases of molecular weights  $M_A$  and  $M_B$  at temperature  $T_A$  and  $T_B$ ;  $T_A M_B = T_B M_A$ , then which property has the same magnitude for both the gases.

(A) Density (B) Pressure (C) KE per mol (D) RMS speed  
Given that 
$$T_A M_B = T_B M_A \Rightarrow \frac{T_A}{M_A} = \frac{T_B}{M_B}$$
  
But, r.m.s.  $= \sqrt{\frac{3RT}{M}}$   
 $\therefore r.m.s_A = \sqrt{\frac{3RT_A}{M_A}}$  &  $r.m.s_B = \sqrt{\frac{3RT_B}{M_B}}$   
 $\therefore r.m.s_A = r.m.s_B$   
 $\therefore Ans. (D)$ 

**Ex.22** It has been considered that during the formation of earth  $H_2$  gas was available at the earth. But due to the excessive heat on the earth this had been escaped. What was the temperature of earth during its formation?

## (The escape velocity is 1.1 x 10<sup>6</sup> cm/s)

**Sol.** Escape velocity of  $H_2$  should be equal to average velocity of  $H_2$ .

:. Avg velocity of H<sub>2</sub> = 
$$1.1 \times 10^6$$
 cm/s =  $1.1 \times 10^4$  m/s

But, avg. velocity = 
$$\sqrt{\frac{8RT}{\pi M}}$$

$$\Rightarrow 1.1 \times 10^4 = \sqrt{\frac{8 \times 8.314 \times T}{\pi \times 2 \times 10^{-3}}} \left( \mathsf{M}_{\mathsf{H}_2} = 2\mathsf{g} = 2 \times 10^{-3} \mathsf{kg} \right)$$

:. 
$$T = \frac{(1.1 \times 10^4)^2 \times \pi \times 2 \times 10^{-3}}{8 \times 8.314}$$
 K = 11430.5 K = 11157.5°C Ans.

E	xercise # 1		[Single Correct Choice	Type Questions]
1.	A thin balloon filled with litre, the temperature of	th air at 47°C has a volu f room is :	me of 3 litre. If on placing it in a c	cooled room its volume becomes 2.7
	(A)42°C	<b>(B)</b> 100°C	( <b>C</b> ) 15℃	<b>(D)</b> 200°C
2.	If a mixture containing of initial and final volution $(A) = 2 \cdot 1$	3 moles of hydrogen an me under the same temp $(\mathbf{P})$ 1 · 2	d 1 mole of nitrogen is converted perature and pressure would be $\frac{1}{2}$	completely into ammonia, the ratio
3.	(A) 5.1 SO <sub>2</sub> at STP contained i Then the weight of O <sub>2</sub> $\gamma$	<b>(b)</b> 1.5 n a flask was replaced b will be of $SO_2$	y $O_2$ under identical conditions o	f pressure, temperature and volume.
	(A) half	(B) one fourth	(C) twice	(D) four times.
4.	Assuming that $O_2$ mole the total volume of gas	cule is spherical in shap at S.T.P. is :	pe with radius 2 Å, the percentage $(0,0,000,0)$	ge of the volume of $O_2$ molecules to
5.	(A) 0.09 % If the pressure of a gas of	(B) 0.9 %	essel is increased by 0.4 % when	(D) 0.045 % heated by 1°C its initial temperature
	must be : (A) 250 K	<b>(B)</b> 250°C	(C) 25°C	<b>(D)</b> 25 K
6.	A gas is heated from $0^{\circ}$ C	to 100°C at 1.0 atm pres	ssure. If the initial volume of the ga	s is $10.0 \lambda$ , its final volume would be :
_	(A) 1.52 K	( <b>b</b> ) 10.00 χ		(D) 20.00 X
7.	Under what conditions of 1 mol litre <sup>-1</sup> . [ $\mathbf{R} = 0$	will a pure sample of an 0.082 litre a <mark>tm mol <sup>-1</sup> K</mark> <sup>-</sup>	ideal gas not only exhibit a press	sure of 1 atm but also a concentration
	(A) at S.T.P. (C) when T = 12 K		<ul><li>(B) when V = 22.42 L</li><li>(D) impossible under an</li></ul>	ny condition
8.	An amount of $1.00 \text{ g of}$ compound is (R = 0.082	a gaseous comp <mark>ound</mark> of 0 liter atm mole <sup>-1</sup> K <sup>-1</sup> ; a	Foron and hydrogen occupies 0. at. wt: $H = 1.0, B = 10.8$ )	820 liter at 1.00 atm and at 3 <sup>0</sup> C. The
	(A) BH <sub>3</sub>	<b>(B)</b> $B_4H_{10}$	$(\mathbf{C}) \mathbf{B}_2 \mathbf{H}_6$	<b>(D)</b> $B_3H_{12}$
9.	A 0.5 dm <sup>3</sup> flask contain that of B = $1.5 \text{ g/dm}^3$ and	s gas A and 1 dm <sup>3</sup> flask on the molar mass of A	contains gas B at the same tempe $= 1/2$ of B, the ratio of pressure of	rature. If density of $A = 3 \text{ g/dm}^3$ and exerted by gases is :
	(A) $\frac{P_A}{P_B} = 2$	(B) $\frac{P_A}{P_B} = 1$	(C) $\frac{P_A}{P_B} = 4$	(D) $\frac{P_A}{P_B} = 3$
10.	A and B are two identic	al vessels. A contains 1	5 g ethane at 1 atm and 298 K. Th	he vessel B contains 75 g of a gas $X_2$
	at same temperature an (A) 75	d pressure. The vapour (B) 150	r density of $X_2$ is : (C) 37.5	<b>(D)</b> 45
11.	The density of neon wi (A) STP	ll be highest at : (B) 0°C, 2 atm	(C) 273°C. 1 atm	<b>(D)</b> 273°C. 2 atm



# **CHEMISTRY FOR JEE MAIN & ADVANCED**

12.	Equal weights of ethane exerted by hydrogen is:	& hydrogen are mixed in	an empty container at 25° C	C, the fraction of the total pressure
	(A) 1:2	<b>(B)</b> 1:1	<b>(C)</b> 1:16	<b>(D)</b> 15:16
13.	A mixture of hydrogen a hydrogen will be (A) 0.2 bar	nd oxygen at one bar pres	ssure contains 20% by weig	ht of hydrogen. Partial pressure of
14.	A compound exists in the molecular mass of $A_2$ is 9 heated to 273°C. The pretthese conditions will be :	e gaseous phase both as n 6. In an experiment 96 g of essure developed if the co	nonomer (A) and dimer ( $A_2$ the compound was confined mpound exists as dimer to the second	). The atomic mass of A is 48 and in a vessel of volume 33.6 litre and he extent of 50 % by weight under
	(A) 1 atm	<b>(B)</b> 2 atm	(C) 1.5 atm	<b>(D)</b> 4 atm
15.	$20 \bullet \text{ of SO}_2 \text{ diffuses through the seconds will be :}$	ough a porous partition in 6	50 seconds. Volume of O <sub>2</sub> dif	ffuse under similar conditions in 30
	(A) 12.14 ●	<b>(B)</b> 14.14 ●	<b>(C)</b> 18.14 ●	<b>(D)</b> 28.14 ●
16.	See the figure-1 : $NH_3$ —			
	The valves of X and Y are (A)A	e opened simultaneously. T (B) B	The white fumes of NH <sub>4</sub> Cl w	ill first form at: (D) A,B and C simultaneously
17.	X ml of $H_2$ gas effuses the the gas specified below u (A) 10 sec. He	rough a hole in a container inder identical conditions (B) 20 sec. O <sub>2</sub>	in 5 sec. The time taken for is : (C) 25 sec. $CO_2$	the effusion of the same volume of <b>(D)</b> 55 sec. CO <sub>2</sub>
18.	Three identical footballs a of the gas occurs with tim three footballs under ider	are r <mark>espectiv</mark> ely filled with e from the filling hole, the ntical conditions (in equal	n nitrogen , hydrogen and hel: n the ratio of the rate of leaki time interval) is :	ium at same pressure. If the leaking ing of gases $(r_{N_2} : r_{H_2} : r_{H_e})$ from
	<b>(A)</b> $(1:\sqrt{14}:\sqrt{7})$	<b>(B)</b> $\left(\sqrt{14} : \sqrt{7} : 1\right)$	(C) $(\sqrt{7}:1:\sqrt{14})$	<b>(D)</b> $(1:\sqrt{7}:\sqrt{14})$
19.	The rates of diffusion of S (A) $PCl_3 > SO_3 > SO_2 > C$ (C) $SO_2 > SO_3 > PCl_3 > C$	$SO_3, CO_2, PCl_3 \text{ and } SO_2 \text{ and } O_2 O_2$	The in the following order - (B) $CO_2 > SO_2 > PCl_3 > S$ (D) $CO_2 > SO_2 > SO_3 > P$	SO <sub>3</sub> Cl <sub>3</sub>
20.	The kinetic energy of N r $2 x$ . The latter sample cor	nolecules of $O_2$ is x joule tains molecules	at $- 123^{\circ}$ C. Another sample c of O <sub>2</sub> .	$of O_2$ at 27°C has a kinetic energy of
	(A) N	<b>(B)</b> N/2	(C) 2 N	( <b>D</b> ) 3 N
21.	The average kinetic energy (A) $6.21 \times 10^{-20}$ J/molecul (C) $6.21 \times 10^{-22}$ J/molecul	gy (in joules of) molecules e le	in 8.0 g of methane at 27° C (B) 6.21 × 10 <sup>-21</sup> J/molecu (D) 3.1 × 10 <sup>-22</sup> J/molecul	is : le e
22.	According to kinetic theo (A) The pressure exerted (B) The pressure exerted (C) The r.m.s. velocity of	bry of gases, for a diatomic by the gas is proportional by the gas is proportional `the molecule is inversely	molecule : to the mean velocity of the to the r.m.s. velocity of the proportional to the temperat	molecule. molecule. ure.

(D) The mean translational K.E. of the molecule is proportional to the absolute temperature.



# GASEOUS STATE

Temperature at which r.m.s. speed of  $O_2$  is equal to that of neon at 300 K is : 23. (A) 280 K (B) 480 K (C) 680 K (D) 180 K 24. The R.M.S. speed of the molecules of a gas of density 4 kg m<sup>-3</sup> and pressure  $1.2 \times 10^5$  N m<sup>-2</sup> is : (C)  $600 \text{ ms}^{-1}$ **(B)**  $300 \text{ ms}^{-1}$ (A)  $120 \text{ ms}^{-1}$ (D) 900 m s<sup>-1</sup> 25. The mass of molecule A is twice that of molecule B. The root mean square velocity of molecule A is twice that of molecule B. If two containers of equal volume have same number of molecules, the ratio of pressure  $P_A/P_B$  will be : **(B)** 1 : 8 **(C)**4:1 (A) 8:1 **(D)**1:4 26. Which of the following expression correctly represents the relationship between the average kinetic energy of CO and N<sub>2</sub> molecules at the same temperature. (A)  $\overline{E}$  (CO) >  $\overline{E}$  (N<sub>2</sub>) (B)  $\overline{E}$  (CO) <  $\overline{E}$  (N<sub>2</sub>) (C)  $\overline{E}$  (CO) =  $\overline{E}$  (N<sub>2</sub>) (D) Cannot be predicted unless volumes of the gases are given Helium atom is two times heavier than a hydrogen molecule. At 298 K, the average kinetic energy of a helium atom 27. is (A) two times that of a hydrogen molecules (B) same as that of a hydrogen molecules (C) four times that of a hydrogen molecules (D) half that of a hydrogen molecules 28. The temperature of an ideal gas is increased from 120 K to 480 K. If at 120 K the root-mean-square velocity of the gas molecules is v, at 480 K it becomes : (A) 4v **(B)** 2v (C) v/2 **(D)** v/4 29. The ratio between the r.m.s. velocity of  $H_2$  at 50 K and that of  $O_2$  at 800 K is: **(A)**4 **(D)** 1/4 **(B)**2 30. Compressibility factor for H<sub>2</sub> behaving as real gas is : **(B)**  $\left(1 - \frac{a}{RTV}\right)$  **(C)**  $\left(1 + \frac{Pb}{RT}\right)$ (D)  $\frac{\text{RTV}}{(1-a)}$ **(A)** 1 31. At low pressures (For 1 mole), the Vander Waal's equation is written as  $\left[ p + \frac{a}{V^2} \right] V = RT$ The compressibility factor is then equal to : **(B)**  $\left(1 - \frac{RTV}{a}\right)$  **(C)**  $\left(1 + \frac{a}{RTV}\right)$  **(D)**  $\left(1 + \frac{RTV}{a}\right)$ (A)  $\left(1 - \frac{a}{RTV}\right)$ 32. Calculate the radius of He atoms if its Vander Waal's constant 'b' is  $24 \text{ ml mol}^{-1}$ . (Note 1 ml = 1 cubic centimeter) (A) 1.355 Å **(B)** 1.314 Å (C) 1.255 Å (D) 0.355 Å 33. A real gas obeying Vander Waal's equation will resemble ideal gas, if the : (A) constants a & b are small (B) a is large & b is small (C) a is small & b is large (D) constant a & b are large 34. For the non-zero values of force of attraction between gas molecules, gas equation will be : (**D**)  $P = \frac{nRT}{V-h}$ (A)  $PV = nRT - \frac{n^2a}{V}$ **(B)** PV = nRT + nbP(C) PV = nRT

# **CHEMISTRY FOR JEE MAIN & ADVANCED**

35.	The correct order of norm	nal boiling points of $O_2$ , $N_2$ ,	$NH_3$ and $CH_4$ , for whom the	e values of vander Waal's constant
	(A) $O_3 < N_3 < NH_3 < CH_4$	(B) $O_3 < N_2 < CH_4 < NH_2$	$(C) NH_2 < CH_4 < N_2 < O_2$	(D) $NH_2 \leq CH_4 \leq O_2 \leq N_2$
36.	NH <sub>3</sub> gas is liquefied more (A) Vander Waal's consta (B) Vander Waal's consta (C) a (NH <sub>3</sub> ) > a (N <sub>2</sub> ) but b (D) a (NH <sub>3</sub> ) < a (N <sub>2</sub> ) but b	e easily than N <sub>2</sub> . Hence: ints 'a' and 'b' of NH <sub>3</sub> > that ints 'a' and 'b' of NH <sub>3</sub> < that $(NH_3) < b (N_2)$ $(NH_3) > b (N_2)$	of N <sub>2</sub> of N <sub>2</sub>	
37.	In vander Waal's equation	n of state for a non ideal gas	s the term that accounts for	intermolecular forces is ·
•	(A) nb	(B) nRT	(C) $n^2a/V^2$	( <b>D</b> ) (nRT) <sup>-1</sup>
38.	7.5 ml of a gaseous hydro be 28.5 ml, 15 ml of which volumes are measured un (A) $C_3H_4$	carbon was exploded with 3 n was absorbed by KOH and der same conditions, the fo (B) $C_2H_4$	36 ml of oxygen. The volume the rest was absorbed in a so rmula of hydrocarbon is (C) $C_2H_6$	e of gases on cooling was found to obtain of alkaline pyrogallol. If all <b>(D)</b> $C_3H_6$
39.	A gaseous alkane is explo	ded with oxygen. The volun	ne of $O_2$ for complete combu	stion to $CO_2$ formed is in the ratio
	7/4. The molecular formul	la of alkane is :		
	$(\mathbf{A}) \mathrm{C}_{2} \mathrm{H}_{4}$	$(\mathbf{B}) \operatorname{C}_2 \operatorname{H}_6$	(C) CH <sub>4</sub>	<b>(D)</b> $C_4 H_{12}$
40.	LPG is a mixture of n - bu (A) 2240 ●t	tane & iso - butane. The vol (B) 2510 ●t	ume of oxygen needed to bu (C) 1000 ●t	rn 1 kg of LPG at NTP would be : (D) 500 ●t
41.	The volume of $CO_2$ produces (A) 40 ml	uced by the combustion of 4 (B) 80 ml	40 ml of gaseous acetone in (C) 60 ml	excess of oxygen is (D) 120 ml
42.	500 ml of a hydrocarbon g being measured at the sam (A) $C_5 H_{10}$	gas burnt in excess of oxygen ne temperature and pressur (B) $C_5H_{12}$	n yields 2500 ml of $CO_2$ and e. The formula of the hydro (C) $C_4H_{10}$	3 lts of water vapours. All volume carbon is (D) $C_4H_8$
43.	15 ml of a gaseous hydrod and the gaseous products of (A) $C_3H_8$	carbon w <mark>as required f</mark> or com ccupied 327 ml (all volumes b (B) C <sub>4</sub> H <sub>8</sub>	nplete combustion in 357ml being measured at NTP). What (C) $C_5H_{10}$	of air (21% of oxygen by volume) t is the formula of the hydrocarbon? (D) $C_4H_{10}$
44.	Two flasks of equal volut of $H_2$ at 0.5 atm. One of the pressure in each flask is :	me are connected by a narro e flask is then immersed into	w tube (of negligible volume a bath kept at 127° C, while t	) all at 27°C and contain 0.70 mole he other remains at 27°C. The final
	(A) Final pressure = $0.571$ (C) Final pressure = $0.582$	4 atm	(B) Final pressure = $1.5/1$	4 atm
	$(\mathbf{C})$ r mar pressure – 0.382	4 aun	(D) None of these	
45.	On the surface of the earth maximum capacity. The	n at 1 atm pressure, a balloon balloon is left in air. It sta	n filled with $H_2$ gas occupies rts rising. The height abov	500 mL. This volume is 5/6 of its e which the balloon will burst if
	(A) 120 m	(B) 136.67 m	(C) 126.67 m	(D) 100 m
46.	A 40 ml of a mixture of l complete. The remaining the mole fraction of $H_2$ in	$H_2$ and $O_2$ at 18 °C and 1 a pure gas had a volume of the 40 ml mixture is :	tm pressure was sparked so 10 ml at 18°C and 1 atm pres	that the formation of water was ssure. If the remaining gas was $H_2$ ,
	(A) 0.75	<b>(B)</b> 0.5	<b>(C)</b> 0.65	<b>(D)</b> 0.85

47. I, II, III are three isotherms respectively at  $T_1$ ,  $T_2$  and  $T_3$  as shown in graph. Temperature will be in order (A)  $T_1 = T_2 = T_3$ **(B)**  $T_1 < T_2 < T_3$ P (C)  $T_1 > T_2 > T_3$ II **(D)**  $T_1 > T_2 = T_3$ - III **48**. A vessel of volume 5 litre contains 1.4 g of nitrogen at a temperature 1800 K. The pressure of the gas if 30% of its molecules are dissociated into atoms at this temperature is : (A) 4.05 atm **(B)** 2.025 atm (D) 1.92 atm (C) 3.84 atm 49. One litre of a gaseous mixture of two gases effuses in 311 seconds while 2 litres of oxygen takes 20 minutes. The vapour density of gaseous mixture containing CH<sub>4</sub> and H<sub>2</sub> is **(A)**4 **(B)** 4.3 (C) 3.4 **(D)** 5 **50**. Pure O2 diffuses through an aperture in 224 second, whereas mixture of O2 and another gas containing 80% O2 diffuses from the same in 234 second. The molecular mass of gas will be **(B)** 48.6 **(D)** 46.6 (A) 51.5 (C) 55 51. A straight glass tube has 2 inlets X & Y at the two ends of 200 cm long tube. HCl gas through inlet X and NH<sub>3</sub> gas through inlet Y are allowed to enter in the tube at the same time and under the identical conditions. At a point P inside the tube both the gases meet first. The distance of point P from X is : (A) 118.9 cm **(B)** 81.1 cm (C) 91.1 cm (D) 108.9 cm **52.** Two flasks of equal volume are connected by a narrow tube (of negligible volume) all at 27° C and contain 0.70 moles of H<sub>2</sub> at 0.5 atm. One of the flask is then immersed into a bath kept at 127° C, while the other remains at 27° C. The number of moles of  $H_2$  in flask 1 and flask 2 are : (A) Moles in flask 1 = 0.4, Moles in flask 2 = 0.3(B) Moles in flask 1 = 0.2, Moles in flask 2 = 0.3(C) Moles in flask 1 = 0.3, Moles in flask 2 = 0.2(D) Moles in flask 1 = 0.4, Moles in flask 2 = 0.253. A teacher enters a classroom from front door while a student from back door. There are 13 equidistant rows of benches in the classroom. The teacher releases N<sub>2</sub>O, the laughing gas, from the first bench while the student releases the weeping gas ( $C_6H_{11}OBr$ ) from the last bench. At which row will the students starts laughing and weeping simultaneously **(A)**7 **(B)** 10 (C)9 **(D)**8 A real gas most closely approaches the behaviour of an ideal gas at -**54**. (A) 15 atm and 200 K (B) 1 atm and 273 K (C) 0.5 atm and 500 K (D) 15 atm and 500 K 55. Calculate the compressibility factor for CO<sub>2</sub>, if one mole of it occupies 0.4 litre at 300 K and 40 atm. Comment on the result. (A) 0.40, CO<sub>2</sub> is more compressible than ideal gas **(B)** 0.65, CO<sub>2</sub> is more compressible than ideal gas (C) 0.55, CO<sub>2</sub> is more compressible than ideal gas (D) 0.62, CO<sub>2</sub> is more compressible than ideal gas 56. Which of following statement (s) is true I – Slope of isotherm at critical point is maximum. II – Larger is the value of  $T_c$  easier is the liquification of gas. III - Vander waals equation of state is applicable below critical temperature at all pressure. (D) only II (A) only I **(B)** I & II (C) II & III



# **CHEMISTRY FOR JEE MAIN & ADVANCED**

A certain volume of argon gas (Mol. Wt = 40) requires 45 s to effuse through a hole at a certain pressure and 57. temperature. The same volume of another gas of unknown molecular weight requires 60 s to pass through the same hole under the same conditions of temperature and pressure. The molecular weight of the gas is : (A) 53 **(B)** 35 (C)71 **(D)** 120 58. A sample of an ideal gas was heated from 30°C to 60°C at constant pressure. Which of the following statement(s) is/ are true. (A) Kinetic energy of the gas is doubled (B) Boyle's law will apply (C) Volume of the gas will be doubled (D) None of the above **59**. The curve of pressure volume (PV) against pressure (P) of CO the gas at a particular temperature is as shown, according to CH<sub>4</sub> the graph which of the following is incorrect (in the low Η, pressure region): He (A) H<sub>2</sub> and He shows +ve deviation from ideal gas equation. PV I Ideal gas **(B)** CO,  $CH_4$  and  $O_2$  show negative deviation from ideal gas equation. (C)  $H_2$  and He show negative deviation while CO,  $CH_4$  and O<sub>2</sub> show positive deviation. (D) H, and He are less compressible than that of an ideal gas while CO, CH<sub>4</sub> and O<sub>2</sub> more compressible than that of ideal 0 P. gas. **60**. For a real gas the P-V curve was experimentally plotted and it had the following appearance. With respect to liquifaction. Р Choose the correct statement. (A) at T = 500 K, P = 40 atm, the state will be liquid. 50 atm (B) at T = 300 K, P = 50 atm, the state will be gas  $T_{c} = 500 \text{ K}$ 20 atm (C) at T < 300 K, P > 20 atm, the state will be gas T = 300 K(D) at 300 K < T < 500 K, P > 50 atm, the state will be liquid. 61. Consider the following statements: The coefficient B in the virial equation of state (i) is independent of temperature  $PV_{m} = RT \left( 1 + \frac{B}{V_{m}} + \frac{C}{V_{m}^{2}} + \dots \right)$ (ii) is equal to zero at boyle temperature (iii) has the dimension of molar volume Which of the above statements are correct. (A) i and ii **(B)** i and iii (C) ii and iii (D) i, ii and iii Consider the following statements: If the van der Waal's parameters of two gases are given as **62**. a (atm lit<sup>2</sup> mol<sup>-2</sup>) b (lit mol<sup>-1</sup>) Gas X: 6.5 0.056 Gas Y: 8.0 0.011 then (i):  $V_C(X) \leq V_C(Y)$ (ii):  $P_C(X) < P_C(Y)$ (iii):  $T_C(X) < T_C(Y)$ Select correct alternate: (A) (i) alone **(B)** (i) and (ii) (C) (i), (ii) and (iii) (D) (ii) and (iii)



63.	<ul> <li>Select correct statement</li> <li>(A) we can condense v</li> <li>(B) to liquify a gas one</li> <li>(C) at T<sub>c</sub>, there is no d density of the vapour</li> <li>(D) all the statements a</li> </ul>	t(s): vapours simply by applying must lower the temperatu istinction between liquid a re correct statements	g pressure re below T <sub>C</sub> and also app and vapour state, hence d	ly pressure ensity of the liquid is nearly equal	to
64.	A chemist has synthesiz	zed a greenish yellow gase	ous compound of chlorin	e and oxygen and finds that its dens	ity
	is 7.71 g/L at 36°C and 2	2.88 atm. Then the molecul	ar formula of the compou	nd will be	
	$(\mathbf{A})$ ClO <sub>3</sub>	<b>(B)</b> ClO <sub>2</sub>	(C) ClO	<b>(D)</b> $Cl_2O_2$	
65.	At what temperature th	e average speed of gas mo	lecules be double of that	at temperature 27°C?	
	(A) 120°C	(B) 108°C	(C) 927°C	<b>D</b> 300°C	
	(11) 120 0	(1)100 C	(0))210		
66.	Two glass bulbs A (of 1 tube of negligible volum B. The stopcock is oper	00 mL capacity), and B (of ne. At particular temperatur ned without changing the t	150 mL capacity) contain e the pressure in A was fou emperature. The pressure	ning same gas are connected by a sm nd to be 20 times more than that in bu in A will	all 1lb
	(A) drop by 75%	(B) drop by 57%	(C) drop by 25%	(D) will remain same	
67.	The product of PV is p correct about $T_1$ and $T_2$	lotted against P at two ten ?	nperatures $T_1$ and $T_2$ and	the 'result is shown in figure. What	t is
		Î	T		
			I_2		
		PV	T		

(A) 
$$T_1 > T_2$$
 (B)  $T_2 > T_1$  (C)  $T_1 = T_2$  (D)  $T_1 + T_2 = 1$ 

- 68. 2.5 L of a sample of a gas at 27°C and 1 bar pressure is compressed to a volume of 500 mL keeping the temperature constant, the percentage increase in pressure is
  (A) 100%
  (B) 400%
  (C) 500%
  (D) 80%
- 70. A quantity of gas is collected in a graduated tube over the mercury. The volume of gas at 18 °C is 50 ml and the level of mercury in the tube is 100 mm above the outside mercury level. The barometer reads 750 torr. Hence, volume at S.T.P. is approximately:
  (A) 22 ml
  (B) 40 ml
  (C) 20 ml
  (D) 44 ml
- 71. If equal weights of oxygen and nitrogen are placed in separate containers of equal volume at the same temperature, which one of the following statements is true? (mol wt:  $N_2 = 28, O_2 = 32$ )
  - (A) Both flasks contain the same number of molecules.
  - (B) The pressure in the nitrogen flask is greater than the one in the oxygen flask.
  - (C) More molecules are present in the oxygen flask.
  - (D) Molecules in the oxygen flask are moving faster on the average than the ones in the nitrogen flask.
  - (E) The nitrogen has a greater average kinetic energy per mole.



# Exercise # 2 Part # I [Multiple Correct Choice Type Questions]

1. A gas cylinder containing cooking gas can withstand a pressure of 14.9 atmosphere. The pressure guaze of cylinder indicates 12 atmosphere at 27 °C. Due to sudden fire in the building temperature starts rising. The temperature at which cylinder will explode is :

(A) 372.5 K (B) 99.5 °C

(C) 199 ℃

**(D)** 472.5 k

- Which of the following statements are correct ?(A) Helium diffuses at a rate 8.65 times as much as CO does.
  - (B) Helium escapes at a rate 2.65 times as fast as CO does.
  - (C) Helium escapes at a rate 4 times as fast as  $CO_2$  does.
  - **(D)** Helium escapes at a rate 4 times as fast as  $SO_2$  does.
- 3. The rate of diffusion of 2 gases 'A' and 'B' are in the ratio 16: 3. If the ratio of their masses present in the mixture is 2:3. Then
  - (A) The ratio of their molar masses is 16:1
  - (B) The ratio of their molar masses is 1:4
  - (C) The ratio of their moles present inside the container is 1:24
  - (D) The ratio of their moles present inside the container is 8:3
- 4. For two gases, A and B with molecular weights  $M_A$  and  $M_B$ , it is observed that at a certain temperature, T, the mean velocity of A is equal to the root mean square velocity of B. Thus the mean velocity of A can be made equal to the mean velocity of B, if
  - (A) A is at temperature,  $T_1$  and B at  $T_2 T_1 > T_2$
  - (B) A is lowered to a temperature  $T_2 < T$  while B is at T
  - (C) Both A and B are raised to a higher temperature
  - (D) Both A and B are lowered in temperature.
- 5. Match of following (where  $U_{ms} = root$  mean square speed,  $U_{av} = average$  speed,  $U_{mp} = most$  probable speed)

	List I			List II
(A)	$U_{\rm rms} / U_{\rm av}$		(i)	1.22
(B)	$U_{av}/U_{mp}$		(ii)	1.13
(C)	$U_{\rm rms}/U_{\rm mp}$		(iii)	1.08
(A) (A)-	(iii), (B)-(ii), (C)-(i)			<b>(B)</b> (A)-(i), (B)-(ii), (C)-(iii)
(C) (A)-	(iii), (B)-(i), (C)-(ii)			<b>(D)</b> (A)-(ii), (B)-(iii), (C)-(i).

6.  $N_2 + 3H_2 \longrightarrow 2NH_3$ . 1 mol  $N_2$  and 4 mol  $H_2$  are taken in 15 L flask at 27°C. After complete conversion of  $N_2$  into  $NH_3$ , 5 L of  $H_2O$  is added. Pressure set up in the flask is :

(A) $\frac{3 \times 0.0821 \times 300}{15}$ atm	(B) $\frac{2 \times 0.0821 \times 300}{10}$ atm
(C) $\frac{1 \times 0.0821 \times 300}{15}$ atm	<b>(D)</b> $\frac{1 \times 0.0821 \times 300}{10}$ atm

7.

Which of the following is not the correct set of pressure and volume at constant temperature and constant moles of gas ?

Р	V	Р	V
(A) 1 atm	200 ml	<b>(B)</b> 760 mm	0.2 L
(C) 0.5 atm	100 L	<b>(D)</b> 2 atm	100 mL



- At what temperature will the total KE of 0.3 mol of He be the same as the total KE of 0.40 mol of Ar at 400 K ?
  (A) 533 K
  (B) 400 K
  (C) 346 K
  (D) 300 K
- 9. Potassium hydroxide solutions are used to absorb CO<sub>2</sub>. How many litres of CO<sub>2</sub> at 1.00 atm and 22°C would be

absorbed by an aqueous solution containing 15.0 g of KOH? (Take  $R = \frac{1}{12} \bullet atm/K/mole$ )

 $2\text{KOH} + \text{CO}_2 \longrightarrow \text{K}_2\text{CO}_3 + \text{H}_2\text{O}$ (A) 3.24 L
(B) 1.62 L

(C) 6.48 L

**(D)** 0.324 L

**(D)**  $\frac{27}{64} \frac{R^2 T_C^2}{P_C}$ 

- **10.** The volume of a gas increases by a factor of 2 while the pressure decreases by a factor of 3. Given that the number of moles is unaffected, the factor by which the temperature changes is :
  - (A)  $\frac{3}{2}$  (B)  $3 \times 2$  (C)  $\frac{2}{3}$  (D)  $\frac{1}{2} \times 3$
- 11. If  $V_0$  is the volume of a given mass of gas at 273 K at constant pressure, then according to Charle's law, the volume at 10 °C will be:

(A) 
$$10 V_0$$
 (B)  $\frac{2}{273} (V_0 + 10)$  (C)  $V_0 + \frac{10}{273}$  (D)  $\frac{283}{273} V_0$ 

- 12. When a gas is compressed at constant temperature :
  - (A) the speeds of the molecules increase
  - (B) the collisions between the molecules increase
  - (C) the speeds of the molecules decrease
  - (D) the collisions between the molecules decrease
- 13.2 litres of moist hydrogen were collected over water at  $26^{\circ}$ C at a total pressure of one atmosphere. On analysis, it was<br/>found that the quantity of H2 collected was 0.0788 mole. What is the mole fraction of H2 in the moist gas<br/>(A) 0.989(B) 0.897(C) 0.953(D) 0.967
- 14. When  $CO_2$  under high pressure is released from a fire extinguisher, particles of solid  $CO_2$  are formed, despite the low sublimation temperature (-77°C) of CO<sub>2</sub> at 1.0 atm. It is
  - (A) the gas does work pushing back the atmosphere using KE of molecules and thus lowering the temperature
  - (B) volume of the gas is decreased rapidly hence, temperature is lowered
  - (C) both (A) and (B)
  - (D) None of the above
- 15. If a gas is allowed to expand at constant tempeature then which of the following does not hold true :
  - (A) the kinetic energy of the gas molecules decreases
  - (B) the kinetic energy of the gas molecules increases
  - (C) the kinetic energy of the gas molecules remains the same
  - (D) Can not be predicted
- 16. The vander waal gas constant 'a' is given by
  - (A)  $\frac{1}{3}$  V<sub>c</sub> (B) 3P<sub>c</sub> V<sub>c</sub><sup>2</sup> (C)  $\frac{1}{8} \frac{\text{RT}_{\text{C}}}{\text{P}_{\text{C}}}$

17. Which of the following are correct statements ?

- (A) vander Waals constant 'a' is a measure of attractive force
- (B) van der Waals constant 'b' is also called co-volume or excluded volume
- (C) 'b' is expressed in L mol<sup>-1</sup>
- (**D**) 'a' is expressed in atm  $L^2$  mol<sup>-2</sup>



18. For gaseous state at constant temperature which of the following plot is correct ?



19. A hypothetical gaseous element having molecular formula Mx may be changed to another gaseous allotrope having molecular formula My at 310 K. In this act volume of the gas is contracted by 12 ml to a volume of 8 ml. The simplest possible molecular formula of the two allotropes is : (A)  $M_5 \& M_3$  (B)  $M_4 \& M_5$  (C)  $M_1 \& M_2$  (D)  $M_2 \& M_3$ 

- 20. What is the total pressure exerted by the mixture of 7.0 g of N<sub>2</sub>, 2g of hydrogen and 8.0 g of sulphur dioxide gases in a vessel of 6 L capacity that has been kept in a reservoir at 27°C?
  (A) 2.5 bar
  (B) 4.5 bar
  (C) 10 atm
  (D) 5.7 bar
- 21. At what temperature root mean square speed of  $N_2$  gas is equal to that of propane gas at S.T.P. conditions. (A) 173.7°C (B) 173.7 K (C) S.T.P. (D) -40°C
- A gaseous mixture of three gases A, B and C has a pressure of 10 atm. The total number of moles of all the gases is 10. If the partial pressure of A and B are 3.0 and 1.0 atm respectively and if C has mol. wt. of 2.0, what is the weight of C in g present in the mixture ?
  (A) 6
  (B) 8
  (C) 12
  (D) 3
- 23. 1 mol of a gaseous aliphahatic compound  $C_n H_{3n} O_m$  is completely burnt in an excess of oxygen. The contraction in volume is (assume water get condensed out)

(A) 
$$\left(1+\frac{1}{2}n-\frac{3}{4}m\right)$$
 (B)  $\left(1+\frac{3}{4}n-\frac{1}{4}m\right)$  (C)  $\left(1-\frac{1}{2}n-\frac{3}{4}m\right)$  (D)  $\left(1+\frac{3}{4}n-\frac{1}{2}m\right)$ 

24. A cylinder is filled with a gaseous mixture containing equal masses of CO and  $N_2$ . The partial pressure ratio is :

(A) 
$$P_{N_2} = P_{CO}$$
 (B)  $P_{CO} = 0.875 P_{N_2}$  (C)  $P_{CO} = 2 P_{N_2}$  (D)  $P_{CO} = \frac{1}{2} P_{N_2}$ 

- 25. Helium atom is two times heavier than a hydrogen molecule at 298 k, the average kinetic energy of helium is : (A) two times that of hydrogen molecule
  - (B) same as that of the hydrogen molecule
  - (C) four times that of a hydrogen molecule
  - (D) half that of a hydrogen molecule
- 26. Two glass bulbs A and B are connected by a very small tube having a stop cock. Bulb A has a volume of 100 cm<sup>3</sup> and contained the gas, while bulb B was empty. On opening the stop cock, the pressure fell down to 40%. The volume of the bulb B must be :

(A)  $75 \text{ cm}^3$ 

**(B)**  $125 \text{ cm}^3$ 

(C)  $150 \, \text{cm}^3$ 

(D)  $250 \, \text{cm}^3$ 

- One mole of a gas is defined as -
  - (A) The number of molecules in one litre of gas
  - (B) The number of molecules in one formula weight of gas
  - (C) The number of molecules contained in 12 grams of (12 C) isotope
  - (D) The number of molecules in 22.4 litres of a gas at S.T.P.



27.

# GASEOUS STATE

If two moles of an ideal gas at 546 K occupies a volume of 44.8 litres, the pressure must be -28.  $(\mathbf{A})$  2 atm **(B)** 3 atm (C) 4 atm (D) 1 atm 29. At constant pressure which of the following does not represent Charle's law ? (C)  $V \propto \frac{1}{T^2}$ (A)  $V \propto \frac{1}{T}$ (**B**) V ∝ T (D)  $V \propto d$ 30. Which of the following does not shows explicitly the relationship between Boyle's law and Charles' law ? (A)  $\frac{P_1}{P_2} = \frac{T_1}{T_2}$ (C)  $\frac{P_2}{P_1} = \frac{V_1}{V_2}$ **(D)**  $\frac{V_2}{V_1} = \frac{P_1}{P_2} \times \frac{T_2}{T_1}$ **(B)** PV = KThe vander waal gas constant 'a' is given by 31. (C)  $\frac{1}{8} \frac{\text{RT}_{\text{C}}}{\text{P}_{\text{C}}}$ (**D**)  $\frac{27}{64} \frac{R^2 T_C^2}{P_C}$ (A)  $\frac{1}{2}$  V<sub>c</sub> **(B)**  $3P_{C}V_{C}^{2}$ [Assertion & Reason Type Questions] Part # II

### Each question has 5 choices (A), (B), (C), (D) and (E) out of which only one is correct.

- (A) Statement-1 is true, Statement-2 is true and Statement-2 is correct explanation for Statement-1
- (B) Statement-1 is true, Statement-2 is true and Statement-2 is not correct explanation for Statement-1
- (C) Statement-1 is true, Statement-2 is false
- (D) Statement-1 is false, Statement-2 is true

(E) Both Statements are false

- Statement-1 : Pressure exerted by a mixture of gases is equal to the sum of their partial pressures.
   Statement-2 : Reacting gases react to form a new gas having pressure equal to the sum of both.
- 2. Statement-1 :  $CH_4$ ,  $CO_2$  has value of Z (compressibility factor) less than one at low pressure and at low temperature. Statement-2 : Z < 1 is due to repulsive forces among the molecules.
- 3. Statement-1 : Excluded volume or co-volume equals to (V-nb) for n moles gas. Statement-2 : Co-volume depends on the effective size of gas molecules.
- Statement-1 : Gases like N<sub>2</sub>, O<sub>2</sub> behave as ideal gases at high temperature and low pressure.
   Statement-2 : Molecular interaction diminishes at high temperature and low pressure .
- 5. Statement-1 : Absolute zero temperature is a theoretically possible temperature at which the volume of the gas becomes zero.

Statement-2 : The total kinetic energy of the molecules is zero at this temperature.

6. Statement-1 : In a container containing gas 'A' at temp 400 K, some more gas A at temp. 300 K is introduced. The pressure of the system increases.

Statement-2 : Increase in gaseous particles increases the number of collisions among the molecules.

7. Statement-1 : Noble gases can be liquefied.

Statement-2 : Attractive forces can exist between non-polar molecules.



# **CHEMISTRY FOR JEE MAIN & ADVANCED**

- Statement-1 : The diffusion rate of oxygen is smaller than that of nitrogen under identical conditions.
   Statement-2 : Molecular mass of nitrogen is smaller than that of oxygen.
- Statement-1 : Most probable velocity of particles of gas is the velocity possessed by maximum fraction of particles at the same temperature.
   Statement-2 : On collision, more and more molecules acquire higher speed at the same temperature.
- Statement-I: Plot of P Vs. 1/V (volume) is a straight line.
   Statement-II: Pressure is directly proportional to volume.
- Statement-I : Critical temperature of the gas is the temperature at which it occupies 22.4 L of volume.
   Statement-II : Molar volume of every gas at NTP is 22.4 L.
- Statement-I : Carbondioxide has greater value of root mean square velocity u<sub>rms</sub> than carbon monoxide.
   Statement-II : u<sub>rms</sub> is directly proportional to molar mass.
- 13. Statement-I: The effusion rate of oxygen is smaller than that of nitrogen.Statement-II: Molecular size of nitrogen is smaller than that of oxygen.





# **CHEMISTRY FOR JEE MAIN & ADVANCED**

3.	Column – I	Column – II
	(A) At low pressure	$(\mathbf{p}) \ \mathbf{Z} = 1 + \frac{\mathbf{p}\mathbf{b}}{\mathbf{R}\mathbf{T}}$
	(B) At higher pressure	(q) $Z = 1 - \frac{a}{V_m RT}$
	(C) At low density of gas	(r) gas is more compressible than ideal gas
	<b>(D)</b> For $H_2$ and $He$ at $0^{\circ}C$	(s) gas is less compressible than ideal gas

### [Comprehension Type Questions]

## **Comprehension #1**

### Critical constant of A gas

When pressure is incerases at constant temp volume of gas decreases

 $AB \rightarrow gases, BC \rightarrow vapour + liquid, CD \rightarrow liquid$ critical point : At this point all the physical properties of liquid phase will be same as the physical properties in vapour

such as, density of liquid = density of vapour

**TC or critical temp :** Temperature above which a gas can not be liquified



**PC or critical pressure :** minimum pressure which must be applied at critical temp to convert the gas into liquid. **VC or critical volume :** volume occupied by one mole of gas at  $T_c \& P_c$ 

### Critical constant using vander wall equations

$$\begin{pmatrix} P + \frac{a}{V_m^2} \end{pmatrix} (V_m - b) = RT \qquad \Rightarrow \qquad (PV_m^2 + a) (V_m - b) = RT V_m^2$$

$$PV_m^3 + aV_m - PbV_m^2 - ab - RTV_m^2 = 0 \qquad \Rightarrow \qquad V_m^3 + V_m^2 \left(b + \frac{RT}{P}\right) + \frac{a}{P} \frac{V}{m} - \frac{ab}{P} = 0$$

since equation is cubic in  $V_m$  hence there will be three roots of equation at any temperature and pressure. At critical point all three roots will coincide and will give single value of  $V_m = V_c$ at critical point, Vander Waal equation will be

$$V_{m}^{3} - V_{m}^{2} \left( b + \frac{RT_{C}}{P_{C}} \right) + \frac{a}{P_{C}} V_{m} - \frac{ab}{P_{C}} = 0$$
 ...(1)

But at critical point all three roots of the equation should be equal, hence equation should be :

$$V_{m} = V_{c} (V_{m} - V_{c})^{3} = 0 V_{m}^{3} - 3V_{m}^{2}V_{c} + 3V_{m}V_{c}^{2} - V_{c}^{3} = 0$$
...(2) comparing with equation (1)

$$b + \frac{RT_{C}}{P_{C}} = 3V_{C}$$
 ....(i)  $\frac{a}{P_{C}} = 3V_{C}^{2}$  ...(ii)  $\frac{ab}{P_{C}} = V_{C}^{3}$  ...(iii)



From (ii) and (iii),  $V_c = 3b$ 

From (ii) 
$$P_c = \frac{a}{3V_c^2}$$
 substituting  $P_c = \frac{a}{3(3b)^2} = \frac{a}{27b^2}$ 

From (i)  $\frac{RT_{c}}{P_{c}} = 3 V_{c} - b = 9b - b = 8b \implies T_{c} = \frac{8a}{27 Rb}$ 

At critical point, the slope of PV curve (slope of isotherm) will be zero at all other point slope will be negative zero is the maximum value of slope.

$$\left(\frac{\partial P}{\partial V_m}\right)_{T_c} = 0 \qquad \dots(i) \qquad \qquad \frac{\partial}{\partial V_m} \left(\frac{\partial P}{\partial V_m}\right)_{T_c} = 0 \qquad \dots(ii)$$

{Mathematically such points an known as point of inflection (where first two derivatives becomes zero)} using the two  $T_c P_c$  and  $V_c$  can be calculate

1. A scientist proposed the following equation of state  $P = \frac{RT}{V_m} - \frac{B}{V_m^2} + \frac{C}{V_m^3}$ . If this equation leads to the critical behaviour then critical temperature is :

(A) 
$$\frac{8B}{27RC}$$
 (B)  $\frac{-B}{8RC}$  (C)  $\frac{B^2}{3RC}$  (D) None of these

2. If the critical constants for a hypothetical gas are  $V_c = 150 \text{ cm}^3 \text{ mol}^{-1}$ .  $P_c = 50 \text{ atm}$  and  $T_c = 300 \text{ K}$ . Then the approximate radius of the molecule is : [Take  $R = \frac{1}{12}$  Ltr atm mol<sup>-1</sup> K<sup>-1</sup>]

(A) 
$$\left(\frac{75}{2\pi N_A}\right)^{1/3}$$
 (B)  $\left(\frac{75}{8\pi N_A}\right)^{1/3}$  (C)  $\left(\frac{3}{\pi N_A}\right)^{1/3}$  (D)  $\left(\frac{3}{256\pi N_A}\right)^{1/3}$ 

3.

Identify the wrong statement related to the above graph :
(A) between 50 K and 150 K temperature and pressure ranging from 10 atm to 20 atm matter may have liquid state.
(B) zero is the maximum value of the slope of P-V Curve
(C) If vander wall equation of state is applicable above critical temperature then cubic equation of V<sub>m</sub> will have one real and two imaginary roots.

(D) At 100 K and pressure below 20 atm it has liquid state only





## Comprehension #2

### **MEASUREMENT OF PRESSURE**

#### Barometer

A barometer is an instrument that is used for the measurement of pressure. The construction of the barometer is as follows





A thin narrow calibrated capillary tube is filled to the brim, with a liquid such as mercury, and is inverted into a trough filled with the same fluid. Now depending on the external atmospheric pressure, the level of the mercury inside the tube will adjust itself, the reading of which can be monitored. When the mercury column inside the capillary comes to rest, then the net forces on the column should be balanced.

Applying force balance, we get,

 $P_{atm} \times A = m \times g$  ('A' is the cross-sectional area of the capillary tube) If ' $\rho$ ' is the density of the fluid, then  $m = \rho \times g \times h$  ('h' is the height to which mercury has risen in the capillary) hence,  $P_{atm} \times A = (\rho \times g \times h) \times A$ 

or, 
$$P_{atm} = \rho g h$$

### **Faulty Barometer**

An ideal barometer will show a correct reading only if the space above the mercury column is vacuum, but in case if some gas column is trapped in the space above the mercury column, then the barometer is classified as a faulty barometer. The reading of such a barometer will be less than the true pressure. For such a faulty barometer  $P_{m} \times A$ 

$$P_{0}A = mg + P_{gas}A$$

$$P_{0} = \rho gh + P_{gas}$$
or
$$\rho gh = P_{0} - P_{gas}$$



1. A tube closed at one end is dipped in mercury as shown in figure-3 such that the closed surface coincides with the mercury level in the container. By how much length of the tube should be extended such that the level of Hg in the tube is 5 cm below the mercury level inside the container. (assume temperature remains constant)





3. A gas column is trapped between closed end of a tube and a mercury column of length (h) when this tube is placed with its open end upwards the length of gas column is (●₁) the length of gas column becomes (●₂) when open end of tube is held downwards (as shown in fig.-4). Find atmospheric pressure in

terms of height of Hg column. (assume temperature remains constant)

(A) 
$$\frac{h(l_1+l_2)}{(l_2-l_1)}$$
 (B)  $\frac{h(l_2-l_1)}{(l_1+l_2)}$ 

(C) 
$$\frac{(l_1+l_2)}{h(l_2-l_1)}$$
 (D)  $(h_1 \bullet_1 + h_2)$ 

## **Comprehension #3**

One of the important approach to the study of real gases involves the analysis of a parameter Z called the compressibility factor  $Z = \frac{PV_m}{RT}$  where P is pressure,  $V_m$  is molar volume, T is absolute temperature and R is the

universal gas constant. Such a relation can also be expressed as  $Z = \left(\frac{V_{m \text{ real}}}{V_{m \text{ ideal}}}\right)$  (where  $V_{m \text{ ideal}}$  and  $V_{m \text{ real}}$  are the molar

volume for ideal and real gas respectively). Gas corresponding Z > 1 have repulsive tendencies among constituent particles due to their size factor, whereas those corresponding to Z < 1 have attractive forces among constituent particles. As the pressure is lowered or temperature is increased the value of Z approaches 1. (reaching the ideal behaviour)

- 1. Choose the conclusions which are appropriate for the observation stated.
  - Observation

     I.
     Z = 1

     II.
     Z > 1

     III.
     Z < 1</td>
  - IV.  $Z \rightarrow 1$  for low P
  - (A) All conclusions are true
  - (C) Conclusions I,III & IV are true

# Conclusion

- I. The gas need not be showing the ideal behaviour
  II. On applying pressure the gas will respond by increasing its volume
  III. The gas has the ability to be liquefied.
  IV. The gas is approaching the ideal behaviour.
  (B) Conclusions I, II & IV are true
  (D) Conclusions III & IV are true
- 2. For a real gas 'G' Z > 1 at STP Then for 'G' :
  - Which of the following is true :
  - (A) 1 mole of the gas occupies 22.4 L at NTP
  - (B) 1 mole of the gas occupies 22.4 L at pressure higher than that at STP (keeping temperature constant)
  - (C) 1 mole of the gas occupies 22.4 L at pressure lower than that at STP (keeping temperature constant)
  - (D) None of the above





**3.** Following graph represents a pressure (P) volume (V) relationship at a fixed temperature (T) for n moles of a real gas. The graph has two regions marked (I) and (II). Which of the following options is true.

(A) Z < 1 in the region (II)

**(B)** Z = 1 in the region (II)

(C) Z = 1 for the curve

**(D)** Z approaches 1 as we move from region (II) to region (I)

## **Comprehension #4**

 $\begin{array}{c}
\uparrow \\ P \\
\hline \\ Region (I) \\
\hline \\ V \rightarrow \end{array}$ 

The rate of change of pressure (p) of a gas at constant temperature and constant external pressure due to effusion of gas from a vessel of constant volume is related to rate of change of number of molecules present by

$$\frac{\mathrm{d}p}{\mathrm{d}t} = \frac{\mathrm{k}T}{\mathrm{V}}\frac{\mathrm{d}N}{\mathrm{d}t}$$

where k = Boltzmann constant, T = temperature, V = volume of vessel & N = No. of molecules and  $\frac{dN}{dt} = \frac{-pA_0}{(2\pi mkT)^{1/2}}, \text{ where } A_0 = \text{ area of orifice and } m = \text{ mass of molecule.}$ 

at  $(2\pi m \kappa I)$ 

1. Time required for pressure inside vessel to reduce to 1/e of its initial value in (ln e = 1)

$$(\mathbf{A}) \left(\frac{2\pi \mathbf{m}}{\mathbf{k}T}\right)^{1/2} \frac{\mathbf{V}}{\mathbf{A}_0} \qquad \qquad (\mathbf{B}) \left(\frac{\mathbf{k}T}{2\pi \mathbf{m}}\right)^{1/2} \frac{\mathbf{V}}{\mathbf{A}_0} \qquad \qquad (\mathbf{C}) \left(\frac{2\pi \mathbf{m}\mathbf{k}T}{\mathbf{A}_0}\right)^{1/2} \qquad \qquad (\mathbf{D}) \frac{2\pi \mathbf{m}}{\mathbf{k}T} \frac{\mathbf{V}}{\mathbf{A}_0}$$

2. If the gas inside the vessel had molecular weight 9 times the gas in previous example and area of orifice was doubled and temperature maintained at 4T, time required for pressure to fall to 1/e times of its initial value would be (t = answer of previous option)

(A) 1.33 t (B) 4.24 t (C) 0.75 t (D) 1.125 t

- 3. The incorrect statement (s) is/are.
  - [I] Pressure will not fall to zero in infinite time.

[II] Time required for pressure to decrease to half its initial value is independent of initial pressure.

- [III] The relations given above are true for real gases also.
- (A) I (B) II (C) III (D) I and III

## Comprehension #5

Sketch shows the plot of Z v/s P for a hypothetical gas for one mole at three distinct temperature.





Boyle's temperature is the temperature at which a gas shows ideal behaviour over a pressure range in the low pressure region. Boyle's temperature  $(T_b) = \frac{a}{Rb}$ . If a plot is obtained at temperatures well below Boyle's temperature then the curve will show negative deviation, in low pressure region and positive deviation in the high pressure region. Near critical temperature the curve is more likely as CO, and the temperature well above critical temperature curve is more like H2 at 0°C as shown above. At high pressure suppose all the constant temperature curve varies linearly with pressure according to the following equation  $Z = 1 + \frac{Pb}{RT}$  $(R = 2 \text{ cal mol}^{-1} \text{ K}^{-1})$ Which of the following is correct : (A)  $\frac{a}{b} < 0.4 \text{ k cal mol}^{-1}$ **(B)** 0.4 k cal mol<sup>-1</sup>  $< \frac{a}{b} < 2$  k cal mol<sup>-1</sup> **(D)**  $\frac{a}{b} = 1 \text{ K cal mol}^{-1}$ (C)  $\frac{a}{b} > 0.4 \text{ k cal mol}^{-1}$ For 500 K plot value of Z changes from 2 to 2.2 if pressure is varied from 1000 atm to 1200 atm (high pressure) then the value of  $\frac{b}{RT}$  will be :-**(B)**  $2 \times 10^{-3} \text{ atm}^{-1}$  **(C)**  $5 \times 10^{-4} \text{ atm}^{-1}$ (**D**)  $10^{-4}$  atm<sup>-1</sup> (A)  $10^{-3}$  atm<sup>-1</sup> As shown in the figure at 200 K and 500 atm value of compressibility factor is 2 (approx). Then volume of the gas at this point will be :-(A) 0.01 L (B) 0.09 L (C) 0.065 L (D) 0.657 L Plot at Boyle's temperature for the gas will be : Z4 (A) **(B)**  $P \rightarrow$  $P \rightarrow$ **(C) (D)**  $P \rightarrow$  $P \rightarrow$ In very high pressure region if Z v/s P is plotted at 1200 K for the above gas then it will have greatest slope. (A) true (B) false (C) can't say (**D**) not related to the paragraph



1.

2.

3.

4.

5.

# Exercise # 4

## [Subjective Type Questions]

- 1. A quantity of an ideal gas is collected in a graduated tube over the mercury. The volume of gas at 20 °C is 50 ml and the level of mercury is 100 mm above the outside of the mercury level. The atmospheric pressure is 750 mm. Volume of gas at STP is : (Take R = 0.083 lt. atm/K/mole)
- 2. A quantity of hydrogen is confined in a chamber of constant volume. When the chamber is immersed in a bath of melting ice, the pressure of the gas is 1000 torr. (a) What is the Celsius temperature when the pressure manometer indicates an absolute pressure of 400 torr? (b) What pressure will be indicated when the chamber in brought to 100°C?
- 3. An open vessel at 27°C is heated until (3/5)th of the air in it has been expelled. Assuming that the volume of the vessel remains constant. Find out.
  - (a) The temperature at which vessel was heated.
  - (b) Volume of the air escaped out if vessel is heated to 900 K
  - (c) The temperature at which half of the air escapes out.
- 4. A gas cylinder contains 320 g oxygen gas at 24.6 atm pressure and 27°C. What mass of oxygen would escape if first the cylinder were heated to 133°C and then the valve were held open until the gas pressure was 1.00 atm, the temperature being maintained at 133°C? (R = 0.0821 L. atm/K/mole)
- 5. A volume V of a gas at a temperature  $T_1$  and a pressure p is enclosed in a sphere. It is connected to another sphere

of volume  $\frac{V}{2}$  by a tube and stopcock. The second sphere is initially evacuated and the stopcock is closed. If the

stopcock is opened the temperature of the gas in the second sphere becomes  $T_2$ . The first sphere is maintained at a temperature  $T_1$ . What is the final pressure  $p_1$  within the apparatus ?

- 6. A gas occupies 100.0 mL at 50°C and 1 atm pressure. The gas is cooled at constant pressure so that volume is reduced to 50.0 mL. What is the final temperature of the gas.
- 7. A sample of gas at 27°C and 1.00 atm pressure occupies 2.50 L. What temperature is required to adjust the pressure of that gas to 1.50 atm after it has been transferred to a 2.00 L container ?
- 8. Assuming the same pressure in each case, calculate the mass of hydrogen required to inflate a balloon to a certain volume V at 127°C if 8 g helium is required to inflate the balloon to half the volume, 0.50 V, at 27°C.
- 9. A mixture of gases at 760 torr contains 55.0% nitrogen, 25.0% oxygen and 20.0% carbon dioxide by mole. What is the partial pressure of each gas in torr ?
- 10. What will be pressure exerted by a mixture of 3.2g of methane of 4.4g of carbon dioxide contained in a 9dm<sup>3</sup> flask at  $27^{\circ}C$ ?
- 11. Oxygen and cyclopropane at partial pressures of 570 torr and 170 torr respectively are mixed in a gas cylinder. What is the ratio of the number of moles of cyclopropane to the number of moles of oxygen?
- 12. At the top of a mountain the thermometer reads -23°C and the barometer reads 700 mm Hg. At the bottom of the mountain the temperature is 27°C and the pressure is 750 mm Hg. Compare the density of the air at the top with that at the bottom.
- 13. A 300 mL sample of hydrogen was collected over water at 21°C on a day and the pressure over water was 748 Torr and vapour pressure of water was 19 Torr.
  - (a) How many mmoles of  $H_2O$  were present?
  - (b) What is the mole fraction of  $H_2$  in the moist gas mixture ?
  - (c) What would be the mass of the gas sample if it were dry?



- 14. A container contains the mixture of water vapour and oxygen gas with total pressure 1.1 atm at certain temperature. If volume is made one third then find the total pressure (assume aqueous tension of water at this temperature is 0.1 atm.)?
- **15.** For 10 minute each, at 0 °C, from two identical holes nitrogen and an unknown gas are leaked into a common vessel of 4 litre capacity. The resulting pressure is 2.8 atm and the mixture contains 0.4 mole of nitrogen. What is the molar mass of unknown gas?
- 16. The pressure in a vessel that contained pure oxygen dropped from 2000 torr to 1500 torr in 40 min as the oxygen leaked through a small hole into a vacuum. When the same vessel was filled with another gas, the pressure dropped from 2000 torr to 1500 torr in 80 min. What is the molecular weight of the second gas ?
- 17. The rates of diffusion of two gases A and B are in the ratio 1 : 4. If the ratio of their masses present in the mixture is 2 : 3. The ratio of their mole fraction is :
- 18. A gaseous mixture contains oxygen and another unknown gas in the molar ratio of 4 : 1 diffuses through a porous plug in 245 seconds. Under similar conditions same volume of oxygen takes 220 sec to diffuse. Find the molecular mass of the unknown gas.
- 19. The root mean square speed of gas molecules at a temperature 27 K and pressure 1.5 bar is  $1 \times 10^4$  cm/sec. If both temperature and pressure are raised three times, calculate the new rms speed of gas molecules.
- 20. At what temperature would the most probable speed of  $CO_2$  molecules be twice that at 127°C
- 21. Suppose a gas sample in all have  $6 \ge 10^{23}$  molecules. Each 1/3 rd of the molecules have rms speed  $10^4$  cm/sec,  $2 \ge 10^4$  cm/sec and  $3 \ge 10^4$  cm/sec. Calculate the rms speed of gas molecules in sample.
- 22. At what temperature will hydrogen molecules have the same root mean square speed as nitrogen molecules have at 35°C?
- 23. If density of vapours of a substance of molar mass 18 gm at 1 atm pressure and 500 K is 0.36 kg m<sup>-3</sup>, then calculate the value of Z for the vapours. (Take R = 0.082 L atm mole<sup>-1</sup> K<sup>-1</sup>)
- 24 One litre gas at 400 K and 300 atm pressure is compressed to a pressure of 600 atm and 200 K. The compressibility factor is changed from 1.2 to 1.6 respectively. Calculate the final volume of the gas.
- 25. Reduced temperature for benzene is 0.7277 and its reduced volume is 0.40. Calculate the reduced pressure of benzene.
- 26. The critical temperature and critical pressure of a gas are 31°C and 728 atmospheres respectively. Calculate the constants 'a' and 'b'.
- 27. Calculate the volume occupied by 2.0 mole of N<sub>2</sub> at 200 K and 8.21 atm pressure, if  $\frac{P_C V_C}{RT_C} = \frac{3}{8}$  and P V

$$\frac{P_r V_r}{T_r} = 2.4.$$

- 28. Explain the physical significance of van der waals parameters.
- 29. Using the van der Waals equation, calculate the pressure of 10.0 mol NH<sub>3</sub> gas in a 10.0 L vessel at 27°C.

$$\left(P + n^2 \frac{a}{V^2}\right) (V - nb) = nRT$$
  $a = 4.2 L^2. atm/mol^2$   $b = 0.037 L/mol$ 

30. 1 litre of a mixture of CO and  $CO_2$  is taken. This mixture is passed through a tube containing red hot charcoal. The volume now becomes 1.6 litres. The volumes are measured under the same conditions. Find the composition of the mixture by volume.



- **31.** 40 ml of ammonia gas, taken in an eudiometer tube, was subjected to sparks till the volume did not further change. The volume was found to increase by 40 ml. 40 ml of oxygen gas then mixed and the mixture was further exploded. The gases remained were 30 ml. Deduce the formula of ammonia.
- 32. When 100 ml of a  $O_2 O_3$  mixture was passed through turpentine, there was reduction of volume by 20 ml. If 100 ml of such a mixture is heated, what will be the increase in volume? [Hint:  $O_3$  is absorbed by turpentine]
- 33. 60 ml of a mixture of nitrous oxide and nitric oxide was exploded with excess of hydrogen. If 38 ml of  $N_2$  was formed, calculate the volume of each gas in the mixture.
- 34. A mixture of formic acid and oxalic acid is heated with concentrated  $H_2SO_4$ . The gases produced are collected and on its treatment with KOH solution the volume of the gas decreased by one-sixth. Calculate the molar ratio of the two acids in the original mixture. [Hint :  $H_2SO_4$  is a dehydrating agent. HCOOH produces  $H_2O$  and CO;  $H_2C_2O_4$  produces  $H_2O$ , CO, and CO]
- 35. A sample of a gaseous hydrocarbon occupying 1.12 litres at NTP when completely burnt in air produced 2.2 g of  $CO_2$  and 1.8 g of  $H_2O$ . Calculate the weight of the compound taken and the volume of  $O_2$  at NTP required for its burning. Find the molecular formula of the hydrocarbon.
- 36. A vertical hollow cylinder of height 1.52 m is fitted with a movable piston of negligible mass and thickness. The lower half of the cylinder contains an ideal gas and the upper half is filled with mercury. The cylinder is initially at 300 K. When the temperature is raised, half of the mercury comes out of the cylinder. Find the temperature, assuming the thermal expansion of mercury to be negligible.
- 37. A column of Hg of 100 mm in length is contained in the middle of a narrow tube 1 m long which is closed at both ends. Both the halves of the tube contained air at a pressure of 760 mm of Hg. By what distance will the column of Hg lie displaced if the tube is held vertical. Assume decrease in length of mercury column to be negligible, also take the process at constant temperature. (isothermal process).
- 38. A container holds 22.4 litre of a gas at 1 atmospheric pressure and at 0°C. The gas consists of a mixture of argon, oxygen and sulphur dioxide in which :
  - (a) Partial pressure of SO<sub>2</sub> = (Partial pressure O<sub>2</sub>) + (Partial pressure of Ar)
  - (b) Partial pressure of  $O_2 = 2 \times \text{partial pressure of Ar}$

Calculate the density of the gas mixture under these conditions.

A mixture of nitrogen and water vapours is admitted to a flask which contains a solid drying agent. Immediately after admission, the pressure of the flask is 760 mm. After some hours the pressure reached a steady value of 745 mm.
 (a) Calculate the composition, in mol and per cent of original mixture.

(b) If the experiment is done at 20°C and the drying agent increases in weight by 0.15 g, what is the volume of the flask ? (the volume occupied by the drying agent may be ignored) ?

- 40. A flask of 1.5 L capacity contains 400 mg of  $O_2$  and 60 mg of  $H_2$  at 100°C. Calculate the total pressure of the gaseous mixture. If the mixture is permitted to react to form water vapours at 100°C, what materials will be left and what will be their partial pressures.
- **41.** A spherical balloon of 21 cm diameter is to be filled up with hydrogen at NTP, from a cylinder containing the gas at 20 atm at 27° C. If the cylinder can hold 2.82 litre of water, calculate the number of balloons that can be filled up.



- 42. An LPG cylinder weighs 14.8 kg when empty. When full, it weighs 29.0 kg & shows a pressure of 2.5 atm. In the course of use at 27° C. The weight of the full cylinder reduced to 23.2 kg. Find out the volume of the gas in cubic metres used up at the normal usage conditions and the final pressure inside the cylinder. Assume LPG to be n-butane with normal boiling point 0°C.
- 43. A closed container of volume 0.02 m<sup>3</sup> contains a mixture of neon and argon gases, at a temperature of 27°C and pressure of  $1 \times 10^5$  Nm<sup>-2</sup>. The total mass of the mixture is 28 g. If the gram molecular weights of neon and argon are 20 and 40 respectively. Find the masses of the individual gases in the container, assuming them to be ideal. (Universal gas constant R = 8.314 J/mole K)
- 44. 6.0 g He and 12.0 g Ne molecules both having average velocity  $4 \times 10^2$  ms<sup>-1</sup> are mixed. Calculate kinetic energy per mol of the mixture.
- 45. 1 mole of  $CCl_4$  vapours at 77°C occupies a volume of 35.0 L.If van der Waal's constant are  $a = 20.39 L^2 \text{ atm mol}^{-2} \text{ and } b = 0.1383 L \text{ mol}^{-1}$ , calculate compressibility factor Z under, (a) low pressure region (b) high pressure region
- 46. At 27°C, hydrogen is leaked through a tiny hole into a vessel for 20 min. Another unknown gas at the same T & P as that of  $H_2$ , is leaked through the same hole for 20 min. After the effusion of the gases the mixture exerts a pressure of 6 atm. The hydrogen content of the mixture is 0.7 mole. If the volume of the container is 3 litre, what is molecular weight of unknown gas. (Use R = 0.0821 L atm  $K^{-1}$  mole<sup>-1</sup>)
- 47. At 20°C, two balloons of equal volume and porosity are filled to a pressure of 2 atm, one with 14 kg N<sub>2</sub> and other with 1 kg of H<sub>2</sub>. The N<sub>2</sub> balloon leaks to a pressure of 1/2 atm in 1 hr. How long will it take for H<sub>2</sub> balloon to reach a pressure of 1/2 atm ?
- 48. A mixture of ethane & ethene occupies 40 litre at 1 atm pressure & 400 K temperature. The mixture reacts completely with 130 g of  $O_2$  to produce  $CO_2$  &  $H_2O$ . Assuming ideal gas behaviour, calculate the mole fractions of ethane and ethene in the mixture.
- 49. 10 ml of a mixture of  $CH_4$ ,  $C_2H_4$  and  $CO_2$  was exploded with excess of air. After explosion there was a contraction of 17 ml and after treatment with KOH, there was further reduction of 14ml. What was the composition of the mixture?
- 50. To an evacuated 504.2 mL steel container is added 25 g  $CaCO_3$  and the temperature is raised to 1500 K causing a complete decomposition of the salt. If the density of CaO formed is 3.3 g/cc, find the accurate pressure developed in the container using the Van der waals equation of state. The van der waals constants for  $CO_2(g)$  are

$$a = 4 \frac{L^2 - atm}{mol^2}, b = 0.04 \frac{L}{mol}. (Ca - 40, C - 12, O - 16)$$





[**JEE**(Main) 2014]

10.For gaseous state, if most probable speed is denoted by  $C^*$ , average speed by  $\overline{C}$  and mean square speed by C, then<br/>for a large number of molecules the ratios of these speeds are :[JEE(Main) 2013]

(A)  $C^*: \overline{C}: C = 1.225: 1.128: 1$ (B)  $C^*: \overline{C}: C = 1.128: 1.225: 1$ (C)  $C^*: \overline{C}: C = 1: 1.128: 1.225$ (D)  $C^*: \overline{C}: C = 1: 1.225: 1.128$ 

A gaseous hydrocarbon gives upon combustion 0.72 g of water and 3.08 g. of CO<sub>2</sub>. The empirical formula of the hydrocarbon is : [JEE(Main) 2013]

(A) 
$$C_2H_4$$
 (B)  $C_3H_4$  (C)  $C_6H_5$  (D)  $C_7H_8$ 

12. If Z is a compressibility factor, van der Waals equation at low pressure can be written as : [JEE(Main) 2014]

(A) 
$$Z = 1 - \frac{Pb}{RT}$$
 (B)  $Z = 1 + \frac{Pb}{RT}$  (C)  $Z = 1 + \frac{RT}{Pb}$  (D)  $Z = 1 - \frac{a}{VRT}$ 

**13.** The ratio of masses of oxygen and nitrogen in a particular gaseous mixture is 1 : 4. The ratio of number of their molecule is ;

14. Two closed bulbs of equal volume (V) containing an ideal gas initially at pressure  $p_i$  and temperature  $T_1$  are connected through a narrow tube of negligible volume as shown in the figure below. The temperature of one of the bulbs is then raised to  $T_2$ . The final pressure  $p_f$  is : [JEE(Main) 2016]

$$(A) 2p_i \left(\frac{T_1}{T_1 + T_2}\right) (B) 2p_i \left(\frac{T_2}{T_1 + T_2}\right) (C) 2p_i \left(\frac{T_1T_2}{T_1 + T_2}\right) (D) p_i \left(\frac{T_1T_2}{T_1 + T_2}\right)$$

$$(A) 2p_i \left(\frac{T_1}{T_1 + T_2}\right) (B) 2p_i \left(\frac{T_2}{T_1 + T_2}\right) (C) 2p_i \left(\frac{T_1T_2}{T_1 + T_2}\right) (D) p_i \left(\frac{T_1T_2}{T_1 + T_2}\right)$$

$$(A) \sqrt{\frac{2E}{M}} (B) \sqrt{\frac{3E}{M}} (C) \sqrt{\frac{2E}{3M}} (D) \sqrt{\frac{3E}{2M}}$$

$$(A) \sqrt{\frac{2E}{M}} (B) \sqrt{\frac{3E}{M}} (C) \sqrt{\frac{2E}{3M}} (D) \sqrt{\frac{3E}{2M}}$$

$$(A) \frac{1}{2} (B) 3 (C) \frac{1}{3} (D) 2$$
Figure displays the plot of the compression factor Z verses p for a few gases [JEE-2006]



1.

2.

3.

Π

--- III

# **CHEMISTRY FOR JEE MAIN & ADVANCED**

- Which of the following statements is/are correct for a van-der waals gas :
- (A) The plot I is applicable provided the vander waals constant a is negligible.
- (B) The plot II is applicable provided the vander waals constant b is negligible.
- (C) The plot III is applicable provided the vander waals constants a and b are negligible.
- (D) The plot IV is applicable provided the temperature of the gas is much higher than its critical temperature.

4. Match gases under specified conditions listed in Column-I with their properties / laws in Column-II. [JEE-2007] Column-I

- (A) Hydrogen gas (P = 200 atm, T = 273 K) (p) compressibility factor  $\neq 1$
- (B) Hydrogen gas  $(P \sim 0, T = 273 \text{ K})$  (q) attractive forces are dominant
- (C)  $CO_2(P=1 \text{ atm}, T=273 \text{ K})$  (r) PV=nRT
- (D) Real gas with very large molar volume (s)
- 5. A gas described by van der Waals equation

(A) behaves similar to an ideal gas in the limit of large molar volumes

- (B) behaves similar to an ideal gas is in limit of large pressures
- (C) is characterised by van der Waals coefficients that are dependent on the identity of the gas but are independent of the temperature.

P(V-nb) = nRT

(D) has the pressure that is lower than the pressure exerted by the same gas behaving ideally

6. The term that corrects for the attractive forces present in a real gas in the vander Waals equation is : [JEE-2009]
 (A) nb

**(B)** 
$$\frac{\mathrm{an}^2}{\mathrm{V}^2}$$

 $(\mathbf{C}) - \frac{\mathrm{an}^2}{\mathrm{V}^2}$ 

**(D)** –nb

- 7. At 400 K, the root mean square (rms) speed of a gas X (molecular weight = 40) is equal to the most probable speed of gas Y at 60 K. The molecular weight of the gas Y is. [JEE-2009]
- 8. According to kinetic theory gases
  - (A) collisions are always elastic
  - (B) heavier molecules transfer more momentum to the wall of the container
  - (C) only a small number of molecules have very high velocity
  - (D) between collisions, the molecules move in straight lines with constant velocities.
- 9. To an evacuated vessel with movable piston under external pressure of 1 atm., 0.1 mol of He and 1.0 mol of an unknown compound (vapour pressure 0.68 atm. at 0°C) are introduced. Considering the ideal gas behaviour, the total volume (in litre) of the gases at 0°C is close to [JEE-2011]
- 10. For one mole of a van der Waals gas when b = 0 and T = 300 K, the PV vs. 1/V plot is shown below. The value of the vander Waals constant a (atm.liter<sup>2</sup> mol<sup>-2</sup>) : [JEE-2012]





[**JEE-2008**]



11. The atomic masses of He and Ne are 4 and 20 a.m.u., respectively. The value of the de Broglie wavelength of He gas at -73 °C is "M" times that of the de Broglie wavelength of Ne at 727 °C. M is [JEE(ADVANCED)-2013]

# Paragraph for Questions 12 to 13

A fixed mass 'm' of a gas is subjected to transormation of states from K to L to M to N and back to K as shown in the figure



[JEE(ADVANCED)-2013]

[JEE(ADVANCED)-2013]

- 12. The succeeding operations that enable this transformation of states are
  - (A) Heating, cooling, heating, cooling
  - (B) Cooling, heating, cooling, heating
  - (C) Heating, cooling, cooling, heating
  - **(D)** Cooling, heating, heating, cooling

**13.** The pair of isochoric processes among the transormation of states is

(A) K to L and L to M

(A) 1.0

- (B) L to M and N to K
- (C) L to M and M to N
- (D) M to N and N to K



14.One mole of a monatomic real gas satisfies the equation p(V - b) = RT where b is a constant. The relationship of<br/>interatomic V(r) and interatomic distance r for the gas is given by[JEE(ADVANCED)-2015]



- 15. The diffusin coefficient of an ideal gas is proportional to its mean free path and mean speed. The absolute temperature of an ideal gas is increased 4 times and its pressure is increased 2 times. As a result, the diffusion coefficient of this gas increases x times. The value of x is [JEE(ADVANCED)-2016]
- 16. A closed tank has two compartments A and B, both filled with oxygen (assumed to be ideal gas). The partition separating the two compartments is fixed and is a perfect heat insulator (Figure 1). If the old partition is replaced by a new partition which can slide and conduct heat but does NOT allow the gas to leak across (Figure 2), the volume (in m<sup>3</sup>) of the compartment A after the system attains equilibrium is [JEE(ADVANCED)-2018]





			MOCK TEST		
		<b>SECTION - I</b>	: STRAIGHT OBJECTI	VE TYPE	
1.	If density of vapour of Z for the vapours	rs of a substance of m s is : ( Take R = 0.082	olar masss 18gm/mole at 1 atm 2 L atm mole <sup>-1</sup> K <sup>-1</sup> )	pressureand 500K is 0.	$36 \text{ kg m}^{-3}$ , then value
	(A) $\frac{41}{50}$	<b>(B)</b> $\frac{50}{41}$	<b>(C)</b> 1.1	<b>(D)</b> 0.9	
2.	The density of gase $(F = 18)$	eous HF at 1.0 atm a	nd 300 K is 3.17 g/L. Hence, H	IF in gaseous state is -	
	(A) Dimer	(B) Monome	er (C) Tetramer	(D) Data in	sufficient
3.	Equal amount (ma temperature are in t	ss) of methane and e the ratio.	thane have their total translation	onal kinetic enegy in the	e ratio 3 : 1 then their
	$(A)^{5}:8$	<b>(B)</b> 45 : 8	<b>(C)</b> 15 : 8	<b>(D)</b> 8:5	
4.	Which of the follow $\log \sqrt{1}$	wing sketches is an i	sobar $\left(\frac{nR}{P} > 1\right)$		
	(A)	log T	(B)	log T	
	log V		log V		
	(C)	$\rightarrow$ log T	(D)	log T	
5.	For a certain gas w values of pressure, on the Y-axis,which	which deviates a litlle P. The plot of P/ρ o n was equal to	e from ideal behaviour, the val n the Y-axis versus P on the X	ues of density, ρ were r - axis was nonlinear a	neasured at different and had an intercept
	DT				

(C) RT	$(\mathbf{D}) \overline{\mathbf{V}}$
	(C) RT

- 6. A sample of water gas has a composition by volume of  $50\% H_2$ , 45% CO and 5% of CO<sub>2</sub>. Calculate the volume in litre at S.T.P of water gas which on treatment with excess of steam will produce 5 litre  $H_2$ . The equation for the reaction is  $CO + H_2O \longrightarrow CO_2 + H_2$ (A) 4.263 Litre (B) 5.263 Litre (B) 6.263 Litre (D) 7.263 Litre
- The rate of diffusion of a sample of ozonized oxygen is 0.98 times than that of oxygen find the percentage (by volume) of ozone in the ozonised sample.
   (A) 7.25
   (B) 8.25
   (C) 10.25
   (D) 15.25



8. Flask A of volume 10 litre containing 20 gram of  $H_2$  and flask B of volume 10 litre containing 88 gram of  $CO_2$  are connected by a connector having negligible volume. When valve of the connector iss opened what is the composition of  $H_2$  gas in the flask B after opening the valve.



11. There are n containers having volumes V, 2V,..., nV. A fixed mass of a gas is filled in all the containers connected with stopcock. All containers are at same temperature if pressure of first container is P then final pressure when all stopcocks are opened is :

(A)  $\frac{np}{n(n+1)}$  (B)  $\frac{2np}{n(n+1)}$  (C)  $\frac{3np}{n(n+1)}$  (D)  $\frac{np}{2n(n+1)}$ 

12. A mixture of two gases A and B in the mole ratio 2 : 3 is kept in a 2 litre vessel. A second 3 litre vessel has the same two gases in the mole ratio 3 : 5. Both gas mixtures have the same temperature and same total pressure. They are allowed to intermix and the final temperature and total pressure are the same as the initial values, the final volume being 5 litres. Given that the molar masses are  $M_A$  and  $M_B$ , what is the mean molar masses of the final mixture?

(A) 
$$\frac{77M_A + 123M_B}{200}$$
 (B)  $\frac{123M_A + 77M_B}{200}$  (C)  $\frac{77M_A + 123M_B}{250}$  (D)  $\frac{123M_A + 77M_B}{250}$ 

13. A 2 m long tube closed at one end is lowered vertically into water until the closed end is flush with the water surface. See figure below. Calculate the water level height in the tube. (Barometric pressure - 1 atm = 10 m of hydrostatic water head, Temperature =  $25^{\circ}$ C, Density of water = 1.00 g/ml. Neglect water vapour pressure).





- 14.At a certain temperature for which RT = 25 lit. atm. mol<sup>-1</sup>, the density of a gas, in gm lit<sup>-1</sup>, is  $d = 2.00P + 0.020 P^2$ , where<br/>P is the pressure in atmosphere. The molecular weight of the gas in<br/>(A) 25<br/>(B) 50<br/>(C) 75<br/>(D) 100
- A mixture of carbon monoxide and carbon dioxide is found to have a density of 1.7 g/lit at S.T.P. The mole fraction of carbon monoxide is:
   (A) 0.37
   (B) 0.40
   (C) 0.30
   (D) 0.50
- 16. The molecular radius for a certain gas = 1.25 Å. What is a reasonable estimate of the magnitude of the van der Waals constant, b, for the gas ?
   (A) 0.98 × 10<sup>-2</sup> litre/mole
   (B) 1.43 × 10<sup>-2</sup> litre/mole
   (C) 1.97 × 10<sup>-2</sup> litre/mole
   (D) 3.33 × 10<sup>-2</sup> litre/mole
- 17. Given the value of their van der Waals' constant 'a' arrange the following gases in the order of their expected liquification pressure at a temperature T. T is below the critical point of all the gases. Gas Kr Ν, CH. Cl. 'a'(atmL<sup>2</sup>mol-1) 2.283 2.439 1.408 6.579 (A)  $CH_4 < Kr < N_2 < Cl_2$ **(B)**  $N_2 < CH_4 < Kr < Cl_2$ **(B)**  $\operatorname{Cl}_{2} \stackrel{\circ}{<} \operatorname{Kr} < \operatorname{CH}_{4} < \operatorname{N}_{2}$ (**D**)  $C\tilde{l}_{2} < N_{2} < Kr < CH_{4}$
- 18. The critical volume of a gas is 0.072 lit. mol-1. The radius of the molecule will be, in cm

$$(\mathbf{A}) \left(\frac{3}{4\pi} \times 10^{-23}\right)^{\frac{1}{3}} \qquad (\mathbf{B}) \left(\frac{4\pi}{3} \times 10^{-23}\right)^{\frac{1}{3}} \qquad (\mathbf{C}) \left(\frac{3\pi}{4} \times 10^{-23}\right)^{\frac{1}{3}} \qquad (\mathbf{D}) \left(\frac{3}{4\pi} \times 10^{-8}\right)^{\frac{1}{3}}$$

**19.** Which of the following statements is not true ?

(A) The ratio of the mean speed to the rms speed is independent of the temperature.

(B) The square of the mean speed of the molecules is equal to the mean squared speed at a certain temperature.

(C) Mean kinetic energy of the gas molecules at any given temperature is independent of the mean speed.

(D) The difference between rms speed and mean speed at any given temperature for different gases diminishes as larger if larger molar masses are considerd.

20. A capillary tube of uniform diameter contains gas samples A and B, separated by a short column of Hg, '●' mm in length. The ends are sealed. In horizontal position, the confined gases occupy 'a' mm and 'b' mm in length with a common unknown pressure (P). In vertical position, the lengths become respectively a' mm and b' mm. Then P is equal to

(A) 
$$\frac{1}{\left(\frac{b}{b'}-\frac{a}{a'}\right)}$$
 (B)  $\frac{1}{\left(\frac{a}{a'}-\frac{b}{b'}\right)}$  (C)  $l\left(\frac{a}{a'}-\frac{b}{b'}\right)$  (D)  $l\left(\frac{b}{b'}-\frac{a}{a'}\right)$ 

# **SECTION - II : MULTIPLE CORRECT ANSWER TYPE**

21. Following graph is constructed foe the fixed amount of gas.
(A) From 1-2 pressure will increase.
(B) From 2-3 pressure remains constant
(C) Gas pressure at (3) is greater at state (1)
(D) From 1-2 pressure will decrease



22. Which of the following statements are correct

(A) Average velocity of molecules of a gas in a container is zero.

(B) All molecules in a gas are moving with the same speed.

(C) If an open container is heated from 300 K to 400 K the percentage of air which goes out with respect to originally present is 25%.

(D) If compressibility factor of a gas at STP is less than unity then its molar volume is less than 222.4 L at STP.



23. There are three closed containers in which equal amounts of the gas are filled.



If the containers are placed at the same temperatures the find the correct options :

(A) Pressure of the gas is minimum in (III) container

- (B) Pressure of the gas is equal in (I) and (II) container
- (C) Pressure of the gas is maximum in (I)
- (D) The ratio of pressure in II and III container is 3 : 4



With reference to the above graph, shoose the correct alternatives  $(\mathbf{A}) \mathbf{P}_{\mathbf{B}} > \mathbf{P}_{\mathbf{A}}$  $(\mathbf{B}) \mathbf{P}_{\mathrm{A}} > \mathbf{P}_{\mathrm{B}}$ (C) Pressure first increases then decreases

(D) Pressure first decreases then increases.

## SECTION - III : ASSERTION AND REASON TYPE

25. Statement - 1 : The value of vander waal's constant (A) is larger for ammonia than for nitrogen. Statement - 2 : Hydrogen bonding is present in ammonia. (A) Statement - 1 is True, Statement - 2 is True and Statement - 2 is correct explanation for statement - 1 (B) Statement - 1 is True, Statement - 2 is True and Statement - 2 is NOT a correct explanation for statement - 1. (C) Statement - 1 is True, Statement - 2 is False (D) Statement - 1 is False, Statement - 2 is True. Statement - 1 : At Boyle's temperature a real gas behaves as ideal gas for wide range of

26.

temperature and pressure. Statement - 2 : At Boyle's temperature vander waal constant 'a' and 'b' componsate each other.

(A) Statement - 1 is True, Statement - 2 is True and Statement - 2 is correct explanation for statement - 1

(B) Statement - 1 is True, Statement - 2 is True and Statement - 2 is NOT a correct

explana tion for statement - 1.

(C) Statement - 1 is True, Statement - 2 is False

(D) Statement - 1 is False, Statement - 2 is True



27. Statement - 1 : Greater is critical temperature more easily a gas can be liquified.

Statement -2 : Critical temperature depends on the magnitude of intermolecular forces of attraction between the gases.

(A) Statement - 1 is True, Statement - 2 is True and Statement - 2 is correct explanation for statement - 1

(B) Statement - 1 is True, Statement - 2 is True and Statement - 2 is NOT a correct explana tion for statement - 1.

(C) Statement - 1 is True, Statement - 2 is False

(D) Statement - 1 is False, Statement - 2 is True

## **SECTION - IV : COMPREHENSION TYPE**

Read the following comprehensions carefully and answer the questions.

### **Comprehension #1**

follows

#### **MEASUREMENT OF PRESSURE**

#### Barometer

A barometer is an instrument that is used for the measurement of pressure. The construction of the barometer is as



Cross sectional view of the capillary column

A thin narrow calibrated capillary tube is filled to the brim, with a liquid such as mercury, and is inverted into a trough filled with the same fluid. Now depending on the external atmospheric pressure, the level of the mercury inside the tube will adjust itself, the reading of which can be monitored. When the mercury column inside the capillary comes to rest, then the net forces on the column should be balanced.

Applying force balance, we get,

 $P_{atm} \times A = m \times g$  ('A' is the cross-sectional area of the capillary tube) If 'a' is the density of the fluid then  $m = a \times a \times b$  ('h' is the height to which moreover has

If ' $\rho$ ' is the density of the fluid, then m=  $\rho \times g \times h$  ('h' is the height to which mercury has risen in the capillary) hence,  $P_{atm} \times A = (\rho \times g \times h) \times A$ 

or,  $P_{atm} = \rho g h$ 

### **Faulty Barometer**

An ideal barometer will show a correct reading only if the space above the mercury column is vacuum, but in case if some gas column is trapped in the space above the mercury column, then the barometer is classified as a faulty barometer. The reading of such a barometer will be less than the true pressure.

For such a faulty barometer

or





28.

A tube closed at one end is dipped in mercury as shown in figure-3 such that the closed surface coincides with the mercury level in the container. By how much length of the tube should be extended such that the level of Hg in the tube is 5 cm below the mercury level inside the container. (assume temperature remains constant)  $P_{\rm e} = 70 \text{ cm of Hg}$ 

(A) 18 cm
(B) 19 cm
(C) 24 cm

(D) 30 cm





**29.** If above tube is placed vertically with the open end upward then the length of the air column will be (assume temperature

remains constant)

(A) 20 cm (B) 36 cm

(C) 18 cm

24 cm

case I

Hg

h

10cm 10cm, of Hg

**(D)** 15 cm

 $P_{atm} = 75 \text{ cm}$ 

= 20.4 gm/ml

case II

Hg h

P<sub>o</sub>

Fig.-4

**30.** A gas column is trapped between closed end of a tube and a mercury column of length (h) when this tube is placed with its open end upwards the length of gas column is  $(\bullet_1)$  the length of gas column becomes  $(\bullet_2)$  when open end of tube is held downwards (as shown in fig.-4). Find atmospheric pressure in

terms of height of Hg column. (assume temperature remains constant)



# **SECTION - V : MATRIX - MATCH TYPE**







# **SECTION - VI : SUBJECTIVE TYPE**

34. A bilb of constant volume is attached to a manometer tube open at other end as shown in the figure. The manometer is filled with a liquid of density (1/3)<sup>rd</sup> that of mercury. Initially h was 228 cm. Through a small hole in the bulb gas leaked

causing pressure decrease as  $\frac{dp}{dt} = -kp$ . If value of h is 114 cm after 7 minutes.

Calculate value of k in units of hour<sup>-1</sup>. (Report answer in multiple of  $10^{-1}$ ) [Use : in (4/3) = 0.28 & density of Hg = 13.6 g/ml]





# **ANSWER KEY**

### EXERCISE - 1

<b>1.</b> C	<b>2.</b> C	<b>3.</b> A	<b>4.</b> A	5. A	<b>6.</b> C	<b>7.</b> C	<b>8.</b> C	<b>9.</b> C	10. A	11. B	12. D	13. D
14. B	15. B	16. C	17. B	18. A	19. D	<b>20.</b> A	<b>21.</b> B	22. D	<b>23.</b> B	24. B	25. A	<b>26.</b> C
<b>27.</b> B	<b>28.</b> B	<b>29.</b> C	<b>30.</b> C	<b>31.</b> A	<b>32.</b> A	<b>33.</b> A	<b>34.</b> A	35. B	<b>36.</b> C	37. C	<b>38.</b> B	<b>39.</b> B
<b>40.</b> B	<b>41.</b> D	<b>42.</b> B	<b>43.</b> A	<b>44.</b> A	<b>45.</b> C	<b>46.</b> A	<b>47.</b> C	<b>48.</b> D	<b>49.</b> B	50. A	51. B	52. A
<b>53.</b> C	54. C	55. B	56. B	<b>57.</b> C	58. D	<b>59.</b> C	60. C	61. C	62. D	63. D	64. D	65. C
<b>66.</b> B	67. B	<b>68.</b> B	<b>69.</b> A	70. B	<b>71.</b> B							

EXERCISE - 2 : PART # I

1.	A, B	2.	B,D	3.	B, D	4.	В	5.	А	6.	D	7.	С	8.	А	9.	A
10.	С	11.	D	12.	В	13.	D	14.	Α	15.	В	16.	С	17.	D		
18.	A, B, C	19.	D	20.	D	21.	В	22.	С	23.	D	24.	А	25.	В	26.	С
27.	D	28.	А	29.	A,C,D	30.	A,B,C	31.	B, D								

## PART # II

1. C 2. C 3. D 4. A 5. B 6. B 7. A 8. A 9. C 10. C 11. D 12. E 13. C

## EXERCISE - 3 : PART # I

1. $A \rightarrow (s), B -$	$(q, s), C \rightarrow$	$(r), D \rightarrow$	(p)
-----------------------------	-------------------------	----------------------	-----

2.  $A \rightarrow (8), B \rightarrow (6), C \rightarrow (7), D \rightarrow (1), E \rightarrow (9), (F) \rightarrow (10), (G) \rightarrow (3), (H) \rightarrow (2), (I) \rightarrow (4), (J) \rightarrow (5)$ 

3.  $A \rightarrow (q, r), B \rightarrow (p, s), C \rightarrow (q, r), D \rightarrow (p, r)$ 

## PART # II

Comprehension #1:	1.	С	2.	D	3.	D				
Comprehension #2:	1.	В	2.	С	3.	А				
Comprehension #3:	1.	D	2.	В	3.	D				
Comprehension #4:	1.	Α	2.	С	3.	С				
Comprehension # 5 :	1.	В	2.	А	3.	С	4.	С	5.	В

### **EXERCISE - 5 : PART # I**

1. C 2. C 3. C 4. C 5. A 6. D 7. A 8. C 9. C 10. C 11. D 12. D 13. D 14. B

## PART # II

1.	434 m/s	2.	A 3. D	) 4.	А,	B,C <b>5.</b>	$A \rightarrow (p$	, s), B $\rightarrow$	$(\mathbf{r}),\mathbf{C}\rightarrow$	(p,q), D	$\rightarrow$ (r)	6.	A,C,D	7.	В
8.	$M_{\gamma} = 4$	9.	A, B, C, D	10	. 7	<b>11.</b> C	<b>12.</b> 5	13. C	14. B	15. C	16.	2.22			

# **MOCK TEST**

1.	В	2.	С	3.	D	4.	А	5.	А	6.	В	7.	в	8.	В	9.	В
10.	А	11.	В	12.	А	13.	С	14.	В	15.	Α	16	. C	17.	С	18.	A
19.	В	20.	Α	21.	A, B, C	22.	A, C, D	23.	A, C, D	24.	B,C	25	. A	26.	А	27.	А
28.	В	29.	С	30.	А												
31.	$A\!\rightarrow\!(p,$	r), B	$B \rightarrow (q, s)$	), C –	→(r), D -	<b>→</b> (p	, s)										
32.	$A \rightarrow (p,$	s), B	$B \rightarrow (p, r, $	s), (	$C \rightarrow (q), \tilde{c}$	$D \rightarrow$	(p, r, s)										
33.	$A \rightarrow (q)$	. B –	$\rightarrow$ (r), C –	→(s).	$D \rightarrow (p)$												

