GASEOUS STATE

GRAHAM'S LAW OF DIFFUSION

1. Which pair of the gaseous species diffuse through a small jet with the same rate of diffusion at same P and T :

(1) NO, CO (2) NO, CO_2

(3) NH_3,PH_3 (4) NO, C_2H_6

2. A football bladder contains equimolar proportions of H_2 and O_2. The composition by mass of the mixture effusing out of punctured football is in the ratio (H_2 : O_2)

(1) 1 : 4 (2) $2\sqrt{2}$: 1

(3) 1 : $2\sqrt{2}$ (4) 4 : 1

3. If the vapour densities of methane & oxygen are in the ratio 1 : 2, the ratio of rate of diffusion of O_2 & CH_4 is respectively

(1) 1 : 2 (2) 1 : 1.414

(3) 2 : 1 (4) 1.414 : 1

4. Since the atomic weights of carbon, nitrogen and oxygen are 12, 14 and 16 respectively, among the following pairs of gases, the pair that will diffuse at the same rate is :

(1) Carbon dioxide and nitrous oxide

(2) Carbon dioxide and nitrogen peroxide

(3) Carbon dioxide and carbon monoxide

(4) Carbon dioxide and nitric oxide

5. 50 ml of a gas A diffuse through a membrane in the same time as for the diffusion of 40 ml of a gas B under identical pressure temperature conditions. If the Molecular weight of A = 64, that of B would be :

(1) 100 (2) 250 (3) 200 (4) 80

6. The rate of diffusion of a gas having molecular weight just double of nitrogen gas is 56 ml per sec the rate of diffusion of nitrogen gas will be :

(1) 79.19 ml/sec. (2) 112 ml/sec

(3) 56 ml/sec (4) 90 ml/sec

DEVIATION FROM IDEAL GAS BEHAVIOUR

7. When does a real gas show behaviour same as ideal gas:

(1) At low temperature and low pressure

(2) At high temperature and high pressure

(3) At low temperature and high pressure

(4) At high temperature and low pressure

8. In van der Waal's equation of state of the gas law, the constant 'b' is a measure of :

(1) intermolecular repulsions

(2) intermolecular attraction

(3) volume occupied by the molecules

(4) intermolecular collisions per unit volume

9. The term that accounts for intermolecular force in van der Waals' equation for non ideal gas is :

(1) RT (2) V – b

(3) $\left(P+\frac{a}{V^2}\right)$ (4) $[RT]^{-1}$

10. At relatively high pressure, van der waals' equation reduces to :

(1) PV = RT (2) $PV = RT + \frac{a}{V}$

(3) PV = RT + Pb (4) $PV = RT - \frac{a}{V^2}$

11. The compressibility of a gas is less than unity at STP therefore :

(1) V_m > 22.4 L (2) V_m < 22.4 L

(3) V_m = 22.4 L (4) V_m = 44.8 L

12. The values of van der Waal's constant 'a' for the gases O_2, N_2, NH_3 and CH_4 are 1.360, 1.390, 4.170 and 2.253 L^2 atm mol^{-2} respectively. The gas which can most easily be liquefied is :

(1) O_2 (2) N_2

(3) NH_3 (4) CH_4

SOLUTION

GASEOUS STATE

1. At same P, T and container

$$r_{effusion} \propto \frac{1}{\sqrt{M\omega t}}$$

So NO ($M\omega t$ = 30) & C_2H_6($M\omega t$ = 30) diffuse with same rate

2. $n_{H_2} : n_{O_2} = 1 : 1 = P_{H_2} : P_{O_2}$

$$\frac{r_{H_2}}{r_{O_2}} = \frac{P_{H_2}}{P_{O_2}}\sqrt{\frac{M_{O_2}}{M_{H_2}}} \quad \text{(at same T)}$$

$$= \frac{1}{1}\sqrt{\frac{32}{2}}$$

$$\frac{r_{H_2}}{r_{O_2}} = \frac{4}{1} \quad \text{(by moles)}$$

$$= \frac{4 \times 2}{1 \times 32} \quad \text{(by mass)}$$

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

3. $V.D. = \frac{M\omega t}{2}$

$$VD_{CH_4} : VD_{O_2} = 1 : 2 = M_{CH_4} : M_{O_2}$$

$$\frac{r_{O_2}}{r_{CH_4}} = \sqrt{\frac{M_{CH_4}}{MO_2}} = \sqrt{\frac{1}{2}} = \frac{1}{1.414}$$

4. $r_{effusion} \propto \frac{1}{\sqrt{M\omega t}}$

CO_2($M\omega t$ = 44)
N_2O($M\omega t$ = 44)
diffuse with same rate

5. $\frac{r_A}{r_B} = \sqrt{\frac{M_B}{M_A}} \Rightarrow \frac{V_A / t}{V_B / t} = \sqrt{\frac{M_B}{M_A}}$

$$\frac{50 / t}{40 / t} = \sqrt{\frac{M_B}{64}} \Rightarrow M_B = 100$$

6. $\frac{r_X}{r_{N_2}} = \sqrt{\frac{M_{N_2}}{M_X}}$ ($M_X = 2 \times M_{N_2}$)

$$\frac{56\text{ml per sec}}{r_{N_2}} = \sqrt{\frac{1}{2}}$$

$r_{N_2} = 56\sqrt{2}$ ml per sec = 79.19 ml/sec

7. Real gas behave like ideal gas at low pressure and high temprature.

8. b : Excluded volume that is volume occupied by the molecules.

9. Term that account intermolecular forces is $\frac{a}{v^2}$

So expression is $\left(P + \frac{a}{V^2}\right)$

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

At High P : V samll.

$\frac{an^2}{v^2}$ can be neglected

P·(V–nb) = nRT
PV = RT + Pb (n = 1 mole)

11. Z < 1

$$\frac{V_m}{V_{ideal}} < 1$$

V_m < 22.4L (at STP)

12. Liquification tendency
$\propto$ 'a'
So NH_3 liquified easily