SRIGAYATRI EDUCATIONAL INSTITUTIONS

INDIA

STATES OF MATTER UT-03

1. An open vessel containing air is heated from 300 K to 400 K. The fraction of air originality present which goes out of it is:

a) $\frac{3}{4}$ b) $\frac{1}{4}$ c) 2/3 d) 1/8

2. NH_3 gas is liquefied more easily than N_2. Hence:

a) Vander Waals' constant a and b of $NH_3 >$ that of N_2

b) Vander Waals' constant a and b of $NH_3 <$ that of N_2

c) $a(NH_3) > a(N_2)$ but $b(NH_3) < b(N_2)$

d) $a(NH_3) > a(N_2)$ but $b(NH_3) > b(N_2)$

3. The term that accounts for intermolecular force in Vander Wall's equation for non-ideal gas is :

a) RT b) V-B c) $(P+a/V^2)$ d) $[RT]^{-1}$

4. If the pressure at the triple point of a substance is greater than 1 atm, we expect :

a) The boiling point of the liquid to be lower than triple point temperature

b) That the substance cannot exist as a liquid

c) The solid sublines without melting

d) The melting point of the solid to be at a lower temperature than the triple point temperature

5. If the intermolecular force vanish away, the volume occupies by the molecules contained in 4.5 kg water at STP will be :

a) $5.6 m^3$ b) $4.5 m^3$ c) 11.2 liter d) $11.2 m^3$

6. The ratio a/b (the terms used in Vander Waals' equation) has the unit :

a) atm liter mol^{-1} b) atm $dm^3 mol^{-1}$ c) dyne cm mol^{-1} d) all of these

7. The Vander Waals' equation is $\left(P+\frac{n^2a}{V}\right)$ (V-nB) = n RT for n moles where a and b are Vander Waals' constants. Which of the following statements are true about a and b when the temperature of the gas is too low ?

a) Both remains same b) a remains same ,. b varies

c) a varies, b remains same d) both varies

8. A $v dm^3$ flask contains gas A and another flask of 2V dm^3 contains gas B at the same temperature. If density of gas A is 3.0 g/dm^3 and wt. of B. Then the ratio of pressure 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) $\frac{P_A}{P_B} = 3$

9. The correct order of temperature for a real gas is :

Boyle temperature. critical temperature,. Inversion temperature

(I) (II) (III)

a) III>I>II b) I>II>III c) II>I>III d) I>III>II

10. Which pair of gases with show same rate of diffusion at same pressure and temperatures

a) CO and Ne b) C_2H_4 and CO c) B_2H_6 and C_2H_4 d) All of these

11. Equal moles of CO, B_2H_6, H_2 and CH_4 are placed in a container. If a hole was made in container, after 5 minutes partial pressure of gases in container would be : (at wt. of C,O, B and H are 12, 16, 11 and 1 respectively) :

a) $P_{CO} > P_{B_2H_6} > P_{H_2} > P_{CH_4}$ b) $P_{CO} = P_{B_2H_6} > P_{CH_4} > P_{CH_2}$

c) $P_{CO} > P_{B_2H_6} = P_{H_2} > P_{CH_4}$ d) $P_{B_2H_6} > P_{H_2} > P_{CH_4} > P_{CO}$

12. An ideal gas can never be liquefied because:

a) Its critical temperature is always above 0^0C
b) Its molecules are relatively small is size
c) It solidifies before becoming liquid
d) Forces of attraction among ideal gas molecules are negligible

13. Molecule weight of air at sea level is low. This is practical evidence of:

a) Boyle's law b) Charles' law
c) Dalton's law d) Presence of moisture

14. A vessel contains a mixture of one mole of Oxygen and two moles of nitrogen at 300K. The ratio of the average rotational kinetic energy per O_2 molecule to N_2 molecule is :

a) 1 : 1 b) 1 : 2 c) 2 :1 d) Depends upon

15. To expel half the mass of air from a large flask at 27^0C it must be heated to :

a) 54^0C b) 177^0C c) 277^0C d) 327^0C

16. Two vessels A and B have volumes V and 4V respectively. Both vessels contain some water. The pressure in the space above water is P_1 in vessel A and P_2 in vessel B at temperature T, which one is correct ?

a) $P_1 = P_2$ b) $4P_1 = P_2$ c) $P_1 = 4P_2$ d) $P_1 = 16P_2$

17. The density of a gas at STP is 2.68g/L. The gas may be :

a) NO_2 b) Kr c) COS d) SO_2

18. Which of the following statement is incorrect ?

a) gas molecules are always evenly disturbed in atmosphere
b) Vibrational motion is present in mono-atomic gases.
c) The molecules in a gas are in rapid random motion
d) None of these

19. The rates of diffusion of two gases A and B are in the ratio 1:4, A mixture contains these. Gases A and B in the ratio 2:3, the ratio of mole fraction of the gases A and B in the mixture is: (assume that $P_A = P_B$).

a) 1 : 24 b) 1 : 18 c) 1 :12 d) 1: 6

20 A jar contains He and H_2 in the molar ratio 1: 5. The ratio of mean transitional kinetic energy is in the ratio at the same temperature is:

a) 1: 1 b) 2 : 1 c) 5 :1 d) 1 : 5

21. What weight of hydrogen at STP could be contained in a vessel that holds 4.8g Oxygen at STP ?

a) 4.8 g b) 3.0 g c) 0.6 g d) 0. 3 g

22. A quantity of hydrogen gas occupies a volume of 30.0 mL at a certain temperature and pressure. What volume would half this mass of hydrogen occupy at triple the absolute temperature if the pressure were one-ninth that of the original gas?

a) 270 mL b) 90 mL c) 405 mL d) 137 mL

23. A gas in an open container is heated from 27^0C to 127^0C. The fraction of the original amount of the gas remaining in the container will be

a) 3/4 b) 1/2 c) 1/4 d) 1/8

24. The pressure of real gas is less than the pressure of an ideal gas because of :

a) Increase in collisions b) Increase in intermolecular forces
c) Infinite size of molecules d) Statement is incorrect

25. **O_2 gas at STP contained in a flask was replaced by SO_2 under same conditions. The weight of SO_2 will be:**

a) Equal to that of O_2 b) Half that O_2

c) Twice that of O_2 d) One fourth of O_2

26. **At what temperature will hydrogen molecules have same KE as nitrogen molecules at 280 K?**

a) 280 K   b) 40 K   c) 400 K   d) 50 K

27. **The volume of helium is 44.8 L at**

a) 100^0C and1 atm   b) 0^0C and1 atm

c) 0^0C and0.5 atm   d) 100^0C and0.5 atm

28. **A balloon filled with ethylene is picked with a sharp point and quickly dropped in a tank of H_2 gas under identical conditions. After a while the balloon will:**

a) Shrink   b) Completely collapse

c) Completely collapse   d) Remain unchanged in size

29. **When glass plate is immersed in mercury the surface near the plate**

a) Become concave   b) Is depressed   c) Is flat   d) Becomes convex

30. **Number of N_2 molecules present in L vessel at NTP when compressibility factor is 1.2 is**

a) 2.23×10^{24} b) 2.23×10^{22} c) 2.7×10^{22} d) 2.7×10^{24}

31. **It is easier to liquefy oxygen than hydrogen because**

a) Oxygen has a higher critical temperature and lower inversion temperature than hydrogen

b) Oxygen ha a lower critical temperature and higher inversion temperature than hydrogen

c) Oxygen has higher critical temperature and higher inversion temperature than hydrogen

d) The critical temperature and inversion temperature of oxygen is very low.

32. **The density of a gas A is twice that of a gas B at the same temperature. The molecular gas B is thrice that of A. The ratio of the pressure acting on A and B will be**

a) 1 : 6   b) 7 : 8   c) 2 : 5   d) 1:4

33. **The density of a gas at 27^0C and 1 atm is d. Pressure remaining constant, at which of the following temperature will its density become 0.75 d ?**

a) 20^0C b) 30^0C c) 400 K   d) 300 K

34. **Which of the following statements is wrong for gases ?**

a) Gases do not have a definite shape and volume.

b) Volume of the gas is equal to volume of container confining the gas

c) Confining gas exerts uniform pressure on the walls of container in all directions

d) Mass of gas cannot be determined by weighing a container in which it is enclosed.

35. **Which of the following statements is not correct about the three states of matter, i.e., solids, liquids and gas ?**

a) Molecules of a solid possess least energy where as those of a gas possess highest energy

b) The density of a solid is highest where as that of gases is lowest.

c) Gases like liquids possess definite volumes.

d) Molecules of a solid possess vibratory motion

36. **Which of the following is true about gaseous state ?**

a) Thermal energy = Molecular attraction

b) Thermal energy >> Molecular attraction

c) Thermal energy << Molecular attraction

d) Molecular forces >> Those in liquids

37. **According to kinetic theory of gases, for a diatomic molecule.**
a) The pressure exerted by the gas is proportional to the mean velocity of the molecules
b) The pressure exerted by the gas is proportional to the root mean square velocity of the molecules.
c) The root mean square velocity is inversely proportional to the temperature
d) The mean transitional kinetic energy of the molecules is proportional to the absolute temperature

38. **When is deviation more in the behavior of a gas from the ideal gas equation PV= nRT ?**
a) At high temperature and low pressure b) At low pressure and high temperature
c) At high temperature and high pressure d) At low temperature and low pressure

39. **Which expression gives average speed of gas molecules ?**
a) $\sqrt{\frac{8RT}{M}}$ b) $\frac{8RT}{M}$ c) $\left[\frac{8RT}{\pi M}\right]^{1/2}$ d) $\frac{8RT}{3.14M}$

40. **Under similar conditions , which of the following gas will have same value of U_{rms} as CO_2 ?**
a) NO b) C_3H_8 c) CO d) N_2

INTEGER TYPE QUESTIONS

41. **Calculate the weight of CH_4 in a 9 dm^3 cylinder at 16 bar and 27^0C (weight should be in gram)**

42. **At 0^0C, the density of a gaseous oxide at 2 bar is same as that of nitrogen at 5 bar. What is the molecular mass of the oxide in gram .**

43. **What will be pressure of gas mixture when 0.5 L of H_2 at 0.8 bar and 2.0 L of O_2 at 0.7 bar are introduced in a 1 L Vessel at 27^0C ? (Pressure should be in bar)**

44. **Calculate the volume occupied by 4.5 kg water molecules at 1 atm and 300 K if intermolecular forces vanish way (Vin m^3).**

45. **The drain cleaner, Drainer contains small bits of aluminum which react with caustic soda to produce hydrogen. What volume of H_2 at 20^0C and one bar will be released when 0.15 g of aluminium reacts ? (V in L)**

KEY SHEET

1) **B**	2) **C**	3) **C**	4) **A**	5) **A**	6) **D**	7) **D**	8) **C**	9) **A**	10) **D**
11) **B**	12) **D**	13) **D**	14) **A**	15) **D**	16) **C**	17) **C**	18) **B**	19) **A**	20) **A**
21) **D**	22) **C**	23) **A**	24) **B**	25) **C**	26) **A**	27) **C**	28) **B**	29) **D**	30) **B**
31) **C**	32) **A**	33) **C**	34) **D**	35) **C**	36) **B**	37) **D**	38) **B**	39) **C**	40) **B**
41) **92.5**	42) **70**	43) **1.8**	44) **0.158**	45) **0.202L**					

SOLUTIONS

1. On heating the gas in open vessel

   At 300 K ; $P_1V_1 = n_1 R 300$

   At 400 K ; $P_1V_1 = n_2 R 400$

   $\therefore \frac{n_1}{n_2} = \frac{400}{300}$

   $n_e = \frac{3}{4} n_1$

2. Highest is Vander Waals constant for attraction, easier is liquefaction.

   Also $b_{(NH_3)} < b_{(N_2)}$

3. Pressure correction term $= \frac{a}{V^2}$

4. Boiling point of a liquid is the temperature at which is its vapour pressure becomes equal to 1 atm.

5. Mole of water evaporated = $\frac{4.5 \times 10^3}{18}$

   Now calculate volume of vapours assuming, mole occupies 22-4 liters or $22.4 \times 10^{-3} m^{-3}$

6. Unit of a = atm $\text{litre}^2 \text{mol}^{-2}$

   $= \text{atm dm}^6 \text{mol}^{-2}$

   $= \text{dyne cm}^4 \text{mol}^{-2}$

   Unit of b = litre mol^{-1}

   $= \text{dm}^3 \text{mol}^{-1} = \text{cm}^3 \text{mol}^{-1}$

7. The Vander Waals constant a and b proposed to be characteristic constant were found to vary with temperature and pressure. This is one of the limitations of Vander Waals equation.

8. Using $PV = \frac{w}{M} RT \text{ or } P = \frac{d}{m} RT$

   For gas A , $P_A = \frac{3}{M_A} \times R \times T$ and

   $P_B = \frac{1.5}{M_B} \times R \times T$

   $\therefore \frac{P_A}{P_B} = \frac{2 \times M_B}{M_A} = \frac{2 \times 2 \times M_A}{M_A} = 4$

9. $T_i = \frac{2a}{Rb}, T_C = \frac{8a}{27Rb}, T_b = \frac{a}{Rb}$

10. Each pair of gas (CO and N_2, C_2H_4, CO, B_2H_6 and C_2H_4) has same molecular mass

11. CO and B_2H_6 have same molecular mass. The diffusion of lighter gas will be more. Thus moles coming out from container will show.

    $H_2 > CH_4 > CO = B_2H_6$.

12. To get liquid, appreciable value for force of attractions among molecules is must.

13. Molecular Weight of air (Mol. wt. 29.4 as 80% $N_2 + 20\% O_2$) is low at sea level as it contains more moisture (Mol.Wt.18) .

14. Both are diatomic gases and thus possess two degree of freedom associated with rotational kinetic energy. At same T, they have same kinetic energy.

15. $PV = nRT$ at constant P and V.

$$n_1T_1 = n_2T_2$$

$$n_1 \times 300 = \frac{n_1}{2} \times T$$

$$\therefore T = 600K = 327^0 C$$

16. $P_1 \times V = P_2 \times 4V$

$$P_1 = 4P_2$$

17. $d = \frac{PM}{RT}$ $\therefore M = \frac{dRT}{P}$

$$= \frac{2.68 \times 0.0821 \times 273}{1} = 60.1$$

i.e., $\cos(12+16+32) = 60$

18. Vibrational motion are never found in mono-atomic gases

19. $\frac{r_A}{r_B} = \sqrt{\frac{MB}{MA}} = \frac{1}{4}$

$$\frac{MB}{MA} = \frac{1}{16}$$

Now $\frac{nA}{nB} = \frac{nA}{(nA+nB)} \times \frac{nA+nB}{nB}$

$$\frac{WA}{MA} \times \frac{MB}{WB} = \frac{2}{3} \times \frac{1}{16} = \frac{1}{21}$$

20. The mean translational kinetic energy

$$E^1 = \frac{3}{2}kT \ or \ E^1 = \frac{3}{2}\frac{R}{N} = T$$

21. $4.8\,g\,O_2 = \frac{4.8}{32}\,\text{mol}\,O_2 = \frac{4.8}{32} \times 2\text{g}\,\text{H}_2\text{=0.3g}$

22. $P_1V_1 = n_1RT_1$

$$P_2V_2 = n_2RT_2$$

$$\frac{P_2V_2}{P_1V_1} = \frac{n_2T_2}{n_1T_1}$$

$$\frac{P_1}{9\,P_1} = \frac{V_2}{30} = \frac{1}{2}\frac{n_1}{n_1}\;\frac{3T_1}{T_1}$$

$$V_2 = 405\,ML$$

23. $PV = nRT$

$$n_1T_1 = n_2T_2$$

$$n_2 = \frac{T_1}{T_2} = \frac{3}{4}$$

24. -

25. 1mol of O_2=1 mol SO_2

32g O_2=64g SO_2

26. $\text{KE} = \frac{3}{2}RT$

$\text{KE} \propto T$

27. Use PV=RT

28. H_2 gas is greater than diffuses into balloon because rate of diffusion of H_2 is greater than the rate of diffusion of ethylene. Hence it is enlarged.

29. Conceptual

30. $Z = \frac{PV}{nRT} \Rightarrow n = \frac{PV}{nRT} = \frac{1\times 1}{1.2\times 0.082\times 273} = 0.037$

$\therefore \text{No. of molecules} = 0.037\times 6.023\times 10^{23}$

$= 2.23\times 10^{22}$

31. $\text{M}_{\text{rms}}(\text{H}_2) = \sqrt{\frac{T}{M}} = \sqrt{\frac{50}{2}} = 5$

$\text{M}_{\text{rms}} \text{of } \text{O}_2 \propto \sqrt{\frac{T}{M}} = \sqrt{\frac{800}{2}} = 5$

Therefore, the ratio is 1.

32. Pm = d RT

$\frac{P_A M_B}{P_B M_B} = \frac{d_A RT}{d_B RT}$

$\frac{P_A}{P_B}\times\frac{1}{3} = 2$

$P_A : P_B = 6:1$

33. $(\text{d})_1 = \text{d}$

$(\text{d})_2 = 0.75\text{d}$,

$\text{P}_1 = 1\text{atm}; \text{T}_1 = 27^0 C = 300K$

$\text{P}_2 = 1\text{atm}; \text{T}_2 = ?$

$\left[\frac{d_1}{d_2}\right] = \frac{P_1\times T_2}{P_1\times P_2}$ *or* $\frac{T_2}{T_1}$

$\therefore T_2 = \frac{\text{d}_1}{\text{d}_2}\times T_1 = \frac{\text{d}}{0.75\text{d}}\times 300 = 400K$

34. -

35. Gases and liquid do not possess definite volume.

36. Thermal energy > > molecular attraction

37. $KE = \frac{3}{2}RT$

38. At low temperature and high pressure, gases deviate more from ideal condition

39. $M_{ar} = \sqrt{\frac{8RT}{\pi M}}$

40. $M_{rms} = \sqrt{\frac{3RT}{M}}$

$M_{CO_2} = 44g$

$M_{O_2}H_8 = 44g$

$\therefore (H_{rms})Co_2 = (M_{rms})C_3H_8$

41. $\mathrm{P = 16\,bar; V = 9dm^3; T = 300K}$

$\mathrm{M_{CH4}} = 16, R = 0.083\ \mathrm{bar\ dm^3K^-mol\text{-}PV} = (\mathrm{w/m})RT$

$16 \times 9 = (w/16) \times 0.083 \times 300$

W = 92.5 g

42. $d = \frac{Pm}{RT}$

$\frac{\mathrm{P_{N_2} \times M_{N_2}}}{\mathrm{RT}} = \frac{\mathrm{P_{oxide} \times M_{oxide}}}{\mathrm{RT}}$

$\frac{\mathrm{S \times 28}}{\mathrm{RT}} = \frac{\mathrm{2 \times Mol.mass\,of\ oxide}}{\mathrm{RT}}$

Molecular mass of oxide = 70

43. For $H_2 : n = \frac{PV}{RT} = \frac{0.8 \times 0.5}{RT} = \frac{0.4}{RT}$

For $O_2 : n = \frac{0.7 \times 0.2}{RT} = \frac{1.4}{RT}$

Total moles $= \frac{0.4 \times}{RT} + \frac{1.4}{RT} = \frac{1.8}{RT}$

$PV = nRT \Rightarrow \times l = \frac{1.8}{RT} \times RT \Rightarrow 1.8$

44. In absence of intermolecular forces $H_2O_{(l)}$ will be converted into $H_2O_{(g)}$.

Thus at P = latin , T= 300K

$W_{H_2O} = 4.5 \times 10^3 g$

PV = n RT

$1 \times V = \frac{4.5 \times 10^3}{18} \times 0.0821 \times 300$

$V = 6.158 \times 10^3 L = 6.158\ \mathrm{m}^3$

45. $2Al + 2NaOH + 2H_2O \rightarrow 2Na\,AlO_2 + 3H_2$

Initial $\frac{0.15}{27} + 2NaOH + 2H_2O \rightarrow 2Na\,AlO_2 + 3H_2$

Final $\frac{0.15}{27} + 2NaOH + 2H_2O \rightarrow 2Na + \frac{3}{2} \times \frac{0.15}{27}$

Moles of $H_2 = \frac{0.15 \times 3}{2 \times 27} = 8.33 \times 10^{-3}$

By PV = n RT, P = 1 Bar = 0.987 atm.

T = 20 + 273 = 293 K

$0.987 \times V = 833 \times 10^{-3} \times 0.082 \times 293$

$V = 0.2029\,L.$