Chapter 5. States of Matter: Geses and Liquids

1. Equal moles of hydrogen and oxygen gases are placed in a container with a pin-hole through which both can escape. What fraction of the oxygen escapes in the time required for one-half of the hydrogen to escape?
(a) 3/8 (b) 1/2 (c) 1/8 (d) 1/4
(NEET-I 2016)

2. A gas such as carbon monoxide would be most likely to obey the ideal gas law at
(a) low temperatures and high pressures
(b) high temperatures and high pressures
(c) low temperatures and low pressures
(d) high temperatures and low pressures.
(2015)

3. Maximum deviation from ideal gas is expected from
(a) $CH_{4(g)}$ (b) $NH_{3(g)}$ (c) $H_{2(g)}$ (d) $N_{2(g)}$
(NEET 2013)

4. What is the density of N_2 gas at 227°C and 5.00 atm. pressure? ($R = 0.082$ L atm $K^{-1}mol^{-1}$)
(a) 1.40 g/mL (b) 2.81 g/mL
(c) 3.41 g/mL (d) 0.29 g/mL
(Karnataka NEET 2013)

5. 50 mL of each gas A and of gas B takes 150 and 200 seconds respectively for effusing through a pin hole under the similar conditions. If molecular mass of gas B is 36, the molecular mass of gas A will be
(a) 96 (b) 128 (c) 32 (d) 64
(2012)

6. A certain gas takes three times as long to effuse out as helium. Its molecular mass will be
(a) 27 u (b) 36 u (c) 64 u (d) 9 u
(*Mains 2012)*

7. For real gases van der Waals equation is written as $\left(p + \frac{an^2}{V^2}\right)(V - nb) = n\,RT$
where a and b are van der Waals constants Two sets of gases are
(I) O_2, CO_2, H_2 and He
(II) CH_4, O_2 and H_2
The gases given in set-I in increasing order of b and gases given in set-II in decreasing order of a, are arranged below. Select the correct order from the following
(a) (I) $He < H_2 < CO_2 < O_2$ (II) $CH_4 > H_2 > O_2$
(b) (I) $O_2 < He < H_2 < CO_2$ (II) $H_2 > O_2 > CH_4$
(c) (I) $H_2 < He < O_2 < CO_2$ (II) $CH_4 > O_2 > H_2$
(d) (I) $H_2 < O_2 < He < CO_2$ (II) $O_2 > CH_4 > H_2$
(Mains 2012)

8. Equal volumes of two monatomic gases, A and B at same temperature and pressure are mixed. The ratio of specific heats (C_P/C_V) of the mixture will be
(a) 0.83 (b) 1.50 (c) 3.3 (d) 1.67
(2012)

9. By what factor does the average velocity of a gaseous molecule increase when the temperature (in Kelvin) is doubled?
(a) 2.0 (b) 2.8 (c) 4.0 (d) 1.4
(2011)

10. Two gases A and B having the same volume diffuse through a porous partition in 20 and 10 seconds respectively. The molecular mass of A is 49 u. Molecular mas of B will be
(a) 50.00 u (b) 12.25 u
(c) 6.50 u (d) 25.00 u *(2011)*

11. A gaseous mixture was prepared by taking equal mole of CO and N_2. If the total pressure of the mixture was found 1 atmosphere, the partial pressure of the nitrogen (N_2) in the mixture is
(a) 0.5 atm (b) 0.8 atm
(c) 0.9 atm (d) 1 atm *(2011)*

12. A bubble of air is underwater at temperature 15°C and the pressure 1.5 bar. If the bubble rises to the surface where the temperature is 25°C and the pressure is 1.0 bar, what will happen to the volume of the bubble?

(a) Volume will become greater by a factor of 1.6.
(b) Volume will become greater by a factor of 1.1.
(c) Volume will become smaller by a factor of 0.70.
(d) Volume will become greater by a factor of 2.5. *(Mains 2011)*

13. The pressure exerted by 6.0 g of methane gas in a 0.03 m^3 vessel at 129°C is (Atomic masses: C = 12.01, H = 1.01 and $R = 8.314\ J\ K^{-1}\ mol^{-1}$)
(a) 215216 Pa (b) 13409 Pa
(c) 41648 Pa (d) 31684 Pa
(Mains 2010)

14. The energy absorbed by each molecule (A_2) of a substance is 4.4×10^{-19} J and bond energy per molecule is 4.0×10^{-19} J. The kinetic energy of the molecule per atom will be
(a) 2.2×10^{-19} J (b) 2.0×10^{-19} J
(c) 4.0×10^{-20} J (d) 2.0×10^{-20} J
(2009)

15. If a gas expands at constant temperature, it indicates that
(a) kinetic energy of molecules remains the same
(b) number of the molecules of gas increases
(c) kinetic energy of molecules decreases
(d) pressure of the gas increases. *(2008)*

16. Volume occupied by one molecule of water (density = 1 g cm^{-3}) is
(a) $3.0 \times 10^{-23}\ cm^3$ (b) $5.5 \times 10^{-23}\ cm^3$
(c) $9.0 \times 10^{-23}\ cm^3$ (d) $6.023 \times 10^{-23}\ cm^3$
(2008)

17. van der Waal's real gas, acts as an ideal gas, at which conditions?
(a) High temperature, low pressure
(b) Low temperature, high pressure
(c) High temperature, high pressure
(d) Low temperature, low pressure *(2002)*

18. Average molar kinetic energy of CO and N_2 at same temperature is
(a) $KE_1 = KE_2$
(b) $KE_1 > KE_2$
(c) $KE_1 < KE_2$
(d) can't say any thing. Both volumes are not given. *(2000)*

19. At 25°C and 730 mm pressure, 380 mL of dry oxygen was collected. If the temperature is constant, what volume will the oxygen occupy at 760 mm pressure?
(a) 569 mL (b) 365 mL
(c) 265 mL (d) 621 mL
(1999)

20. Which of the following statements is wrong for gases?
(a) Confined gas exerts uniform pressure on the walls of its container in all directions.
(b) Volume of the gas is equal to volume of container confining the gas.
(c) Gases do not have a definite shape and volume.
(d) Mass of a gas cannot be determined by weighing a container in which it is enclosed. *(1999)*

21. The average kinetic energy of an ideal gas, per molecule in S.I. units, at 25°C will be
(a) 6.17×10^{-20} J (b) 7.16×10^{-20} J
(c) 61.7×10^{-21} J (d) 6.17×10^{-21} J
(1996)

22. At what temperature, the rate of effusion of N_2 would be 1.625 times than the rate of SO_2 at 500°C?
(a) 373°C (b) 620°C
(c) 110°C (d) 173°C *(1996)*

23. Which of the following mixture of gases does not obey Dalton's Law of partial pressure?
(a) Cl_2 and SO_2 (b) CO_2 and He
(c) O_2 and CO_2 (d) N_2 and O_2
(1996)

24. An ideal gas, obeying kinetic theory of gases can not be liquefied, because
(a) it solidifies before becoming a liquid
(b) forces acting between its molecules are negligible
(c) its critical temperature is above 0°C
(d) its molecules are relatively small in size. *(1995)*

25. 50 mL of hydrogen diffuses out through a small hole of a vessel, in 20 minutes. The time taken by 40 mL of oxygen to diffuse out is
(a) 32 minutes (b) 64 minutes
(c) 8 minutes (d) 12 minutes
(1994)

26. The temperature of a gas is raised from 27°C to 927°C. The root mean square speed of the gas
(a) remains same
(b) gets $\sqrt{\dfrac{927}{27}}$ times

(c) gets halved
(d) gets doubled. *(1994)*

27. At STP, 0.50 mol H_2 gas and 1.0 mol He gas
(a) have equal average kinetic energies
(b) have equal molecular speeds
(c) occupy equal volumes
(d) have equal effusion rates. *(1993)*

28. Under what conditions will a pure sample of an ideal gas not only exhibit a pressure of 1 atm but also a concentration of 1 mole $litre^{-1}$? (R = 0.082 litre atm mol^{-1} deg^{-1})
(a) At STP
(b) When V = 22.4 litres
(c) When T = 12 K
(d) Impossible under any conditions. *(1993)*

29. Internal energy and pressure of a gas per unit volume are related as
(a) $P = \frac{2}{3}E$ (b) $P = \frac{3}{2}E$
(c) $P = \frac{1}{2}E$ (d) $P = 2E$ *(1993)*

30. The ratio among most probable velocity, mean velocity and root mean square velocity is given by
(a) 1 : 2 : 3 (b) $1:\sqrt{2}:\sqrt{3}$
(c) $\sqrt{2}:\sqrt{3}:\sqrt{8/\pi}$ (d) $\sqrt{2}:\sqrt{8/\pi}:\sqrt{3}$ *(1993)*

31. When is deviation more in the behaviour of a gas from the ideal gas equation $PV = nRT$?
(a) At high temperature and low pressure
(b) At low temperature and high pressure
(c) At high temperature and high pressure
(d) At low temperature and low pressure. *(1993)*

32. A closed flask contains water in all its three states solid, liquid and vapour at 0°C. In this situation, the average kinetic energy of water molecules will be
(a) the greatest in all the three states
(b) the greatest in vapour state
(c) the greatest in the liquid state
(d) the greatest in the solid state. *(1992)*

33. Which is not true in case of an ideal gas?
(a) It cannot be converted into a liquid.
(b) There is no interaction between the molecules.
(c) All molecules of the gas move with same speed.
(d) At a given temperature, PV is proportional to the amount of the gas. *(1992)*

34. The correct value of the gas constant 'R' is close to
(a) 0.082 litre-atmosphere K
(b) 0.082 litre-atmosphere K^{-1} mol^{-1}
(c) 0.082 $litre\text{-}atmosphere^{-1}$ K mol^{-1}
(d) 0.082 $litre^{-1}$ $atmosphere^{-1}$ K mol. *(1992)*

35. An ideal gas can't be liquefied because
(a) its critical temperature is always above 0°C
(b) its molecules are relatively smaller in size
(c) it solidifies before becoming a liquid
(d) forces operative between its molecules are negligible. *(1992)*

36. Select one correct statement. In the gas equation, $PV = nRT$
(a) n is the number of molecules of a gas
(b) V denotes volume of one mole of the gas
(c) n moles of the gas have a volume V
(d) P is the pressure of the gas when only one mole of gas is present. *(1992)*

37. A gas is said to behave like an ideal gas when the relation PV/T = constant. When do you expect a real gas to behave like an ideal gas?
(a) When the temperature is low.
(b) When both the temperature and pressure are low.
(c) When both the temperature and pressure are high.
(d) When the temperature is high and pressure is low. *(1991)*

38. In a closed flask of 5 litres, 1.0 g of H_2 is heated from 300 to 600 K. Which statement is not correct?
(a) Pressure of the gas increases
(b) The rate of collision increases
(c) The number of moles of gas increases
(d) The energy of gaseous molecules increases *(1991)*

39. At constant temperature, in a given mass of an ideal gas
(a) the ratio of pressure and volume always remains constant
(b) volume always remains constant
(c) pressure always remains constant
(d) the product of pressure and volume always remains constant. *(1991)*

40. The root mean square velocity at STP for the gases H_2, N_2, and HBr are in the order
(a) $H_2 < N_2 < O_2 < HBr$
(b) $HBr < O_2 < N_2 < H_2$
(c) $H_2 < N_2 = O_2 < HBr$
(d) $HBr < O_2 < H_2 < N_2$ *(1991)*

41. Root mean square velocity of a gas molecule is proportional to
(a) $m^{1/2}$ (b) m^0 (c) $m^{-1/2}$ (d) m (1990)

42. Absolute zero is defined as the temperature
(a) at which all molecular motion ceases
(b) at which liquid helium boils
(c) at which ether boils
(d) all of the above. *(1990)*

43. In van der Waals equation of state for a non-ideal gas, the term that accounts for intermolecular forces is
(a) $(V - b)$ (b) $(RT)^{-1}$
(c) $\left(P + \frac{a}{V^2}\right)$ (d) RT *(1990)*

44. If P, V, M, T and R are pressure, volume, molar mass, temperature and gas constant respectively, then for an ideal gas, the density is given by
(a) $\frac{RT}{PM}$ (b) $\frac{P}{RT}$ (c) $\frac{M}{V}$ (d) $\frac{PM}{RT}$ *(1989)*

45. Pressure remaining the same, the volume of a given mass of an ideal gas increases for every degree centrigrade rise in temperature by definite fraction of its volume at
(a) 0°C
(b) its critical temperature
(c) absolute zero
(d) its Boyle temperature. *(1989)*

46. Correct gas equation is
(a) $\frac{V_1T_2}{P_1} = \frac{V_2T_1}{P_2}$ (b) $\frac{P_1V_1}{P_2V_2} = \frac{T_1}{T_2}$
(c) $\frac{P_1T_2}{V_1} = \frac{P_2V_2}{T_2}$ (d) $\frac{V_1V_2}{T_1T_2} = P_1P_2$ *(1989)*

Answer Key

1.	(c)	**2.**	(d)	**3.**	(b)	**4.**	(c)	**5.**	(None)			**6.**	(b)	**7.**	(c)	**8.**	(d)	**9.**	(d)
10.	(b)	**11.**	(a)	**12.**	(a)	**13.**	(c)	**14.**	(d)	**15.**	(a)	**16.**	(a)	**17.**	(a)	**18.**	(a)	**19.**	(b)
20.	(d)	**21.**	(d)	**22.**	(b)	**23.**	(a)	**24.**	(b)	**25.**	(b)	**26.**	(d)	**27.**	(a)	**28.**	(c)	**29.**	(a)
30.	(d)	**31.**	(b)	**32.**	(b)	**33.**	(c)	**34.**	(b)	**35.**	(d)	**36.**	(c)	**37.**	(d)	**38.**	(c)	**39.**	(d)
40.	(b)	**41.**	(c)	**42.**	(a)	**43.**	(c)	**44.**	(d)	**45.**	(a)	**46.**	(b)						

EXPLANATIONS

1. (c) : Let the number of moles of each gas = x

Fraction of hydrogen escaped $= \frac{1}{2}x$

$$\frac{r_{O_2}}{r_{H_2}} = \sqrt{\frac{M_{H_2}}{M_{O_2}}} \Rightarrow \frac{n_{O_2}/t}{\frac{x}{2}/t} = \sqrt{\frac{2}{32}} = \sqrt{\frac{1}{16}} = \frac{1}{4}$$

$$\Rightarrow \frac{n_{O_2}/t}{\frac{x}{2}/t} = \frac{1}{4} \Rightarrow n_{O_2} = \frac{1}{8}x$$

Hence, fraction of oxygen escaped = $\frac{1}{8}$

2. (d) : Real gases show ideal gas behaviour at high temperatures and low pressures.

3. (b) : NH_3 is a polar molecule, thus more attractive forces between NH_3 molecule.

4. (c) : $PV = nRT$

$$PV = \frac{W}{M}RT \qquad \left[n = \frac{\text{Weight of the gas taken }(W)}{\text{Mol. mass of gas }(M)}\right]$$

$$P = \frac{W}{M} \times \frac{RT}{V}$$

$$P = \frac{dRT}{M} \qquad \left[\text{Density} = \frac{\text{Mass}}{\text{Volume}}\right]$$

$$d = \frac{PM}{RT} = \frac{5 \times 28}{0.0821 \times 500} = 3.41 \text{ g / mL}$$

5. (None)

According to Graham's law of diffusion,

$$\frac{r_1}{r_2} = \sqrt{\frac{d_2}{d_1}} = \sqrt{\frac{M_2}{M_1}}$$

$$r_A = \frac{V_A}{T_A}, \quad r_B = \frac{V_B}{T_B}$$

$$\frac{V_A/T_A}{V_B/T_B} = \sqrt{\frac{M_B}{M_A}}$$

$V_A = V_B$, $T_A = 150$ sec, $T_B = 200$ sec, $M_B = 36, M_A = ?$

$$\frac{T_B}{T_A} = \sqrt{\frac{M_B}{M_A}} \Rightarrow \frac{200}{150} = \sqrt{\frac{36}{M_A}}$$

$$\frac{4}{3} = \sqrt{\frac{36}{M_A}} \quad \text{or} \quad \frac{4 \times 4}{3 \times 3} = \frac{36}{M_A}$$

$$\text{or} \quad M_A = \frac{36}{4 \times 4} \times 3 \times 3 = 20.25$$

6. (b) : According to Graham's law of diffusion

$$r \propto \frac{1}{\sqrt{d}} \propto \frac{1}{\sqrt{M}} \Rightarrow \frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}}$$

$$\text{Rate of diffusion} = \frac{\text{Volume of gas diffused }(V)}{\text{Time taken }(t)}$$

$$\therefore \frac{V_1/t_1}{V_2/t_2} = \sqrt{\frac{M_2}{M_1}}$$

If same volume of two gases diffuse, then $V_1 = V_2$

$$\therefore \frac{t_2}{t_1} = \sqrt{\frac{M_2}{M_1}}$$

Here $t_2 = 3t_1, M_1 = 4 \text{ u}, M_2 = ?$

$$\therefore \frac{3t_1}{t_1} = \sqrt{\frac{M_2}{4}} \Rightarrow 3 = \sqrt{\frac{M_2}{4}}$$

$$\Rightarrow 9 = \frac{M_2}{4} \Rightarrow M_2 = 36 \text{ u}$$

7. (c) : Van der Waal gas constant ‘a‘ represent intermolecular force of attraction of gaseous molecules and Van der Waal gas constant ‘b‘ represent effective size of molecules. Therefore order should be

(I) $H_2 < He < O_2 < CO_2$ (II) $CH_4 > O_2 > H_2$

8. (d) : C_P for monoatomic gas mixture of same volume $= \frac{5}{2}R$

$$C_V = \frac{3}{2}R$$

$$\therefore \frac{C_P}{C_V} = \frac{\frac{5}{2}R}{\frac{3}{2}R} = \frac{5}{3} = 1.67$$

9. (d) : Average velocity = $\sqrt{\frac{8RT}{\pi M}}$

10. (b) : We know that $\frac{r_A}{r_B} = \frac{v/t_A}{v/t_B} = \sqrt{\frac{M_B}{M_A}}$

$$\frac{t_B}{t_A} = \sqrt{\frac{M_B}{M_A}} \Rightarrow \frac{10}{20} = \sqrt{\frac{M_B}{49}}$$

$$\Rightarrow \left(\frac{10}{20}\right)^2 = \frac{M_B}{49} \Rightarrow \frac{100}{400} = \frac{M_B}{49}$$

$$\Rightarrow M_B = \frac{49 \times 100}{400} = 12.25 \text{ u}$$

11. (a) : $P_{CO} + P_{N_2} = 1$ atm

$2P_{N_2} = 1$ $\quad [\because n_{CO} = n_{N_2}]$

$P_{N_2} = \frac{1}{2} = 0.5$ atm

12. (a) : We know that from ideal equation,

$$V \propto \frac{T}{P}$$

Given $T_1 = 15 + 273 = 288$, $P_1 = 1.5$ bar

$T_2 = 25 + 273 = 298$, $P_2 = 1$ bar

$$V_1 \propto \frac{288}{1.5} \text{ i.e. } V_1 \propto 192 \text{ and } V_2 \propto \frac{298}{1}$$

$$\frac{V_2}{V_1} = \frac{298}{192} = 1.55 \approx 1.6$$

13. (c) : Given, mass of CH_4, $w = 6$ g

Volume of CH_4, $V = 0.03\ m^3$

$T = 129°C = 129 + 273 = 402$ K

$R = 8.314\ J\ K^{-1}\ mol^{-1}$

Molecular mass of CH_4, $M = 12.01 + 4 \times 1.01 = 16.05$

$$PV = nRT = \frac{w}{M}RT$$

$$\therefore \quad P = \frac{w}{M}\frac{RT}{V} = \frac{6}{16.05} \times \frac{8.314 \times 402}{0.03}$$

$$= 41647.7 \text{ Pa} \approx 41648 \text{ Pa}$$

14. (d) : Energy absorbed by each molecule

$= 4.4 \times 10^{-19}$ J

Energy required to break the bond $= 4.0 \times 10^{-19}$ J

Remaining energy to get converted to kinetic energy

$= (4.4 \times 10^{-19} - 4.0 \times 10^{-19})$ J

$= 0.4 \times 10^{-19}$ J per molecule

$\therefore$ Kinetic energy per atom $= 0.2 \times 10^{-19}$ J

or 2×10^{-20} J

15. (a) : The average translational K.E. of one molecule of an ideal gas will be given by

$$E_t = \frac{\text{K.E.}}{N_A} = \frac{3/2RT}{N_A} = \frac{3}{2}KT$$

When R/N_A = Boltzmann consant

i.e. $E_t \propto T$

So, at constant temperature K.E. of molecules remains same

16. (a) : Wt. of 6.023×10^{23} molecule of water = 18 g

$\therefore$ Volume occupied by 6.023×10^{23} molecule of water (density = $1 g\ cm^{-3}$) will be

$$= \frac{18 \text{ g}}{1 \text{ g cm}^{-3}} = 18 \text{ cm}^3 \text{ or mL}$$

$\therefore$ Volume occupied by one molecule of water

$$= \frac{18}{6.023 \times 10^{23}} = 2.988 \times 10^{-23} \approx 3.0 \times 10^{-23} \text{ cm}^3$$

17. (a) : At low pressure and high temperature van der Waals real gas acts as ideal gas and observed to obey $PV = nRT$ relation. At very low pressure when the gas-volume is quite large the space occupied by the molecules themselves becomes negligible comparatively and because the molecules are then far apart, the force of mutual attraction becomes too feeble, the real gas would satisfy the postulates of kinetic theory. As temperature is raised, the volume of the gas increases and we can consider $\left(P + \frac{n^2a}{V^2}\right)$ term as P and at low pressure $(V - nb)$ term as V.

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

(van der Waals equation)

The gas equation becomes $PV = nRT$

This is ideal gas equation.

18. (a) : $KE = \frac{3}{2}RT$ (for one mole of a gas)

As temperatures are same and KE is independent of molecular mass, so $KE_1 = KE_2$.

19. (b) : $V_1 = 380$ mL, $P_1 = 730$ mm, $V_2 = ?$, $P_2 = 760$ mm.

From Boyle's law, $P_1V_1 = P_2V_2$

$$\Rightarrow \quad V_2 = \frac{380 \times 730}{760} = 365 \text{ mL}$$

20. (d) : Mass of the gas = mass of the cylinder including gas – mass of empty cylinder.

So mass of a gas can be determined by weighing the container in which it is enclosed.

Thus, the statement (d) is wrong for gases.

21. (d) : Temperature $(T) = 25°C = 298$ K.

Therefore *K.E.* per molecule

$$= \frac{3RT}{2n} = \frac{3 \times 8.314 \times 298}{2 \times (6.02 \times 10^{23})} = 6.17 \times 10^{-21} \text{ J}$$

22. (b) : $R_1 = 1.625R_2$ and $T_2 = 500°C = 773$ K

We know that $\frac{R_1}{R_2} = \sqrt{\frac{M_1}{M_2} \times \frac{T_1}{T_2}}$

or $\quad 1.625 = \sqrt{\frac{64}{28} \times \frac{T_1}{773}}$

or $\quad T_1 = \frac{(1.625)^2 \times 28 \times 773}{64} = 893 \text{ K} = 620°C$

23. (a) : $Cl_2 + SO_2 \xrightarrow{\text{Sunlight}} SO_2Cl_2$

(sulphuryl chloride)

Dalton's law of partial pressure is applicable only in those cases where gases are non-reacting. As Cl_2 and SO_2 reacts to form SO_2Cl_2 so this law is not obeyed in given case.

24. (b) : A gas can only be liquefied, if some forces of attraction are acting in its molecules. Since, an ideal gas is devoid of force of attraction in its molecules, therefore it can not be liquefied.

25. (b) : Volume of hydrogen = 50 mL; Time for diffusion (t) = 20 min and volume of oxygen = 40 mL.

Rate of diffusion of hydrogen $(r_1) = \frac{50}{20} = 2.5$ mL/min

Rate of diffusion of oxygen $(r_2) = \frac{40}{t}$ mL/min

Since the molecular mass of hydrogen (M_1) = 2 and that of oxygen (M_2) = 32, therefore

$$\frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}} \Rightarrow \frac{2.5}{40/t} = \sqrt{\frac{32}{2}}$$

$$\Rightarrow \frac{t}{16} = 4 \Rightarrow t = 64 \text{ minutes}$$

26. (d) : $T_1 = 27°\text{C} = 300\text{ K}$ and
$T_2 = 927°\text{C} = 1200\text{ K}$

We know that root mean square speed $(v) \propto \sqrt{T}$. Therefore root mean square speed of the gas, when its temperature is raised $= \sqrt{\frac{T_2}{T_1}} = \sqrt{\frac{1200}{300}} = 2$

27. (a) : Because average kinetic energy depends only on temperature $KE = \frac{3}{2}nkT$

28. (c) : $PV = nRT$ or $P = \frac{n}{V}RT = CRT$

Hence, $1 = 1 \times 0.082 \times T$

is $T = \frac{1}{0.082} = 12$ K

29. (a) : $PV = \frac{1}{3}mnu^2 = \frac{1}{3}Mu^2$

$$= \frac{2}{3} \cdot \frac{1}{2}Mu^2 = \frac{2}{3}E \qquad \left\{\because \frac{1}{2}Mu^2 = E\right\}$$

or $P = \frac{2}{3}E$ per unit volume.

30. (d) : Most probable velocity, $(u_{mp}) = \sqrt{\frac{2RT}{M}}$

Mean velocity, $(\bar{v}) = \sqrt{\frac{8RT}{\pi M}}$

Root mean square velocity, $(u_{r.m.s}) = \sqrt{\frac{3RT}{M}}$

$$\therefore \quad u_{mp} : \bar{v} : (u_{r.m.s}) = \sqrt{\frac{2RT}{M}} : \sqrt{\frac{8RT}{\pi M}} : \sqrt{\frac{3RT}{M}}$$

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

31. (b) : At low temperature and high pressure, there is a deviation from the ideal behaviour in gases.

32. (b) : Velocity and hence average *K.E.* of water molecules is maximum in the gaseous state.

33. (c) : Molecules in an ideal gas move with different speeds. Due to collision between the particle their speed changes.

34. (b)

35. (d) : In an ideal gas, the intermolecular forces of attraction are negligible and hence it cannot be liquefied.

36. (c) : In the van der Waal's equation
$PV = nRT$
n moles of the gas have Volume V

37. (d) : At high temperature and low pressure the effect of a/V^2 and b is negligible.
As we know,
$PV = nRT$ (Ideal gas equation)

$PV = RT$ or $\frac{PV}{RT} = 1$

$\therefore$ $Z = 1$ [Z is compressibility factor]
Hence gas shows ideal behaviour.

38. (c) : Here volume is constant and mass of H_2 is fixed so the no. of moles of the gas do not change. As temperature increases the pressure also increases, therefore the rate of collision among the gas molecules and their energy also increases.

39. (d) : According to Boyle's law at constant temperature, $P \propto \frac{1}{V}$ or PV = constant

40. (b) : We know, $PV = \frac{1}{3}mnu^2 = \frac{1}{3}Mu^2$

or $u = \sqrt{3PV/M}$

At STP, $u \propto \sqrt{\frac{1}{M}}$

and molecular masses of H_2, N_2, O_2 and HBr are 2, 28, 32 and 81.

41. (c) : $PV = \frac{1}{3}mNu^2$,
here u = root mean square velocity.

Now $u^2 = \frac{3PV}{mN}$ or $u \propto \frac{1}{\sqrt{m}}$

42. (a) : Temperature at which all molecular motion ceases is called absolute zero.

43. (c) : van der Waal's equation for 1 mole is

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

Here, $\left(P+\frac{a}{V^2}\right)$ represents the intermolecular forces and $(V-b)$ is the corrected volume.

44. (d) : Ideal gas equation is

$$PV = nRT = \frac{m}{M}RT$$

or $PM = \frac{m}{V}RT = dRT$ [here d = density]

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

45. (a) : According to Charles' law which states that The volume of the given mass of a gas increases or decreases by $\frac{1}{273}$ of its volume at 0°C for each degree rise or fall of temperature at constant pressure.

$$V_t = V_0\left(1+\frac{t}{273}\right) \text{ at constant } P \text{ and } n$$

46. (b) : $\frac{PV}{T} = \text{constant or } \frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \Rightarrow \frac{P_1V_1}{P_2V_2} = \frac{T_1}{T_2}$

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