QB365

Important Questions - Kinetic Theory

11th Standard CBSE

Physics

Reg.No. : | | | | | | |

Time : 01:00:00 Hrs

Total Marks : 50

Section-A

1) Under what conditions, real gases behave as an ideal gas ? 1

2) According to kinetic theory of gases, explain absolute zero. 1

3) What is the number of degree of freedom of a bee flying in a room? 1

4) The specific heat of argon at constant volume is 0.075kg^{-1}K^{-1}, then what will be its atomic weight?[Given, R=2 cal mol^{-1}K^{-1}] 1

5) Name an experimental evidence in support of random motion of gas molecules. 1

6) What is mean free path of a gas? 1

7) Calculate the ratio of the mean free paths of the molecules of two gases having molecular diameters $1\overset{0}{A}$ and $2\overset{0}{A}$. The gases may be considered under identical conditions of temperature, pressure and volume. 1

8) If there are f degrees of freedom with n moles of a gas, then find the internal energy possessed at a temperature T. 1

9) What is the rms speed of hydrogen gas molecules at STP. Given, density is 0.09 kg m^{-3}. 1

10) Find the temperature at which rms speed of a gas is half of its value of 0^{0}C, pressure remaining constant. 1

Section-B

11) What will be the internal energy of 8g of oxygen at STP? 2

12) What is basic law followed by equipartition of energy? 2

13) Calculate the temperature at which the rms speed of CO_2 gas molecule will be 1 kms^{-1}. Given that molecular mass of CO_4 = 44 u 2

14) What is the kinetic energy of translation of one molecule of a gas at 300 K ? Gas is having three degree of freedom. k_B = 1.38 x 10^{-23} JK^{-1}. 2

15) One mole of a monoatomic gas is mixed with three moles of a diatomic gas. What is the molar specific heat of the mixture at constant volume. (R = 8.31 J mol^{-1} K^{-1}) 2

16) At what temperature, will the molecules in a sample of helium gas have an rms speed of 0.1 km/s? 2

17) If the pressure of a gas filled in closed container is increased by 0.2 %. When temperature is increased by 1K,calculate the initial temperature of the gas. 2

18) If the ratio of molecular weights of two gases is 4.What will be ratio of the V_{rms} values for the molecules of those two gases? 2

19) Write the difference between ideal gas and real gas. 2

20) If one mole of a monoatomic gas is mixed with three moles of a diatomic gas.What is the molar specific heat of mixture at constant value?[Take, R=8.31 J mol^{-1}K^{-1}] 2

Section-C

21) A vessel contains two non-reacting gases, i.e. neon (monoatonic) and oxygen (diatomic). The ratio of their partial pressures is 3:2. Estimate the ration of number of molecules 5

22) A vessel contains two non-reacting gases, i.e. neon (monoatonic) and oxygen (diatomic). The ratio of their partial pressures is 3:2. Estimate the ration of 5

23) Calculate the mean free path of nitrogen gas at STP. Given the diameter of nitrogen molecule is 4 $\mathring{A}$. 5

24) An electric bulb of volume 250 cm^3 was sealed off during manufacture at a pressure of 10^{-3} mm of mercury at 27^{0}C. Compute the number of air molecule contained in the bulb.Given that, molecules contained in the bulb. Given that, R=8.31 J/mol/K N_A=$6.02 \times 10^{23} mol^{-1}$. 5

****

Section-A

1) At low pressure and high temperature, real gases behave as an ideal gas. 1

2) Absolute zero is the temperature at which the molecules of a gas becomes motionless .i.e. $\bar{V}_{rms}$ = 0 1

3) Three, because bee is free to move along x-direction or y-direction or z-direction. 1

4) Argon is a monoatomic gas, so $C_v = \frac{3}{2}R = \frac{3}{2} \times 2 = 3 cal mol^{-1} K^{-1} C_v = Mc_v M = \frac{C_v}{c_v} = \frac{3}{0.075} = 40$ 1

5) Brownian motion and diffusion of gases provide experimental evidence in support of random motion of gas molecules. 1

6) The average distance travelled by molecules between two successive collisions is known as mean free path of the molecule. 1

7) As, we know, mean free path, $\lambda \propto \frac{1}{d^2} Given, \quad d_1 = 1\overset{0}{A} \quad and \quad d_2 = 2\overset{0}{A} \Rightarrow \lambda_1 : \lambda_2 = 4:1$ 1

8) For 1 mole with f degrees of freedom, Internal energy, U=1XC_vxT=$\frac{f}{2}RT$ For n moles, U=nC_vT=$\frac{nf}{2}RT$ 1

9) 1.8 x 10^3 ms^{-1} 1

10) 68.25 K 1

Section-B

11) 2

Oxygen is a diatomic gas.

Number of moles of O_2 gas

$= \frac{Atomic \quad wt.}{Molecular \quad wt.} = \frac{8}{32} = \frac{1}{4} = 0.25 \therefore \quad Energy \quad associated \quad with \quad 1 \quad mole \quad of \quad oxygen U = \frac{5}{2}RT \therefore \quad Internal \quad enreyg \quad of \quad 8g \quad of \quad oxygen = 0.25 \times \frac{5}{2} \times 8.31 \times 273 = 1417.9J$

12) The law of equipartition of energy for any dynamical system in thermal equilibrium, the total energy is distributed q=equally amongst all the degrees of freedom. 2

The energy associated with each molecule per degree of freedom is $\frac{1}{2}k_BT$, where K_B is Boltzmann's constant and T is temperature of the system.

13) 1.8×10^3 K 2

14) 6.21×10^{-21} J 2

15) 2.25 R 2

16) **Ans.**160 K 2

17) **Ans .**500 K 2

18) **Ans.**0.5 2

19) 2

Ideal Gas	**Real Gas**
(i)It obeys ideal gas equation ,pV = μRT at all temperatures and pressures	It does not obey , pV= μRT
(ii) The volume of the molecules of an ideal gas is zero.	The volume of the molecules of a real gas is non zero.
(iii)there is no intermolecular force between the molecules.	There is intermolecular force of attraction or repulsion depending on whether intermolecular seperation is larger or small.
(iv) There is no intermolecular potential energy(U) because intermolecular force (F) is zero	Potential energy(U) does not equal to zero as intermolecular force (F) is not zero.
(v) It has only kinetic energy.	It has both kinetic and potential energy.
(vi) At absolute zero, the volume , pressure and internal energy become zero.	All real gases st liquified before reaching the absolute zero.The internal energy of the liquified gas is not zero.

20) 2

Given, for monoatomic gas,

$\mu_1 = 1, C_{v_1} = \frac{3}{2}R \quad and \quad for \quad adiatomic \quad gas, \quad \mu_2 = 3 \quad and \quad C_{v_2} = \frac{5}{2}R \therefore Total \quad heat \quad energy \quad required \quad to \quad raise \quad the \quad temperat5ure \quad of \quad mixture \quad by \quad \Delta T. \Delta U = \mu_1 C_{v_1} \Delta$

Section-C

21) As V and T are same for the two gases, we can write 5

$$p_{Ne}V = \mu_{Ne}RT and \quad p_{O_2}V = \mu_{O_2}RT or \quad \frac{p_{Ne}}{p_{O_2}} = \frac{\mu_{Ne}}{\mu_{O_2}} \therefore \quad \frac{p_{Ne}}{p_{O_2}} = \frac{2}{3} \Rightarrow \frac{\mu_{Ne}}{\mu_{O_2}} = \frac{3}{2}$$

In N_{Ne} and N_{O_2} are the number of molecules of the two gases and N_A is Avogadro's number, then

$$\frac{\mu_{Ne}}{\mu_{O_2}} = \frac{N_{Ne}/N_A}{N_{O_2}/N_A} = \frac{3}{2} \Rightarrow \frac{N_{Ne}}{N_{O_2}} = 1.5$$

22) Now, 5

$$\mu_{O_2} = \frac{m_{O_2}}{M_{O_2}} \quad and \quad \mu_{Ne} = \frac{m_{Ne}}{M_{Ne}}$$

$$\therefore \frac{\rho_{Ne}}{\rho_{O_2}} = \frac{m_{Ne}/V}{m_{O_2}/V} = \frac{m_{Ne}}{m_{O_2}} = \frac{\mu_{Ne}M_{Ne}}{\mu_{O_2}M_{O_2}} \qquad = \frac{3}{2} \times \frac{20.2}{32} = 0.947$$

23) 5×10^{-8} m 5

24) **Ans.**8×10^{15} 5