Class XI

Kinetic Theory of Gases worksheet 2

1. State the law of equi-partition of energy? 1

Ans. According to law of equi-partition of energy, the average kinetic energy of a molecule in each degree of freedom is same and is equal to (1/2)kT

2. On what factors, does the average kinetic energy of gas molecules depend? 1

Ans. Absolute tem. (Average K.E α T)

3. Why the temperature less than absolute zero is not possible? 1

Ans. Since, mean square velocity is directly proportional to temperature. If temperature is zero then mean square velocity is zero and since K. E. of molecules cannot be negative and hence temperature less than absolute zone is not possible.

4. If a vessel contains 1 mole of O_2 gas (molar mass 32) at temperature T. The pressure of the gas is P. What is the pressure if an identical vessel contains 1 mole of He at a temperature 2T? 1

Ans. $n = 1$

$V_1 = V_2 = V(identical\ vessels)$

$T_1 = T$

$T_2 = 2T$

$PV = nRT$

$\frac{PV}{T} = const$

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$\frac{PV}{T} = \frac{P_2V}{2T}$

$P_2 = 2P$

5. At very low pressure and high temperature, the real gas behaves like ideal gas. Why? 2

Ans. An ideal gas is one which has Zero volume of molecule and no intermolecular forces. Now:
1) At very low pressure, the volume of gas is large so that the volume of molecule is negligible compared to volume of gas.
2) At very high temperature, the kinetic energy of molecules is very large and effect of intermolecular forces can be neglected.
Hence real gases behave as an ideal gas at low pressure and high temperature.

6. Two perfect gases at absolute temperature T_1 and T_2 are mixed. There is no loss of energy. Find the temperature of the mixture if the masses of molecules are m_1 and m_2 and number of molecules is n_1 and n_2? 2

Ans. By law of equi-partition of energy

$\frac{1}{2}mv^2 = \frac{3}{2}kT$

$K.E.\ of\ one\ gas \quad K_1 = \frac{3}{2} n_1 k T_1$

$K.E.\ of\ other\ gas \quad K_2 = \frac{3}{2} n_2 k T_2$

$Total\ K.E. = \frac{3}{2} k(n_1 T_1 + n_2 T_2) \longrightarrow (1)$

Let T be the tem. Of the mixture of gases so, for the mixture

$Total\ K.E. = \frac{3}{2} k(n_1 T + n_2 T) = \frac{3}{2} kT(n_1 + n_2) \longrightarrow (2)$

As there is no loss of energy so from (1) and (2)

$\frac{3}{2} kT(n_1 + n_2) = \frac{3}{2} k(n_1 T_1 + n_2 T_2)$

$T = \frac{n_1 T_1 + n_2 T_2}{n_1 + n_2}$

7. Calculate the degree of freedom for monatomic, diatomic and triatomic gas? 3

8. Determine the volume of 1 mole of any gas at S. T. P., assuming it behaves like an ideal gas? 1

Ans. $n = 1$

$T = 273K$

$R = 8.31 J.mol^{-1}$

$P = 1.01 \times 10^5 Nm^{-2}$

$V = \frac{nRT}{P} = \frac{1 \times 8.31 \times 273}{1.01 \times 10^5} = 22.4 \times 10^{-3} m^3 = 22.4l$

9. A tank of volume $0.3 m^3$ contains 2 moles of Helium gas at $20\ ^0C$. Assuming the helium behave as an ideal gas; 2

1) Find the total internal energy of the system.

2) Determine the r. m. s. Speed of the atoms.

Ans. $n = 2$

$T = 20\ ^0C = 20 + 273 = 293K$

$R = 8.31 J.mol^{-1}$

$M_{He} = 4 gmol^{-1} = 4 \times 10^3 kgmol^{-1}$

1) $E = \frac{3}{2} nRT = \frac{3}{2} \times 2 \times 8.31 \times 293 = 7.3 \times 10^3 J$

2) $v_{rms} = \sqrt{\frac{3RT}{M}} = \sqrt{\frac{3 \times 8.31 \times 293}{4 \times 10^{-3}}} = 1.35 \times 10^3 ms^{-1}$

10. What is the relation between pressure and kinetic energy of gas? 1

Ans. $P = \frac{2}{3} E$