Class XI: Physics
Chapter 13: Kinetic Theory

Key Learning:

1. Kinetic theory of gases relates the macroscopic properties of gases like pressure, temperature etc. to the microscopic properties of its gas molecules example speed, kinetic energy etc.
2. Ideal gas is one for which the pressure p, volume V and temperature T are related by pV = nRT where R is called the gas constant.
3. Real gases satisfy the ideal gas equations only approximately, more so at low pressures and high temperatures.
4. Kinetic theory of an ideal gas gives the relation

$$P = \frac{1}{3} n\, m\overline{v^2}$$

   Where n is number density of molecules, m the mass of the molecule and $\overline{v^2}$ is the mean of squared speed.

5. The temperature of a gas is a measure of the average kinetic energy of molecules, independent of the nature of the gas or molecule. In a mixture of gases at a fixed temperature the heavier molecule has the lower average speed.

6. The pressure exerted by n moles of an ideal gas, in terms of the speed of its molecules is $P = 1/3 nm\, v_{rms}^2$.
7. The average kinetic energy of a molecule is proportional to the absolute temperature of the gas.
8. Degrees of freedom of a gas molecule are independent ways in which the molecule can store energy.
9. Law of equipartition of energy states that every degree of freedom of a molecule has associated with it, on average, an internal energy of (½)kT per molecule.

10. Monoatomic gases only have three translational degrees of freedom.
11. Diatomic gases in general have three translational, two rotational and two vibrational degrees of freedom.
12. The molar specific heat at constant volume C_v can be written as (f/2)R where f is the number of degrees of freedom of the ideal gas molecule.

Top Formulae:

1. Boyle's law, PV = constant.
2. Charle's law, V/T = a constant
3. Gaylussac's law, P/T = a constant,
4. Gas equation, PV = μRT, where μ is the no. of moles of the given gas.
5. Pressure exerted by gas, $P = \frac{1}{3}\frac{M}{V}C^2 = \frac{1}{3}\rho C^2$
6. Mean K.E. of translation per molecule of a gas $= \frac{1}{2}mC^2 = \frac{3}{2}kT$
7. Mean K.E. of translation per mole of gas $= \frac{1}{2}MC^2 = \frac{3}{2}RT = \frac{3}{2}NkT$,
8. Total K.E. per mole of gas$= \frac{n}{2}RT$, where n is number of degrees of freedom of each molecule.
9. $C_{rms} = \sqrt{\frac{C_1^2 + C_2^2 + \ldots + C_n^2}{n}}$
10. Effect of temperature: $\frac{C_2}{C_1} = \sqrt{\frac{T_2}{T_1}}$
11. Mean free path, $\lambda = \frac{k_B T}{\sqrt{2}\pi d^2 p} = \frac{1}{\sqrt{2}\pi d^2 n}$ where n = number of molecules per unit volume of the gas.
12. Collision frequency $f = \nu / \lambda$