Relation between Kinetic Energy and Temperature of a gas.

The relationship between Kinetic Energy and Temperature can be derived from the Kinetic gas equation.

We know from Kinetic gas equation

$$PV = \frac{1}{3} mnc^2 \quad \text{——— (1)}$$

$$\text{or} \quad PV = \frac{2}{3} \times \frac{1}{2} mnc^2$$

$$\text{or,} \quad PV = \frac{2}{3} \times \frac{1}{2} Mc^2 \quad \text{——— (2)} \quad [\because mn = M \text{ M = Mass of the gas}]$$

$$\because PV = RT \quad \text{(For 1 mole of gas)} \quad \text{——— (3)}$$

From eqn (2) and (3)

$$RT = \frac{2}{3} \times \frac{1}{2} Mc^2$$

$$RT = \frac{2}{3} \times K.E. \qquad [\because K.E = \frac{1}{2} Mc^2 \text{ Where M is Mass \& C is velocity}]$$

$$\therefore K.E = \frac{3}{2} RT$$

$$\text{or } K.E \propto T \qquad [\text{Where } \frac{3}{2} R \text{ is Constant}]$$

So, It is clear that K.E of translation of an ideal gas is independent of the nature of the gas and its pressure. It depends only upon the temperature of the gas.

Derivation of the gas-laws on the basis of Kinetic gas equation.

(1) Derivation of the Boyle's Law:-

According to Kinetic theory of gases, the average Kinetic Energy ($\frac{1}{2} mnc^2$) is directly proportional to absolute Temperature (T)

i.e. $\frac{1}{2} mnc^2 = RT$

$$\frac{3}{2} \times \frac{1}{3} mnc^2 = RT$$

$$\frac{3}{2} P.V = RT \qquad [\because \frac{1}{3} mnc^2 = PV]$$

$$\text{or } PV = \frac{2}{3} RT$$

Therefore, the product of Pressure and volume is a Constant at a Constant temperature,