COURSE TITLE : PHYSICAL CHEMISTRY I

COURSE CODE : 15U5CRCHE07

UNIT 1 : GASEOUS STATE

SESSION 5 : Deductions from Kinetic Gas Equation

Kinetic Gas Equation

$$PV = \frac{1}{3} mNu^2$$

$$\frac{1}{2} mu^2 \propto T$$

$$\frac{1}{2} mNu^2 \propto T$$ for N molecules

$$\frac{1}{2} mNu^2 = KT$$ where, K is a constant

$$\frac{2}{3} \times \frac{1}{2} mNu^2 = \frac{2}{3} KT$$

$$\frac{1}{3} mNu^2 = \frac{2}{3} KT$$

$$PV = \frac{2}{3} KT$$

$$PV = \frac{2}{3}KT$$

At constant T condition, $PV = \text{constant}$ which is Boyle's law.

At constant P condition, $\frac{V}{T} = \text{constant}$ which is Charles's law.

At constant V condition, $\frac{P}{T} = \text{constant}$ which is Gay-Lussac's law.

Equation for Average Kinetic Energy of Gas Molecules:

$$PV = RT$$

For 1 mole of a gas

$$PV = \frac{1}{3} m N_0 u^2$$

The kinetic gas equation for Avogadro number of molecules

$$PV = \frac{2}{3} \times \frac{1}{2} m N_0 u^2$$

$$E_K = \frac{1}{2} m N_0 u^2$$

$$PV = \frac{2}{3} \times E_K$$

$$RT = \frac{2}{3} \times E_K$$

$$E_K = \frac{3}{2} RT$$

The average kinetic energy of 1 mole of a gas:

$$E_K = \frac{3}{2} RT$$

The average kinetic energy per molecule of a gas:

$$\varepsilon_K = \frac{\frac{3}{2} RT}{N_0} = \frac{3}{2} kT$$

$$k = \frac{R}{N_0}$$ Boltzmann constant $1.380649 \times 10^{-23}\ J \cdot K^{-1}$