Quadrant II – Transcript and Related Materials

Programme: Bachelor Of Science(First Year)

Subject: Physics

Paper Code: PYC-102

Paper Title: Heat and Thermodynamics and Properties of matter and Acoustics(Section-I)

Unit: kinetic theory of gases

Module Name: Relation between RMS velocity and temperature, average kinetic energy of a gas molecule, heat and temperature, kinetic interpretation of temperature.

Module No: 03

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Notes

kinetic interpretation of temperature.

The pressure of a gas is;

$$P = \frac{1}{3}\rho C^2$$

$$P = \frac{MC^2}{3V}$$

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

For 1 mole of ideal gas we have

$$PV = RT$$

$$\frac{1}{3}MC^2 = RT$$

$$\frac{1}{2}MC^2 = \frac{3}{2}RT$$

Let the mass of each molecule be m and N be Avogadro's number.

But $$M = m \times N$$

$$\frac{1}{2}mNC^2 = \frac{3}{2}RT$$

$$\frac{1}{2}mC^2 = \frac{3}{2}\frac{R}{N}T = \frac{3}{2}kT$$

Average kinetic energy of a gas molecule

We know that the average kinetuc energy of a gas molecule is given by;

$$\frac{1}{2}mC^2 = \frac{3}{2}\frac{R}{N}T = \frac{3}{2}kT$$

$$K.E = \frac{3}{2}kT$$

Where;

$$C^2 = \frac{3KT}{m}$$

Therefore the mean kinetic energy of a molecule is directly proportional to the absolute temperature of a gas. When the temperature of the gas is increased, the mean kinetic energy of the molecules increases.When heat is withdrawn from a gas, the mean kinetic energy of the molecules decreases. Thus at absolute zero temperature the kinetic energy should be zero. It means at zero temperature the molecules are in a perfect state of rest and have no kinetic energy.

Relation between RMS velocity and temperature

$$\frac{1}{2}mC^2 = \frac{3}{2}\frac{R}{N}T = \frac{3}{2}kT$$

$$C^2 = \frac{3KT}{m}$$

$$C^2 \propto T$$

$$C \propto \sqrt{T}$$

Therefore RMS velocity is directly proportional to the square root of absolute temperature.