$\because M = mN_A$

by Eq (5) $\quad v_{rms} = \sqrt{\frac{3RT}{mN_A}}$; $\quad \frac{R}{N_A} = k_B \rightarrow$ Boltzman const.

$$\boxed{v_{rms} = \sqrt{\frac{3k_BT}{m}}} \quad -(6)$$

EXAMPLE: Calculate the rms speed of the oxygen molecules at 27°C. Given: $k_B = 1.38 \times 10^{-23}$ J/K, $N_A = 6.022 \times 10^{23}$/mol. Molar mass of O_2 = 32 g/mol.

Sol: $\quad T = 27°C = (27 + 273) = 300K$

$M = 32 g/mol = 32 \times 10^{-3} kg$, $m = ?$

$\because \quad mN_A = M \Rightarrow m = \frac{M}{N_A} = \frac{32 \times 10^{-3}}{6.022 \times 10^{23}} kg$

$$v_{rms} = \sqrt{\frac{3k_BT}{m}} = \sqrt{\frac{3 \times 1.38 \times 10^{-23} \times 300}{\frac{32 \times 10^{-3}}{6.022 \times 10^{23}}}}$$

$$= \sqrt{\frac{3 \times 1.38 \times 10^{-23} \times 300 \times 6.022 \times 10^{23}}{32 \times 10^{-3}}}$$

3.011

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