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

$$v_{rms}^2 = \frac{3P}{\rho}$$

$$v_{rms} = \sqrt{\frac{3P}{\rho}} \quad \text{— (4)}$$

N = Total number of gas molecules

mN = Total mass of gas

ρ = density of gas

EXAMPLE: Calculate the rms speed of the hydrogen molecules at NTP. Given molecular weight of hydrogen is 2g/mol.

Sol: $P = 1\,atm = 1.013 \times 10^5\ N/m^2$

Mass of 1 mol. of gas $= 2g = 2 \times 10^{-3}\ kg$

$V = 22.4\,Lt = 22.4 \times 10^{-3}\ m^3$

$$\rho = \frac{Mass}{V} = \frac{2 \times 10^{-3}}{22.4 \times 10^{-3}} = \frac{1}{11.2}\ kg/m^3$$

$$v_{rms} = \sqrt{\frac{3P}{\rho}} = \sqrt{\frac{3 \times 1.013 \times 10^5}{1/11.2}}$$