ADDENDUM

EXERCISE : Estimate the mean free path, λ, of a nitrogen molecule in nitrogen gas at $T = 273\,K$, $P = 1$ atm, given molecular diameter $D \simeq 0.3$ nm.

SOLUTION : $\lambda = \dfrac{V}{\pi N D^2}$, so we need N/V.

But from the ideal gas law $PV = N k_B T$,

$$\frac{N}{V} = \frac{P}{k_B T} .$$

Hence

$$\lambda = \frac{V}{\pi N D^2} = \frac{k_B T}{P \times \pi D^2}$$

$$= \frac{1.4 \times 10^{-23} \times 273}{1.01 \times 10^5 \times \pi \times (3 \times 10^{-10})^2}$$

$$\simeq 1.3 \times 10^{-7}\,m = \underline{130\,nm}.$$