

35. (a) We use the ideal gas law $pV = nRT = NkT$, where p is the pressure, V is the volume, T is the temperature, n is the number of moles, and N is the number of molecules. The substitutions $N = nN_A$ and $k = R/N_A$ were made. Since 1 cm of mercury = 1333 Pa, the pressure is $p = (10^{-7})(1333) = 1.333 \times 10^{-4}$ Pa. Thus,

$$\begin{aligned}\frac{N}{V} &= \frac{p}{kT} = \frac{1.333 \times 10^{-4} \text{ Pa}}{(1.38 \times 10^{-23} \text{ J/K})(295 \text{ K})} \\ &= 3.27 \times 10^{16} \text{ molecules/m}^3 = 3.27 \times 10^{10} \text{ molecules/cm}^3 .\end{aligned}$$

- (b) The molecular diameter is $d = 2.00 \times 10^{-10}$ m, so, according to Eq. 20–25, the mean free path is

$$\lambda = \frac{1}{\sqrt{2}\pi d^2 N/V} = \frac{1}{\sqrt{2}\pi (2.00 \times 10^{-10} \text{ m})^2 (3.27 \times 10^{16} \text{ m}^{-3})} = 172 \text{ m} .$$