

16.40. Model: Assume the gas in the evacuated volume is an ideal gas.

Solve: The number density of particles is N/V . Using the ideal-gas equation,

$$pV = Nk_B T \Rightarrow \frac{N}{V} = \frac{p}{k_B T}$$

The pressure is

$$p = (1 \times 10^{-10} \text{ mm of Hg}) \times \frac{1 \text{ atm}}{760 \text{ mm of Hg}} \times \frac{1.013 \times 10^5 \text{ Pa}}{1 \text{ atm}} = 1.33 \times 10^{-8} \text{ Pa}$$
$$\Rightarrow \frac{N}{V} = \frac{1.33 \times 10^{-8} \text{ Pa}}{(1.38 \times 10^{-23} \text{ J/K})(293 \text{ K})} = 3.3 \times 10^{12} \text{ m}^{-3} = 3.3 \times 10^6 \text{ cm}^{-3}$$