

19. (a) The ideal gas law in the form of Eq. 20-9 leads to $p = NkT/V = nkT$. Thus, we solve for the molecules per cubic meter:

$$n = \frac{p}{kT} = \frac{(1.0 \text{ atm})(1.0 \times 10^5 \text{ Pa/atm})}{(1.38 \times 10^{-23} \text{ J/K})(273 \text{ K})} = 2.7 \times 10^{25} \text{ m}^{-3} .$$

- (b) Combining Eqs. 42-2, 42-3 and 42-4 leads to the conduction electrons per cubic meter in copper:

$$n = \frac{8.96 \times 10^3 \text{ kg/m}^3}{(63.54)(1.67 \times 10^{-27} \text{ kg})} = 8.43 \times 10^{28} \text{ m}^{-3} .$$

- (c) The ratio is $(8.43 \times 10^{28} \text{ m}^{-3})/(2.7 \times 10^{25} \text{ m}^{-3}) = 3.1 \times 10^3$.

- (d) We use $d_{\text{avg}} = n^{-1/3}$. For case (a), $d_{\text{avg}} = (2.7 \times 10^{25} \text{ m}^{-3})^{-1/3}$ which equals 3.3 nm. For case (b), $d_{\text{avg}} = (8.43 \times 10^{28} \text{ m}^{-3})^{-1/3} = 0.23 \text{ nm}$.