18.11 (a) The number of free electrons per cubic meter for aluminum at room temperature may be computed using Equation 18.8 as

$$n = \frac{\sigma}{|e|\,\mu_e}$$

$$= \frac{3.8\ \text{x}\ 10^{7}\ (\Omega - \text{m})^{-1}}{(1.602\ \text{x}\ 10^{-19}\ \text{C})(0.0012\ \text{m}^2/\text{V-s})}$$

$$= 1.98\ \text{x}\ 10^{29}\ \text{m}^{-3}$$

(b) In order to calculate the number of free electrons per aluminum atom, we must first determine the number of copper atoms per cubic meter, N_{Al}. From Equation 4.2 (and using the atomic weight and density values for Al found inside the front cover—viz. 26.98 g/mol and 2.71 g/cm^3)

$$N_{\text{Al}} = \frac{N_{\text{A}}\,\rho'}{A_{\text{Al}}}$$

$$= \frac{(6.023\ \text{x}\ 10^{23}\ \text{atoms/mol})(2.71\ \text{g/cm}^3)(10^6\ \text{cm}^3/\text{m}^3)}{26.98\ \text{g/mol}}$$

$$= 6.03\ \text{x}\ 10^{28}\ \text{m}^{-3}$$

(*Note*: in the above expression, density is represented by ρ' in order to avoid confusion with resistivity which is designated by ρ.) And, finally, the number of free electrons per aluminum atom is just n/N_{Al}

$$\frac{n}{N_{\text{Al}}} = \frac{1.98\ \text{x}\ 10^{29}\ \text{m}^{-3}}{6.03\ \text{x}\ 10^{28}\ \text{m}^{-3}} = 3.28$$