4.18 This problem asks that we determine, for a hypothetical alloy that is composed of 25 wt% of metal A and 75 wt% of metal B, whether the crystal structure is simple cubic, face-centered cubic, or body-centered cubic. We are given the densities of the these metals (ρ_A = 6.17 g/cm^3 and ρ_B = 8.00 g/cm^3 for B), their atomic weights (A_A = 171.3 g/mol and A_B = 162.0 g/mol), and that the unit cell edge length is 0.332 nm (i.e., 3.32 x 10^{-8} cm). In order to solve this problem it is necessary to employ Equation 3.5; in this expression density and atomic weight will be averages for the alloy—that is

$$\rho_{\text{ave}} = \frac{nA_{\text{ave}}}{V_C N_A}$$

Inasmuch as for each of the possible crystal structures, the unit cell is cubic, then $V_C = a^3$, or

$$\rho_{\text{ave}} = \frac{nA_{\text{ave}}}{a^3 N_A}$$

And, in order to determine the crystal structure it is necessary to solve for n, the number of atoms per unit cell. For n =1, the crystal structure is simple cubic, whereas for n values of 2 and 4, the crystal structure will be either BCC or FCC, respectively. When we solve the above expression for n the result is as follows:

$$n = \frac{\rho_{\text{ave}} a^3 N_A}{A_{\text{ave}}}$$

Expressions for A_{ave} and ρ_{ave} are found in Equations 4.11a and 4.10a, respectively, which, when incorporated into the above expression yields

$$n = \frac{\left(\dfrac{100}{\dfrac{C_A}{\rho_A} + \dfrac{C_B}{\rho_B}}\right) a^3 N_A}{\left(\dfrac{100}{\dfrac{C_A}{A_A} + \dfrac{C_B}{A_B}}\right)}$$

Substitution of the concentration values (i.e., C_A = 25 wt% and C_B = 75 wt%) as well as values for the other parameters given in the problem statement, into the above equation gives