

3.13 In order to determine whether Nb has an FCC or a BCC crystal structure, we need to compute its density for each of the crystal structures. For FCC, $n = 4$, and $a = 2R\sqrt{2}$ (Equation 3.1). Also, from Figure 2.6, its atomic weight is 92.91 g/mol. Thus, for FCC (employing Equation 3.5)

$$\begin{aligned}\rho &= \frac{nA_{\text{Nb}}}{a^3 N_{\text{A}}} = \frac{nA_{\text{Nb}}}{(2R\sqrt{2})^3 N_{\text{A}}} \\ &= \frac{(4 \text{ atoms/unit cell})(92.91 \text{ g/mol})}{\left\{ \left[(2)(1.43 \times 10^{-8} \text{ cm})(\sqrt{2}) \right]^3 / (\text{unit cell}) \right\} (6.023 \times 10^{23} \text{ atoms/mol})} \\ &= 9.33 \text{ g/cm}^3\end{aligned}$$

For BCC, $n = 2$, and $a = \frac{4R}{\sqrt{3}}$ (Equation 3.3), thus

$$\begin{aligned}\rho &= \frac{nA_{\text{Nb}}}{\left(\frac{4R}{\sqrt{3}} \right)^3 N_{\text{A}}} \\ \rho &= \frac{(2 \text{ atoms/unit cell})(92.91 \text{ g/mol})}{\left\{ \left[\frac{(4)(1.43 \times 10^{-8} \text{ cm})}{\sqrt{3}} \right]^3 / (\text{unit cell}) \right\} (6.023 \times 10^{23} \text{ atoms/mol})} \\ &= 8.57 \text{ g/cm}^3\end{aligned}$$

which is the value provided in the problem statement. Therefore, Nb has a BCC crystal structure.