1. Draw the unit cells for FCC and HCP crystal structures. Compare the difference in their stacking sequence. (Section 3.11)

FCC unit cell:

HCP unit cell:

As shown in the following figure, the stacking sequence for HCP is ABABAB… and for FCC it is ABCABCABC…
2. Show that the atomic packing factor for FCC is 0.74. (Example 3.2)

The APF is defined as the fraction of solid sphere volume in a unit cell, or

$$\text{APF} = \frac{\text{total sphere volume}}{\text{total unit cell volume}} = \frac{V_S}{V_C}$$

Both the total sphere and unit cell volumes may be calculated in terms of the atomic radius R. The volume for a sphere is $4/3 \pi R^3$, and since there are four atoms per FCC unit cell, the total FCC sphere volume is

$$V_S = 4 \times \frac{4}{3} \pi R^3 = \frac{16}{3} \pi R^3$$

The total unit cell volume is

$$V_C = 16R^3 \sqrt{2}$$

Therefore the atomic packing factor is

$$\text{APF} = \frac{V_S}{V_C} = \frac{\frac{16}{3} \pi R^3}{16R^3 \sqrt{2}} = 0.74$$

3. Copper has an atomic radius of 0.128 nm, an FCC crystal structure, and an atomic weight of 63.5 g/mol. Compute its density. (Example 3.3)
Equation 3.5 is employed in the solution of this problem. Since the crystal structure is FCC, \( n \), the number of atoms per unit cell, is 4. Furthermore, the atomic weight \( A_{\text{Cu}} \) is given as 63.5 g/mol. The unit cell volume \( V_C \) for FCC was determined in example problem 3.1 as \( 16R^3 \sqrt{2} \), where \( R \), the atomic radius, is 0.128 nm.

Substitution for the various parameters into equation 3.5 (given below) yields

\[
\rho = \frac{nA_{\text{Cu}}}{V_C N_A} = \frac{nA_{\text{Cu}}}{(16R^3 \sqrt{2})N_A} \quad \text{... (equation 3.5)}
\]

\[
= \frac{(4 \text{ atoms/unit cell})(63.5 \text{ g/mol})}{[16\sqrt{2} \ (1.28 \times 10^{-8} \text{ cm})^3/\text{unit cell}](6.02 \times 10^{23} \text{ atoms/mol})} = 8.89 \text{ g/cm}^3
\]

The literature value for the density of copper is 8.94 g/cm\(^3\), which is in very close agreement with the foregoing result.

4. Calculate the planar density of the (110) plane for FCC. (**Example 3.11**)

The atomic packing of this plane is represented in the following figure. Consider that portion of the plane that intersects a unit cell, and then compute both this planar area and total circle area in terms of the atomic radius \( R \). Planar density, then, is just the ratio of these two areas.

The unit cell plane area, \( A_P \) is simply that of the rectangle circumscribed by the centers of the atoms, A, C, D, and F. The rectangle length (AC) and width (AD) are respectively,

\[
AC = 4R \\
AD = 2R \sqrt{2}
\]
Therefore,

\[ A_p = (AC)(AD) \]
\[ = (4R)(2R \sqrt{2}) = 8R^2 \sqrt{2} \]

Now, for the total number of atoms, one fourth of each of atoms A, C, D, and F and the one half of atoms B and E reside within this rectangle, which gives a total of 2 equivalent atoms.

\[
PD = \frac{\text{number of atoms}}{A_p} = \frac{2}{8R^2 \sqrt{2}}
\]