1.2 (a) The lattice constant of GaAs is 5.65 Å. Determine the number of Ga atoms and As atoms per cm$^3$. (b) Determine the volume density of germanium atoms in a germanium semiconductor. The lattice constant of germanium is 5.65 Å.

(a) 4 Ga atoms per unit cell
   \[
   \text{Density} = \frac{4}{(6.65 \times 10^{-8})^3} \rightarrow \\
   \text{Density of Ga} = 2.22 \times 10^{22} \text{cm}^{-3}
   \]

4 As atoms per unit cell, so that

(b) 8 Ge atoms per unit cell
   \[
   \text{Density} = \frac{8}{(5.65 \times 10^{-8})^3} \rightarrow \\
   \text{Density of Ge} = 4.44 \times 10^{22} \text{cm}^{-3}
   \]

1.4 A material, with a volume of 1 cm$^3$, is composed of an fcc lattice with a lattice constant of 2.5 mm. The "atoms" in this material are actually coffee beans. Assume the coffee beans are hard spheres with each bean touching its nearest neighbor. Determine the volume of coffee after the coffee beans have been ground. (Assume 100 percent packing density of the ground coffee.)

From Problem 1.3, percent volume of fcc atoms is 74%; Therefore after coffee is ground,
   \[
   \text{Volume} = 0.74 \text{cm}^3
   \]

1.17 Calculate the density of valence electrons in silicon.

1.17

Density of silicon atoms = 5 \times 10^{22} \text{cm}^{-3} and 4 valence electrons per atom, so Density of Valence electrons 2 \times 10^{23} \text{cm}^{-3}.