1.2 In the Al\textsubscript{0.5}Ga\textsubscript{0.5}As unit cell, pictured below, fcc sublattice sites containing the Column III elements are equally occupied by Al and Ga atoms.

1.3 Ge crystallizes in the diamond lattice where there are 8 atoms per unit cell (see subsection 1.2.3). Thus

\[
\text{Density} = \frac{8}{a^3} = \frac{8}{(5.65 \times 10^{-8})^3} = 4.44 \times 10^{22} \text{ atoms/cm}^3
\]
1.4 (a) From Fig. 1.3(c), we conclude nearest-neighbors in the bcc lattice lie along the unit cell body diagonal. Since the body diagonal of a cube is equal to $\sqrt{3}$ times a cube side length (the lattice constant $a$),

$$\left( \frac{\text{Nearest-Neighbor}}{\text{Distance}} \right) = \frac{\sqrt{3}}{2} \ a$$

(b) From Fig 1.3(d), nearest-neighbors in the fcc lattice are concluded to lie along a cube-face diagonal. The diagonal of a cube face is equal to $\sqrt{2}$ times a cube side length. Thus

$$\left( \frac{\text{Nearest-Neighbor}}{\text{Distance}} \right) = \frac{\sqrt{2}}{2} \ a$$
Si has a diamond lattice, which is equivalent to two fcc lattices, where one of the fcc lattices is shifted one-quarter of a body diagonal along a body diagonal direction relative to the other fcc lattice.

\[ \text{area} = \frac{1}{2} \times \frac{a}{\sqrt{2}} \times \frac{a}{\sqrt{2}} = \frac{a^2}{4\sqrt{2}} \]

\[ \frac{1/2}{a^2/4\sqrt{2}} = \frac{2\sqrt{2}}{a^2} = 9.59 \times 10^9 \text{ Si atoms/cm}^2 \]

DL2

(i) Following the procedure outlined in the text:

2, 5, 3 ... intercepts

1/2, 1/5, 1/3 ... \([1/\text{intercept}]\)

15, 6, 10 ... reduction to lowest whole-number set

(15, 6, 10) ... Miller index notation for plane

(ii) [313] ... Miller index notation for normal to plane
Miller indices may be viewed as specifying the projection (in arbitrary units) of the to-be-pictured vectors along the coordinate axes. For example, [010] corresponds to a vector with a unit projection along the y-axis and no projection along the x- or z-axes. In other words, [010] is coincident with the y-axis. The other required direction vectors are deduced in a similar manner and are as pictured below.
1.11 (a) If the Fig. Pl. 11 unit cell is conceptually copied and the cells stacked like blocks in a nursery, one concludes the resulting lattice is a simple cubic lattice.

(b) There is one atom inside the unit cell and the unit cell volume is \( a^3 \). Thus atom/unit volume = \( \frac{1}{a^3} \).

(c) For a (110) surface plane the atom positioning would be as pictured below.

\[
\text{atoms/unit area} = \frac{1 \text{ atom}}{(a)(\sqrt{2}a)} = \frac{1}{\sqrt{2}a^2}
\]