1.3 If the lattice constant of silicon is 5.43 Å, calculate (*a*) the distance from the center of one silicon atom to the center of its nearest neighbor, (*b*) the number density of silicon atoms (#/cm^3), and (*c*) the mass density (g/cm^3) of silicon.

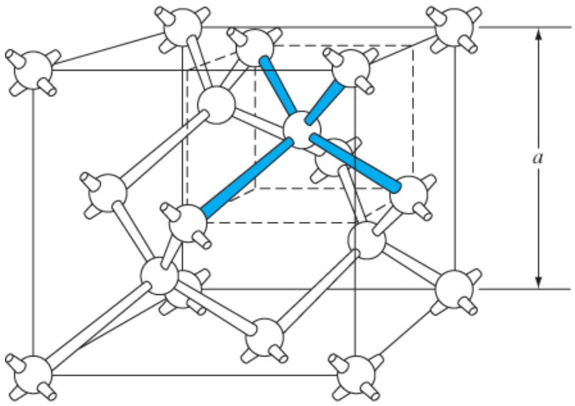

Figure 1.11 | The diamond structure.

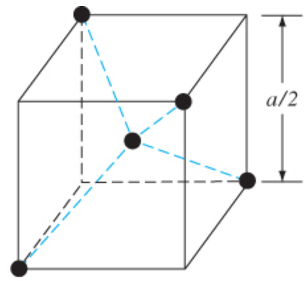

Figure 1.12 | The tetrahedral structure of closest neighbors in the diamond lattice.

a) From Fig 1.12, the nearest neighbor is half the diagonal of the primitive cell shown.

$$d/2 = 0.5\sqrt{(a/2)^2 + (a/2)^2 + (a/2)^2} = \sqrt{3}\,a/4 = \sqrt{3}\,(5.43)/4$$

$\Rightarrow$ ***d*/2 = 2.35 Å**

b) From Fig 1.12,

\# atoms/unit cell = 8 corners (1/8 atoms/corner) + 6 faces (1/2 atoms/face) + 4 interior

= 1 + 3 + 4 = 8

\# density = 8 atoms/a^3 = $8/(5.43\times10^{-10}\text{ m})^3 = 4.99678 \times 10^{28}$ atoms/m^3

$\Rightarrow$ **# density = 4.99678×10^{22} atoms/cm^3**

c) From Table B.4, the atomic weight of silicon is 28.09

mass density = (# atoms/unit cell) (atomic weight) / N_A

= 4.99678×10^{22} atoms/cm^3 (28.09)/ $6.02214076 \times 10^{23}$

$\Rightarrow$ **mass density = 2.3307 g/cm^3**