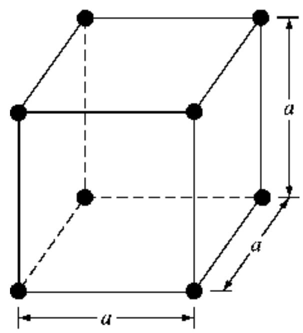
1.7 Assume the radius of an atom, which can be represented as a hard sphere, is r = 1.95 Å. The atom is placed in a (*a*) simple cubic, (*b*) fcc, (*c*) bcc, and (*d*) diamond lattice. Assuming that nearest atoms are touching each other, what is the lattice constant of each lattice?

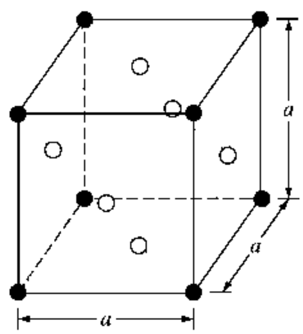
a) simple cubic



For a simple cubic lattice, the lattice constant

$$a = r + r = 2(1.95) \quad \Rightarrow \quad \underline{a = 3.9\ \text{Å}}.$$

b) fcc

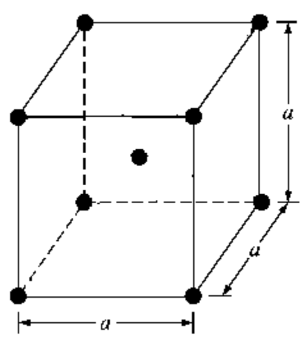


For an fcc lattice, the face diagonal is

$d = r + 2r + r = 4r = \sqrt{a^2 + a^2} = \sqrt{2}a$. Therefore, we get

$$a = 4r/\sqrt{2} = 4(1.95)/\sqrt{2} \quad \Rightarrow \quad \underline{a = 5.515\ \text{Å}}.$$

c) bcc

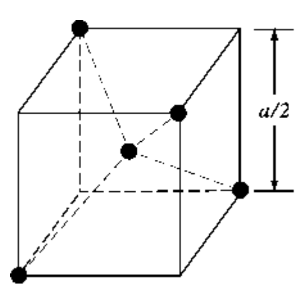


For a bcc lattice, the corner-to-corner diagonal is

$$d = r + 2r + r = 4r = \sqrt{a^2 + a^2 + a^2} = \sqrt{3}a.$$

Therefore, we get $a = 4r/\sqrt{3} = 4(1.95)/\sqrt{3}$ $\Rightarrow$ $\underline{a = 4.503\ \text{Å}}$.

d) diamond



For a diamond lattice, the corner-to-corner diagonal of the primitive cell is $d = r + 2r + r = 4r = \sqrt{(a/2)^2 + (a/2)^2 + (a/2)^2} = \sqrt{3}(a/2)$.

Therefore, we get $a = 8r/\sqrt{3} = 8(1.95)/\sqrt{3}$ $\Rightarrow$ $\underline{a = 9.007\ \text{Å}}$.