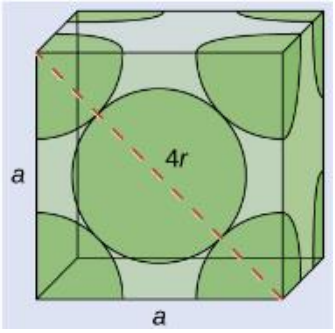
Answer on Question #72000 – Chemistry – General Chemistry

The density of Ag is 10.6 g/cm^3. Using a Fcc structure, what is the atomic radius of Ag and the edge length at the unit cell.

Solution:



Density = mass / volume $\rho = m / V$

The density of Ag can be found by determining the density of its unit cell: for example, the mass contained within a unit cell divided by the volume of the unit cell. A face-centered Ag unit cell has one-eighth of an atom at each of the eight corners (8 × 1/8 = 1atom) and one-half of an atom on each of the six faces 6 × ½ = 3 atoms), for a total of four atoms in the unit cell.

The mass of the unit cell can be found by:

$$1 \text{ Ag unit cell} \times \frac{4\ Ag\ atoms}{1\ Ag\ unit\ cell} \times \frac{1\ mol\ Ag}{6.022 \times 10^{23} Ag\ atoms} \times \frac{108\ g}{1\ mol\ Ag} = 7.17 \times 10^{-22}\ \text{g}$$

The volume of a Ca unit cell can be found by:

$$V = m / \rho = 7.17 \times 10^{-22}\ \text{g} / 10.6\ \text{g/cm}^3 = 6.76 \times 10^{-23}\ \text{cm}^3$$

$$V = a^3 = 6.76 \times 10^{-23}\ \text{cm}^3$$

Edge length at the Ag unit cell $a = \sqrt[3]{V} = \sqrt[3]{6.76 \times 10^{-23}} = 0.407 \times 10^{-7}\ \text{cm}^3 = 407 \times 10^{-10}\ \text{cm}^3$

$= 407$ pm

In an FCC structure, Ag atoms contact each other across the diagonal of the face, so the length of the diagonal is equal to four Ag atomic radii (d = 4*r*).

Two adjacent edges and the diagonal of the face form a right triangle, with the length of each side equal to 407 pm and the length of the hypotenuse equal to four Ag atomic radii:

$$a^2 + a^2 = d^2 = (4r)^2$$

$$r = \sqrt{\frac{(407)^2 + (407)^2}{16}} = 144\ \text{pm}$$

Atomic radius of Ag $r = 144$ pm

Edge length at the Ag unit cell $a = 407$ pm