Answer on Question #46466-Physics-Atomic Physics

Sodium metal crystallizes in the bcc structure. The metal has atomic weight 23 and density 971 kgm^−3. Calculate the cubic lattice parameter a and the shortest distance between atoms in this structure.

Solution

For the BCC structure, the density is given by:

$$\rho = \frac{2\dfrac{M_{at}\left(10^{-3}\frac{kg}{g}\right)}{N_A}}{a^3}.$$

Thus the lattice parameter a is:

$$a = \left(\frac{1}{500\frac{g}{kg}}\frac{M_{at}}{N_A\rho}\right)^{\frac{1}{3}} = \left(\frac{1}{500\frac{g}{kg}}\frac{(23\frac{g}{mol})}{(6.022\cdot10^{23}\ mol^{-1})\cdot971\frac{kg}{m^3}}\right)^{\frac{1}{3}} = 4.28\cdot10^{-10}m.$$

The radius of the atom, R, and the lattice parameter, a, are related.

$$R = \frac{\sqrt{3}}{4}a.$$

The shortest distance between atoms in this structure is one diameter

$$d = 2R = 2\cdot\frac{\sqrt{3}}{4}a = \frac{\sqrt{3}}{2}a = \frac{\sqrt{3}}{2}(4.28\cdot10^{-10}m) = 3.71\cdot10^{-10}m.$$

http://www.AssignmentExpert.com/