Answer on Question #62385, Chemistry / General Chemistry

Problem 2.20 (Chapter 2)

An atom of rhodium (Rh) has a diameter of about 2.7×10^{-8}cm.

1) What is the radius of a rhodium atom in angstroms (Å)?

2) How many Rh atoms would have to be placed side by side to span a distance of 3.5 μm?

3) If the atom is assumed to be a sphere, what is the volume in m^3 of a single Rh atom?

Solution:

(1)

An Angstrom is a unit of length: 1 Å = 1.0 x 10^{-10} m. Since the radius is one-half the diameter, in Angstroms we have

$$r = \frac{2.7 \cdot 10^{-8} cm}{2} \times \left(\frac{1\ m}{100\ cm}\right) \times \left(\frac{1\text{Å}}{1.0 \cdot 10^{-10} m}\right) = 1.4\ \text{Å}$$

(2)

Let's assume that the atoms are actually touching each other. If one Rh atom has a diameter of 2.7 x 10^{-8} cm, then we can use our units to find how many Rh atoms we have per cm (or m):

$$\frac{1\ Rh\_atom}{2.7 \cdot 10^{-8} cm} \times \left(\frac{100\ cm}{1\ m}\right) = 3.7 \cdot 10^{9}\ \frac{Rh\_atom}{m}$$

So we can fit 3.7x10^9 Rh atoms in a meter. Now, it's just a unit problem.. 1 μm = 1.0 x 10^{-6} m

$$3.7 \cdot 10^{9}\ \frac{Rh\_atom}{m} \times \left(\frac{1.0 \cdot 10^{-6} m}{1 \mu m}\right) \times 3.5 \mu m = 1.3 \cdot 10^{4} Rh\_atom$$

(3)

The formula for volume of a sphere is V = $4pr^3/3$; the diameter is twice the radius, so in meter units,

$$V = \frac{4\pi \times (1.4 \cdot 10^{-10} m)^3}{3} = 1.15 \cdot 10^{-29}\ m^3$$

Answer: (1) 1.4 Å; (2) $1.3 \cdot 10^{4} Rh\_atom$; (3) $1.15 \cdot 10^{-29}\ m^3$