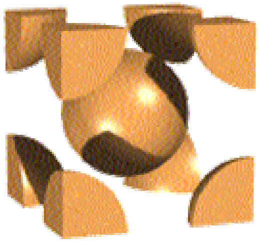
1. **Calculating the Atomic Radius of Alkali Metals (**body-centered cubic)

Atoms of alkali metals are stacked in such a way as to form a body-centered cubic. There are 8 sections of an atom at the corner and one full one at the center. If you imagine stacking several of these blocks, you'll realize that each corner is adjacent to seven others, so that each corner represents 1/8th of an atom.

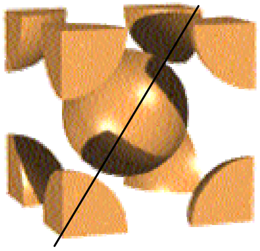


The cell therefore represents 8(1/8) + 1 central = 2 atoms.

1. Write a formula for the mass of these two atoms in terms of molar mass and Avogadro's number.

$m = 2$ atoms(mole/($6.022\ \text{X}10^{23}$ atoms)(M g/mole)
$= 2M/N_A$ where M = molar mass
N_A= Avogadro's number

2. Next we need an expression for the total volume of this cell (including the empty spaces in between the spheres; these will affect the density of the metal.)
The diagonal of a cube is equal to $\sqrt{3}$ times the length of one of its sides. The diagonal of the cube covers r +2r + r = 4r.(the middle sphere actually touches the corner-section)



Express the volume of the cubic unit in terms of the sphere's radius, *r*.

$s\sqrt{3} = 4r$
$s = 4r / \sqrt{3}$
$s^3 = (64/9)\ \sqrt{3}\ r^3$

3. We can now write an expression for the density of alkali metal solids, since we have the mass and volume from parts 1 and 2. Write such an expression.

$$d = m/v = (2M/N_A) / [(64/9)\ \sqrt{3}\ r^3] = \frac{9M}{32\sqrt{3}N_A r^3} = d$$

4. Rearrange it to obtain an expression for r.

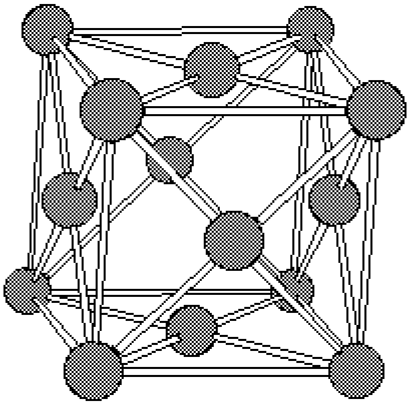
$$r = \sqrt[3]{\frac{9M}{32\sqrt{3}N_A d}}$$

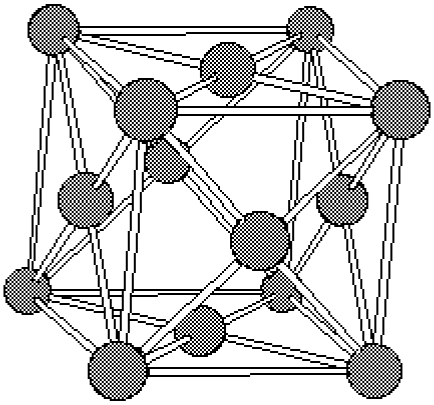
5. Test its validity by calculating the atomic radii for all the alkali metals and also for other metals with a body-centered cubic structure.

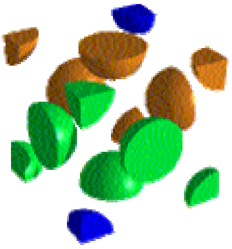
Element	**molar mass(g/mole)**	**Density(g/cm^3)**	**Radius (cm)**	**Radius (Å);** **[1 Å = 10^{-8} cm]**
Li	6.939	0.53		
Na	22.9898	0.97		
K	39.102	0.86		
Rb	85.47	1.53		
Cs	132.905	1.90		
Cr	51.996	7.19		
Fe	55.847	7.86		
W	183.85	19.3		

Li	6.939	0.53	1.52266E-08	1.5
Na	22.9898	0.97	1.85574E-08	1.9
K	39.102	0.86	2.30585E-08	2.3
Rb	85.47	1.53	2.46966E-08	2.47
Cs	132.905	1.9	2.66191E-08	2.7
Cr	51.996	7.19	1.24933E-08	1.25
Fe	55.847	7.86	1.242E-08	1.24
W	183.85	19.3	1.36951E-08	1.37

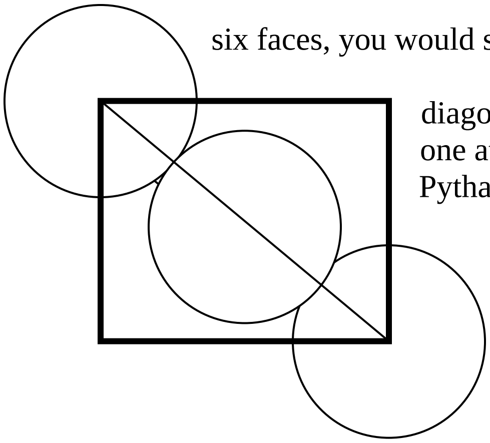
2. **Calculating the Atomic Radius of Ni and Cu families (**face-centered cubic)







Members of the nickel and copper families and a few other metals form face-centered cubic crystal. Again one eighth of an atom is at each corner of the cubic, but unlike the body-centered cubic, there is also half an atom on each of the cubes six faces. That amounts to the equivalent of 8*(1/8) + 6*(1/2) = 4 atoms per cubic cell.



If you consider one of the cube’s six faces, you would see what is inside the thick square of side *s*.

1. Since the diagonal measures r + 2r + r = 4r, where r = radius of one atom, write an expression relating s to r using the Pythagorean Theorem.

$s^2+s^2=(4r)^2$.

$2s^2 = 16r^2$.

$S = 2r\sqrt{2}$

2. Write an expression for the volume of the cell.

The volume of the cell $= s^3 = (2r\sqrt{2})^3 = 16r^3\sqrt{2} = V$.

3. Write an expression for the density.

By writing an expression for density = mass/volume and remembering that there are 4 atoms per cell, we get $d = \frac{4M/N_A}{16r^3\sqrt{2}}$

$$d = \frac{M\sqrt{2}}{8N_A r^3}$$

4. Rearrange the equation and solve for r.

Solving for r we get,

$$r = \sqrt[3]{\frac{M\sqrt{2}}{8N_A d}}$$

Element	**molar mass(g/mole)**	**Density(g/cm^3)**	**Radius (cm)**	**Radius (Å); [1 Å = 10^{-8} cm]**
Ni	58.71	8.9		
Pd	106.4	12		
Pt	195.09	21.4		
Cu	63.54	8.96		
Ag	107.87	10.5		
Au	196.967	19.3		

Ni	58.71	8.9	1.24643E-08	1.2
Pd	106.4	12	1.37557E-08	1.4
Pt	195.09	21.4	1.38836E-08	1.39
Cu	63.54	8.96	1.27685E-08	1.28
Ag	107.87	10.5	1.44477E-08	1.44
Au	196.967	19.3	1.44158E-08	1.44