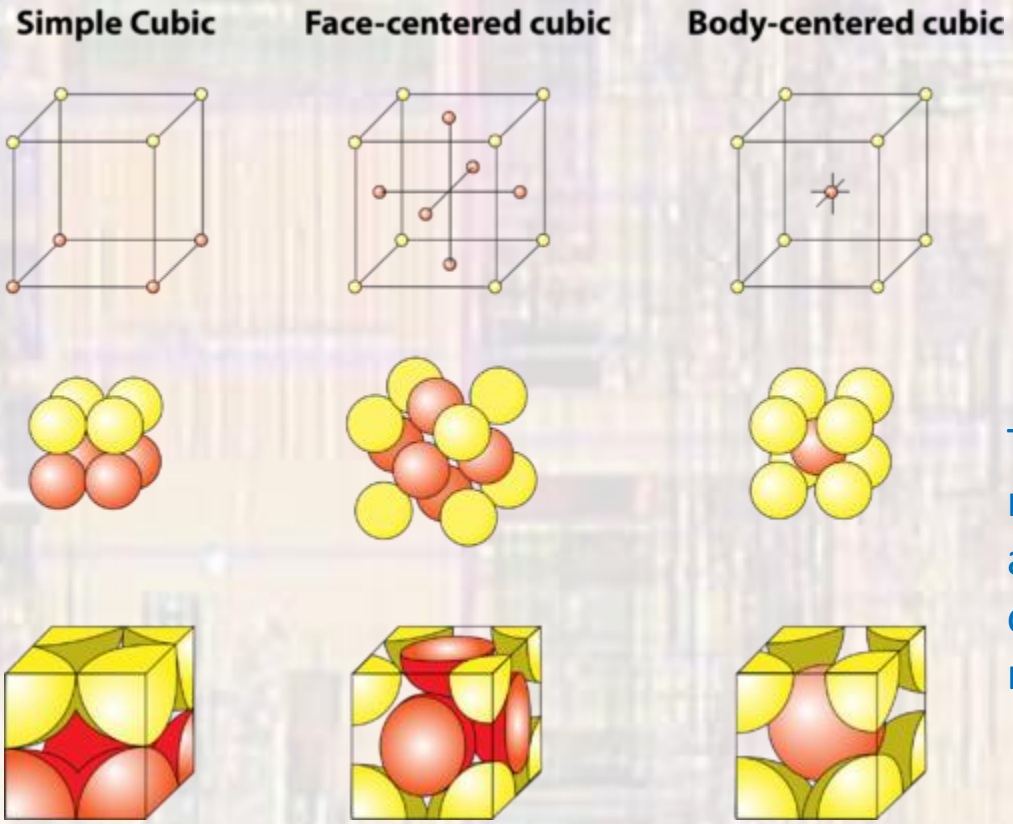
Silicon Crystal Structure

Last updated 7/1/23

These concepts have been greatly simplified

Silicon Crystal Structure

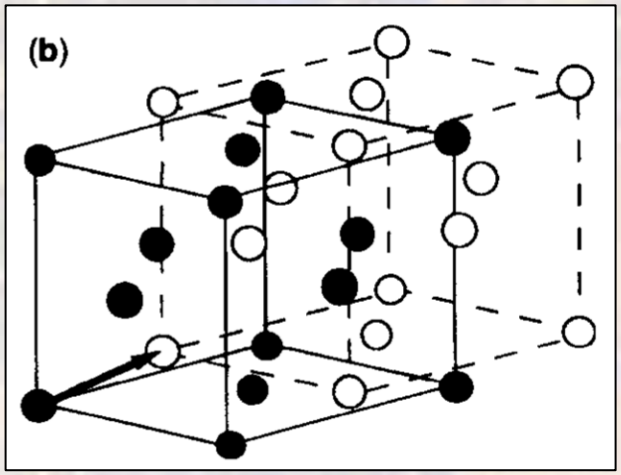
- Crystals are characterized with 3d geometric structures (unit cell)



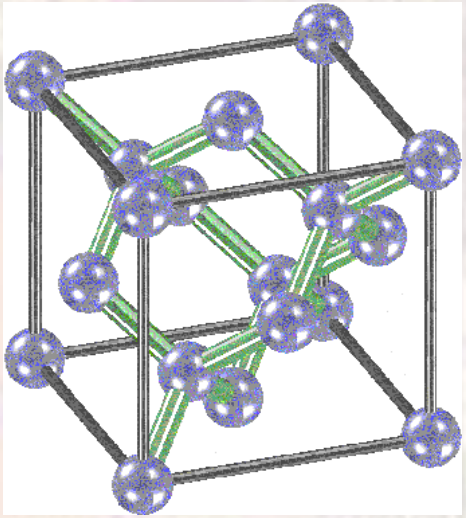
The spheres here represent the approximate extents of the atom, not the nuclei

Silicon Crystal Structure

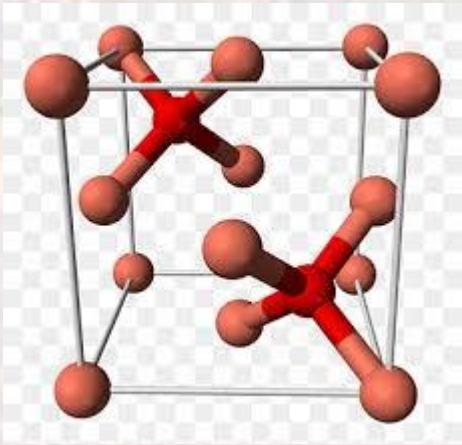
- Silicon unit cell
  - 2 interpenetrating Face Centered Cubic Cells



2 FCC cells
1 shifted ¼ of the way
along the major diagonal



Resulting diamond
cubic lattice



Atoms showing
4 nearest neighbor
structure

Lattice parameter (edge length) of 0.543 nm
Nearest neighbor distance is 0.235 nm.

Silicon Crystal Structure

- Silicon unit cell
  - Corners: 8, 1/8 atoms/unit cell
  - Faces: 6, 1/2 atoms/unit cell
  - Inside: 4 full atoms/unit cell

1
3
4
8 atoms/unit cell

Cell volume:

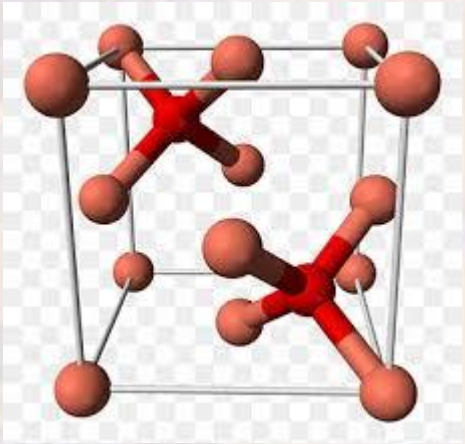
$(.543\ \text{nm})^3 = 1.6 \times 10^{-22}\ \text{cm}^3$

Density of silicon atoms

$= (8\ \text{atoms}) / (\text{cell volume}) = 5 \times 10^{22}\ \text{atoms/cm}^3$

Silicon Crystal Structure

- Silicon unit cell – bonding model
  - Si has a half full outer electron shell (4 / 8)
  - Lowest energy state is the Diamond Lattice
    - 4 electrons are shared between 4 nearest neighbors



Atoms showing
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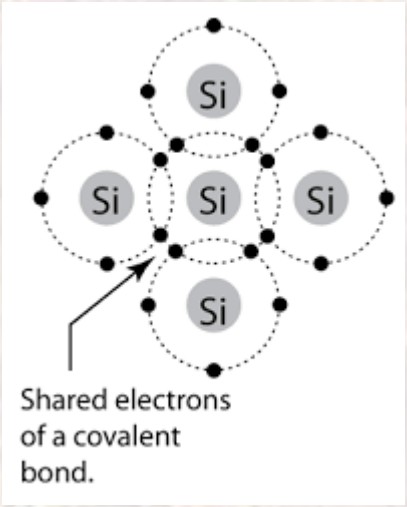

Each atom appears to have a full valence band → very stable