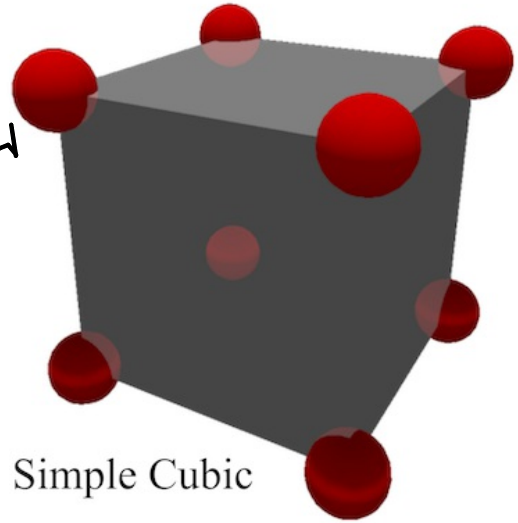
Chapter 10: Solids - Condensed Matter

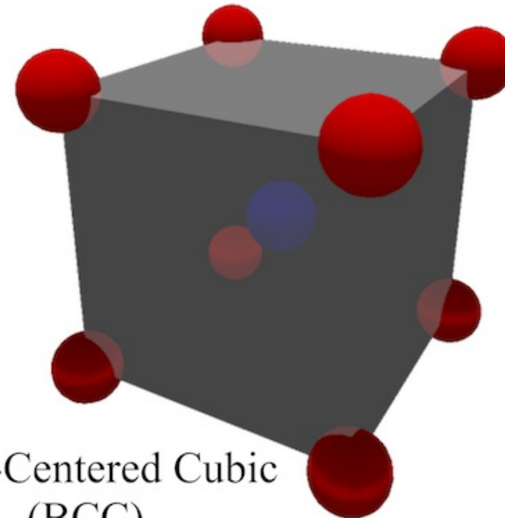
- amorphous solids - glass, rubber
  molecules scattered randomly

crystalline solids (most)
molecules in a regular lattice
usually spaced about ~ 0.25 - 0.5 nm
5-10 atomic radii

Uncommon



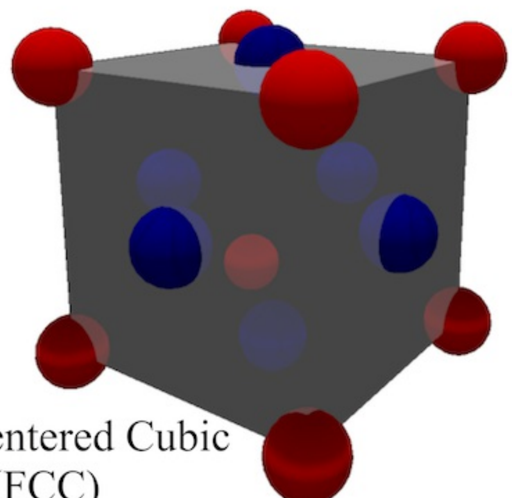
Simple Cubic



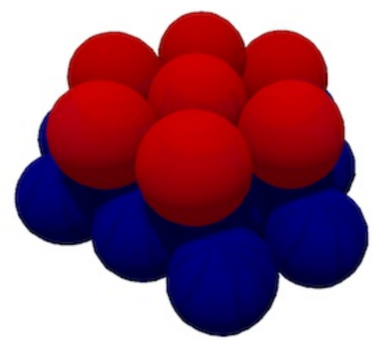
Body-Centered Cubic
(BCC)

I A
iron
chromium
tungsten

Solid Noble gases
Cu
Ag
Au



Face-Centered Cubic
(FCC)



Hexagonal Close-Packed
(HCP)

densest packing

He
Mg
Zn
Os

Covalent solids

atoms bond covalently - share electrons
strong bonds

Hard, high melting point

Poor electrical conductors

Lattice type comes from directionality of bonds

Ionic solids

NaCl Na^+ Cl^-

atoms steal electrons
bonded electrostatically

relatively hard, high melting point
poor electric conductors
never pure elements - only combinations
lattice comes from whatever minimizes potential energy

Metallic solid

- leftover valence electrons
- electron wavefunctions span the solid
- held together by ions & electron gas

ions are not connected to each other
- form structure that minimizes energy
metals often malleable
w/ lower melting point

excellent conductors

Molecular Solid

- Atoms or molecules which are tight packages
- don't share or give away electrons

e.g. Noble gases, H_2 N_2 O_2 F_2 NH_3 H_2O

if molecules have no permanent dipole e.g. O_2
if one molecule develops a temporary dipole, it can induce a dipole moment in another neighbor & two are attracted via dipole-dipole interactions

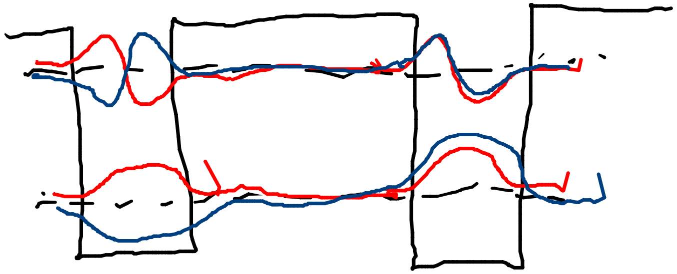
London force

very weak - Temperature must be low for solid to form
- soft

if molecule has a permanent dipole (H_2O)
bond is stronger
water has relatively high melting point compared to these others

Poor electrical conductor

"Atoms"

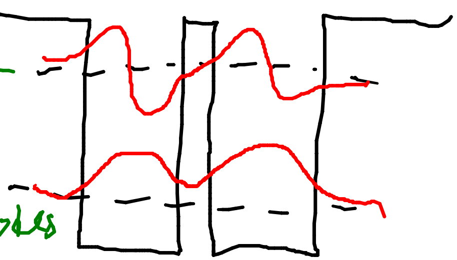


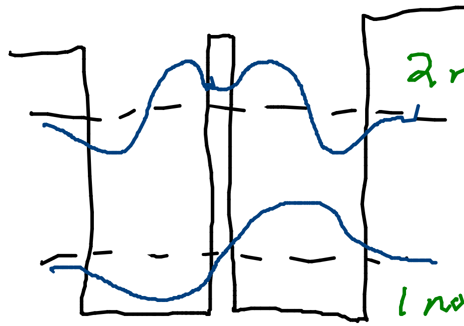
← far apart →

independent
2 Ψ for each
energy level –
have same energy

3 nodes

0 nodes

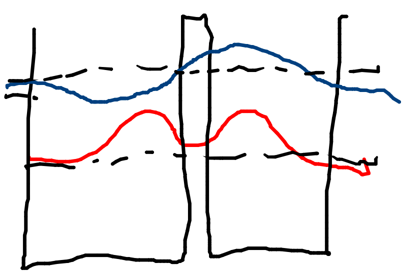




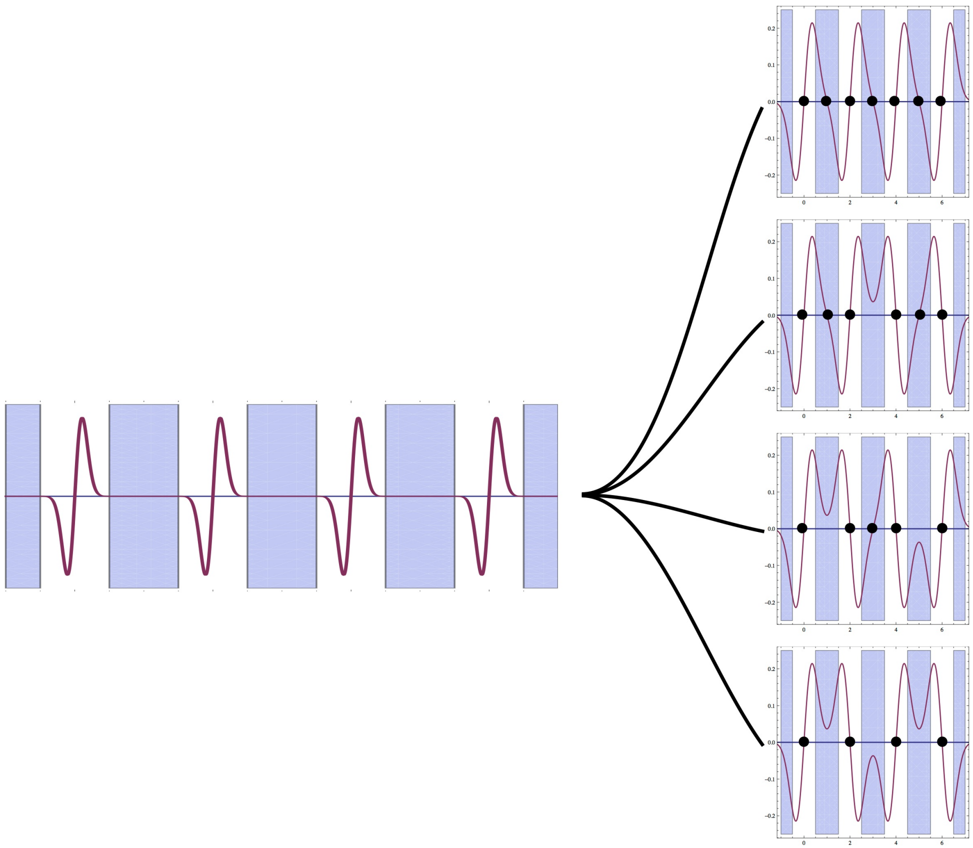
2 nodes

1 node

nodes ~ k ~ KE



So 1 node state
has slightly more
energy than 0 node
state — but when
far apart, energies are equal.



N atoms

Each single-atom energy state breaks up into N different energy states

if $N \gg 1$, get a continuous band of energy