Sept. 10/18

No questions from Ch. 1

↳ Questions from Ch. 2 will be on midterm

Ch. 1 {
- Composites - Combination of metals, ceramics, etc. (more than 1 family)
- IC's - mini circuits made by doping silicone (single crystal of Si)
- nano-materials - materials with size smaller than 100 nm
}

Chapter 2: (midterm Q's likely to be multiple choice)

- Atomic number: (Z) - number of protons
- Atomic mass: (A) - mass of protons + mass of neutrons

  A = P + N (unit is amu) * 1.67×10^{-27} kg
- Isotope: Same number of protons, but different number of neutrons $_{12}C$ vs. $_{13}C$
- Atomic mass unit (amu)
- Mole: 6.022 (avogadro's number)
- Atomic weight: $\bar{A}_m = \sum f_{im} A_{im}$ → atomic mass of the isotope; f_{im} ← fraction of isotope

  ↳ 1 amu/atom = 1 g/mol (molecular weight as amu/molecule or g/mol)

Show that 1 amu/atom is equal to 1 g/mol:

$$\frac{1\ \text{amu}}{\text{atom}} \times \frac{1.67 \times 10^{-27}\ \text{kg}}{1\ \text{amu}} \times \frac{1000\ \text{g}}{1\ \text{kg}} \times \frac{6.022 \times 10^{23}\ \text{atom}}{1\ \text{mol}}$$

→ 1.005 ≈ 1.0 g/mol

Energy due to transition $\Delta E = \frac{hc}{\lambda}$ (h → Planck's constant; c → speed of light; λ → wavelength of radiation)

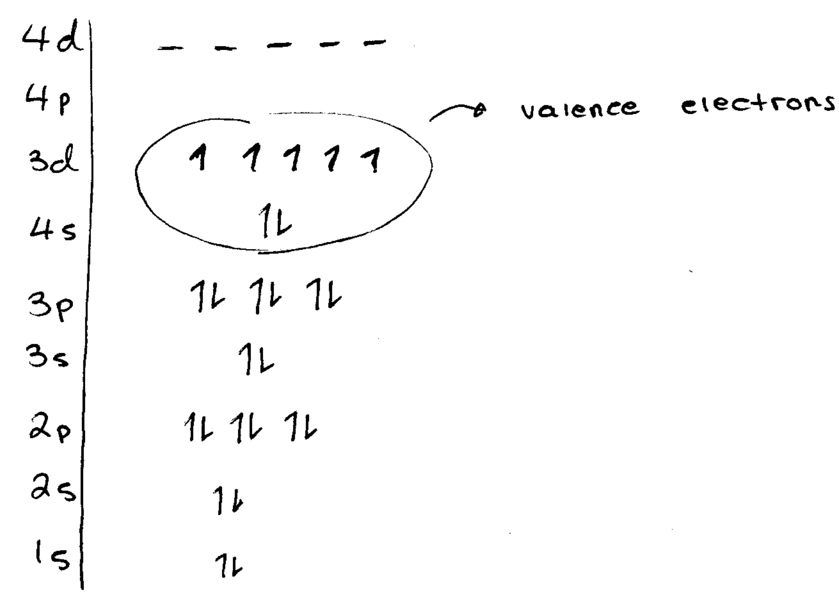
Principle quantum number (n) - identify shells (1, 2, ...,) (K, L, M,)

Subsidiary quantum number (l) - 0, ..., n-1 → number and shape of subshells

l		
0	s →	spherical
1	p →	dumbell
2	d →	

- valence electons: occupying outermost shell of electron
  - ↳ Full outermost shell results in noble gas (stable)

Example 2.1 : → For $_{25}Mn$: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^5$



on periodic table :

electronegativity ⟶ increases
↓ decreases ↳ (From H)

- Ionic bonding : metals + non-metals (transfer)
- covalent bonding : nonmetals + nonmetals (sharing)
- Metallic bonding : metallic cations (sea of electrons)

↳ nature of attractive forces is coulombic

- high (E) modulus of elasticity = high m.p. (melting point)

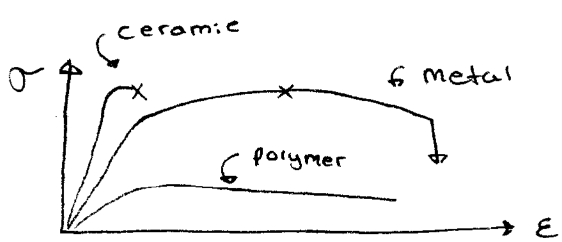
Sept. 12/18

Midterm: 1p → 3p (12 → 2 ?)
↳ Saturday Oct. 20™, AT1001/AT1003

Covalent bonds
- not a large difference in electronegativity
- atoms share valence electrons
- directional, depending on type of partic. atoms
- very strong or very weak (e.g. diamond vs. chlorine)
- most covalent bonded materials are insulators

Metallic bonding
- good conductors (heat/electricity)
- bonding energies v. weak (mercury) and v. strong (tungsten)
- non-directional

Pure metals are more maleable than ionic or covalent networked materials



Secondary bonding (Van Der Waals bonding)
- secondary bonds due to the attractions of electric dipoles in atoms or molecules

- Fluctuating induced dipole bonds: non-polar/non-polar
⟷⟷ (dipole temporarily induced by vibrating molecule)
- Polar molecule - induced dipole bonds: polar/non-polar
- Permanent dipole bonds: polar/polar (hydrogen bonding)

Fluctating Induced : due to vibrating nucleus

Induced dipole : attraction indiced by another polar molecule, resulting in permanent bonding

Mixed bonding : there are few materials that show pure ionic, covalent and metallic bonding.

Mixed bonding types :

- Covalent - ionic
  the higher the difference between electroneg. of atoms, the more ionic
- Covalent - metallic (IIIA , IVA)
   - semi - metals
  B, Si, Ge, As
- Metallic - ionic
  two metals w/ large difference in electronegativity
  $AuCu_3$

Percent Ionic character of a bond :

$$\% IC = \{1 - \exp[-(0.25)(X_A - X_B)^2]\} \times 100\%$$

where X_A and X_B are electronegativity of atoms

Q : what is % IC if $(X_A - X_B)$ is extremely large or small ?

$X_A - X_B = \infty \longrightarrow \% IC = 100\%$

$X_A - X_B = 0 \longrightarrow \% IC = 0\%$

Chapter 3

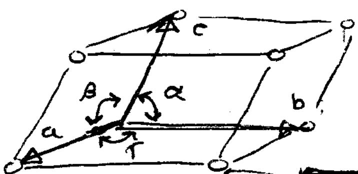
all metals, most ceramics, some polymers

Crystalline materials : atoms packed in 3D arrays

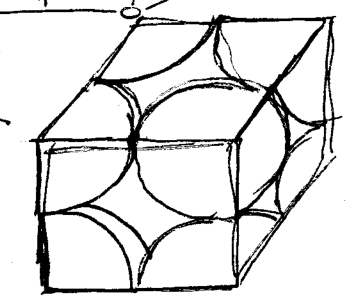
Amorphous materials : atoms with no periodic packing

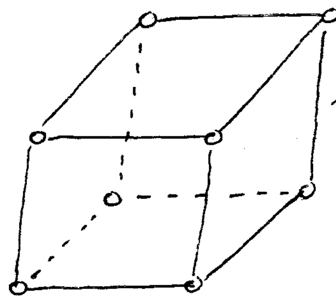
Unit cell : smallest repeating structure

↳ Four basic types :
- Simply cubic (SC)
- body centered cubic (BCC)
- Face centered cubic (FCC)
- hexagonal closed-pack (HCP)



hard Sphere





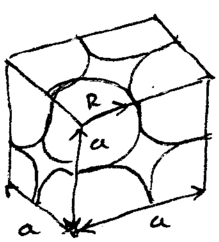
reduced sphere

Atomic packing Factor (APF)

$$APF = \frac{\text{Volume of atoms in unit cell}^*}{\text{Volume of unit cell}}$$

* assume hard spheres

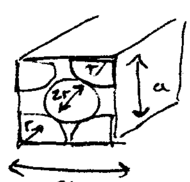
For SC : $\begin{cases} a = 2R \\ R = a/2 \end{cases}$



$$\Rightarrow \frac{1 \times \frac{4}{3}\pi\left(\frac{a}{2}\right)^3}{a^3} = .52$$

$$r = \frac{4}{3}\pi R^3$$

FCC :



$$a^2 + a^2 = 4r^2$$