Totally Epic AP Chem Review: Bonding and IMFs in a Day!

Chemical bonds: forces of attraction that hold groups of atoms together within a molecule or crystal lattice and make them function as a unit

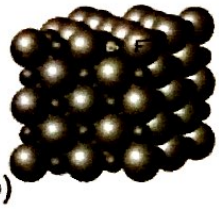
Remember, nature is striving for a lower energy state!

Ionic

Characteristics of ionic substance usually include:

- Electrons are **transferred** between atoms having large differences in electronegativity
- Often contain a metal and a non-metal
- Strong Coulombic attractions between + and − ions
- Formulas are given in the simplest ratios of elements (empirical formula; NaCl, $MgCl_2$)
- Solids at room temperature
- Form a crystal lattice structure as pictured to the right
- Melt at high temperatures
- Good conductors of electricity in the molten (l) or dissolved (aq) state


(a)


(b)

Covalent

Characteristics of covalent substance usually include:

- Electrons are **shared** between atoms having small differences in electronegativity
- Non-metals attracted to other non-metals
- Formulas are given in the true ratios of elements (molecular formula; $C_6H_{12}O_6$)
- May exist in any state of matter at room temperature (solid, liquid, or gas)
- Melt at low temperatures (held together by IMFs) ← Separate molecules
- Do NOT conduct electricity (EXCEPT strong acids!) ← when (aq)

when (s) or (aq) / (l)

Metallic

Characteristics of metallic substance usually include:

- Substances that are metals
- A sea of delocalized, mobile electrons surrounding a positively charged metal center
- An attraction between metal ions and surrounding ~~atoms~~ electrons
- Formulas are written as a neutral atom (Mg, Pb)
- Solid with a crystalline structure at room temperature
- Range of melting points – usually depending on the number of valence electrons
- Excellent conductors of electricity since electrons in the "sea" are free to move

Most chemical bonds are in fact somewhere between purely ionic and purely covalent.

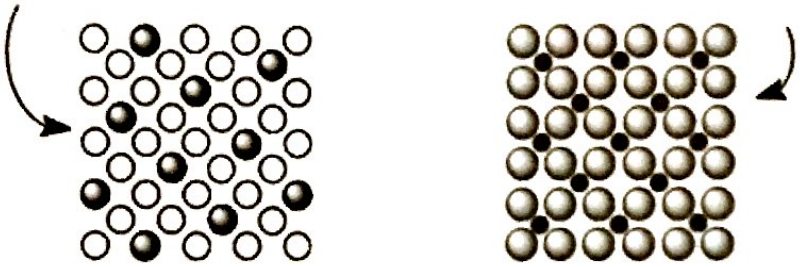
DRAW THE DANG LEWIS DOT STRUCTURE

when answering bonding multiple choice or free response questions.

Alloys: similar in structure to pure metal solids, but contain more than one type of element.

There are two types of alloys that are AP tested!

Substitutional Alloys	Interstitial Alloys
Form between atoms of similar size, where one atom substitutes for the other in the lattice. • Similar properties to component atoms • still malleable and ductile	Form between atoms of different size, where the smaller atoms fill the interstitial spaces (lattice holes) between the larger atoms. • Properties change!! • More brittle, harder • less malleable and ductile



IONIC BONDS: All about Coulomb's Law

When answering questions about ionic bond strength, justify your response using Coulomb's Law:

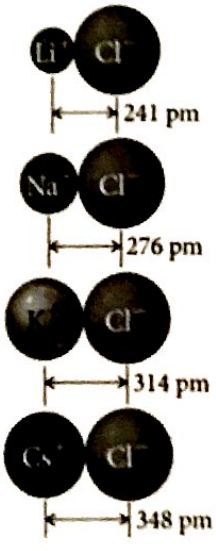
$$Lattice\ Energy = k(\frac{Q_1 Q_2}{d})$$

Use Coulomb's Law to justify melting point, solubility, and lattice energy differences between two ionic compounds.

➔ The more highly charged the ions OR the smaller the ions, the **GREATER** the attraction!

Lattice energy: energy released when the solid crystal forms from separate ions in the gas phase

- Directly dependent on size of charges
- Inversely dependent on distance between ions
- Ion charge is generally more important than ion size



Greater lattice energy = more energy required to separate ions

➔ stronger ionic bond

➔ ↑ melting point

➔ ↓ solubility (ions must separate/dissociate from one another and attach to water to dissolve)

Percent Ionic Character:

- The greater the difference in electronegativity between two bonded atoms, the greater the ionic character of the bond.
- The more similar in electronegativity, the greater the covalent character of the bond.

Dipole moment: a measure of bond polarity; ↑ dipole moment means ↑ ionic character!

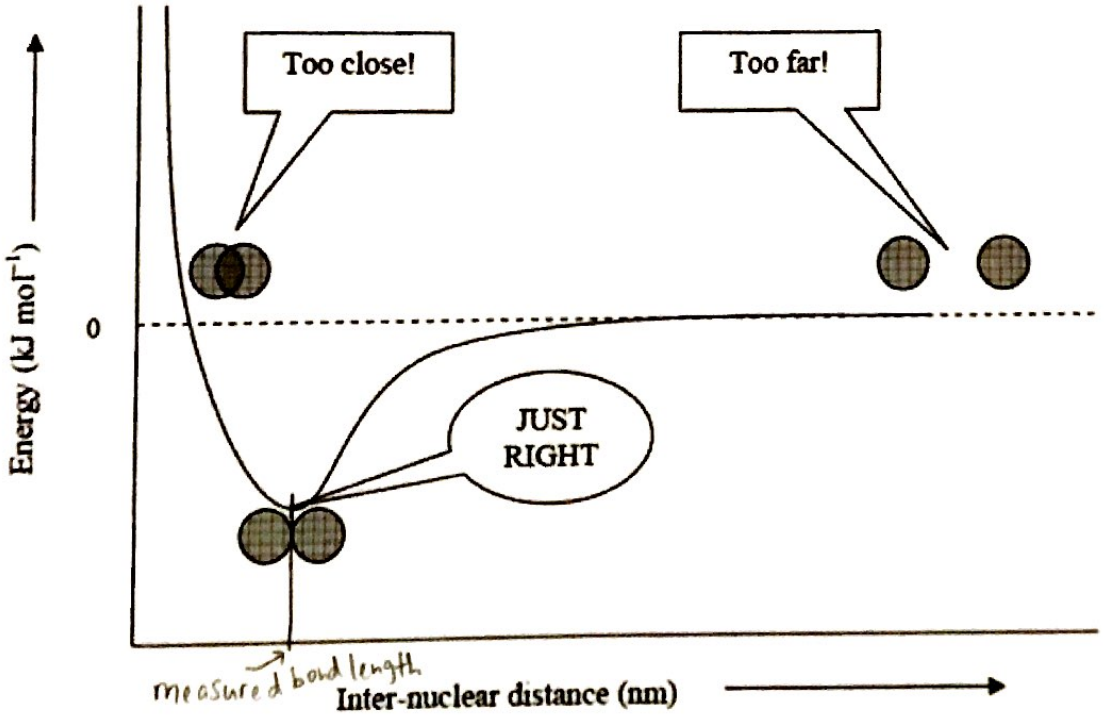
$$\overset{+\longrightarrow}{H—F} \quad or \quad \overset{\delta^+\ \delta^-}{H—F}$$

➔ Represented by an arrow pointing in the direction of greater electron density

COVALENT BONDS

Bond length: the distance two covalently bonded atoms at their lowest potential energy. It is a balance between opposing forces:

- Attractive electrostatic forces between the nucleus of one atom and the electrons of another
- Repulsive forces between the two positively charged nuclei



Bond Order: the number of chemical bonds between a pair of atoms; indicates the stability of a bond.

Bond Type	Bond Order	Bond Length	Bond Strength
Single bond	1	longer	weaker
Double bond	2	medium	medium
Triple bond	3	shorter	stronger

Higher Bond Order: ↑ electron density, ↓ nucleus-nucleus repulsion, ↑ electron-nuclei attraction

→ multiple bonds ↑ bond strength and ↓ bond length!