2.2 Part 2

- Answer a question with group members and make poster
- Gallery walk of all questions
- Packet problems if time

Answer you group question

- Make a poster explaining your question
- Be sure to JUSTIFY your answer

Gallery walk

Walk to each station and read the question and justification

Leave any glows/grows

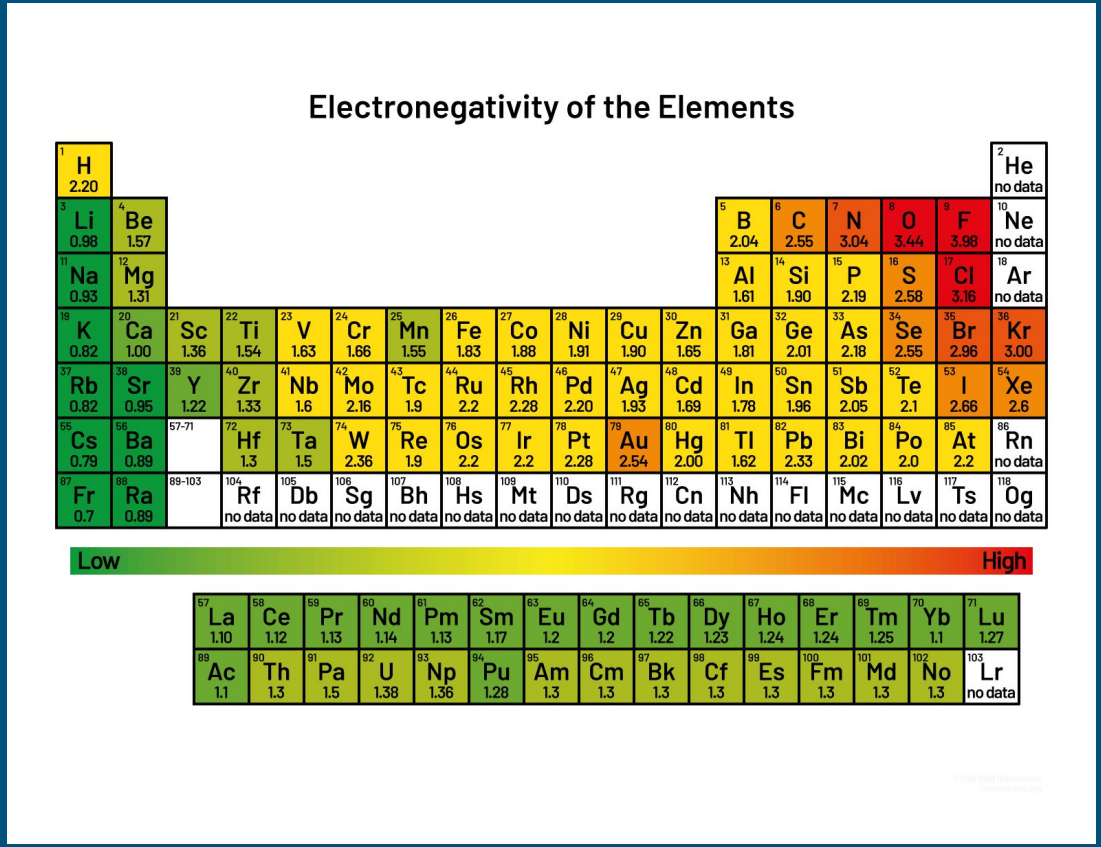
Feel free to take notes along the way

TOPIC 2.1: TYPES OF CHEMICAL BONDS

Enduring Understanding	
SAP-3	Atoms or ions bond due to interactions between them, forming molecules.
Learning Objective	
SAP-3A	Explain the relationship between the type of bonding and the properties of the elements participating in the bond.

Electronegativity

Electronegativity is a measure of the ability of an atom (or group of atoms) to attract **shared** electrons.



Coulomb’s Law

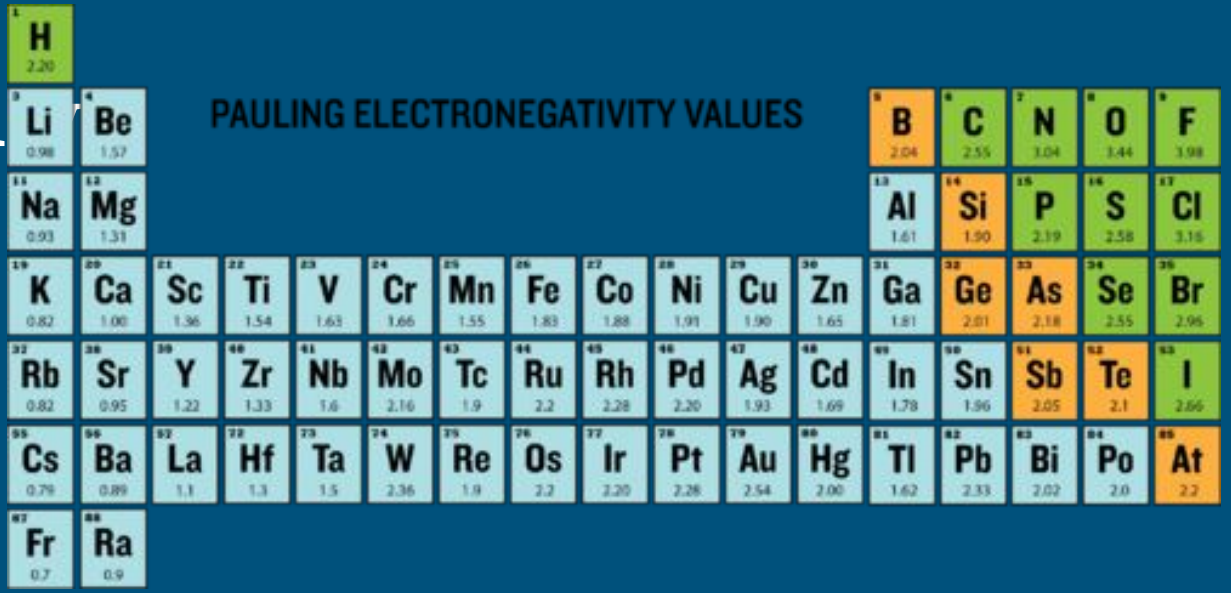
Electronegativity can be explained using Coulomb’s Law:

$$F = k\frac{q_1 q_2}{r^2}$$

The attractive force between charged particles increases with an increase in charge and decreases with an increase in the distance.

Electronegativi

Electronegativity **decreases as you move down a group** as there is a greater distance from the nucleus.



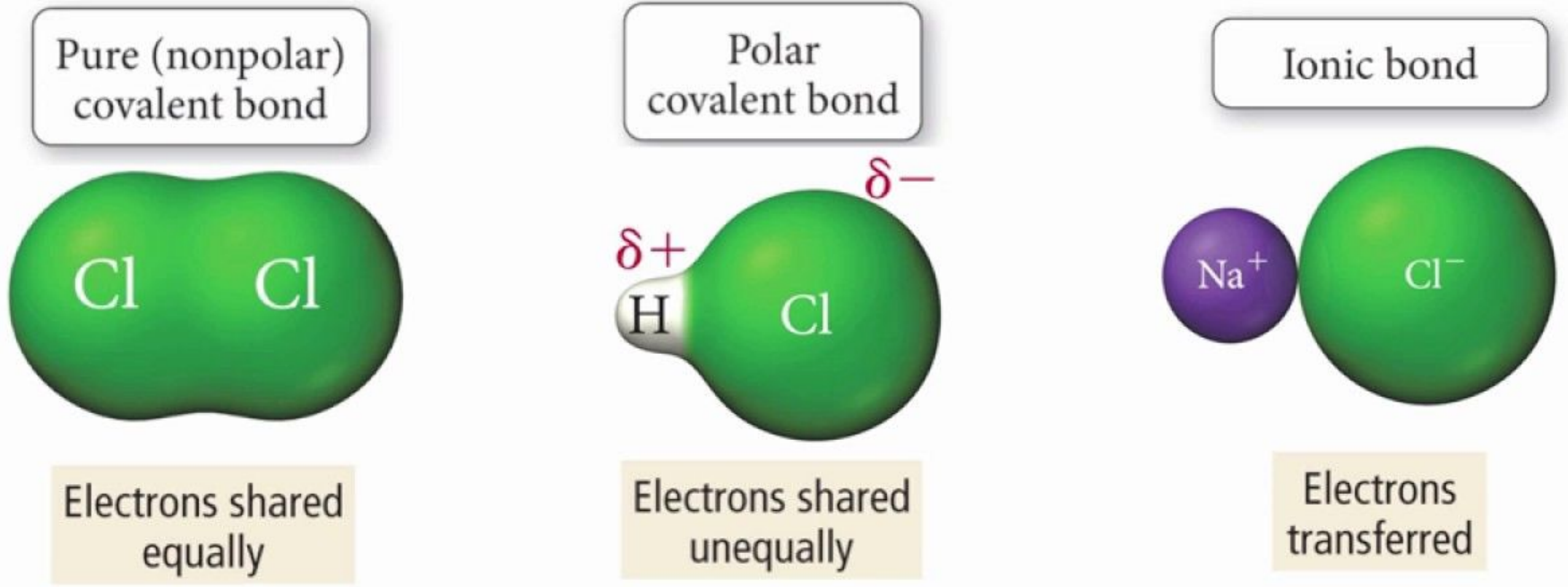
Electronegativity **increases as you move across a period** from left to right. This is because the atomic radius is decreasing while the number of protons (and effective nuclear charge) is increasing.

Electronegativity & Bond Type

When you compare the differences in electronegativity between two atoms there are (arbitrary) cut-offs for what makes a nonpolar bond, a polar bond and an ionic bond.

	Covalent		Ionic
	Nonpolar	Polar	Ionic
Sharing of electrons	Equal	Unequal	Transferred
Visual of electron sharing	A --:-- B	A ---:-B	A :B
Bond dipole moment	no	partial	Positive and Negative
Electronegativity difference	<0.5	0.5-1.7	>1.7

Examples With Chlorine



Ionic Compounds

- Ionic interactions occur between **metal** and **nonmetal** atoms when they lose or gain electrons to form ions. This type of attraction is a coulombic or electrostatic attraction.
- The ionic bonds are stronger when the charges are larger and the ions are smaller, this is explained by Coulomb's Law:

$$F = k\frac{q_1 q_2}{r^2}$$

Properties of Ionic Compounds

· Form crystals (lattice of positive and negative

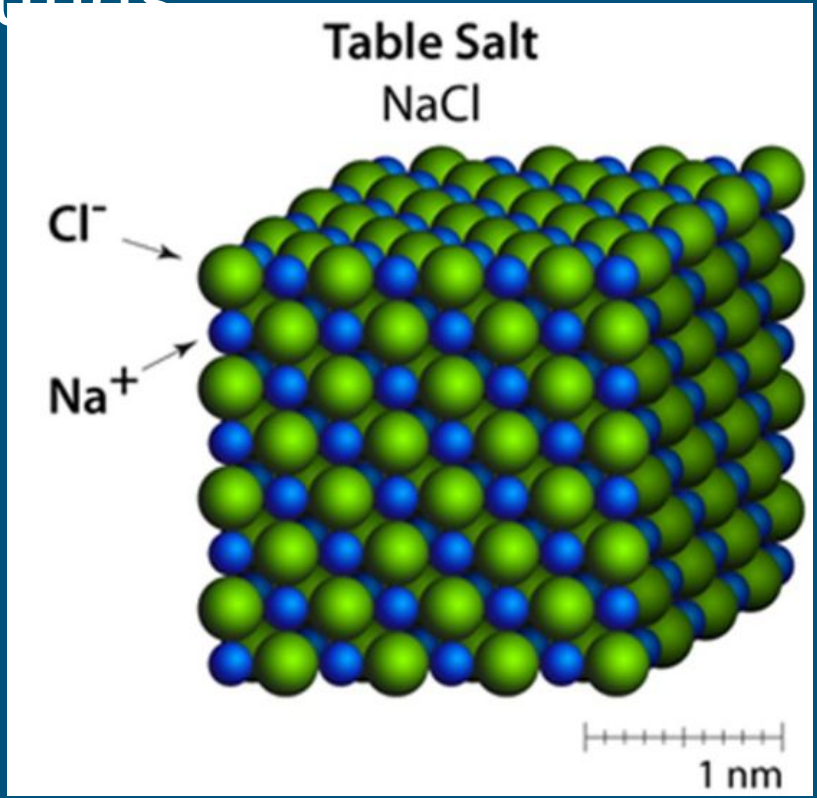
· High melting and boiling points

· Hard

· Brittle

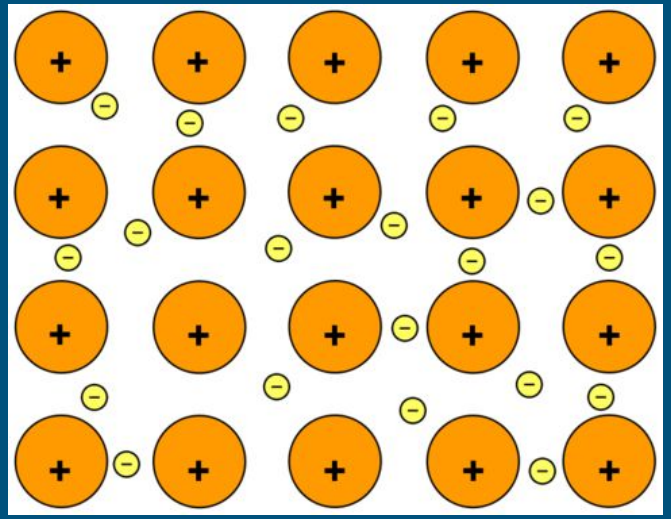
· Conduct electricity when dissolved and when molten (melted)

· Good insulators as a solid



Metallic Bonding

- Metallic bonding occurs between metal atoms.
  - Pure substance - one type of metal atoms
  - Alloy - a mixture of two or more atoms (at least one of which is a metal)



- The metallic attractions are due to multiple metallic cations being attracted to a delocalized sea of valence electrons.
- The IMF is stronger when there are smaller metallic cations and when there are more valence electrons.

Properties of Metals

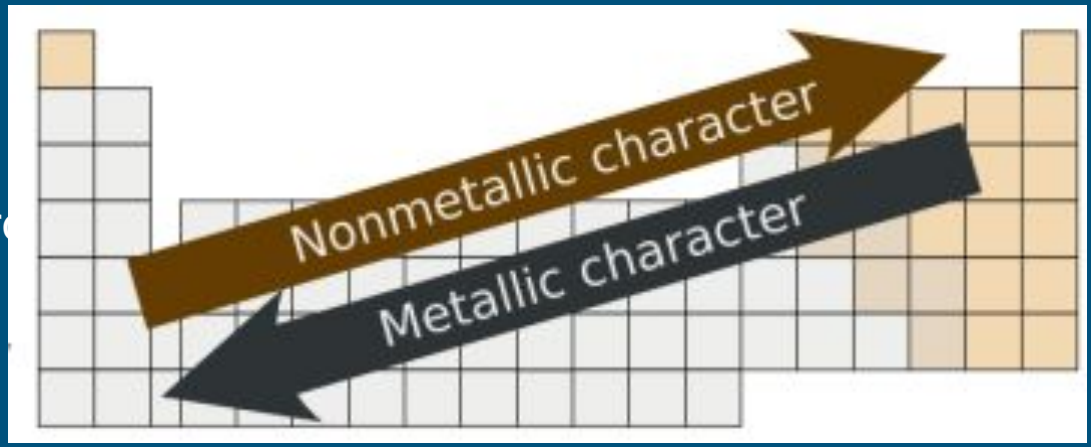
- Lustrous
- Malleable
- Ductile
- Good conductors of heat and electricity

*Metal atoms lose electrons to form cations.

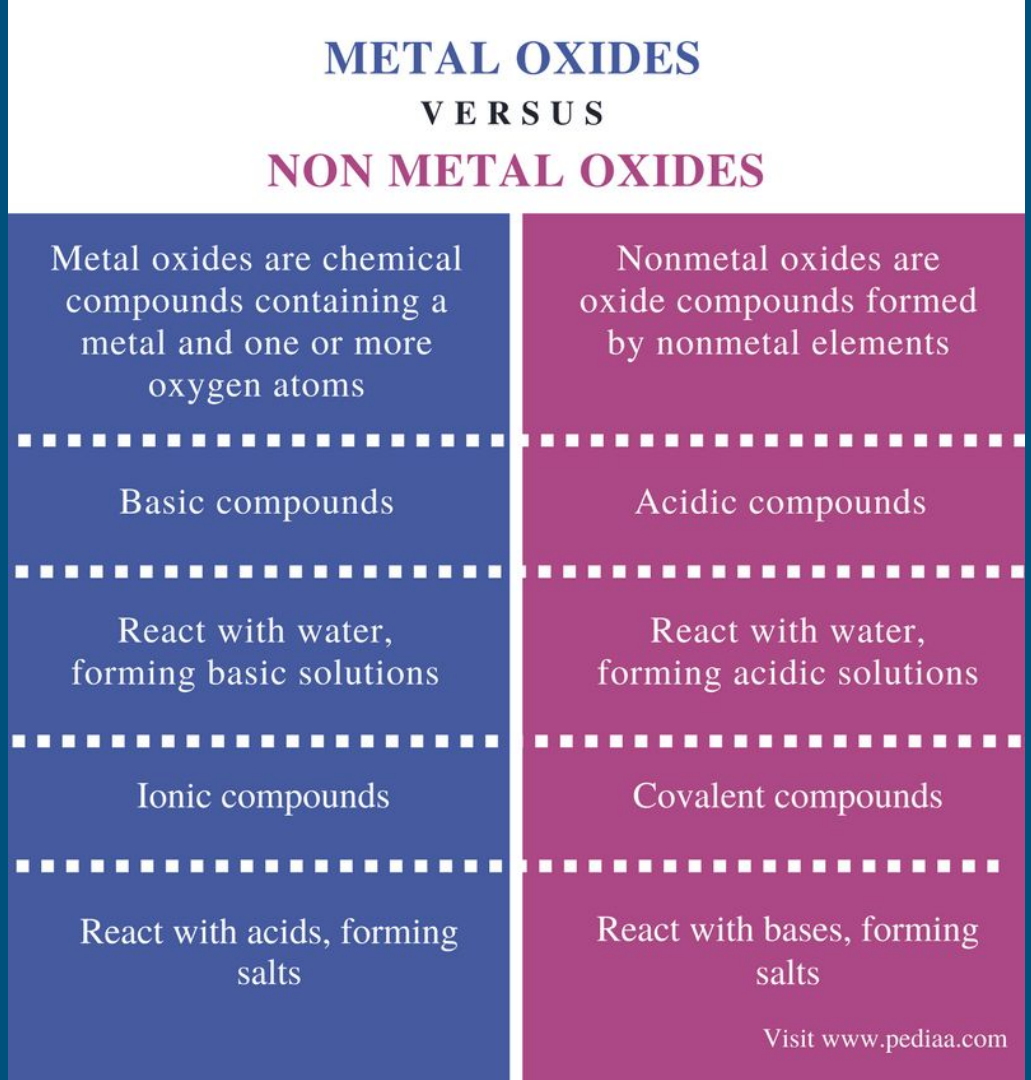
*Metal oxides are ionic compounds and basic. (CaO, Na_2O)

Properties of Covalent Molecules (non-metals)

- Non-lustrous, various colors
- Brittle (can be hard or soft)
- Poor conductors
- Form anions by gaining electr
- Nonmetallic oxides are acidic covalent (CO_2, SO_2)



Quick comparison of Metal oxides and Non Metal Oxides



Together

1. Place the following bonds in order of increasing polarity.

   C-H, C-F, C-C, C-O, Ca-C

You Do, We Review

2. Classify the substances below as Nonpolar Covalent, Polar Covalent, Ionic, or Metallic:
    a. H_2
    b. NaF
    c. $ZnCl_2$
    d. NO
    e. CuZn
    f. NCl_3
    g. CH_4
    h. Al

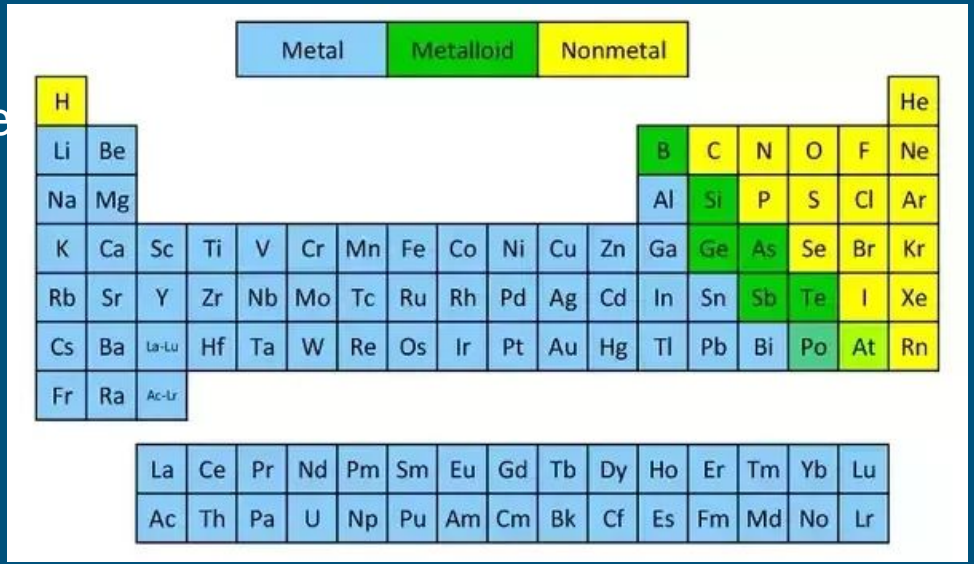
TOPIC 2.2: INTRAMOLECULAR FORCE & POTENTIAL ENERGY

Enduring Understanding	
SAP-3	Atoms or ions bond due to interactions between them, forming molecules.
Learning Objective	
SAP-3B	Represent the relationship between potential energy and distance between atoms, based on factors that influence the interaction strength.

Covalent Bonds

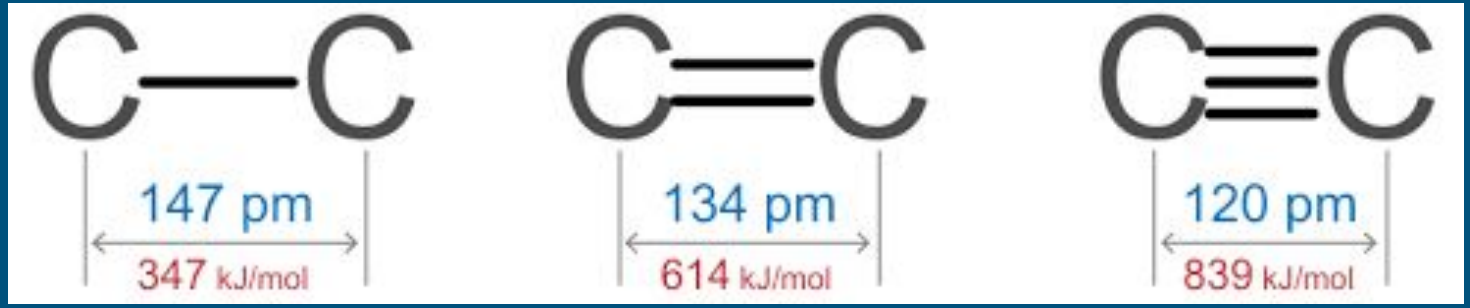
Covalent bonds are the bonds between two nonmetals when they share valence electrons.

Covalent bonds can be polar (electrons shared unequally) or nonpolar (electrons shared equally).



Covalent bonds

Covalent bonds can be single, double, triple bonds or an average of those if there are resonance structures.



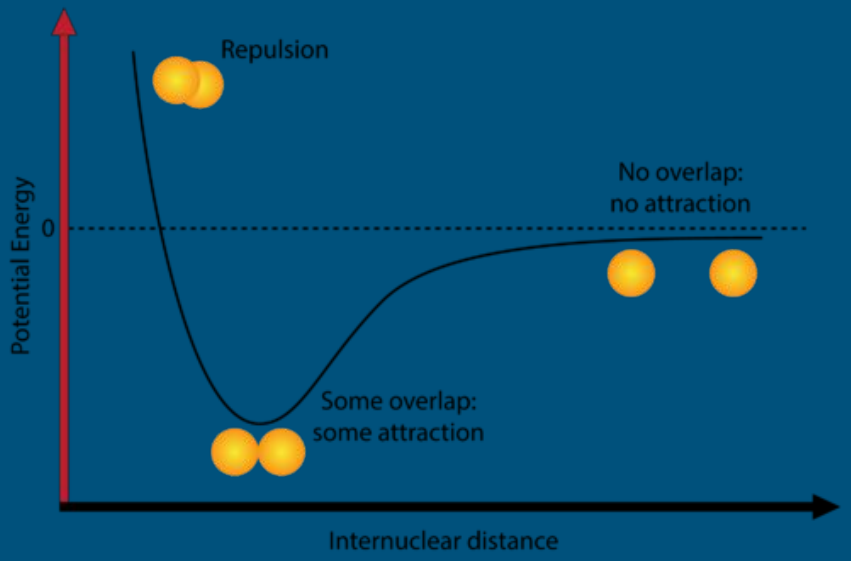
Covalent bonds and Energy

Covalent bonds occur at the **lowest energy state.**

This happens when the attraction between the nuclei is greatest for the shared electrons, and the repulsions between electrons and between the nuclei is the least.

If the atoms are too close together the nuclei will repel each other.

If the atoms are too far apart the attraction will not be enough to hold them together.



Bond Enthalpy

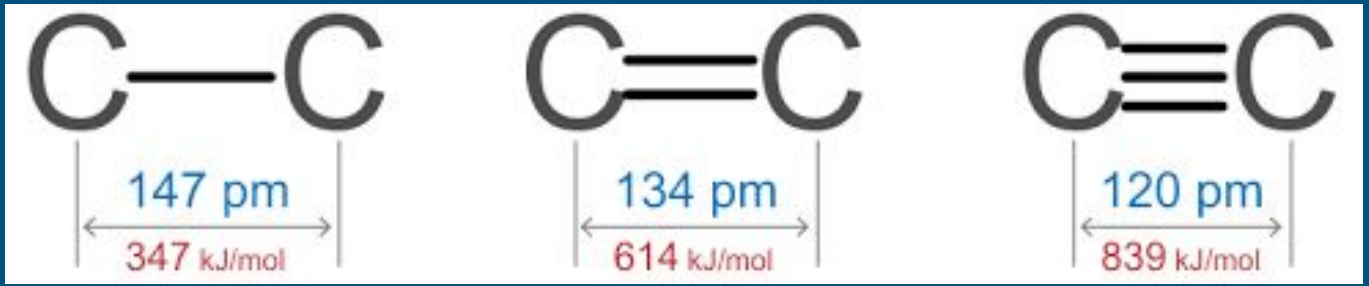
Bond enthalpy is the energy required to break a bond, or the energy released when a bond is formed. The magnitude is the same, but the sign is different.

*Larger atomic radii increase the bond length. Longer bond length decreases the bond energy.

Bond	Enthalpy kJ/mol
H—H	432
H—F	565
H—Cl	427
H—Br	363
H—I	295

Bond Enthalpy

*Increasing the bond order (single, double, triple) increases the bond energy: more electrons and shorter bond length = greater **coulombic attraction.**



Ionic Compounds and Lattice Energy

The energy to separate ions in ionic compounds is their **lattice energy**. It is defined as the change in energy that takes place when gaseous ions are combined to form an ionic solid. Combining ions will release energy.

Lattice energy can be represented using a modified version of Coulomb's law:

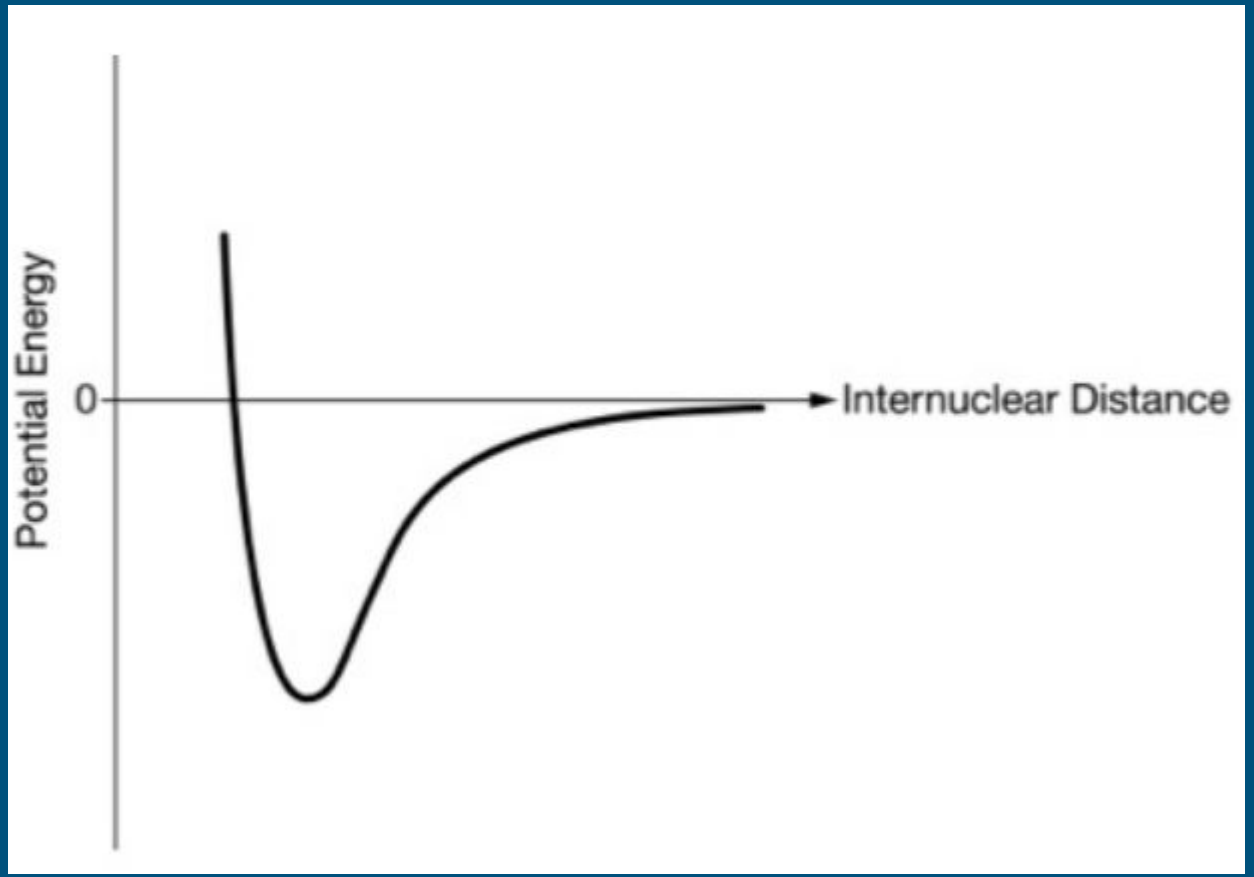
$$\text{Lattice Energy} = k\left(\frac{Q_1 Q_2}{r}\right)$$

*Larger charges - higher lattice ener

*Smaller radii - higher lattice energy

Together

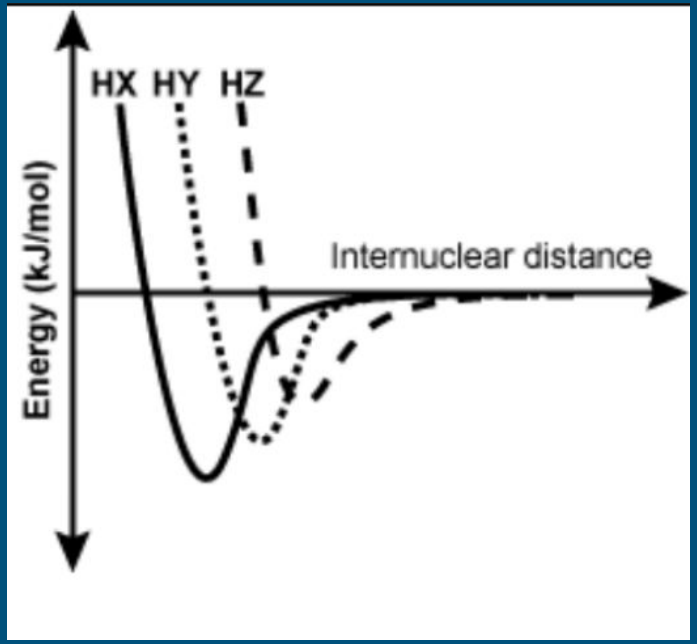
The bond energy for a C=C bond is 614 kJ/mol with a bond length of 1.34 Å. It is shown on the graph right. Sketch a C-C bond and a C=C bond on the graph. Include a key.



YOu Do, we Review

One way to identify an unknown substance is to measure the bond energy. HX, HY and HZ were analyzed and the following graph was created.

It was known that HI, HCl and HBr were tested. Use the graph to match the unknowns with the knowns.

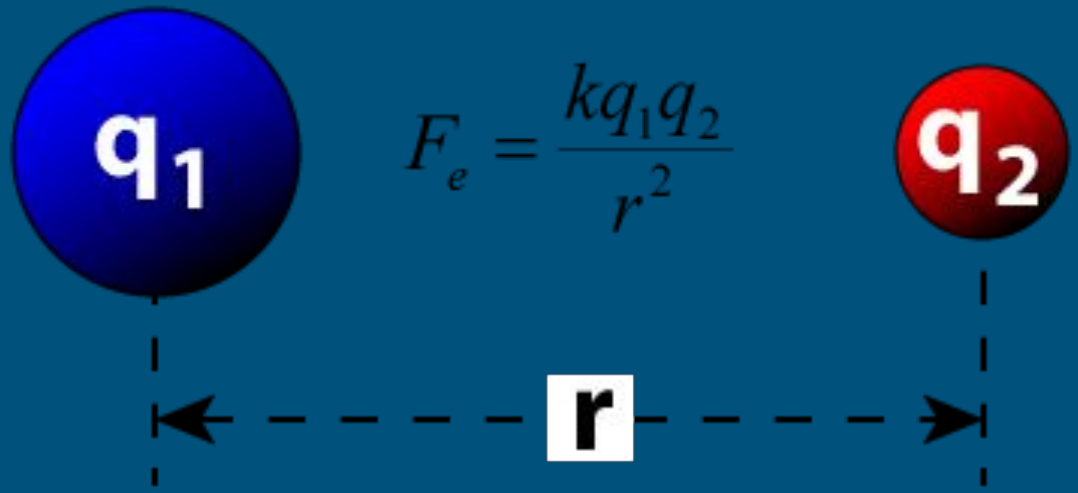


Agenda

- Bellwork
- Review of test
- 2.1 (2nd video and questions) and 2.3
- 2.4
- Quizizz

Test Review

a. Write the equation for the ionization of atomic fluorine. (1.7)


q1
$F_e = \frac{kq_1q_2}{r^2}$
q2
r

Orbital Diagrams

- Do NOT mention that a certain amount of electrons in an orbital make it more stable
  - Several people mentioned that F had a more stable orbital diagram due to having two paired electrons in the p orbital
    - THIS ISN'T TRUE
  - Don't assume that noble gases are the smallest due to having a full valence shell

TOPIC 2.3: STRUCTURE OF IONIC SOLIDS

Enduring Understanding	
SAP-3	Atoms or ions bond due to interactions between them, forming molecules.
Learning Objective	
SAP-3C	Represent an ionic solid with a particulate model that is consistent with Coulomb's law and the properties of the constituent ions.

Lowest Correct on Unit Test 1: 11, 12, 13, & 15

11. A sample of $CaCO_3$ (molar mass 100. g) was reported as being 30. percent Ca. Assuming no calcium was present in any impurities, the percent of $CaCO_3$ in the sample is

(A) 30%

(B) 40%

(C) 70%

(D) 75%

(E) 100%

Most common wrong answer E.

12. Which of the following represents the ground state electron configuration for the Mn^{3+} ion? (Atomic number Mn = 25)

(A) $1s^2\ 2s^2 2p^6\ 3s^2 3p^6 3d^4$

(B) $1s^2\ 2s^2 2p^6\ 3s^2 3p^6 3d^5\ 4s^2$

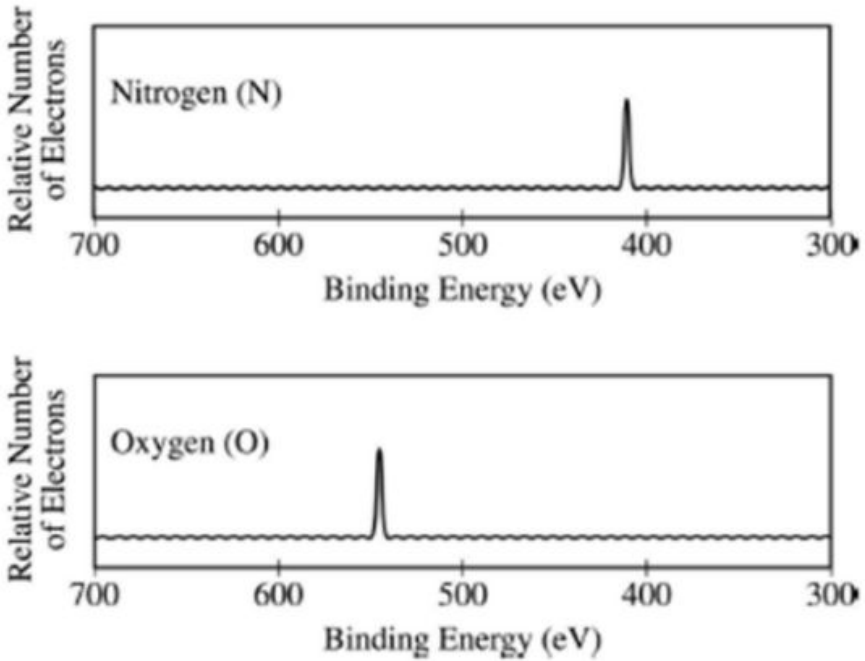
(C) $1s^2\ 2s^2 2p^6\ 3s^2 3p^6 3d^2\ 4s^2$

(D) $1s^2\ 2s^2 2p^6\ 3s^2 3p^6 3d^8\ 4s^2$

(E) $1s^2\ 2s^2 2p^6\ 3s^2 3p^6 3d^3\ 4s^1$

Most common wrong answer C? C???

13.



The photoelectron spectra above show the energy required to remove a 1*s* electron from a nitrogen atom and from an oxygen atom. Which of the following statements best accounts for the peak in the upper spectrum being to the right of the peak in the lower spectrum?

(A) Nitrogen atoms have a half-filled *p* subshell.

(B) There are more electron-electron repulsions in oxygen atoms than in nitrogen atoms.

(C) Electrons in the *p* subshell of oxygen atoms provide more shielding than electrons in the *p* subshell of nitrogen atoms.

(D) Nitrogen atoms have a smaller nuclear charge than oxygen atoms.

Most common wrong answer A.

15. Which of the following best helps to account for the fact that the F^- ion is smaller than the O^{2-} ion?

(A) F^- has a larger nuclear mass than O^{2-} has.

(B) F^- has a larger nuclear charge than O^{2-} has.

(C) F^- has more electrons than O^{2-} has.

(D) F^- is more electronegative than O^{2-} is.

(E) F^- is more polarizable than O^{2-} is.

Most common wrong answers D and E.

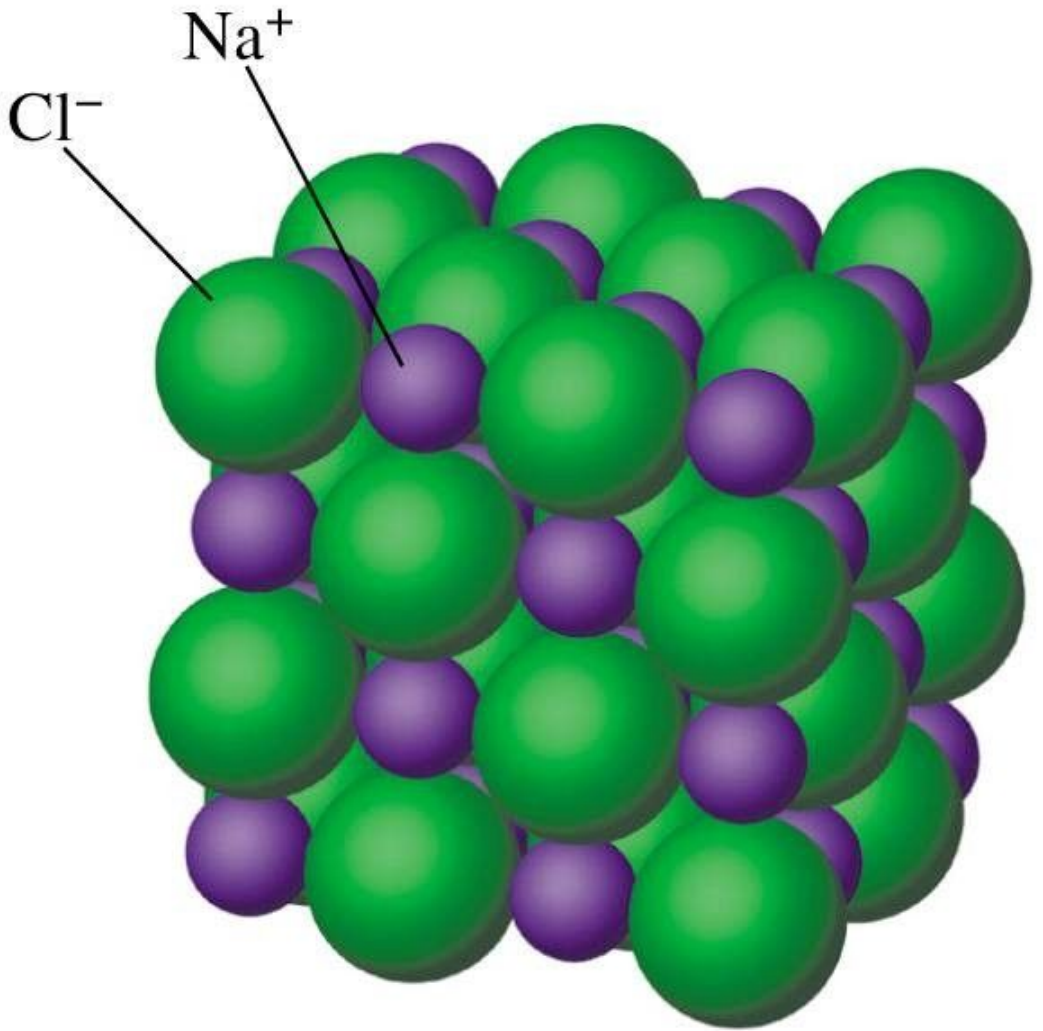
Want 3 extra benchmark grades for Unit 1? Complete free response question by Friday.

Ionic Solids

Ionic solids consist of cations and anions.

Discrete ionic molecules do not exist.

A repeating array of molecules are held together by strong Coulombic forces (ionic bonds) between oppositely charged ions adjacent to one another.



Properties of Ionic Solids

- Nonvolatile and have high melting points – ionic bonds must be broken to melt the solid, which separates oppositely charged particles. This requires very high temperature to give the particles enough kinetic energy.
- Ionic solids do not conduct electricity – the charged ions are fixed in place. When melted or dissolved in solution, the ions become free to move about, enabling electrical conduction.
- Many ionic compounds are soluble in polar solvents like water and insoluble in non-polar solvents like benzene.

Coulomb's Law

$$F = k\frac{q_1 q_2}{r^2}$$

Relative strength of different ionic bonds can be estimated from Coulomb's Law.

- Higher ion charges = stronger bonds
  - Compare calcium oxide (CaO) and sodium chloride (NaCl)
  - Why does CaO have stronger bonds than NaCl?
  - Bond strength corresponds to melting point (2927°C for CaO versus 801°C for NaCl).
- Larger atoms = weaker bonds
  - Compare sodium chloride (NaCl) and sodium bromide (NaBr)
  - Which bond length in longer?
  - Bond strength corresponds to melting point (801°C for NaCl versus 747°C NaBr).

NaCL vs NaBR

NaBr melting 747 degrees

NaCl melting 808

Together

1. Why does KBr (672 kJ/mol) have a higher lattice energy than KI (632 kJ/mol)?

You Do, we Review

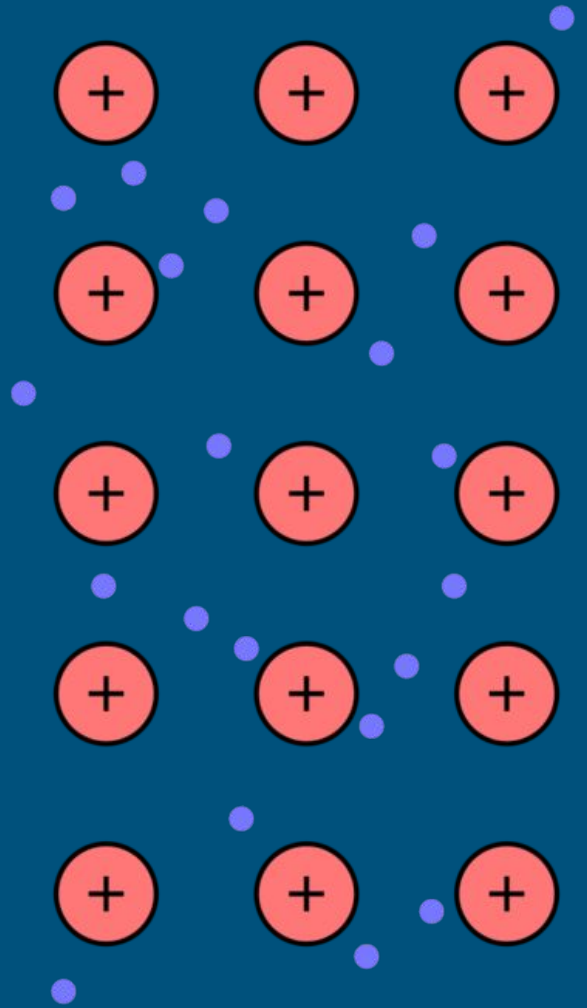
2. Draw a particle diagram of rubidium chloride. Be sure to include relative sizes.

TOPIC 2.4: STRUCTURE OF METALS & ALLOYS

Enduring Understanding	
SAP-3	Atoms or ions bond due to interactions between them, forming molecules.
Learning Objective	
SAP-3D	Represent a metallic solid and/or alloy using a model to show essential characteristics of the structure and interactions present in the substance.

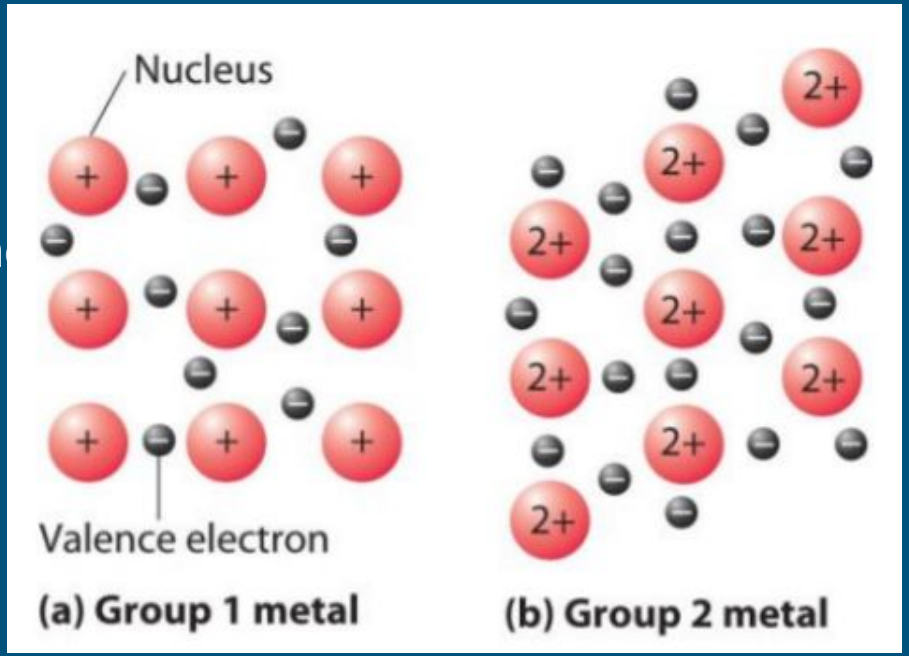
Metals

- **Metals** are composed of cations that are embedded in delocalized sea of valence electrons.
- Electrons do not stay with one atom, rather they are able to move throughout the entire substance.
- The cations and the electrons are attracted to one another through a **Coulombic attraction**.



Coulombic Attraction

- The number of valence electron determines the amount of electrons in the delocalized sea of electrons.
- When the charge on the cations and th number of electrons increases the attractions are greater.
- When the ionic radius decreases the attraction increases.



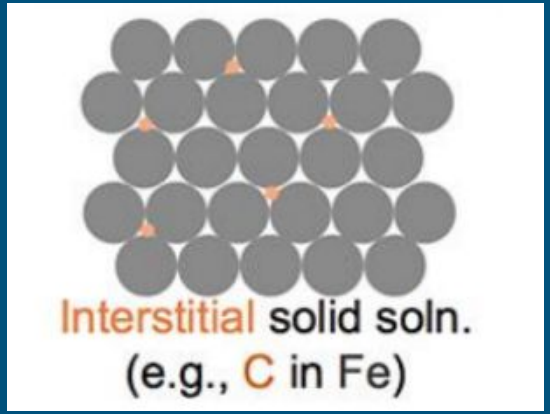
Alloys - Size Matters

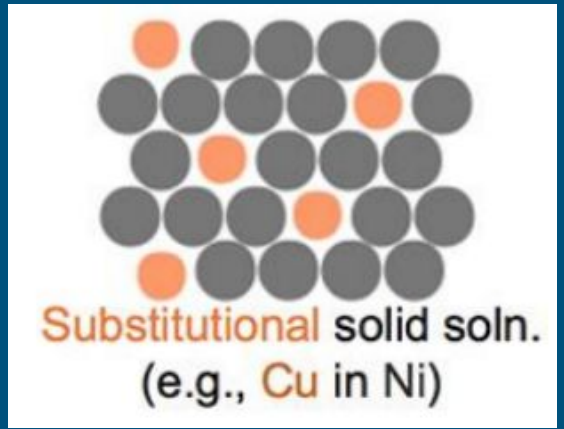
Mixtures of metals are called alloys; they can be examples of a solution.

Interstitial Alloys - The atoms added to the metal are small and fit in between the metal atoms in the existing holes (interstices).

*Often H, B, C and N are added

Substitutional Alloys - The atoms added to the metal have similar radii so they replace atoms in the lattice.



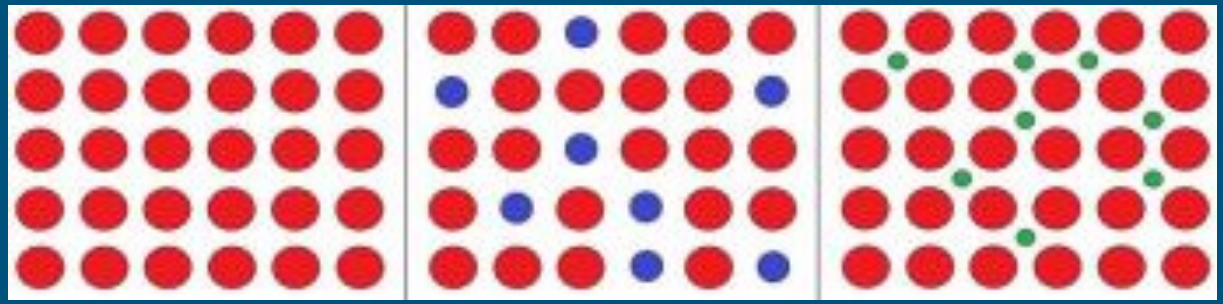


Together

1. Carbon steel is an alloy composed of a small amount of carbon atoms combined with iron. Consider the atomic radii of both carbon and iron and draw a model that describes the alloy that forms.

You Do, WE Review

2. Examine the diagrams below, and then label each with the type of substance shown.



TOPIC 2.5: LEWIS DIAGRAMS

Enduring Understanding	
SAP-4	Molecular compounds are arranged based on Lewis diagrams and Valence Shell Electron Pair Repulsion (VSEPR) theory.
Learning Objective	
SAP-4A	Represent a molecule with a Lewis diagram.

Lewis Structures

- Covalent bonds are formed between atoms sharing electrons.
- Lewis structures are a simple way of representing covalent bonds. The shared valence electrons can be drawn using dots to represent individual valence electrons, or lines to represent shared electron pairs.

Lewis Structures

- A pair of valence electrons in a bonded atom that does not participate in bonding is called a lone pair. Lone pair electrons contribute to molecular shape.
- Atoms can form double or triple covalent bonds as well, in which each atom shares four valence electrons (double bond) or six valence electrons (triple bond).

Rules for Drawing Molecules

1. Write the symbols of the elements down so that the atom that makes the most bonds is in the middle.

NO_3^-

Rules For Drawing MOlecules

2. Count up the total number of valence electrons. Write the number down on the side.

Rules for Drawing Molecules

3. Draw a bond between each atom using a line.

- Each line counts as 2 electrons! Keep track of how many electrons have been used up.

Rules for Drawing Molecules

4. Using the remaining electrons, start drawing pairs of electrons around each of the outside atoms.

- Hydrogen can only have 2 electrons, since it makes only 1 bond, never give electrons to hydrogen.

Rules for Drawing Molecules

5. If there are any electrons left, give them to the middle atom. There should be zero electrons left after this step.

Rules for Drawing Molecules

6. Check for octets (duets for hydrogen). If any atoms don’t have octets, “borrow” pairs from that atom’s neighbors until every atom has an octet.

Lewis STructures, Ions, & Expanded Octets

- If a molecule is positive (a cation) it has LOST valence electrons.
- If a molecule is negative (an anion) it has GAINED valence electrons.

*Remember this in step 2 when counting the total number of valence electrons.

*Atoms in Period 3 and below CAN bond to more than 4 atoms in what is called an EXPANDED OCTET. Phosphorus and Sulfur are common examples.

together

Draw a Lewis diagram for C_2H_3Cl

YOu do, we review

Draw a Lewis diagram for the following:

a. C_2H_2
b. OH^-
c. CF_2S
d. BCl_3
e. SF_6