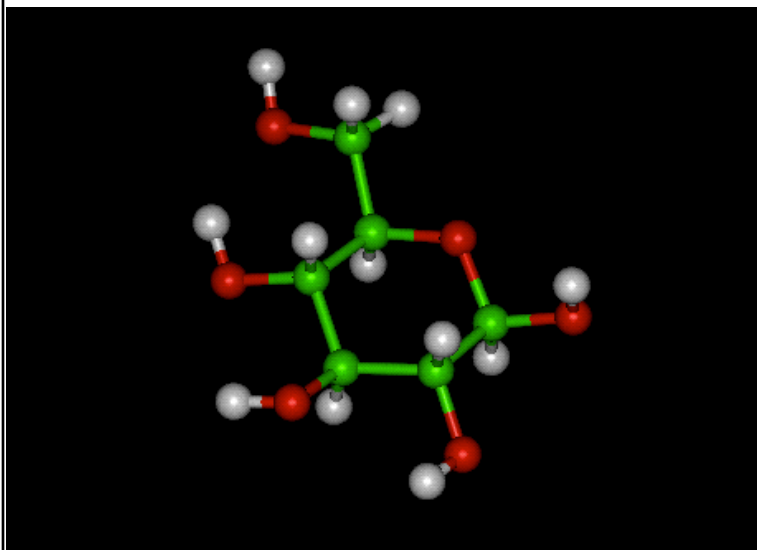
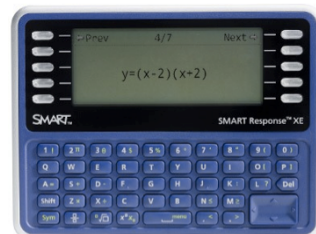


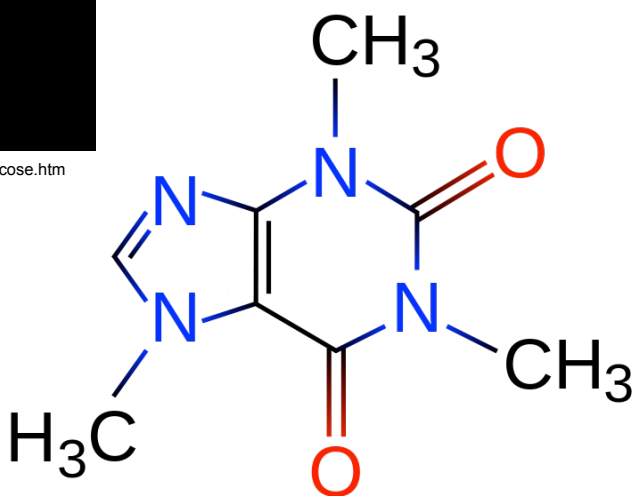
Chemical Bonds



<http://www.worldofmolecules.com/foods/glucose.htm>



Get a clicker!



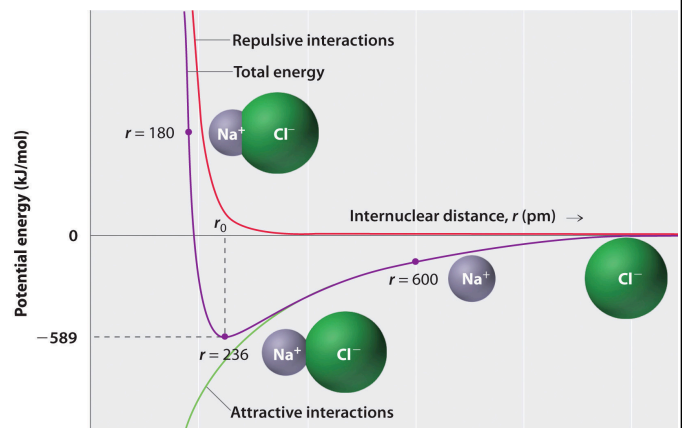
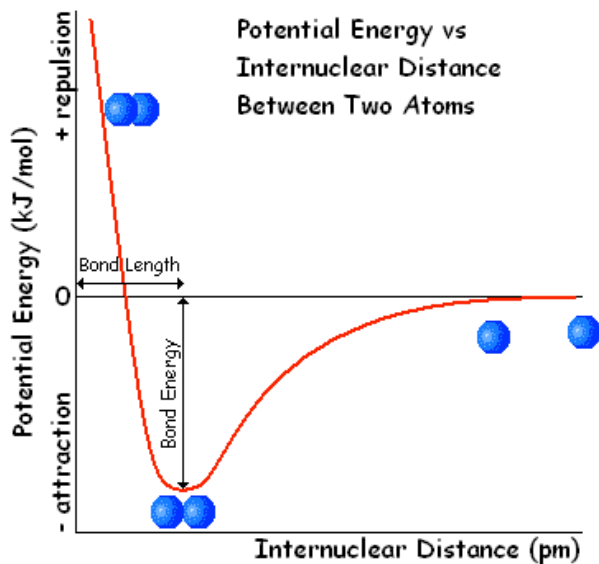
<http://commons.wikimedia.org/wiki/File:Caffeine.svg>

What is a chemical bond?

- Chemical bonds are the forces that hold atoms together. They are a result of either the attraction between a positive and negative ion, or the attraction between the nucleus and electrons.
 - > Electrostatic force: attraction of opposite charges, repulsion of like charges

Why do bonds form?

- Lowers the potential energy of particles in the atom
- Energy is released when bonds are formed
- Energy is absorbed when bonds are broken



Octet Rule

- **Valence electrons** are involved in forming chemical bonds.
 - > The valence electrons determine the reactivity of various elements.
- **Octet rule:** Atoms tend to gain, lose, or share electrons in order to acquire a full set of valence electrons (like noble gasses!)
 - > Most stable
 - > ns^2np^6

Examples: CO_2 and F_2



<http://chemistry.about.com/od/electronicstructure/a/Octet-Rule.htm>

Octet Rule Exceptions:

- Less than an octet:
 - > Hydrogen and helium are stable with only 2 electrons
 - > Beryllium forms 2 single bonds
 - > Boron forms 3 single bonds
- More than an octet:
 - > Third period and beyond can have an expanded octet due to unfilled d-electrons.

1 How many more electrons does Sulfur need to achieve an octet?

A 6

B 4

C 2

D 1

2 Based on the bonding activity, which of the following is true about elements in group 2?

- A Elements in group 2 need to SHARE their 2 electrons to achieve an octet.
- B Elements in group 2 GIVE AWAY their valence electrons to achieve an octet.
- C Elements in group 2 TAKE 6 electrons to achieve a stable octet.

Types of Chemical Bonds

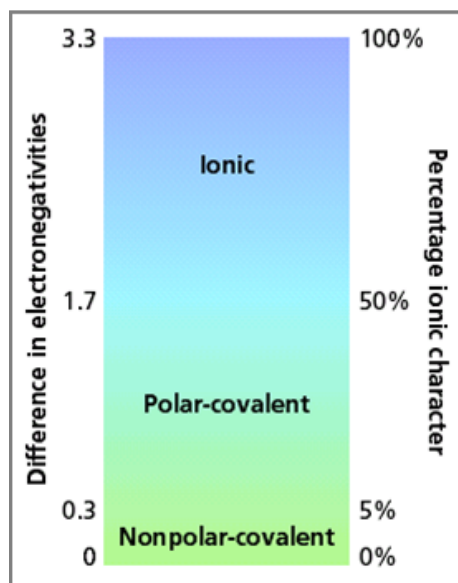
1. Ionic bonds: Transferring electrons
2. Covalent bonds: Sharing electrons
 - > nonpolar covalent (sharing equally)
 - > polar covalent (unequal sharing)
3. Metallic bonds: Sharing delocalized electrons

Type of Chemical Bonds is Determined by EN

- If the difference in electronegativity between the two atoms forming a bond is...
 - > 0-0.2: Nonpolar covalent bonds
 - > 0.3-1.7: Polar covalent bonds
 - > >1.7: Ionic bond
- The three types of bonds are a continuum ranging from nonpolar to ionic based on the "tug-of-war" for electrons.

If the bond is between a metal and a nonmetal, consider it ionic*

If the bond is between a nonmetal and a nonmetal, check EN to see if it is polar or nonpolar.



Example 1: What kind of bonds will the following form?

- Calcium (Ca) and Chlorine (Cl)
- Carbon (C) and Hydrogen (H)
- Oxygen (O) and Nitrogen (N)
- Copper (Cu) and Sulfur (S)

3 When the difference in electronegativity is very large, the atoms will likely form

A an ionic bond because one atom has a very high affinity for valence electrons.

B a covalent bond because the two atoms will share their electrons

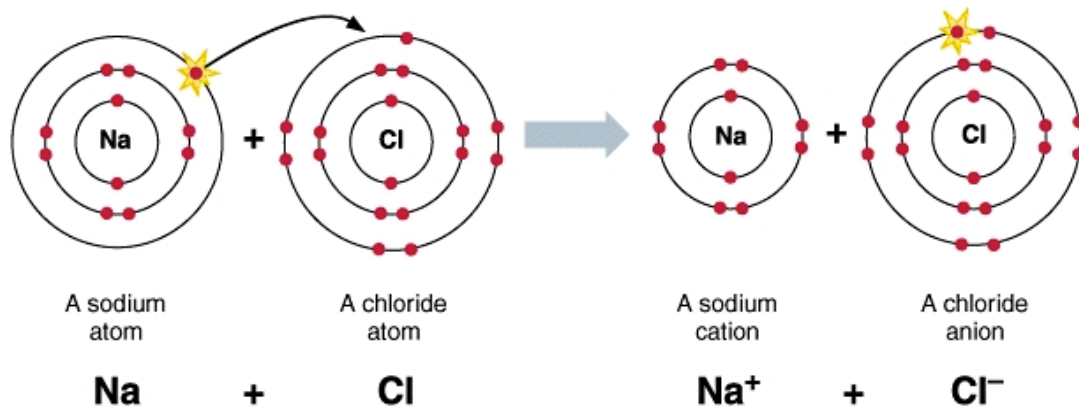
C The atoms will likely not form bonds.

4 Calcium and bromine will form

- A Ionic bond
- B Polar covalent bond
- C Nonpolar covalent bond
- D Metallic bond

Ionic Bonds

- **Ionic bond** is a kind of chemical bond between a cation and an anion. It is the electrostatic force that holds oppositely charged particles together.
 - > Charges of ions need to balance out
- Ionic compounds are compounds held together by ionic bonds.



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Cation and Anions

Some elements **lose electrons** to reach a stable octet. They form **cations**.

>  tend to lose electrons

Some elements **gain electrons** to reach a stable octet. They form **anions**.

>  tend to gain electrons

Example 2: What ions will the following elements form?

Calcium (Ca)

Oxygen (O)

Sodium (Na)

Fluorine (F)

Magnesium (Mg)

Chlorine (Cl)

Aluminum (Al)

Phosphorous (P)

Example 3: How would the following elements combine to form ionic compounds?

1. Oxygen and Magnesium
2. Sodium and Fluorine
3. Potassium and Chlorine
4. Magnesium and Chlorine
5. Calcium and Fluorine
6. Aluminum and nitrogen
7. Magnesium and phosphorus

5 Fluorine will form what kind of ion?

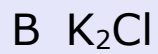
A 1-

B 2-

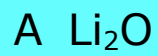
C 1+

D 2+

6 Which of the following shows the compound that potassium and chlorine will form?



7 Which of the following compounds will lithium and oxygen form?

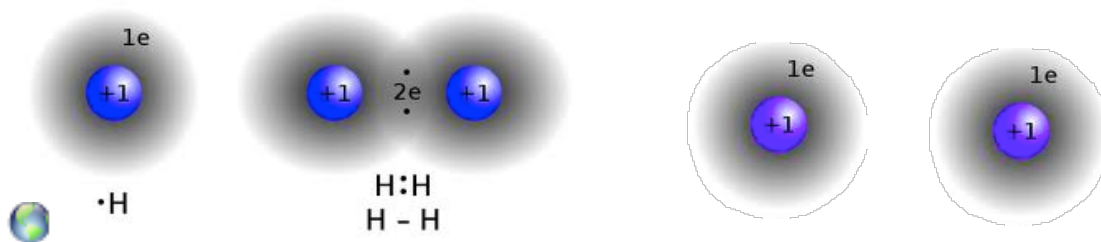


Covalent Bond

- **Covalent bond:** One or more electrons are simultaneously attracted to two nuclei.
 - > Atoms achieve the octet by **sharing** electrons

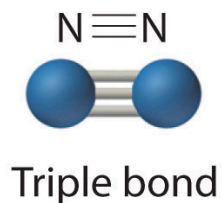
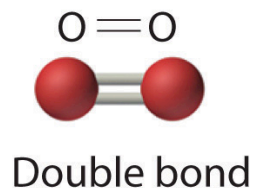
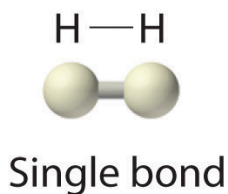
As two atoms approach each other, orbitals overlap:

- Repulsive force between electrons and between protons of two atoms
- Attractive force between nuclei (protons) and electrons of other atom
- At point of maximum attraction, the attractive force balances the repulsive force
- Atoms bond to form a **molecule**



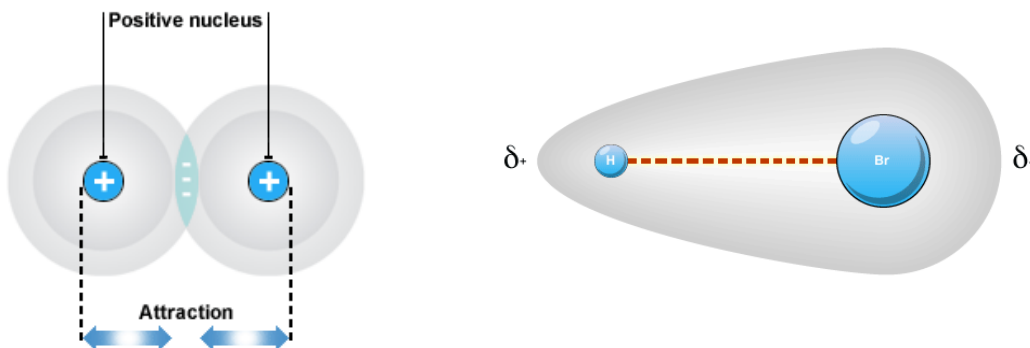
Covalent Bond

- **Covalent bond:** One or more electrons are simultaneously attracted to two nuclei.
 - > Atoms achieve the octet by **sharing** electrons
 - > Sharing 2 electrons = single bond
 - > Sharing 4 electrons = double bond
 - > Sharing 6 electrons = triple bond



Covalent Bond

- There are 2 types of covalent bonds
 - > **Nonpolar**: electrons are shared equally
 - Same, or very similar electronegativity
 - > **Polar**: electrons are shared unequally
 - One atom will have a stronger attraction for the shared electrons due to differences in electronegativity.



Example 4: How do the following form covalent bonds? Show each bond with a straight line.

1. H_2O

2. CO_2

3. CH_4

4. O_2

5. PCl_3

8 Which pairs of atoms are likely to form a covalent bond?

A Nonmetal-nonmetal

B metal-metal

C metal-nonmetal

9 How many single bonds does carbon need to form to satisfy its octet?

A 1

B 2

C 3

D 4

10 How many bonds does Nitrogen need to form to satisfy its octet?

A 1

B 2

C 3

D 4

Lewis Structures

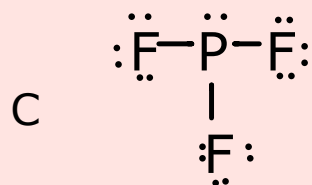
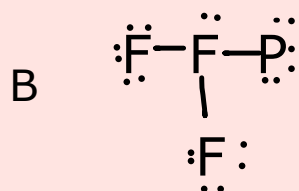
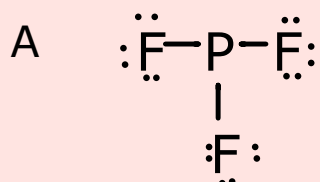
- **Lewis Structures** = representation of a molecule that shows how the valence electrons are arranged among atoms. *Electron-dot diagrams for molecules!
 1. Add up all of the valence electrons from the atoms
 2. Draw a skeleton structure of the molecule
 - > Hydrogen is always terminal.
 - > Put the least electronegative element "central"
 3. Use two electrons to form a bond between each pair of bound atoms (use a line)
 4. Arrange remaining electrons to satisfy octet rule.
 5. *remember the exceptions to the octet rule
 6. *Bonding electrons are those electrons involved in a bond.
 7. *Lone pairs are unshared electrons.

Example 5: Draw the lewis structure for the following

1. PCl_3
2. BF_3 (exception!)
3. CH_4
4. SO_4^{2-}
5. CO_2

****Polyatomic ions** ions made up of more than one atom. The atoms are covalently bonded and have an overall positive or negative charge. They form ionic bonds with other ions.

11 Which of the following is the correct Lewis structure for PF_3



Ho
pa
lo

12 How many total valence electrons does CH_3Cl have?

A 14

B 10

C 6

D 8

Draw
the
pair

13 How many total valence electrons does NH_4^+ have?

A 12

B 9

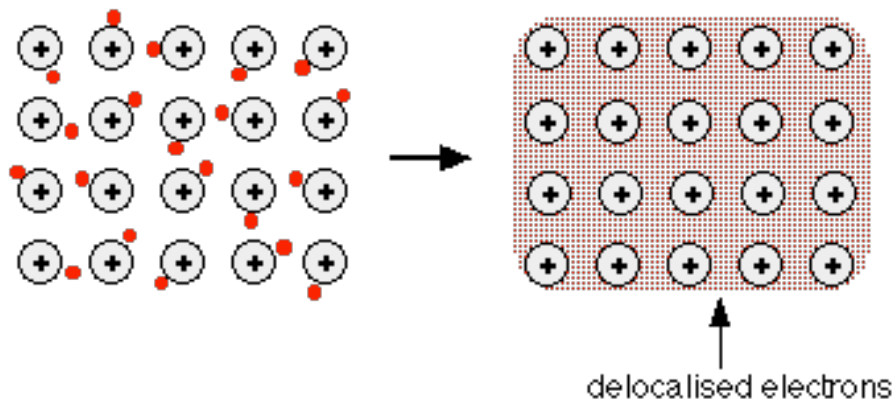
C 10

D 8

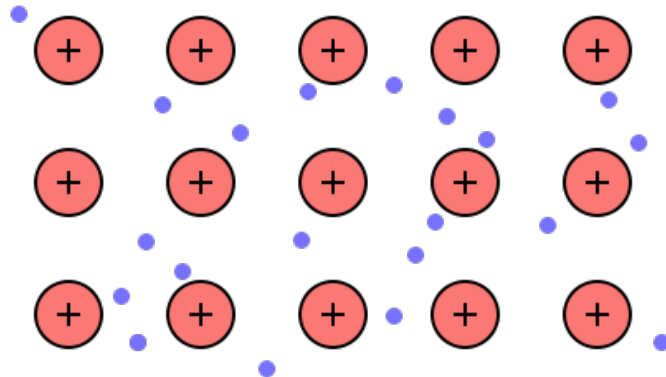
D
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Metallic Bonds

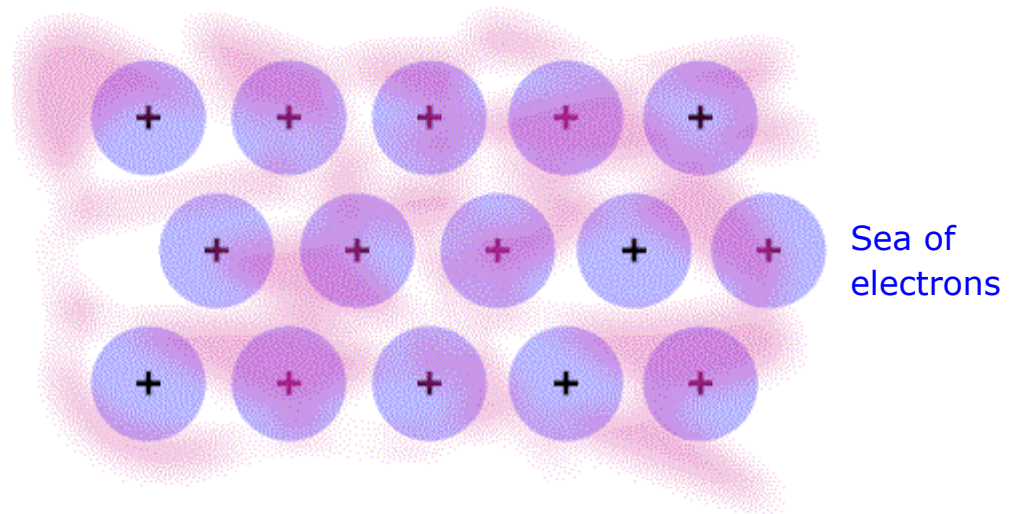
- In metal atoms, valence electrons are not held tightly to any nuclei
- They can move easily from one atom to another and are called **delocalized electrons**
- **Metallic bond**: Metal nuclei are attracted to delocalized electrons



<http://www.chemguide.co.uk/atoms/bonding/metallic.html>

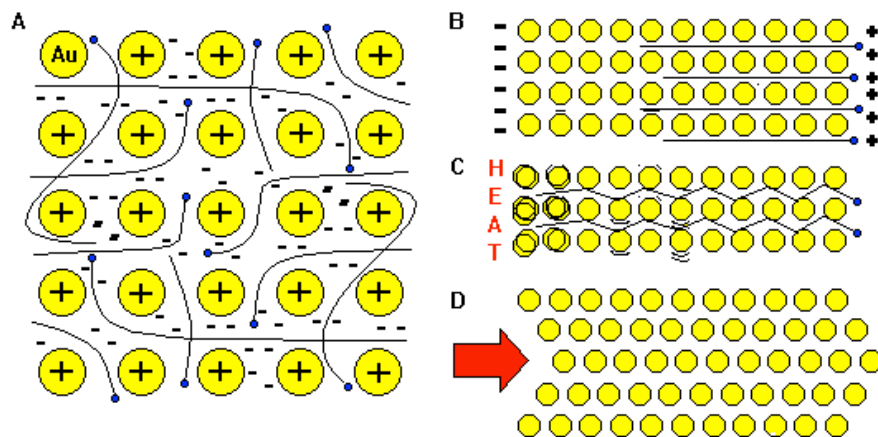


http://commons.wikimedia.org/wiki/File:Nuvola_di_elettroni.svg



Metallic Bonds Give Metals their Properties!

- Malleable and ductile
 - > The electrons are mobile (remember sea of electrons!) so you can push/pull the atoms out of position without breaking the bonds.
- Conduct electricity and heat
 - > The delocalized electrons are free to move when an electric current is applied.
 - > delocalized electrons can move heat faster



<https://www.uwgb.edu/dutchs/EarthSC202Notes/minerals.htm>

In Lab 4, you will be exploring the properties of ionic and covalent compounds!

