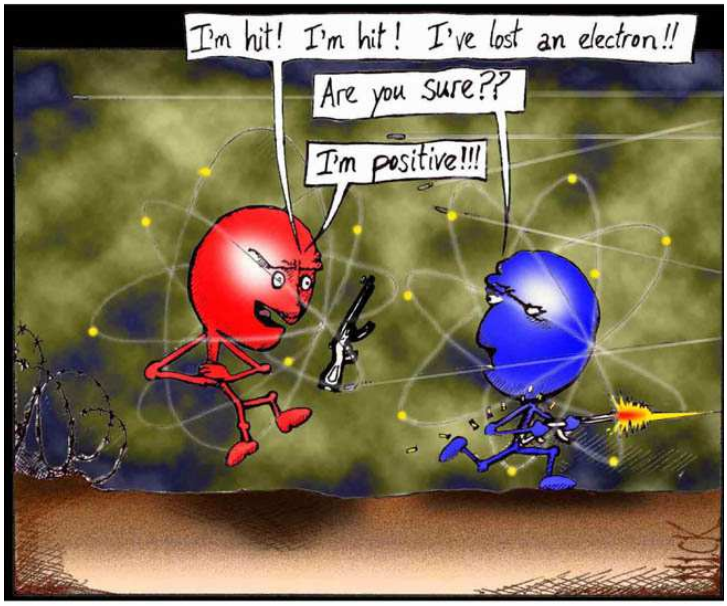
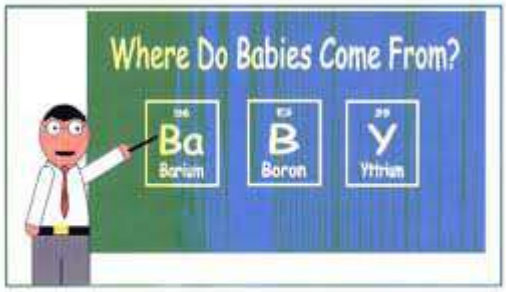
Name:

Regents Chemistry: Mr. Palermo

NOTES: Unit 5: Bonding



Another casualty in the War of the Atoms.



Due to budget cuts, science and health were both taught by the chemistry teacher!

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Vocabulary:

1. Ion
2. Ionic Bond
3. Stable Octet
4. Diatomic Molecules
5. Electronegativity
6. Ionic Bond
7. Covalent Bond
8. Metallic Bond
9. Dipole
10. Polar covalent bond
11. Non polar covalent bond
12. Intramolecular force
13. Intermolecular forces
14. Van der waals forces
15. Hydrogen bonding
16. Dipole-dipole

Unit Objectives: When you complete this unit you *will be able to do* the following...

1. Compounds can be differentiated by their chemical and physical properties
2. Two major categories of compounds are ionic and molecular (covalent) compounds.
3. Chemical bonds are formed when valence electrons are: transferred from one atom to another (ionic); shared between atoms (covalent); mobile within a metal (metallic).
4. In a multiple covalent bond, more than one pair of electrons is shared between two atoms. Unsaturated organic compounds contain at least one double or triple bond.
5. Molecular polarity can be determined by the shape and distribution of that charge. Symmetrical (nonpolar) molecules include CO_2, CH_4, and diatomic elements. Asymmetrical (polar) molecules include HCl, NH_3, and H_2O.

6. When an atom gains one or more electrons, it becomes a negative ion and its radius increases. When an atom loses one or more electrons, it becomes a positive ion and its radius decreases.

7. When a bond is broken, energy is absorbed. When a bond is formed, energy is released.

8. Atoms attain a stable valence electron configuration by bonding with other atoms. Noble gases have stable valence electron configurations and tend not to bond.

9. Physical properties of substances can be explained in terms of chemical bonds and intermolecular forces. These properties include conductivity, malleability, solubility, hardness, melting point, and boiling point.

10. Electron-dot diagrams (Lewis structures) can represent the valence electron arrangement in elements, compounds, and ions.

11. Electronegativity indicates how strongly an atom of an element attracts electrons in a chemical bond. Electronegativity values are assigned according to an arbitrary scale.

12. The electronegativity difference between two bonded atoms is used to assess the degree of polarity in the bond.

13. Metals tend to react with nonmetals to form ionic compounds. Nonmetals tend to react with other nonmetals to form molecular (covalent) compounds. Ionic compounds containing polyatomic ions have both ionic and covalent bonding.

14. Determine the noble gas configuration an atom will achieve when bonding.

15. Demonstrate bonding concepts, using Lewis dot structures, representing valence electrons: transferred (ionic bonding); shared (covalent bonding); in a stable octet.

16. Distinguish between nonpolar and covalent bonds (two of the same nonmetals) and polar covalent bonds.

UNIT 5: Bonding and Naming
LESSON 1: Types of Bonds

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Objective:

- *Identify whether a bond is being broken or formed based upon energy being absorbed or released*
- *Distinguish between the three types of bonds and Decide which type of bond is present based upon the atoms involved*

What is a BOND?

_____ that hold one atom to another in a compound

What type of energy is stored in a bond?

Why do atoms bond?

When a bond is FORMED energy is?

When a bond is BROKEN energy is?

PRACTICE:

Which statement best describes the energy change as bonds are formed and broken in this reaction? $H_2 + Cl_2 \rightarrow 2HCl$

a) The forming of the H-Cl bond releases energy
b) The forming of the H-Cl bond absorbs energy
c) The breaking of the H-H bond releases energy
d) The breaking of the Cl-Cl bond releases energy

TYPES OF BONDS

What are the 3 types of bonds?

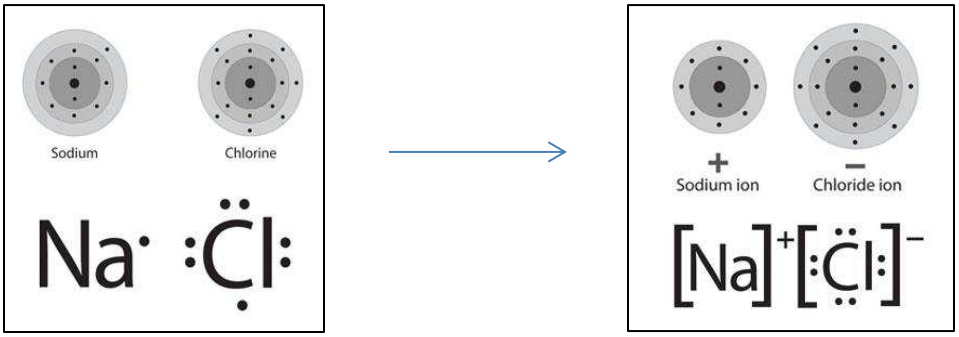
1. IONIC BONDS:

Occur between:

_____ from metal to nonmetal to form a bond.

WHY is there a transfer of electrons?

EXAMPLE:



What is the **ELECTRONEGATIVITY DIFFERENCE (E.N.D)** in an IONIC BOND?

2. COVALENT BONDS:

Occur between:

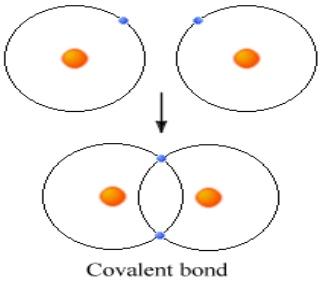
_____to obtain a full valence shell (stable)

WHY?

Why do they *SHARE* electrons instead of transfer?

What is the **ELECTRONEGATIVITY DIFFERENCE (E.N.D)** in a COVALENET BOND?

EXAMPLE: H_2



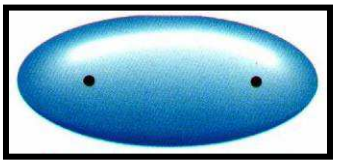
TYPES OF COVALENT BONDS

NONPOLAR COVALENT BOND:

How are electrons shared?

What is the E.N.D. ?

- Usually between identical atoms
- Ex. Cl_2



POLAR COVALENT BOND:

How are electrons shared?

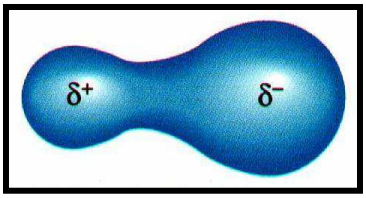
What is the E.N.D. ?

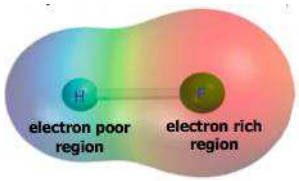
- One atom is slightly negative and one atom is slightly positive.
- This is known as a _____.

What is the symbol for partial positive charge?

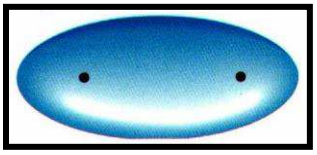
What is the symbol for partial negative charge?

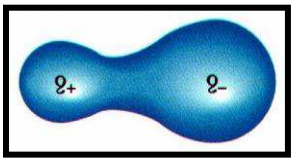
Ex. HCl

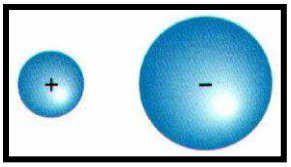




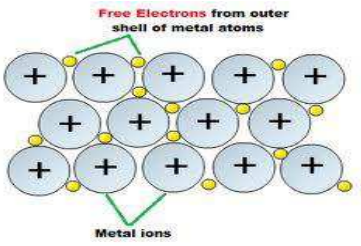
COMPARING IONIC AND COVALENT BONDS







3. METALLIC BONDS:
Occur between:



PRACTICE:

Which formula represents an ionic compound?

A) H_2
B) CH_4
C) CH_3OH
D) $CaCl_2$

PRACTICE:

The bond between hydrogen and oxygen in a water molecule is classified as
a) covalent and nonpolar
c) ionic and polar
b) ionic and nonpolar
d) covalent and polar

CHECK YOUR UNDERSTANDING:

The electrons in a bond between two iodine atoms (I_2) are shared
a) unequally, and the resulting bond is polar
b) equally, and the resulting bond is polar
c) unequally, and the resulting bond is nonpolar
d) equally, and the resulting bond is nonpolar

Objective:

- ***Assess compounds and identify the presence polyatomic ions***
- ***Describe the type of bonds present in a polyatomic ion***

POLYATOMIC IONS:

Where are polyatomic ions located in the reference table?

What type of bonds to polyatomic ions CONTAIN?

What type of bonds to polyatomic ions FORM?

Ex. $[NH_4]^+[Cl]^-$

PRACTICE:

Which compound contains both covalent and ionic bonds?

a) CCl_4

b) KCl

c) $MgCl_2$

d) NH_4Cl

CHECK YOUR UNDERSTANDING:

Why do compounds contain both ionic and covalent bonds?

Objective:

- ***Classify a substance as Ionic, Covalent or Metallic based upon its properties***
-

PROPERTIES OF IONIC COMPOUNDS:

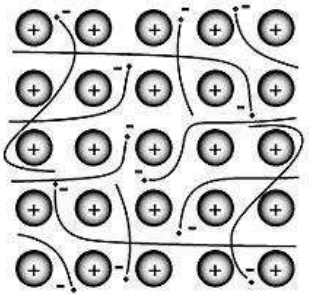
What are the properties of IONIC COMPOUNDS?

PROPERTIES OF COVALENT COMPOUNDS:

What are the properties of COVALENT COMPOUNDS?

PROPERTIES OF METALS:

What are the properties of METALS?



PRACTICE:

A solid substance is an excellent conductor of electricity. The chemical bonds in this substance are most likely?

A) ionic, because the valence electrons are shared between atoms
B) ionic, because the valence electrons are mobile
C) metallic, because the valence electrons are stationary
D) metallic, because the valence electrons are mobile

PRACTICE:

A substance is an excellent conductor of electricity in solution. The chemical bonds in this substance are most likely?

A) ionic, because the valence electrons are mobile
B) ionic, because the valence electrons are stationary
C) covalent, because the valence electrons are stationary
D) metallic, because the valence electrons are stationary

CHECK YOUR UNDERSTANDING:

In terms of electrons, why are metals excellent conductors of electricity?

Objective:

- ***Construct lewis diagrams for ionic compounds***

STEPS FOR CONSTRUCTING DOT DIAGRAMS FOR IONIC COMPOUNDS

Draw ion dot diagrams next to each other making sure that:

1. The ion charges cancel out (add up to zero)
2. The opposite charged ions are next to each other, and the like charged ions are as far away from each other as they can be.

EXAMPLE: Draw dot diagram of NaCl

EXAMPLE: $CaCl_2$ (Calcium Chloride)

PRACTICE: Draw dot diagram of the compound containing Barium and Sulfur

PRACTICE: Draw dot diagram of the compound containing Aluminum and Bromine

PRACTICE: Draw dot diagram of compound containing Barium and Chlorine

PRACTICE: Draw the dot diagram of the compound containing Magnesium and Bromine

CHECK YOUR UNDERSTANDING: Draw the dot diagram of the compound containing Magnesium and chlorine

UNIT 5: Bonding
LESSON 5: Writing chemical formulas for Ionic Compounds

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Objective:

- ***Construct chemical formulas to represent ionic compounds***

RECALL…. $2Ca(NO_3)_2$ *(See supplement video for more review)*

Coefficient: in front of Formula

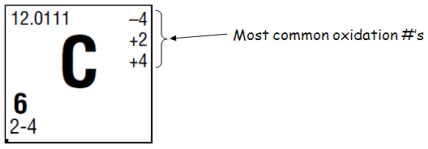
Subscript: small # after an atom

Subscript after ( ) multiply everything inside by that #

# of atoms of each substance in the formula above: 2Ca, 2N, 6O

OXIDATION NUMBERS:

What are oxidation numbers and where are they located?



RULES FOR WRITING FORMULAS FOR IONIC COMPOUNDS

1. Write each ion (metal first)
2. **CRISS CROSS & REDUCE** the oxidation numbers not the signs
3. Write numbers as subscripts
4. Do not write 1's

EXAMPLE: Compound containing Magnesium and Chlorine

EXAMPLE: Compound containing Barium and Oxygen

PRACTICE: Write the formula for the following ionic compounds:

1. Sodium and bromine

2. Calcium and Fluorine

3. Aluminum and Oxygen

CHECK YOUR UNDERSTANDING 1: *Write the formula for the compound containing Calcium and Oxygen*

RULES FOR WRITING FORMULAS FOR IONIC COMPOUNDS

Same as Ionic Formulas

- **Never** change the polyatomic ion
- If more than 1 polyatomic put in parenthesis followed by subscript

EXAMPLE: Combine ammonium ion and chlorine

EXAMPLE: Combine lithium and carbonate ion

EXAMPLE: Combine calcium and hydroxide ion

PRACTICE: Write the formula for the ionic compounds containing:

Magnesium and hydroxide ion

Potassium and sulfate ion

CHECK YOUR UNDERSTANDING 2: *Write the formula for the compound containing calcium and the nitrate ion*

Objective:

- ***Formulate the name of ionic compounds from their formulas***
- ***Formulate the formulas of ionic compounds form their names***

What is IUPAC? International Union of Pure and Applied Chemists (created this naming system)

STEPS FOR NAMING IONIC COMPOUNDS

1. Name **Metal** (positive ion) first
2. Write the first syllable of negative element (nonmetal) and add "ide"
3. If polyatomic use name listed on table E

EXAMPLE: LiBr

EXAMPLE: (Polyatomic) Na_2SO_4

STEPS FOR NAMING IF MORE THAN 1 OXIDATION STATE (TRANSITION METALS)

1. Determine the charge on the metal ion (reverse criss cross)
2. Indicate the oxidation state of metal ion with a roman numeral.
3. Put in ( ) after metal ion

EXAMPLE: (Multiple oxidation states) $CuCl_2$

PRACTICE: Name K_2O

PRACTICE: Name $CaBr_2$

PRACTICE: $CoCl_3$

CHECK YOUR UNDERSTANDING 1: Name the following substance: NH_4Cl

EXAMPLE: Writing the formula given the name

zinc oxide

Iron (II) chloride

PRACTICE: Write the formula for calcium oxide

CHECK YOUR UNDERSTANDING 2: Write the formula for Copper (I) bromide

Objective:

- ***Construct chemical formulas for Covalent compounds***
- ***Formulate names of covalent compounds based on the formula***

RULES FOR NAMING COVALENT COMPOUNDS

1. Name less electronegative atom first
2. Add prefixes to indicate # of atoms. Omit mono prefix on first element.
3. Write the first syllable of second element and add "ide"

Table of prefixes

# of atoms (subscript)	1	2	3	4	5	6	7	8	9	10
Prefix	mono	di	tri	tetra	penta	hexa	hepta	octo	nona	deca

EXAMPLE: Name the following covalent compound CCl_4

EXAMPLE: Name the following covalent compound N_2O

PRACTICE: Name the following: SF_6

PRACTICE: Name the following: N_2S_5

CHECK YOUR UNDERSTANDING: Name H_2O (don't say water)

WRITING CHEMICAL FORMULAS FOR COVALENT COMPOUNDS

Prefixes (number of atoms of each element) indicates the subscripts

EXAMPLE: Write the formula for Dinitrogen Pentoxide

EXAMPLE: : Write the formula for Carbon Monoxide

PRACTICE: Write the formula for Carbon dioxide

PRACTICE: Write the formula for Phosphorus trihydride

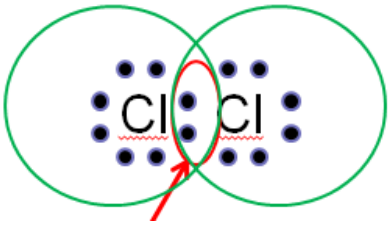
CHECK YOUR UNDERSTANDING: Dinitrogen trioxide

Objective:

- ***Construct lewis dot diagrams for covalent compounds***
-

RULES FOR DRAWING DOT DIAGRAMS FOR COVALENT COMPOUNDS

1. Write the element symbols next to each other (if more than two symbols write the UNIQUE symbol in the center)
2. Count up the total number of valence electrons for all the elements
3. Put 8 electrons around the central atom (if only two atoms pick one to place them around)
4. Distribute the remaining valence electrons to the other atoms equally until you run out
5. Check to see if each atom has a complete valence shell (8 electrons except Hydrogen which has 2)



EXAMPLE: H_2O

EXAMPLE: F_2

PRACTICE: Draw dot diagram for HBr

PRACTICE: Draw dot diagram for CH_4

PRACTICE: Draw dot diagram for Cl_2

IF ALL ATOMS DO NOT HAVE A FULL VALENCE SHELL

YOU MUST ADD MULTIPLE BONDS (sharing of 2 or more PAIRS of electrons)

EXAMPLE: CO_2

HOW MANY ELECTRONS CAN BE SHARED:

Single bond = sharing a pair (2) electrons

Double bond = sharing 2 pair (4) electrons

Triple bond = sharing 3 pair (6) electrons

PRACTICE: Draw the dot diagram for O_2

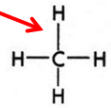
CHECK YOUR UNDERSTANDING: Draw the dot diagram for N_2

STRUCTURAL DIAGRAMS

In chemistry a covalent bond (a pair of shared electrons) is often drawn as a line:

ONE DASH/LINE is called a
SINGLE BOND

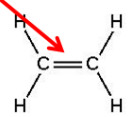
- EX: CH_4



- 2 electrons (1pair) shared between carbon and hydrogen

TWO DASH/LINES is called a
DOUBLE BOND

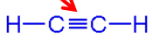
- Ex. C_2H_4



- 4 electrons (2 pair) shared between carbon and carbon

THREE DASH/LINES is called a
TRIPLE BOND

- Ex. C_2H_2

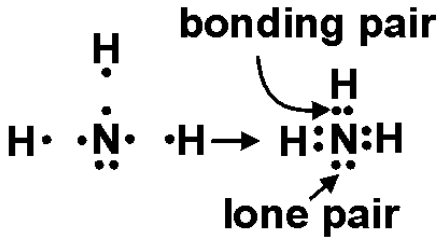


- 6 electrons (3 pair) shared between carbon and carbon

Objective:

- Determine the polarity of a molecule
- Determine the shape of a molecule

What are the 2 types of electron pairs?



2.

<u>Molecular Polarity Depends Upon:</u>

1. **Bond Polarity**
2. **Shape of molecule (**Symmetrical vs. nonsymmetrical)

The shape of a molecule is caused by:

- The **Valence Shell Electron Pair Repulsion**
- Valence electrons are arranged as far from one another as possible to minimize the repulsion between them

POLAR VS. NON POLAR MOLECULES

What determines if a molecule is **POLAR?**

What determines if a molecule is **NONPOLAR?**

SHAPES OF POLAR MOLECULES

1. **LINEAR**

2. **BENT**

3. **PYRAMIDAL**

SHAPES OF NONPOLAR MOLECULES

1. **LINEAR**

2. **TETRAHEDRAL**

SUMMARY OF POLARITY AND SHAPES

If the central atom has ...	the shape is	Bond type
1 or 2 bonds only	linear	Polar if asymmetrical Nonpolar if symmetrical
2 bonded pairs and 2 lone pairs	bent	polar
3 bonded pairs and 1 lone pair	pyramidal	polar
4 bonded pairs and 0 lone pairs	tetrahedral	Non-polar

PRACTICE: Determine the molecular polarity and shape of CCl_4

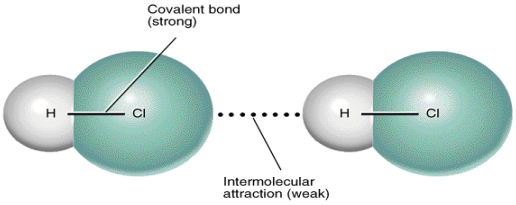
PRACTICE: Determine the molecular polarity and shape of H_2S

CHECK YOUR UNDERSTANDING: Determine the molecular polarity and shape of NF_3

Objective:

- ***Determine the type of intermolecular force that exists between covalent compounds***

What is an **INTERMOLECULAR FORCE?**

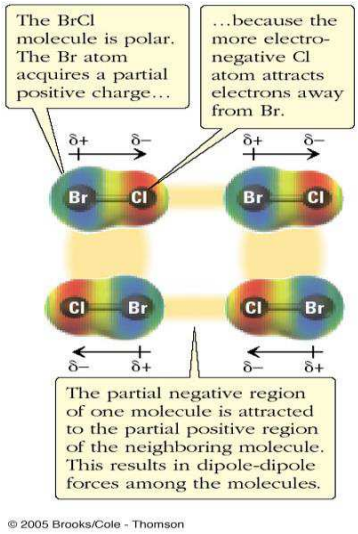


TYPES OF INTERMOLECULAR FORCES

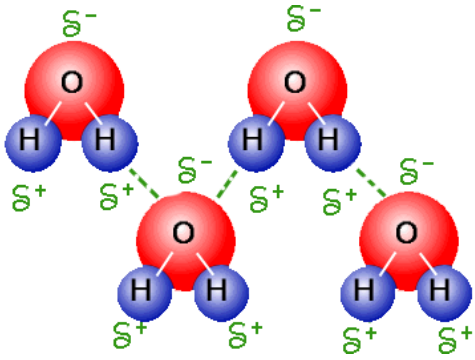
1. Van der Waals
2. Dipole-Dipole
3. Hydrogen Bonding

What are **VANDERWAALS FORCES?**

What are **DIPOLE DIPOLE FORCES?**



What is **HYDROGEN BONDING?**



PRACTICE: What type of IMF occurs between molecules of H_2?

PRACTICE: What type of IMF occurs between molecules of NH_3?

CHECK YOUR UNDERSTANDING: What type of force exists between molecules of HF?