Bonding & Molecular Shapes

Review: Octet Rule – atom's will lose, gain or share e⁻ to get 8e⁻ in the outer shell.

Ions – atom's that have lost or gained e⁻ to complete their octet

- lose e⁻ become a cation
- gain e⁻ become an anion

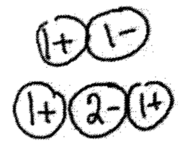
Cation = positive ion

Anion = negative ion

Types of bonds: Ionic Bonds form between ions. Covalent Bonds form when e⁻ are shared.

Types of Bonds

Ionic: permanent transfer of electrons between atoms. The newly charged ions are then attracted + form a compound.



lose e⁻ → pos charge cation

gain e⁻ → neg. charge anion

Covalent: Sharing of electrons

Non-polar covalent bonds – equal sharing

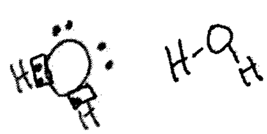
polar covalent bonds – unequal sharing, the unequal sharing creates polar regions. (temporary)

Calculating Type of Bond

Difference in Electronegativity *	Type of Bond
Ø to 0.49	Non-Polar Covalent (NPC)
0.5 to 1.99	Polar Covalent (PC)
2.0 to 4.0	Ionic (I)

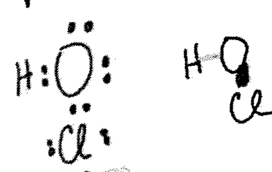
Subtract electronegativities for the 2 elements that are bonded.

water H_2O



O 3.5
−H 2.1
1.4 polar covalent bond

HOCl



O 3.5
H 2.1
1.4 PC

O 3.5
Cl 3.0
0.5 PC

Ionic Compounds

1. Composed of ionic bonds
2. they have crystalline patterns
3. they are brittle
4. most dissolve in water
5. they will conduct electricity when dissolved in water – Electrolytes
6. high melting points

Memory Work

acetate	$C_2H_3O_2^{1-}$
chlorate	ClO_3^{1-}
nitrate	NO_3^{1-}
carbonate	CO_3^{2-}
sulfate	SO_4^{2-}
phosphate	PO_4^{3-}
hydroxide	OH^{1-}
cyanide	CN^{1-}
peroxide	O_2^{2-}
ammonium	NH_4^{1+}

Terms for ions

anion = a negative ion
cation = positive ion
monatomic ion = one atom ion
polyatomic ion = multiple atoms covalently bonded that have acquired additional e^- and generally have a negative charge

Naming an Ionic Compound (Nomenclature)

* Say the name of the metal, then change the ending of the non-metal to ide.

So for example NaCl sodium chlor~~ine~~ide → sodium chloride
K_2O potassium ox~~ygen~~ide → potassium oxide

Ionic Formula Writing:

use the charges to determine the # of each atom required to have a balanced compound.

Al is 3+ if it joins with F which is 1-, you will need 3F to balance one Al → $Al^{3+} F^{1-}$ → AlF_3 ← subscript tells quantity.

IONIC EXAMPLES

barium chloride $Ba^{2+}\ Cl^{1-} \rightarrow BaCl_2$

magnesium phosphate $Mg^{2+}\ PO_4^{3-} \rightarrow Mg_3(PO_4)_2$

hydrogen peroxide $H^{1+}\ O_2^{2-} \rightarrow H_2O_2$

lithium chloride $Li^{1+}\ Cl^{1-} \rightarrow LiCl$

potassium bromide $K^{1+}Br^{1-} \rightarrow KBr$

Covalent Compounds (molecules): formed by sharing e^-

The amount of sharing is determined by the differences in electronegativities — *subtract the EN values for only the two atoms in the bond.

Naming a covalent compound (Nomenclature)

1. Determine the electronegativity values for all elements,
2. Keep the names of the elements w/ the lowest EN value,
3. Change the ending of the element with the highest EN to ide.
4. use prefixes to indicate the quantity of each element

Example: CCl_4 Carbon EN = 2.5 Chlorine EN = 3.0

Carbon tetrachloride

Some covalent compounds have kept their old names:

H_2O → water NH_3 → ammonia

Other complex compounds that are hydrogen & carbon based also have a unique naming system.

Covalent Formula Writing

The prefix in the name tells you the formula to write.

Example: Carbon dioxide → one carbon 2 oxygen → CO_2

Four Types of Covalent Bonds

- Single bond = the sharing of one pair of e^-
- Double bond = the sharing of two pairs of e^-
- Triple bond = the sharing of three pairs of e^-
- Coordinate Covalent Bond = one of the atoms donates both e^- to the bond.

Metallic Bonding: Occurs in bonding of pure metals + is very strong. The e⁻ flow between nuclei in what is called a sea of e⁻.

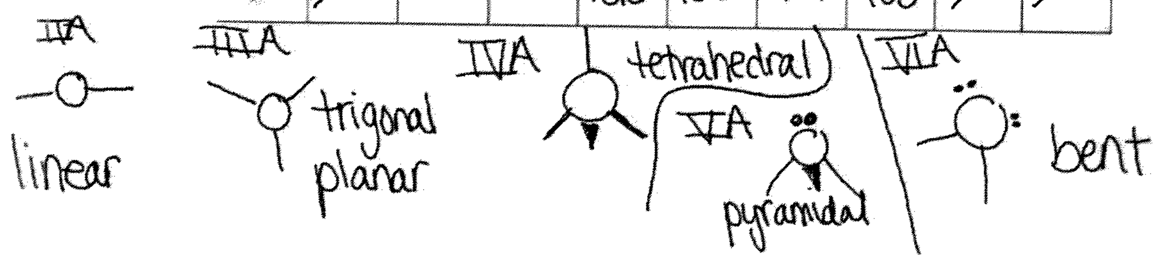
Name: ______ Block: ___ Date: ______
Periodic Trends Worksheet

VSEPR
valence shell electron pair repulsion

← Atomic Radii Inc
Ionization Energy + Electronegativity Inc →
Atomic Radii Inc ↓
IE + EN. inc. ↑
He 2 val e⁻ — He:

	I A	II A	Group B	III A	IV A	V A	VI A	VII A	VIII A
# of Valence Electrons	1	2	2 (2s, 0p)	3	4	5	6	7	8
Charge	1+ X·	2+ ·X·	Varies	3+ ·X·	2+ 4+ 4- ·X·	3- :X·	2- :X:	1- :X:	☺ :X:
Bonding Capacity	1	2		3	4	3	2	1	Ø
Shape of central atom	/	linear		trigonal planar	tetrahedral	pyramidal	bent	/	/
Resulting Bond Angle	/	180°		120°	109.5°	107°	105°	/	/

Memorize this chart



Lewis Dot Structures are used to help illustrate Molecular Structures

Elements are drawn w/ dots representing the val. e⁻. Think of them as rotational - they can be turned to aide in connecting elements to make a compound.

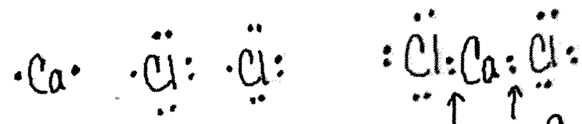
Steps to Making Lewis Structures

1. Determine total # of valence e⁻.
2. Determine the # of e⁻ needed to satisfy atoms
   Grp 1 need 2, Grp 2 need 4, Grp 3 need 6, Grp 4-8 need 8
3. Determine the # of bonds required:
   Step 1 − Step 2 = ☐ ÷ 2 = # of bonds required.
4. Chose a central Atom − ~~geo~~ generally needs the most bonds or has lowest EN value
5. Draw Structure − if a pair of e⁻ is shared draw a line.

Know This!

Illustrating Compounds

1. Lewis Dot Diagrams $CaCl_2$

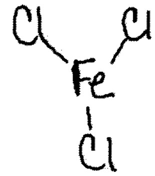


bonds Ca—Cl
2 of these bonds

Cl 3.0
\- Ca 1.0
2.0 ionic bond

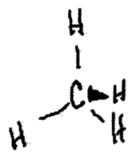
2. Molecular Shape: uses dashes to indicate bonds

Iron (III) chloride → $FeCl_3$
Fe^{3+} Cl^{1-}



Cl 3.0
Fe 1.8
1.2
polar covalent bonds

3. Ball + Stick
"3-D" model



CH_4
methane

C 2.5
H 2.1
0.4
non polar covalent

PRACTICE (To complete in class)

Name/Formula	Lewis Dot	Type of Bond	Molecular Structure	Name of Shape
ammonia NH_3				
Carbon dioxide CO_2				
Calcium fluoride CaF_2				
oxygen O_2				

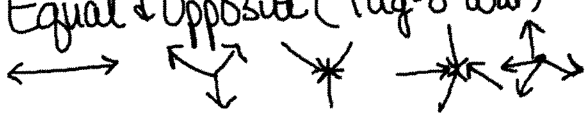
Determining Molecular Polarity

Step 1 Determine the Type of Bond (Math)

- Non-Polar Covalent (EN diff ≤ 0.49)
  - ✓ NonPolar Molecule
- Polar Covalent (EN diff 0.5 to 1.9) or Ionic (EN diff ≥ 2.0)

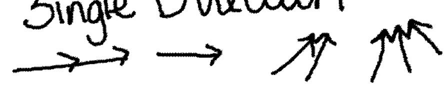
Step 2 Draw an arrow at each bond pointing toward the element w ↑ EN

- Equal & Opposite (Tug-o-war)



Non-Polar Molecules

- Single Direction



Polar Molecules