Naming Compounds and Bonding

Ionic Compounds

- Ionic compounds form when one element gives up one or more electrons to another.
- This is due to an electronegativity difference between the elements of greater than 1.9.
- This causes both elements to become charged ions.
- The ions are now attracted to each other because they have opposite charges, so they form an ionic bond.
- An ionic compound must be neutrally charged after being formed.

Naming Ionic compounds

- The two types of ions are cations (positively charged) and anions (negatively charged)
- They can be monatomic (a single atom) or polyatomic (made up of multiple atoms bonded together that together have a charge)
- Just memorize the names (which I know you did) and put the names of the two ions together.
- Ex. Sodium chloride, magnesium sulfate…
- Remember that all monatomic anions end in –ide

Naming Ionic Compounds cont.

- Metals columns 3 and beyond need roman numerals to tell their charge because they can have several possible charges.
- The roman numeral *IS* the charge!
- Ex. Iron (II) = Fe^{+2}, Iron (III) = Fe^{+3}
- Anions never change their charge so never have roman numerals
- Exceptions of metals that don't need roman numerals are Ag^{+}, Zn^{2+}, Cd^{2+}, and Al^{3+}

Formulas of Ionic compounds

- Formulas of ionic compounds must have a neutral charge.
- The amount of electrons a cation gives off must be the amount an anion gains.
- Sometimes this requires multiple ions to accomplish, so include the number of ions that make the charges cancel.
- To have more, put a subscript number after the ion. If the ion is polyatomic, put the whole ion in parenthesis and put the subscript after.

Ionic compound examples

- Calcium oxide: Cation is Ca^{2+}, anion is O^{2-}
- So charges are balanced if you put one of each together to get CaO.
- Iron (III) chloride: cation is Fe^{3+}, Anion is Cl^{-}
- You need a -3 charge to balance the +3, so you need 3 chloride ions to get $FeCl_3$.
- Ammonium sulfate: cation is NH_4^{+}, anion is SO_4^{2-}
- You need two ammoniums to balance the charge, so you get $(NH_4)_2SO_4$
- Its the least common multiple to find the common charge!

Molecular compounds

- Molecular compounds are made up of 2 non-metals.
- Non-metals have high electronegativities so they like to gain electrons.
- Because they both want to gain electrons, they are forced to share them.
- This shared pair of electrons is what makes a covalent (molecular) bond.
- Because they can share multiple electrons with multiple atoms, there can be several compounds made with the same two elements.

Naming molecular compounds

- The prefix tells how many of each atom there are.
- 1-mono, 2-di, 3-tri, 4-tetra, 5-penta, 6-hexa, 7-hepta, 8-octa, 9-nona, 10-deca.
- The first element name is written, and then the second element name is written with –ide on the end.
- Mono is never written if there is one of the first element.
- Ex . NO is nitrogen monoxide
- NO_2 is nitrogen dioxide
- N_2O_5 is dinitrogen pentoxide.

Naming Acids

- All acids have hydrogen ions (H^+) which are always written first in the formula
- Monatomic acids are when the hydrogens have bonded with a halogen and have hydro in the name.
- Ex HCl – hydrochloric acid
- HF – hydrofluoric acid
- HBr – hydrobromic acid
- HI – hydroiodic acid

Naming acids cont.

- Polyatomic acids are as follows
- HNO_3 – Nitric Acid
- $HC_2H_3O_2$ – Acetic Acid
- H_2CO_3 – Carbonic Acid
- H_2SO_4 – Sulfuric Acid
- H_3PO_4 – Phosphoric Acid

Hydrates

- Hydrates are ionic compounds with water attached to the crystal in a constant ratio.
- You can recognize the formula from the water molecules multiplied at the end.
- Name the ionic compound as you normally would.
- Then put the prefix for how many water molecules are attached. Write hydrate instead of water.
- Ex $Ba(OH)_2 \cdot 5H_2O$
- Barium hydroxide pentahydrate

Diatomic Molecules

- Some elements are so reactive that they will never be found as single atoms.
- If they are not bonded to a different element, they will bond with another by themselves.
- These are very common elements and should always be written this way as pure elements.
- H_2, N_2, O_2, F_2, Cl_2, Br_2, I_2

Bond types

- As already stated, if the electronegativity difference between the 2 elements is greater than 1.9 it will be an ionic bond.
- If the electronegativity difference is between 0.4 and 1.9 it will be a polar covalent bond.
- This means that the atoms will not share the electrons equally and so one atom will get a slight negative charge (from having the electron near it more) and the other atom will get a slight positive charge (from not having the electrons near it as much).

Bond types cont.

- Polar refers to the poles of a magnet.
- If the electronegativity difference between the two atoms is less than 0.4 then the bond is a non-polar covalent bond.
- This means the electrons are shared equally.
- Polar covalent bonds in a molecule can cause the whole molecule to be polarized.
- That is determined by how the bonds are oriented.

Lewis (electron) dot structures

- These help to see the bonds in a molecule.
- Based on the octet rule, that all atoms except hydrogen want 8 valence electrons. (Hydrogen wants 2)
- The number of valence electrons a molecule has can be determined by counting the number of boxes across that row of the periodic table the element is.
- Ex. H=1, C=4, O=6, Al=3, Br = 7 (notice that the transition metals are ignored for counting)

Drawing dot structures

- Draw dots around the symbol representing the electrons.
- Draw one on each side before you pair them up.
- Ex. Nitrogen = 5 valance e^-

1 5

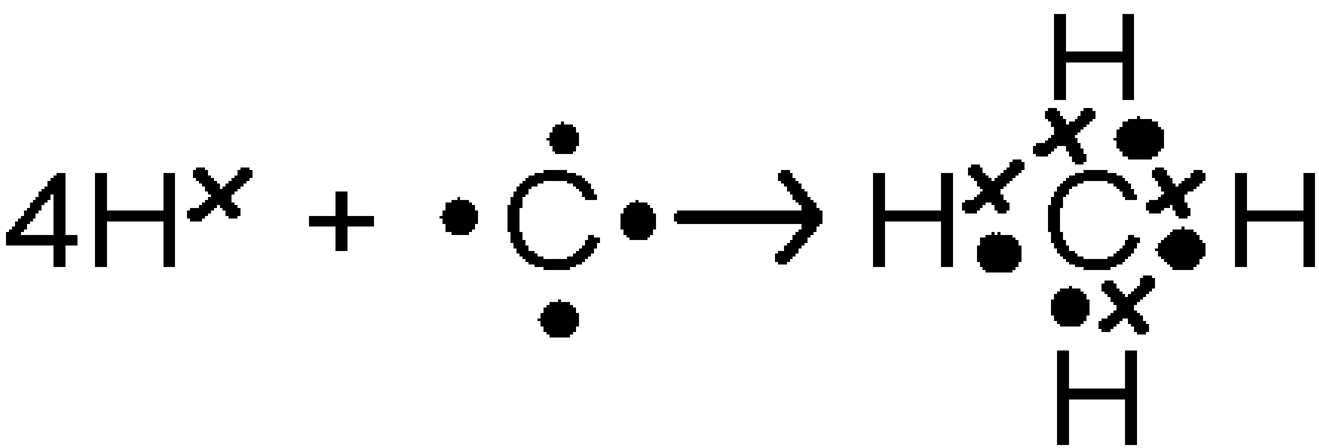
4 N 2

3

- The 2 electrons on top (1 and 5) are called a non-bonding pair so nitrogen can make 3 bonds.

Drawing dot-structures

- If the molecule is CH_4, then draw out all the atoms.
- Simply put the puzzle together the only way they fit.
- Every pair of electrons between 2 elements is the covalent bond



Advanced dot-structures

- If after all of the atoms are put together there are stilled unpaired electrons, consider double or triple bonds.
- If the 2 elements that have unpaired electrons are next to each other, then you can have them share a second pair.
- This is common for carbon, oxygen, and nitrogen to do this.

Polar vs non-polar molecules

- If the molecule is made up of all non-polar covalent bonds, then the molecule can only be non-polar.
- If the molecule is made up of polar covalent bonds, then it can be polar or non-polar.
- It depends on symmetry.
  - If the molecule is symmetric (looks the same from all sides) then it is non-polar.
  - If the molecule is asymmetric (looks different in only one plane) then its polar.

Polar vs. non-polar cont.

- So CH_4 is symmetric = non-polar
- CO_2 is symmetric = non-polar (has 2 double bonds)
- CH_3Cl is asymmetric = polar
- H_2O is asymmetric = polar
- Polar molecules (slight charges) will attract each other and will attract ions.
- Polar substances will dissolve in other polar substances.
- Non-polar dissolves non-polar.
- Non-polar and polar substances cannot dissolve in each other.

Water's properties

- Water is very, very polar and so it has very unique properties.
  - It can dissolve both polar molecular substances and ionic compounds.
  - It has a very high boiling point considering it has a small mass.
  - It has a very large range between its freezing point and boiling point.
  - It has a very high surface tension
  - Its solid phase is less dense than its liquid phase.