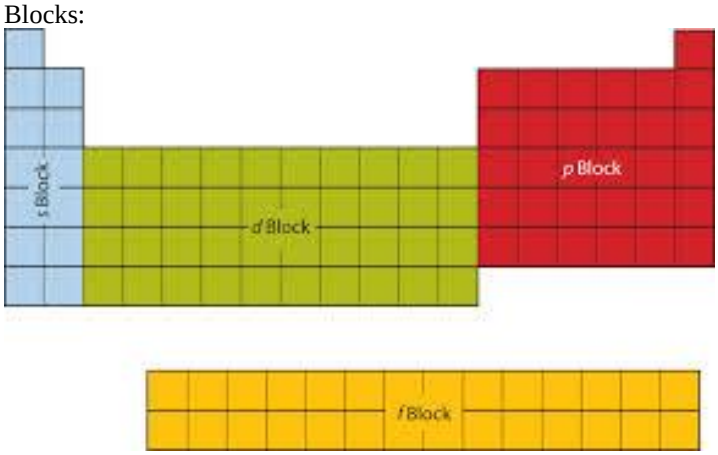
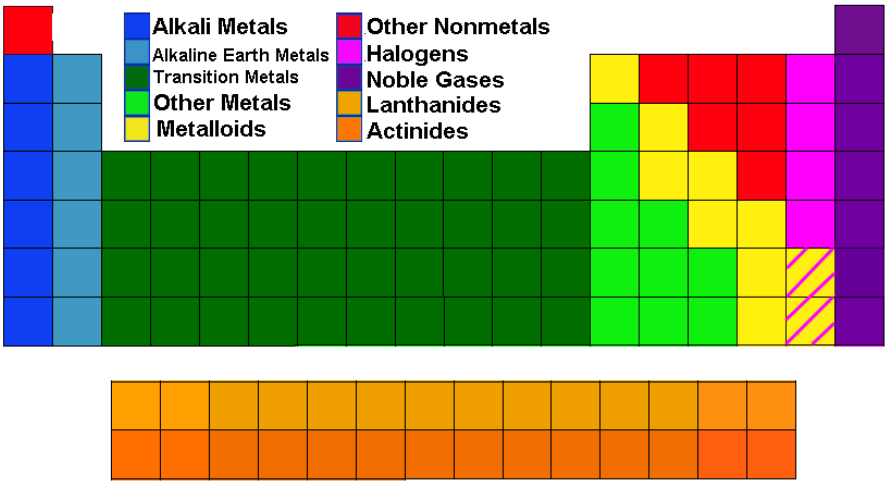
REVIEW: Unit 2: Formulas, Part 1

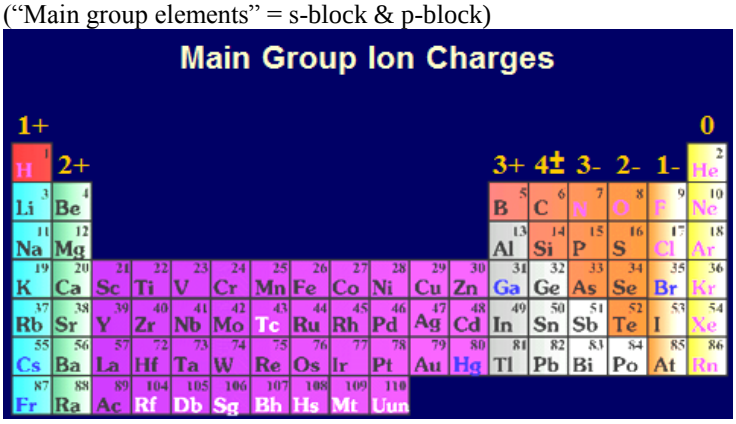
1) Elements
   a) The Periodic Table:
      i) Above (to the right of) the "staircase" are NONmetals.
      ii) Below (to the left of) the "staircase" are METALS.
      iii) Metalloids are touching the staircase, but not Aluminum (it's a metal). So: B, Si, Ge, As, Sb, Te, Po, At are the metalloids, for our purposes.
   b) You should be familiar with what the nonmetal elements change to when their endings are replaced with "ide" in compounds.
      i) The test is multiple choice, so you don't have to have these memorized, but you should recognize them when you see them.
      ii) Here's a cute list for you, in case you're nervous about recognizing them:
         (1) Carbon → Carbide
         (2) Nitrogen → Nitride
         (3) Oxygen → Oxide
         (4) Fluorine → Fluoride
         (5) Phosphorus → Phosphide
         (6) Sulfur → Sulfide
         (7) Chlorine → Chloride
         (8) Arsenic → Arsenide
         (9) Selenium → Selenide
         (10) Bromine → Bromide
         (11) Tellurium → Telluride
         (12) Iodine → Iodide
         (13) Astatine → Astatide
   c) Remember when we learned names of some special sections on the periodic table? Still true.
      i) Blocks:



      ii) Families:



d) Charges of monatomic ions:
   i) The periodic table is organized so that the "main groups" (s-block and p-block) are ordered by *how many valence electrons the atoms have*. (1, 2, skip a few, 3, 4, 5, 6, 7, 8)
   ii) Atoms gain or lose valence electrons to obtain a "full octet."
      (1) Full octet = 8 valence electrons
         (a) Valence electrons = the electrons in the outermost energy level of the atom
         (b) The most valence electrons an atom can have is 8. If you try to add a 9th electron, it gets bumped to a new energy level (so now you only have 1 valence electron).
      (2) This results in predictable charges for the main-group elements.
         (a) ("Main group elements" = s-block & p-block)



      (3) The charges go in this order: 1+, 2+, 3+, 4±, 3-, 2-, 1-, 0
         (a) 4± is the carbon column—group 14. They can gain 4 electrons (4- charge) or lose 4 electrons (4+ charge)
         (b) 0 is the noble gases—the Helium column—group 18. They already have full octets, so they don't gain or lose any electrons, therefore they do not receive charges.

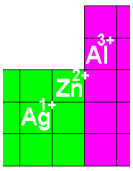
2) Ionic Compounds
   a) Ionic compound (and ionic bonds) are formed when valence electrons are *transferred* from one atom to another.
      i) Atoms are electrically neutral. (The number of positives and negatives is equal, so they cancel out.)
      ii) When at atom gains or loses electrons, it isn't neutral anymore.
         (1) Now it is an ION. (A charge particle.)
         (2) Positive ions = cations (cats are paws-itive) (ca+ions are +)
         (3) Negative ions = anions
      iii) Ionic compounds exist as crystals
         (1) The crystal is a 3D checkerboard (called a "crystal lattice") made of cations & anions
         (2) In a simple crystal lattice, each cation is surrounded by (and ionically bonded to) 6 anions; each anion is surrounded by (and ionically bonded to) 6 cations; all those bonds mean that ionic crystals stay together.
            (a) Ionic substances are solids at room temperature.
            (b) Ionic substances have very high melting points (because it's hard to break all those bonds)
   b) Nomenclature (Naming compounds when you are given an ionic formula.)
      i) Binary (only two capital letters in the formula)
         (1) Name the first element
         (2) Name the second element
         (3) Change the ending to –ide.
      ii) Ternary (three capital letters in the formula)
         (1) Name the first element
         (2) Name the polyatomic ion
         (3) Don't change the ending.
      iii) If the metal was in the d-block, f-block, or p-block (but not Ag, Zn, Al), add a Roman numeral to indicate its positive charge.

(1) Stated a different way: The only metals that do NOT require Roman numerals are the s-block metals, Ag, Zn, and Al.
   (a) Group 1 (Column 1—the lithium and sodium column) always form 1+ cations.
   (b) Group 2 (Column 2—the beryllium and magnesium column) always form 2+ cations.
   (c) Ag (silver) forms a 1+ cation.
   (d) Zn (zinc) forms a 2+ cation.
   (e) Al (aluminum) forms a 3+ cation.
(2) How do I know the charge so I can assign a Roman numeral?
   (a) You (should) know the negative charge assigned to the second half of the compound. Remember, the beginning is always the positive (cation) part. The second half of the compound is either:
      (i) a monatomic anion (one element with a negative charge which can be predicted based on what periodic table column the element is from)
      (ii) a polyatomic ion (two or more elements bonded together—whose overall charge I can look up on the polyatomic ion chart on the back of my periodic table).
   (b) Add up all the negative charges. The positive charge (from the first half of the compound must be equal and opposite in order to "charge balance" the compound.
(3) For example:
   (a) $FeCl_2$
      (i) Fe = iron, Cl = chlorine, change the ending to ide = chloride; iron (?) chloride
      (ii) Fe needs a Roman numeral because it is NOT in the s-block and it is NOT Ag, Zn, or Al
         1. Cl is assigned a charge of 1- because it is in the halogen column (group 17).
         2. There are two Cl, for a total of -2.
         3. The Fe has to be worth +2 to cancel out the two chloride ions. So the Roman numeral will be II.
      (iii) Iron (II) chloride
   (b) Cr_2S_3
      (i) Cr = chromium, S = sulfur, change the ending to ide = sulfide; chromium (?) sulfide
      (ii) Cr needs a Roman numeral because it is NOT in the s-block and it is NOT Ag, Zn, or Al.
         1. S is assigned a charge of 2- because it is in the 6-valence-electron-column (group 16).
         2. There are 3 S, for a total of -6. (3x-2 = -6)
         3. The two chromium ions must be worth +6 total, to cancel out the three sulfide ions.
            a. Since two Cr worked together to provide the +6 charge, each individual Cr is only worth +3.
            b. So the Roman numeral will be III.
      (iii) Chromium (III) sulfide
   (c) $V_2(C_2O_4)_3$
      (i) There are three capital letters in this compound, so it must contain a polyatomic ion.
         1. Fun fact #1: if something is in parentheses, it is a polyatomic ion.
         2. Fun fact #2: even if there weren't parentheses anywhere, the polyatomic ion almost *never* involves the first element, so I probably would've looked for the other two elements on my poly ion chart even without the parentheses as a hint.
      (ii) V = vanadium, C_2O_4 is on the poly ion chart as "oxalate"; vanadium (?) oxalate
      (iii) V needs a Roman numeral because it is NOT in the s-block and it is NOT Ag, Zn, or Al.
         1. When I found oxalate on the polyatomic ion chart, it said: $C_2O_4^{2-}$.
         2. There are three oxalate ions. 3 x -2 = -6
         3. The V atoms have to be worth +6 total to cancel out the oxalates.
            a. Since two V ions worked together to provide the +6 charge, each individual V is only worth +3.
            b. So the Roman numeral will be III.
         4. Vanadium (III) oxalate.
         5. Notice that we did NOT change the ending of the polyatomic ion name!!!
(4) What's with Ag, Zn, Al? They don't need Roman numerals because they only have one option

each for charge.

(a) Ag = +1, Zn = +2, Al = +3

(b) They count in order along their little diagonal: +1, +2, +3

(c) 

3) Formulas (Writing formulas when you are given a compound name.)

i) If the compound name ends with "ide", you are *probably** dealing with a BINARY ionic compound.

(1) Look up the elements named in the compound on your periodic table.

(2) Assign charges to the elements based on the columns they are in. (1+, 2+, 3+, 4±, 3-, 2-, 1-, 0)

(3) **Probably* dealing with a BINARY compound. Unfortunately: there are 3 dirty deceivers in the polyatomic ions: hydroxide, peroxide, and cyanide.

(a) These three names end in "ide", but they aren't elements, they're polyatomic ions with names that break the rule.

(b) They follow the ternary rules. (Look up the polyatomic ion on the ion chart.)

ii) If the compound name ends with "ate" or "ite", you are dealing with a TERNARY ionic compound.

(1) Look up the first element and determine its charge from its periodic table column.

(2) The second half of the compound is a polyatomic ion. Look it up on the polyatomic ion chart on the back of your periodic table.

(a) Make sure you get the right one! "chlorite" is different from "chlorate"—and those are both different from "hypochlorite", "perchlorate", and "chloride" !!!

(b) Write down the charge—"-" means -1. (In chemistry, the + and – signs are required, but the "1" is optional.)

iii) Now that you've assigned a charge to both the positive (cation) and the negative (anion) part of the compound:

(1) Find the least common multiple of the charges (you need the total amount of positive charge to equal the total amount of negative charge).

(2) Add subscripts to 'charge balance' the compound.

(a) If part of the compound was a polyatomic ion, you need to **put it in parentheses** before adding a subscript.

(b) In "grown up" chemistry, subscripts of "1" are not written down.

(i) On this unit test, subscripts of "1" will be left off.

(ii) Why did we make you write the 1 on your homework? Because otherwise we can't tell if you did the problem (figured out it should be a 1 and chose not to write it) or skipped the problem (there's no subscript there because you didn't do it). Yeah. Good times.

(c) Let's all be super clear about this:

(i) "Subscript" is the name of the little numbers at the bottom. $S_1U_2B_3S_4C_5R_6I_7P_8T_9S_{10}$

(ii) Subscripts tell you how many of the atom (or polyatomic ion) preceding it.

1. So in the silly formula above, the "5" refers to C
2. And the "6" refers to R.

(iii) $Sr(OH)_2$ contains only 1 Sr, but 2 O and 2 H.

(3) Here are some examples of charge balancing:

(a) Sodium phosphate

(i) Sodium = Na^+

1. The charge is 1+ because sodium is in group 1.

(ii) Phosphate = PO_4^{3-}

1. Phosphate ends with "ate", so I looked it up on the ion chart. The ion chart gave me both its formula (PO_4) and its charge (3-).

(iii) The least common multiple of 1 and 3 is 3.

1. I need 3 sodiums (3 x +1 = +3)
2. I only need 1 phosphate (it is already worth -3)

(iv) Na_3PO_4

(b) Sodium phosphide

(i) Sodium = Na^+

1. The charge is 1+ because sodium is in group 1.

(ii) Phosphide = P^{3-}

1. Phosphide ends with "ide", so I looked for the element phosphorus on the periodic table.
2. Because it is in column 15 (the 5-valence-electrons-column), the common ion charge of P is 3-.

(iii) The least common multiple of 1 and 3 is 3.

1. I need 3 sodiums (3 x +1 = +3)
2. I only need 1 phosphide (it is already worth -3)

(iv) Na_3P

(c) Gold (IV) hydroxide

(i) Gold (IV) = Au^{4+}

1. The Roman numeral tells me the positive charge of the gold

(ii) Hydroxide = OH^-

1. Hydroxide ends in "ide", so at first I thought I should find an element called "hydroxium" on the periodic table. There isn't one. Then I remembered that there are three polyatomic ions that end in "ide." Hydroxide is one of them. I got its formula and charge from my ion chart.

(iii) The LCM of 4 and 1 is 4.

1. I only need 1 gold—it is already worth +4.
2. I need four hydroxide ions (4 x -1 = -4)
   a. The hydroxide ions MUST be in parentheses before I add the subscript 4
   b. OH_4
      i. is wrong
      ii. because I've quadrupled the H, but not the O.
   c. $(OH)_4$
      i. is right
      ii. because it means the polyatomic (hydroxide) happened 4 times.

(iv) $Au(OH)_4$

(d) Gold (IV) oxide

(i) Gold (IV) = Au^{4+}

1. The Roman numeral tells me the positive charge of the gold

(ii) Oxide = O^{2-}

1. Oxide ends in "ide", so I looked for the element oxygen on the periodic table.
2. Because oxygen is in column 16 (the 6-valence-electrons-column), its common ion charge is 2-.

(iii) The LCM of 4 and 2 is 4.

1. I only need 1 gold—it is already worth +4.
2. I need two oxide ions (2 x -2 = -4)

(iv) **AuO_2**

1. You might be tempted to write Au_2O_4. That would be incorrect.
2. Ionic formulas should always use the smallest whole number ratio, and a 2:4 ratio can be simplified to 1:2.

(e) Silver nitride

(i) Silver = Ag^+

1. Silver didn't have a Roman numeral. How did I know it was +1? Silver is *always* +1. That is why silver is in the special diagonal of no-Roman-numerals.
   a. Ag = 1+
   b. Zn = 2+
   c. Al = 3+

(ii) Nitride = N^{3-}

1. Nitride ends in “ide”, so I looked for the element nitrogen on the periodic table.
2. Because nitrogen is in column 15 (the 5-valence-electrons-column), its common ion charge is 3-.

(iii) The LCM of 1 and 3 is 3.

1. I need 3 silver ions (3 x +1 = +3)
2. I only need one nitride ion (it is already worth -3)

(iv) **Ag_3N**

A few people have asked how to put the periodic table stuff on a 3x5 card (because you’ll be given a CLEAN periodic table to use on the test—not the one you’ve been labeling with notes).

You can do it all in words:

- Column 1 = alkali metals
- Column 2 = alkaline earth metals
- d-block (middle) = transition metals
- p-block under stairs = other metals…

Or you can just draw the basic shape of the periodic table without the individual squares, and label that: