NOTES#11/AqChemG/Balancing Redox Reactions-1/2Method/ApChem

INTRODUCTION:
- What you are about to experience is in your book, but you will find it in chapter 20. It is an important part of the AP test and an important aspect of redox chemistry.
-Balancing reactions are easy when all you have to balance is the number of atoms. Redox reactions are a little more difficult.

THE REDOX REACTION (½ Method) REGIMENT:

- When you are dealing with redox reactions that occur in an aqueous acidic or basic medium, the "Half-Reaction" method needs to be used.

- The Half-Reaction Method: You separate the unbalanced reaction into two half-reactions, one involving oxidation and the other reduction. Balance each of these reactions separately following specific guidelines. Then, re-add the half reactions to obtain a balanced equation. This method will vary depending on if you are in an acidic or basic medium:

ex: $MnO_4^- + Fe^{2+}$ **----------->** $Fe^{3+} + Mn^{2+}$ ***(in an Aq, acidic medium)***

STEP 1. Determine oxidation numbers for EACH element. Decide what is being Oxidized and what's being reduced.

STEP 2. Write out and balance each half reaction.

- Balance the **reduction** reaction first. — RED: MnO_4^- ------------> Mn^{2+}
  - a. Balance any atoms *besides* O or H first: — *The manganese is already balanced.*
  - b. Balance O atoms with water molecules: — MnO_4^- -------> Mn^{2+} + **4 H_2O**
  - c. Balance H atoms with H^+ ions (from the acid): — **8H^+** + MnO_4^- -------> Mn^{2+} + 4 H_2O
  - d. Balance the charge using (-) electrons: — 8 H^+ + MnO_4^- + **5 e^-** ----> Mn^{2+} + 4 H_2O
    - Right: $1(2^+) = 2^+$

- Now, balance the **oxidation** reaction the EXACT same way: — Fe^{2+} -------> Fe^{3+}
  - a. Fe is already balanced.
  - b-c. No adjustment of O or H is necessary.
  - d. Balance the charge using (-) electrons: — Fe^{2+} --------> Fe^{3+} + e^-

STEP 3. Make the electrons transfer in each of the two reactions EQUAL: — **5** Fe^{2+} ---------> **5** Fe^{3+} + **5** e^-
*** Since the reduction reaction involves 5 electrons, but the oxidation reaction only involves one electron, everything in the oxidation half-reaction must be multiplied by 5.*

STEP 4. Re-add the half reactions: 5 Fe^{2+} + 8 H^+ + MnO_4^- + 5 e^- ------> 5 Fe^{3+} + 5 e- + Mn^{2+} + 4 H_2O
Cancel out electrons: **5 Fe^{2+} + 8 H^+ + MnO_4^- ------> 5 Fe^{3+} + Mn^{2+} + 4 H_2O**
** *This is your final BALANCED equation.* **

STEP 5. Check that all the atoms and charges balance on both sides of the equation.
ATOMS: 5 Fe, 1 Mn, 4 O, 8 H -------> 5 Fe, 1 Mn, 4 O, 8 H

CHARGES: Left: $5(2^+) + 8(1^+) + 1(1^-) =$ **17^+**
Right: $5(3^+) + 1(2^+) =$ **17^+**

* The end! That's the "Half Reaction Method" in an aqueous acidic medium.

B. **REDOX RXNS IN A <u>BASIC</u> MEDIUM**:

ex. $Ag(s) + CN^- (aq) + O_2 (g)$ **------->** $Ag(CN)_2^- (aq)$ ***(in a BASIC medium)***

STEP 1. Pretend that this reaction is actually taking place in an acidic medium and solve it just like you did above. (*trust me...this is a "trick" that ALWAYS works)*

STEP 2. How many H^+s do you see? Add that same amount of OH^- ions to BOTH sides of the equation from STE

STEP 3. On the side that has both H^+ and OH^-, make as many H_2O molecules as possible. Eliminate the number of H_2O molecules that appear on both sides of the equation. BAM! There's your final BALANCED equation.

STEP 4. Check that the number of atoms and charges balance.

** As has been stated many times, the key to success is PRACTICE!!! **