NS B.1 (pg 1 of 2) Balancing Redox Reactions

Name___________________Per___

Balancing some redox reactions can be particularly challenging because both the number and type of each atom must be balanced as well as the charge. Using oxidation umbers can help facilitate this process.

Following a prescribed set of steps can help. The oxidation # "quickie" method is presented here:

(Not every step is always necessary, but going in order is important.)

(You will be told if the reaction occurs in acidic or basic solution, perform the first 7 steps the same, then 8-10 if basic.)

1. Identify which elements are oxidized and reduced by writing out oxidation numbers above each element.
2. Balance the number of redox atoms by inspection.
3. Adjust the number of redox atoms so the number of electrons lost equals the number of electrons gained. (This is the number of electrons transferred.)
4. Balance any other elements. (any non-redox atoms and atoms other than H and O)
5. Balance oxygen by adding water as necessary.
6. Balance hydrogen by adding H^+ as necessary.
7. Recheck by confirming that ion charge is balanced.

   If the solution is basic,

8. "Neutralize" the H^+ ions by adding the same number of OH^- ions to both sides of the equation.
   a. Convert number of $H^+ + OH^-$ on the same side of the reaction into the same number of water molecules.
   b. simplify by gathering H_2O all to one side of reaction

For example, permanganate ion will cause the oxidation of the bromide ion into manganese(IV) oxide and iodine.
The numbers listed correspond to the steps above.

1. $\underset{7+\ 2-}{MnO_4^-} + \underset{1-}{I^-} \rightarrow \underset{4+\ 2-}{MnO_2} + \underset{0}{I_2}$ *(manganese is reduced, iodine is oxidized)*

2. $MnO_4^- + 2\,I^- \rightarrow MnO_2 + I_2$ *(you must make the # I's same on both sides)*

3. $2\,MnO_4^- + 6\,I^- \rightarrow 2\,MnO_2 + 3\,I_2$ *(for I, 1− to 0 twice is 2e−, and Mn, 7+ to 4+ is 3e−, "think 6")*

4. $2\,MnO_4^- + 6\,I^- \rightarrow 2\,MnO_2 + 3\,I_2$ *(there are no "other" elements, other than H and O in next step)*

5. $2\,MnO_4^- + 6\,I^- \rightarrow 2\,MnO_2 + 3\,I_2 + 4\,H_2O$ *(8 O's on left, only 4 on right, need to add 4 H_2O)*

6. $8H^+ + 2\,MnO_4^- + 6\,I^- \rightarrow 2\,MnO_2 + 3\,I_2 + 4\,H_2O$ *(8 H's on right require addition on $8H^+$'s on left)*

7. $8H^+ + 2\,MnO_4^- + 6\,I^- \rightarrow 2\,MnO_2 + 3\,I_2 + 4\,H_2O$ *(checking charges of ions, results in 0 charge on both sides)*

8. $8H^+ + 8OH^- + 2\,MnO_4^- + 6\,I^- \rightarrow 2\,MnO_2 + 3\,I_2 + 4\,H_2O + 8OH^-$ *(neutralize with $8OH^-$ on both sides)*

   a. $8\,H_2O + 2\,MnO_4^- + 6\,I^- \rightarrow 2\,MnO_2 + 3\,I_2 + 4\,H_2O + 8OH^-$ *($8H^+ + 8OH^- = 8\,H_2O$)*

   b. $4\,H_2O + 2\,MnO_4^- + 6\,I^- \rightarrow 2\,MnO_2 + 3\,I_2 + 8OH^-$ *(4 H_2O's subtracted from both sides)*

Oxidation # method

1. using oxidation #'s identify which elements are oxidized and reduced
2. balance the redox atoms by inspection
3. multiply redox atoms by integers so that total electrons transferred will be equal
4. balance any other elements, other than H and O
5. balance O by adding H_2O as necessary
6. balance H by adding H^+ as necessary
7. if the reaction occurs in *basic solution*, convert to basic by adding an equal number of OH^- ions to both sides to cancel out the H^+ ions
    a. convert H^+ & OH^- into H_2O
    b. simplify by gathering H_2O all to one side of reaction
8. recheck by confirming that charge is balanced

Half-Reaction Method

1. divide the reaction into two unbalancd half reactions
2. balance each half reaction:
    a. balance each element other than H and O
    b. balance O by adding H_2O as necessary
    c. balance H by adding H^+ as necessary
    d. balance the charge by adding electrons
3. multiply each half reaction by an integer so the total number of electrons is the same in each half reaction
4. add the half reaction and simplify by gathering terms
5. if the reaction occurs in *basic solution*, convert to basic by adding an equal number of OH^- ions to both sides to cancel out the H^+ ions
    a. convert H^+ & OH^- into H_2O
    b. simplify by gathering H_2O all to one side of reaction
6. recheck by confirming that charge is balanced