Redox

Oxidation - Reduction

I. Redox - the competition for electrons between atoms
  A. Combination of oxidation and reduction - both processes occur together
  B. Oxidation - loss of electrons (**OIL - Oxidation is Loss**)
    1. named because oxygen is so electronegative, it caused elements to lose electrons
    2. ***also called the reducing agent (causes reduction of another)***
    3. Group I & II elements easily oxidized
  C. Reduction - gain of electrons (**RIG - Reduction is Gain**)
    1. oxidation number is reduced (ex. 0 to -2)
    2. ***also called the oxidizing agent (causes oxidation of another)***
    3. Group VI & VII elements easily reduced (higher electronegativity)
  D. Oxidation Number (oxidation state)
    1. the charge of the atom in a particular molecule or ion
    2. allows you to keep track of electrons in a reaction
    3. In unlike atoms - electrons belong to the more electronegative substance

II. Rules for Determining Oxidation Numbers
  A. Free elements - oxidation # = 0
    1. ex. Na, H_2
  B. Single ions - oxidation # = charge on ion
    1. ex. Na^+ = +1
  C. Covalent compounds - the more electronegative element is negative oxidation and the other element is given a positive oxidation number
  D. Ionic compounds - the sum of each ions charges must = 0
    1. ex. $FeCl_3$ = Fe = +3

    = Cl = -1 X 3 chlorines = -3

    Total charge = 0

      a. Group I elements are always +1
      b. Group II elements are always +2
  D. Oxygen = -2 except in peroxides when it is -1
  E. Hydrogen = +1 except in metal hydrides, when it is -1
  F. Polyatomic ions - oxidation # of all atoms must = the charge on the ion
    1. ex. SO_4^{2-} oxygen = -2 X 4 = -8

    sulfur = +6

    = -2 charge on ion

  H. Neutral molecules - oxidation numbers of all atoms = 0

1. ex. H_2SO_4 H = +1 X 2 = +2

   O = -2 X 4 = -8

   S = +6

2. Check Periodic Table to double check possible oxidation number

II. ***Balancing Redox Reactions***

A. ***Determine the oxidation numbers for each atom of the reactants and products***
   1. ***Determine the atoms oxidized and reduced***
B. ***Write a half reaction for the atoms oxidized including the electrons***
   1. ***Balance the half reaction if necessary and adjust the number of electrons***
C. ***Write a half reaction for the atoms reduced including the electrons***
   1. ***Balance the half reaction if necessary and adjust the number of electrons***
D. ***Balance the two half reactions together, using the least common multiplier to balance the number of electrons on both sides of the equation***
E. ***Place the coefficients in the appropriate places in the original equation, matching the atoms of the redox half reactions***
F. ***Balance all other atoms involved in the reaction except H and O***
G. ***Balance the Hydrogens***
H. ***Check to see if the number of oxygens on both sides are equal***

III. Electric Current through an Electrolyte (ionic conduction) REDCAT ANOX

A. Electrochemical Cells (Voltaic Cell) - any device that makes use of a redox reaction to produce an electric current
   1. Reaction must occur spontaneously
   2. Provides its own electrical current
   3. Anode is -, Cathode is +
   4. Requires a separation of the metals and ions in the reaction (salt bridge)
      a. Salt Bridge - allows transfer of electrons from one solution to another.
   5. Example 1 - Copper and Zinc
      a. Be able to :
         1. Predict the direction of electron flow
         2. Predict the direction of ion movement
         3. Label all parts of the electrochemical cell
      b. Steps to label an electrochemical (voltaic cell)
         1. Look up the 2 electrodes on table J
            1. They are in ORder (oxidation is first, reduction is second)
         2. Apply the Red Fat Cat (reduction at cathode, is growing) and the Anorexic Ox (oxidation at the anode, is shrinking)
         3. Good Cats take care of themselves (Cathode is positive, anode is negative)

4. Write the half reactions (REduction has Reactant Electrons

5. Flow of electrons goes to the cat (that’s why its fur stands up!!)

B. Electrolysis - the process by which an electric current brings about a redox reaction in a conducting liquid or solution

1. Does NOT occur spontaneously ***(determined by E^0 (electrode potential)***
2. Requires an outside source of energy (battery)
3. Anode is +, Cathode is -
4. Broken down into 2 circuits
   a. internal circuit - made up of the electrolyte solution
   b. external circuit - made up of the electrodes, wires and battery
5. Requires inactive substances as electrodes (platinum, graphite)
6. Steps to label an electrolytic Cell
   1. Flow of electrons comes from the – battery and still flow to the cat
   2. Bad cats need help (cathode is -, anode is +)

   3. Apply the Red Fat Cat (reduction at cathode, is growing) and the Anorexic Ox (oxidation at the anode, is shrinking)

   4. Write the half reactions

7. Example 1 - Electrolysis of Molten NaCl
   a. Half Reactions: $Na^+ + e^-$ ® Na (reduction)

   I. $2Cl^-$ ® $Cl_2 + 2e^-$ (oxidation)

   2. oxidation occurs at the anode with the anion
   3. reduction occurs at the cathode with the cation
   a. produces Na metal and Cl_2 gas
7. Example 2 - Electroplating - use of electrolysis to coat a material with a layer of metal
   a. requires a soluble metal salt (ex. $AgNO_3$) and it’s metal (Ag^0)
   b. Half reactions: $Ag^+ + e^-$ ® Ag (reduction)

   1. Ag ® $Ag^+ + e^-$ (oxidation)