Cell potential vs. concentration

- Standard potentials are for 1 M solutions at 25°C.
- When there are various concentrations, write the balanced equation for the cell and use LeChatelier's principle to determine the effect on the potential.
  - Shift to the left reduces the potential.
  - Shift to the right increases the potential.

Concentration Cell:

Is a voltaic cell in which each ½ cell is made of the same components but the electrolyte has a different concentration.

Rxn proceeds in the direction that will equalize the ion concentration in the compartments and the voltage is small.

Relationship bet. emf and ΔG

$\Delta G = \Delta G^0 + RT \ln Q$

$\Delta G = -nFE_{cell}$

n = # e^- transferred

F = Faraday's constant – quantity of electrical charge on 1 mole of electrons

1 F = 96,500 coulombs/mol = 96,500 J/V·mol

E = cell potential

1V = 1 J/C

Positive cell potential, E_{cell}, and a negative free energy, ΔG, indicate the reaction is spontaneous.

When a cell is “dead”, E=0, equilibrium has been reached bec. the concentration of reactants and products stops changing.

Use Nernst Equation: used for nonstandard conditions

$$E = E^0 - \frac{0.0592\ V}{n} \log Q \qquad @\ 298\ K$$

E^0 = cell potential at normal conditions

$$Q = \frac{[\text{products}]}{[\text{reactants}]}$$

As the reactants are converted to products Q increases and the value of E decreases.

At equilibrium E = 0 and the reaction quotient = equilibrium constant.

$Q = K_{eq}$

Then: can use Nernst Equation to calculate K_{eq}

$$0 = E^0 - \frac{0.0592}{n} \log K_{eq}$$

$$- E = - \frac{0.0592}{n} \log K_{eq}$$

$$\frac{E^0 n}{0.0592} = \log K_{eq}$$ use to find equilibrium constant

Battery:

- Is self-contained electrochemical device with one or more voltaic cells
- Lead Storage Battery: car battery
  - Composed of 6 two volt cells
    - Anode = lead
    - Cathode = lead IV oxide (commonly called lead dioxide)
    - Electrolyte = H_2SO_4

Dry Cell Battery: "normal" batteries
- Composed of:
  - Anode = Zn case
  - Cathode = C (graphite) rod
  - Electrolyte = moist paste of solids
    - Acid version = MnO_2 and NH_4Cl
    - Basic version = KOH or NaOH with the MnO_2
      - Alkaline batteries last longer than acid ones
        - bec. Zn corrodes more slowly in a basic environment

Fuel Cells:

- Voltaic cell in which the reactants are continuously supplied
- Utilizes redox rxns involving H_2 and CH_4.
- Energy normally lost as heat is used to produced electricity.

Corrosion:

- Metal is oxidized by oxygen and is spontaneous.
- Can coat metal to prevent corrosion (use Al, Sn, Cr, or Zn)

Electrolysis:

Carried out in an electrolytic cell

- Source of energy must be added
- Doesn't spontaneously produce electricity

Cell potential is negative.

Electroplating is a type of electrolysis.