5.111 Principles of Chemical Science: Week 9

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Progress Update

Over the past week I have been introduced to:

1. Reduction-oxidation problems and electrochemical celss
2. Transition metals and coordination complexes

Reduction-oxidation reactions

A reduction-oxidation reaction, otherwise known as a redox reaction, involves the transfer of electrons; consider the following definitions:

1. Oxidation - the loss of electrons by a species
2. Reduction - the gain of electrons by a species (note that the charge is lower than before, ie reduced)
3. Oxidizing agents - a species that excels at oxidizing others while reducing itself.
4. Reducing agents - a species that oxidizes itself to reduce others.

Balancing redox reactions undergoes a different procedure compared to normal:

1. Write half reactions from given unbalanced reaction
2. Balance non-hydrogen and non-oxygen
3. Add H_2O to balance oxygen
4. Add hydrogen ion to balance hydrogen
5. Add electrons to balance electrons
6. Add some multiple of each half reaction such that the electrons cancel.
7. If reaction is in basic solution, add OH^- to each side.

Consider the review problem on the following page:

Review problem

Problem:

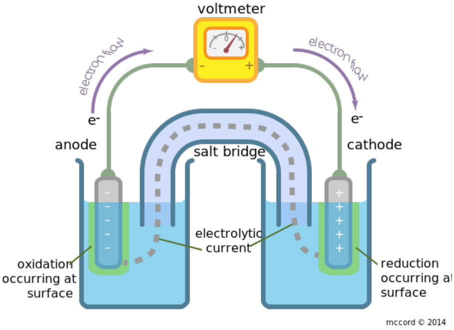
4. Using half-reactions, balance the following equations in **basic** solution. Determine which atom or compound is the oxidizing agent and which is the reducing agent in each reaction.

(a) $CO_2\ (g) + F_2\ (g) \rightarrow FO_3^-\ (aq) + C_2O_4^{-2}\ (aq)$

Solution: Spoken.

Electrochemical cells

In an electrochemical cell, a redox reaction occurs that either produces or requires the flow of electricity; the standard setup of an electrochemical cell is



Electrochemical cells (continued)

The reaction within the cell can be determined to be spontaneous or not by the equation

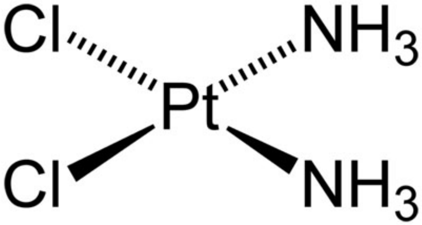
$$\Delta G_{\text{cell}} = -nF\Delta E_{\text{cell}} \tag{1}$$

where F is Faraday's constant and n is the number of electrons transferred.

$$\Delta E_{\text{cell}} = E^{\circ}_{\text{cathode}} - \Delta E^{\circ}_{\text{anode}} \tag{2}$$

Coordination complexes & geometry (again)

In a coordination complex, a number of *ligands* bind to a central transition metal. Consider cisplatinum:



It has 4 ligands bound to the central platinum, thus it has a coordination number of 4.

Chemistry Olympiad problem

Consider the following problem from the 2018 Chemistry Olympiad:

52. A coordination complex $M(NH_3)_2Cl_2$ can be separated into a pair of geometric isomers. Is this observation consistent with a tetrahedral or a square planar geometry at the metal center?

(A) It is consistent only with a tetrahedral geometry.

(B) It is consistent only with a square planar geometry.

(C) It is consistent with either a square planar or a tetrahedral geometry.

(D) It is consistent with neither a square planar nor a tetrahedral geometry.