Chemistry 116: Lecture 15
10/23/08 (JR)

Nuclear Chemistry (Chapter 21)

- Chemical bonding and reactions are all about the electrons.
- Nuclear chemistry is what occurs in the nucleus

Review: Isotopes are varying forms of the same element with the same number of protons and a different number of neutrons.

- Atomic number: Number of protons
- Mass Number: Number of protons + neutrons
- Some isotopes are stable, while others are radioactive.
  - Radioactive isotopes can go through different processes of decay.
- Protons determine the identity of an element (for example, hydrogen is the first element on the periodic table simply because all atoms of hydrogen have only one proton).

If a decaying process creates a product with a different number of protons (atomic number), then the identity of the product element is different than the reactant.

Conservation of mass does not apply in nuclear decays. However, conservation of mass number and atomic number DO apply (the atomic number and mass number cannot be created or destroyed—it is conserved).

Examples of nuclear processes (alpha decay, beta decay, and gamma decay)

- Alpha decay: represented with a 4 on top of a 2 in bottom of the element ($^{4}_{2}\mathrm{He}$)
- Beta decay: represented with a 0 on top of a -1 on bottom in front of an e ($^{0}_{-1}e$).
- Gamma decay: has a 0 on top of a 0 in front of the gamma sign ($^{0}_{0}\gamma$).
- Positron: a positive electron (antielectron) ($^{0}_{+1}e$).

For examples, look at page 3 of lecture 15 under where does the mass go?
The numbers before the elements on the product side of the reaction need to add up to the numbers on the reactant side of the equation.

- In beta decays, do not make the mistake of leaving out the negative sign in front of the 1.
- The negative number in the beta decays comes from neutron changing to a proton + an electron (electron flies off). $^{1}_{0}n = ^{1}_{1}p + ^{0}_{-1}e$

Gamma radiation is the most dangerous (takes a lot to protect against the radiation).
Beta radiation is in between gamma and alpha in terms of strength.
Alpha radiation is the least dangerous (does not take much to stop the radiation, clothing or a piece of paper)

- Electrons and positrons can be captured (look at the example equations on page 4 of lecture 15)
- Larger nuclei can split (fission) into smaller nuclei (often by neutron bombardment).
- Smaller nuclei can fuse into larger nuclei.

Neutron to proton ratio determines stability.

Graph on page 4: Number of Protons vs. Number of neutrons (Isotope)
- Points in the middle of the shaded are stable, and points on the edges of the shaded area are less stable.

For test: Know how to write the nuclear equation, and balance the protons (bottom number) and mass number (top number). Protons and neutrons are held together in the nucleus by forces that are stronger than the + to + electrical repulsions. When the composition of the nucleus is charges, energy is released or must be absorbed.

END OF INFORMATION FOR EXAM 2.

What is Equilibrium?
- When in equilibrium, forward and reverse rates are equal.
- Concentration remains constant.
- Looks like nothing is happening, but at a particle level, the molecule are changing back and forth.

Q (Reaction Quotient): function of time
- Q approaches the equilibrium constant (ratio of the rate constants of the forward and reverse reactions) in equilibrium.

$K_{eq} = k_{forward}/k_{reverse}$

- Over time, concentrations stabilize out and reach equilibrium.
- Ratio of concentrations will always be the same.
- The value of Q at equilibrium is always K, which only depends on temperature.

*Concentrations are irrelevant when in the solid phase.
- If the only reactant is a solid, the denominator is 1.

*Know Reaction quotient equation (page 10 of Lecture 15).