CHEM 1110
Midterm Exam 3 Study Guide (Ch. 5-7)

This study guide is meant to provide only the barest direction as you study. Try to find practice problems from the textbook (both in the chapter text and in the end-of-chapter questions) rather than just relying on this guide. Note that most tables and equations will not be provided here, or on the exam. You can find them in your textbook now, but should memorize them in preparation for the exam.

Chapter 5 – Classification and Balancing of Chemical Reactions

- How to balance chemical reactions
  - Start with elements that appear in *only* one place on each side of the equation
  - Often it is best to balance oxygen last
  - double everything if necessary to get rid of fractional coefficients
- Classes of chemical reactions
  - Precipitation reactions
  - Acid-base reactions
  - Oxidation-reduction reactions
- Precipitation reactions
  - Solubility rules in Table 5.1
  - Reactants will switch binding partners (cations and anions)
  - Check the solubility of the new products
  - Net ionic equations will eliminate the spectator ions
- Acid/base neutralization reactions
  - Acids produce H_3O^+ in water
  - Bases produce OH^- in water
  - Acids and bases react together to produce neutral solutions with salt, and sometimes water
- Reduction-oxidation reactions
  - Redox reactions involve the transfer of electrons
  - Electrons are tracked with oxidation numbers
    * Elemental forms have oxidation states of 0
    * H usually takes +1 and O usually takes -2
    * The sum of all oxidation numbers should equal the overall charge

  - OIL-RIG – Oxidation is losing electrons, reduction is gaining electrons
  - See how oxidation states change to identify which elements were oxidized and which were reduced
  - Oxidizing agents and reducing agents are identified by their effect on their reaction partner

Chapter 6 – Chemical Reactions: Mole and Mass Relationships

- Calculating molecular weights and formula weights
- Calculating moles from mass, and mass from moles
- Stoichiometric ratios between reactants and products
- Calculating theoretical yield
- Limiting reactant problems
  - Which is the limiting reactant?
  - How much excess reactant is left over?
  - What is the percent yield?

Chapter 7 – Chemical Reactions: Energy, Rates, and Equilibrium

- Energy is released by forming bonds and energy is required to break bonds
- Finding enthalpies of reaction from bond enthalpies
  $\Delta H_{rxn} \approx \sum Bonds\ Broken - \sum Bonds\ Formed$
- Find the enthalpy of reaction for the following reaction:
  $H_2(g) + Cl_2(g) \longrightarrow 2\,HCl$
- Answer: $\Delta H_{rxn} \approx -43\,\frac{kcal}{mol}$
- Question: If $5.00\ g$ of H_2 react with excess Cl_2 to produce HCl, how much heat is released?
- Answer: $107\ kcal$
- Exothermic vs Endothermic reactions
- Free energy and spontanaety (negative $\Delta G_{rxn} is spontaneous$)
  $\Delta G_{rxn} = \Delta H_{rxn} - T\Delta S_{rxn}$
- Suppose a reaction has $\Delta H_{rxn} > 0$ and $\Delta S_{rxn} > 0$. Will this reaction be spontaneous at high, low, all, or no temperatures?
- Answer: High temperature

- Rates of chemical reactions are controlled by three factors:
  - The frequency of collisions - Concentration of reactants
  - The energy of collisions - Must be greater than activation energy. Temperature dictates average energy
  - Reaction pathway - A catalyst could speed a reaction
- True/False Increasing the temperature will decrease the reaction rate for exothermic reactions.
- Answer: False. Increasing the temperature always increases the reaction rate.
- Reaction coordinate diagrams
- Some reactions are *reversible*. They reach an equilibrium rather than going all the way to products
- The equilibrium conditions are governed by the equilibrium constant: $K_{eq} = \frac{[Products]^m}{[Rreactants]^n}$
- Give the equilibrium constant for the following reaction:

  $PO_4^{3-}(aq) + 2\,H_2O(l) \longleftrightarrow H_2PO_4^{-}(aq) + 2\,OH^{-}(aq)$
- Answer: $K_{eq} = \frac{[H_2PO_4^-][OH]^2}{[PO4^{3-}]}$ (note that the water is absent because it is (l))
- Le Châtelier's Principle:
  - Shifting in response to adding or removing reactants or products
  - Shifting in response to changes in pressure
  - Shifting in response to changes in temperature