CHE 205 -- Chemical Process Principles STUDY GUIDE FOR THE FINAL EXAM

- **"Test Yourself" questions from Chapter 8 and Chapter 9 through 9.4.**
- **Explanations**. Be able to briefly and clearly explain each of the following in your own words: Why mist sometimes forms above the surface of a pond. (The term dew point should be used.) Why food cooks more rapidly in a pressure cooker. (Refer to the phase diagram for water.) Why soda fizzes when you take the bottle cap off, and why it fizzes more if the soda is warm. (Refer to Henry's law.) Why you feel warm when you step into a shower and cold when you step out, even if the room temperature is the same.
- Explain the following: State property. Process path. Why you can choose any convenient path from one state to another to evaluate the associated internal energy or enthalpy change. What makes a path convenient. Exactly what it means to say, "The specific enthalpy of benzene vapor at 50$_o$C and 2 atm relative to benzene liquid at 10^{o}C and 1 atm is 35.73 kJ/mol."
- How to account for the energy necessary to overcome a phase change (i.e. liquid to vapor). When this energy is positive and when is it negative
- State when to use Kopp's Rule and Trouton's Rule
- C_v and C_p--how they are defined and how they are related for ideal gases, liquids, and solids. Inlet-outlet enthalpy tables--what they are and how to use them.
- Dry bulb and wet bulb temperature and why they are different except at a relative humidity of 100%. Why you feel cool on a hot day if you are near a fountain.
- What happens when you mix a strong acid or a strong base with water, and why it happens. (The term "bonds" should appear in your explanation.) Heats of mixing and solution. Heat of solution at infinite dilution.
- Heat of reaction. Standard heat of reaction. Why the heat of reaction doubles when you double the stoichiometric equation. When reactions are exothermic and endothermic. Hess's law, and why it is important for calculating heats of reaction that cannot be measured directly (give an example).
- Standard heats of formation and combustion: what they are and what the assumed reactants and products are for each of them (including their phases if values from Table 1 are used).
- **Estimation of heat capacities.** Estimate the heat capacity (C_p) of a solid or liquid using Kopp's rule. Given a value or formula for C_p, calculate the corresponding value or formula for C_v and vice versa.
- **Psychrometric chart.** Given values of any two of the properties shown on the psychrometric chart (including dew point, which does not appear explicitly), find the values of all of the others and briefly explain what they mean. Give the reference states used to calculate the enthalpies shown on the chart.

- Use the chart to quickly perform material and energy balances on an air conditioner, a condenser, or a dryer.
- **Determination of internal energy and enthalpy changes for a single species undergoing a change in state**. Given a species that makes a transition from one specified state (phase, *T*, *P*) to another, calculate the associated internal energy or enthalpy change using appropriate data in the text (i.e., using the most accurate available data or correlation for the given task). The data you use may include the steam tables, specific enthalpies from Tables B.8 and B.9, heat capacities from Table B.2 or (if necessary) from Kopp's rule, and latent heats from Table B.1 or (if necessary) Section 8.4b.
- **Mixing and solution.** Given a specified quantity or flow rate of sulfuric acid, sodium hydroxide, or hydrogen chloride at a specified temperature being mixed with (or dissolved in) a specified quantity or flow rate of liquid water at a specified temperature, calculate (i) the heat transfer (*Q*) required to achieve a specified product solution temperature, or (ii) the product solution temperature if the mixing is adiabatic.
- **Heats of reaction.** The heat of the reaction in which ammonia is oxidized to nitric oxide is

- $4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$, $\Delta\hat{H}_r^o = -904.7$ kJ/mol
  - What process is –904.7 kJ the enthalpy change for? (Specify quantities of reactants and the conditions at which the reaction occurs.) Kilojoules per mol of what? What does the superscript $_o$ denote?
  - Calculate the rate of enthalpy change if 2 mol NO/s are produced in this reaction with both reactants and products at 25_oC.
  - Calculate for the reaction, and be able to derive the formula you use to do it. □ □Uro
  - Calculate the standard heat of the same reaction with *liquid* water being the product. (Note that the heat of vaporization of water at 25^oC is given on p. 463 of the text.)
- **Heats of formation and combustion.** Given a stoichiometric equation, calculate its standard heat of reaction from tabulated standard heats of formation and (if possible) heats of combustion. Construct a process path to show why each method works.
- **Material and energy balances on nonreactive processes.** Given any process that does not involve heats of mixing or chemical reactions,
- Draw and label a flowchart, including in the labeling the states of all species in the inlet and outlet streams and any nonzero heat or work terms
- Do the degree-of-freedom analysis
- Set up an inlet-outlet internal energy table (closed system at constant volume) or enthalpy table (open system, closed system at constant pressure), filling in amounts and flow rates from the flowchart and labeling all unknown specific internal energies or enthalpies (H_1, H_2,...)
- Write in order the equations you would use to calculate all requested quantities. Circle the variable(s) for which you would solve each equation (or each set of simultaneous equations). If a formula includes a physical property (a specific internal energy or enthalpy, heat capacity, latent heat, melting or boiling point, vapor pressure,...), state where in the text you would obtain the required value or formula. **NO CALCULUS, ALGEBRA, OR ARITHMETIC!**
- Perform the calculations. (You will certainly not be asked to do this for the entire process.)