Chapter 10
Thermochemistry: Energy Changes in Chemical Reactions
Learning Objectives

8.2.2021

To satisfy the minimum requirements for this course, you should be able to:

1. Demonstrate an understanding of thermochemistry by:
   - explaining the relationships among the following: system, surroundings, and universe; exothermic process and endothermic process; internal energy (E) and enthalpy (H); ΔE, ΔH, q, and w
   - stating the first law of thermodynamics in words and performing calculations using the first law for a closed system ($\Delta E = q + w$)
   - distinguishing between state functions and path functions and identifying examples of each
   - explaining the sign conventions for heat and work
   - associating the sign of ΔH with whether the process is exothermic or endothermic
   - calculating the quantity of heat involved in a reaction given the quantity of reactants and the enthalpy change for the reaction
   - calculating the amount of reactant needed to generate a given amount of heat

2. State the definitions of the standard states for elements, solids, liquids, gases, and solutes in solution.

3. Use the Kinetic Molecular Theory to explain the relative energy changes associated with each phase change (ΔH_{vap}, ΔH_{fus}, ΔH_{sub}) and calculate the energy associated with heating or cooling a substance through a temperature range that includes phase changes, given the appropriate thermodynamic data

4. Demonstrate an understanding of the concept of calorimetry by:
   - describe the concept of heat capacity (C_P), specific heat (c_P) and molar heat capacity ($c_{P,n}$). Note: follow the units of heat capacity to be able to apply the correct formula.
   - performing calculations using the equations:
     a. $q = m\, c_P\, \Delta T$
     b. $q = C_P\, \Delta T$
     c. $q = n\, c_{P,n}\, \Delta T$
     d. $q = n\, \Delta H$ for a chemical reaction or phase transition
   - using constant pressure calorimetry data to calculate the standard reaction enthalpy or to calculate the specific heat of a substance

5. Calculate the standard enthalpy of reaction (ΔH_{rxn}^{o}) using:
   - Hess's law (indirect method)
   - standard enthalpies of formation (ΔH_f^{o} found in found in Appendix 4, Table A4.3, p. APP-18-24) of reactants and products (direct method)

6. Use bond energies (Bond Energies are both in Table 4.6, p. 173 and Appendix 4, Table A4.1, p. APP-17) to estimate ΔH

7. *Naval Application: Fuels and Lubricants (see handout and Section 10.9 - Fuels Applications)*
   - understand the term fuel value (or energy content) and compare fuel values for fuels
   - describe how the percent oxygen in a fuel affects its fuel value, and explain how adding ethanol to gasoline affects its fuel value
   - define the terms flashpoint, flammability, and volatility
   - describe the relative flammability of the military fuels: JP-4, JP-5, and JP-8
   - describe several uses of lubricating oils

N.B. Section 10.8 will not be covered.