CHAPTER 8

THERMOCHEMISTRY: CHEMICAL ENERGY

We will spend three lecture days on this chapter and will only do selected parts of it. Note that we will breeze through Sections 1 – 6 and then focus on Sections 7 - 12. Here is the plan:

❖ Day 1. Briefly cover Section 1 – 5 and then 6 and 9 (units on thermal energy, quantitative energy calculations).
❖ Day 2 we do calculations involving calorimetry and heats of formation (Sections 7 and 9).
❖ Day 3 we will cover Hess’s law and bond energies (Sections 8 and 10).

Read the introductory paragraph to Chapter 8 and Sections 8.1 – 8.5. We will use the summary for these sections (other side)

❖ Memorize the definition of the standard state (25 °C and 1 atm). If solutions are involved, standard state is 1 molar.
❖ Do

Section 8.6 ❖ Given a balanced chemical equation and enthalpy change for a chemical reaction, calculate the enthalpy change per mole or per gram of each reactant and product.
❖ Do Problems: 7, 8, 56, 58, 60,

Section 8.7 ❖ Perform calculations involving specific heat (or molar heat capacity), heat flow, and temperature change.
Calculate $\Delta H$ or $\Delta E$ in a calorimetry experiment.
❖ Do 9 – 11, 62, 64, 66, 68 (Hint: limiting reagent problem: Go Moles!)

Section 8.8 ❖ Use Hess’s law to calculate a standard heat of reaction.
❖ Do 12 – 14

Section 8.9 ❖ Use standard heats of formation to calculate a standard heat of reaction.
❖ Do 15, 16, 70, 74, 76, 78, 80, 82, 84, 86

Section 8.10 ❖ Use bond dissociation energies to approximate a standard heat of reaction.
❖ Do 17, 18, 88, 90,

Section 8.11 ❖ Write balanced equations for combustion reactions.
❖ Use Hess’s Law to calculate enthalpies of combustion.
Quick & Easy Thermodynamics

1. Internal Energy = Kinetic Energy + Potential Energy: \( E = KE + PE \)

2. Change in energy:
   
   In general: \( \Delta E = E_{\text{final}} - E_{\text{initial}} \)
   
   For reactions: \( \Delta E = E_{\text{products}} - E_{\text{reactants}} \)

   
   \( \Delta E = \text{heat} + \text{work} \quad (q = \text{heat and } w = \text{work}) \)

4. Work is done when there is a change in volume:
   
   \( w = -P\Delta V \)
   
   \( \Delta E = q - P\Delta V \)

5. Chemists don’t want to worry about volume changes (we use open beakers - and don’t want to measure the gas volumes produced, etc.) so we invented enthalpy, \( H \):
   
   \( H = E + PV \)
   
   \( \Delta H = \Delta E + P\Delta V \)
   
   \( \Delta H = (q - P\Delta V) + P\Delta V = q \)

6. \( \Delta H \) and \( \Delta E \) are very similar in value under normal conditions - and are identical when there is no change in volume.

7. The standard state. When values are reported at 298 K and 1 atm and 1 M, a little “0” is added to \( \Delta H \) to indicate the values are at standard state. Thus, \( \Delta H^0 \) indicates the value is at standard state and \( \Delta H \) indicates that the conditions were not standard conditions.