

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 – 6 and then 7 and 10 (units on thermal energy, quantitative energy calculations).
- ❖ Day 2 we do calculations involving calorimetry and heats of formation (Sections 8 and 10).
- ❖ Day 3 we will cover Hess's law and bond energies (Sections 9 and 11).

□ **Read the introductory paragraph to Chapter 8 and Sections 8.1 – 8.6. We will use the one-page summary for these sections (given at the end of this guide)**

- Memorize the definition of the standard state (25 °C and 1 atm). If solutions are involved, standard state is 1 molar.
- Do Problems 44 on page 309.

Section 8.7 □ 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: 8 and 9 on page 285, and problems 50, 52 and 54 on page 309.

Section 8.8 □ Perform calculations involving specific heat (or molar heat capacity), heat flow, and temperature change.

Calculate ΔH or ΔE in a calorimetry experiment.

- Do Problems 10 – 12 on pages 288 and 289, problems 58, 60, and 62 on page 310, and problem 98 on page 312.

Section 8.9 □ Use Hess's law to calculate a standard heat of reaction.

- Do Problems 13 – 15 on page 291, problem 30 on page 308, problem 68 on page 310, problem 100 on page 312, and problem 110 on page 313.

Section 8.10 □ Use standard heats of formation to calculate a standard heat of reaction.

- Do Problems 16 and 17 on page 294, and problems 70, 72, 74 on page 310.

Section 8.11 □ Use bond dissociation energies to approximate a standard heat of reaction.

- Do Problems 18 and 19 on page 296, problems 76 and 78 on page 311, problem 104 on page 312.

Section 8.12 □ Write balanced equations for combustion reactions.

- Use Hess's Law to calculate enthalpies of combustion.
- Do Problem 20 on pg 298, problem 106 on page 312.

Section 8.13 Predict whether entropy increases or decreases for a chemical reaction or physical change.

- Do Problem 21 on page 300, problem 82 and 84 on page 311.

Section 8.14 □ Predict the signs of ΔH , ΔS and ΔG for a reaction.

- Use the equation $\Delta G = \Delta H - T\Delta S$ to determine whether the forward reaction or the reverse reaction is favored.
- Use ΔH and ΔS to determine the temperature at which a reversible system is at equilibrium.
- Do Problems 23 – 25 on pages 303 and 304, and problems 86, 88, 90, 92 on pg 311.



“Hey! Look what Zog do!”

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: $\Delta E = E_{\text{products}} - E_{\text{reactants}}$

3. First Law of Thermodynamics: (Law of Conservation of Energy)

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

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. ΔH and ΔE 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 "o" is added to ΔH to indicate the values are at standard state.

Thus, ΔH° indicates the value is at standard state and ΔH indicates that the conditions were not standard conditions.

7. Entropy: the quantity that describes the degree of randomness of a system. Entropy is given the symbol S.

8. The Second Law of Thermodynamics:

Whenever a spontaneous event takes place in our universe, it is accompanied by an overall increase in entropy.

9. The Third Law of Thermodynamics:

At absolute zero, the entropy of a perfectly ordered crystalline substance is zero.