

Salt Lake Community College, Chemistry Department

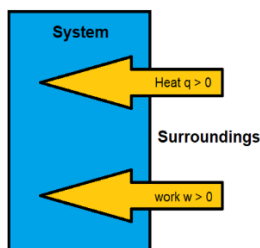
Chem 1110 Workshop 8

Topic: Thermodynamics

Objective:

- To be able to explain what factors influence energy loss or gain during reactions
- To understand the relationship between free-energy, enthalpy, and entropy changes in reactions
- To understand the concept of equilibrium and relate it to chemical reactions

The First Law of Thermodynamics:



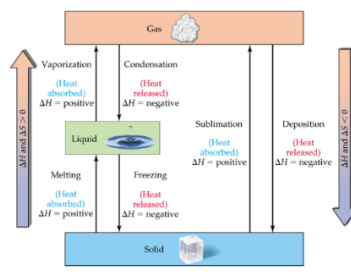
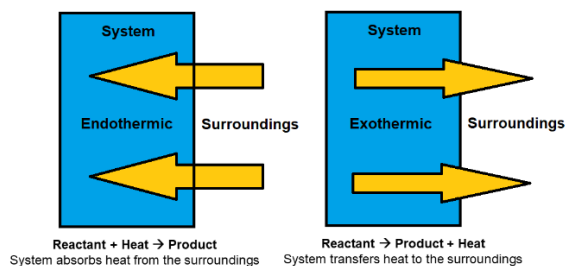
Sign Conventions for q

- $q > 0$, heat is transferred from the surrounding to the system
- $q < 0$, heat is transferred from the system to the surroundings
- $w > 0$, work is done by the surroundings on the system
- $w < 0$, work is done by the system on the surroundings

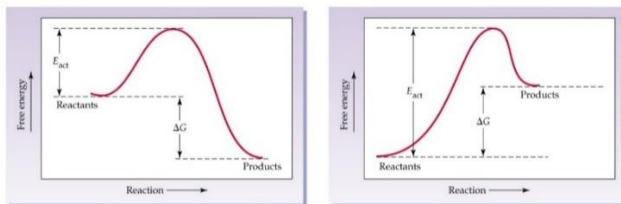
The sign of $\Delta E = q + w$

- $q > 0, w > 0 : \Delta E > 0$
- $q < 0, w < 0 : \Delta E < 0$

Endothermic and Exothermic Processes:



How Do Chemical Reactions Occur? Reaction Rates



Effects of Temperature, Concentration, and Catalysts on Reaction Rates:

Table 7.3 Effects of Changes in Reaction Conditions on Reaction Rates

Change	Effect
Concentration	Increase in reactant concentration increases rate. Decrease in reactant concentration decreases rate.
Temperature	Increase in temperature increases rate. Decrease in temperature decreases rate.
Catalyst added	Increases reaction rate.

Practice problems:**1. True (T) or false (F)?**

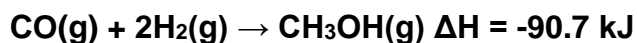
- a) If the heat is transferred from the surrounding to the system and the work is done by the surroundings on the system, $\Delta E > 0$ _____.

2. Indicate the sign of the enthalpy change, ΔH , in each of the following processes, $P = \text{constant}$:

- a) Baking Bread
- b) Burning a Candle
- c) an ice cube melts

3. Calculate the change of internal energy of a system, ΔE , if 0.010 kJ of heat is added to this system and the system does 20 J of work on the surroundings. Be careful with the units!

4. Calculate the amount of heat transferred when 1.60 kg of $\text{CH}_3\text{OH}(\text{g})$ is produced during the following reaction



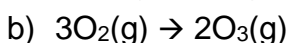
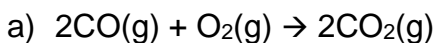
5. Use $\Delta H^\circ = -890 \text{ kJ}$ to find the heat produced when 4.80 g of CH_4 gas is burned in O_2 at 25°C and 1 atm?

6. Consider the reaction shown:



When 50.0 g of N_2 react, _____ kcal will be _____ (produced or consumed).

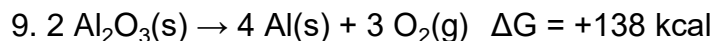
7. Write the equilibrium equations for the following reactions:



8. For the following reaction: $\text{PCl}_5\text{(g)} \rightleftharpoons \text{PCl}_3\text{(g)} + \text{Cl}_2\text{(g)}$ with $\Delta H^\circ = 90.0 \text{ kJ}$ in which direction will the equilibrium shift when: (possible answers: left, right, no shift)

(a) $\text{Cl}_2\text{(g)}$ is removed? _____

(b) $\text{PCl}_3\text{(g)}$ is added? _____



Consider the contribution of entropy to the spontaneity of this reaction. As written, the reaction is _____, and the entropy of the system _____.

- a) spontaneous; increases
- b) spontaneous; decreases
- c) non-spontaneous; increases
- d) non-spontaneous; decreases
- e) non-spontaneous; does not change

10. Which statement best describes the way a catalyst works?

- a) It decreases the value of ΔH .
- b) It increases the value of ΔH .
- c) It decreases the value of E_{act} .
- d) It increases the value of E_{act} .
- e) It increases the value of ΔG .