CHM 111 Chapter 5 Thermodynamics Worksheet and Study Guide

Purpose: This is a guide for your as you work through the chapter. The major topics are provided so that you can write notes on each topic and work the corresponding problems.

This should serve a s a study guide as you go on to do the problems in Sapling and take the quizzes and exams.

The Problems are embedded in the Topics.

Section 1: By the end of this section, you will be able to:

- **Define energy, distinguish types of energy, and describe the nature of energy changes that accompany chemical and physical changes**
- **Distinguish the related properties of heat, thermal energy, and temperature**
- **Define and distinguish specific heat and heat capacity, and describe the physical implications of both**
- **Perform calculations involving heat, specific heat, and temperature change**

(A) Define:

Thermochemistry

Energy and kinetic energy, potential energy

Calorie (cal) and Joule

work (w)

heat (q) and Thermal Energy

Temperature

Heat Capacity(C) and Specific Heat Capacity (c) or (C_s)

Endothermic and Exothermic

System and Surroundings

(B) State the first law of thermodynamics

(C) Label each as endo or exo thermic

i. The freezing of ethanol.

ii. The combustion of glucose.

iii. A hot cup of tea (system) cools on a countertop.

iv. The chemical reaction in a "cold pack" often used to treat injuries.

v. The melting of ice.

(D) Define and distinguish specific heat and heat capacity, and describe the physical implications of both
Perform calculations involving heat, specific heat, and temperature change
$q = C_s \times m \times \Delta T = C_s \times m \times (T_{final} - T_{initial})$
$q = C \times \Delta T$

(E) A sample of copper at 15 °C absorbs 143.6 kJ of heat, resulting in a final temperature of 85.0 °C, determine the mass of the copper if the specific heat capacity of copper is 0.385 J/g°C.

Section 2: By the end of this section, you will be able to:
Explain the technique of calorimetry, Calculate and interpret heat and related properties using typical calorimetry data. $q_{reaction} + q_{solution} = 0$ $q_{rxn} = -q_{soln}$

(A) Define:

bomb calorimeter

calorimeter

calorimetry

nutritional calorie (Calorie)

(B) 145.0 g of water at 98.0°C is mixed with an unknown amount of water at 27.5 °C. If the final temperature of the mixture is 48.0 °C, what was the mass of the unknown water? The specific heat capacity of water is 4.184 J/g°C.

(C) Define enthalpy (*H*), enthalpy change (Δ*H*),

(D) 1.60 g of NH_4NO_3 is dissolved in 75.0 grams of water at 25.00 °C. The final temperature of the mixture is 23.35 °C. Assuming that no heat is lost to the container and the surroundings and assuming that the specific heat capacity of the mixture is 4.18 J/g°C, what is the $\Delta H_{reaction}$?

Section 3: By the end of this section, you will be able to:

- **Define enthalpy and explain its classification as a state function**
- **Define State Function:**

- **Write and balance thermochemical equations**
- **Calculate enthalpy changes for various chemical reactions**
- **Explain Hess's law and use it to compute reaction enthalpies**
- **Understand and use Standard Enthalpies of formation.**

(A) Define: Standard Enthalpy of Formation

(B) What is the Standard Enthalpy of formation of an element?

(C) The standard enthalpy of combustion (burning in oxygen to produce carbon dioxide and water) for benzene, C_6H_6(l), is –3267 kJ/mole of benzene. Write the balanced reaction.

Calculate the amount of heat released when 125 g of benzene is burned in Oxygen.

Calculate the amount of heat released when 75.0 grams of water is produced.

(D) State Hess's Law

Calculate the enthalpy of reaction for:

$C_2H_4 + 6\ F_2 \rightarrow 2\ CF_4 + 4\ HF$

Given:	ΔH°
$H_2 + F_2 \rightarrow 2\ HF$	- 537 kJ
$C + 2\ F_2 \rightarrow CF_4$	- 680 kJ
$2\ C + 2\ H_2 \rightarrow C_2H_4$	+ 52.3 kJ

(E) Use Enthalpies of formation to calculate the enthalpy for a reaction:

$$\Delta H^\circ_{reaction} = \sum n \times \Delta H^\circ_f(_{products}) - \sum n \times \Delta H^\circ_f(_{reactants})$$

7. Calculate the ΔH°_{rxn} for:

$SiCl_4(l) + 2\ H_2O(l) \rightarrow SiO_2(s) + 4\ HCl(g)$

Given:	ΔH°_f (kJ/mole)
$SiCl_4(l)$	–640
$H_2O(l)$	–286
$SiO_2(s)$	–911
$HCl(g)$	– 92