NAME: HONORS CHEMISTRY

SECTION: Putting It All Together IV

Energy and Chemistry

Part I: Hess' Law

Refer to pp. 303-305 in your textbook.

1. Use the following two reactions to find the ΔH of the synthesis of water *vapor* from its elements:

   $2\ H_2(g) + O_2(g) \rightarrow 2\ H_2O(l)$ $\Delta H = -571.6$ kJ

   $H_2O(l) \rightarrow H_2O(g)$ $\Delta H = +\ 40.6$ kJ

2. Using the following equations, find the ΔH of combustion of methane.

   Target equation:

   $C(s) + O_2(g) \rightarrow CO_2(g)$ $\Delta H = -393.5$ kJ

   $O_2(g) + 2\ H_2(g) \rightarrow 2\ H_2O(g)$ $\Delta H = -483.6$ kJ

   $C(s) + 2\ H_2(g) \rightarrow CH_4(g)$ $\Delta H = -74.8$ kJ

3. What is a standard enthalpy of formation? How can this information be used to find the enthalpy of reaction?

Part II: Thermodynamics Refer to pp. 305-306 and pp. 311-315 in your textbook
Systems tend to change from a system of _____ disorder to a state of _____ disorder. The main driving forces are _____ and _____.

Complete the equation for Gibb's Free Energy: $\Delta G =$

1. Does entropy increase or decrease in the following reactions?
   a. $NH_3(g) + HCl(g) \rightarrow NH_4Cl(s)$
   b. $2\ NaHCO_3(s) \rightarrow Na_2CO_3(s) + H_2O(g) + CO_2(g)$
   c. $CaO(s) + CO_2(g) \rightarrow CaCO_3(s)$
2. Explain how you can use free energy to predict if a reaction will occur spontaneously.

3. For the decomposition of $CaCO_3(s)$ to $CaO(s)$ and $CO_2(g)$ at 25^oC,. The $\Delta H^o = 178.5$ kJ/mol and the ΔS^o is 161.6 J/K mol. Is the reaction spontaneous at this temperature?

Part III: Calorimetry
Refer to pp. 294-301 in your textbook.
1. Silver has a specific heat capacity of 0.23 J/g ^oC. A 15.0 g silver coin is heated to 100.0^oC in a beaker of boiling water, then allowed to cool to 20.0^oC (room temperature). How much heat does the silver coin release as it cools?

2. A 25.00 grams sample of an unknown metal was removed from boiling water at 100.0^oC and placed in a calorimeter containing 100.0 grams of water at 20.0^oC. When the temperature of the water and the metal came to thermal equilibrium, the new temperature of the water was 23.8^oC. What is the specific heat of the unknown metal? (*Hint: Heat lost by the hot metal = heat gained by the cool water).*

	Metal	Water
Mass (g)	25.00	100.00
Specific Heat		4.184 J/g ^oC
Initial Temperature	100.0	20.0
Final Temperature	23.8	23.8
ΔT		

Part IV: Potential Energy Diagrams

Refer to p. 546 in your textbook.

Sketch the following potential energy diagrams, labeling E_a, reactants, products, ΔH, and the activated complex (transition state). On diagram B, sketch in the energy curve if a catalyst is added to the reaction.

A. An exothermic reaction with a small activation energy

B. An endothermic reaction with a large E_a and a small ΔH

Part V: Energy and Stoichiometry

Refer to pp. 301-302 in your textbook.

1. Glucose is metabolized by your body according to the following equation:

$$C_6H_{12}O_6(s) + 6O_2(g) \rightarrow 6\ H_2O(l) + 6\ CO_2(g) + 2220\ kJ$$

a) Is this reaction endothermic or exothermic?

b) What is the ΔH for this reaction? Include the correct sign.

c) How much energy is produced by metabolizing 25.0 g of glucose?

2. The ΔH formation for tin (IV) chloride is –511.3 kJ/mol. If 250.0 g of tin (IV) chloride are produced from their elements in their standard states, how much heat is released?

Part VI: Reaction Rates

How is reaction rate calculated?

Four ways the rate of a reaction can be changed include:

1. The rate law for the reaction NO(g) + O_3 (g) → NO_2(g) + O_2(g) is first order in NO and second order overall. Write the complete rate law for this reaction. If the concentration of NO doubles, how will the reaction rate be affected? (Refer to your notes)

2. A chemical reaction occurs in several steps:

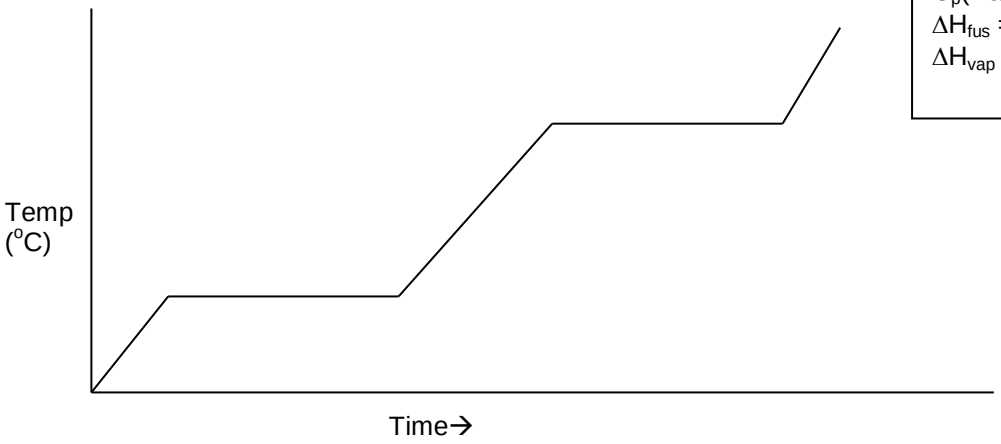
   Step 1: A + 2B → C fast
   Step 2: C + A → D slow
   Step 3: 3 D → E fast

   What is the overall (net) reaction?
   What intermediates are formed?
   What step determines the overall rate of the reaction?

Part VII: Phase Changes

Use the following constants in your problems:
C_p(ice) = 2.077 J /g ^oC
C_p(water) = 4.180 J /g ^oC
C_p(water vapor) = 2.042 J /g ^oC
ΔH_{fus} = 6.00 kJ/mol= 333 J/g
ΔH_{vap} = 40.6 kJ/mol = 2254 J/g

The following is a heating curve for water. The water is initially frozen solid.



1. Label the graph to show which phase (or phases) are present on each segment and the temperatures at which phase changes occur.

2. The amount of heat absorbed by the water can be calculated for any segment of the curve. Next to each segment of the graph, write the appropriate equation showing how to calculate the heat absorbed in that segment.

If 200.0 g of ice at -25.0^oC are converted to steam at 115.0^oC, how much heat is absorbed by the water. (This is a five step calculation!)