Honors Pre-AP Chemistry—Chapter 6—Thermochemistry Test

Name__________________________________ Date_________________ Section_____

Answer the following questions. Questions 1-8 (12 pts each). Question 9 (20 pts).

1) If 1.507 g of NH_4Cl is dissolved in 100.0 g of water at 25°C, the temperature of the water drops to 23.98°C. Calculate the heat of the <u>solution</u> (q_{sol}), the heat of the <u>reaction</u> (q_{rxn}), and the ΔH_{rxn} in (kJ/mol). The "s" for water is 4.184 J/g°C.

2) When 57.7 g of copper metal at 99.0°C is added to 100.0 g of water at 27.5°C, the final temperature is found to be 31.0°C. What is the molar heat capacity "s" of the metal? The "s" of the water is 4.184 J/g^{0}C

3) A 2.02 g sample of quinine, $C_6H_4O_2$, is burned in a bomb calorimeter whose heat capacity "C_p" is 7.845 kJ/°C. The temperature of the calorimeter increases from 23.44°C to 30.57°C. What is the heat of combustion per gram of the quinine? Per mole of quinine?

4) For the following reaction, **$2\ C(s) + H_2\ (g) \rightarrow C_2H_2\ (g)$**

Apply Hess's Law to the following steps for this reaction.

$C_2H_2 + 5/2\ O_2 \rightarrow 2CO_2 + H_2O$	$\Delta H = -1299.6$ kJ
$C + O_2 \rightarrow CO_2$	$\Delta H = -393.5$ kJ
$H_2 + ½\ O_2 \rightarrow H_2O$	$\Delta H = -285.9$ kJ

5) For the following reaction,

$C_2H_2\ (g) + 5\ N_2O\ (g) \rightarrow 2\ CO_2\ (g) + H_2O\ (g) + 5\ N_2\ (g)$

Apply Hess's Law to the following steps for this reaction.

$2\ C_2H_2 + 5\ O_2 \rightarrow 4\ CO_2 + 2\ H_2O$	$\Delta H = -2512$ kJ
$N_2 + ½\ O_2 \rightarrow N_2O$	$\Delta H = 104$ kJ

6) Consider the reaction between solid silver sulfide and liquid water producing silver metal, hydrogen sulfide gas, and oxygen gas. **Note: ΔH_f** of Ag_2S = -31.8 kJ/mol.
H_2O = -241.8 kJ/mol
H_2S = -20.2 kJ/mol
Ag = 0

$2\ Ag_2S\ (s) + 2\ H_2O\ (l) \rightarrow 2\ H_2S\ (g) + O_2\ (g) + 4\ Ag\ (s)$

What is the enthalpy of the reaction?

What is the heat required to produce 0.0928 mol of silver? (EC)

7) The complete combustion of acetone, C_3H_6O, results in the liberation of 1790 kJ.

$$\mathbf{C_3H_6O\ (l) + 4\ O_2\ (g) \rightarrow 3\ CO_2\ (g) + 3\ H_2O\ (l) \qquad \Delta H = -1790\ kJ}$$

ΔH_f for C_3H_6O = ?

$O_2 = 0$

$CO_2 =$ -393.5 kJ/mol

$H_2O =$ -285.8 kJ/mol

8) What is the Δ**E** for a reaction (system) if the surroundings transfer **375 J of heat** to the system and the system exerts **2.3 atm of pressure** on the surroundings changing the volume by **5.2 L**? Note: (101.3 J/atm L)

9) **The standard molar enthalpies of formation for CH_4 (g) and C_2H_6 (g) as follows: -74.8** kJ/mol**, and -84.68** kJ/mol **respectively.**

Calculate the heat of combustion (ΔH_{rxn}) for these hydrocarbons when the combine with gaseous oxygen (O_2) to produce CO_2 (g) and H_2O (l).

ΔH_f CO_2 (g) **= -393.5 kJ/**mol　　　　　ΔH_f H_2O (l) **= -285.8** kJ/mol

What is the **ΔH/mol** for **each** hydrocarbon reaction. Which one is the **more efficient per mole?** (Hint: after calculating ΔH of the reactions, set up ratios to find ΔH for one mole of hydrocarbon)

CH_4 (g) + 2 O_2 (g) $\rightarrow$ CO_2 (g) + 2 H_2O (l) ///// 2 C_2H_6 (g) + 7 O_2 (g) $\rightarrow$ 4 CO_2 (g) + 6 H_2O (l)

Equations

$q = s\,m\,\Delta T \quad s_{H2O} = 4.184$ J/g ^oC

$q_{rxn} = -\,q_{sol} \qquad q_{rxn} = -\,q_{cal}$

$q_{bomb\ cal} = C_p\,\Delta T$

$q_{metal} = -\,q_{H2O}$ **or** $(m\,s\,\Delta T)_{metal\,=\,-}\,(m\,s\,\Delta T)_{H2O}$

$\Delta E = q + w \qquad w = (P\Delta V)(101.3)$

$\mathbf{\Delta H_{rxn} = \sum n\,\Delta H_{f\,(prod)} - \sum n\,\Delta H_{f(react)}}$