CHM 1010 **GAGE**

PROBLEM INVOLVING ENERGY IN PROCESSES

1. Decide whether each of the following processes are endothermic or exothermic:

a. condensing steam into water	exothermic
b. burning a candle	exothermic
c. melting ice cream	endothermic
d. cooling hot coffee	exothermic
e. formation of snow flakes	exothermic
f. heating iron to form iron (II) oxide (from Reactions lab)	endothermic

2. a. How many kJ are represented by 3.44×10^4 cal of heat?

$$3.44 \times 10^4 \times \frac{4.184\ \text{J}}{1\ \text{cal}} \times \frac{1\ \text{kJ}}{1000\ \text{J}} = 144\ \text{kJ}$$

b. If a reaction releases 70.8 kJ, how many nutritional calories does it generate?

$$70.8\ \text{kJ} \times \frac{1\ \text{kcal}}{4.184\ \text{kJ}} = 16.9\ \text{kcal or nutritional cal}$$

since 4.184 J = 1 cal, 4.184 kJ = 1 kcal

1 kcal = 1 nutritional cal

c. How can you determine the amount of heat exchanged in a reaction?

You can do the reaction in a container immersed in a known amount of water. If you measure the change in the temperature of the water you can calculate the energy released or absorbed since it takes 1 calorie (or 4.184 J) to raise one gram of water by 1 degree centigrade (or 1 cal absorbed for each 1 degree drop per gram).

3. Use the following equation to answer the questions that follow it:

$$2\ H_2O\ (l) \ \text{---->}\ 2\ H_2\ (g) + O_2\ (g) \qquad \Delta H = +571.6\ \text{kJ}$$

a. Is this process exothermic or endothermic and why?

Endothermic since ΔH is positive which means products contain more energy than the reactants.

b. How many kJ are transferred when 25.0 g of water are decomposed?

$$25.0\ \text{g}\ H_2O \times \frac{1\ \text{mol}\ H_2O}{18.0\ \text{g}\ H_2O} \times \frac{571.6\ \text{kJ}}{2\ \text{mol}\ H_2O} = 397\ \text{kJ}$$

c. How many g of hydrogen are produced when 775 J of energy are used?

$$775\ \text{J} \times \frac{1\ \text{kJ}}{1000\ \text{J}} \times \frac{2\ \text{mol}\ H_2}{571.6\ \text{kJ}} \times \frac{2.00\ \text{g}\ H_2}{1\ \text{mol}\ H_2} = 5.4 \times 10^{-3}\ \text{g}\ H_2$$

d. How many mol of water are decomposed if 450 kJ are used?

$$450 \text{ kJ x } \frac{2 \text{ mol } H_2O}{571.6 \text{ kJ}} = 1.57 \text{ mol } H_2O$$

4. Use the following equation to answer the questions that follow it:

CH_4 (g) + $2\ O_2$ (g) ----> CO_2 (g) + $2\ H_2O$(l) $\Delta H = -890.4$ kJ
methane

a. Is this process exothermic or endothermic and why?
Exothermic because ΔH = - so the products have less energy than the reactants and energy was released.

b. How many moles of methane are required to transfer 4.66×10^3 kJ?

$$4.66 \text{ x } 10^3 \text{ kJ x } \frac{1 \text{ mol } CH_4}{890.4 \text{ kJ}} = 5.23 \text{ mol } CH_4$$

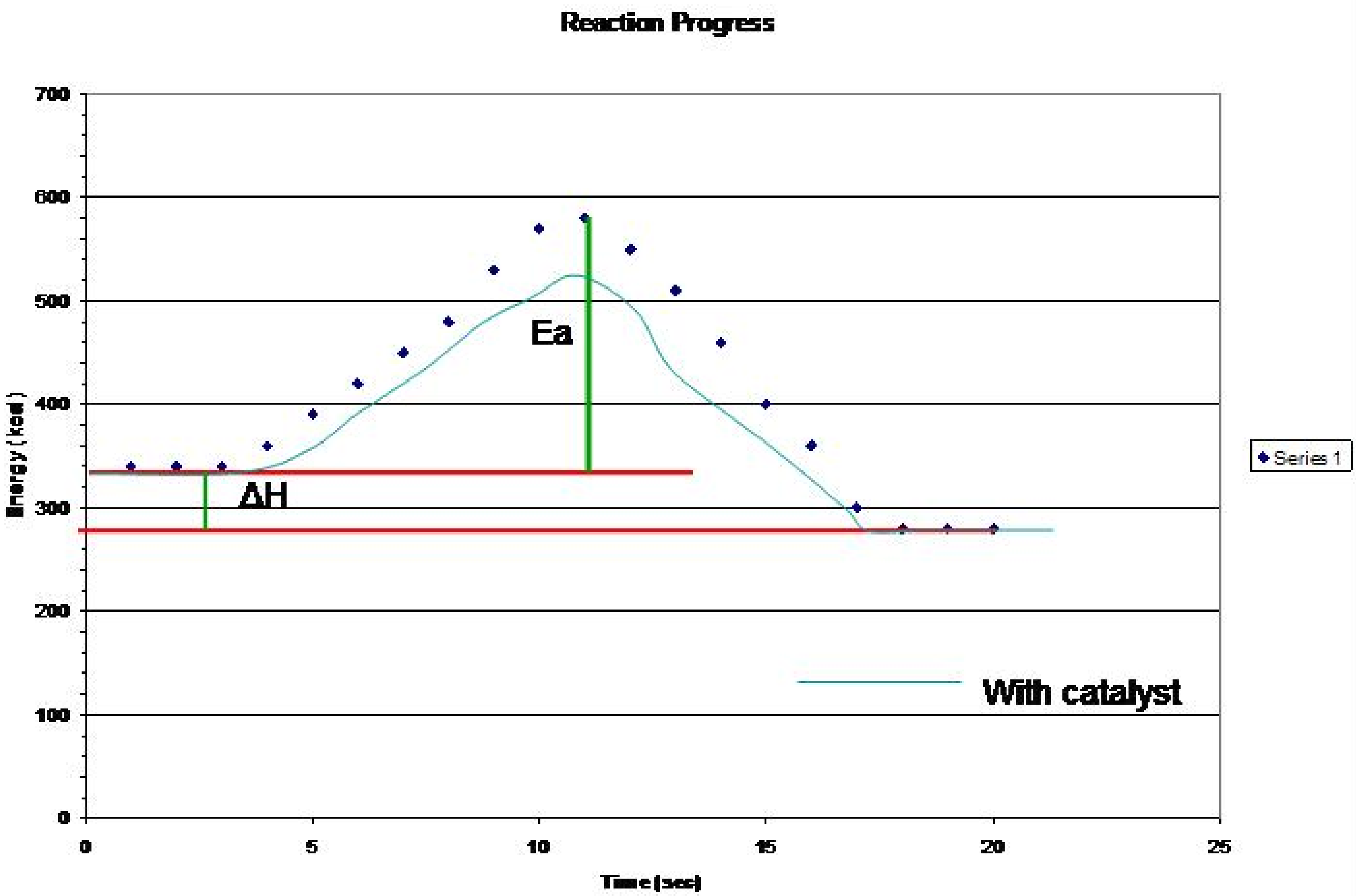
c. If you start with 10.0 g of methane and 20 g of oxygen gas, how much energy will be transferred?

$$10.0 \text{ g } CH_4 \text{ x } \frac{1 \text{ mol } CH_4}{16.0 \text{ g } CH_4} \text{ x } \frac{890.4 \text{ kJ}}{1 \text{ mol } CH_4} = 557 \text{ kJ}$$

$$20.0 \text{ g } O_2 \text{ x } \frac{1 \text{ mol } O_2}{32.0 \text{ g } O_2} \text{ x } \frac{890.4 \text{ kJ}}{2 \text{ mol } O_2} = 2.8 \text{ x } 10^2 \text{ kJ}$$

The answer is 2.8×10^2 kJ because this is a limiting reactant situation and you select the least amount of energy released.

5. Use the graph below to address the questions that follow it:



a. Determine the activation energy for this reaction.
   580 – 335 kcal = 245 kcal
b. Is the reaction endothermic or exothermic? Explain how you know.
   Exothermic because the final products have less energy than the reactants so energy must have been released.
c. Determine the amount of energy absorbed or released in the process.
   335-280 kcal = 55 kcal
d. On the axes above, sketch the graph of the reaction if a catalyst is added.
   See graph above