Unit 13 Review - Thermochemistry

LT1: I can distinguish between exothermic and endothermic reactions

1. List 4 characteristics of an exothermic process and list 2 examples.

energy is released
feels hot
energy of products is higher than reactants
heat flows from system to surroundings

hot packs
burning logs

2. List 4 characteristics of an endothermic process and 2 examples.

energy is absorbed
feels cold
energy of reactants is higher than products
heat flows from surroundings to system

melting ice
boiling water

3. Explain heat flow for the following reactions using the terms systems and surroundings:
   a. Endothermic

heat flows from surroundings into the system.

   b. Exothermic

heat flows from system to surroundings

LT2: I can convert between different units of energy

4. Complete the following unit conversions
   a. 14 Calories to Joules

$$14\,\text{Cal} \times \frac{1000\,\text{cal}}{1\,\text{Cal}} \times \frac{4.184\,\text{J}}{1\,\text{cal}} = 59{,}000\,\text{J}$$

   b. 190 calories to Joules

$$190\,\text{cal} \times \frac{4.184\,\text{J}}{1\,\text{cal}} = 790\,\text{J}$$

   c. 3848 Joules to Calories

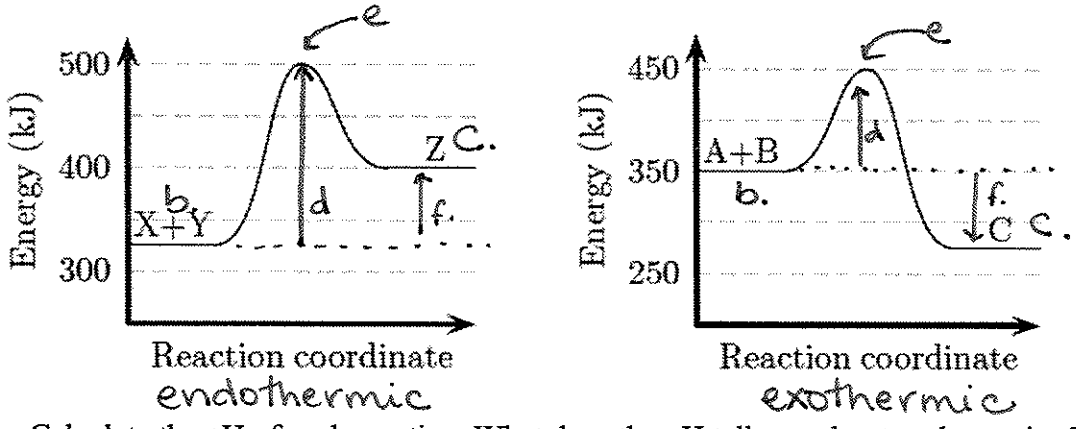
$$3848\,\text{J} \times \frac{1\,\text{cal}}{4.184\,\text{J}} \times \frac{1\,\text{Cal}}{1000\,\text{cal}} = .9197\,\text{Cal}$$

5. Put these units in order from smallest to largest (cal, Cal J, kJ,)

J, cal, KJ, Cal

LT3: I can explain what is meant by enthalpy and enthalpy changes.
LT4: I can draw and interpret exothermic/endothermic energy diagrams

6. Label the following on the diagrams below
   a. Exothermic or endothermic
   b. Energy of reactants
   c. Energy of products
   d. Activation energy
   e. Activated complex
   f. ΔH



7. Calculate the ΔH of each reaction. What does the ΔH tell you about each reaction?

+75kJ -75 kJ

amount of energy absorbed or released

LT5: I can use enthalpy of a reaction in order to calculate the heat involved for any mass of a substance used in a chemical reaction (thermostoich)

Hydrazine (N_2H_4) reacts with chlorine gas according to the following equation.

$$N_2H_4\,(l) + 2\,Cl_2\,(g) \rightarrow 4\,HCl\,(g) + N_2\,(g) \qquad \Delta H = -420.0\ kJ$$

Calculate the change in enthalpy for this reaction under each of the following conditions.

8. 25.4 g of hydrazine reacts with excess chlorine.

$$25.4\ g\ N_2H_4 \times \frac{1\ mol\ N_2H_4}{32.06\ g\ N_2H_4} \times \frac{-420.0\ kJ}{1\ mol\ N_2H_4} = -333\ kJ$$

9. 1.45 mol HCl is generated.

$$1.45\ mol\ HCl \times \frac{-420.0\ kJ}{4\ mol\ HCl} = -152\ kJ$$

For the reaction $2\ Mg\ (s) + O_2\ (g) \rightarrow 2\ MgO\ (s)$ $\quad \Delta H = -288$ kcal.

10. Calculate the change in heat when 45.32 g MgO is produced

$$45.32\text{g MgO} \times \frac{1\text{mol MgO}}{40.31\text{g MgO}} \times \frac{-288\text{ kcal}}{2\text{mol}} = -161.9\text{ kcal}$$

161.9 kcal produced

11. Calculate how many grams of MgO will be produced if 1,356 kcal are produced.

$$-1356\text{kcal} \times \frac{2\text{mol MgO}}{-288\text{ kcal}} \times \frac{40.31\text{g MgO}}{1\text{mol MgO}} = 379.6\text{ g MgO}$$

LT6: Calculate the heat lost or gained by any material by using its specific heat

12. What does the specific heat capacity tell us about a substance?

The amount of energy required to change 1 gram by 1°C

13. What does the size of specific heat tell us about a substance?

higher the specific heat the more energy needed to be gained/lost to change the temperature

14. What is the specific heat of aluminum if the temperature of a 56.8 g sample of aluminum is increased by 9.2°C when 454 J of heat is added?

$q = ms\Delta T$

$m = 56.8g$
$S = x$
$\Delta T = 9.2°C$
$q = 454J$

$$S = \frac{q}{m\Delta T} = \frac{454\text{J}}{56.8\text{g} \times 9.2°\text{C}} = .87\text{ J/g°C}$$

15. How much heat is absorbed by 15.34 grams of gold when the temperature goes from 76°C to 102.9°C? (Specific heat of gold is 0.129 J/g°C)

$q = x$
$m = 15.34g$
$S = .129\text{J/g°C}$
$\Delta T = 102.9 - 76 = 26.9 = 27°C$

$$q = 15.34 \times .129\text{J/g°C} \times 27°\text{C} = 53\text{J}$$

16. A 29.87 gram piece of Titanium absorbs 79.89 J of heat. If the metal starts out at 64.6°C, what is the **final temperature** of the metal? (Specific heat of titanium is 0.52 J/g°C)

q 79.89J
m 29.87g
S .52J/g°C
ΔT x −64.6°C

$$\Delta T = \frac{q}{ms} = \frac{79.89}{29.87 \times .52\text{J/g°C}} = 5.1°\text{C}$$

$\Delta T = T_f - T_i$
$5.1°C = x - 64.6$
$T_f = 5.1 + 64.6 = 69.7°C$

LT7: I can describe how a calorimeter determines energy of a system

17. How does the energy change of the system compare to the energy change of the surrounding.

Quantity is the same, but value is opposite.

$q_{sur} = -q_{sys}$

18. A 20.26 g sample of an unknown solid is heated to 78.3°C and placed into a calorimeter containing 43.83 g of water at 30.7°C. If the final temperature of the solid sample and water is 33.3°C, what is the specific heat of the solid?

$q_{sur} = -q_{sys}$

m 43.83g m 20.26g
S 4.184J/g°C S
ΔT 33.3 − 30.7 = 2.6 ΔT 33.3 − 78.3°C = −45.0°C

$S = \frac{43.83\,g \times 4.184\,J/g°C \times 2.6°C}{-20.26 \times -45.0°C}$

$= .523\,J/g°C$

Substance	Specific heat in J/g°C
Gold	0.129
Iron	0.449
Titanium	0.523
Copper	0.385

Titanium

19. An unknown mass of water at 58.3°C is mixed with 25.5 g of ethanol at 44.0°C. The final temperature of the mixture is 52.8°C. The specific heat of water and ethanol is 4.184 J/g°C and 2.44 J/g°C respectively. What is the mass of water?

$q_{sur} = -q_{sys}$

m x m 25.5g
S 4.184J/g°C S 2.44J/g°C
ΔT 52.8 − 58.3°C = −5.5 ΔT 52.8 − 44.0 = 8.8°C

$m = \frac{25.5\,g \times 2.44\,J/g°C \times 8.8°C}{-4.184\,J/g°C \times -5.5°C}$

$= 23.8\,g\ H_2O$

$= 24\,g\ H_2O$