WLHS / Chem / Monson – Unit 9 Thermochemistry Name_____
Date_____Per_____

ACTIVITY: Energy of Combustion of a Candle Activity

INTRODUCTION:

In this activity you will determine the energy released from the combustion of a candle. The energy from the flame is from the candle wax burning. Energy is released as the bonds in the candle wax molecules and oxygen molecules break. Some of the energy remains in the chemical bonds of the products, carbon dioxide and water. The rest of the energy is released as heat and light.

- the reactants are: **candle wax ($C_{20}H_{42}$) and oxygen (O_2).**
- the products are: **carbon dioxide (CO_2) and water (H_2O)**.
- the amount of heat produced will depend on the amount of wax burned.

In this activity, the heat released per gram of candle wax burned will be determined using the following equations:

Heat lost by the candle = Heat gained by water in the can

Heat gained by water = mc∆T = mass of water • specific heat of water • ∆T of water

Energy of combustion of candle wax = heat lost by candle wax / mass of wax lost

Specific heat of water = 4.18 J/g•°C

$$\textbf{Heat of Combustion} = \frac{\textbf{Heat lost by candle } (J)}{\textbf{mass of candle wax that burned } (g)}$$

Procedure:

1) With the candle apparatus (large can) in place, adjust the height of the small can so that the bottom of the can is about 1-2 inches above the tip of the candle wick. The tip of the flame should almost but not quite reach the bottom of the can. ***The candle apparatus protects the candle from drafts.***

2) Mass the candle and large can to the nearest 0.01 gram. Record the mass of candle and can in your data table. Note the balance so that when you mass the candle again you can use the same balance.

3) Fill a beaker with approximately 300 mL of water from the cold water tank / cooler. **Do not record this temperature.**

4) Fill the small soda can **about two-thirds full with cold water** from the beaker. **Absolutely NO ice can be in the pop can!** Do not measure the volume of the water at this time.

5) Read and **record** the temperature of the water to the nearest 0.1°C.

6) Light the candle and quickly place the can of water in position. Heat the water, stirring it gently, until it reaches about 45°C. Carefully blow out the candle flame. Continue to stir the water, while watching the thermometer reading, **until the highest temperature is reached**. **Record** the highest temperature reached to the nearest 0.1 °C.

7) Mass the candle on the same balance that was used before. Make certain that any drippings from the candle are massed with it. **Record** the mass.

8) Using a graduated cylinder, measure and **record** the water volume to the nearest mL. *(**You may need to fill the graduated cylinder multiple times)*

9) Repeat above steps for a second trial.

Data Table: INCLUDE APPROPRIATE UNITS!!

MEASUREMENT:	**TRIAL 1:**	**TRIAL 2:**
Mass of can and candle BEFORE combustion		
Mass of can and candle AFTER combustion		
Temperature of H_2O BEFORE heating		
Temperature of H_2O AFTER heating		
Volume of H_2O		

Processing the Data: Show equation used, substitution of values, and your answer **with correct sig fig and units!**

1) Determine the mass of candle wax burned for each trial.

TRIAL 1: **TRIAL 2:**

2) Determine the mass of water heated for each trial.
(use the density of water) $\mathbf{D_{water} = 1.0\ g/mL}$

Density = mass / Volume, so mass = (Density)•(Volume)

TRIAL 1: **TRIAL 2:**

3) Determine the temperature change of the water for each trial.

TRIAL 1: **TRIAL 2:**

4) Calculate the quantity of heat absorbed by the water in the soda can for each trial.

TRIAL 1: **TRIAL 2:**

5) Based on your answer to #4, what amount of energy was released by the burning wax for each trial?

TRIAL 1: **TRIAL 2:**

6) Calculate the heat of combustion for candle wax (Joules per gram) for each trial.

TRIAL 1: **TRIAL 2:**

7) Determine the average heat of combustion value from your two trials.

POST-LAB Questions:

1) What type of reaction is burning candle wax? (endothermic or exothermic)

2) Was all the heat released by the candle absorbed by the water? Explain. *(HINT: where else could some of the heat have gone??)*

3) In steps 4-5 of the procedure, you measured and recorded the initial temperature of the water after pouring it into the soda can and it was important for no ice to be in the water. **WHY?**

4) A Calorimeter is a device used to capture heat from a reaction. In this experiment the pop can was a calorimeter. What properties make a good calorimeter?

5) The actual value for heat of combustion of wax is 38,000 J/g. What was your experimental percent error? (use the average value you obtained)

APPLICATION QUESTION: Burning a peanut with a mass of 0.609 grams releases enough energy to raise the temperature of 500.0 grams of water from 22.0^{o}C up to 32.0 ^{o}C.

A) How many joules are contained in the peanut? (HINT: calculate the energy absorbed by the water first!)

B) What is the energy content of the peanut in Joules per gram (J/g)?

C) What is the energy of the peanut in kcal per gram? (1 kcal = 4180 Joules)

D) If one “serving” of peanuts is 28 peanuts, what is the energy contained in one serving of peanuts (in kcal)? (assume each peanut has a mass of 0.609 g)