Lab- Honors
Heat of Combustion
[20 pts]

Name _____
Lab Partner(s) _____
Period _____ ***Date***_____

Introduction: In this experiment you will determine the amount of heat released when a candle and a corn nut burn. You will determine how much heat is released by warming up a known amount of water. We will measure the heat released in calories, an old unit of heat, to compare our measurements to food Calories. One calorie is defined as the amount of heat needed to heat up 1g of water by 1°C. We will assume that all of the heat released is absorbed by the water. Thus, you can find the amount of heat released by determining the amount of heat absorbed by the water. To do this, use the following formula:

heat absorbed by water = (mass of water heated) $\left(\frac{1\text{ cal}}{1\text{ g}\cdot 1°\text{C}}\right)$ **(change in water temperature)**

or more simply : **heat absorbed = mcΔT** where **c** is the specific heat of water (1 cal/g ºC)

Part I: Procedure for Combustion of a Candle

1) Attach a candle to a piece of cardboard. Find the mass of the candle/cardboard combination.
2) Set up the apparatus (ring stand, ring, tin can, stirring rod). Put the candle just below the can, so that the flame of the candle when lit will just touch the bottom of the can. *(Do not light the candle yet.)*
3) Use a graduated cylinder to obtain 200.0 mL of cold ice water to the can (obtain from bottle). Record the mass of this volume of water. *(The volume of water in mL will be equal to the mass of the water in grams since we can assume that the density of water is 1.0 g/mL.)*
4) Record initial temperature of water to the nearest 0.1°C.
5) Light the candle and begin heating the water. Periodically stir gently. Continue heating until the water temperature has increased by about 20°C. At this point, carefully blow out the candle, but continue to stir the water and watch temperature readings. Record the highest temperature that is reached.
6) Determine and record the mass of the candle/cardboard after burning *(Make sure you don't lose any wax drippings. Remember, you want to find out how much candle was actually burned.).*

Part II: Procedure for Combustion of a Corn Nut.

7) Find the total mass of two corn nuts on a cork/paper clip stand. Record below.
8) Set up the apparatus (ring stand, ring, tin can, stirring rod). Put the paper clip stand with the corn nut just below the can so the flame will just touch the can as before. *(Do not light the corn nuts yet.)*
9) Add 200.0 mL of cold ice water as before. Record the mass of this volume of water as before.
10) Read and record the initial temperature of the water to the nearest 0.1°C.
11) Light a wooden splint and use it to light the corn nuts directly. (Hold wooden splint underneath the corn nuts until they burns on their own. The water will begin to warm up.
12) When the corn nuts stop burning, stir the water and record the highest temperature that is reached.
13) Carefully carry the paper clip stand with the corn nut residue over to the balance. Mass out.

DATA:

	I. Candle Data	**II. Corn Nut data**
initial mass of candle/board or corn nut		
final mass of candle/board or corn nut		
change in mass of candle or corn nut		
initial temperature of water		
final temperature of water		
change in water temperature		
mass of water heated (vol in mL = mass in g)		

Write up: [20 pts] Do the rest on a separate sheet of paper.
Calculations: [9 pts] You must show all steps in calculations clearly. Every number must have units. Every answer must have correct sig figs. *(Be particularly careful of the sig figs in ΔT values—often they only give 2 or 3 sig figs.)*

1) For candle:
   a) [1 pt] Calculate the quantity of heat (in cal) absorbed by the water when the candle was burned.
   b) [1 pt] Calculate the heat released per gram of candle burned (in cal/g). Write your value(w/ correct SF's) in the shared Google doc along with the initials of all lab partners.
   c) [0.5 pt] At the end of class, we will calculate the class average for question (b). Just record the class average.
   d) [1 pt] The accepted value for burning a candle is about 10,000 cal/g. Calculate your percent error.
   e) [1 pt] Convert your value of cal/g into kJ/g. (1000 cal = 1 kcal = 4.184 kJ)
   f) [1 pt] Candles are made of paraffin. Paraffin has the formula $C_{25}H_{52}$. The heat of combustion (ΔH_{comb}) of paraffin can be expressed in kJ per mole of paraffin burned. Calculate the ΔH of paraffin in kJ/mole. *Remember: Put in the correct sign (+/–) for ΔH. (Hint—Does burning paraffin release or absorb heat?)*
2) For corn nut:
   a) [1 pt] Calculate the quantity of heat (in cal) absorbed by the water when the corn nut was burned.
   b) [1 pt] Calculate the heat released per gram of corn nut burned. (in cal/g)
   c) [1 pt] How many food Calories were released per gram of corn nut burned? (Cal/g) *1 Food Calorie = 1 Cal = 1 kcal = 1000 cal*
   d) [0.5 pt] The accepted value for the Cal/g for a corn nut is 4.4 Cal/g. Calculate the percent error of your value.

Conclusions: [4 pts]

3) Discuss the results of burning the candle. Include the following in your discussion:
   - [0.5 pt] Compare your value of cal/g for the combustion of your candle to that of the class average. Was your value similar to the class average?
   - [0.5 pt] Compare your value of cal/g for the candle with the accepted value. State your percent error. Was your value too high or too low?
   - [1 pts] Typically, experimental cal/g values in this lab are significantly and consistently low. Explain what the main source of heat loss is for this experiment.
4) Discuss the results of the combustion of the corn nut. Include the following in your discussion:
   - [0.5 pt] What percent error did you compute?
   - [0.5 pt] Again, typically experimental heat of combustion values are consistently too low. Again, what is the main source of heat loss?
   - [1 pt] However, for the burning of the corn nut, there is a reason for the water to gain more heat than it should. What could cause this to happen? (How did you light the corn nut?)

Post Lab Questions: [7 pts] *You must show all steps in calculations clearly. Every number must have units. Every answer must have correct sig figs.*

5) [1 pt] The combustion of acetylene, C_2H_2, can be represented as $C_2H_2 + O_2 \rightarrow 2\ CO_2 + 2\ H_2O + 1256$ kJ
   How much heat (in kJ) is produced if 15.0 g of acetylene is burned?

6) [2 pts] One ounce of a popular frosted cereal contains 3.0 teaspoons of sugar. When burned, this sugar can heat 860 g of water from 22°C to 85°C.
   a) How much energy (in cal) was contained in the three teaspoons of sugar?
   b) How many food Calories are contained in one teaspoon of sugar?

7) [3 pts] Assume that your regular diet and regular amount of exercise just maintains your current body weight. Suppose that today you wish to eat an extra ice-cream sundae. This sundae contains 375 Cal.
   a) How many minutes of rollerblading would burn the sundae off if you expend 5.6 Cal per minute?
   b) How many minutes of studying would you have to do to burn of the sundae if you expend 1.7 Cal per min?
   c) If you choose not to exercise more than usual, how much weight will you gain if you had an extra sundae three times each week for exactly 16 weeks? (1 lb. of body fat = 4000.0 Cal of energy)

8) [1 pt] Ultimately, chemical energy comes to be stored in petroleum, plants and animals because of photosynthesis. The equation for photosynthesis is $6\ CO_2\ (g) + 6\ H_2O \rightarrow C_6H_{12}O_6\ (s) + 6\ O_2\ (g)$
   Photosynthesis is the reverse of burning glucose. Thus, is photosynthesis an exothermic or endothermic reaction? What else is needed (besides CO_2 and H_2O) to get photosynthesis to occur?