Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_

Lab Section: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**CHEM 131 Lab Experiment:**  **Energy of a Snack Food**

**Background**

**Calorimetry** is a technique that is used to determine the heat involved in a chemical reaction. When determining the heat of combustion of a substance or the caloric value of foods, the measurements are often made using a *bomb calorimeter (Figure 1)*.

 In this device, the weighed sample is placed in a heavy steel container called a *bomb* and the atmosphere of the bomb is filled with pure oxygen. The bomb is then placed in a well-insulated container called a **calorimeter** which has been filled with a measured amount of water. The sample, in the pure oxygen atmosphere, is ignited by an electric spark and the heat generated by the burning sample warms the bomb and the surrounding water. At equilibrium, both the bomb and the water will be at the same temperature.

***Figure 1***

Using the law of conservation of energy:

Heat evolved by the reaction = Heat absorbed by the water + Heat absorbed by the bomb

or, in equation form: qreaction = -(qwater + qbomb ) (where qis the symbol for heat)

The qreaction has a negative value because the combustion reaction is **exothermic**(i.e., it releases energy to the surroundings). The qwater and the qbomb are calculated from the temperature change of the water and the bomb and the specific heat of the water and the bomb. The total gives the heat of combustion of the sample that was used.

In this experiment, the energy of a snack food will be determined using a simplified set-up. The snack food will be burned in air, instead of pure oxygen. Instead of a heavy metal bomb, a metal can, such as an aluminum soft drink can small juice or soup can is used. To eliminate the determination of the specific heat of the metal can (the heated needed to heat the metal that composes the can), the experimental conditions are modified to maintain a constant temperature of the can by filling it with a large quantity of ice. This will maintain a temperature of 0ºC, as long as all the ice does not melt. The heat evolved by the burning snack food will melt some of the ice and the amount of liquid water formed will be measured to give the heat of combustion of the sample. After determining the energy of a snack food, the procedure will be repeated using other foods.

**Materials needed**

a metal can (a small juice can, soup can, or soft drink can) with the top removed

heavy wire stand to hold the snack food

150ºC thermometer

graduated cylinder, 50 or 100-mL

tongs or forceps

funnel

snack foods such as cheese curls, potato chips, etc...

**Safety precautions**

Wear safety goggles at all times in the laboratory.

**CAUTION – HEALTH HAZARD:**

* There are no safety hazards with any of the materials used in this experiment.
* The metal stand holding the sample will get hot during the reaction. Handle it using tongs or forceps.
* **Do not eat any of the foods used in this experiment**. It is assumed that they may be contaminated with laboratory chemicals.
* **Disposal -** There are no disposal problems with materials in this experiment. Burnt snack food, can be disposed of in the trash. Ice and water should be placed in sink.

**Procedure**

1. Obtain a metal can. If necessary, wipe any carbon deposits off the bottom of the can using a paper towel.



1. Set up the apparatus as shown in Figure 1. Use a large adjustable clamp to hold the metal can. Place a metal stand for holding the snack food on the base of the ring stand. Loosen the clamp and move the metal can off to the side of the apparatus.

**Figure 1** Apparatus for determination of the energy of a snack food

1. Select a snack food, weigh it, and record its mass.
2. Add ice to the can so it is at least half-filled.
3. Place the snack food on the stand and light it using a match or a lighter. Move the can over the burning snack food and position it so that the top of the flame just touches the bottom of the can. Allow the it to burn completely. If the flame goes out and the snack food is not completely burned, relight it. Remember to move the can away from over the snack food when relighting it.
4. After the food material is burned, some charcoal remains. Carefully transfer the remaining material to a **preweighed**piece of weighing paper, or a weighing dish, and weigh it. Determine the mass of the remaining material. The mass of food burned is equal to the initial mass of the food minus the mass of the remaining material.
5. After the food has burned out, using the clamp holding the can as a handle, carefully pour the liquid water (but no ice) from the can into the graduated cylinder. Placing a funnel on top of the graduated cylinder will prevent any solid ice from falling into the cylinder. Determine the volume of the water and record it in your notebook. If desired, you may also measure and record the temperature of the water.
6. Repeat the procedure again with another snack food.

How do your results compare with the caloric values on the label of the food container?

Select a different kind food material (such as corn or cheese curls, potato chips, or tortilla chips) supplied by your instructor. Repeat the procedure twice more using the new food sample.

**Calculations**

In this experiment, heat is measured in **calories**. One calorie is the quantity of heat needed to raise the temperature of 1 g of water by 1ºC. Due to the excess of ice in the metal can, the temperature of the system should remain constant at 0ºC, thus we are melting ice into liquid water at a constant temperature. The heat needed to melt 1 g of ice to water at 0ºC is known as the *heat of fusion* and has a value of 80 cal/g for water.

The density of water is 1.0 g/cm3, so it is assumed that the volume of water in mL will be equal to the mass of the water in g.

 1 mL H2O = 1 g H2O

The heat produced by the snack food is calculated by the equation:

 qfood = mwater x 80 cal/g

where: qfood = heat produced by the food in calories

 mwater = mass of the water in g (this is equal to the volume of the melted ice in mL)

 80 cal/g = the heat of fusion of ice (the heat needed to melt 1 gram of ice)

The heat, in calories, generated by a one gram sample of the food is calculated by the equation:

 q = qfood / mfood

where: q = heat generated per gram of sample in calories

 qfood = heat produced by the burning food in calories

 mfood = mass of the food that burned in grams

Calculate the *nutritional calories* or **kilocalories**available from the snack foods you used. To calculate kilocalories, divide the heat generated by 1 gram of sample by 1000.

kilocalories = q / 1000cal/kcal

where q = heat generated per gram of sample in calories

To calculate "Calories" per gram (from label)

 "Calories" per gram = "Calories" per serving size / Serving size in g

NAME \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ SECTION \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

PARTNER \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ DATE \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Data Sheet**

**Part 1. Energy of a snack food (First Product)**

**Type of food:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

|  |  |  |
| --- | --- | --- |
|  | **Trial 1** | **Trial 2** |
| Mass of food |  | g |  | g |
| Mass of remaining material |  | g |  | g |
| Mass of food that burned |  | g |  | g |
| Volume of liquid water |  | mL |  | mL |
| Mass of liquid water |  | g |  | g |
| Heat produced by food |  | cal |  | cal |
| Heat produced by 1g of food |  | cal/g |  | cal/g |
| Kilocalories of heat from 1g of food |  | kcal/g |  | kcal/g |
| Serving Size (from label) |  | g |
| “Calories” per serving (from label) |  | “Cal” |
| “Calories” per gram (from label) |  | “Cal”/g |

Sample calculation:

**Part 2. Energy of a snack food (Second Product)**

**Type of food:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

|  |  |  |
| --- | --- | --- |
|  | **Trial 1** | **Trial 2** |
| Mass of food |  | g |  | g |
| Mass of remaining material |  | g |  | g |
| Mass of food that burned |  | g |  | g |
| Volume of liquid water |  | mL |  | mL |
| Mass of liquid water |  | g |  | g |
| Heat produced by food |  | cal |  | cal |
| Heat produced by 1g of food |  | cal/g |  | cal/g |
| Kilocalories of heat from 1g of food |  | kcal/g |  | kcal/g |
| Serving Size (from label) |  | g |
| “Calories” per serving (from label) |  | “Cal” |
| “Calories” per gram (from label) |  | “Cal”/g |

Sample calculation:

NAME \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ SECTION \_\_\_\_\_\_\_\_\_

 DATE \_\_\_\_\_\_\_\_\_\_\_\_

**Energy of a snack food**

**Post- lab Questions**

1. Why is it necessary to maintain a large excess of ice in the metal can?
2. What errors do you encounter in this procedure and how do they affect the results (i.e., a large effect or a small effect)?
3. How does your value for the caloric energy of a snack food compare to the label information?
4. Calculate the “calories per gram of fat” (from the label information) for the foods you tested. How do these values compare with your experimental values?

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**Energy of a snack food**

**Pre-lab Assignment**

Define the following terms:

1. calorimetry
2. calorimeter?
3. exothermic reaction?
4. calorie?
5. kilocalorie?

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