Food Explorations Lab:
Energy Balance

STUDENT LAB INVESTIGATIONS

Name: _____

Lab Overview

In this investigation, you will work in groups and with your teacher to determine the potential energy of a peanut through the use of a bomb calorimeter.

Lab Objectives:

In this lab, you will learn how to…

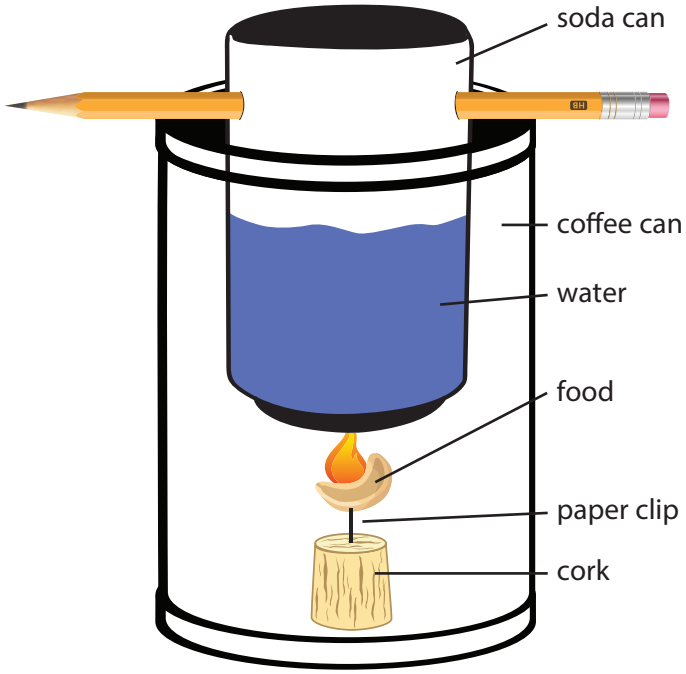
1. Calculate the energy content in peanuts using measurements involving the bomb calorimeter.
2. Compare experimental results to accepted values (Nutrition Fact Label) and identify possible sources of error.
3. Suggest possible design improvements to the bomb calorimeter to reduce error.
4. Explain the importance of maintaining a diet that provides proper calorie content.

Lab Safety: Before beginning ANY investigation you should put on your safety goggles and apron. It is important to avoid getting chemicals on your hands. Always wash your hands following completion of an investigation. When handling food, you should also wash your hands prior to beginning an investigation.

Observations of Burning Energy

MATERIALS

small bowl to weigh peanuts
graduated cylinder or liquid measuring cup (any size)
triple beam balance
distilled water (room temperature)
peanuts



PROCEDURE

In this investigation, you will work in groups and with your teacher to determine the energy density of a peanut through the use of a bomb calorimeter.

1. Within your group, measure 100mL of distilled water.
2. Place your thermometer in the water, wait 30 seconds and record its temperature. Record your findings in Table A.
3. Predict how many peanuts consist of approximately 200 kilocalories. Obtain the amount that represents your prediction, weigh the peanuts, and record the amount of grams in Table B.
4. Your teacher will demonstrate or show a video of the remaining procedural steps within this investigation. Your teacher will weigh and record the weight of a single peanut prior to placing it in the bomb calorimeter. You should also record the weight of the single peanut in Table C.

A bomb calorimeter can be made using everyday items such as a coffee can, soda can, pencil, paperclip and cork.

5. Your teacher will place 100mL of room temperature distilled water in a soda can and then measure the temperature of the water.

6. Your teacher will place the soda can inside of the coffee can.

7. Your teaching will uncoil the paper clip and insert it in the cork.

8. Your teacher will wrap the paper clip attached to the cork around the peanut.

9. Your teacher will ignite the peanut. Once on fire, he or she will immediately place the coffee can around the burning food or insert the burning food into the coffee can through a hole near the bottom.

10. Your teacher will make sure the food burns completely. If the fire goes out, he or she will re-light the food.

11. Once the food has completely burned, your teacher will stir the water with the thermometer and re-measure the temperature. Record the temperature in Table A.

12. After the burned food has cooled, your teacher will measure and record its mass. You should also record the mass in Table C.

Table A: Bomb Calorimeter Water Temperature

	Water Temperature BEFORE Burning (°C)	Water Temperature AFTER Burning (°C)
Peanut	21°C	23°C

Table B: Bomb Calorimeter Mass Prediction

	Mass - PREDICTION (Grams)
Peanut	50g

TABLE C: Bomb Calorimeter Mass Measurements

	Mass BEFORE Burning (Grams)	Mass AFTER Burning (Grams)
Peanut	1g	0g

Conclusion:

1. Calculate the calories released by the peanut in the bomb calorimeter using the following equation:

mcΔT = Q

Q = Amount of Heat Transferred (calories)

m = Mass of Water

C = Specific Heat of Water – 1 cal/g/°C

ΔT = Change in Temperature (°C)

(23 °C after burning) – (21 °C before burning) = 2 °C (ΔT)

100 gram(s) water (**m**) × 1 calorie/g/°C (**c**) × 2 °C (ΔT) = 200 calories(**Q**)

2. Calculate the kilocalories released by the peanut. 1000 calories = 1 kilocalorie

$$\frac{200 \text{ calories}}{1 \text{ gram peanut}} \times \frac{1 \text{ kilocalorie}}{1000 \text{ calories}} = 0.2 \text{ kcal/gram of peanut}$$

3. Using the Nutrition Facts label on the peanut container, find the potential energy (calories per gram – before burning) of the peanut.

160 kilocalories ÷ 28 grams = 5.71 kilocalorie/gram

4. How does the value obtained in question 3 compare to the value in question 2? Describe possible sources of error that would explain any differences.

   The value in question 2 is much smaller. The bomb calorimeter was not closed, so some of the heat could have escaped, decreasing the rise in water temperature.

5. How would you improve the design of the coffee can bomb calorimeter to produce more accurate measurements of caloric energy?

   Because heat loss is a problem, you could heat or cool the water to keep the temperature constant. Then, measure the energy that is required to keep the temperature constant.

6. Using the mass obtained from your prediction (Table B) and your results from question 3, determine how many *actual* total calories (potential energy) are in the peanuts you measured out? By what percentage did you over or underestimate the portion? What surprised you about your estimate of the kilocalorie content of 200 grams peanuts?

   50 (predicted peanuts) grams × 5.71 (kcal/gram peanuts) kcal = 286 kcal predicted peanuts

   286 kcal predicted peanuts ÷ 200 kilocalories = 1.43 x 100 =

   143 % accurate

7. Which method do you think is more accurate when estimating the potential energy (kilocalorie content) of food: (1) looking at the amount of the food and estimating based on your own knowledge or (2) multiplying the amount of food to be eaten by the kilocalories listed on the Nutrition Facts label? Why?

   The most accurate measure of potential energy would be to multiply the amount of food to be eaten by the kilocalories listed on the Nutrition Facts label because the energy in the food has already been measured in a controlled situation. It would be more appropriate to multiply those numbers by the amount eaten than to determine on my own.

8. Based on the reading, why do we need to eat food?

   We need to eat food because it supplies our bodies with the energy needed to function. We need to balance our energy burned with energy consumed.

9. Based on the reading, what will happen if you take in too much potential energy from food? Too little? Describe the negative implications for humans in both situations.

   Too much potential energy from food will lead to body fat storage (overweight and obesity). There are many health problems related to excess fat including heart disease, stroke, and diabetes. Too little potential energy from food will lead to excess burning of stored energy. This can lead to malnourishment and weakness.