Name ______________________ Class ______________ Date ____________

Investigative Lab 7

Food as Fuel

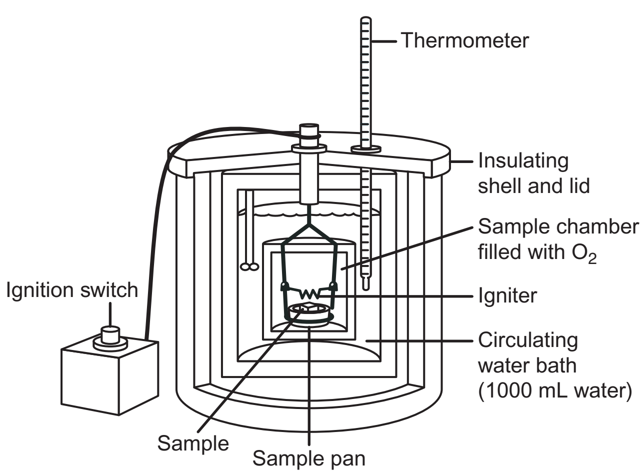
Measuring the Chemical Energy Stored in Food

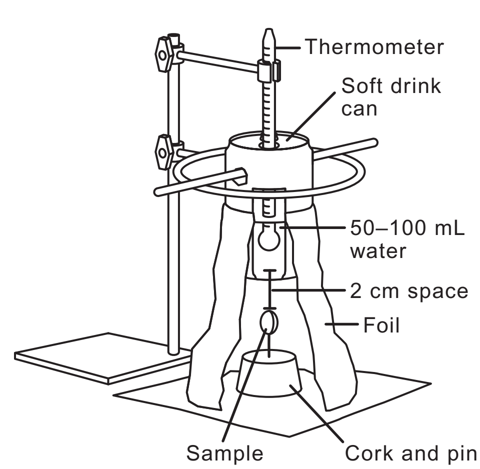
Question How can you measure the calorie content of a peanut?

Lab Overview In this investigation, you will construct and use a simple calorimeter to measure the approximate number of calories in a peanut. You will compare the number of calories in a peanut with the calorie content of other foods. **CAUTION:** *This investigative lab includes peanuts and other food products as materials. If you are allergic to peanuts or any other food products, alert your teacher.*

Introduction Have you ever roasted marshmallows and accidentally set one on fire? You may have been amazed by the size of the flame that the marshmallow fueled! All food contains stored energy that can be released when the food is burned. To investigate the chemical energy stored in food, you need a calorimeter—an apparatus that measures the calorie content of food samples. Recall that a calorie is defined as the amount of energy required to raise the temperature of 1 g of water by 1°C. (Note that the "calorie" counts listed on food packaging labels are given in kilocalories [kcal]. One kilocalorie is equal to 1000 calories.) It is also useful to know that different types of molecules can store different amounts of energy. While proteins and carbohydrates contain 4 kcal/g, fats contain 9 kcal/g.

Prelab Activity Study the diagrams of two calorimeters below. The diagram on the left shows a commercial calorimeter used in laboratories. The diagram on the right shows the calorimeter you will construct and use in this investigation. Compare the features of both calorimeters, then answer the questions.





Prelab Questions

1. Which part of a calorimeter enables you to make measurements? In what units are the measurements?

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2. A food sample burned in the commercial calorimeter raised the temperature of the water surrounding the sample chamber by 4°C. Note that 1 g water = 1 mL water. To calculate the number of calories in the sample, multiply the amount of water in the chamber by the change in temperature in degrees Celsius (°C).

Temperature change of _____ °C × 1000 mL =

_____ calories ÷ 1000 = _____ kcal

3. Suppose you place a food sample in the chamber of the commercial calorimeter. This time, you put only 500 mL of water in the calorimeter. When you burn the sample, the water temperature increases by 2°C. How many kcal were in the food sample?

4. Compare the features of the commercial calorimeter with those of the calorimeter you will construct in the lab. What features do both calorimeters have? How are these shared features different between the two calorimeters?

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5. Do you think that the differences between the shared features of the two calorimeters could affect the accuracy of the measurements you will make in the lab? Explain.

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Materials

- hammer
- nail
- soft-drink can
- ring stand (10-cm or 4-inch ring)
- wooden dowel (3 mm or 1/8 inch in diameter)
- aluminum foil (heavy-duty type)
- water
- graduated cylinder
- samples of foods, including peanuts
- laboratory balance
- thermometer or temperature probe
- cork
- pin to hold food sample (dissecting pins work well)
- safety matches
- calculator (optional)

Procedure

1. Before you begin the construction of your calorimeter, predict which food sample will burn the longest. Explain your prediction.

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2. Use a nail to poke two holes in the opposite sides of the soft drink can as shown. Carefully push the dowel through the can. **CAUTION:** *Be careful not to touch the sharp edges of the holes*.

3. Rest each end of the dowel on the ring on the ring stand.

4. Wrap the foil around the bottom of the soft drink can, creating a tent-like structure. Leave an opening that will allow you to easily place the cork with the food to be tested beneath the can.

5. Measure 75 mL of cool water with a graduated cylinder, and pour it into the soft drink can. (1 mL of water weighs 1 gram; therefore 75 mL = 75 grams.)

6. Record the mass of the peanut to be tested in Data Table 1 on the next page as **Beginning mass of food**.

7. Measure the starting temperature of the water and record it in Data Table 1 as **Initial water temperature**.

8. Gently, but firmly, push the blunt end of the pin into the cork. Hold the sides of the pin rather than pushing on the sharp point. **CAUTION:** *Be careful to avoid injuring yourself with the protruding sharp end of the pin*. Place the food sample to be tested on the sharp end of the pin.

9. Place the cork, pin, and food sample under the soft drink can. Make sure there is approximately a 2-cm space between the soft drink can and the food sample by raising or lowering the ring as needed. **CAUTION:** *Tie back loose hair and make sure your safety goggles are in place before proceeding.*
10. Place the cork with the food sample under the soft drink can, and light the food sample with a safety match. One person should use a clock or watch to time for how long the sample burns and record the time at the bottom of Data Table 1.
11. When the food is burning, determine the highest water temperature reached and record it in Data Table 1 as **Highest water temperature.**
12. When the food sample has finished burning, weigh any remaining ash. Record your results in Data Table 1 as **Final mass of food.**
13. Repeat steps 6 through 12 two more times—one for each additional food sample. Remember to use fresh, cool water for each sample. Record the results in Data Table 1.
14. Use the formulas in Data Table 1 to help you determine the number of kilocalories per gram in each food sample.

Data Table 1

	Peanut	Sample 2	Sample 3
Beginning mass of food sample (g)			
Final mass of food sample (g)			
Mass of food burned (g) (Beginning mass − final mass)			
Beginning water temperature (°C)			
Highest water temperature (°C)			
Water temperature change (°C) (Highest temperature − beginning temperature)			
Mass of water used (1 mL = 1 g)			
Total calories (water mass in g × temperature change in °C)			
Total kilocalories (calories/1000)			
Kilocalories per gram (kcal/g) (total kcal/mass of food burned)			
Time sample burned			

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Analysis and Conclusions

1. Compare your results from the three food samples. Suggest why different foods might produce different results.

2. Do your results agree or disagree with the data below? If your results disagree, suggest two possible reasons why.

Food	**kcal/g**
Peanuts	5.81 kcal/g

3. What happened to the heat that was not "captured" by the water?

4. Which sample burned the longest? Did this agree with your prediction?

5. Look at your data. Is there any relationship between how long a sample burned and its calorie content? Explain.

6. Compare and contrast the burning of food in a calorimeter to the burning of food in your body.

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Extension

Obtain and analyze the data collected by the other students in your class for each type of food sample tested. Then, write a summary comparing the class data with the information in Question 2. Suggest a new experiment to test your hypothesis explaining differences in the data. (**NOTE:** *Be sure to check with your teacher before carrying out any investigations.*)