# Energy in Food

Food supplies energy for all animals—without it we could not live. The quantity of energy stored in food is of great interest to humans. The energy your body needs for running, talking, and thinking comes from the foods you eat. Not all foods contain the same amount of energy, nor are all foods equally nutritious for you. An average person should consume a minimum of 2,000 kilocalories per day, which is equivalent to 8,360 kilojoules. Calories and joules are both units of energy. We will use joules in this lab since it is the accepted SI metric standard.

You can determine the energy content of food by burning a portion of it and capturing the heat released to a known amount of water. This technique is called *calorimetry*. The energy content of the food is the amount of heat produced by the combustion of 1 gram of a substance. It is measured in kilojoules per gram (kJ/g).

## OBJECTIVES

In this experiment, you will

- Use a temperature probe to measure temperature changes.
- Monitor the energy given off by food as it burns.
- Determine and compare the energy content of different foods.

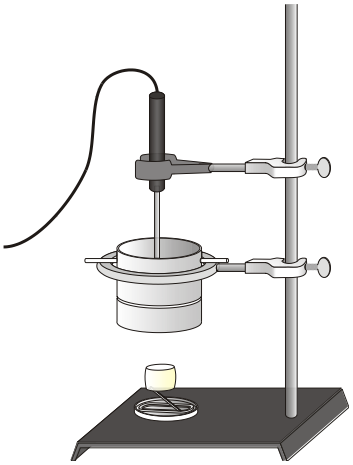

*Figure 1*

## MATERIALS

TI-Nspire handheld **or**
computer and TI-Nspire software
EasyTemp **or** Go!Temp **or**
Temperature Probe and data-collection interface
100 mL graduated cylinder
ring stand and 10 cm (4") ring
balance
utility clamp
food holder
aluminum foil
matches
soup or juice can
wooden splint
two stirring rods
cold water
two single-hole stoppers
two food samples (nut, popcorn, or marshmallow)

## PROCEDURE

1. Obtain and wear goggles.

2. Connect the Temperature Probe to the data-collection interface. Connect the interface to the TI-Nspire handheld or computer. (If you are using an EasyTemp or Go!Temp, you do not need a data-collection interface.)

3. Set up DataQuest for data collection.

   a. Choose New Experiment from the Experiment menu
   b. Choose Collection Setup from the Experiment menu.
   c. Enter **0.2** as the rate (samples/second).
   d. Enter **480** as experiment duration in seconds. The number of points collected will be 97.
   e. Select OK.

4. Obtain a sample of food and a food holder similar to the one shown in Figure 1. Mount the food onto the food holder so that it can burn without damaging the holder. Determine and record the initial mass of the food sample and food holder in Table 1. **CAUTION:** *Do not eat or drink in the laboratory.*

5. Set up the apparatus shown in Figure 1.

   a. Determine the mass of an empty can. Record the value in Table 1.
   b. Place about 50 mL of cold water into the can.
   c. Determine and record the mass of the can plus the water.
   d. Insert a stirring rod through the holes in the top of the can and hold it in place with two one-hole stoppers. Position the can 2.5 cm (~1 inch) above the food sample.
   e. Use a utility clamp to suspend the temperature probe in the water as shown in Figure 1. The probe should not touch the bottom or side of the can.

6. You are now ready to begin collecting data.

   a. Start data collection by hitting the play button.
   b. Use a match to light the food sample. Position the burning food sample directly below the center of the water-filled can. Quickly light the food sample again if it stops burning during data collection. **CAUTION:** *Always keep hair and clothing away from open flames.*
   c. A real-time graph of temperature *vs.* time will be displayed on the screen during data collection.
   d. Temperature readings (in °C) are displayed in the Graph Details box located to the left of the graph.

7. Stir the water slowly and continuously using the stirring rod until data collection stops.

8. After data collection has stopped, click any data point by using the cursor button to examine the data points on the graph. Locate the maximum and minimum temperatures and record these values in Table 1.

9. Remove the food holder and determine the final mass of the food and holder. Record the mass in Table 1.

10. Clean off the food holder and empty the can of water.

11. Click the Store Data button to save the first run data.
12. Repeat Steps 4–10 for the second food sample.
13. A good way to compare the two samples is to view both sets of data on one graph. To display a graph click on graph view and click **run 2** then click select **All**. Sketch or print the graph as directed by your instructor.
14. When finished, discard all burnt matches and food samples as directed by your teacher.

## DATA

| Table 1 | | |
|---|---|---|
| Measurements | Sample 1 | Sample 2 |
| Food used | | |
| Mass of empty can (g) | | |
| Mass of can plus water (g) | | |
| Initial temperature of water (°C) | | |
| Final temperature of water (°C) | | |
| Initial mass of food and holder (g) | | |
| Final mass of food and holder (g) | | |

## PROCESSING THE DATA

Record the following calculations in Table 2. Show your work in Table 3.

1. Determine the mass of the water and record in Table 2.
2. Calculate the change in mass of each food sample. Show your calculations.
3. Calculate the changes in the temperature of the water, $\Delta t$. Record this in Table 2. Show your calculations.
4. Calculate the energy gained by the heated water. Show your calculations. To do this, use the following equation:

   Energy gained by water = (mass of water) x ($\Delta t$ of water) x (4.18 J/g°C)
5. Convert the energy you calculated in Step 4 to kilojoules (1 kJ = 1000 J).
6. Use your answer in Step 5 to calculate the energy content of each food sample (in kJ/g):

   Energy content of food = Energy gained by water / Δmass of food
7. Record your results and the results of other groups in Table 4.

| Table 2 | | |
|---|---|---|
| Calculations | Sample 1 | Sample 2 |
| Mass of water (g) | | |
| $\Delta t$ of water (°C) | | |
| $\Delta$mass of food (g) | | |
| Energy gained by water (J) | | |
| Energy content of food (J/g) | | |

| Table 3 | | |
|---|---|---|
| Calculation | Sample 1 | Sample 2 |
| $\Delta$mass | | |
| $\Delta t$ | | |
| Energy gained | | |
| Energy content | | |

| Table 4: Class Results | | | | |
|---|---|---|---|---|
| Food type: | | | | |
| Energy content (kJ/g) | | | | |
| Group 1 | | | | |
| Group 2 | | | | |
| Group 3 | | | | |
| Group 4 | | | | |
| Group 5 | | | | |
| Group 6 | | | | |
| Class Average: | | | | |

## QUESTIONS

1. Which of the foods has the greatest energy content?

2. Which of the tested foods is the best energy source? Why?

3. What was the original source of energy in the foods tested?

4. Why might some foods with a lower energy content be better energy sources than other foods with a higher energy content?

5. Would you expect the energy content values that you measured to be close to the value listed in dietary books? Why?

## EXTENSION

1. Determine the energy content of other combustible foods.