Experiment
10

Energy Content of Foods

Energy content is an important property of food. The energy your body needs for running, talking, and thinking comes from the food you eat. Energy content is the amount of heat produced by the burning of 1 gram of a substance, and is measured in joules per gram (J/g).

You can determine energy content by burning a portion of food and capturing the heat released to a known mass of water in a calorimeter. If you measure the initial and final temperatures, the energy released can be calculated using the equation

$$H = \Delta t \cdot m \cdot Cp$$

where H = heat energy absorbed (in J), Δt = change in temperature (in °C), m = mass (in g), and C_p = specific heat capacity (4.18 J/g°C for water). Dividing the resulting energy value by grams of food burned gives the energy content (in J/g).

OBJECTIVES

In this experiment, you will

- use a computer to measure temperature
- use a computer to analyze data
- use a balance
- determine energy content
- compare the energy content of different foods

MATERIALS

Power Macintosh or Windows PC
Vernier computer interface
Logger*Pro*
Vernier Temperature Probe
2 food samples (nut, popcorn, or marshmallow)
ring stand and 4" ring
100-mL graduated cylinder
2 stirring rods
balance
small can
slit stopper
cold water
food holder
matches
wooden splint

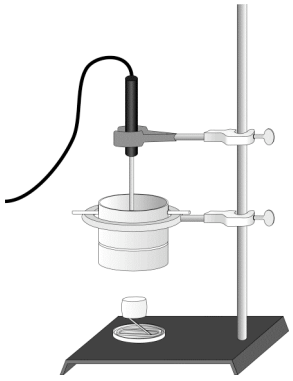

Figure 1

PROCEDURE

1. Obtain and wear goggles.

2. Prepare the computer for data collection by opening the Experiment 10 folder from *Physical Science with Computers*. Then open the experiment file that matches the probe you are using. The vertical axis will have temperature scaled from 0 to 100°C. The horizontal axis will have time scaled from 0 to 10 minutes.

3. Get a sample of food and a food holder like the one shown in Figure 1. Find and record the initial mass of the food sample and food holder. **CAUTION:** *Do not eat or drink in the laboratory.*

4. Set up the apparatus shown in Figure 1.
   - Determine and record the mass of an empty can.
   - Place about 50 mL of cold water into the can.
   - Determine and record the mass of the can plus water.
   - Use a stirring rod to suspend the can about 2.5 cm (1") above the food sample.
   - Use a utility clamp and slit stopper to suspend the Temperature Probe in the water. The probe should not touch the bottom of the can.

5. Click Collect to begin measuring temperature. Record the initial temperature of the water.

6. Remove the food sample from under the can and use a wooden splint to light it. Quickly place the burning food sample directly under the center of the can. Allow the water to be heated until the food sample stops burning. **CAUTION:** *Keep hair and clothing away from an open flame.*

7. Stir the water until the temperature stops rising. Record this final temperature. Click Stop to end data collection.

8. Determine the final mass of the food sample and food holder.

9. To confirm the initial temperature, examine the initial data points in the Table window. To confirm the final temperature, click the Graph window and then click the Statistics button, STAT. The maximum temperature is listed in the statistics box on the graph.

10. Repeat the procedure for a second food sample. Use a new 50-mL portion of cold water.

11. When you are done, place burned food, used matches, and partly-burned wooden splints in the container supplied by the teacher.

DATA

	Sample 1	Sample 2
Food used	_____	_____
Mass of food and holder (initial)	_____ g	_____ g
Mass of food and holder (final)	_____ g	_____ g
Mass of empty can	_____ g	_____ g
Mass of can plus water	_____ g	_____ g
Initial water temperature	_____ °C	_____ °C
Final water temperature	_____ °C	_____ °C

PROCESSING THE DATA

1. Calculate change in water temperature, Δt, for each sample, by subtracting the initial temperature from the final temperature ($\Delta t = t_{final} - t_{initial}$).

2. Calculate the mass (in g) of the water heated for each sample. Subtract the mass of the empty can from the mass of the can plus water.

3. Use the results of Steps 1 and 2 to determine the heat energy gained by the water (in J). Use the equation

$$H = \Delta t \cdot m \cdot C_p$$

where H = heat absorbed (in J), Δt = change in temperature (in °C), m = mass of the water heated (in g), and C_p = specific heat capacity (4.18 J/g°C for water).

4. Calculate the mass (in g) of each food sample burned. Subtract the final mass from the initial mass.

5. Use the results of Steps 3 and 4 to calculate the energy content (in J/g) of each food sample.

6. Record your results and the results of other groups below.

Class Results

Food Type	Food Type	Food Type	Food Type
_____	_____	_____	_____
_____ J/g	_____ J/g	_____ J/g	_____ J/g
_____ J/g	_____ J/g	_____ J/g	_____ J/g
_____ J/g	_____ J/g	_____ J/g	_____ J/g
_____ J/g	_____ J/g	_____ J/g	_____ J/g
_____ J/g	_____ J/g	_____ J/g	_____ J/g
_____ J/g	_____ J/g	_____ J/g	_____ J/g
Avg._____ J/g	_____ J/g	_____ J/g	_____ J/g

7. Which of the foods has the greatest energy content? Why do these foods have the greatest energy content?

EXTENSION

1. Determine the energy content of other combustible foods.