10. ENERGY CONTENT OF FOOD

Do different foods have different amounts of energy stored in them?

Objectives

- Compare the amount of thermal energy given off by different kinds of foods to estimate their available energy.

Materials and Equipment

- Data collection system
- Wireless temperature link with fast response temperature probe
- Graduated cylinder, 100-mL
- Ring stand or base and support rod
- Test tube clamp or three-finger clamp
- Balance (Readability: 0.01 g)
- Distilled water, 100 mL
- Wooden splints (4)
- Matches or lighter
- Large steel paper clips (2)
- Aluminum cans (2), 12-oz
- Aluminum foil, 20 cm × 20 cm
- Cardboard, 10 cm × 10 cm
- Tape
- Whole nut such as a cashew or peanut
- Large marshmallow

Safety

Follow these important safety precautions in addition to your regular classroom procedures:

- Wear safety goggles at all times.
- Tie back long hair, roll up long sleeves, and remove dangling jewelry.
- If you have a food allergy to any of the foods used in this investigation, let your lab partner handle the food.
- Work in a well-ventilated room or under a fume hood.

Procedure

1. Select Sensor Data in SPARKvue.
2. Connect the temperature probe to your device.
3. Choose the Graph template.
4. Use a bent paper clip, cardboard, and tape to construct a food stand similar to the one shown in Figure 1. Cover the cardboard with foil.
5. Rinse the aluminum cans and shake out excess water. Dry the outside of each can.
6. Fill each can with 50 mL of distilled water. Pour slowly to avoid splashes and spills.
7. Set the nut in the food stand hook as shown. Record the initial mass of the food stand and nut in Table 1.

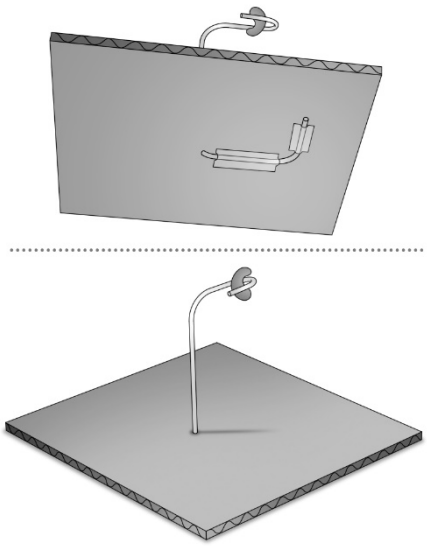


Figure 1: Food stand, bottom and top view

8. Tape the temperature probe to a wooden splint as shown in Figure 2. The end of the probe should sit 1-2 mm from the edge.

Figure 2: Secure the probe to the splint

9. Set the splint inside the can. Use a paper clip to suspend the can from a clamp attached to a ring stand as shown in Figure 3.

10. Adjust the can height so the nut is about 1 inch (or 2.5 cm) below the bottom of the can.

11. Select Start to begin collecting data. Record the initial temperature in Table 1.

12. Slide the food stand away from the can. Place a burning wooden splint beneath the nut so the top third of the flame contacts the nut. Hold the flame steady until the nut produces its own flame. Once ignited, slide the food stand back underneath the can. Do not disturb the system while the food burns.

13. Stop collecting data when the temperature stops rising. Record the maximum temperature in Table 1.

Note: Temperature may continue to rise after a flame is no longer visible.

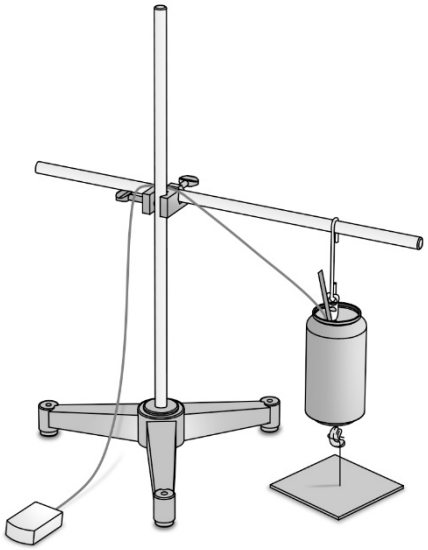


Figure 3: Complete setup

14. Record the final mass of the food stand and all remains of the nut in Table 1.

15. Discard the can. Remove the remains of the nut from the food stand. Detach the temperature probe from the splint and dry it.

16. Repeat Steps 7-14 using a marshmallow and a new, dry splint.

17. Show both runs in SPARKvue and scale the display. Sketch your results in Graph 1. Include numbers, labels, and units on the x- and y-axes. Add a key to identify each run.

18. Use the following equations to calculate change in mass and change in temperature for each food source; record the results in Table 1.

    Change in Mass = Final - Initial; Change in Temperature = Maximum - Initial

19. Use the equation below to calculate the estimated heat absorbed by the water in the can for each food source and record the result in Table 2. Show your work in the space above Table 2. The units *Cal* are food Calories seen on nutrition information labels found on packaged food.

    Heat Absorbed (Cal) = (50 g) × (0.001 Cal/g∗°C) × Change in Temperature (°C, from Table 1)

20. Use the heat absorbed calculated in the previous step and the equation below to determine the estimated energy available per gram of each food source. Record the result in Table 2; show your work in the space provided above Table 2.

    Est. Energy per Gram (Cal/g) = Heat Absorbed by Water (Cal) ÷ Change in Mass (g, Table 1)

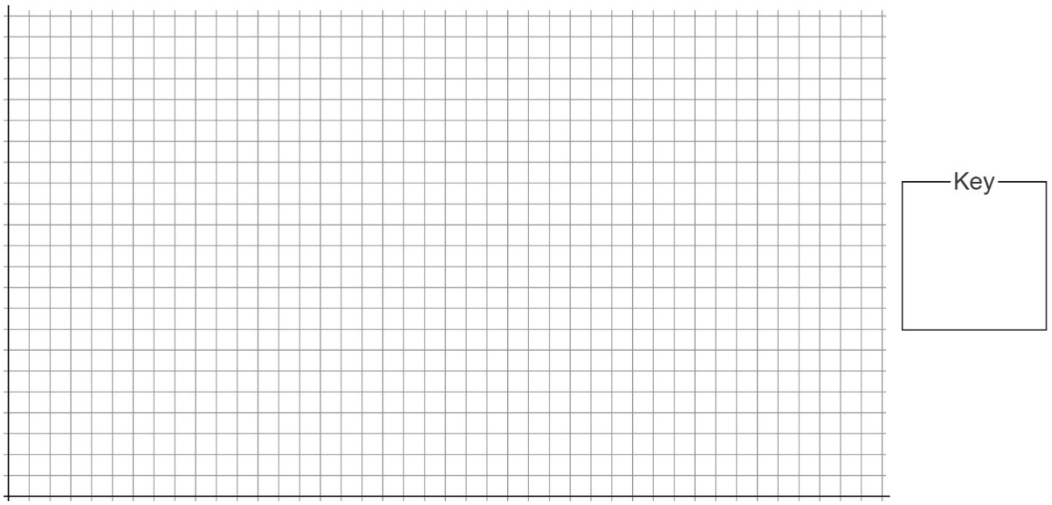
21. Compile class data for the estimated energy per gram for each food source and calculate the average. Record the result in Table 2.

Data Collection

Table 1: Mass and temperature data for each food source

Food Source	Initial Mass (g)	Final Mass (g)	Initial Temperature (°C)	Maximum Temperature (°C)	Change in Mass (g)	Change in Temperature (°C)
Nut						
Marshmallow						

Graph 1: Change in water temperature from each food source



Show work for calculations in the space below:

Table 2: Calculation of estimated energy available per gram of food for each food source

Food Source	Heat Absorbed by Water (Cal)	Estimated Energy per Gram (Cal/g)	Class Average: Estimated Energy per Gram (Cal/g)
Nut			
Marshmallow			

Questions and Analysis

1. Based on the samples you tested what can you conclude about the relative energy content of fats and carbohydrates? Support your answer with data.

2. Do you think all of the energy released by the burning food sample was absorbed by the water? Why or Why not?

3. Reading consumes about 1.7 Calories per minute. Based on your data, how many minutes of reading could you manage from a 50-g serving of each of the foods you investigated? Show your calculations and explain your answer.

4. Go online to find the value for Cal/g reported on a nutrition label for the food sources you investigated. Discuss how your results compare to the values found online.

5. Why is measuring the energy released from burning food comparable to the energy available to our bodies when that food is eaten? Explain your answer.