TEACHER INFORMATION

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Energy in Food

1. The student pages with complete instructions for data collection using LabQuest App, Logger *Pro* (computers), DataQuest (TI-Nspire Technology), EasyData or DataMate (calculators), and DataPro (Palm handhelds), can be found on the CD that accompanies this book. See *Appendix A* for more information.

2. Any four nuts could be used for this experiment. Walnuts, pecans, peanuts, and almonds are easy to obtain and give excellent results.

3. The water should be approximately 1-1/2 to 2 inches in diameter and about 3 inches long. A small juice can will do. Drill two holes in the can just under the metal rim, large enough so that a solid glass rod can easy fit in. The can will be suspended by the glass rod with a one-hole rubber stopper at each end. The rubber stoppers will rest on a metal 4 inch ring.

4. The food stand is made using a cork stopper, size 7 or larger, and a paper clip. Straighten one end of the paper clip and push it into the bottom of the cork stopper. Bend the other end of the paper clip into a ring so it will cup the food sample.

5. The two rubber stoppers on the very end of the stirring rod holding the can will prevent the can from slipping off the ring stand.

6. Heat is lost to the environment during this experiment as the fuel is burning. Therefore, the energy content that students measure will not be similar to the published values. This lab is still valid, however, since the heat lost to the environment is nearly proportional in every experiment. If the physical conditions in every experiment are the same, the energy contents will be proportional. Several key factors include:
   - The distance from the bottom of the can to the flame (or table top) should be equal.
   - The cans should be of equal dimensions.
   - The flame should not be in a breeze.

7. Provide each lab group with a container to discard their burnt foods. The charred pieces will make a mess otherwise. Soot will accumulate on the outside of the calorimeter can. Provide a paper towel for students to set the can onto between experiments. Soap may be needed after this experiment!

8. The Vernier temperature calibrations that are stored in the data-collection software will work fine for this experiment.

9. Use of nuts, especially peanuts, is being restricted and phased out of schools due to increasing numbers of allergic reactions and the heightened sensitivity that some students exhibit.

10. If you are collecting data on a calculator, we suggest that you clear all other programs and miscellaneous data off of the calculators to make room in the memory for collected data before loading EasyData.

SAMPLE RESULTS

Table 1			
Measurements	Sample 1	Sample 2	Sample 3
Food used	walnut	almond	pine nut
Mass of empty can (g)	28.51	28.51	28.51
Mass of can plus water (g)	77.35	78.27	76.99
Initial temperature of water (°C)	21.6	22.5	22.3
Final temperature of water (°C)	47.7	49.8	31.4
Initial mass of food (g)	12.85	12.92	12.30
Final mass of food (g)	12.25	12.18	12.10

Table 2			
Calculations	Sample 1	Sample 2	Sample 3
Mass of water (g)	49.18	49.76	48.48
Δt of water (°C)	26.1	27.3	9.1
Δmass of food (g)	0.60	0.74	0.20
Energy gained by water (J)	5330	5680	1840
Energy content of food (J/g)	8880	7670	9220

Since this experiment is designed for 9th and 10th grade students, the mathematics has been simplified. Here is a more complete description of some of the mathematical reasoning.

The law of conservation of energy states that the energy lost by the food should equal the energy gained by the water.

$$\Delta E_{\text{food}} = \Delta E_{\text{water}}$$

The energy lost to the environment is nearly proportional in every experiment so it can be ignored. The energy gained by the water can be calculated using the equation below where m_{water} is the mass of the water in grams, C_p is the heat capacity of water which is equal to 4.186 J/g$^{\circ}$C, and Δt is the change in temperature in $^{\circ}$C.

$$\Delta E_{\text{water}} = m_{\text{water}} \bullet C_p \bullet \Delta t$$

Since the energy gained by the water is equal to the energy lost by the food, then the energy lost by the food can be found by using this equation.

$$\Delta E_{\text{food}} = \Delta E_{\text{water}} = m_{\text{water}} \bullet C_p \bullet \Delta t$$

To calculate how much energy would be lost by one gram of the same food, divide the energy lost by the food by the mass of food that did burn.

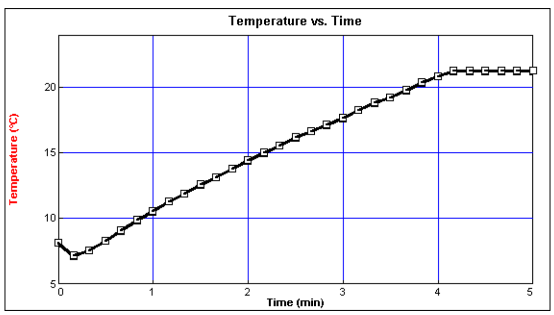
$$\text{Energy content} = \frac{\Delta E_{\text{food}}}{1\,\text{gram}} = \frac{m_{\text{water}} \bullet C_p \bullet \Delta t}{\Delta m_{\text{food}}}$$

After converting joules to kilojoules, this gives us an answer similar to that in the student handout. We define the term *energy content* to be that amount of energy that can be obtained by the combustion of one gram of food.

The energy contents of a few sample foods are listed below. Note that these should be proportional to the measured energy contents, not equal to them, since heat was lost to the environment, and combustion was not complete.

Food	Energy content (kJ/g)
almond	26.8
brazil nuts	29.0
cashews	25.5
coconut (dry)	23.8
kidney beans	25.9

Food	Energy content (kJ/g)
lard	37.6
lima bean	14.3
peanuts	25.9
walnut	29.3



Walnut burning and warming water

ANSWERS TO QUESTIONS

For Sample Answers to the questions in this lab, please contact Vernier Software and Technology at swnanswers@vernier.com