

Junk Food Calorimetry

Energy in Food

Objectives

1. Students will determine the energy content in various foods and present the data in terms of kJ/g.
2. Students will compare their measured energy content (in kJ/g) with the energy content values given on the junk food packages (in Calories) and will present reasons for the differences in the values.

Measuring the energy in food

Many people like to eat junk food. Cheese Doodles, potato chips, Extra Nacho Doritos, peanuts... mmmm, good. Of course, everybody knows they're bad for you, but what makes them bad? Mostly, they provide a lot of calories, which seem to add to your thighs, but not much else. So, what is a calorie, and what do they have to do with putting on weight? *A calorie is a unit of heat, just like an hour is a unit of time.* So what is the connection between a Cheese Doodle, a calorie and your thighs? Well, if you took a Cheese Doodle and burned it, wouldn't it give off heat? Maybe you've never burned a Cheese Doodle, but they really burn like crazy.

Different materials give off different amounts of heat when you burn the same amount of material. A pound of gasoline would give off a lot more heat than a pound of celery. Now, people don't usually eat gasoline, but they do eat things that burn just as readily. The food that we eat can be divided into three main categories: *carbohydrates* (also called sugars), *protein*, and *lipids* (also called fats). Of these three, pound-for-pound, lipids contain more energy, and thus gives off more heat when burned, than either carbohydrates or protein.

So fat contains a lot of energy, but you need a lot of energy to live. If you weren't able to store energy somehow, you would have to constantly eat to replace the energy you use just by walking, running, attending your bio lab, etc. Your clever body stores fat, and then you can do interesting things, like attending lab, where you can't eat anyway. So why don't we all weigh 400 pounds? Simple--because carrying all that weight around costs energy. Instead your body stores just enough fat to carry you through a couple weeks with no food, which during the wintertime is a real situation for wild animals. But starvation is not a situation many modern humans in developed countries face. We have food available all the time, and we don't get much exercise. As a result, our bodies store any food energy in excess, not knowing that more food is always coming. As fat contains the most energy pound-for-pound of all the foods we normally eat, the body stores fat—which ends up on your thighs.

Unless you get a lot of exercise, your body stores the fat that you eat. Junk foods, almost by definition, tend to contain a lot of fat because, guess what, the thing that tends to make food so delicious is fat. No fools, the people who make junk foods know the better those foods taste, the more you'll buy, so junk foods tend to be heavy on the fat side. A measure of how bad a junk food is for you (in terms of putting on weight that you don't want) is how much energy a food contains. The easiest way to measure the energy is to burn the food, and see how much heat is liberated. And that's what we're going to do today.

Generally, what are we doing today? In today's lab, you will ignite different junk food items, and measure how much heat is released as it warms a given amount of water. You will burn a piece of junk food under an Erlenmeyer flask with a measured amount of water. The flask will hold an electronic thermometer so you can measure changes in the temperature of the water. This procedure is called "**calorimetry**," and the basic principle is the same as used by food processors when they measure Calories for food labels. The electronic thermometer you will use is called a LabQuest, and we are using it today, and will use it again for another couple labs. The LabQuest works well, but is not always user-friendly. Follow the lab procedure step by step, and if you are still having trouble with your LabQuest, ask your TA for help.

Important note: an average person should consume a minimum of 2,000 kilocalories per day, which is equivalent to 8,360 kilojoules. One **kilocalorie** is the same as one "big calorie" or **Calorie** (with a capital C). "Big calories" or Calories are used on American food labels and it is what you are accustomed to seeing. Using the technique called calorimetry, we will determine the energy content of food, by measuring the amount of heat produced by the combustion of one gram of the food. We will measure the heat in **Calories** per gram (Cal/g).

Safety info: We will have open flames in lab today. Your TA will point out the location of the fire extinguisher. All students must tie back long hair, and tuck away loose clothing. **If you are allergic to foods used in today's lab, notify your TA immediately.** Do NOT eat or drink in the lab. EMERGENCY PHONE # 874-2121.

PRE-LAB QUESTIONS

- 1. What is the purpose of today's lab?** In 1-2 sentences and in your own words, describe what you are trying to determine by doing this experiment.

- 2. What is your hypothesis for the lab experiment?** A hypothesis describes what you expect the outcome of the experiment to be, based on previous experience, observations, research, etc. State your hypothesis.

- 3. What reasoning did you use to arrive at your hypothesis?** Explain your hypothesis using the scientific concepts of this lab to show the reasoning behind your prediction.

Procedure for today's lab

Students may work in groups of 2 or 3 today. Each GROUP should start with:

- a ring stand with 2 clamps attached to it
- one test tube
- one test tube rack
- one LabQuest with a temperature probe
- three different junk food samples

Students will share the:

- electronic balances in the classroom.

1) Obtain and wear goggles.

2) Plug the Temperature Probe into Channel 1 on the top of the LabQuest; follow the procedure on the instruction sheet provided by your TA. Make sure that your group's LabQuest data collection parameters are properly set up before moving on to the next step.

3) Obtain a sample of food and a paper clip. Bend the clip so that you can hold it with the test tube holder, using the other end to hold the food. Mount the food onto the paper clip (this may take some imagination on your part). Determine and record the initial mass of the food sample AND food holder in Table 1.

4) Set up your calorimetry apparatus. Your TA will demonstrate.

5) Make your initial measurements.

- a) Determine and record the mass of an empty Erlenmeyer flask in Table 1.
- b) Place about 30 mL of cold tap water into the test tube.
- c) Determine and record the mass of the flask plus the water.
- d) Position the bottom of the flask ~2.5cm directly above the food sample.
- e) Place the temperature probe in the water in the flask.

Be sure the probe does not sit on the bottom of the flask—this will skew your results.

6) You are now ready to begin collecting data.

- a) Use a match to light the food sample. Position the burning food directly below the center of the water-filled flask. Re-light the food if it stops burning. As soon as the food is ignited, select **START** on the main screen of the LabQuest. *Caution: Keep hair and clothing from flames. Do not attempt to eat burning food sample.*
- b) A real-time graph of temperature vs. time will be displayed on the calculator screen during data collection.
- c) Temperature readings (in °C) can also be monitored in the upper-right corner of the graph.
- d) Data collection will stop automatically after 180 seconds, and a graph of temperature vs. time will be displayed.

- 7) Analyze the graph to determine maximum and minimum temperatures.
- Use the stylus to move the cursor across the line of the graph.
 - Record the min and max values as the initial and final water temperatures in your data table.
 - Press **ENTER** to return to the **ANALYZE OPTIONS** menu, and select **RETURN TO MAIN SCREEN (1)**.
- 8) Determine the final mass of the burnt food remaining on the clip AND the clip. Record the mass in Table 1. You will use the initial mass and the final mass to calculate change in mass of food (Δ mass food).
(*This Greek symbol: Δ is delta. Delta is used to represent "change in..." so you are calculating "delta mass" or change in mass of food.*)
- 9) Clean off the clip and empty the water from the flask.
- 10) Repeat Steps 3-9 (with cold tap water in your flask) for the second and third food samples.
- 11) Discard all burnt matches and food samples. Clean any burnt food or smudges on your bench with water and paper towels. Turn off the LabQuest.

Data

Table 1. Measurements

<u>MEASUREMENTS</u>	Sample 1	Sample 2	Sample 3
Food used:			
Mass of empty flask (g)			
Mass of flask plus water (g)			
Initial temperature of water ($^{\circ}\text{C}$)			
Final temperature of water ($^{\circ}\text{C}$)			
Initial mass of food and holder (g)			
Final mass of food and holder (g)			

Processing the Data

Record the following calculations in Table 2.

- 1) Use your data in Table 1 to determine the mass of the water.

$$\text{mass of water} = (\text{mass of flask plus water}) - (\text{mass of empty flask})$$

- 2) Calculate the change in the temperature of the water, Δt .

$$\Delta \text{ temperature of water} = (\text{max temp. of water}) - (\text{min temp. of water})$$

- 3) Calculate the change in mass of each food sample, Δm .

$$\Delta \text{ mass of food} = (\text{initial mass of food and food holder}) - (\text{final mass of food and food holder})$$

- 4) Calculate the energy gained by the heated water.

$$\text{Energy gained by water (Cal)} = (\text{mass of water}) \times (\Delta t \text{ of water})$$

- 5) Use your answer in Step 4 to calculate the energy content of each food sample.

$$\text{Energy content of food (Cal/g)} = \text{Energy gained by water (Cal)} / \Delta \text{ mass of food (g)}$$

- 6) Read the Nutrition Label on each of the junk foods to determine **Calories/1 g**.

$$\text{Calories/1 g} = \frac{[\text{Calories/serving (the value listed on the label)}]}{[\text{number of grams in one serving (listed under: \# g / serving size)}]}$$

- 7) Record your results from Step 5 and the results of other groups in Table 3. Your TA will ask each group to write their data on the board first.

Table 2. Calculations

<u>CALCULATIONS</u>	Sample 1	Sample 2	Sample 3
Food used:			
Mass of water (g)			
Δt of water ($^{\circ}\text{C}$)			
Δ mass of food (g)			
Energy gained by water (Cal)			
Energy content of food (Cal/g)			
<i>Data from food label:</i> Energy content of food (Calories/ 1 gram) *You must divide the calories/serving by the number of grams in one serving!!			

Table 3. Class Results – Energy Content of Foods (Cal/g)

<u>GROUP NUMBER</u>	Sample 1	Sample 2	Sample 3
Food used:			
1			
2			
3			
4			
5			
6			
7			
Average Energy Content (Cal/g)			

ANALYSIS and CONCLUSIONS

1. Which of the foods has the greatest energy content in the class results? Which of the foods has the least energy content in the class results?
2. Does the data support your *original hypothesis*? Why or why not? Based on your answer, what would you do next?
3. What was the original source of energy in the foods tested? Explain.
4. Why might some foods with lower energy content be better energy sources for your body than foods with higher energy content?
5. Were your measured Energy Content values higher or lower than those published on the food bags on the Nutrition Facts label? How can you account for the difference in the values?