Food Calories

Objects in photograph are cheesier than they appear!

Introduction

Everyone is familiar with the nutrition labels printed on food packages. Even if you are not counting calories or carbs or grams of fat, you have sat at the breakfast table and read the nutrition label on the cereal box. When you read that one serving of cereal has 110 calories, what does this mean? The calorie is a unit of heat, which is energy. The Calorie content of any food item, then, is the amount of energy the food will release when you eat and digest it. Some food items are Calorie dense: pure fat contains 9 Calories per gram. Both protein and carbohydrates contain only 4 Calories per gram. This is why you feel fuller when you eat a pound of butter (4000 Calories) compared to a pound of broccoli (120 Calories): you have eaten the same amount of food, but the pound of butter is a lot more fuel. Not that you would sit down and eat a pound of butter...you wouldn't eat a whole pound of butter, would you?

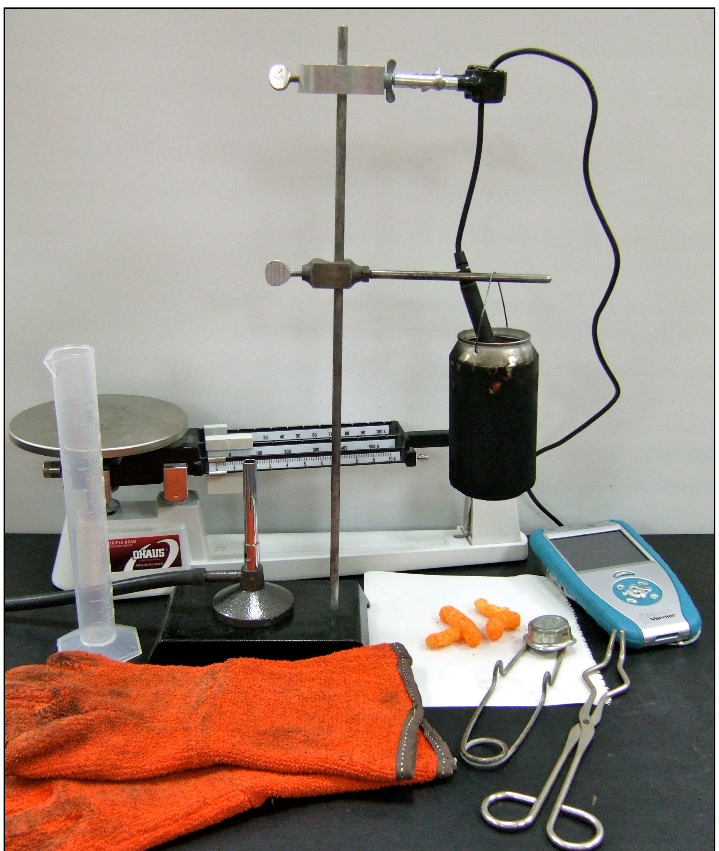
We also have to be very careful with our units: the calories of heat that we use in class to quantify the specific heat of metal samples are not the same as the Calories listed on nutrition labels. One calorie of heat is a very small unit compared to the amount of energy in food. A food Calorie, then, is actually 1000 calories of heat, or a **kilocalorie**.

Objectives

- Learn the difference between a calorie of heat and a food Calorie
- Measure the amount of heat released when food is burned
- Determine the number of food Calories per serving of food
- Calculate the amount of experimental error in the results
- Examine sources of experimental error and suggest improvements

Equipment

- Ring stand and burner
- Aluminum can with hanger
- Triple beam balance
- Graduated cylinder
- LabQuest with temperature probe
- Food product
- Paper clips and clamps



That can is covered with burned cheese gunk.
And it's every bit as disgusting as it looks.

Experimental Procedure

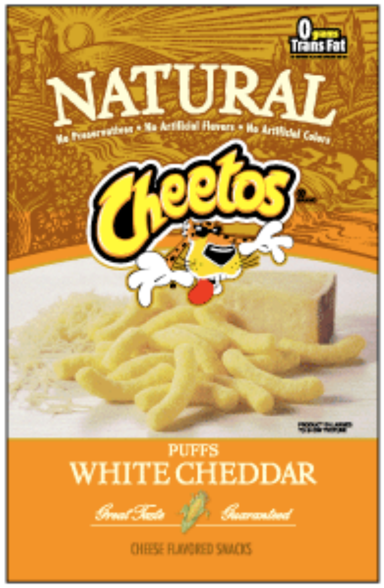
- Connect the temperature probe to the LabQuest and switch it on. You do not need a timed data trial, so you can simply read the temperature from the display.
- Measure and record the mass of two pieces of food using the balance.
- Use the graduated cylinder to carefully measure 50 ml (which is 50g) of tap water. Add to the can.
- Using the ring stand and clamps, hang the aluminum can. Suspend the temperature probe as shown so that it is in the water, but not touching the bottom of the can.
- Skewer the food on a paper clip as demonstrated by the instructor, and place under the aluminum can.
- Measure and record the initial temperature of the water.
- Light the food on fire and hold it under the can. Stir the water in the can (with the temperature probe) while the food is burning.
- Record the final temperature of the water after the food has stopped burning. Make sure the temperature probe is not touching the bottom of the can.
- Discard whatever charred remnant is left of the food, as well as the water from the can.
- Repeat the entire experiment, using the second piece of food.

Data & Analysis

If you have not already, organize your data into a neat table:

Trial	Food Mass m (g)	Water Mass m_W (g)	Water Temp T_W (°C)	Final Temp T_F (°C)	Q (cal)	Calories (Cal)	Cal/g	Average Cal/g	Package Cal/g	% Error
1										
2										

1. For each trial, compute the amount of heat that raised the temperature of the water by the amount you measured:
$$Q = m_w c_w \left(T_f - T_i\right)$$
Remember that the specific heat of water, c_w is **1 cal/g·°C**.
2. For each trial, determine the number of kcals (food Calories) is this amount of heat:
$$Calories = \frac{Q}{1000}$$
3. For each trial, find the number of Calories per gram in the sample you tested:
$$Cal/g = \frac{Calories}{m}$$
4. Find the average value for the number of calories per gram of food, using the two values from step 3 above.
5. Using the information listed on the bag of food, determine how many Calories the manufacturer claims is in each gram of the food product:
$$package = \frac{(Calories/serving)}{(grams/serving)}$$
6. Calculate the percent error between your measured value and the listed value:
$$\%\ error = \left(\frac{package - average}{package}\right)\cdot 100$$



Ingredients: Organic Corn Meal, Expeller-Pressed Sunflower Oil, Whey, Cheddar Cheese (Cultured Milk, Salt, Enzymes), Maltodextrin, Sea Salt, Natural Flavors, Disodium Phosphate, Sour Cream (Cultured Skim Milk, Cream, Cornstarch, Nonfat Dry Milk) Torula Yeast, Lactic Acid, and Citric Acid.

CONTAINS MILK INGREDIENTS

Nutrition Facts

Serving Size 1 oz.

Amount Per Serving

Calories 150 Calories from Fat 80

	% Daily Value*
Total Fat 9g	**14%**
Saturated Fat 1.5g	**7%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 290mg	**12%**
Total Carbohydrate 16g	**5%**
Dietary Fiber less than 1g	**3%**
Sugars 1g	
Protein 2g	

Vitamin A 0% • Vitamin C 0%
Calcium 2% • Iron 0%
Vitamin E 10% • Riboflavin 2%
Vitamin B_6 2% • Phosphorus 4%

* Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

One delicious, cheesy serving is 1 ounce, and one ounce is 28 grams.

7. Which value is larger, your average or the manufacturer's? Why is your value smaller?
8. If we used all of the data from the class in addition to your two trials, would this be sufficient to match the manufacturer's claim? Explain.
9. Suggest some ways that you might make your experimental results more accurate.
10. How accurate is the manufacturer's claim? Are there factors that might affect the accuracy of the value we accepted as the "correct" value?