COUNTING CALORIES
Background

All foods contain energy, although the amount of potential energy stored will vary greatly depending on the type of food. When we eat food, our bodies convert the stored energy to chemical energy, allowing us to do work. The energy values of food are measured by the Calorie, with a capital C. A Calorie is equal to 1,000 calories or 1 kilocalorie (kcal). A calorie is the amount of heat (energy) required to raise the temperature of 1 gram (g) of water 1 degree Celsius (°C). You can find information about the amount of Calories in a food on the Nutrition Facts panel. For example, the Nutrition Facts panel below shows that this food contains 250 Calories. The label also shows how many grams of fat, carbohydrates, and protein it contains. These components contribute different amounts of Calories to the overall food product. Here is how many Calories are in a gram of each:

- 1 g fat = 9 Calories
- 1 g carbohydrate = 4 Calories
- 1 g protein = 4 Calories

To determine the amount of Calories in a food, nutrition and food scientists can use an instrument that is called a calorimeter. A calorimeter (from the Latin word *calor*, meaning heat) is a device that measures the heat generated by a chemical reaction or change of state.

Reference

Sizer, F and Whitney, E. 1997. Nutrition Concepts and Controversies. 7th ed. Wadsworth: CA.

Nutrition Facts

Serving Size 1 cup (228g)
Servings Per Container 2

Amount Per Serving	
Calories 250	Calories from Fat 110
	% Daily Value*
Total Fat 12g	18%
Saturated Fat 3g	15%
Trans Fat 3g	
Cholesterol 30mg	10%
Sodium 470mg	20%
Total Carbohydrate 31g	10%
Dietary Fiber 0g	0%
Sugars 5g	
Protein 5g	
Vitamin A	4%
Vitamin C	2%
Calcium	20%
Iron	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

www.cfsan.fda.gov

COUNTING CALORIES
Administrator's Guide

Grade levels: 9-12
Estimated Preparation Time: 30 minutes
Estimated Demonstration Time: 30 minutes
Standard Addressed: Content Standard C (Matter, Energy, and Organization in Living Systems)

- The chemical bonds of food molecules contain energy. Energy is released when the bonds of food molecules are broken and new compounds with lower energy bonds are formed. Cells usually store this energy temporarily in phosphate bonds of a small high-energy compound called adenosine triphosphate (ATP).

- As matter and energy flows through different levels of organization of living systems—cells, organs, organisms, communities—and between living systems and the physical environment, chemical elements are recombined in different ways. Each recombination results in storage and dissipation of energy into the environment as heat. Matter and energy are conserved in each change.

Objectives:

- To introduce food science to students
- To introduce a method of food analysis

Reference:

Sizer, F and Whitney, E. 1997. Nutrition Concepts and Controversies. 7th ed. Wadsworth: CA.

Materials:

- Cashew (save the Nutrition Facts panel)
- Popcorn (save the Nutrition Facts panel)
- Measuring cup
- Water (at room temperature)
- Ring stand
- Two paper clips
- Celsius thermometer
- Matches
- Two shallow glass dishes (Pyrex® 10 oz. custard cups work well)
- Safety goggles

Procedures:

1. Unravel one paperclip. Stick the popcorn on one end. Bend the other end of the paper clip so that it forms a support base. Place the paper clip support holding the popcorn on the base of the ring stand.

2. Pour 100 mL (0.1 kg) of water into the glass dish and place the dish in the ring on the ring stand approximately 3-4 cm above the popcorn. The amount of water added must be exactly 0.1 kg.

3. Measure and record the temperature of the water (it should be at room temperature).

4. Remember to secure loose clothing and long hair before lighting a match. Wearing safety goggles, light the popcorn with a match. The burning popcorn will release energy to heat the water.

5. As soon as the popcorn stops burning check the temperature of the water again. Do not let it cool down. Note: the temperature will only increase a few degrees.

6. Repeat steps 1-6 with one piece of cashew. Note: The cashew may be more difficult to light on fire. The temperature should increase 30° or more.

7. Have students calculate the Calories in each type of nut.

Sample calculation for the cashew (in a trial $\Delta T = 30°$):

Calorie Calculation: $Qw=(m)(c)(\Delta T)$

Qw=Heat gained by the water in calories (cal)
C=Specific heat capacity of water (1 calorie/g°C)
m=Mass of the water (grams)
ΔT=Change in water temperature (°C)
1 Kg = 1,000 g
1 Calorie = 1,000 calories

$Qw=(m)(c)(\Delta T)$
Qw=100g * 1 calorie/g°C * 30°C
Qw =3000 calories
Qw=3000 calories * 1 Calorie/1000 calories
Qw =3 Calories

Sample Nutrition Facts panel for cashews. According to the manufacturer, 28g=23 servings. Therefore, each cashew contains approximately 7 Calories.

NUTRITION FACTS

Serving Size 28g

Servings per Container about 10

Amount Per Serving

Calories 170 Calories from Fat 120

To improve the accuracy, you can also enclose the system in a coffee can. See this experiment for more detail: http://bioweb.usc.edu/courses/2004-fall/documents/bisc150-lab_burningcal.pdf.

COUNTING CALORIES
Student Handout

Background: All foods contain energy, although the amount of potential energy stored will vary greatly depending on the type of food. When we eat food, our bodies convert the stored energy to chemical energy, allowing us to do work. The energy values of food are measured by the Calorie, with a capital C. A Calorie is equal to 1,000 calories or 1 kilocalorie (kcal). A calorie is the amount of heat (energy) required to raise the temperature of 1 gram (g) of water 1 degree Celsius (°C).

To determine the amount of Calories in a food, nutrition and food scientists use an instrument that is called a calorimeter. A calorimeter (from the Latin word *calor*, meaning heat) is a device that measures the heat generated by a chemical reaction or change of state. There are many different types of calorimeters. This demonstration uses a homemade calorimeter in which a food is ignited; the water above the food absorbs the heat of the burning food, thereby causing the temperature (T) of the water to increase. By measuring the change in temperature (ΔT) of a known volume of water (in this case, 0.1 kg), you will be able to calculate the amount of energy in the food because the heat gained by the water is equal to the heat lost by the food.

Objective: To measure the amount of Calories in certain foods.

Calorie Calculation: $Qw=(m)(c)(\Delta T)$

Qw=Heat gained by the water in calories (cal)
C=Specific heat capacity of water (1 calorie/g°C)
m=Mass of the water (grams)
ΔT=Change in water temperature (°C)

Note:
1 Kg = 1,000 g
1 Calorie = 1,000 calories

Conclusion Questions:

1. How many Calories are in 1 piece of popcorn? What about in 1 cashew?

2. Was there a difference in Calories between the two products? If so, which contains more Calories?

3. Some heat is lost into the air and into the metal ring stand and dish. Does this mean the food contained more or less Calories than you observed?

4. How would you improve this experiment so that it is more accurate?

5. What is the source of energy in the foods tested?

Record Data Here:

	Water Temperature (°C)		
Food Item	*Initial Temperature*	*Final Temperature*	*Change in Temperature (ΔT)*
Cashew			
Popcorn			