

# Calories in a Peanut

Adapted from Wyoming Energy Curriculum



-David Rizor

## Overview

A peanut is burned and students explore the "calorie" as a unit of energy by measuring the heat produced. They equate this unit of energy with other energy measurements and relate the measurement of energy to conservation ideas.

## Objectives

Students will:

- be able to demonstrate that energy can be measured and that the calorie is the unit of energy used for determining energy in the foods we eat.
- be able to relate calories to other units of energy measurement and see how conservation of energy may be quantified.

**Grade Levels** 5-6

**Time Needed** 6 min.

**Subjects to Integrate** Science, Math

**Topics** measuring energy, conservation of energy in heating, properties of coal, recycling, storage of light energy in photosynthesis, food chains

**Skills** observation, communication, math, prediction, interpretation data, kinesthetic concept development

## Goals and Objectives

**A** 20; **B** 13; **C** 13, 16, 32; **E** 3, 5, 15, 17, **F** 1, 4,

## Materials

\*Safety goggles\*

Test tubes and test tube holders

Corks and needles

Celsius thermometers

Peanuts or Pecans

Matches

Test tube racks

## Background

### Teachers Note

Some parts of this activity will be very challenging for elementary students.

We all hear a lot about calories, usually in a negative context. We hear continuous warnings to watch calories in association with body weight - this or that food has too many calories. But without calories life would not exist. A characteristic of all organisms is that they use energy. A calorie is a unit that has been invented to measure energy. In this activity, with considerable help from their instructor, students measure the number of calories in a peanut.

A small calorie or gram calorie is defined as the amount of heat necessary to raise the temperature of one gram of water one degree Celsius. A kilocalorie, or sometimes called a big Calorie (note the capital C) is 1000 calories. The kilocalorie is more commonly used than the small calorie. If you read that a slice of bread contains 100 Calories it is 100 big calories.

Scientists determine the calories in a particular food by burning the food in a calorimeter. A calorimeter is an insulated chamber with an oxygen supply that is surrounded by a specific amount of water. The dehydrated food is burned and the rise in the temperature of the water surrounding the chamber with the burning food determines the calories of heat energy there is in the food. For example, it is possible to burn lettuce. First it must be entirely dry, so it is dehydrated. The dry weight of the sample is determined and it is placed in the oxygen filled chamber and burned. A thermometer in the surrounding water gives a reading of the increase in temperature of the water when the lettuce burns. The calories per gram of most foods have been determined. Foods like peanuts are loaded with calories, while foods like lettuce have few.

Other units are used to measure energy. When measurements are made for large amounts of energy, often the BTU (British Thermal Unit) or joules are used. A BTU is defined as the amount of heat necessary to raise the temperature of one pound of water one degree Fahrenheit. One thousand small calories equals 3.98 British Thermal Units.

Electrical energy is usually measured in watts. A watt is about the electrical energy necessary to light a Christmas tree light. Electric bulbs for

lamps are given measurements of how much electricity is necessary to light them. For example, a bulb marked 60 watts means that it needs 60 watts to cause it to produce maximum light. The 60 watt bulb will use 60 watts of electricity in one hour, or 60 watt hours. If the light were on for 100 hours it would use 6,000 watts hours of electricity or 6 kilowatts. Kilo means one thousand. Your monthly electricity bill is measured in kilowatts hours. A large electric power plant may produce 1,000 megawatts of power. Mega is a prefix for million. It could light 1,000 million one-watt Christmas tree lights or 16.7 million 60 watt bulbs (1,000 mega watts divided by 60). The largest power plant in Wyoming is the Jim Bridger Power Plant near Rock Springs and it can produce 2,000 million watts of electricity (megawatts). Think of watts of electricity like water flowing out of a hose. A small hose may furnish enough water to run one sprinkler on the lawn. Enough water to accommodate a fire hole is much more. Enough watts to meet the needs of a small city may be a megawatt.

The energy contained in foods is energy that came from the sun. The producers in ecosystems of the earth (plants, algae, and some bacteria) are able to trap energy by storing it in chemical bonds in the process of photosynthesis. In this process, producer organisms use chlorophyll as a catalyst to break water molecules and combine carbon dioxide with the hydrogen from the broken water molecule to make sugar. These sugars provide energy for all other organic molecules to be formed. This complex process evolved on earth more than a billion years ago. Since its evolution, this conversion process has been making energy available not only to the organisms that have chlorophyll but to organisms that have evolved to metabolize the producer organisms that store the energy. These are the consumers. Photosynthesis enables food chains to exist in nature.

An analogy used frequently in this curriculum to help children understand the storage of energy is a mouse trap. Outside energy is used to set the trap — cocking the spring. The sun's energy does this in photosynthesis using carbon dioxide and the hydrogen from water. The set trap with the stored energy is the combination of the carbon dioxide and the hydrogen in the sugar molecule that is formed in photosynthesis. The stored energy from the sugar and the sugar itself are used to form other rich energy compounds such as fats and proteins.

The energy from the sun, incorporated through the process of photosynthesis, is also the source of energy stored in coal, oil, and natural gas. It was

stored millions of years ago, and since nature is not always an efficient recycler (some products of photosynthesis are not always consumed in decay of once living organisms), we have fossil fuels to supply our modern world with its huge energy needs.

The peanut is a high energy seed composed of fats, proteins, and carbohydrates. It has a lot of stored energy to produce a new peanut plant or it is accessible to animals that eat peanuts. Coal is also a very high energy compound, even with more calories per gram than a peanut. But animals do not have the chemical processes in their physiology to metabolize coal and release its energy for their use. However, we have developed ways to capture a high percentage of the energy stored in coal. The energy in coal may heat homes, be made into oil or it can produce electricity in power plants.

## Procedure

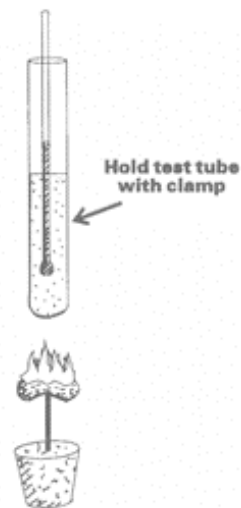
With explicit directions, fifth and sixth grade students can do this activity. However, the teacher may want to do the activity as a demonstration, depending on the skill and behavior of the students.

Peanuts usually have some water in them which does not allow them to burn well. Place them in an oven at 200 degrees for several hours to dehydrate them.

Using pliers or tweezers, push a needle (the dull end) into a cork. Stick a peanut on the sharp end of the needle. Put 10 milliliters of water (1 ml. of water weighs one gram) in a test tube and set it in the test tube rack with the Celsius thermometer in the water in the test tube. Record the temperature of the water.

With the cork, needle, and peanut on a hot pad, light the very dry peanut on fire with a match. Immediately grip the test tube with the test tube holder and place the tube about one inch (above the orange part of the flame) as shown.

Let the peanut burn until it goes out. Immediately record the temperature again. Subtract the ending temperature from the beginning temperature to get the temperature increase. Since a calorie is the amount of energy needed to raise 1 ml of water (weighs 1 gram) 1 degree Celsius, and you used 10 ml of water, the number of calories contained in the peanut equals the number of degrees the water temperature rose:



$10 \times 1(\text{temp. incr. multiplied by the number of ml of water}) = \text{calories}$

## Questions for discussion about the experiment

1. How many degrees did the temperature of the water change? How many grams of water were heated? How many calories were produced in causing the temperature of the water to raise the amount it raised?

Example:

$10 \text{ grams} \times 15 \text{ degree change} = 150 \text{ calories}$

2. Did all of the energy stored in the peanut go into the tube with the water? (No. Some went into the space around the tube and some of the energy was released as light energy. A calorimeter can capture nearly all of the heat from the burning material.)

3. Where did the energy come from that was in the peanut? (The sun)

Where did the energy come from that is in coal, natural gas, and oil? (The sun)

Where did the energy come from that you used in doing this experiment? (The sun)

Where does the energy in ethanol, used in gasoline, come from? (The sun. It is produced mostly from corn.)

4. A BTU is a heat energy unit used to measure large amounts of energy. One BTU is equal to about 251 small calories. How many BTU's were stored in the peanut?

## Conservation and Calories

Following are some problems wherein students may see how energy measurements are used in determining energy use and conservation.

1. To manufacture one kilogram of aluminum (2.2 pounds) requires 12,000 Calories (note the big C) of energy. To recycle the same amount and make it ready for reuse requires only 1/20 of the amount of energy as to produce the aluminum from the raw ore bauxite. How much energy does it take to recycle aluminum to make one kilogram of aluminum?

2. Wyoming coal is low in sulfur and causes less sulfur dioxide in the air when it burns. Sulfur dioxide may turn to sulfuric acid in the air and cause acid rain. However, it burns with fewer BTU's per pound than most coal mined in the eastern states of Pennsylvania and West Virginia. If a train load of Wyoming coal shipped to Ohio has 8,500 BTU's per pound, and a train load contains 11,000 tons, how many BTU's are there in the train load of coal. (There are 2,000 pounds in a ton.) Some power plants use two one hundred car trains of coal each day.

3. The Laramie River Power Plant near Wheatland, Wyoming uses three train loads of coal (27,000 tons) each day. To make one kilowatt of electricity requires 10,000 BTU's of heat energy from the coal. About how many kilowatts of electricity would 2 and 1/2 train loads of coal produce?

4. Would it take fewer BTU's of coal to heat your home with electricity made from burning coal or to use coal directly by burning it in a furnace?

## Extending the Activity

1. Have students look at the specification sticker on their home furnace and report how many BTU's of heat it produces.

2. Have students weigh equal amounts of peanuts and cracker. Dehydrate them both and perform the same experiment as was done with the peanut above. Which food contains the most calories?

3. New laws of labeling require that food producers label the calories in foods. Ask students

to check labels on a variety of foods in stores and report on the calories many contain.

4. To conserve energy, begin an aluminum recycling project at your school.

## Assessment

Use questions 1-4 of the "Procedure" to evaluate the objectives of this activity.

## Additional Resources

"A Diamond in the Rough," in this section may be used to accompany this activity.

Relate photosynthesis studies in fifth and sixth grade science classes to "Calories in a Peanut".

*Hot and Cold* by Irving Alder is about calories and heat. Harper Collins, 1975.

On line sources of energy activities:  
[energyteachers.org/Links.php?LinkTopicSelect=52](http://energyteachers.org/Links.php?LinkTopicSelect=52) Energy teachers.org has many sources of activities for elementary teachers including California's Energy Quest.

## **CONTENT STANDARD**

### **1. CONCEPTS AND PROCESSES**

**In the context of unifying concepts and processes, students develop an understanding of scientific content through inquiry. Science is a dynamic process; concepts and content are best learned through inquiry and investigation.**

#### **BENCHMARK Grade 8**

##### **UNIFYING CONCEPTS AND PROCESSES**

**Concepts in LIFE SYSTEMS and EARTH, SPACE, and PHYSICAL SYSTEMS are taught within the context of the following Unifying Change, constancy, and measurement**

##### **EARTH, SPACE, AND PHYSICAL SCIENCE**

**12. Forms and Uses of Energy: Students investigate energy as a property of substances in a variety of forms with a range of uses.**

## **CONTENT STANDARD**

### **2. SCIENCE AS INQUIRY**

**Students demonstrate knowledge, skills, and habits of mind necessary to safely perform scientific inquiry. Inquiry is the foundation for the development of content, teaching students the use of processes of science that enable them to construct and develop their own knowledge. Inquiry requires appropriate laboratory experiences with suitable facilities and equipment.**

#### **BENCHMARK Grade 8**

**2. Students use inquiry to conduct scientific investigations.**

- Ask questions that lead to conducting an investigation**
- Draw conclusions based on evidence and make connections to applied scientific concepts.**
- Clearly and accurately communicate the result of the investigation.**

**4. Students recognize the relationship between science and technology in meeting human needs.**

**5. Students properly use appropriate scientific and safety equipment, recognize hazards and safety symbols, and observe standard safety procedures.**

## **CONTENT STANDARD**

### **3. HISTORY AND NATURE OF SCIENCE IN PERSONAL AND SOCIAL DECISIONS**

**Students recognize the nature of science, its history, and its connections to personal, social, economic, and political decisions. Historically, scientific events have had significant impacts on our cultural heritage.**

**2. Students explore how scientific information is used to make decisions.**

**C. Origins and conservation of natural resources, including Wyoming examples information and principles to make responsible decisions about**

## Wyoming Math Standards

### CONTENT STANDARD

**3. MEASUREMENT** Students use a variety of tools and techniques of measurement in a problem-solving situation.

### BENCHMARK GRADE 6

**4.** Students demonstrate relationships within the U.S. customary units for weight and capacity and within the metric system (centimeters to meters) in problem-solving situations. Students use mathematical language to communicate sound reasoning in problem-solving situations.

### CONTENT STANDARD

**1. NUMBER OPERATIONS AND CONCEPTS** Students use numbers, number sense, and number relationships in a problem-solving situation.

### BENCHMARK Grade 5

**3.** Students demonstrate an understanding of whole number operations by: explaining the relationships between the operations of addition, subtraction, multiplication, and division; and multiplying by two-digit whole numbers and dividing by single-digit whole numbers.

**4.** Students explain their choice of estimation or problem-solving strategies and justify results when performing number operations in problem-solving situations.