# "Burning" Calories
## The Energy in Food

Objective

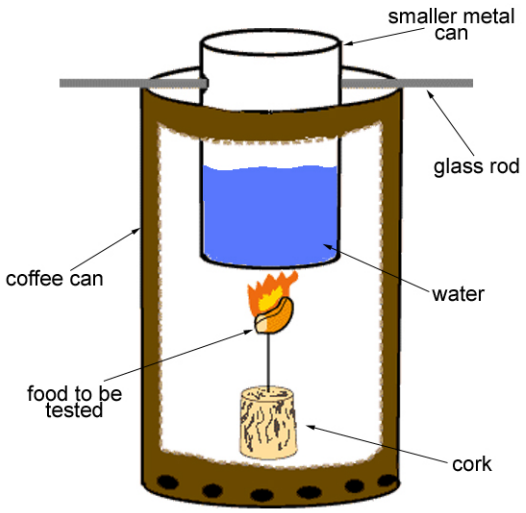
To determine the Calories in food.

Introduction

Why are marathon runners advised to eat a large plate of pasta the night before a competition? Because pasta is a good source of energy, or fuel for the body. All foods contain energy, but the amount of potential energy stored will vary greatly depending on the type of food. Moreover, not all of the stored energy is available to do work. When we eat food, our bodies convert the stored energy, known as **Calories**, to chemical energy, thereby allowing us to do work. A **calorie** is the amount of heat (energy) required to raise the temperature of 1 gram (g) of water 1 degree Celsius (°C). The density of water is 1 gram per milliliter (1g/ml) therefore 1 g of water is equal to 1 ml of water. When we talk about caloric values of food, we refer to them as Calories (notice the capital "C"), which are actually kilocalories. There are 1000 calories in a kilocalorie. So in reality, a food item that is listed as having 38 Calories has 38,000 calories. Calories are a way to measure the energy you get from the food you eat.

Just as pasta can provide a runner energy to run a marathon, a tiny peanut contains stored energy that can be used to heat a container of water. For this lab exercise, you will indirectly measure the amount of Calories in couple of food items using a calorimeter. A **calorimeter** (*calor* = Latin for heat) is a device that measures the heat generated by a chemical reaction, change of state, or formation of a solution. There are several types of calorimeters but the main emphasis of all calorimeters is to insulate the reaction to prevent heat loss. We will be using a homemade calorimeter modeled after a constant-volume calorimeter. A particular food item will be ignited, the homemade calorimeter will trap the heat of the burning food, and the water above will absorb the heat, thereby causing the temperature (T) of the water to

Types of calorimeters




Homemade calorimeter

increase. By measuring the change in temperature ($\Delta T$) of a known volume of water, you will be able to calculate the amount of energy in the food tested because the heat gained by the water will equal the heat lost by the food item:

$$Q_{\text{lost by food}} = Q_{\text{gained by water}}$$

The energy gained by the water can be calculated as follows:

$$Q_{\text{water}} = (m)(c)(\Delta T)$$

where **Q** is the heat gained in calories (cal); **m** is the mass of water in grams (g); **c** is the specific heat capacity of water (1 calorie/g °C); and **ΔT** is the change in temperature in degrees Celsius (°C). Note: Energy can also be measured in Joules (J) or British thermal unit (Btu). There are 4.184 J in 1 calorie. A Btu is the amount of heat required to raise the temperature of one pound of water by one degree Fahrenheit and 1 Btu is equivalent to 252 Calories.

Materials per pair:

- Graduated cylinder
- Water bottle with distilled water
- Homemade calorimeter
  - Coffee can
  - Small metal can (2)
  - Glass rod
- Cork with wire attached
- Thermometer (in °C)
- Lighter
- 2 Safety glasses
- Forceps

Materials in lab:

- Roasted cashew nuts
- Popcorn
- Weigh boats
- Scales
- Distilled water
- Gloves

***CAUTION!!! Flames will be used and items may be hot!***
***All long hair must be tied back.***

Procedure

1. Of the 2 food items you will be testing, hypothesize which one will have more Calories (energy). Record your prediction in the Laboratory Report.

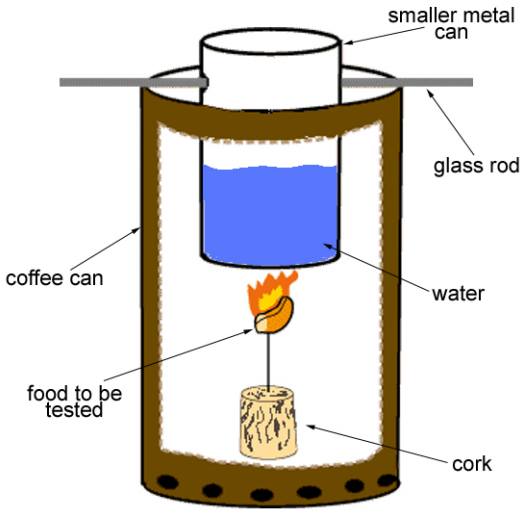
2. Obtain a weigh boat and determine its weight. Record your data.

3. Obtain a cashew nut and using the same weigh-boat, determine the weight of the cashew ($w_i$). Record your data. (Resist eating any cashews; they have to last the whole week….and there's no eating in lab.)

4. Using the graduated cylinder, measure out 100 ml of distilled water from the water bottle and pour it into the small metal can.

5. Measure the initial temperature of the water ($T_i$). Record your data.
   - Slide the glass rod through the holes in the top of the small can.

6. Gently wrap the wire attached to the cork around the cashew. It is better to have the cashew at a slight angle. If the cashew breaks, use another one; however, you will have to reweigh the new cashew.




Homemade calorimeter

7. Place the cork with the cashew on a nonflammable surface. Put on your safety glasses and light the peanut. It may take a while for the cashew to catch on fire.

8. As soon as the cashew catches fire, immediately place the large can around the nut. Then carefully balance the small can, using the glass rod, on top of the large can and over the burning cashew (see figure above).

9. Allow the cashew to burn until it goes out. If possible try to keep an eye on it and if it goes out quickly (less than a minute), relight the cashew.

10. Once the cashew has finished burning, carefully remove the small can by holding the glass rod and place it on the lab bench. Then remove the glass rod. Caution! The cans and water will be warm!

11. Using the thermometer, **carefully** stir the water and then measure the temperature again ($T_f$). You may have to leave the thermometer in the water for a while in order to get the highest reading. Record your data.

12. **After the burnt cashew has cooled**, transfer it to the original weigh-boat (use the forceps if necessary) and weigh the remnants ($w_f$). Record your data.

13. Repeat Steps 2 – 11 with the popcorn. Make sure you use a new small can and fresh water. Also, you can just poke the popcorn into the tip of the wire. Record all your data.

Name _____

TA _____

Lab Day/Time _____

**Laboratory Report** (15 pts)

1. Which food item do you predict to contain more energy?

2. Weight of weigh-boat:

   1st _____g_

   2nd _____g_

3. Record your data.

| Food Item | Weight (Mass) of Food (g)[a] | | | Temperature of Water (°C) | | |
|---|---|---|---|---|---|---|
| | **Initial Weight ($w_i$)[a]** | **Final Weight ($w_f$)[a]** | **Mass of Sample Burned ($\Delta w = w_i - w_f$)** | **Initial Temperature ($T_i$)** | **Final Temperature ($T_f$)** | **Change in Temperature ($\Delta T = T_f - T_i$)** |
| **Cashew** | | | | | | |
| **Popcorn** | | | | | | |

[a]Don't forget to subtract the weight of the weigh-boat.

Name _____

TA _____

Lab Day/Time _____

4. Determine the Calories of the food:
   - ***Make sure you show all your calculations and you include all proper units***.

| **Food** | | **Energy or calories (cal)** | **Calories (Cal) or kilocalories (kcal)** | **Cal/g** |
|---|---|---|---|---|
| **Cashew** | calculations | | | |
| | answer | | | |
| **Popcorn** | calculations | | | |
| | answer | | | |

*Remember that the density of water is 1g/ml therefore 1 g of water = 1 ml of water.

5. How many Calories are in 1 whole cashew? In 1 popcorn?

6. Were you able to determine the entire Calorie content of the food item? Why?

7. Do you think the number of Calories you calculated is likely to be lower or higher than it really is? Explain why.

8. What is the original source of energy in all of the foods tested?