Peanut Energy

Overview: Put your safety goggles on for today's lab –we'll be looking at fire again. You'll be measuring how much energy a peanut holds by setting it on fire and measuring an increase in water temperature.

What to Learn: All our energy needs on earth come from somewhere. We cannot make our own food, but plants can. We are all connected to the plants and soils that they grow in because they provide our very basic needs, as well as some of our more modern needs.

Materials

- Goggles
- 2 shelled peanuts
- Small pair of pliers
- Match or lighter
- Test tube in wire test tube holders (these look like pliers that are designed to hold a test tube)
- Scale
- Thermometer

Lab Time

1. Today we're working with fire, so follow all special instructions provided about working with fire today.
2. Measure your test tube on the scale when it's empty: _____ grams
3. Fill up your test tube with about 10 grams of water and weigh it again: _____ grams
4. Measure the initial temperature of the water: _____ ^{o}C
5. Put on safety goggles.
6. Using a small pair of pliers, hold the peanut and ask an adult to light the peanut with the lighter until it catches fire.
7. Upon ignition (when the peanut is burning by itself and doesn't need the lighter), hold the peanut under the water close to the bottom of the test tube until the peanut stops burning.
8. Quickly measure the final temperature of the water: _____ ^{o}C
9. Record your results on the worksheet.
10. Allow the peanut to cool as you record your observations and complete the data tables.

Let's take an example measurement. Suppose you measured a temperature increase from 20 °C to 100 °C for 10 grams of water, and boiled off 2 grams. We need to break this problem down into two parts - the first part deals with the temperature increase, and the second deals with the water escaping as vapor.

The first basic heat equation is this: Q = m c T

Q is the heat flow (in calories)
m is the mass of the water (in grams)
c is the specific heat of water (which is 1 degree per calorie per gram)
and T is the temperature change (in degrees)

So our equation becomes: Q = 10 * 1 * 80 = 800 calories.

If you measured that we boiled off 2 grams of water, your equation would look like this for heat energy: Q = L m

L is the latent heat of vaporization of water (L= 540 calories per gram)
m is the mass of the water (in grams)

So our equation becomes: Q = 540 * 2 = 1080 calories.

The total energy needed is the sum of these two:

Q = 800 calories + 1080 calories = **1880 calories.**

Reading

Did you know that eating a single peanut will power your brain for 30 minutes? The energy in a peanut also produces a large amount of energy when burned in a flame, which can be used to boil water and measure energy.

Peanuts are part of the bean family, and actually grow underground (not from trees like almonds or walnuts). In addition to your lunchtime sandwich, peanuts are also used in woman's cosmetics, certain plastics, paint dyes, and also when making nitroglycerin.

What makes up a peanut? Inside you'll find a lot of fats (most of them unsaturated) and antioxidants (as much as found in berries). And more than half of all the peanuts Americans eat are produced in Alabama. We're going to learn how to release the energy inside a peanut and how to measure it.

There's chemical energy stored inside a peanut, which gets transformed into heat energy when you ignite it. This heat flows to raise the water temperature, which you can measure with a thermometer. You should find that your peanut contains 1500-2100 calories of energy! Now don't panic - this isn't the same as the number of calories you're allowed to eat in a day. The average person aims to eat around 2,000 Calories (with a capital "C"). 1 Calorie = 1,000 calories. So each peanut contains 1.5-2.1 Calories of energy (the kind you eat in a day). Do you see the difference?

So did all the energy from the peanut go straight to the water, or did it leak somewhere else, too? The heat actually warmed up the nearby air, too, but we weren't able to measure that. If you were a food scientist, you'd use a nifty little device known as a *bomb calorimeter* to measure calorie content. It's basically a well-insulated, well-sealed device that catches nearly ***all*** the energy and flows it to the water, so you get a much more accurate temperature reading. (Using a bomb calorimeter, you'd get 6.1-6.8 Calories of energy from one peanut!)

Peanut Energy Data and Observations

Trial #	Mass of Water (grams)	Temperature Increase (°C)	Heat Energy 1 (calories)
Sample	*10 grams*	*80 °C*	*= (10 grams) x (1 degree per cal per gram) x 80 (°C)* *= 800 calories*

Trial #	Mass of Water Boiled Off (grams)	Heat Energy 2 (calories)
Sample	*2 grams*	*=542calories per gram x 2 grams* *= 1080 calories*

Trial #	Heat Energy 1 (calories)	Heat Energy 2 (calories)	Total Energy Produced (calories)
Sample	*800 cal*	*1080 cal*	*1880 Calories*