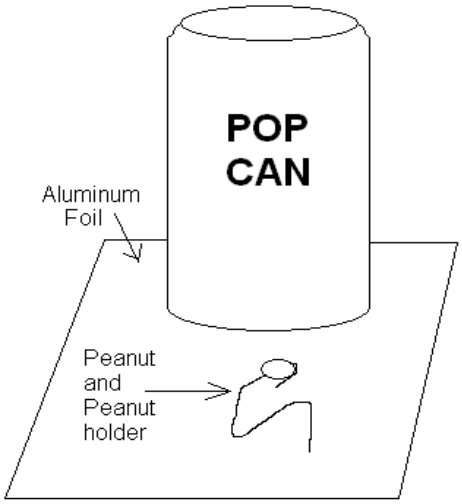
Phys 220 - Chemical to Thermal Energy

Materials and equipment: pop can, paper clip, foil, peanut, matches, ice, graduated cylinder and a scale.

You know that food contains chemical energy that your body uses to function. Have you ever wondered how nutritionists know how many Calories a certain food contains? In this lab you will build a homemade calorimeter to capture the energy released from burning a small food item, like a nut or a piece of popcorn. This activity gives a new meaning to the phrase "burning calories."

To measure the amount of thermal energy in a peanut you will measure the amount of ice the peanut can melt when it burns.

Experiment



- Lay the aluminum on the table top to protect the surface. Turn up the edges to make a shallow tray. If the peanut falls off the stand, the edges should keep it from falling on the floor.
- Fill the "POP" can about 1/4 full of ice.
- Set the peanut on the paper clip stand as shown.
- Set the stand on the table – do not hold it while you burn the peanut!
- Light the peanut by holding the match directly below the peanut. It might take a couple of matches to get the peanut burning.
- Another person should pour off any excess water that has collected while someone is trying to light the peanut. There should be as little water in the can as possible when the peanut starts to burn.
- As soon as the peanut starts to burn by itself, the match should be removed and the "POP" can held about 5 centimeters (2 in.) above the peanut.
- Hold the can above the flame and gently swirl as long as the peanut continues to burn (if your peanut goes out prematurely you will have to relight it).
- When the peanut has burned completely, measure the volume of ice (1 ml = 1 g) that was melted by the flame.

If all of the ice melts before your peanut is completely burned, you must get a new peanut and try again.

Analysis

1. Calculate the thermal energy required to melt your ice using $Q = mL$ ($L_f = 3.33 \times 10^5$ J/kg)
2. Find the chemical energy lost by the peanut in food Calories. (4,186 J = 1 Cal)
3. If there are about 40 average peanuts in a one ounce serving, based on your experimental value for one *whole* peanut how many calories would there be in an average serving? Write this value on the board.
4. How does your value of calories per serving size compare to the class average? How does the class average compare to the label?
5. Why do you think the class average is different from the label?
6. What improvements do you think real calorimeters have over our homemade version?
7. Why was it suggested to have plenty of ice in the pop can that you held over your peanut while it burned? What change, if any, to your procedures would you have had to make if all of the ice melted in your experiment?

Extension

Let's say that Sally Sue and Jimmy Bob did not put enough ice in their pop can. They burned their peanut and melted all of their ice. Immediately after the peanut finished burning, they checked the temperature of their water and it was 30°C. When they measured, they had 1.5 ml of water in the can. Find the food Calories in their peanut.