
Lab: Specific Heat

All the measurements can be found here: <https://www.youtube.com/watch?v=cw7q433ynYg>
It's a bit of a scavenger hunt to find all the measurements, but she makes all of them.
Complete prelab questions on page 1 and fill out page 4.

Qty	Equipment and Materials
1	Temperature Probe
1	Balance
1	Coke Can
1	Food holder (cardboard square, paperclip, string)
1	Marshmallow
1	Graduated cylinder
1	Large Base and Support Rod
1	Match
50 mL	Water

Purpose

The purpose of the activity is to measure the energy content of food by burning the food to warm a known quantity of water. Measure the change in temperature of the water.

Background

When burning food warms a known quantity of water, the amount of heat given off by the food is theoretically equal to the amount of thermal energy gained by the water. The following is an equation that describes this idea:



$$Q = m \times c \times \Delta T$$

where Q is the heat, m is the mass of the water, c is the *specific heat* of the water, and ΔT is the change in temperature of the water.

The specific heat, c , of water is:

$$c = \frac{1 \text{ calorie}}{\text{gram}^\circ\text{C}} = \frac{4.186 \text{ joule}}{\text{gram}^\circ\text{C}}$$

In this activity, burn a sample of food under a container of water to heat the water. Measure the change in temperature of the water as it is heated by the burning food.

Note that a food calorie (what you see on nutrition labels), is 1000 calories, e.g., 1 food calorie equals 4186 joules.

Pre-lab Questions

1. The USDA recommends a 2000 calorie per day diet. Find the equivalent wattage of a light bulb that outputs the same amount of energy.
2. Read through the procedure. Where are there potential sources for experimental error?

Safety Precautions

- Take care when using matches.
- Follow all directions for using the equipment.
- Wear protective gear (e.g., safety goggles, gloves, apron).

Procedure

Temperature Probe

1. Turn on the computer. Turn on the Pasco interface. Connect the interface to the computer with the USB cable. Connect the temperature probe to the interface. Click on the Capstone icon on the computer. Select to plot temperature versus time in the Capstone program.

Equipment Setup

2. Measure and record the mass of the aluminum can. Pour 50 mL of water into the aluminum can. Measure and record the total mass of the can plus the water.
3. Set up the equipment as shown. Use an unbent paper clip to hang the aluminum can from the rod.
4. Place the end of the temperature probe into the water, but don't let the end of the probe rest on the bottom of the can.
5. Use the square piece of cardboard, two large paper clips, and tape to build the food holder as shown (see the Appendix for instructions).
6. Place the food sample on the paper clips of the food holder. Measure and record the total mass of the food sample and holder.



Figure 2: Setup

Record Data

7. Click the record button on the computer. The computer will now start plotting temperature as a function of time.
8. Light the marshmallow. Quickly place the burning food sample directly under the center of the container. Leave the sample under the container until the food sample stops burning.

CAUTION: Keep hair, clothing, and other items away from open flames.

9. Leave the sensor in the water for at least 45 seconds after the food has stopped burning. Gently twirl the can to stir the water. *Stop* recording data when the temperature stops rising.
10. Measure and record the mass of the burned food sample and holder.

Analysis

11. Use your recorded data to find the *change in temperature* of the water heated by the marshmallow.
12. Use your measured data to find the *change of mass* of the food sample.
13. Calculate the heat absorbed by the water, Q . Remember the equation:

$$Q = m \times c \times \Delta T$$

For water, the specific heat "*c*" is 4.186 J/g°C.

14. Determine the mass of the food that burned.
15. Calculate the *energy content*, or *ratio* of heat divided by the mass of the marshmallow that burned.

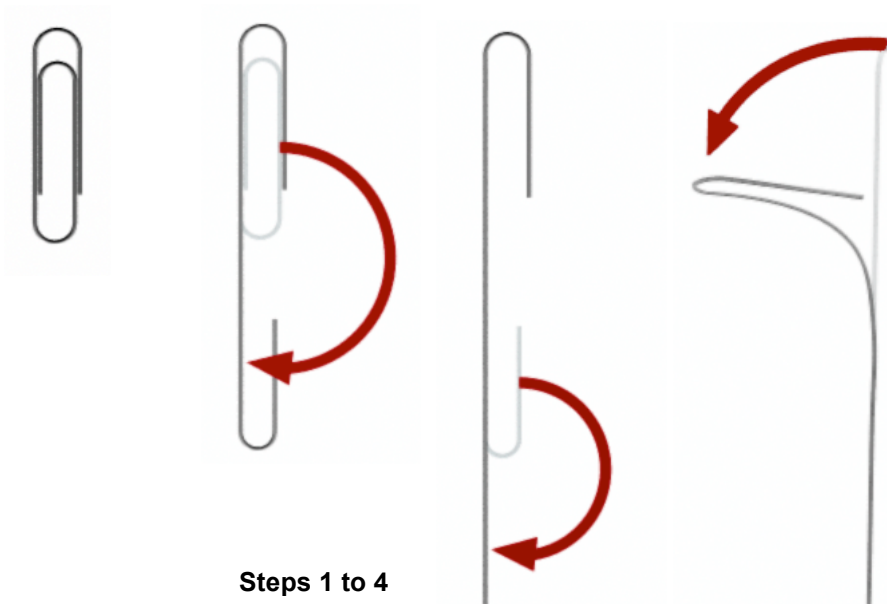
Record your results in the Lab Report.

Appendix: Building a Food Holder

(1) Start with a large paperclip. (2) Unfold the paperclip as shown. (3) Straighten one end of the paperclip. (4) Bend over the curved end of the paperclip to about ninety degrees.

(5) Push the straightened end of the paperclip through the cardboard square near the center of the square. (6) Bend over the straightened end to about ninety degrees. (7) Use tape to fasten the bent part of the paperclip to the bottom of the cardboard square.

Repeat the process with a second paperclip. Push the second straightened paperclip through the cardboard square at a spot about 2 or 3 cm from the first paperclip.



Steps 1 to 4



Steps 5 to 7

After you tape the second paperclip to the bottom of the cardboard, bend the tops of the two paperclips so they hook together and form a platform to hold the food sample.

Lab Report – Specific Heat

Name _____ Date _____

Pre-Lab Questions

1. The USDA recommends a 2000 calorie per day diet. Find the equivalent wattage of a light bulb that outputs the same amount of energy.
2. Read through the procedure. Where are there potential sources for experimental error?

Data Table

Item	Sample 1
Mass of empty container	
Mass of container + water	
Mass of water	
Initial mass of sample + holder	
Final mass of sample + holder	
Change of mass, food sample	
Initial temperature	
Final temperature	
Temperature change, ΔT	
Heat, Q	
Energy content (heat/mass)	

Questions

1. The calorie information on a label is per serving. Using your calculated results for the calories per gram and multiplying by the mass of one serving, how many calories are in a serving of marshmallow?
2. The percent error is: $100 \times (\text{true value} - \text{measured value}) / \text{true value}$. Calculate the percent error for your answer to question 1.
3. Where did the mass of the burnt marshmallow go?