Laboratory Investigation Name _____

Physics@Frisch Date _____ Period _____

Measuring Specific Heat

Problem

How is the specific heat of a metal measured?

Introduction

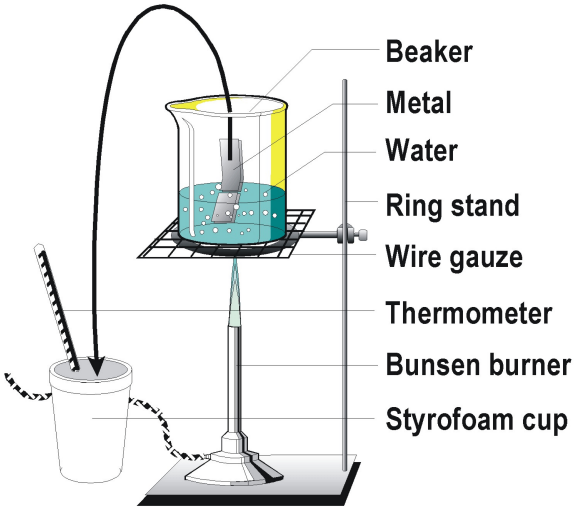
Two pans are sitting on a stove over two flames. Everything about the two setups is almost identical, except one of the pans has a metal handle and the other has a wooden handle. Which is more comfortable to pick up after it sits on the flame for awhile? For a given quantity of heat energy, different substances change their temperatures by different amounts: A metal will have larger temperature change than wood, so the wooden handle is more comfortable to touch. The quantity that relates temperature changes to absorption or release of heat energy is called specific heat or heat capacity. It is denoted by the symbol c_p. The units of specific heat are joules per gram per degree Celsius, or the equivalent units, joules per gram per kelvin. Formally, specific heat is defined as the quantity of heat energy needed to change the temperature of one gram of substance one Celsius degree. In this lab you will measure the specific heat of two metals.

Materials (*per group*)

Balance; beaker; Bunsen burner; metals; ring stand and ring; safety goggles; styrofoam cup; thermometer; tongs;

Procedure

1. Put on safety goggles. Fill a 250 mL beaker partway with water. Set up a hot water bath as shown to the right with a ring, ring stand, wire gauze, Bunsen burner, and the beaker of water. Light the Bunsen burner.



2. Obtain sample of metal. Describe the metal color in the data table on the next page. Measure the metal's mass. Record the result in the data table on the next page. Using tongs, place the metal into the hot water bath and allow the water to come to a rapid boil.

3. Measure the mass of an empty styrofoam cup. Record the result in the data table. Fill the styrofoam cup about half way with tap water. Measure the mass of the cup and the water. Record the result in the data table.

4. Measure the initial temperature of the water in the styrofoam cup with a thermometer. Record the result in the data table on the next page.

5. Measure the temperature of the boiling water. This is the initial temperature of the metal. Record the result in the data table on the next page.

6. Using tongs, remove the metal from the boiling water and place it in the styrofoam cup. Stir the water gently with the thermometer. When the temperature stops rising, measure the final temperature. This is both the final temperature of the water and the final temperature of the metal. Record the result in the data table on the next page.

7. Repeat the procedure using another metal

CALCULATIONS

8. Calculate the mass of the water by subtracting the mass of the empty cup from the mass of the cup plus water.

9. Calculate the temperature changes of both the water and the metal by finding the absolute value of the difference between the final and initial temperatures. Record the results in the data table below.

10. Calculate the number of joules gained by the water using the equation below.

$$\mathbf{Q = m \times C_p \times \Delta T}$$

Q = heat energy $\quad$ **ΔT** = change in temperature

m = mass of water $\quad$ C_p = specific heat capacity

Note: The specific heat of water is 4.184 J/g°C.

Record the result in the data table below.

11. Calculate the specific heat of the metal. The number of joules gained by the water must be equal to the number of joules lost by the metal. the specific heat is therefore,

$$C_p = \frac{Q}{m \times \Delta T}$$

where "Q" is the number of joules absorbed by the water, "m" is the mass of the metal, and "ΔT" is the change in temperature of the metal. Record the result in the data table below.

OBSERVATIONS

		Metal 1	Metal 2
[a]	metal color		
[b]	mass of metal		
[c]	mass of cup		
[d]	mass of cup and water		
[e]	initial temperature of water		
[f]	initial temperature of metal		
[g]	final temperature		
[h]	mass of water		
[i]	change in the temperature of water		
[j]	change in the temperature of metal		
[k]	joules gained by water		
[l]	specific heat of metal		

CONCLUSIONS

1. How do we know that the heat gained by the water must be equal to the heat lost by the metal? _____

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2. Why should the final temperature of both the water and the metal be the same? _____

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3. Which had the larger temperature change, water or metal? Why? _____

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4. What are some sources of error in this experiment and how would it affect your determination of specific heat? _____

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