Heat can be defined as energy transferred between matter because of differences in temperature. The ability of matter to transfer heat depends on its mass and temperature. A calorimeter is an instrument used to measure changes in heat energy. You can make a simple calorimeter using a Styrofoam cup to contain water, a beaker for more insulation and support, and a temperature probe as shown in Figure 1. The joule (J) is the SI unit for heat energy. An equation that can be used to calculate change in heat energy is

$$H = \Delta t \cdot m \cdot C_p$$

where H = heat absorbed or released (in J), Δt = change in temperature (in °C), m = mass (in g), and C_p = specific heat capacity (4.18 J/g°C for water).

OBJECTIVES

In this experiment, you will

- construct and use a simple calorimeter
- use the LabPro system and two temperature probes to measure temperature
- mix cold and warm water
- determine heat lost by cooling water
- determine heat gained by warming water
- compare heat lost by cooling water and heat gained by warming water

MATERIALS

LabPro System
2 Vernier Temperature Probes
50-mL graduated cylinder
Styrofoam cup
250-mL beaker
cold water
warm water

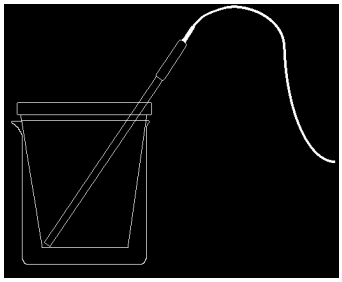


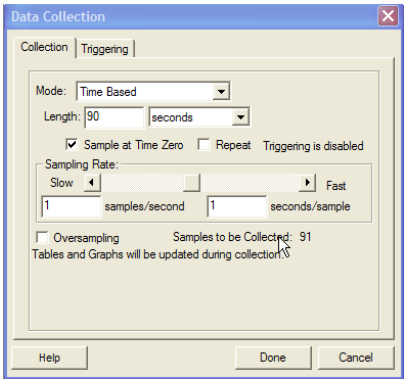
Figure 1

Set-up Procedure

1. Set-up your LabPro unit
   Plug the LabPro unit in (listen for the beeps)
   Connect the LabPro to the Computer using the USB cable
   Run the Logger Pro software on the PC

2. Plug two temperature probes into Channels 1 and 2 of the LabPro System. Make sure they are both recognized by the program.

3. Set-up data collection (Experiment menu, data collection option). Enter 90 seconds for the length of the experiment. Enter 1 sample for every 1 second.



4. Label your data table with Cold Temperature (channel 1) and Warm Temperature (channel 2). Units are both C (Celsius).

Experiment Procedure

6. Place a Styrofoam cup into a 250-mL beaker as shown in Figure 1. Use a 50-mL graduated cylinder to get 50.0 mL (50.0 g) of cold water from the container supplied by the teacher. Be careful not to take any ice pieces. Pour the cold water into the Styrofoam cup and insert Temperature Probe Channel 1.

7. Use a 50-mL graduated cylinder to get 50.0 mL (50.0 g) of warm water from the container supplied by the teacher. Place Temperature Probe Channel 2 into the warm water in the 50-mL graduated cylinder. After the probes have been in the cold and warm water for at least 45 seconds, you are ready to begin data collection.

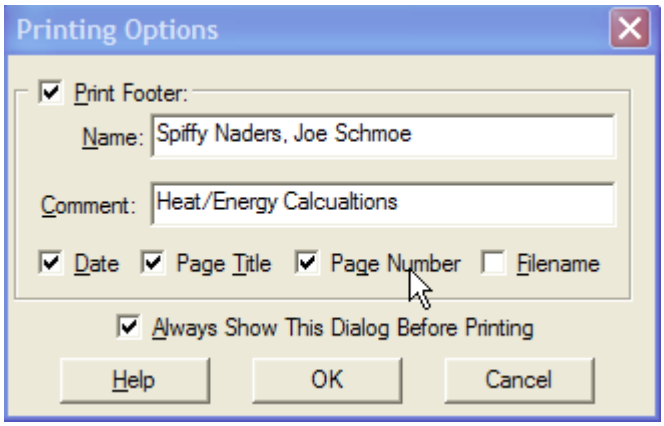
8. • After the probes have been in the liquids for at least 45 seconds, start collection data (hit F11 key or click on Collect). When 10 seconds have passed, transfer the warm water **and its probe** to the Styrofoam cup.
   • Stir to mix the warm water with the cold water. Continue stirring until data collection is complete.

9. When data collection is complete, record the maximum and minimum temperatures from your data table for the cold-water probe (round to the nearest 0.1°C).

   Use the data table to record the maximum and minimum temperatures for the warm water probe (round to the nearest 0.1°C).

10. Print out **BOTH** the Data Table and Graph (on separate sheets). Make sure to set-up the header first with your names and the comment as shown below.

Label your graph as well as "Heat/Energy Gain and Loss" (double-click on the graph to do this).



DATA

DATA TABLE		
	Cold Water (Probe 1)	Warm Water (Probe 2)
Minimum Temperature		
Maximum Temperature		
Temperature Change		
Heat Gain/Heat Loss		

PROCESSING THE DATA

1. Calculate the temperature change, Δt, for the warming of cold water and the cooling of warm water by subtracting the minimum temperature from the maximum temperature for the cold water ($\Delta t = t_{max} - t_{min}$). Record this number in your data table above.

Calculate the heat gained by the cold water (in J). Use the equation

$$H = \Delta t \bullet m \bullet C_p$$

where H = heat absorbed (in J), Δt = change in temperature (in °C), m = mass (50.0 g in this experiment), and C_p = specific heat capacity (4.18 J/g°C for water).

Record your answer in the data table above.

2. Calculate the temperature change, Δt, for the cooling of warm water by subtracting the minimum temperature from the maximum temperature for the warm water. ($\Delta t = t_{max} - t_{min}$).
   Record this number in the data table above.

Calculate the heat lost by the warm water (in J). Use the equation

$$H = \Delta t \bullet m \bullet C_p$$

where H = heat absorbed (in J), Δt = change in temperature (in °C), m = mass (50.0 g in this experiment), and C_p = specific heat capacity (4.18 J/g°C for water). Record your answer in the data table.

4. Calculate the percent difference using the formula

$$\% \text{ difference} = \frac{heat_{lost} - heat_{gained}}{heat_{lost}} \times 100$$

5. What are some factors that might have caused the difference determined in Step 4?