Lab 6: Heat Capacity and Specific Heat

1. You have 5 aluminum cylinders on your table marked A, B, C, D, and E. Use the digital scale to find their masses.

Cylinder	A	B	C	D	E
Mass (g)					

2. Use the following procedure to perform the experiment.

   Step 1: Use the hot plate to boil water in the large metal bucket.

   Step 2: Measure 50 mL of water into the styrofoam cup (use 75 mL for cylinders D and E).

   Step 3: Tie a string around one of the cylinders using the hole through the center and use the string to place the cylinder into the boiling water. After at least 30 seconds in the boiling water the aluminum will be in thermal equilibrium with it, and therefore at the same temperature (remember the temperature of boiling water is 100°C).

   Step 4: Open **Logger Pro Specific Heat** file to record temperature. Place the temperature probe in the tap water and record its initial temperature.

   Step 5: Gently (but quickly) transfer the cylinder from the boiling water into the cold water, trying to minimize the amount of time the aluminum is losing heat to the air.

   Step 6: Stir the water gently with the temperature probe and record the temperature when it stops rising.

   Repeat the experiment with a fresh sample of tap water for each cylinder and record your data in the following table.

Tap Water					Aluminum Cylinder					
Mass (g)	Initial temp	Final temp	Temp change	Mass x Temp change	Cyl ID	Mass (g)	Initial temp	Final temp	Temp change	Mass x Temp change
50					A					
50					B					
50					C					
75					D					
75					E					

   (a) When mixing hot and cold water samples, you learned that the quantity *mass x temperature change* gives thermal energy (in calories). With this in mind, for each of your experiments involving cylinders A-C, what is the heat gained by the water?

(b) How should the heat gained by the water be related to the heat lost by the cylinder? Does your data support this relationship? What evidence do you have?

Once all of the lab groups have completed the experiment, your instructor will lead a class discussion about *heat capacity* and *specific heat*. When you are done, please let your instructor know and wait patiently for the other groups to finish.

3. Calculate the heat capacity of each of the cylinders to fill in the following chart.

Cylinder	A	B	C	D	E
Heat Capacity					

(a) What are the units of heat capacity? Explain.

(b) Does the heat capacity of a sample depend on its mass? How do you know?

4. An aluminum cylinder with heat capacity of 5 cal/°C is placed into 25 g of water at a temperature of 25°C.

(a) How much heat must be transferred for the water to warm by one degree?

(b) What is the heat capacity of the water sample?

(c) For each one degree change in the temperature of the water, how much does the temperature of the hot aluminum change?

5. Imagine that the same number of calories (as defined in the previous two questions) is transferred from the aluminum to the water several times, each time resulting in the water warming by one degree until the water and aluminum are in thermal equilibrium. Use the following table to describe this process (your last step may not be a "whole" step).

Heat Transferred	Temp of Water	Temp of Aluminum
0 calories	25°C	100°C
	26°C	

(a) What is the final temperature?

(b) What is the total heat transferred?

6. An aluminum cylinder at 100°C with heat capacity 50 cal/°C is placed in a tank of oil at 20°C with a heat capacity of 200 cal/°C.

(a) What is the temperature of the hot aluminum when the oil warms by one degree? Explain.

(b) Determine the final temperature when the aluminum and oil come to thermal equilibrium algebraically (using an equation).

7. Using your data from the beginning of lab, make a graph of heat capacity versus mass for the aluminum cylinders on a sheet of graph paper your instructor will provide. Draw a best fit line and determine its slope (remember that this slope will be the specific heat of the aluminum).

   (a) What is the specific heat of aluminum? State the units with your answer.

   (b) The "textbook" value of the specific heat of aluminum is 0.22 cal/°C. You instructor will give you a formula to determine the percent error between an accepted value and a calculated value. What percent error did you get?

   (c) Write an equation relating the heat capacity ($\mathcal{K}$) to specific heat (c) and mass (m).

   (d) What is the specific heat of water?

   (e) Does it require more heat to increase the temperature of a gram of water by 1°C or a gram of aluminum? Explain your reasoning.

   (f) If equal masses of aluminum and water at different temperatures are mixed, will the final temperature be closer to the initial temperature of the water of the initial temperature of the aluminum? Explain your reasoning.