Heat and Temperature

Equipment

1	Quad Temperature Sensor	PS-2143
1	Energy Transfer Calorimeter	ET-8499
	Required but not included:	
1	Graduated Cylinder, 100-ml	
	Water (100 ml)	

Introduction

The purpose of this activity is to explore the relationship between heat and temperature by measuring the amount of temperature change in two different volumes of the same fluid, subject to the same amount of added thermal energy.

Background

Heat is defined as energy that is transferred between two or more objects by way of thermal interaction (conduction, radiation, or convection). The heat energy in an object is a representation of the TOTAL kinetic energy of ALL the particles that make up the object, and similar to mechanical energy, heat energy is a conserved quantity.

Temperature is a physical measurement of how "hot" or "cold" a substance is based on the AVERAGE kinetic energy of particles in the substance.

The amount of heat energy in an object is related to temperature, but temperature by itself cannot tell you how much thermal energy (heat) is in an object. Identical thermometers in two pots of water on a hot stove will show different temperatures even if the pots have been on the stove for the same time if the amount of water in one pot is different than the amount in the other.

Figure 1: Equipment

Setup

1. Assemble the Energy Transfer Calorimeter similar to Figure 2, using the heating resistor with two-hole rubber stopper.

2. Connect the red and black patch cords from the heating resistor to Output #1 on the 850 interface.

3. Connect the Quad Temperature sensor to any PASPORT channel on the 850 interface, and then connect a stainless steel temperature probe to port 1 on the Quad Temperature sensor.

4. Insert the stainless steel temperature probe into the second hole on the two-hole rubber stopper and gently push the probe down until it touches the bottom of the calorimeter cup.

5. In PASCO Capstone, set the sample rate to 1 Hz.

6. Create a graph of Temperature vs. Time.

Figure 2: Calorimeter Assembly

Resistor Safety

Data will be collected on the next pages, and during data collection about 1 A of current will be continuously flowing through the resistor. This current will cause the resistor to heat up which will in turn heat the water that will be placed in the calorimeter. Do not start recording data until the heating resistor is completely submerged in the water. Collecting data while the resistor is not submerged can cause it to burn up, or be dangerously hot. Do not touch the heating resistor.

Procedure: 40 ml

1. Use the graduated cylinder to measure 40 ml of water, and then lift the lid on the calorimeter and pour the measured water into the inner cup.

   NOTE: Use cool (not cold) tap water, or water that has an initial temperature below 24 °C.

2. Replace the calorimeter lid with the heating resistor and stainless steel temperature probe submerged in the water in the cup.

3. Click the record button below to activate the heating resistor. Data will not be recorded until the temperature of the water in the calorimeter reaches 24 °C, and then will automatically stop after 300 seconds (5 minutes).

4. Gently swirl the water in the cup as data is recorded so the water will be heated evenly.

5. When data recording stops, pour out the warm water and set the calorimeter lid with temperature probe and heating resistor on the lab table for about a minute to cool.

Procedure: 60 ml

6. Use the graduated cylinder to measure 60 ml of water, and then pour the measured water into the inner cup in the calorimeter.

   NOTE: Use cool (not cold) tap water, or water that has an initial temperature below 24 °C.

7. Replace the calorimeter lid with the heating resistor and stainless steel temperature probe submerged in the water in the cup.

8. Click the record button below to activate the heating resistor. Data will not be recorded until the temperature of the water in the calorimeter reaches 24 °C, and then will automatically stop after 300 seconds (5 minutes).

9. Gently swirl the water in the cup as data is recorded so the water will be heated evenly.

Analysis

1. Use the graph tools to determine the change in temperature for each volume of water, 40 ml and 60 ml. Record both values below.

2. How does the ΔT for 40 ml of water compare to the ΔT for 60 ml of water?

3. Did the 40 ml of water receive more, less, or the same amount of energy as the 60 ml? Why?

4. Considering your answer to the previous question, why is the final temperature of the 40 ml of water higher than the 60 ml.