A resistance-thermometer probe will be used with a digital multimeter for measuring the temperature of the water in the calorimeter and for measuring room temperature. The probe is inserted into the calorimeter as shown in Figure 1. The test leads from the probe are connected to the common and kΩ jacks on the digital multimeter, and the multimeter is set to its 200 kΩ resistance range. Higher temperatures reduce the resistance of the semiconductor in the tip of the probe. A chart will be provided in the laboratory which lists the temperature corresponding to each resistance reading for a range of temperatures near room temperature. (Other laboratories often use resistance thermometers with their own digital readout in °C.) The chart provides a reading to the nearest .01 to .03 °C. Admittedly, the absolute accuracy of the resistance thermometer would not justify readings in such fine steps. But when we are trying to measure a difference between two temperatures only a few degrees apart, some of the error in the thermometer tends to cancel out. Suppose, for instance, that the true value of t_{1w} is 24.00 °C and the measured value is 25.15 °C. Then, suppose that the true value of t_{2w} is 26.00 °C and the measured value is 27.20. The error in $t_{2w} - t_{1w}$ would be only 0.05 C°. But, of course, some of the resistance thermometers are not this accurate, and there are a number of other sources of error.

You will probably be using a liquid-in-glass thermometer for reading the temperature of the boiling water. It may be slightly different from 100 °C due to non-standard atmospheric pressure or to impurities in the water. The high temperature could damage some types of resistance thermometers.

Apparatus

Calorimeter
Resistance-thermometer probe
Chart of temperature vs. resistance for probe
Digital multimeter
Electric stove or immersion heater
Thermometer, liquid in glass type, -20 °C to + 110 °C
Aluminum sample
Other metal sample
Wire with loop on end for handling samples
Beaker, 1000 ml
Beaker, 400 ml or 250 ml
Triple-beam balance

Procedure

1. Locate the electric stove at one end of the table and the calorimeter and the resistance thermometer at the other. Fill the large beaker about three-quarters full of water. Begin heating the large beaker of water on the stove in preparation for boiling it. If you use an immersion heater, be sure it is always under water when it is receiving electric power.

2. Weigh the aluminum cylinder on the triple-beam balance and find its mass (m_s).

$$m_s = \underline{37.2} \text{ g}$$

3. Place the hook of the aluminum cylinder through the loop on the end of the wire. Use the wire to lower the aluminum cylinder into the hot water. Leave the cylinder standing in the beaker with its hook upward, so that you can easily remove the cylinder from the boiling water later. Be sure the cylinder does not touch the immersion heater.