Lower Merion High School Chemistry

Specific Heat of Metals

Lab #24

The amount of heat (q) that something gives up (or takes in) can be calculated by the equation $q=mc\Delta T$, where q is heat, m is mass, c is specific heat, and ΔT is the change in Temperature. Specific heat is the amount of heat required to raise the temperature of 1 gram of a substance one degree. In English, that means it is a measure of how much (or little) heat is needed to make something hotter. The larger the number, the more heat something will absorb without getting hot.

The specific heat of water is 1 cal/g^{o}C (calorie per gram degree Celsius). This is a defined number (infinite significant figures). Most things (and certainly most metals) have much lower specific heats (it takes less heat to make them hotter)

In this lab you will be determining the specific heat of three metals (Cu, Pb, and Al).

Materials:

TI-83 calculator with CHEMBIO	Water	test tube	metal sample(s)
CBL System	Temperature probe	beaker	Styrofoam cup

Procedure:

Set up a CBL/calculator with a temperature probe.

Get a Styrofoam cup. Weigh the cup and add approximately 50 ml of water, then reweigh the cup and water.

Obtain a large test tube, weigh it and then add *X* g of metal shot (little round beads of metal). For Cu and Pb *X* = 40. For Al *X*=30. Reweigh the test tube to determine the exact weight of the shot.

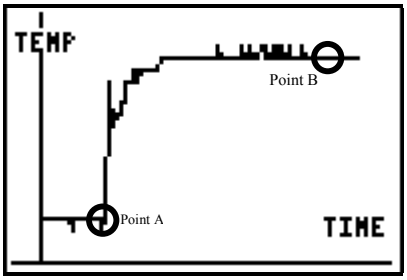
Suspend the test tube in a large beaker of water and heat the water until it is boiling. Leave the test tube in the boiling water for approximately 10 minutes.

Start the CHEMBIO program. SET UP PROBES using the STORED calibration for the temperature probe if asked. Place the temperature probe in the cup of water, being careful not to spill any water.

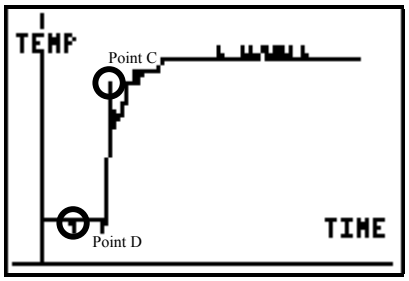
Choose COLLECT DATA, then TIME GRAPH. Take samples every **1 second** for **180 samples**. Set the YMIN to 0 and the YMAX to 110, set the Y SCALE to 20.

When the metal has been in the boiling water for 10 minutes, press ENTER to start the data collection. Wait approximately 10-15 seconds and then dump the metal shot out of the test tube, into the water in the cup. Stir the water with the temperature probe being careful to keep the probe in the water, but not in contact with the metal.

When the CBL says DONE, press ENTER on your calculator to see the full graph of your data. It should look like this:



Move the cursor on the graph to find the temperature of the water just before adding the metal shot (**Point A**) and record that value. Then move the cursor to find the final temperature (**Point B**), and record that value.



If you accidentally touched the metal while you were stirring you will get spikes in the data (**Point C**). If you accidentally pulled the probe out of the water, you will get drops (**Point D**). Ignore these points.

Repeat the experiment with the other two metals. To save time, you may want to have one metal heating while you are doing the experiment with another. (For example heat a test tube of Cu while the Pb shot is in the cup with the water.

Once you have recorded all of your data for all three metals. Put all equipment away and clean up your lab area.

Calculations:

Determine the ΔT for the metal and water in each experiment. (Remember the metal started at $100^{o}C$, since it was in boiling water).

For each experiment, assume that the heat lost by the metal is equal to the heat gained by the water. This allows you to set up the equation $m_w c_w \Delta T_w = -m_m c_m \Delta T_m$, where m_w is the mass of the water, c_w is the specific heat of water, ΔT_w is the change in the temperature of the water, m_m is the mass of the metal, etc.

Use this equation to determine the specific heat of each metal.