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7.0.C Hands-on Heating Cooling Curves

Christopher F. Bauer
University of New Hampshire, chris.bauer@unh.edu

Experiments in the heating and cooling of substances

You will be working in groups of three. Once the groups are organized, the manager is the person in the group who is the youngest in age. The safety monitor is the person who is the eldest in age. The data recorder is the third person.

Each group will be following a similar general procedure, but using different substances. The goal is to either heat up or cool down a substance (or both) and to monitor the temperature of a thermometer embedded in the substance. You will put your data onto large graph paper, and the whole class's results will be combined for discussion.

Group	Experiment	
A	Heating/cooling stearic acid	
B	Heating/cooling lauric acid	
C	Heating three liquids; cooling one of them	
D	Cooling/warming water	
E	Cooling/warming oleic acid	
F	Cooling/warming methyl salicylate	
G	Cooling/warming ethylene glycol	

SAFETY CONCERNS:

You will be working with DRY ICE, which can cause frostbite if held in your hand for more than a few seconds.

You will be creating HOT LIQUIDS and LABORATORY HOT PLATES, whose temperatures are hot enough to cause serious burns.

You will be handling chemical substances that COULD BE toxic to you, but only if you ingested them. Everything you are using can be found in the kitchen, craft store, or automotive store. DO NOT eat or chew gum (or your nails) while in the lab. Don't rub your eyes. AFTER CLASS ENDS, WASH YOUR HANDS in the bathroom down the hall.

You never know what's been on a lab bench before you. Don't sit on it. Minimize putting any personal stuff on the lab bench.

Watch out for your neighbors.

Keep your eye protection on all the time.

Christopher F. Bauer, Principal Investigator.
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Procedures:

General (for everyone):

1. Organize your group and roles.
2. Find your experiment station (in classroom or lab room).
3. Inspect the physical set-up of the experiment, and make a record of what it looks like.
4. Review the procedure for your experiment.
5. Review potential safety issues.
6. Decide the process by which you will collect and record. Once you start the procedure, you can't restart it easily. Talk through what you intend to do and anticipate problems.
7. BEFORE YOU START, get an OK from CB or one of the grad students.
8. Data collection may take 40-60 minutes all together.

A. Heating/cooling stearic acid (lab room)

1) The water bath should be at a temperature of 80 to 90 ^oC.
2) Turn on the digital thermometer embedded in the strearic acid.
3) Take an initial reading of the temperature.
4) When you are ready, ask CB or one of the grad students to adjust the clamps to immerse the stearic acid in the water bath, or ask one of them to watch you do it.
5) IMMEDIATELY, start recording data. Record temperature data every 15 seconds. You may be doing this for 10 minutes. Make visual observations of the material as well. If you miss a recording time, just pick up with the next one.
6) When the recorded temperature is at 80 ^oC or above, call CB or one of the grad students over to determine whether it's time to stop.
7) Adjust the clamp to raise the material out of the water bath.
8) Carefully remove the thermometer from the clamp (HOLD IT AT THE TOP), and set the stearic acid into the room temperature water bath. IMMEDIATELYI, start recording data as before.
9) At any point, turn off the heater and stirrer. CAUTION, THESE WILL REMAIN HOT FOR MANY MINUTES.
10) When the stearic acid has cooled down to at least 35 ^OC, you can stop taking data.

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B. Heating/cooling lauric acid (Iab room)

1) The water bath should be at a temperature of 55 to 65 °C.
2) Turn on the digital thermometer embedded in the strearic acid.
3) Take an initial reading of the temperature.
4) When you are ready, ask CB or one of the grad students to adjust the clamps to immerse the lauric acid in the water bath, or ask one of them to watch you do it.
5) IMMEDIATELY, start recording data. Record temperature data every 15 seconds. You may be doing this for 10 minutes. Make visual observations of the material as well. If you miss a recording time, just pick up with the next one.
6) When the recorded temperature is at 55 °C or above, call CB or one of the grad students over to determine whether it's time to stop.
7) Adjust the clamp to raise the material out of the water bath.
8) Carefully remove the thermometer from the clamp (HOLD IT AT THE TOP), and set the lauric acid into the room temperature water bath. IMMEDIATELYI, start recording data as before.
9) At any point, turn off the heater and stirrer. CAUTION, THESE WILL REMAIN HOT FOR MANY MINUTES.
10) When the lauric acid has cooled down to at least 25 °C, you can stop taking data.

E. Cooling/warming Oliec Acid (OA)

1) Find thermometer with bulb attached with the appropriate label. Turn on digital thermometer, and take initial temperature reading.
2) Obtain some water ice in the coffee mug, add some water to this. It should be deep enough to cover up to the liquid level of oleic acid in the bulb. sufficient to pack around the <u>bottom</u> of the bulb. IMMEDIATELY, start taking temperature readings.
3) Record temperature data every 10 seconds. You may be doing this for 10 minutes. If you miss a recording time, just pick up with the next one.
4) When the recorded temperature is at 5 °C or below, call CB or one of the grad students over to determine whether it's time to stop.
5) Carefully remove the thermometer, observe the substance in the bulb, and set it into the room temperature water bath. IMMEDIATELYI, start recording data as before.
6) When the water has warmed up to at least 20 °C, you can stop taking data.

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C. Heating three liquids and cooling one

1) The heating experiments should be done one at a time, first oil, then water, then salt water.
2) For each heating experiment, the procedure is the same.
   a) Turn on digital thermometer immersed in the liquid. Take initial temperature reading.
   b) Turn on the stirrer to get gentle stirring.
   c) Turn the heater on to its highest setting.
   d) IMMEDIATELY, start recording data. Record temperature data every 10 seconds. You may not be taking data for very long. Make visual observations of the material as well. If you miss a recording time, just pick up with the next one.
   e) When the oil exceeds 120 ^{o}C, turn off the heater, but continue to monitor temperature for 2 more minutes.
   f) Move on to water. Repeat the process. Continue until you think you can stop. You may with to ask CB or an intern for advice. Turn heater off after that.
   g) Move on to salt water. Repeat the process. Turn heater off after that.
3) Find thermometer with bulb attached that says salt water on it. Take temperature reading.
4) Obtain some crushed dry ice in the coffee mug, sufficient to pack around the <u>bottom</u> of the bulb. IMMEDIATELY, start taking temperature readings every 15 seconds.
5) Record temperature data every 15 seconds. You may be doing this for 10 minutes. Make visual observations of the material as well. If you miss a recording time, just pick up with the next one.
6) When the recorded temperature is at - 25 ^{o}C or below, call CB or one of the grad students over to determine whether it's time to stop.
7) Carefully remove the thermometer and set it into the room temperature water bath. IMMEDIATELYI, start recording data as before.
8) When the salt water has warmed up to at least 15 ^{O}C, you can stop taking data.

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D. Cooling/warming water (W)

1) Find thermometer with bulb attached with the appropriate label. Turn on digital thermometer, and take initial temperature reading.
2) Obtain some crushed dry ice in the coffee mug, sufficient to pack around the <u>bottom</u> of the bulb. IMMEDIATELY, start taking temperature readings every 15 seconds.
3) Record temperature data every 15 seconds. You may be doing this for 10 minutes. If you miss a recording time, just pick up with the next one.
4) When the recorded temperature is at - 25 ^{o}C or below, call CB or one of the grad students over to determine whether it's time to stop.
5) Carefully remove the thermometer, observe the substance in the bulb, and set it into the room temperature water bath. IMMEDIATELYI, start recording data as before.
6) When the water has warmed up to at least 15 ^{O}C, you can stop taking data.

F. Cooling/warming methyl salicylate (MS)
G. Cooling/warming ethylene glycol (EG)

1) Find thermometer with bulb attached with the appropriate label. Turn on digital thermometer, and take initial temperature reading.
2) Obtain some crushed dry ice in the coffee mug, sufficient to cover up to the liquid level in the bulb. IMMEDIATELY, start taking temperature readings every 15 seconds.
3) Record temperature data every 15 seconds. You may be doing this for 10 minutes. If you miss a recording time, just pick up with the next one.
4) When the recorded temperature is at - 25 ^{o}C or below, call CB or one of the grad students over to determine whether it's time to stop.
5) Carefully remove the thermometer, observe the substance in the bulb, and set it into the room temperature water bath. IMMEDIATELYI, start recording data as before.
6) When the substance has warmed up to at least 0 ^{O}C, you can stop taking data.

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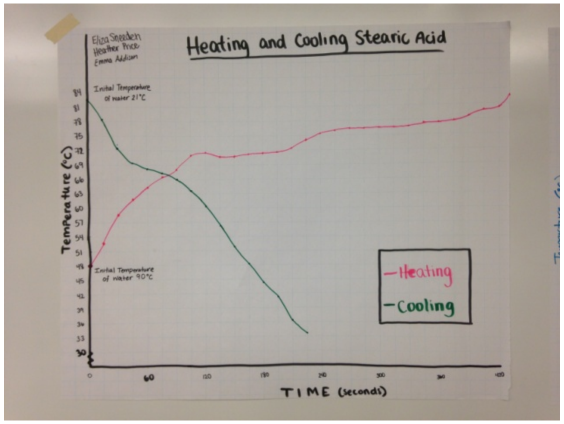

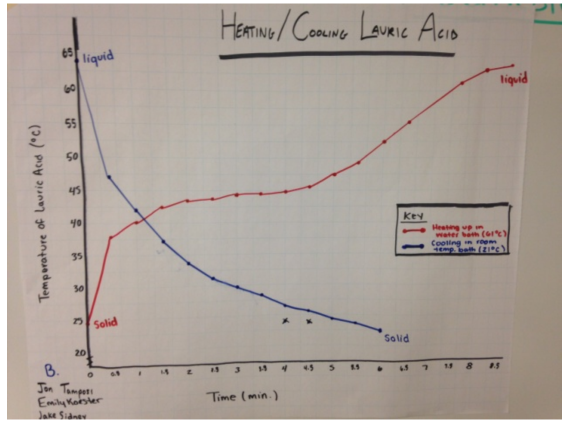

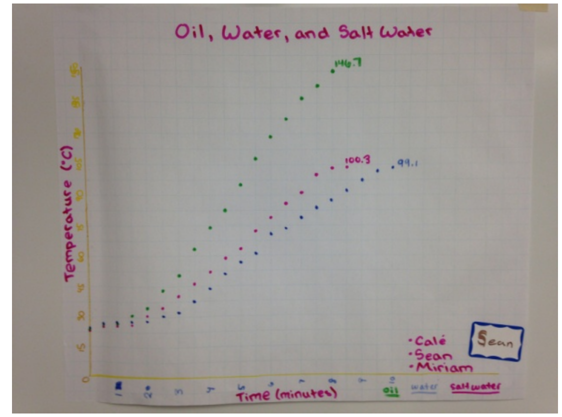

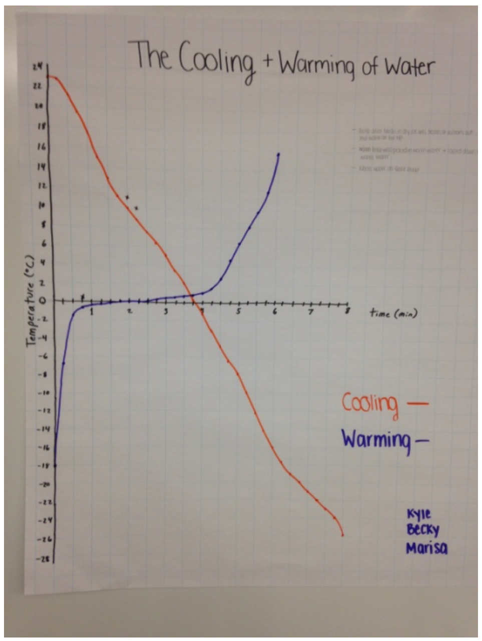

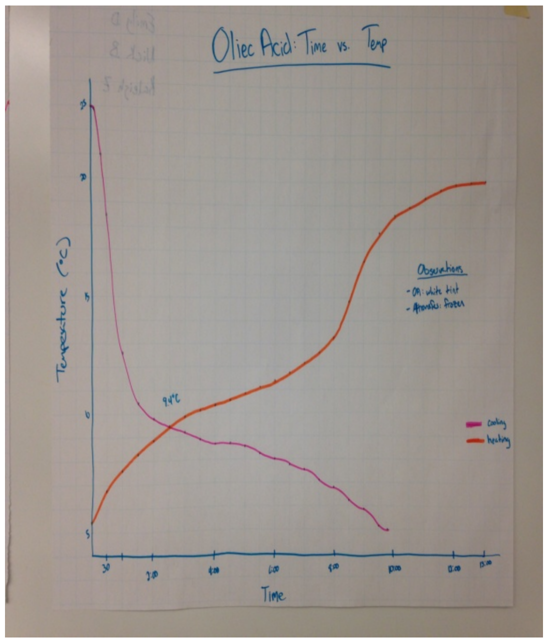

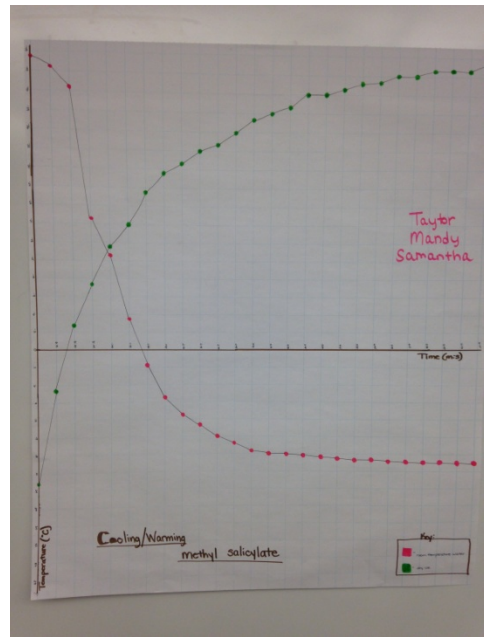

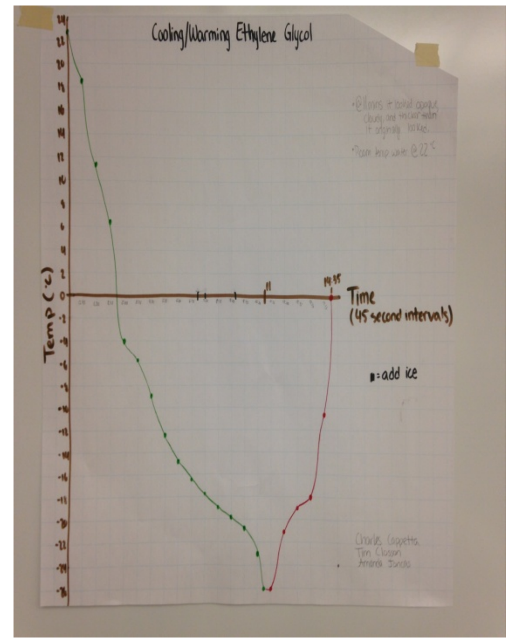

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