Physics

Cold Fusion Lab

Purpose & Hypotheses

This lab measures the "heat of fusion" for water, and the experiment itself is pretty simple. However, the analysis is much more challenging, and most groups will need help to complete it properly. **Before** beginning the lab, think carefully and then **write down** an answer to the following question: is it possible to add a significant amount of heat to a small object without changing the object's temperature at all?

Procedure

1. **Design** and **construct** a table for recording the temperature of the water inside your calorimeter at 15-second intervals for up to 5 minutes. What is the maximum number of data points your table must hold? Have one person assigned to watch the clock and record the data (the **Data Recorder**) and one person assigned to read the thermometer (the **Temperature Reader**). Read through **Steps #2-9** right now so that everyone understands what is going to happen.
2. Remove the top from your calorimeter, hand the top to someone you can trust **not** to break the thermometer, and then bring the rest of the calorimeter up to the front desk to get some hot water. Bring your data table as well so you can show me how beautiful it is.
3. I'll pour some very hot water (careful!) into your calorimeter, and I'll tell you the volume of this water. Return to your group without spilling the water, and replace the calorimeter top (taking care not to break the thermometer).
4. **Record** the volume of the water I gave you, then wait about 3 minutes for the water and the calorimeter to reach thermal equilibrium.
5. While you're waiting for thermal equilibrium, send one group member (the **Ice Retriever**) back to the front of the room to get some ice. The **Ice Retriever** should return from the front of the room with the ice and keep it relatively dry using your paper towel.
6. Once the 3 minutes have passed, record the temperature of the hot water in the first cell of your data table (0 seconds). The **Data Recorder** must **immediately** begin watching the clock so that s/he can call for the next temperature reading 15 seconds later.
7. **Immediately** lift the top, **carefully** drop the ice into your calorimeter, replace the top, and continue **recording** the temperature of the water every 15 seconds in your data table. The water will be changing temperature **very quickly** at first, so move fast to record the data accurately for the first minute, but keep **watching** for signs that the temperature change has slowed.
8. Continue **recording** the temperature until the temperature change gets really slow, and then start peeking into the calorimeter periodically to see whether the ice has melted completely. Stir the water occasionally by **gently** lifting and then lowering the metal rod protruding from the calorimeter top. Do not break the thermometer!
9. Once the ice has **completely** melted (be careful!), **record** the final temperature of the water in your table.
10. Remove the top of your calorimeter again, and bring it to the front of the room, where I'll help you measure the total volume of water it now contains. **Record** this volume.
11. Make sure that **each person** in your group has a complete copy of your temperature data, as well as the other data you collected.

Analysis & Conclusions

The analysis section is the really hard part of this lab, and there are several steps where you'll have to think carefully, discuss the question at length, do some math, and then hopefully convince yourselves that you've got the right idea. I can help you, but only **after** you've spent a significant amount of time and effort trying to come up with a formula on your own.

Important! **Carefully identify** each number you calculate, so that you'll know what it means and how it can be used for subsequent calculations. For example, write "Mass of original water = 800 g" instead of "800" or "A1 = 800g".

A1. Calculate and **record** the mass of the **original** water before you added the ice cube. **Hint #1**: It's not 800 grams – that was just an example of an (incorrect) answer! **Hint #2**: What is the density of water?

A2. Calculate and **record** the mass of the ice cube(s) you added. **Send one member to check your answers with me before continuing.**

A3. Come up with a formula for the total amount of heat energy lost by the **original** water from the point at which you added the ice to the point at which you stopped measuring the calorimeter temperature. **Hint**: What is the specific heat of water? **Send one member to check your formula with me before continuing.**

A4. Use your formula to calculate and **record** the total amount of heat lost by the **original** hot water.

A5. Use the same formula to calculate the amount of heat energy absorbed by the **icewater <u>only</u>** as it warmed from 0°C to the final temperature you recorded.

A6. The **difference** between your answers in **Step A4** and **Step A5** should represent the amount of heat absorbed by the ice as it melted. **Make sure every person in your group understands this completely** (and is prepared to explain it carefully in his/her final lab report). Calculate and **record** the heat absorbed by the ice as it melted.

A7. Come up with a formula to estimate the heat of fusion for water, based on the data you collected in the lab. **Hint**: it has to do with the energy you calculated in **Step A6** and the mass you calculated in **Step A2**. **Send one member to check your formula with me before continuing.**

A8. Use your formula to estimate the heat of fusion for water.

A9. Come up with a formula for calculating the percentage error between your estimate and the standard value of 80 calories/gram. **Again, send one member to check your formula with me before continuing.**

A10. Use your formula to calculate the percentage error for your estimated heat of fusion.

A11. Plot all of your temperature data on a graph with time on the horizontal axis and temperature on the vertical axis.

A12. Draw a diagram showing how the heat you calculated in **Step A4** is used for both the process described in **Step A6** and the process described in **Step A5**.

A13. Why was it important to keep the ice relatively dry before placing it into the calorimeter?