Chemistry 150

Please have the following pages ready before class on Wednesday, January 10. Write an abstract and paper-clip it to the front of your individual writeup. The abstract and the carbon-copy pages of the write-up are due in class on Monday, January 22.

When a material undergoes a change of state, e.g., from solid to liquid, or liquid to gas, the temperature of the material remains constant; the heat added during the process produces the phase change. The constant temperature at which a solid material changes to a liquid is known as its melting point and the amount of heat necessary to melt the substance is known as the heat of fusion (ΔH).

The amount of heat transferred during a reaction can be measured with a device called a calorimeter. There are two types of calorimeters: constant pressure (simple) and constant volume (bomb) calorimeters. In lab, we will use a simple calorimeter, which is an insulated vessel with a stirrer, a thermometer, and loose-fitting lid to keep the calorimeter at constant atmospheric pressure. Because the reaction is carried out at constant pressure, transferred heat (q) is equal to the heat of the reaction (ΔH). How can the temperature change inside a calorimeter be used to calculate the heat of the reaction (ΔH)?

In this experiment, ice at 0°C is placed into a calorimeter containing water at a temperature T_f. The ice melts and, in time, a final steady state temperature, T_f, is obtained. If we make the assumption that the calorimeter is thermally isolated, i.e., no heat is gained or lost to the surroundings, then the heat gained by the ice in the process of melting and then rising to temperature T_f is equal to the heat lost by the water in going from T_i to T_f.

Read sections 8.7 and 8.8 of McMurry and Fay to figure out why this is important.

Your name, your partner’s name, date of experiment

Lab 1: Heat of fusion of ice

Part 1. Purpose

Using a simple calorimeter, we will verify the heat of fusion of ice.

Part 2. Materials and methods

Chemicals needed: distilled water, ice

Equipment needed: make a list based on the procedure. Sketch the setup demonstrated in class, and as shown in the photos below. Label more parts than are shown in the photos. NB: The “data logger” shown is the “Vernier LabPro”.

Write the one math equation you will need to calculate the heat of fusion.
Part 3. Procedure

1. Set up the apparatus as shown above; you will need one of the wireless laptops from the cart. Set up the electronics and the experimental parameters according to the “Instructions for Using Temperature Probe with Laptop”, which is a laminated sheet kept with the temperature probes.

2. Start a hot water bath (around 60°C) using a 250 mL beaker and a hot plate. Place a 50 mL graduated cylinder upside down in the water bath to warm it.

3. Pour ~30 mL of warm water into the warmed graduated cylinder and quickly measure the volume (down to the nearest tenth, I hope). Once the volume is measured, pour the water into the calorimeter and begin collecting temperature data with the LabPro temperature probe. It is important to not get a “dip” in the temperature data at this point, since the highest temperature obtained will serve as $T_i$.

4. Add approximately 50 mL of ice to the calorimeter very soon after you begin collecting temperature data. Be sure your ice is not “wet”. If your ice appears to be “wet”, dry it off with a paper towel.

5. Continue collecting temperature data until all the ice has melted and an apparent constant temperature has been reached.

6. After the experiment is complete, measure the volume of the water in the calorimeter.

7. Follow the “Instructions for Using Temperature Probe with Laptop” to save the data as an Excel file.

8. Repeat the experiment until two successive trials give results within 5% of each other.

9. Remember to print out the Excel files of your “good” trials.

Waste disposal — It’s water for goodness sake; dump it down the sink.

Part 4. Original data

Might the density of water at the final temperature be important? If so, record that datum and its source here.

The raw data for the temperature probe should be in this section; it is okay to tape printed copies of your Excel spreadsheet into your notebook, as long as the trial number is clearly marked.

Summarize the main results of all trials in one table that lists the volume (as needed) and mass of both “reactants” (identify them), the initial temperature ($T_i$), the final temperature ($T_f$) and the temperature difference ($\Delta T$) for each trial.
Part 5. Calculated results

For one of the “good” trials, show how you calculated the heat of fusion of ice.

Calculate a mean for your two “good” trials (no standard deviation).

Calculate a percent error between your value of $\Delta H_f$ and the reference value $\Delta H_f$, which is given in the text.

Part 6. Group results

Write the mean of your heat of fusion of ice on the overhead projector and record all groups’ values. Calculate the mean and standard deviation, and comment about where your results fit in (for instance, are your results outliers?). Comment on the class’s results as a whole (for instance, are there any outliers? are all the values systematically high?).

Part 7. Questions

1. What assumption did you make about the Styrofoam cup and the Teflon-covered stir bar? Why is this a reasonable assumption?

2. How would the results for the heat of fusion of water have been affected if the ice were not dried before being placed in the calorimeter? Would this have made the measured heat of fusion larger or smaller? Explain, using a semi-quantitative derivation.

Part 8. Conclusion

A sentence each on:

- Report the class’s mean and standard deviation.
- Report the class’s percent error (use the class mean) off of the reference value.
- Comment on the type of error (random or systematic) suggested by the spread of the class data.
- Suggest a major source of error for the previous sentence and how that would explain the error seen.

Abstract

Name(s), school affiliation, title, text as usual. Make this about your group’s (not the class’s) results. Summarize your “good” trial values, and your percent error off the reference value. Comment on whether the setup lent itself to errors that you could see the effect, and finally state whether this method is effective in accomplishing the purpose.