Molar Heat of Fusion for Water

Strand Phases of Matter and Kinetic Molecular Theory

Topic Investigating properties of matter

Primary SOL CH.5 The student will investigate and understand that the phases of matter are explained by kinetic theory and forces of attraction between two particles. Key concepts include
e) molar heats of fusion and vaporization.

Related SOL CH.1 The student will investigate and understand that experiments in which variables are measured, analyzed, and evaluated produce observations and verifiable data. Key concepts include
a) designated laboratory techniques;
b) safe use of chemicals and equipment;
e) accurate recording, organization, and analysis of data through repeated trials.

Background Information

Heat is the flow of energy due to the temperature difference that exists between a hot body and a cold body. Heat flow will stop when the temperatures of the hot and cold bodies become the same.

Molar heat of fusion is the amount of heat necessary to melt (or freeze) 1.00 mole of a substance at its melting point. Note the two important factors:

- It is 1.00 mole of a substance.
- There is no temperature change.

Keep in mind the fact that this is a very specific value. It is only for one mole of a substance melting. The molar heat of fusion is an important part of energy calculations since it tells you how much energy is needed to melt each mole of substance on hand. (Or, if you are cooling off a substance, how much energy per mole to remove from a substance as it solidifies.)

Every substance has its own molar heat of fusion. The units are usually kilojoules per mole (kJ/mol).

Materials

- Goggles and apron
- Hot plate
- Triple beam or electronic balance
- Thermometer
- Styrofoam cup
- Beaker tongs
- Small plastic spoon
- Hot pad for warm beaker
- Two 400-mL beakers
- One 600-mL beaker

- Tap water
- Ice
- Paper towels
- Attached Molar Heat of Fusion for Water Lab Worksheet

Vocabulary

heat, Joules, molar fusion heat, temperature measures

Student/Teacher Actions (what students and teachers should be doing to facilitate learning)

Introduction

1. Distribute the "Molar Heat of Fusion for Water" worksheet to each student, and go over the preliminary steps.
2. Have lab partners discuss and decide who will do which steps in the setup procedure.

Procedure

CAUTION! Make sure students wear goggles and aprons during the entire course of the lab, which includes all cleanup time. Make sure they handle all glassware with great care, being very careful not to drop or knock over any pieces. Make sure they handle all hot objects with proper care, being very careful to protect them from being burned.

Give students the following verbal instructions to do the experiment:

1. Use beaker tongs to grasp the 400-mL beaker containing the warm water. Pour water into the Styrofoam cup until the cup is half full. Immediately mass the cup and warm water, and record this measurement on a data table. Set the hot beaker on the hot pad until the beaker cools. Place the Styrofoam cup inside the 600-mL beaker to stabilize it.
2. Measure the temperature of the warm water in the Styrofoam cup, and record this value in the data table. Leave the thermometer in the water as you go on to the next step.
3. Immediately after recording the temperature, add the equivalent of a handful of ice cubes to the warm water. Be very careful not to add any cold water (melted ice) in the 400-mL beaker to the warm water. Do not allow any splash to occur.
4. Using the thermometer, gently stir the ice in the water. Your goal is to lower the temperature of the warm water to a single digit value and have no ice remaining. If you decide you need to add more ice to do this, add it one piece at a time, and keep stirring gently without stopping. Once the temperature has stopped going down, record it on the data table.
5. Remove the thermometer from the water. Remove the cup from the 600-mL beaker. Mass the cup and cold water, and record this value in the data table. You are now finished with the experimental portion of run #1 of this lab.
6. Make a second run of the experiment by drying the Styrofoam cup, reheating the water in the 400-mL beaker to about 55°C, and repeating steps 1–5 above.
7. Pour all water into the sink, and return any unused ice to where you got it.
8. Dry all equipment that is wet, including the table top. Put all materials onto a dry paper towel near the back of the table.

9. Make sure you have a copy of all data; do not depend on your partner being present the next day.
10. Wait for the teacher's signal before removing goggles and aprons.

Observations and Conclusions

Have students do the following:

1. Calculate the mass of the warm water in the Styrofoam cup.
2. Calculate the temperature change that the warm water underwent as it melted the ice.
3. Calculate the amount of heat lost, in joules, by the warm water as it melted the ice.
4. Calculate the mass of the ice that melted.
5. Calculate the amount of heat, in joules, that heated the melted ice from 0°C to the final temperature.
6. Calculate the amount of heat, in joules, that actually did melt ice.
7. Calculate, to the 0.01 place
   a) the heat of fusion for water in joules per gram
   b) the molar heat of fusion for water in kilojoules per mole.
8. Calculate the percent error for the value in 7b above. The true value is 6.02 kJ/mol.

Extensions and Connections (for all students)

- Have students visit a local ice rink and tour the facility to learn how the ice is created and maintained.
- Have students complete a research project on how global warming is affecting the polar ice caps.

Strategies for Differentiation

- Have students use a spreadsheet or word processor to create the data table.
- Have students use probeware software to record the collection of data.
- Have students color code the information from the procedure to its corresponding part on the data table.
- Have students preread the procedure and devise a table to record their data.

Molar Heat of Fusion for Water Lab Worksheet

Directions

After discussing the following steps with your lab partner, set up the lab by doing the following preliminary steps:

1. Prepare for the lab by putting on goggles and aprons.
2. Zero the triple beam balance or electronic balance.
3. Make sure the Styrofoam cup is clean, dry, and empty.
4. Mass the Styrofoam cup, create a data table, and record the measurement in your table.
5. Put 150 mL of tap water into a 400-mL beaker, and put it on the hot plate. Turn the hot plate to full power, and put a thermometer in the water. Stir the water gently with the thermometer. You want the water to be between 60° and 70°C. Monitor the temperature of the water, and when it gets to about 55°C, turn the hot plate off.
6. After completing step 5, fill the second 400-mL beaker to the top with ice.
7. Continue the lab by following your teacher's verbal instructions for each step.