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58 Melting Away

Experiment

Purpose

To measure the heat of fusion of water.

Required Equipment/Supplies

250-mL graduated cylinder
8-oz. Styrofoam (plastic foam) cup
water
ice cube (about 25 g)
paper towel
thermometer (Celsius) or
  computer
  temperature probe with interface
  computer and data plotting software (optional)
  printer
graph paper (if computer is not used)

Discussion

If you put heat into an object, will its temperature increase? Don't automatically say yes, for there are exceptions. If you put heat into water at 100°C, its temperature will not increase until all the water has become steam. The energy per gram that goes into changing the phase from liquid to gas is called the *heat of vaporization*. And when you put heat into melting ice, its temperature will not increase until all the ice has melted. The energy per gram that goes into changing the state from solid to liquid is called the *heat of fusion*. That's what this experiment is about.

Procedure

Step 1: Use a graduated cylinder to measure 200 mL of water, and pour it into a Styrofoam cup. The water should be about 5°C warmer than room temperature. If you are using a thermometer, make a data table for temperature and time. With the thermometer or temperature probe, measure and record the temperature of the water every 10 seconds for 3 minutes.

Step 2: Dry an ice cube by patting it with a paper towel. Add it to the water. Continue monitoring the temperature of the water every 10 seconds while gently stirring it until 3 minutes *after* the ice cube has melted. Record the data in a table or with the computer. Note the time at which the ice cube has *just* melted.

Monitor temperature of water.

Determine the final volume of water.

Step 3: Determine the final volume of the water.

final volume = _____

1. What was the mass of the water originally? What was the mass of the ice cube originally? Explain how you determined these masses.

_____

_____

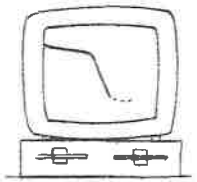
_____

_____

Make graph.

Step 4: Plot your data to make a temperature (vertical axis) vs. time (horizontal axis) graph. If you are using a computer with data plotting software, print a copy for your analysis and report.

Study your graph. Draw vertical dashed lines to break your graph into three distinct regions. Region I covers the time before the ice cube was placed in the water. Region II covers the time while the cube was melting. Region III covers the time after the cube has melted.



2. What was the total temperature change of the water while the cube was melting (Region II)?

_____

_____

_____

3. How did placing the ice cube in the water affect the rate at which the water was cooling?

_____

_____

_____

Compute the energy lost by water.

Step 5: Compute the total amount of heat energy Q lost by the water as the ice cube was melting. Use the relation $Q = mc\Delta T$, where m is the initial mass of the water, c is the specific heat capacity of water (1.00 cal/g•°C), and ΔT is the magnitude of the water's temperature change from the beginning of Region II to the end of Region III where the temperature is stabilized.

heat energy lost by original water = _____ cal

Compute heat energy absorbed during warming.

Step 6: Compute the amount of heat energy absorbed as the water from the melted ice warmed from 0°C to its final temperature.

heat energy absorbed by
melted ice during warming = ____ cal

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Step 7: From the difference between the values found in Steps 5 and 6, compute the amount of heat energy that was absorbed by the ice as it melted.

Compute heat energy absorbed during melting.

heat energy absorbed
by ice during melting = _____ cal

Step 8: Compute the heat by fusion by dividing the value found in Step 7 by the mass of ice that melted in the cup.

Compute heat of fusion.

heat of fusion = _____ cal/g

4. Compare this value to the standard value, 80 cal/g, and calculate the percentage difference.

Analysis

5. In order for the ice cube to melt, it has to extract heat energy from the warmer water, first a small amount of heat to warm up to 0°C (which we neglect in this experiment), then a larger amount to melt. The melting ice absorbs heat energy, and thus cools the water. The heat energy absorbed per gram when a substance changes from a solid to a liquid is called the heat of fusion. How is the amount of heat energy absorbed by the solid related to the heat of fusion and the mass of the solid?

6. The total amount of heat energy lost by the water is equal to the amounts of heat energy it took to do what things?

7. What are some sources of error in this experiment?