NAME: HONORS CHEMISTRY

SECTION: MiniLab: Heat of Fusion of Ice

According to the kinetic-molecular theory, all molecules are in constant random motion. If energy is absorbed by a particle, its molecular velocity will increase. Temperature is a measure of the average kinetic energy or the amount of heat per particle of a substance.

The *specific heat* of a substance is the energy in joules required to raise the temperature of one gram of a material by one Celsius degree. For example, the specific heat of water has been determined to be 4.18 joules/g ^{o}C. To calculate a change in the heat content of a substance (Q) associated with a change in temperature, the following equation is used:

Q = (g substance) x (temperature change in ^{o}C) x (specific heat)

In solids, the motion described by the kinetic molecular theory is restricted to molecular vibration. If particles at the surface of a solid obtain sufficient energy, they escape. Ice requires 333 J/g to liberate particles from a crystalline matrix. The relatively large quantity of energy required for this change in state is called the *heat of fusion,* ΔH_{fus}. The change in heat content of a substance associated with this change of state can be determined using the following equation:

Q = (g substance) x (heat of fusion)

In this experiment, you will determine experimentally the heat of fusion of ice. Energy released by the warm water will be absorbed by pieces of melting ice. The melted ice will then rise in temperature until the solutions reach an equilibrium temperature. If you assume that all the energy released as the warm water cools is absorbed by the melting ice, you can determine the amount of energy involved in each transformation. From these values, you will be able to calculate the heat of fusion of ice.

Objectives
- To calculate the energy released from a mass of cooling water
- To calculate the energy absorbed by a mass of melting ice
- To utilize the collected data to determine the heat of fusion of ice

Materials

Centigram balance
Plastic foam cup
Beaker
Thermometer
Stirring rod
Ice cubes, snow, or crushed ice
Distilled water
Microwave oven

Safety

Your thermometer is made of glass and can break, leaving sharp edges that cut. Handle your thermometer gently. Do not use it to crush or stir ice. If the thermometer breaks, call your teacher.

Roles

Project Manager ____________________
Quality Control Manager____________________
Materials Manager ____________________

Procedure

1. Put on your lab apron and safety goggles.
2. Find the mass of a clean, empty, dry plastic foam cup. Record this value to the appropriate degree of precision in your data table.
3. Add approximately 80 mL of water to a small glass beaker.
4. Set the beaker and water in the microwave. Heat the beaker until the water is about 40^{o}C.
5. Add the heated water to the plastic foam cup until the cup is about half full. Find the mass of the cup and contents and record this value in the data table.
6. Measure the temperature of the water and record this value in the data table.
7. Select two medium-size ice cubes and blot their surfaces dry with a piece of paper towel. Carefully place the ice cubes into the plastic foam cup. Using a stirring rod, gently stir the ice and water mixture.
8. Once the ice cubes have completely melted, insert the thermometer into the solution and determine the temperature of the water. Remove the thermometer and mix the contents with a stirring rod. Continue monitoring the solution temperature until it remains at a fixed value. Record this temperature in the data table.
9. Place the plastic foam cup and its contents on a balance. Find this new mass and record it in the data table.
10. Carry out a second trial.

Data

	Trial 1	Trial 2
a. Mass of cup in grams (Step 2)		
b. Mass of cup and heated water (Step 5)		
c. Mass of heated water (Step 5 – Step 2)		
d. Temperature of heated water (Step 6)		
e. Final Temperature of Mixture (Step 8)		
f. Temperature Difference (Step 6- Step 8)		
g. Mass of cup and contents (Step 9)		
h. Mass of added ice (Step 9 – Step 5)		

Analyze and Apply Questions

1. Calculate Q_{tot}, the amount of heat lost, in joules, by the warm water solution. Use the mass of heated water (c), and temperature difference (f). (Do this separately for each trial)
2. Determine Q_1, the amount of heat absorbed, in joules, as the melted ice warmed to the final temperature. Use the mass of the added ice (h); the value of the temperature difference for this calculation is the final temperature of the mixture (e). (Do this separately for each trial)
3. Determine Q_2, the amount of heat, in joules, that was absorbed during the melting process. Assume that the heat lost by the warm water is equal to the total energy needed to melt the ice and to bring the temperature of that mass of water to the final temperature.
   Therefore, $Q_{tot} = Q_1 + Q_2$. (Calculate this for each trial)
4. Using the formula for phase changes and the mass of the added ice (h), calculate the heat of fusion of ice. Q_2 = mass of added ice x ΔH_{fus}. (Note: you are *calculating* your experimental value of the heat of fusion. DO NOT use the accepted value here!) Average the results from your two trials.
5. Calculate the percent error of your average calculated ΔH_{fus} from the accepted value. Include the % error formula.

Remember to write an appropriate conclusion for this lab. Restate your findings and discuss any possible sources of error to account for deviations between your calculated heat of fusion and the accepted value.

NAME: **HONORS CHEMISTRY**

SECTION: *MiniLab: Heat of Fusion of Ice*

Prelab Questions

Show all your work in the space provided. Hand this sheet in when required.

1. How does added heat affect molecular motion?

2. What is the difference between heat and temperature?

3. What is meant by the term heat of fusion?

4. State the values for the specific heat and heat of fusion of water.

5. Why should a stirring rod and not a thermometer be used to stir the contents of the cup?

6. What is the source of the heat used to melt the ice cubes?

7. What can you assume about the amount of the heat liberated by the warm water?