Heat of Fusion
Determining the Heat of Fusion of Ice

The heat of fusion is the quantity of heat needed to change one kilogram of a substance from the solid state to the liquid state at the normal melting point of the substance. The heat of fusion for ice is:

$$3.33 \times 10^5 \ \frac{\text{J}}{\text{kg}} \ \text{ or } \ \text{J kg}^{-1}$$

The law of conservation of energy requires that the energy lost by one system must be gained by another system. In the simple example that you are working with in this lab, the heat that is lost by the warm water is gained by the ice and ice water.

The equations that you will use in this laboratory are:

Equation 1 $$\left|Q_{lost}\right| = \left|Q_{gained}\right|$$

Equation 2 $$m_{warm\ water} c_{water} \left|\Delta T_{warm\ water}\right| = \left(m_{ice} \Delta H_{fusion}\right) + m_{cold\ water} c_{water} \left|\Delta T_{cold\ water}\right|$$

$$\text{where: } c_{water} = 4.186 \times 10^3 \ \frac{\text{J}}{\text{kg}\ ^{\circ}\text{C}}$$

The absolute value lines indicate that you are interested in the magnitude of the value, regardless of a gain or loss.

You will make two assumptions in this lab:

1) That the temperature of the ice before you put it in the warm water is 0°C since it has been sitting in the room for a while.

2) That the heat transfer to the room and the polystyrene cup is negligible.

PURPOSE

In this activity you will use ice and warm water to determine the heat of fusion of ice.

MATERIALS

- polystyrene cup
- balance
- thermometer
- 4 or 5 medium ice cubes
- paper towels

PROCEDURE

1. Measure and record the mass of the empty, dry polystyrene cup. Record the mass in Data Table 1 on your student answer page.

2. Fill the cup about half way with warm water. Dry the outside of the cup, measure and record the mass of the cup and water. Measure and record the temperature of the warm water.

3. Obtain about four or five medium pieces of ice from the general supply. Dry the ice and carefully put it into the warm water.

4. Gently stir the water until all of the ice melts. Measure and record the temperature of the mixture just after the ice has melted.

5. Measure and record the mass of the mixture.

6. Empty and dry the polystyrene cup. Repeat this experiment to obtain another set of data.

Name ____________________

Period ____________________

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DATA AND OBSERVATIONS

Complete the following table.

Data Table 1		
	Trial 1	**Trial 2**
Mass of the empty cup	g	g
Mass of the cup and warm water	g	g
Final mass of the cup, water and ice	g	g
Initial temperature of the warm water	^{o}C	^{o}C
Final temperature of the mixture	^{o}C	^{o}C

1. Determine the mass of the warm water for each trial.

   Trial 1

   Trial 2

2. Determine the mass of the ice for each trial.

   Trial 1

   Trial 2

3. Rearrange equation 2 to solve for ΔH_{fusion}. Show all of the steps in the process.

4. Using the equation obtained above, substitute your data to determine the heat of fusion of ice for each trial.

   Trial 1

   Trial 2

5. Determine an average value for the heat of fusion of ice.

6. Determine the percent error using the average value of the heat of fusion of ice.

CONCLUSION QUESTIONS

1. Why did we assume that the temperature of the ice was at $0^{o}C$ and not at room temperature?

2. Why did you dry the ice before it was added to the warm water?

3. Why did you use an indirect method for determining the mass of the ice rather than a direct method?

4. Using the heat of fusion concept, explain why cooling a canned soda drink with 50 grams of ice rather than 50 grams of $0^{o}C$ water is more effective.

5. After a long winter the top layer of a pond or lake may be frozen. As the warm weather arrives, it may take several weeks for the air temperature by the lake to reach the temperature farther inland. Explain the reason for this.

6. As a 24-ton piece of glacier melts, how much heat does it absorb from the environment? Assume the glacier is composed of pure water. (1 ton has a mass of 907.2 kg)

7. A student fails to dry his or her ice cubes before placing them into the cup of warm water. Will the student's calculated value for ΔH_{fusion} be too high, too low, or unaffected? Mathematically justify your answer.