Specific Heat of Aluminum

Purpose

To experimentally determine the specific heat capacity of solid aluminum

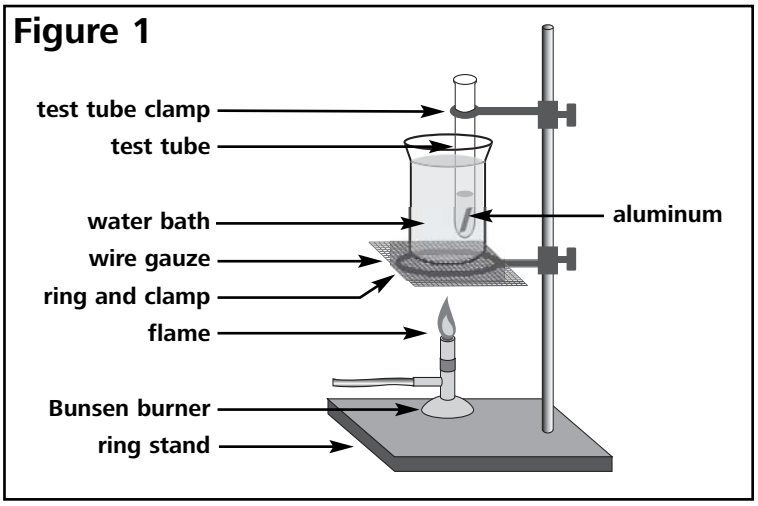
Materials

goggles, science journal, 250 mL beaker, burner, solid aluminum, test tube, test tube clamp, ring stand with ring, wire gauze, 100 mL graduated cylinder, 100 mL distilled water, plastic foam cup, beaker large enough to hold foam cup, stirring rod, 2 thermometers, balance

Procedure

1. Fill the 250 mL beaker with about 190 mL water.
2. Set up the apparatus as shown in Figure 1. ***Do not place the test tube in the beaker filled with water yet.***

Figure 1



3. Use the Bunsen burner to bring the water to a slow boil.
4. While the water is coming to a boil, obtain a sample of about 25 grams of aluminum and record its mass to the nearest 0.01 gram. Record the mass in the data table.
5. Carefully place the aluminum into the test tube. Add distilled water to cover the aluminum.
6. Suspend the test tube in the boiling water, using the ring stand and test tube clamp. (See Fig. 1.) Be sure the bottom of the test tube is not in contact with the bottom of the beaker.
7. Adjust the flame if necessary. The water should be boiling gently.
8. Heat for at least 10 minutes.
9. As the aluminum apparatus is heating, measure 100.0 mL distilled water in a graduated cylinder and pour the water into the plastic foam cup.
10. Place the cup in a larger beaker for support.
11. Place a thermometer and a stirring rod in the cup.

(*continued*)

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12. After the aluminum has heated for 10 minutes, use the second thermometer to measure the temperature of the water bath. The temperature of the aluminum sample is equal to the temperature of the water bath. Record this temperature as the aluminum initial temperature.
13. Measure and record the temperature of the water in the plastic foam cup. This is the water initial temperature.
14. Using the test tube clamp, remove the test tube containing the aluminum and water from the water bath and carefully pour the test tube contents into the water in the cup. Be careful not to spill anything.
15. Use the stirring rod to stir the contents of the foam cup. While stirring, measure and record the temperature inside the foam cup every 10 seconds until the maximum is reached.
16. Record the maximum temperature as the final temperature of both the water and aluminum.

Data

Data Table

	Aluminum	Water
Mass (g)		100.0
$T_{initial}$ (^oC)		
T_{final} (^oC)		
ΔT (C^o)		

Analysis and Conclusions

1. Calculate the change in temperature of the water (ΔT_w), and record it in the data table.
2. Calculate the change in temperature of the aluminum (ΔT_{Al}), and record it in the data table.
3. The equation to calculate the specific heat capacity of aluminum (c_{Al}) is given below. We know that the amount of energy the aluminum (Al) lost must be the same as the amount of energy gained by the water (w) in the foam cup.

$$c_{Al} \times m_{Al} \times \Delta T_{Al} = c_w \times m_w \times \Delta T_w$$

This equation can be rearranged to isolate the unknown:

$$c_{Al} = \frac{c_w \times m_w \times \Delta T_w}{m_{Al} \times \Delta T_{Al}}$$

Because we are using grams of water, use $c_w = 4.186\ J/g \cdot {}^oC$. In the space below, calculate your experimental c_{Al}. Make sure that you use the correct units.

4. Write your calculated specific heat of aluminum on the board. After all the groups have posted their results, calculate the class average. How does this value compare with the accepted value for the specific heat of aluminum?

5. What are possible sources of error in this lab? There is error if your calculated value is not the same as the accepted value. What could you do to decrease error?

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Teacher Directions

- Remind students of significant digits. Students cannot use two-digit temperature readings and then report five-digit specific heats.
- Impress upon students the need to read the thermometers to within 0.1 °C. Inaccurate thermometer readings will be reflected in the accuracy of calculated values.

Answer Key

1. $T_f - T_i = \Delta T_w$
2. $T_i - T_f = \Delta T_{Al}$
3. Answers will vary, but students should have values close to the accepted value of 0.899 J/g·°C.
4. Answers will vary.
5. Answers will vary, but students should be aware that the use of such a simple calorimeter provides room for error. The use of a commercial calorimeter would provide a better estimate of heat gain and loss. If the sample is not pure aluminum, the results will reflect this.