

Sample report on procedures

[Technology](#), [Development](#)



Abstract

The purpose of this experiment was to determine the specific heat capacity of unknown substance and use the quantity to identify the substance. The specific heat capacities of the metals were determined to be 0. 890 Jg⁻¹K⁻¹ and 0. 361 Jg⁻¹K⁻¹. The metals were identified as aluminum and copper respectively. The percentage uncertainty in the determination of specific heat capacities of aluminum and copper were found to be 0. 78% and 6. 23% respectively. These errors were attributed to loss of heat in the atmosphere.

Introduction and Theory

The amount of heat absorbed or released by a substance is proportional to its mass and temperature differences (Arfken 297). That is $Q \propto m\Delta T$. This equation can be rewritten as $Q = c m \Delta T$. The constant of proportionality (c) is called the specific heat capacity of the substance. It is the quantity of heat needed to change the temperature of 1 gram of substance by 1°C (Myers 86). The specific heat capacity depends on the material. Consequently it is an intensive characteristic of a substance.

Usually, a calorimeter is used to measure the specific heat capacity of a substance. Calorimeter works using the principle of conservation of energy. The heat released by the substance is absorbed by the surrounding which is usually water. Calorimeter consists of Styrofoam cup with lid and two openings. The first opening is for the stirrer while the other opening is meant for immersing the thermometer into the calorimeter. It is properly insulated to minimize heat loss to the surrounding.

The specific heat capacity of a metal can be determined by measuring the

mass of the metal and then heating it. The hot metal with known mass and temperature is immersed in a Styrofoam cup having cold water with known volume and initial temperature. Heat would flow the hot metal to the water until such a time when both have the same temperature. The first Law of Thermodynamics predicts that the sum of heat supplied by the hot metal and that absorbed by water would be zero. That is $Q_m + Q_w = 0$. This is the equation used to compute specific heat capacity of the substance under investigation.

The steam generator was filled with water and aluminum piece placed in it. The water was heat until it boiled. A Styrofoam cup was half filled with cold water. The temperature of the cold was measured. The aluminum piece was transferred to the water when its temperature reached that of boiling water. The same procedure was repeated for copper piece

Data and Tables

The following table shows the masses and temperatures of water and metals as measured during the experiment

The following table contains the calculated values of product of masses of the metal or water and change in temperatures

Calculations and Results

Specific Heat capacity of aluminum

Heat given out by the aluminum = Heat absorbed by water

$$Q_a = Q_w$$

$$c_a m_a \Delta T_a = c_w m_w \Delta T_w$$

Where c_a and c_w are the specific heat capacities of aluminium and water respectively

The m_a and m_w are the masses of aluminium and water respectively

ΔT_a and ΔT_w are changes in temperatures of aluminium and water respectively

Trial 1

$$\Delta T_a = 371.5 - 292.3 = 79.2\text{K}$$

$$\Delta T_w = 292.3 - 288.1 = 4.2\text{K}$$

$$c_a \times 79.2 \times 87.9 = 360.7 \times 4.2 \times 4.18$$

$$0.910$$

Trial 2

$$\Delta T_a = 366.4 - 289.8 = 76.6\text{K}$$

$$\Delta T_w = 289.8 - 285.3 = 4.5\text{K}$$

$$c_a \times 76.6 \times 87.9 = 346.6 \times 4.5 \times 4.18$$

$$0.968$$

Trial 3

$$\Delta T_a = 389.0 - 291.3 = 97.7\text{K}$$

$$\Delta T_w = 291.3 - 287.4 = 3.9\text{K}$$

$$c_a \times 97.7 \times 87.9 = 417.5 \times 3.9 \times 4.18$$

$$0.793$$

Average of specific heat capacities

$$0.910 + 0.968 + 0.7933$$

$$0.890$$

Uncertainty

0.897-0.8900.897

0.78%

Specific Heat Capacity of Copper

Heat given out by copper = Heat absorbed by water

$$Q_c = Q_w$$

$$c_c m_c \Delta T_c = c_w m_w \Delta T_w$$

Where c_c and c_w are the specific heat capacities of copper and water respectively

The m_c and m_w are the masses of copper and water respectively

ΔT_c and ΔT_w are changes in temperatures of copper and water respectively

Trial 1

$$\Delta T_c = 373.0 - 288.1 = 84.9 \text{ K}$$

$$\Delta T_w = 288.1 - 282.4 = 5.7 \text{ K}$$

$$c_c \times 84.9 \times 268.6 = 360.7 \times 5.7 \times 4.18$$

0.377

Trial 2

$$\Delta T_c = 363.3 - 290.4 = 72.9 \text{ K}$$

$$\Delta T_w = 290.4 - 284.5 = 5.9 \text{ K}$$

$$c_c \times 72.9 \times 268.6 = 346.6 \times 5.9 \times 4.18$$

0.271

Trial 3

$$\Delta T_c = 357.8 - 287.8 = 70.0 \text{ K}$$

$$\Delta T_w = 287.8 - 283.1 = 4.7 \text{ K}$$

$$c_c \times 70.0 \times 268.6 = 417.5 \times 4.7 \times 4.18$$

$$c_c = 0.436$$

Average of specific heat capacities

$$0.377 + 0.271 + 0.4363$$

$$0.361$$

Uncertainty

$$0.385 - 0.361 = 0.024$$

$$6.23\%$$

Graphs

The following is a graph of the product of the mass of aluminum and change in temperature versus product of mass of water and change in temperature

The following is a graph of the product of the mass of copper and change in temperature versus product of mass of water and change in temperature

Discussion of questions

The slopes of the two graphs give the ratio of the specific heat capacities of the metals and specific heat capacities of water. The experimental values of the specific heat capacities were very close to the theoretical values. The small deviation between the experimental and theoretical values is an indication that the metals were correctly identified. The deviations were caused by errors associated with loss of heat into the surrounding when the

metals were being transferred to the Styrofoam cup. Some of the heat might have been lost through the openings in the lid of Styrofoam cup. Future recommendations for reducing the errors include minimizing the time taken to transfer the metal to the Styrofoam cup and using a properly insulated calorimeter.

Conclusion

The specific heat capacities of the metals were determined and the metals identified. The small value uncertainty in the determination of the specific capacities of the metals is a proof that the experiment was very successful.

Works Cited

Arfken, George B. University Physics. Orlando: Academic Press, 1984. Print.

Myers, Richard L. The Basics of Physics. Westport, Conn: Greenwood Press, 2006. Print.