Experiment 2: Determination of the specific heat of a metal

Introduction

When two objects at different temperatures are placed in contact with each other, heat always flows from the hotter to the cooler object. Heat will flow until the two reach thermal equilibrium, when they are at the same temperature. In other words, the amount of heat lost is equal to the amount of heat gained ($Q_{lost} = Q_{gained}$). In this experiment, the amount of heat that is lost by a sample of metal as it cools is equal to the amount of heat gained by the water in the calorimeter.

Specific Heat Capacity

The specific heat capacity (**c**) of a substance is an intensive property of a sample (solid, liquid, or gas) that describes how the sample's temperature changes as it either absorbs or loses heat energy. So specific heat is generally reported in units of either (J/g. K) or (cal/ g. K).

$$\mathbf{c} = \frac{\mathbf{Q}}{\boldsymbol{m}.\Delta \boldsymbol{T}}$$

Where:

- **c :** The specific heat of the material
- **Q :** The heat energy
- **m :** The mass of the material
- **ΔT :** The temperature change

The objective of the experiment

- To calculate the specific heat of the metal ($\mathbf{c_{metal}}$) using the calorimeter experiment data.
- To calculate the heat energy Q_{lost} and Q_{gained}.

How to calculate

Since the system is isolated then

$\sum Q_i = 0$

$Q_{\text{gained}} + Q_{\text{lost}} = 0$

$Q_{\text{cold water}} + Q_{\text{metal}} + Q_{\text{calorimeter}} = 0$

Materials and Chemicals

Materials	Chemicals
• Calorimeter with mixer • Thermometer • Heating device • Becher • Analytical balance	• Distilled water • Aluminium • Copper

Procedure

1. We take a becher and ignore its weight before filling it with $\mathbf{m_1=300\ g}$ of cool water.

2. Put the cold water into the calorimeter.

3. We close the calorimeter and wait for thermal equilibrium to be achieved, and take a temperature reading of the system (cold water + calorimeter), let it be $\mathbf{T_1}$.

4. We first heat some water to an internal temperature of 90 °C, and then we put a metal in this water.

5. Take the temperature of the hot water and consider it that is the temperature of the metal and let it be $\mathbf{T_{metal}}$.

5. We take the sample of metal and we put it in the calorimeter.

6. We mix the system quietly until balance, and then we take a temperature reading of the system (cold water + metal + calorimeter) and let it be $\mathbf{T_f}$.

7. Weigh the sample of metal

8. Record the obtained results in the table.

Mass of Cold Water m_1(g)	Temperature of Cold Water T_1 (K)	Equilibrium Temperature $T_{f(exp)}$ (K)	Weigh the sample of metal m_2(g)

Answer the questions

1. Calculate the specific heat of the metal ($\mathbf{c_{metal}}$)

2. Compare the theoretical and experimental values.

3. Calculate the Q_{lost} and Q_{gained}.