Practical Work N°2. Determination of the specific heat of solids

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

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. It is the amount of energy required to raise the temperature of 1 g of the substance by one degree Celsius. The **SI** unit of specific heat is (J/g. K) or (cal/ g. K). To calculate the specific heat of a metal you can use the formula.

$$C_m = \frac{Q}{m.\Delta T}$$

Where:

- C_m **:** The specific heat of the metal
- **Q :** The heat absorbed or released
- **m :** The mass of the metal
- **ΔT :** The change in temperature

Objective of the experiment

- To calculate the specific heat of the metal (**C_{metal}**) using the calorimeter.
- 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

Experimental Procedure

1. Take a becher and ignore its weight before filling it with $\mathbf{m_1=100\ g}$ of cool distilled water.
2. Put the cold distilled water into the calorimeter.
3. Close the calorimeter and wait for thermal equilibrium to be achieved, then measure the temperature of the system (cold water + calorimeter), let it be $\mathbf{T_1}$.
4. First heat some distilled water to a temperature between **80** and **90 °C**, and then put a metal in this water.
5. Record the temperature of the hot water and consider it that is the temperature of the metal, let it be $\mathbf{T_{metal}}$.
5. Add the metal sample to the calorimeter.
6. Mix the mixture quietly until it reaches equilibrium, then measure the final temperature reading of the system (cold water + metal + calorimeter) and let it be $\mathbf{T_{eq}}$.
7. Measure the mass of the metal sample and let it be $\mathbf{m_{metal}}$
8. Record the obtained results in the table.

Metals	Mass of Cold Water m_1(g)	Temperature of Cold Water T_1 (K)	Temperature of the metal T_2 (K)	Equilibrium Temperature T_{eq} (K)	Mass of the metal m_{metal} (g)
Cu					
Al					

Questions

1. Determine the specific heat ($\mathbf{C_{metal}}$) of the two metals (aluminum (**Al**) and copper (**Cu**)).
2. Compare the theoretical and experimental values.
3. Calculate the $\mathbf{Q_{lost}}$ and $\mathbf{Q_{gained}}$ in the system.

Given:

K_{cal} = 61.50 J / K ; C_{H2O} = 4.184 J /g. K; C_{Cu} = 0.380 J /g. K; C_{Al} = 0.887 J /g. K