Unit B – Practical 1

Determining the specific heat capacity (SHC) of a metal using a calorimeter

Safety

Be careful when heating water, its containers and all objects that are hot due to contact with the flame or hot water.

Apparatus and materials

- insulated copper calorimeter (inner cooper can + insulation + outer can)
- thermometers or temperature sensors
- block of metal (known metal, dimensions suitable to fit in the calorimeter, string of insulating material attached)
- beaker
- top-pan balance
- copper stirrer
- Bunsen burner
- lighter
- tripod and gauze
- heat-proof tile

Introduction

The heat Q transferred to or from a substance is given by:

$$Q = m\,c\,\Delta T$$

where m is the mass of the substance, c its specific heat capacity (SHC) and ΔT the temperature difference after the heat transfer.

Procedure

1 Measure the mass of the metal block, m_{m}.

2 Place the Bunsen burner, tripod and gauze on the heat-proof tile. Fill the beaker with water until it is two-thirds full and put the metal block inside. Place the beaker on the gauze and light the Bunsen burner.

3 When the water boils, measure its temperature. Leave the metal block inside the beaker of boiling water for enough time for it to be in thermal equilibrium with the boiling water ($T_{\text{m,i}}$).

4 Measure the mass of the inner copper can of the calorimeter together with the copper stirrer, m_{Cu}.

5 Fill the inner copper can with water until it is half full. Measure the combined mass and determine the mass of water in the can, m_{w}.

6 Place the inner can inside the calorimeter and measure the temperature of the water, $T_{\text{w,i}}$. This is also the initial temperature of the copper can and stirrer, $T_{\text{Cu,i}}$.

7 Using the string quickly transfer the metal block from the beaker into the inner can of the calorimeter.

8 Monitor the temperature of the water in the calorimeter and record the maximum value of the water, $T_{w,f}$. This will also be the final temperature of the metal, $T_{m,f}$ and the copper can and stirrer, $T_{Cu,f}$.

9 The heat lost by the metal block is equal to the heat gained by the water, the inner copper can and stirrer. This can be expressed as:

$$m_{\mathrm{m}}\, c_{\mathrm{m}}\, \Delta T_{\mathrm{m}} = m_{\mathrm{w}}\, c_{\mathrm{w}}\, \Delta \mathrm{T}_{\mathrm{w}} + m_{\mathrm{Cu}}\, c_{\mathrm{Cu}}\, \Delta T_{\mathrm{Cu}}$$

where c_w = 4181 J kg^{-1} K^{-1} is the SHC of water, c_{Cu} = 385 J kg^{-1} K^{-1} is the SHC of copper and

ΔT the temperature difference for each substance.

Use your measurements and the above equation to determine the SHC of the metal, c_m.

10 Calculate the uncertainty of this value.

11 Compare the experimentally determined value of c_m with the accepted one.

Questions

1 Name sources of errors in this experiments and ways to minimise their effects.

2 What would be the effect on the value of the SHC you determined if there was no insulation in the calorimeter?

