# Unit B – Practical 2

## *Determining the specific latent heat of ice 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. Wear safety glasses.

### Apparatus and materials

- insulated copper calorimeter (inner copper can + insulation + outer can)
- copper stirrer
- thermometers or temperature sensors
- beaker
- water
- ice
- cloth
- hammer
- top-pan balance
- Bunsen burner
- lighter
- tripod and gauze
- heat-proof tile
- tongs

### Introduction

The heat $Q$ transferred to or from a substance when it changes temperature is given by:

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

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

While a substance changes state, in this case melting, its temperature remains constant. The heat transferred to the substance during melting is given by:

$$Q = m\,l$$

where $m$ is the mass of the substance and $l$ its specific latent heat.

### Procedure

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

**2** 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, $m_w$.

**3** Place the Bunsen burner, tripod and gauze on the heat-proof tile. Place the inner copper can containing the water and the stirrer on the gauze and light the Bunsen burner. Monitor the temperature of the water until it reaches 50 °C. This is the initial temperature of the water and copper, $T_{w,i}$ and $T_{Cu,i}$.

**4** While the water is heating, use a cloth and a hammer to break the ice into very small pieces. Consider 0°C as the initial temperature of the ice, $T_{ice,i}$ .

**5** Using the tongs, transfer the inner copper can from the Bunsen burner to the calorimeter.

**6** Add crushed ice to the hot water and stir, while monitoring the temperature. Continue to do this until the temperature has reached 10°C. This is the final temperature of the water, copper and ice, $T_{w,f}$ , $T_{Cu,f}$ and $T_{ice,f}$.

**7** Measure the new mass of the inner can with the water and the stirrer to determine the mass of ice added, $m_i$.

**8** The heat lost by the hot water and copper is equal to the heat gained by the ice to melt and then increase its temperature. This can be expressed as:

$$m_w\, c_w\, \Delta T_w + m_{Cu}\, c_{Cu}\, \Delta T_{Cu} = m_i\, l + m_i\, c_w\, \Delta T_w$$

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, $\Delta T$ the temperature difference for each substance and $l$ the specific latent heat of melting of ice.

Use your measurements and the above equation to determine the specific latent heat of melting of ice, $l$.

**9** Calculate the uncertainty of this value.

**10** Compare the experimentally determined value of $l$ with the accepted one.

**Questions**

**1** Why do you need to break the ice into small pieces?

**2** What are some sources of uncertainty in this practical?

 