Experiment 1: Determination of Calorimeter Constant (K_{cal})

Heat Energy

The quantity of heat energy is a type of energy that a sample gains or losses, and it is measured using heat-insulating devices such as the calorimeter. The following formula is used to determine the quantity of heat energy (Q):

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

Where:

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

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. It is the amount of energy required to raise the temperature of 1 g of the substance by one degree Celsius. Various materials have various specific heat capacities, for example, the specific heat capacity of water is 4,184 J/g. K or 1cal/g.K.

Thermal capacity

Thermal capacity is a physical property of matter, defined as the amount of heat to be supplied to an object to produce a unit change in its temperature. The **SI** unit of heat capacity is joule per kelvin (J/K).

Remenber

- It's important to remember that temperature and heat are not the same thing. Temperature is a measure of how hot something is, measured in degrees Celsius or degrees Fahrenheit, while heat is a measure of the thermal energy contained in an object measured in joules.
- The relationship between thermal capacity and specific heat is : $K = m.\mathbf{c}$

Specific heat of some elements

Elements	Specific heat (J/g. K)
Water	4.184
Copper	0.385
Silver	0.235
Gold	0.129
Aluminium	0.887
Zinc	0.388
Iron	0.449

The calorimeter

The calorimeter is a device used in chemical laboratories to measure the amount of heat resulting from chemical reactions as well as heat produced by physical changes. **Figure 1** depicts a calorimeter. It has two vessels: an inner vessel and an exterior vessel. In this manner, no heat can be transferred from the inner to the outer vessel or vice versa. As a result, the inner vessel is thermally isolated from its surroundings.

- Thermometer
- Hand mixer
- Cover
- Inner bowl
- External bowl

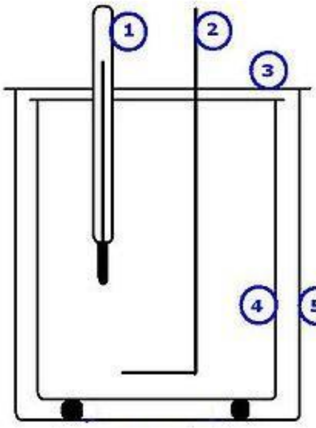

Figure 1. The calorimeter

The objective of the experiment

- To calculate the thermal capacity of the calorimeter (**k_{cal}**).
- To deduce the specific heat of the calorimeter (**c_{cal}**).
- To calculate the heat energy (**Q**) gained and lost.

How to calculate

Since the system is isolated, then

$\sum Q_i = 0$

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

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

Materials and Chemicals

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

Procedure

1. We take a becher and ignore its weight before filling it with **m_1=150 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 **T_1**.
4. We first heat some water to an internal temperature of 80 °C, then we take **m_2=150 g** of hot water.

5. We take another temperature reading of the hot water and set it to $\mathbf{T_2}$ just before adding it in the calorimeter.
6. We mix the system quietly until balance, then we take a temperature reading of the system (cold water + hot water + calorimeter) and let it be $\mathbf{T_f}$.
7. Record the obtained results in the table.

Mass of Cold Water m_1(g)	Mass of Hot Water m_2(g)	Temperature of Cold Water T_1 (K)	Temperature of Hot Water T_2(K)	Equilibrium Temperature $T_{f(exp)}$ (K)