# Edexcel International Chemistry A-level

## Practical 2

Determination of the Enthalpy Change of a Reaction using Hess's Law

## Introduction

Enthalpy change for the decomposition of potassium hydrogencarbonate **cannot be measured directly**. The reaction needs heating, so the recorded ΔT is not exclusively due to the decomposition of the starting material.

**Two reactions** (both with measurable enthalpy changes) can be **combined** to form a desired reaction and therefore the previously unmeasurable enthalpy change can be calculated.

**Hess's law:** The enthalpy change for a reaction is independent of the path taken.

## Method

1. Place approximately 3g of potassium carbonate into a test tube and weigh and record its mass.
2. Put a polystyrene cup in a 250 $cm^3$ beaker for support and then pour 30 $cm^3$ of 2 mol $dm^{-3}$ hydrochloric acid into the cup.
3. Place a thermometer into the cup and record the start temperature of the liquid. Then add the potassium carbonate and monitor the temperature of the solution, recording the highest temperature reached.
4. Reweigh the test tube that contained potassium carbonate and calculate the mass transferred into the polystyrene cup.
5. Repeat steps 1-4 using potassium hydrocarbonate but instead record the lowest temperature reached.

## Key Points

- **Q = mcΔT**,
  where m = mass of the solution, c = specific heat capacity, ΔT = change in temperature.
- **ΔH = Q/moles**,
  where Q is in kJ. Include +/− sign to specify whether the reaction is exothermic or endothermic. If temperature increases it is exothermic. If temperature decreases it is endothermic.
- This practical combines two **neutralisation reactions**:

$$(1)\ K_2CO_3 + 2\ HCl \rightarrow 2\ KCl + H_2O + CO_2$$
$$(2)\ 2\ KHCO_3 + 2\ HCl \rightarrow 2\ KCl + 2H_2O + 2CO_2$$

- The desired reaction is: $2\ KHCO_3 \rightarrow K_2CO_3 + CO_2 + H_2O$. Therefore to find the enthalpy of the desired reaction, measure the enthalpy change for (1) and (2) then calculate **(ΔH2) - (ΔH1)**.

## Errors

- We assume the **specific heat capacity** of the solution to be **that of water**.
- Polystyrene is more **insulating** than glass, so less heat is lost.