

Enthalpy Changes and Calorimetry

30 minutes, 3 stages

Calorimetry is the experimental method chemists use to measure heat released or absorbed during a chemical reaction. Understanding how to calculate enthalpy changes from calorimetry data connects the abstract concept of energy to measurable quantities you can determine in the lab ([Outcome](#)). You will apply the heat equation and interpret enthalpy notation to solve problems at the level you will encounter on the diploma examination ([Outcome](#), [Outcome](#)).

Stage 1: Heat Transfer Calculations (10 min)

Recall that the heat transferred in a calorimeter is calculated using $Q = mc\Delta T$, m is mass in grams, c is specific heat capacity in $\text{J}/(\text{g}\cdot^\circ\text{C})$, and ΔT is the temperature change in $^\circ\text{C}$ ([Outcome](#)).

Task 1: A calorimeter contains 150 g of water. The temperature rises from 22.5°C to 31.8°C when 2.5 g of a food sample burns inside it. Calculate the heat absorbed by the water. Use $c = 4.18 \text{ J}/(\text{g}\cdot^\circ\text{C})$ for water.

Show your work:

- Write the temperature change (ΔT)
- Substitute all values into $Q = mc\Delta T$
- Report your answer in joules and kilojoules

Task 2: In a second experiment, 200 g of water in a calorimeter increases in temperature by 8.2°C when a different fuel burns. Calculate the heat absorbed. Use the same specific heat capacity.

Stage 2: Enthalpy and Molar Enthalpy (12 min)

Enthalpy is a measure of the heat energy available in a chemical system at constant pressure ([Outcome](#)). When you burn a fuel or run a reaction in a calorimeter, the enthalpy change (ΔH) tells you how much energy the reaction released or absorbed per mole of reactant ([Outcome](#)).

Task 3: In a calorimetry experiment, 0.80 g of ethanol ($\text{C}_2\text{H}_5\text{OH}$, molar mass 46 g/mol) burns completely. The heat released is 29.6 kJ. Calculate the molar enthalpy of combustion for ethanol.

Show your work:

- Calculate the number of moles of ethanol burned
- Divide the heat released by the moles
- Write your answer as ΔH_{comb} . Explain whether the sign is positive or negative

Task 4: A reaction absorbs 18 kJ of heat and consumes 0.50 mol of a reactant. What is the molar enthalpy change for this reaction? Write your answer using ΔH ([Outcome](#)).

Stage 3: Calorimetry Data Analysis (8 min)

You now combine the heat equation and molar enthalpy to analyze real calorimetry data.

Task 5: A student burns 1.2 g of sugar ($\text{C}_6\text{H}_{12}\text{O}_6$, molar mass 342 g/mol) in a bomb calorimeter containing 500 g of water. The water temperature rises from 20.0°C to 26.8°C . Calculate the molar enthalpy of combustion for sugar. Use $c = 4.18 \text{ J}/(\text{g}\cdot^\circ\text{C})$.

Show your work in order:

- Calculate Q using $Q = mc\Delta T$
- Convert Q to kilojoules
- Calculate the moles of sugar burned
- Divide Q by moles to find ΔH_{comb}
- Write the final answer with units and sign

Self-check

1. In your own words, explain why the sign of ΔH is negative for a combustion reaction and positive for a melting or dissolving process.
2. If you doubled the mass of fuel burned in a calorimeter but kept everything else the same, how would the heat released (Q) change, and how would the molar enthalpy (ΔH_{comb}) be affected?
3. Look back at Task 5. If the student's calorimeter lost 5% of the heat to the surroundings, would the calculated molar enthalpy be higher or lower than the true value? Why?