

Enthalpy Changes and Calorimetry: Heat Transfer Calculations

30 minutes, 3 stages

Calorimetry is the experimental method chemists use to measure the heat absorbed or released during chemical reactions. Understanding how to calculate heat transfer using the relationship $Q = mc\Delta T$ and how to connect these measurements to enthalpy changes allows you to quantify energy in reactions ([Outcome](#), [Outcome](#)). This skill is essential for analyzing real combustion and dissolution processes and for predicting whether reactions release or absorb energy.

Stage 1: Heat Transfer Calculations (10 min)

Use the relationship $Q = mc\Delta T$ to solve these problems. Remember that Q is heat in joules, m is mass in grams, c is specific heat capacity in $\text{J}/(\text{g}\cdot^\circ\text{C})$, and ΔT is temperature change in $^\circ\text{C}$.

Problem 1: A 250 g sample of water is heated from 20°C to 65°C . The specific heat capacity of water is $4.18 \text{ J}/(\text{g}\cdot^\circ\text{C})$. Calculate the heat absorbed by the water.

Problem 2: In a calorimetry experiment, 150 g of water cools from 45°C to 28°C . How much heat is released? (Use $c = 4.18 \text{ J}/(\text{g}\cdot^\circ\text{C})$.)

Problem 3: An unknown metal sample with a mass of 75 g absorbs 2250 J of heat and its temperature increases by 12°C . Calculate the specific heat capacity of the metal.

Show all your work, including the formula, substitution, and units.

Stage 2: Enthalpy and ΔH

Enthalpy (H) is the total heat content of a system, and molar enthalpy is the heat change per mole of reaction ([Outcome](#)). The notation ΔH is used to represent the change in enthalpy. A negative ΔH indicates an exothermic reaction (heat released), and a positive ΔH indicates an endothermic reaction (heat absorbed) ([Outcome](#)).

Task 1: For each scenario, write whether the reaction is exothermic or endothermic and explain your reasoning.

- A combustion reaction in which ΔH is negative.
- A dissolution process in which ΔH is positive.

Task 2: In a calorimetry experiment, 2.5 mol of ethanol is burned and releases 3100 kJ of heat. Calculate the molar enthalpy of combustion (ΔH_c°) for ethanol. Include the sign and units.

Task 3: A reaction absorbs 450 J of heat. Express this as ΔH , and indicate if the reaction is exothermic or endothermic.

Stage 3: Connecting Calorimetry Data to Enthalpy (8 min)

Calorimetry data, mass, temperature change, and specific heat capacity, allow you to calculate the heat transferred in a reaction, which you then convert to molar enthalpy ([Outcome](#)).

Problem: In a calorimetry experiment, 3.0 g of magnesium is burned in oxygen inside a calorimeter containing 500 g of water. The water temperature increases from 22°C to 54°C . The specific heat capacity of water is $4.18 \text{ J}/(\text{g}\cdot^\circ\text{C})$. The molar mass of magnesium is approximately 24 g/mol.

- Calculate the heat absorbed by the water using $Q = mc\Delta T$.

2. Convert your answer to kilojoules.
3. Calculate the number of moles of magnesium that reacted.
4. Calculate the molar enthalpy of combustion (9D,'`or magnesium in kJ/mol. Is this reaction exothermic or endothermic?

Self-check

1. In a calorimetry experiment, you measure that 200 g of water increases in temperature by 8°C. Without calculating, explain whether the heat absorbed by the water is greater or less than the heat absorbed when 200 g of water increases by 15°C.
2. A reaction has 9D, Ò !#CR ´ ¢öÖöÂà What does the negative sign tell you about whether energy is released or absorbed?
3. If 2.0 mol of a substance reacts and releases 280 kJ of heat, what is the molar enthalpy change for the reaction?