3.1 Energetics

Name: _____ Class: _____ Date: _____ **Total: 20 marks**

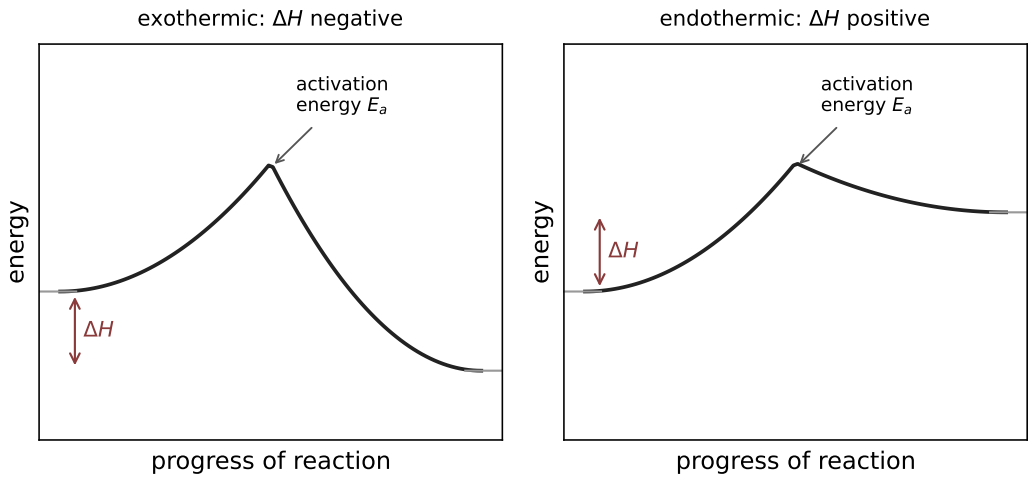
Objective

Cover energetics (3.1–3.8): exo- and endothermic changes, calorimetry with Q = mcΔT, molar enthalpy, (C) energy profiles and bond-energy calculations. Original IGCSE-level practice.

1 Key knowledge and worked examples

■ Q = mcΔT, then per mole

Worked check. 25.0 g of solution warms 14.6 °C in a displacement reaction: $Q = 25.0 \times 4.2 \times 14.6 = 1533$ J. If 0.0050 mol reacted: $\Delta H = -1533/0.0050 = -307\,000\ \mathrm{J\,mol^{-1}} \approx -307\ \mathrm{kJ\,mol^{-1}}$ – negative, because the mixture warmed.



■ (C) Bonds

ΔH = energy to break bonds − energy released making bonds. Breaking is always endothermic, making always exothermic.

2 Practice

2.1 Classify as exothermic or endothermic: burning methane; decomposing limestone; acid + alkali. [3]

2.2 200 g of water warms 12 °C. Calculate Q in kJ. [2]

2.3 0.020 mol of fuel releases 8.4 kJ. Calculate ΔH in kJ/mol with its sign. [2]

2.4 (C) On an energy profile, what do the height of the hump and the gap between the levels represent? [2]

2.5 (C) Which process is exothermic: breaking bonds or making bonds? [1]

3 Exam-style questions

3.1 In a spirit-burner experiment 0.012 mol of ethanol heated 100 g of water from 21.0 °C to 49.0 °C. Calculate Q and the molar enthalpy of combustion, and give one reason the true value is more negative. [4]

3.2 (C) Use bond energies to calculate ΔH for $H_2 + Cl_2 \rightarrow 2HCl$ (H–H 436, Cl–Cl 242, H–Cl 431 kJ/mol), stating the reaction type. [4]

3.3 A student's temperature-rise results are lower than the data book's every time. Give two improvements to the apparatus. [2]

Solutions

2.1 Exothermic; endothermic; exothermic.

2.2 $Q = 200 \times 4.2 \times 12 = 10\,080$ J $= 10.1$ kJ.

2.3 $\Delta H = -8.4/0.020 = -420$ kJ mol^{-1}.

2.4 (C) The hump's height above reactants is the activation energy E_a; the gap between reactant and product levels is ΔH.

2.5 (C) Making bonds.

3.1 $\Delta T = 28.0$ °C; $Q = 100{\times}4.2{\times}28.0 = 11\,760$ J; $\Delta H = -11.76/0.012 = -980$ kJ mol^{-1}. True value more negative because heat escaped to the air and the beaker (insulate with a lid and draught shield).

3.2 (C) Broken: $436 + 242 = 678$; formed: $2 \times 431 = 862$; $\Delta H = 678 - 862 = -184$ kJ/mol – exothermic.

3.3 Any two: insulate the cup/use a lid; use a draught shield around the burner; measure the flame closer under the container; better thermometer resolution.