InkChemistry

ANSWER BOOK

Measuring an enthalpy change: calorimetry

Energetics · Unit C04

AQA 3.1.4.2 · OCR A 3.2.1, PAG 3

14 questions · 43 marks

NAVY EDITION

Every question in this book has a code beside its number.
Type inklearning.co.uk/q/ followed by the code to open that question online.

© 2026 Ink Learning Ltd. All rights reserved.

inklearning.co.uk/chemistry/

SECTION A · Short, 1 to 2 marks

A1 MEC-Q11

B1 the density of the solution is 1.00 g cm^{-3}, so the mass in grams equals the volume in cm^3. **B1** the specific heat capacity of the solution equals that of water, 4.18 J g^{-1} K^{-1}; allow 'the cup absorbs no heat' as the second assumption. [2]

A2 MEC-Q12

B1 amount of zinc = 3.00 ÷ 65.4 = 0.0459 mol and amount of $CuSO_4$ = 0.0250 × 0.500 = 0.0125 mol. **B1** the reacting ratio is 1:1, so copper(II) sulfate is the limiting reagent and zinc is in excess. [2]

A3 MEC-Q13

B1 the heat is absorbed almost entirely by the water of the solution, which is the substance whose temperature is measured. **B1** the zinc is a small mass of solid with a much smaller specific heat capacity than water, so the heat it absorbs is negligible. [2]

A4 MEC-Q15

B1 the reaction is not instantaneous; the zinc takes time to mix through the solution and react. **B1** heat is still being released during that time faster than it is lost, so the temperature keeps rising until the reaction is nearly complete. [2]

SECTION B · Standard, 3 to 5 marks

B1 MEC-Q1

B1 q = mcΔT: heat energy = mass × specific heat capacity × temperature change. **B1** q in J, m in g, c in J g^{-1} K^{-1} and ΔT in K; accept °C for ΔT, since a change is the same size in both. **M1** q = 75.0 × 4.18 × 8.4. **A1** q = 2.6 × 10^3 J, or 2.6 kJ, to two significant figures, matching the 8.4 °C. [4]

B2 MEC-Q9

B1 heat is lost to the surroundings, the air, the can and the clamp, so not all of it warms the water and ΔT is too small. **B1** combustion is incomplete, giving carbon or carbon monoxide, which releases less energy than complete combustion to CO_2. **B1** ethanol evaporates from the wick without burning, so the mass loss overstates the amount burned. **B1** the water formed leaves as steam rather than liquid, so the heat of condensation included in $\Delta_c H^\circ$ is not collected. [4]

B3 MEC-Q6

M1 ΔT is the difference between two readings, so its uncertainty is 2 × 0.1 = ±0.2 °C. **M1** percentage uncertainty = 0.2 ÷ 6.8 × 100. **A1** percentage uncertainty = ±2.9% to two significant figures; 1.5%, from a single reading, scores zero. [3]

B4 MEC-Q7

B1 polystyrene is a poor conductor of heat, so less heat is lost through the walls to the surroundings. **B1** the lid reduces heat lost from the surface of the solution, by convection and evaporation. **B1** polystyrene has a very small heat capacity, so it absorbs little of the heat released, which q = mcΔT ignores. [3]

© 2026 Ink Learning Ltd. All rights reserved.

B5 MEC-Q8

B1 the reaction takes time to finish, and heat is lost to the surroundings throughout. **B1** so by the time the highest temperature is recorded some heat has already been lost, and that reading is too low. **B1** extending the cooling line back to the time of mixing gives the temperature that would have been reached with no heat lost, so ΔT is larger and more accurate. [3]

B6 MEC-Q14

B1 a draught screen around the burner and can, which keeps the flame under the can and reduces heat lost to moving air. **B1** a shorter gap between the flame and the base of the can, so less heat warms the air between them. **B1** keeping the cap on the burner except while it burns, so ethanol does not evaporate and the mass loss is only fuel that burned; accept insulating the can, with a lid. [3]

B7 MEC-Q16

B1 in the cup the heat is released directly into the solution, whereas from a burner it must cross an air gap and the can. **B1** so the burner loses a much larger fraction of the heat, and also suffers incomplete combustion and evaporation. **B1** cup results for neutralisation and displacement are usually within about 10% of the data book, whereas burner results are often much further from it. [3]

B8 MEC-Q18

B1 hydrochloric acid is a strong acid, fully dissociated, so its neutralisation is only $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$. **B1** hydrocyanic acid is a weak acid, mostly undissociated, so more HCN molecules dissociate as OH^- removes the H^+ ions. **B1** that dissociation takes in energy, so less heat is released overall per mole of water formed; 'weak acids release less energy' alone is not enough. [3]

B9 MEC-Q20

B1 after mixing the temperature falls to a minimum and then rises slowly as heat flows in from the warmer surroundings. **B1** the warming line after the minimum is extrapolated back to the time of mixing. **B1** ΔT is the fall from the starting temperature to that extrapolated value, and ΔH is positive. [3]

SECTION C · Long, 6 marks or more

© 2026 Ink Learning Ltd. All rights reserved.

C1 [6]
MEC-Q10

Indicative content

B1 a measured volume of copper(II) sulfate solution, for example 25.0 cm^3 by pipette, in a polystyrene cup with a lid, supported in a beaker. **B1** zinc powder weighed out in excess, so that copper(II) sulfate is the limiting reagent. **B1** the temperature recorded at regular intervals, such as every 30 s, for a few minutes before adding the zinc, to establish the starting temperature. **B1** the zinc added at a recorded time, with stirring, and the temperature recorded at regular intervals until it has been falling steadily for several minutes. **B1** a graph of temperature against time, with the cooling line extrapolated back to the time of mixing to find ΔT. **B1** $q = mc\Delta T$ with m the mass of the solution, divided by the amount of copper(II) sulfate in moles, gives ΔH in kJ mol^{-1} with a negative sign.

Levels

Level 3 (5–6 marks) the measured volume of solution in an insulated cup, zinc in excess, temperature readings before and after mixing at regular intervals, the extrapolated cooling curve to find ΔT, and the processing through $q = mc\Delta T$ and the moles of the limiting reagent to a negative ΔH are all present.

Level 2 (3–4 marks) the solution, the excess zinc and the temperature rise are measured and $q = mc\Delta T$ used with moles of copper(II) sulfate; there is no cooling-curve extrapolation, or no readings before mixing.

Level 1 (1–2 marks) zinc is added and the temperature rise measured; the mass in $q = mc\Delta T$ is often taken as the mass of zinc, and ΔH is left positive.

© 2026 Ink Learning Ltd. All rights reserved.

THIS BOOK ONLINE

Scan the code, or type the address, to open the questions in this book online:

inklearning.co.uk/chemistry/practise/questions/calorimetry/

© 2026 Ink Learning Ltd. All rights reserved.