

Heat, enthalpy and Hess's law

AP Chemistry · Test answers (mark scheme)

Model answers and marking guides follow. Award credit for a correct method with an arithmetic slip, and for sign errors only when the reasoning about direction of heat flow is stated. Bond-enthalpy answers may differ slightly if the table is rounded differently.

Level: AP Chemistry · **Curriculum:** AP Chem Unit 6

Question 1 Reading the sign (2 marks)

The solution absorbs heat from its surroundings: the process is **endothermic** and ΔH is **positive**.

Marking: 1 for endothermic, 1 for positive.

Question 2 Calorimetry (3 marks)

(a) $q = 150.0 \times 4.18 \times 13.5 = \mathbf{8.46 \times 10^3 \text{ J}}$.

(b) The temperature rises, so the reaction is exothermic: $\Delta H = -8.46/0.0400 = \mathbf{-212 \text{ kJ/mol}}$.

Marking: 1 for $\Delta T = 13.5$, 1 for q , 1 for the value with correct sign.

Question 3 Hess's law (3 marks)

Add (1) and (2): $2 \text{ C} + 2 \text{ O}_2 \rightarrow 2 \text{ CO}_2$, $\Delta H = -221 - 566 = -787 \text{ kJ}$. Divide by 2: **$\Delta H = -393.5 \text{ kJ}$** .

Marking: 1 for adding, 1 for cancelling CO, 1 for dividing by 2.

Question 4 Formation enthalpies (3 marks)

$\Delta H^\circ = [4(90.3) + 6(-241.8)] - [4(-45.9) + 0] = (361.2 - 1450.8) + 183.6 = \mathbf{-906.0 \text{ kJ}}$.

Marking: 1 for products minus reactants, 1 for substitution, 1 for the answer.

Question 5 Bond enthalpies (3 marks)

Broken: $\text{C-H} + \text{Cl-Cl} = 413 + 243 = 656 \text{ kJ}$. Formed: $\text{C-Cl} + \text{H-Cl} = 339 + 432 = 771 \text{ kJ}$. $\Delta H \approx 656 - 771 = \mathbf{-115 \text{ kJ}}$.

Marking: 1 for broken, 1 for formed, 1 for ΔH .

Question 6 Heat loss (2 marks)

Some of the heat escapes to the surroundings, so the water warms **less** than it should. A smaller ΔT gives a smaller q and a smaller magnitude of ΔH (-53 instead of -57).

Marking: 1 for the smaller temperature rise, 1 for the smaller magnitude of ΔH .

Question 7 Enthalpy levels (2 marks)

(a) A at 0 and C at -85 : **-85 kJ**.

(b) C is at -85 and B at -120 : **-35 kJ**.

Marking: 1 mark each.

Question 8 Specific heat capacity (2 marks)

$q(\text{water}) = 100.0 \times 4.18 \times 3.5 = 1463$ J. The metal cools by 76.5 °C: $c = 1463 / (45.0 \times 76.5) = \mathbf{0.425 \text{ J/(g } ^\circ\text{C)}}$.

Marking: 1 for heat gained by water, 1 for c with unit.