

Heat changes, energy cycles and bond enthalpies

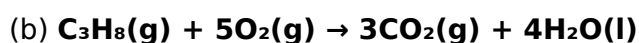
Chemistry grades 11-12 (A Level · IB · Class 11-12) · Test answers (mark scheme)

Model answers and mark schemes follow. Award marks for correct method even when the final value is wrong by one slip, and check the sign and unit of each ΔH carefully.

Level: Chemistry grades 11-12 (A Level · IB · Class 11-12) · **Curriculum:** IB R1.1-R1.2

Question 1 Combustion enthalpy (2 marks)

(a) The enthalpy change when one mole of a substance burns completely in oxygen under standard conditions, with all substances in their standard states.



Marking: 1 for one mole and complete combustion; 1 for the balanced equation with state symbols.

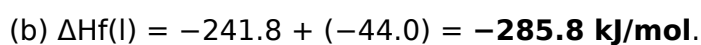
Question 2 Dissolving ammonium nitrate (3 marks)

$q = 100 \times 4.18 \times 3.1 = 1295.8 \text{ J}$. $n = 4.00 / 80.0 = 0.0500 \text{ mol}$. The temperature falls, so the process is endothermic: $\Delta H = +1295.8 / 0.0500 = 25\,916 \text{ J/mol} = \mathbf{+25.9 \text{ kJ/mol}}$.

Marking: 1 for q ; 1 for n ; 1 for the value with the positive sign.

Question 3 Energy cycle (3 marks)

(a) The enthalpy change of a reaction is independent of the route taken.



Marking: 1 for route independence; 1 for adding the two steps; 1 for the answer with sign.

Question 4 Bromine addition (3 marks)

Broken: $612 + 193 = 805 \text{ kJ}$. Formed: $347 + 2(285) = 917 \text{ kJ}$. $\Delta H = 805 - 917 = \mathbf{-112 \text{ kJ/mol}}$.

Marking: 1 for bonds broken; 1 for bonds formed; 1 for ΔH with sign.

Question 5 Why only an estimate (2 marks)

Mean bond enthalpies are averages taken over many different compounds, so they do not

equal the exact bond energies in the molecules concerned. They also refer to gaseous species, whereas calorimetry often involves liquids.

Marking: 1 for averages over different molecules; 1 for the gas phase.

Question 6 Decomposition of calcium carbonate (3 marks)

$\Delta H = (-634.9 - 393.5) - (-1207.0) = -1028.4 + 1207.0 = +178.6 \text{ kJ/mol}$. Positive, so the reaction is endothermic.

Marking: 1 for the correct expression; 1 for the value; 1 for the sign and conclusion.

Question 7 Per mole (2 marks)

Heat is released, so ΔH is negative: $\Delta H = -5.6 / 0.020 = -280 \text{ kJ/mol}$.

Marking: 1 for the division; 1 for the negative sign and unit.

Question 8 Experiment versus data book (2 marks)

Some heat from the burning fuel escapes to the surroundings and warms the container rather than the water, and combustion may be incomplete. The measured temperature rise is too small, so the experimental value is **less exothermic** than the data-book value.

Marking: 1 for heat loss or incomplete combustion; 1 for the effect on ΔT and ΔH .