

Solutions

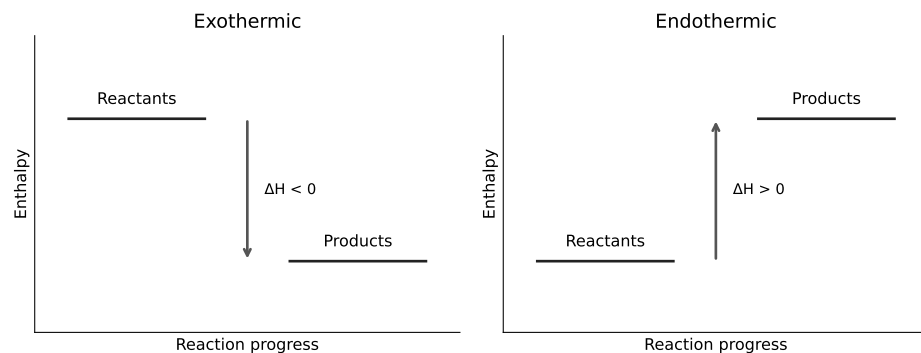
Original marking guidance: M1 method, A1 accuracy, B1 explanation.

2.1 The heat change at constant pressure for the equation as written under specified standard conditions, with reactants/products in their standard states. Halving every coefficient halves ΔH : $-1411 \text{ kJ mol}^{-1}$. The word reaction does not force a coefficient of one for every species.

2.2 Bond enthalpy is the energy needed to break one mole of the specified gaseous bonds. A mean C–H value averages different molecular environments. Liquid water has intermolecular/phase-energy differences not included in simply forming gaseous O–H bonds, so phase information is needed as well as the averaging limitation.

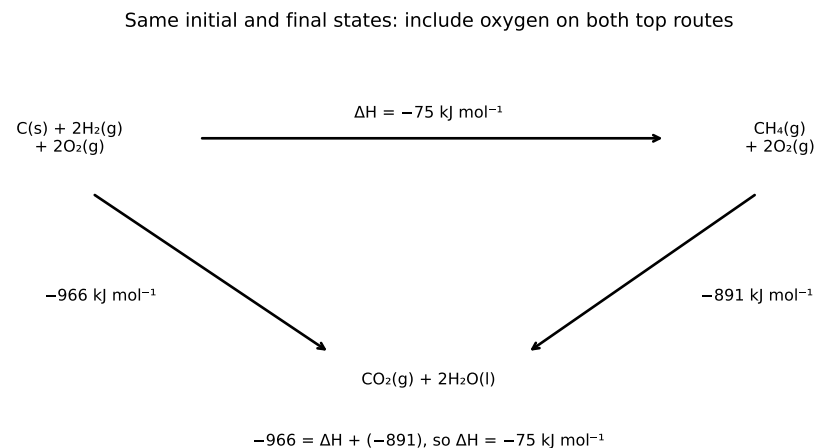
2.3 C–Br needs less energy to break, so it may cleave more readily/first in otherwise comparable pathways. Actual rate depends on the whole activation mechanism and conditions, so bond enthalpy alone does not fix a rate.

3.1



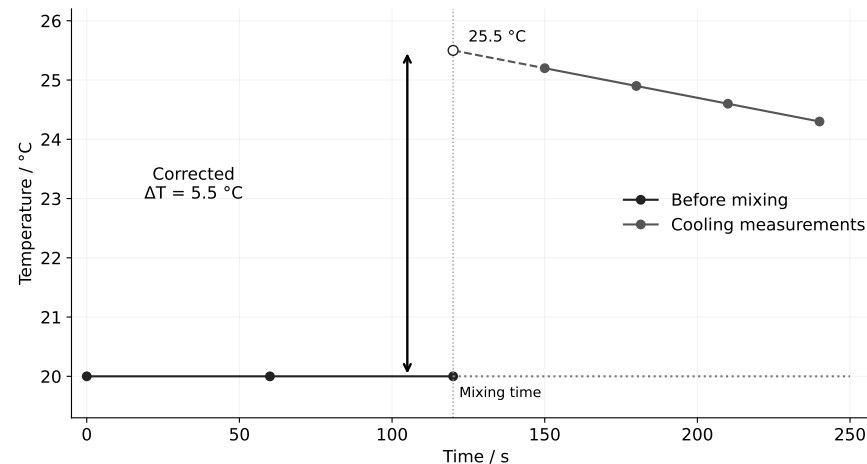
For each diagram, B1 for correct relative labelled levels and B1 for correctly directed/signed ΔH (four marks total).

3.2



Common products $\text{CO}_2\text{(g)} + 2\text{H}_2\text{O(l)}$; correctly scaled left route $-394 + 2(-286) = -966 \text{ kJ mol}^{-1}$; consistent downward arrow directions and spectator O_2 on both top routes. $-966 = \Delta H - 891$, giving $\Delta H = -75 \text{ kJ mol}^{-1}$.

3.3



Correct axes/scales and plotted measurements; cooling line extrapolated to 25.5°C at 120 s; corrected rise = 5.5°C . $q = mc\Delta T = 80.0 \times 4.18 \times 5.5 = 1839.2 \text{ J} = 1.8392 \text{ kJ}$. $n(\text{H}_2\text{O}) = cV = 1.00 \times 0.0400 = 0.0400 \text{ mol}$. $\Delta H = -q/n = -1.8392/0.0400 = -46.0 \text{ kJ mol}^{-1}$. The first measured maximum has already lost heat, so using 5.2°C gives a less negative value. The correction assumes the observed cooling trend reasonably represents heat loss near mixing; changing heat-loss rate, slow mixing or reaction continuing during cooling limits it.