Mark schemes compress these to "M1 A1". Written out fully: state the relationship, substitute with units, evaluate, and check the answer makes chemical sense. Most lost marks are for skipping the first step. M1 A1;

Energetics and equilibrium

When 50.0 cm^3 of 1.00 mol/dm^3 HCl is mixed with 50.0 cm^3 of 1.00 mol/dm^3 NaOH, the temperature rises by 6.8 °C. Calculate the enthalpy change of neutralisation. (Take the specific heat capacity of the mixture as 4.18 J g^{-1} K^{-1} and its density as 1.00 g cm^{-3}.) [5]

Total mass $= 50.0 + 50.0 = 100$ g. Heat released: $q = mc\Delta T = 100 \times 4.18 \times 6.8 = 2842$ J $= 2.84$ kJ. Moles of water formed $= 0.0500 \times 1.00 = 0.0500$ mol. Therefore $\Delta H = -\dfrac{2.84}{0.0500} = -56.8$ kJ mol^{-1}.

Commentary: Use the TOTAL mass of the mixture, 100 g, not 50 g. Halving it doubles the answer.

Commentary: The sign is negative because the reaction is exothermic – the temperature rose. A positive answer here loses a mark on its own.

Commentary: Sense check: neutralisation of a strong acid by a strong base is close to -57 kJ mol^{-1}.

For the equilibrium $\mathbf{N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)}$, ΔH is negative. State and explain the effect of increasing temperature on the yield of ammonia. [3]

Increasing temperature shifts the position of equilibrium in the ENDOTHERMIC direction, which is the reverse reaction, because the system opposes the change by absorbing the added energy. The position of equilibrium therefore moves to the left and the yield of ammonia falls; K_c also decreases.

Commentary: Name the direction (endothermic = reverse) AND the consequence for the yield. Stating only 'equilibrium shifts left' earns one of three.

Commentary: Temperature is the only change that alters K; saying so is often the third mark.

Kinetics and organic

A reaction is first order in A and second order in B. When [A] is doubled and [B] halved, by what factor does the rate change? [3]

Rate $= k[\mathrm{A}][\mathrm{B}]^2$. Doubling [A] multiplies the rate by 2; halving [B] multiplies it by $(1/2)^2 = 1/4$. The overall factor is $2 \times \dfrac{1}{4} = \dfrac{1}{2}$, so the rate halves.

Commentary: Write the rate equation first – it is the method mark and it makes the rest mechanical.

Commentary: Square the change in [B], do not halve the rate twice. The order is an exponent, not a multiplier.

Identify the mechanism and the reagents for converting bromoethane to ethanol, and explain why the reaction is classified as it is. [4]

Warm aqueous sodium hydroxide converts bromoethane to ethanol. The mechanism is nucleophilic substitution: the hydroxide ion is a nucleophile with a lone pair, attracted to the $\delta+$ carbon that carries the bromine because bromine is more electronegative than carbon. The C–Br bond breaks heterolytically, both electrons leaving with the bromine as a bromide ion.

Commentary: AQUEOUS hydroxide gives substitution; ETHANOLIC hydroxide gives elimination to ethene. Naming the solvent is a mark, and confusing the two loses the whole question.

Commentary: The explanation must say why the carbon is $\delta+$; 'the OH$^-$ attacks the carbon' asserts without explaining.

Analysis

A hydrocarbon contains 85.7% carbon by mass and has $M_r = 56$. Determine its empirical and molecular formulae. (A_r: C = 12, H = 1) [4]

Assume 100 g: 85.7 g C and 14.3 g H. Moles: C $= \dfrac{85.7}{12} = 7.14$; H $= \dfrac{14.3}{1} = 14.3$. Divide by the smaller: C = 1, H = 2.00. The empirical formula is CH_2, of mass 14. Since $56 \div 14 = 4$, the molecular formula is C_4H_8.

Commentary: Divide the percentages by the relative atomic masses, not the reverse – the units are moles per 100 g.

Commentary: Always divide through by the SMALLEST result; dividing by the largest gives fractions and hides the ratio.

Commentary: The molecular formula needs M_r; giving only the empirical formula answers half the question.