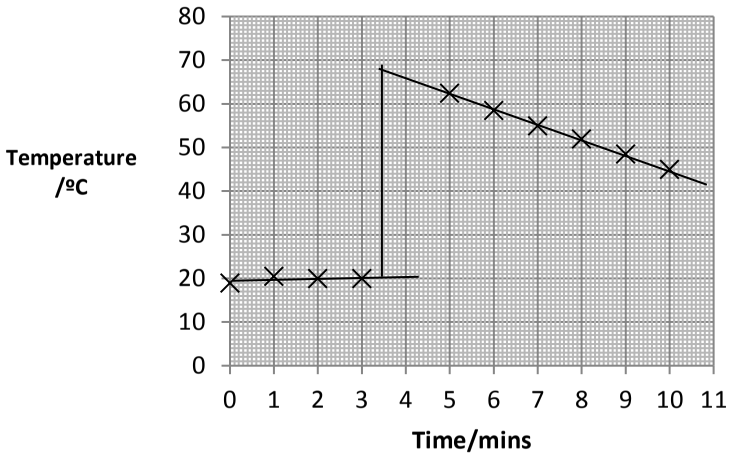
Unit 3 - Mark scheme

Question number	Answer	Additional guidance	Mark
1(a)(i)	• 50 cm^3 measuring cylinder	Allow 100 cm^3 measuring cylinder Do not award beaker/pipette/burette Do not award any other size of measuring cylinder or just 'measuring cylinder'	1

Question number	Answer	Additional guidance	Mark
1(a)(ii)	• 57.5 °C in the table and point plotted on the graph	Allow just 'correctly plotted point'	1

Question number	Answer	Additional guidance	Mark
1(b)(i)	• reaction is still underway	Examples of acceptable answers: the reaction is incomplete energy is still being produced the reaction is slow Do not award just 'it does not fit with the lines of best fit'	1

Question number	Answer		Additional guidance	Mark
1(b)(ii)				3
	• a straight line drawn through the first four points from 0 to 3 mins and a straight line drawn through last six points from 5 to 10 mins	(1)		
	• temperatures (68 °C ± 1 °C, 20 °C) measured using a vertical line at 3.5 minutes	(1)	Allow for any indication on the graph, or if correct answer (48 °C ±1 °C) given	
	• value for ΔT on a vertical line (48 °C ±1 °C)	(1)	Allow ΔT value if the vertical line is drawn other than 3.5 minutes	

Question number	Answer	Additional guidance	Mark
1(b)(iii)	• to ensure equilibration with the surroundings or • to take account of changing initial temperature of solution or • to check that the temperature is constant/steady		1

Question number	Answer	Additional guidance	Mark
1(b)(iv)	• to allow for cooling/heat loss or • to apply a cooling correction	Allow mention of drawing a cooling curve Ignore reference to the extrapolation to allow the reaction to go to completion to obtain the maximum temperature rise	1

Question number	Answer	Additional guidance	Mark
1(c)(i)	• correct value and corresponding units	Example of calculation: $(50 \times 4.2 \times \Delta T) = 10080$ J/10.08 kJ Allow TE for: ΔT heat energy (kJ) 46 9.66 47 9.87 49 10.29 50 10.50 Ignore SF, except 1 SF	1

Question number	Answer	Additional guidance	Mark
1(c)(ii)	• calculation of enthalpy change per mol (1) • answer to 1 or 2 SF (1) • negative sign **and** units (1)	Example of calculation: Answer to (c)(i) ÷ 0.05 ΔT ΔH /kJ mol^{-1} 46 -190 47 -200 48 -200 49 -210 50 -210 Correct answer with no working scores 3	3

Question number	Answer	Additional guidance	Mark
1(d)	• use a lid for the polystyrene cup or • putting insulation around the cup		1

Question number	Answer	Additional guidance	Mark
2(a)(i)	<table><tr><th>Solution</th><th>Letter</th></tr><tr><td>dilute hydrochloric acid, HCl(aq)</td><td>D</td></tr><tr><td>potassium carbonate, K_2CO_3(aq)</td><td>E</td></tr><tr><td>sodium iodide, NaI(aq)</td><td>B</td></tr><tr><td>dilute nitric acid, HNO_3(aq)</td><td>A</td></tr><tr><td>sodium chloride, NaCl(aq)</td><td>C</td></tr></table> • All 5 correct (3)	3 or 4 correct scores (2) 1 or 2 correct scores (1)	3

Question number	Answer	Additional guidance	Mark
2(a)(ii)	• (both give a white precipitate with silver nitrate) but the carbonate fizzes with added nitric acid (and dissolves) whereas chloride does not	There must be a comparison	1

Question number	Answer	Additional guidance	Mark
2(b)	• potassium ions/compounds give a lilac flame sodium ions/compounds give a (persistent) yellow/ yellow-orange/orange flame		1

Question number	Answer	Additional guidance	Mark
2(c)	An answer that makes reference to the following points: • ammonia solution (1) • silver chloride/white precipitate dissolves and silver iodide/yellow precipitate does not dissolve (1) or • (pour off liquid) add concentrated sulfuric acid (1) • silver chloride gives steamy fumes and silver iodide gives purple vapour. (1)	Ignore concentration of ammonia Allow **only** silver chloride/white precipitate dissolves	2

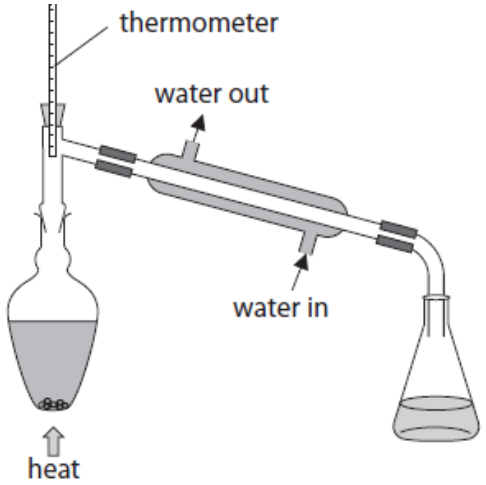
Question number	Answer	Additional guidance	Mark
3(a)(i)	• (misty fumes are) HCl/HCl(g)/hydrogen chloride or • HCl(aq)/hydrochloric acid		1

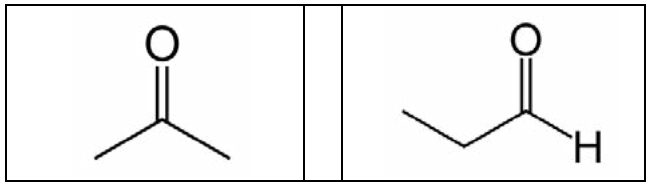
Question number	Answer	Additional guidance	Mark
3(a)(ii)	• (shows presence of) -OH/hydroxyl(l) group or • alcohol	Do not award OH^-/hydroxide group Ignore carboxylic acid	1

Question number	Answer	Additional guidance	Mark
3(b)	• 3750 - 3200 (cm^{-1})/3200 - 3750 (cm^{-1})	Allow a range within the range as long as it includes 3350 (cm^{-1})	1

Question number	Answer	Additional guidance	Mark
3(c)(i)	• from yellow-orange/orange/brown and to colourless	Ignore clear	1

Question number	Answer	Additional guidance	Mark
3(c)(ii)	• $CH_3CHCH_2 + Br_2 \rightarrow CH_3CHBrCH_2Br$ or • $C_3H_6 + Br_2 \rightarrow C_3H_6Br_2$	Allow any mixture of molecular, displayed and structural formulae Do not award for both bromine unambiguously on carbon 1 or on carbons 1 and 3	1

Question number	Answer	Additional guidance	Mark
3(d)(i)	Diagram to show: • round-bottomed/pear-shaped flask and still-head and heat (no need for a thermometer) (1) • condenser with a separate inner tube sloping downwards (1) • with water entering at the bottom and leaving at the top and suitable receiver (e.g. flask or beaker). (1)	Example of diagram:  Allow heating with electrical, water bath, Bunsen burner or just arrow Ignore thermometer and position, tap funnel in still head, absence of reagents/anti-bumping granules in flask Max 2 for gap before condenser Max 2 for sealed apparatus	3

Question number	Answer	Additional guidance	Mark
3(d)(ii)	•  (1) (1)	Accept displayed, skeletal or structural formulae or a mixture of these Allow in either order Allow aldehyde with or without -H in the skeletal formulae	2

Question number	Answer	Additional guidance	Mark
3(e)(i)	• C–H in aldehyde/propanal	Not just C–H	1

Question number	Answer	Additional guidance	Mark
3(e)(ii)	An answer that makes reference to the following points: • Fehling's/Benedict's test (and heat) (1) • red precipitate / solid (with aldehyde). (1)	Accept: Tollens' reagent (and warm) (1) Silver mirror (with aldehyde) (1) Allow: acidified potassium dichromate (and heat) (1) orange to green (with aldehyde) (1)	2

Question number	Answer	Additional guidance	Mark
3(f)	• propan-1-ol		1

Question number	Answer	Additional guidance	Mark
4(a)	mass of hydrated sodium carbonate: 6.70 mass of anhydrous sodium carbonate: 2.62 mass of water removed / g: 4.08 • all 3 numbers correct (2)	Do not award 6.7 Any 1 or 2 correct (1)	2

Question number	Answer	Additional guidance	Mark
4(b)(i)	• calculation of moles of water	Example of calculation: $\frac{4.08}{18}$ = 0.22666667 (mol) Ignore SF except 1 TE on mass of water in table	1

Question number	Answer	Additional guidance	Mark
4(b)(ii)	• calculation of relative formula mass of Na_2CO_3 (1) • calculation of moles of Na_2CO_3 (1)	Example of calculation: 106 = $\frac{2.62}{106}$ = 0.02471698 (mol) Ignore SF except 1 SF TE on mass of Na_2CO_3	2

Question number	Answer	Additional guidance	Mark
4(b)(iii)	• calculation of X (1) • answer to 3 SF (1)	Example of calculation: = answer to 4(b)(i) / answer to 4(b)(ii) = 0.22666667 / 0.02471698 (= 9.17048) 9.17	**2**

Question number	Answer	Additional guidance	Mark
4(c)	• calculation of percentage uncertainty	Example of calculation: $\frac{2 \times 0.0005}{26.06} \times 100 = (\pm)0.0384(\%)$ Ignore SF	**1**

Question number	Answer	Additional guidance	Mark
4(d)	An explanation that makes reference to: • 8.63 is too low because not enough water has been removed (1) • because it's not been heated long/strongly enough (1) • 10.79 is too high because apparently too much water has been removed/some extra material has been lost (1) • because solid has been lost from the crucible. (1)	Accept hydrated sodium carbonate has lost water in storage Ignore reference to impurities in the sodium carbonate Do not award measurement errors	**4**

Question number	Answer		Additional guidance	Mark
4(e)	An answer that makes reference to: • dissolve known mass of solid to form a known volume of solution • titrate with hydrochloric acid solution of known concentration • use of methyl orange indicator (and colour change) • repeat to obtain concordant titre values.	(1) (1) (1) (1)	Accept prepare a solution of sodium carbonate of known concentration Allow sulfuric/nitric acid Allow use of phenolphthalein Do not award: use of litmus or UI Allow within 0.2 cm^3	4