

Unit 3 - Mark scheme

Question number	Answer	Additional guidance	Mark
1(a)(i)	<ul style="list-style-type: none"> 50 cm³ measuring cylinder 	<p>Allow 100 cm³ measuring cylinder</p> <p>Do not award beaker/pipette/burette</p> <p>Do not award any other size of measuring cylinder or just 'measuring cylinder'</p>	1

Question number	Answer	Additional guidance	Mark
1(a)(ii)	<ul style="list-style-type: none"> 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)	<ul style="list-style-type: none"> reaction is still underway 	<p>Examples of acceptable answers:</p> <p>the reaction is incomplete energy is still being produced the reaction is slow</p> <p>Do not award just 'it does not fit with the lines of best fit'</p>	1

Question number	Answer	Additional guidance	Mark
1(b)(ii)	<p>Temperature / °C</p> <p>Time / mins</p> <ul style="list-style-type: none"> 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 ($68^{\circ}\text{C} \pm 1^{\circ}\text{C}$, 20°C) measured using a vertical line at 3.5 minutes (1) value for ΔT on a vertical line ($48^{\circ}\text{C} \pm 1^{\circ}\text{C}$) (1) 	<p>Allow for any indication on the graph, or if correct answer ($48^{\circ}\text{C} \pm 1^{\circ}\text{C}$) given</p> <p>Allow ΔT value if the vertical line is drawn other than 3.5 minutes</p>	3

Question number	Answer	Additional guidance	Mark
1(b)(iii)	<ul style="list-style-type: none"> 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)	<ul style="list-style-type: none"> to allow for cooling/heat loss or to apply a cooling correction 	<p>Allow mention of drawing a cooling curve</p> <p>Ignore reference to the extrapolation to allow the reaction to go to completion to obtain the maximum temperature rise</p>	1

Question number	Answer	Additional guidance	Mark										
1(c)(i)	<ul style="list-style-type: none">correct value and corresponding units	Example of calculation: $(50 \times 4.2 \times \Delta T) = 10080 \text{ J} / 10.08 \text{ kJ}$ Allow TE for: <table><tr><td>ΔT</td><td>heat energy (kJ)</td></tr><tr><td>46</td><td>9.66</td></tr><tr><td>47</td><td>9.87</td></tr><tr><td>49</td><td>10.29</td></tr><tr><td>50</td><td>10.50</td></tr></table> Ignore SF, except 1 SF	ΔT	heat energy (kJ)	46	9.66	47	9.87	49	10.29	50	10.50	1
ΔT	heat energy (kJ)												
46	9.66												
47	9.87												
49	10.29												
50	10.50												

Question number	Answer	Additional guidance	Mark												
1(c)(ii)	<ul style="list-style-type: none">calculation of enthalpy change per molanswer to 1 or 2 SFnegative sign and units	<p>Example of calculation:</p> <p>Answer to (c)(i) ÷ 0.05</p> <table><tr><td>ΔT</td><td>$\Delta H / \text{kJ mol}^{-1}$</td></tr><tr><td>46</td><td>-190</td></tr><tr><td>47</td><td>-200</td></tr><tr><td>48</td><td>-200</td></tr><tr><td>49</td><td>-210</td></tr><tr><td>50</td><td>-210</td></tr></table> <p>Correct answer with no working scores 3</p>	ΔT	$\Delta H / \text{kJ mol}^{-1}$	46	-190	47	-200	48	-200	49	-210	50	-210	3
ΔT	$\Delta H / \text{kJ mol}^{-1}$														
46	-190														
47	-200														
48	-200														
49	-210														
50	-210														

Question number	Answer	Additional guidance	Mark
1(d)	<ul style="list-style-type: none"> 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, K₂CO₃(aq)</td><td>E</td></tr><tr><td>sodium iodide, NaI(aq)</td><td>B</td></tr><tr><td>dilute nitric acid, HNO₃(aq)</td><td>A</td></tr><tr><td>sodium chloride, NaCl(aq)</td><td>C</td></tr></table> <ul style="list-style-type: none">All 5 correct	Solution	Letter	dilute hydrochloric acid, HCl(aq)	D	potassium carbonate, K ₂ CO ₃ (aq)	E	sodium iodide, NaI(aq)	B	dilute nitric acid, HNO ₃ (aq)	A	sodium chloride, NaCl(aq)	C	<p>(3)</p> <p>3 or 4 correct scores (2) 1 or 2 correct scores (1)</p>	3
Solution	Letter														
dilute hydrochloric acid, HCl(aq)	D														
potassium carbonate, K ₂ CO ₃ (aq)	E														
sodium iodide, NaI(aq)	B														
dilute nitric acid, HNO ₃ (aq)	A														
sodium chloride, NaCl(aq)	C														

Question number	Answer	Additional guidance	Mark
2(a)(ii)	<ul style="list-style-type: none"> (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)	<ul style="list-style-type: none"> 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)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> ammonia solution (1) silver chloride/white precipitate dissolves and silver iodide/yellow precipitate does not dissolve or (1) (pour off liquid) add concentrated sulfuric acid (1) silver chloride gives steamy fumes and silver iodide gives purple vapour. (1) 	<p>Ignore concentration of ammonia</p> <p>Allow only silver chloride/white precipitate dissolves</p>	2

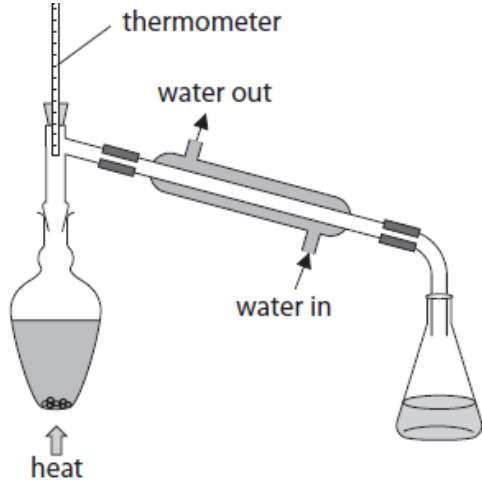
Question number	Answer	Additional guidance	Mark
3(a)(i)	<ul style="list-style-type: none"> (misty fumes are) HCl/HCl(g)/hydrogen chloride or HCl(aq)/hydrochloric acid 		1

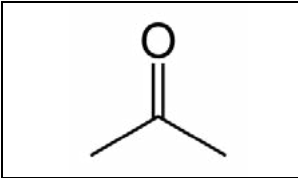
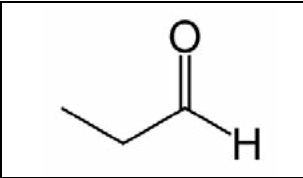
Question number	Answer	Additional guidance	Mark
3(a)(ii)	<ul style="list-style-type: none"> (shows presence of) -OH/hydroxyl(l) group or alcohol 	<p>Do not award OH⁻/hydroxide group</p> <p>Ignore carboxylic acid</p>	1

Question number	Answer	Additional guidance	Mark
3(b)	<ul style="list-style-type: none"> 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)	<ul style="list-style-type: none"> from yellow-orange/orange/brown and to colourless 	Ignore clear	1

Question number	Answer	Additional guidance	Mark
3(c)(ii)	<ul style="list-style-type: none"> $\text{CH}_3\text{CHCH}_2 + \text{Br}_2 \rightarrow \text{CH}_3\text{CHBrCH}_2\text{Br}$ or $\text{C}_3\text{H}_6 + \text{Br}_2 \rightarrow \text{C}_3\text{H}_6\text{Br}_2$ 	<p>Allow any mixture of molecular, displayed and structural formulae</p> <p>Do not award for both bromine unambiguously on carbon 1 or on carbons 1 and 3</p>	1

Question number	Answer	Additional guidance	Mark
3(d)(i)	<p>Diagram to show:</p> <ul style="list-style-type: none"> 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) 	<p>Example of diagram:</p>  <p>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</p> <p>Max 2 for gap before condenser Max 2 for sealed apparatus</p>	3

Question number	Answer	Additional guidance	Mark
3(d)(ii)	<ul style="list-style-type: none"> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  <p>(1)</p> </div> <div style="text-align: center;">  <p>(1)</p> </div> </div> 	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)	<ul style="list-style-type: none"> 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: <ul style="list-style-type: none"> 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)	<ul style="list-style-type: none"> propan-1-ol 		1

Question number	Answer	Additional guidance	Mark						
4(a)	<table><tr><td>mass of hydrated sodium carbonate</td><td>6.70</td></tr><tr><td>mass of anhydrous sodium carbonate</td><td>2.62</td></tr><tr><td>mass of water removed / g</td><td>4.08</td></tr></table>	mass of hydrated sodium carbonate	6.70	mass of anhydrous sodium carbonate	2.62	mass of water removed / g	4.08	Do not award 6.7	2
	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)	Any 1 or 2 correct								
	(1)								

Question number	Answer	Additional guidance	Mark
4(b)(i)	<ul style="list-style-type: none"> calculation of moles of water 	Example of calculation: $\frac{4.08}{18} = 0.22666667 \text{ (mol)}$ Ignore SF except 1 TE on mass of water in table	1

Question number	Answer	Additional guidance	Mark
4(b)(ii)	<ul style="list-style-type: none"> calculation of relative formula mass of Na_2CO_3 calculation of moles of Na_2CO_3 	Example of calculation: 106 $= \frac{2.62}{106} = 0.02471698 \text{ (mol)}$ Ignore SF except 1 SF TE on mass of Na_2CO_3	2

Question number	Answer	Additional guidance	Mark
4(b)(iii)	<ul style="list-style-type: none"> calculation of X answer to 3 SF 	<p>Example of calculation:</p> <p>(1) $= \frac{\text{answer to 4(b)(i)}}{\text{answer to 4(b)(ii)}} = \frac{0.22666667}{0.02471698} (= 9.17048)$</p> <p>(1) 9.17</p>	2

Question number	Answer	Additional guidance	Mark
4(c)	<ul style="list-style-type: none"> calculation of percentage uncertainty 	<p>Example of calculation:</p> <p>$\frac{2 \times 0.0005}{26.06} \times 100 = (\pm)0.0384(\%)$</p> <p>Ignore SF</p>	1

Question number	Answer	Additional guidance	Mark
4(d)	<p>An explanation that makes reference to:</p> <ul style="list-style-type: none"> 8.63 is too low because not enough water has been removed because it's not been heated long/strongly enough 10.79 is too high because apparently too much water has been removed/some extra material has been lost because solid has been lost from the crucible. 	<p>(1) Accept hydrated sodium carbonate has lost water in storage</p> <p>(1)</p> <p>(1) Ignore reference to impurities in the sodium carbonate</p> <p>(1) Do not award measurement errors</p>	4

Question number	Answer	Additional guidance	Mark
4(e)	<p>An answer that makes reference to:</p> <ul style="list-style-type: none"> 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. 	<p>(1) Accept prepare a solution of sodium carbonate of known concentration</p> <p>(1) Allow sulfuric/nitric acid</p> <p>(1) Allow use of phenolphthalein Do not award: use of litmus or UI</p> <p>(1) Allow within 0.2 cm³</p>	4