

CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Level

MARK SCHEME for the May/June 2013 series

9701 CHEMISTRY

9701/51

Paper 5 (Planning, Analysis and Evaluation),
maximum raw mark 30

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

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Page 2	Mark Scheme	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2013	9701	51

Question	Expected Answer	Mark
1 (a) (i)	(Solubility will) decrease	1
	Dissolving/reaction is exothermic so reaction shifts left (owtte).	1
	Increase negates both marks. Allow: Variations in the wording but the word exothermic or heat evolved or the reverse process must be included.	
(ii)	Axes are correctly labelled AND graph is a curve/straight line showing a decrease in solubility with temperature. (ignore units)	1
	Graph goes through the point 25 on temperature scale and 5 on solubility scale AND goes from 0 to 100 °C	1
	Allow ecf from (i) prediction.	
(b)	(i) temperature (increase)	
	(ii) solubility (of chlorine)	1
(c)	1 Pipette (5, 10, 20, 25, 50 cm ³), burette (25, 50 or 100 cm ³) both required for mark.	1
	2 Starch indicator AND blue/blue-black AND colourless/opaque.	1
	3 Concentration of Cl ₂ = 0.0704 mol dm ⁻³ .	1
	4 Calculates M _r of Na ₂ S ₂ O ₃ .5H ₂ O as 248.2 AND calculates mass with unit required for a solution of stated concentration and volume. (Allow any concentration)	1
	5 Mass and volume used must produce a solution twice as concentrated as the chlorine solution (ecf from Cl ₂).	1
	6 Describes making of solution in <u>volumetric flask</u> which must include: <u>dissolving</u> , making up <u>to mark</u> .	1
	7 Titration is repeated to achieve concordant titration results/average titre, 'concordant' not required if meaning clear.	1
	8 Calculates moles Cl ₂ in titration from 0.5 × moles thiosulfate in titre and therefore concentration AND concentration of Cl ₂ in mol dm ⁻³ in aqueous chlorine. Allow any explanation which covers these points, calculations involving concentrations or moles to mass and concentration in g dm ⁻³ , or any formula that would produce a correct answer e.g. $mv / n = mv / n$	1

Page 3	Mark Scheme	Syllabus	Paper
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(d)	Chlorine OR iodine are harmful		1
	Wear a mask/use a fume cupboard/for iodine if harmful to skin/eyes given, allow resistant gloves/goggles		1
		[Total: 15]	

Page 4	Mark Scheme	Syllabus	Paper
	GCE A LEVEL – May/June 2013	9701	51

2 (a)	151.9 AND 18.0	1																																																
(b)	Columns are headed with a label, an expression and units as below. Mol of FeSO₄ AND mol of H₂O are correct to 3 sig. figs. ECF incorrect <i>M_r</i>. ECF the use of incorrect expressions into data. <table><tr><th>D</th><th>E</th><th>F</th><th>G</th></tr><tr><td>FeSO₄ (C – A) / g</td><td>H₂O B – C / g</td><td>FeSO₄ (C – A) / 151.9 OR D / 151.9 mol OR mole</td><td>H₂O (B – C) / 18 OR E / 18 mol OR mole</td></tr><tr><td>1.00</td><td>0.83</td><td>0.00658</td><td>0.0461</td></tr><tr><td>1.31</td><td>1.00</td><td>0.00862</td><td>0.0556</td></tr><tr><td>1.30</td><td>1.08</td><td>0.00856</td><td>0.0600</td></tr><tr><td>1.39</td><td>1.16</td><td>0.00915</td><td>0.0644</td></tr><tr><td>1.50</td><td>1.24</td><td>0.00987</td><td>0.0689</td></tr><tr><td>1.63</td><td>1.35</td><td>0.0107</td><td>0.0750</td></tr><tr><td>1.78</td><td>1.48</td><td>0.0117</td><td>0.0822</td></tr><tr><td>1.84</td><td>1.53</td><td>0.0121</td><td>0.0850</td></tr><tr><td>1.95</td><td>1.62</td><td>0.0128</td><td>0.0900</td></tr><tr><td>2.03</td><td>1.76</td><td>0.0134</td><td>0.0978</td></tr></table>	D	E	F	G	FeSO ₄ (C – A) / g	H ₂ O B – C / g	FeSO ₄ (C – A) / 151.9 OR D / 151.9 mol OR mole	H ₂ O (B – C) / 18 OR E / 18 mol OR mole	1.00	0.83	0.00658	0.0461	1.31	1.00	0.00862	0.0556	1.30	1.08	0.00856	0.0600	1.39	1.16	0.00915	0.0644	1.50	1.24	0.00987	0.0689	1.63	1.35	0.0107	0.0750	1.78	1.48	0.0117	0.0822	1.84	1.53	0.0121	0.0850	1.95	1.62	0.0128	0.0900	2.03	1.76	0.0134	0.0978	1 1
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(c)	x-axis labelled ‘mol of FeSO₄’ and y-axis ‘mol H₂O’ AND plotted points cover at least half the grid in both directions. Allow a correct letter from the table as a label. All 10 points plotted correctly. Best fit straight line drawn.	1 1 1																																																

Page 5	Mark Scheme	Syllabus	Paper
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(d)	Points 2 and 10 circled. (The circled points must be unambiguously referred to in the reasons.)	1
	Point 2 (mass of crucible 15.10) Not all the water had been driven off the iron sulfate crystals OR anhydrous FeSO ₄ absorbed some water OR has an impurity that does not decompose.	1
	Allow water loss is low(er) (than expected).	
	Point 10 (mass of crucible = 15.01) The anhydrous FeSO ₄ had decomposed OR prior to heating the crucible/original sample was wet and water removed on heating OR contained an impurity which decomposed/was removed on heating.	1
	Allow some mass lost (spits out) on heating.	
(e)	Appropriately drawn lines on the graph.	1
	Correctly read values from the graph.	1
	(Figures from the table allowed if no construction lines drawn providing graph drawn does actually go through the points used.)	
	Correctly calculated value of the slope given to 2 or more sig. figs up to calculator value and using the candidate's figures AND no units given.	1
(f)	Most of the points are on the line OR only a few points are not on the line OR there are only a few anomalies.	1
(g) (i)	FeSO ₄ .7H ₂ O (ecf on slope in (e))	1
(ii)	The gradient/slope is the ratio of (moles) of H ₂ O:FeSO ₄ (is 7 or 7:1).	1
		[Total: 15]

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	GCE A LEVEL – May/June 2013	9701	52

Question	Expected Answer	Mark
1 (a) (i)	(Solubility will) decrease	1
	Dissolving/reaction is exothermic so reaction is shifted left (owtte)	1
	Increase negates both marks. Allow: Variations in the wording but the word exothermic/heat evolved (or endothermic/heat absorbed for the reverse process) must be included.	
(ii)	Axes are correctly labelled AND graph is a curve/straight line showing a decrease in solubility with temperature (ignore units)	1
	Graph goes through the point 25°C, 1 g dm ⁻³ AND goes from 0°C to 100°C	1
	(Allow ecf from (i).)	
(b)	(i) temperature	
	(ii) solubility (of calcium hydroxide)	1
(c)	1 Ca(OH) ₂ + 2HCl → CaCl ₂ + 2H ₂ O	1
	2 Pipette (5, 10, 20, 25 or 50 cm ³), burette (25, 50 or 100 cm ³)	1
	3 Named indicator with colours in acid and alkaline solution.	1
	4 Concentration of Ca(OH) ₂ = 0.0135 mol dm ⁻³	1
	5 Describes making a solution of HCl in volumetric flask which must include using a burette or pipette to take a volume of HCl and making it up to the mark with water.	1
	6 Suggests a dilution of HCl of between 50 and 100 fold OR suggests a mixture of HCl and water that would give a dilution of between 50 and 100 fold.	1
	7 Titration is repeated to achieve concordant/average titre.	1
	8 Moles of HCl calculated from titre AND Ca(OH) ₂ = 0.5 x moles of HCl AND concentration of Ca(OH) ₂ is deduced.	1
(d)	Calcium hydroxide OR 2.00 mol dm ⁻³ hydrochloric acid are irritants.	1
	Eye protection must be worn. Eye protection can be goggles, glasses, face masks etc.	1
[Total: 15]		

Page 3	Mark Scheme	Syllabus	Paper
	GCE A LEVEL – May/June 2013	9701	52

2	(a)	159.6 AND 18.0	1																																																
	(b)	Columns are headed with label and correct expression and units. mol of CuSO₄ AND mol of H₂O are correct to 3 sig figs. ECF incorrect <i>M_r</i> or the use of incorrect expressions into data <table><thead><tr><th>D</th><th>E</th><th>F</th><th>G</th></tr><tr><th>CuSO₄ C – A / g</th><th>H₂O B – C / g</th><th>Mol CuSO₄ D / 159.6 / mol</th><th>Mol of H₂O E / 18.0 / mol</th></tr></thead><tbody><tr><td>1.00</td><td>0.56</td><td>0.00627</td><td>0.0311</td></tr><tr><td>1.15</td><td>0.65</td><td>0.00721</td><td>0.0361</td></tr><tr><td>1.28</td><td>0.72</td><td>0.00802</td><td>0.0400</td></tr><tr><td>1.34</td><td>0.76</td><td>0.00840</td><td>0.0422</td></tr><tr><td>1.42</td><td>0.85</td><td>0.00890</td><td>0.0472</td></tr><tr><td>1.53</td><td>0.81</td><td>0.00959</td><td>0.0450</td></tr><tr><td>1.60</td><td>0.90</td><td>0.0100</td><td>0.0500</td></tr><tr><td>1.72</td><td>0.97</td><td>0.0108</td><td>0.0539</td></tr><tr><td>1.85</td><td>1.04</td><td>0.0116</td><td>0.0578</td></tr><tr><td>1.97</td><td>1.11</td><td>0.0123</td><td>0.0617</td></tr></tbody></table>	D	E	F	G	CuSO ₄ C – A / g	H ₂ O B – C / g	Mol CuSO ₄ D / 159.6 / mol	Mol of H ₂ O E / 18.0 / mol	1.00	0.56	0.00627	0.0311	1.15	0.65	0.00721	0.0361	1.28	0.72	0.00802	0.0400	1.34	0.76	0.00840	0.0422	1.42	0.85	0.00890	0.0472	1.53	0.81	0.00959	0.0450	1.60	0.90	0.0100	0.0500	1.72	0.97	0.0108	0.0539	1.85	1.04	0.0116	0.0578	1.97	1.11	0.0123	0.0617	1 1
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	(d)	Points 5 and 6 circled Point 5 (mass of crucible = 15.05) The anhydrous CuSO₄ had decomposed OR prior to heating the crucible/sample was wet OR contained an impurity which decomposed/was removed on heating. Allow: some mass lost (spits) on heating Point 6 (mass of crucible = 14.90) Not all the water had been driven off the copper sulfate crystals OR anhydrous copper sulfate absorbed some water OR has an impurity that does not decompose	1 1 1																																																

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(e)	Appropriately drawn lines on the graph.	1
	Correctly read values from the graph. (Figures from the table allowed if no construction lines drawn providing graph does actually go through the points used.)	1
	Correctly calculated value of the slope given to 2 or more sig figs up to calculator value using the candidate's figures AND with no units given.	1
(f)	Most of the points are on the line OR only a few points are not on the line OR there are only a few anomalies	1
(g) (i)	$\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ ecf on slope in (e)	1
(ii)	The graph / slope is the ratio of $\text{H}_2\text{O}:\text{CuSO}_4$ is 5 / 5:1 OR the slope is the value of x	1
[Total: 15]		

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(ii)	Axes are correctly labelled AND graph is a curve/straight line showing a decrease in solubility with temperature. (ignore units)	1
	Graph goes through the point 25 on temperature scale and 5 on solubility scale AND goes from 0 to 100 °C	1
	Allow ecf from (i) prediction.	
(b)	(i) temperature (increase)	
	(ii) solubility (of chlorine)	1
(c) 1	Pipette (5, 10, 20, 25, 50 cm ³), burette (25, 50 or 100 cm ³) both required for mark.	1
	2 Starch indicator AND blue/blue-black AND colourless/opaque.	1
	3 Concentration of Cl ₂ = 0.0704 mol dm ⁻³ .	1
	4 Calculates M _r of Na ₂ S ₂ O ₃ .5H ₂ O as 248.2 AND calculates mass with unit required for a solution of stated concentration and volume. (Allow any concentration)	1
	5 Mass and volume used must produce a solution twice as concentrated as the chlorine solution (ecf from Cl ₂).	1
	6 Describes making of solution in <u>volumetric flask</u> which must include: <u>dissolving</u> , making up <u>to mark</u> .	1
	7 Titration is repeated to achieve concordant titration results/average titre, 'concordant' not required if meaning clear.	1
	8 Calculates moles Cl ₂ in titration from 0.5 × moles thiosulfate in titre and therefore concentration AND concentration of Cl ₂ in mol dm ⁻³ in aqueous chlorine. Allow any explanation which covers these points, calculations involving concentrations or moles to mass and concentration in g dm ⁻³ , or any formula that would produce a correct answer e.g. $mv / n = mv / n$	1

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(d)	Chlorine OR iodine are harmful		1
	Wear a mask/use a fume cupboard/for iodine if harmful to skin/eyes given, allow resistant gloves/goggles		1
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(d)	Points 2 and 10 circled. (The circled points must be unambiguously referred to in the reasons.)	1
	Point 2 (mass of crucible 15.10) Not all the water had been driven off the iron sulfate crystals OR anhydrous FeSO_4 absorbed some water OR has an impurity that does not decompose.	1
	Allow water loss is low(er) (than expected).	
	Point 10 (mass of crucible = 15.01) The anhydrous FeSO_4 had decomposed OR prior to heating the crucible/original sample was wet and water removed on heating OR contained an impurity which decomposed/was removed on heating.	1
	Allow some mass lost (spits out) on heating.	
(e)	Appropriately drawn lines on the graph.	1
	Correctly read values from the graph.	1
	(Figures from the table allowed if no construction lines drawn providing graph drawn does actually go through the points used.)	
	Correctly calculated value of the slope given to 2 or more sig. figs up to calculator value and using the candidate's figures AND no units given.	1
(f)	Most of the points are on the line OR only a few points are not on the line OR there are only a few anomalies.	1
(g) (i)	$\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ (ecf on slope in (e))	1
(ii)	The gradient/slope is the ratio of (moles) of $\text{H}_2\text{O}:\text{FeSO}_4$ (is 7 or 7:1).	1
		[Total: 15]