

**MARK SCHEME for the October/November 2010 question paper
for the guidance of teachers**

9701 CHEMISTRY

9701/31

Paper 3 (Advanced Practical Skills), maximum raw mark 40

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: Teachers' version	Syllabus	Paper
	GCE A/AS LEVEL – October/November 2010	9701	31

Question	Sections	Indicative material	Mark	
1 (a)	PDO layout	I Volume given for Rough titre and accurate titre details tabulated.	1	
	MMO Collection	II In the correct spaces, records Initial and final burette readings for Rough titre and ; Initial and final burette readings and , volume of FB 2 added recorded for each accurate titre <i>Headings should match readings.</i> <i>Do not award this mark if:</i> <i>50(.00) is used as an initial burette reading;</i> <i>More than one final burette reading is 50.(00);</i> <i>Any burette reading is greater than 50.(00)</i>	1	
	MMO Decisions	III Has two uncorrected, accurate titres within 0.1 cm^3 <i>Do not award this mark if having performed two titres within 0.1 cm^3 a further titration is performed which is more than 0.10 cm^3 from the closer of the initial two titres, unless a fourth titration, within 0.1 cm^3 of the third titration or of the first two titres has also been carried out.</i>	1	
	PDO Recording	IV All accurate burette readings (initial and final) recorded to nearest 0.05 cm^3 . <i>Assessed on burette readings only.</i>	1	
	MMO Quality	V, VI and VII Round any burette readings to the nearest 0.05 cm^3 Check and correct subtractions in the titre table. Select the “best” titre using the hierarchy: two identical; titres within 0.05 cm^3 , titres within 0.10 cm^3 etc. Award <u>V, VI and VII</u> for a difference to Supervisor within 0.20 cm^3 Award <u>V and VI only</u> for a difference of $0.20+ \text{ cm}^3 - 0.40 \text{ cm}^3$ Award <u>V only</u> for a difference of $0.40+ \text{ cm}^3 - 0.80 \text{ cm}^3$ <i>If the selected “best” titres are $> 0.50 \text{ cm}^3$ apart, cancel one of the Q marks awarded.</i>	3	
				[7]

Page 4	Mark Scheme: Teachers' version	Syllabus	Paper
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(d)	ACE Interpretation	Gives $0.1(0) \text{ cm}^3$ as the maximum error in (i). <i>Ignore any sign</i> and the expression $^{0.1}/_{\text{cand titre in (b)}} \times 100$ in (ii)	1	[2]
		Evaluates $^{0.06}/_{25.0} \times 100$ in step (iii) <i>Accept only 0.240 or 0.24,</i> or <i>rounded to 0.2 provided 0.24 has been seen in the working.</i>	1	
	[Total: 15]			

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2	(a)	PDO Layout PDO Recording MMO Decisions MMO Quality	I Records at least four different balance readings and at least one mass of solid/gas <i>Accept 0.0(0X) g as the mass of the empty tube or a statement that the tube is tared.</i> II Gives all appropriate headings and units when recording results. <i>Do not accept mass of empty tube as 0.0(00)g here unless tube is described as tared.</i> <i>(minimum of three pieces of information)</i> III All recorded balance readings consistent to at least 1 decimal place. <i>(minimum of three balance readings)</i> IV Evidence of reheating to “constant” mass. For balances reading to 1 d.p. two masses must be identical For 2 or 3 d.p. balances, two masses must be within 0.05 g V and VI Check and correct all subtractions in the results table. Calculate $\frac{\text{mass heated}}{\text{mass of residue}}$ to 3 significant figures. Compare to Supervisor standard or standard value of 1.45. Award <u>V and VI</u> for a difference up to 0.15 Award <u>V only</u> for a difference of 0.15+ to 0.30 <i>Where a candidate repeats the experiment use cumulative masses of FA 3 and residue.</i> <i>Where masses of FA 3 and residue cannot be checked, accept candidate values to calculate the ratio.</i>	1 1 1 1 2	
	(b)	ACE Interpretation	Evaluates $\frac{\text{cand mass loss from (a)}}{\text{cand mass of FA 3}}$ correct to 2–4 significant figures. <i>Where mass loss or mass of FA 3 is not given in (a), check, from balance readings, the values.</i> <i>A candidate who incorrectly describes the mass of the residue as the mass loss in tabulated results in (a) may “correct” the error and use the correct mass loss here.</i>	1	

[6]

[1]

Page 7	Mark Scheme: Teachers' version	Syllabus	Paper
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FA 4 is $Al_2(SO_4)_3(aq)$; FA 5 is $ZnSO_4(aq)$; FA 6 is $Pb(NO_3)_2(aq)$; FA 7 is $MgSO_4(aq)$				
3	(a)	MMO Collection	1 mark for correct observations in each of the vertical columns. or 1 mark for correct observations in each of the horizontal rows (i), (ii) and (iii). 3 mark maximum Mark the section by the method which gives the better mark.	4
				[4]

test		observations			
		FA 4	FA 5	FA 6	FA 7
(i)	addition of NaOH	white ppt	white ppt	white ppt	white ppt
	further addition of NaOH	ppt soluble	ppt soluble	ppt soluble	ppt insoluble
(ii)	addition of NH_3	white ppt	white ppt	white ppt	white ppt
	further addition of NH_3	ppt insoluble	ppt soluble	ppt insoluble	ppt insoluble
(iii)	addition of KI	no ppt, no reaction, colourless or yellow solution	no ppt, no reaction, colourless or yellow solution	yellow ppt	no ppt, no reaction, colourless or yellow solution

Minimum evidence required in observations for the ion identity marks **I, II and III** in (b)

In some cases, identification may be allowed from incomplete observations. There must, however, be no observations that are contrary to those expected with any “correctly” identified ion.

The same criteria will be applied to “candidate’s supporting evidence in awarding mark **IV**. Candidates are not permitted to introduce (from the Qualitative Analysis Notes) supporting evidence that is not given in the observations. Precipitate colour need not be mentioned in supporting evidence.

Al^{3+}	(white) precipitate, soluble in (excess) NaOH, if yellow ppt with KI
Zn^{2+}	(white) precipitate, soluble in (excess) $NH_3(aq)$
Pb^{2+}	Yellow precipitate with KI
Mg^{2+}	(white) precipitate, insoluble in (excess) NaOH

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FA 4 is $\text{Al}_2(\text{SO}_4)_3(\text{aq})$; FA 5 is $\text{ZnSO}_4(\text{aq})$; FA 6 is $\text{Pb}(\text{NO}_3)_2(\text{aq})$; FA 7 is $\text{MgSO}_4(\text{aq})$				
(b)	ACE Conclusions	Do not accept any ion other than Al^{3+} , Zn^{2+} , Pb^{2+} or Mg^{2+} in any section. Marks I to III Ions must be correct, including charge, if a symbol has been given. – <u>no ecf in this section.</u>	1	
		Award <u>I only</u> if one ion only is identified from correct observations.	1	
		Award <u>I and II</u> if two ions only are identified from correct observations.	1	
		Award <u>I, II and III</u> if all four cations are identified from correct observations. <i>The 4th cation may be identified by elimination from incomplete supporting evidence.</i>	1	
		Award mark <u>IV</u> if the supporting evidence fits the ion identified and the practical performed for at least three of the four ions. Allow ecf on ion order on mark <u>IV</u> .	1	[4]
(c)	MMO Decisions	Selects sodium or potassium chromate(VI), sulfuric acid or hydrochloric acid soln containing one of the following named ions or formula given followed by (aq): CrO_4^{2-} , SO_4^{2-} , Cl^- , Br^- but not I^- , soln containing CrO_4^{2-} ions, H_2SO_4 , HCl ,		[1]

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FA 8 is CuSO ₄ (aq)				
(d)	MMO Collection	I	Records blue colour of solution fading/disappearing on adding zinc powder in (i) <i>If no reaction with Zn(s) is reported do not allow blue to light blue solution.</i>	1
		II	Records a temperature rise in (i) <i>Accept reaction is exothermic/produces heat</i>	1
		III	Records a red-brown, orange-brown, brown or black solid in (i)	1
		IV	Observes a green, lime green, fluorescent green or yellow-green solution in (ii)	1
		V	Observes solution turning blue, or blue solution in (iii) if solution green in (ii) or solution going towards blue in colour on adding water in (iii) If solution is not mentioned in (ii) or (iii) but colours are correct – award point V only .	1
				[5]
(e)	ACE Conclusions	Completes the equation: → Cu(s) + Zn ²⁺ (aq) State symbols required		1
				[1]
				[Total: 15]

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	MMO Decisions	III Has two uncorrected, accurate titres within 0.1 cm^3 <i>Do not award this mark if having performed two titres within 0.1 cm^3 a further titration is performed which is more than 0.10 cm^3 from the closer of the initial two titres, unless a fourth titration, within 0.1 cm^3 of the third titration or of the first two titres has also been carried out.</i>	1	
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		Award <u>I only</u> if one ion only is identified from correct observations.	1	
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		Award mark <u>IV</u> if the supporting evidence fits the ion identified and the practical performed for at least three of the four ions. Allow ecf on ion order on mark <u>IV</u> .	1	
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		IV	Observes a green, lime green, fluorescent green or yellow-green solution in (ii)	1
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	MMO Decisions	III Has two uncorrected, accurate titres within 0.1 cm^3 <i>Do not award this mark if having performed two titres within 0.1 cm^3 a further titration is performed which is more than 0.10 cm^3 from the closer of the initial two titres, unless a fourth titration, within 0.1 cm^3 of the third titration or of either of the pair has also been carried out.</i>	1	
	PDO Recording	IV All accurate burette readings (initial and final) recorded to nearest 0.05 cm^3 . <i>Assessed on burette readings only.</i>	1	
	MMO Quality	V, VI and VII Round any burette readings to the nearest 0.05 cm^3 . Check and correct subtractions in the titre table. Select the “best” titre using the hierarchy: two identical; titres within 0.05 cm^3 , titres within 0.10 cm^3 etc. Award <u>V, VI and VII</u> for a difference to Supervisor within 0.15 cm^3 Award <u>V and VI only</u> for a difference of $0.15+ \text{ cm}^3 - 0.25 \text{ cm}^3$ Award <u>V only</u> for a difference of $0.25+ \text{ cm}^3 - 0.40 \text{ cm}^3$ <i>If the selected “best” titres are $> 0.40 \text{ cm}^3$ apart, cancel one of the Q marks awarded.</i>	3	
				[7]

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(b)	ACE Interpretation	Calculates the mean, correct to 2 decimal places (third decimal place rounded to the nearest 0.05 cm³) from any accurate titres within 0.20 cm³. <i>A mean of exactly .x25 or .x75 is allowed but the candidate may round up or down to the nearest 0.05 cm³.</i> <i>If ALL burette readings are given to 1 decimal place then the mean can be given to 1 decimal place if numerically correct without rounding.</i> <i>Mean of 24.3 and 24.4 = 24.35 (✓)</i> <i>Mean of 24.3 and 24.4 = 24.4 (✗)</i> Titres to be used in calculating the mean must be clearly shown – in an expression or ticked in the titration table.	1	[1]
(c)	ACE Interpretation PDO Display	No additional factor/expression is allowed in any step <i>If an answer, with no working, is given in any section allow if correct.</i> I Uses $\frac{2.00}{158.0}$ in step (i) and answer (i) $\times$ $\frac{\text{cand titre}}{1000}$ in step (ii) II Uses answer (ii) $\times$ 5 in step (iii) and answer (iii) $\times$ $\frac{1000}{25}$ in step (iv) III Uses answer (iv) $\times$ 151.9 in step (v), and answer (v) $\times$ $\frac{100}{21.50}$ in step (vi) IV Appropriate working shown in a minimum of four sections. V 3 to 5 significant figures in final answers to all sections attempted – <i>minimum of four final answers required</i>	1 1 1 1 1	[5]
				[Total: 13]

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2	(a)	PDO Layout	I	Records at least four different balance readings and at least one mass of solid/gas <i>Accept 0.0(0X) g as the mass of the empty tube or a statement that the tube is tared.</i>	1	
		PDO Recording	II	Gives all appropriate headings and units when recording results. <i>Do not accept mass of empty tube as 0.0(00)g here unless tube is described as tared. (minimum of three pieces of information)</i>	1	
			III	All recorded balance readings consistent to at least 1 decimal place. <i>(minimum of three balance readings)</i>	1	
		MMO Decisions	IV	Evidence of reheating to "constant" mass. For balances reading to 1 d.p. two masses must be identical For 2 or 3 d.p. balances, two masses must be within 0.05 g	1	
		MMO Quality	V and VI	checks and corrects if necessary all subtractions in the results table. Calculate $\frac{\text{mass heated}}{\text{mass of residue}}$ to 3 significant figures. Compare to supervisor standard or standard value of 1.40. Award <u>V and VI</u> for a difference up to 0.10 Award <u>V only</u> for a difference of 0.10+ to 0.20 <i>Where a candidate repeats the experiment use cumulative masses of FB 3 and residue. Where masses of FB 3 and residue cannot be checked, accept candidate values to calculate the ratio.</i>	2	
						[6]
(b)	ACE Interpretation	(i)	Calculates 2.71, (2.710, 2.7097) and		1	
	ACE Conclusions	(ii)	Has: cand value in (i) x mass loss from table in (a) If no mass loss is recorded in the table, check the value used. (iii) Ticks the appropriate box for the experiment and makes some comparison between mass of NaHCO ₃ and the mass of FB 3 used If mass of NaHCO ₃ calculated in (ii) $\geq$ mass of FB 3 , ignore any ticked box but award the mark for any statement that the mass is not possible.		1	
						[2]

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(c)	ACE Improvements	(i) No mass change with Na_2CO_3 (on heating). (ii) Evidence for no gas produced, e.g.: limewater unaffected, no gas collected in a gas syringe <i>If there is reference to measuring mass and to measuring volume but the absence of change is not mentioned, award one of the two marks available.</i>	1 1	[2]
(d)	ACE Interpretation	Max errors of 0.05, 0.005 and 0.0005 respectively for balances A, B and C. Calculates: 1.11% error for balance A 0.25% error for balance B 0.20% error for balance C Allow ecf on % errors only if: (i) <i>Max errors given are 0.1, 0.01 and 0.001 respectively for balances A, B and C and % errors are 2.22%, 0.50% and 0.40%</i> (ii) <i>All max errors are incorrect by a factor 10 e.g. 0. 5, 0. 05 and 0. 005. % errors are 11.1%, 2.5% and 2.0%</i>	1 1	[2]
[Total: 12]				

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FB 4 is $\text{MnSO}_4(\text{aq})$; FB 5 is $\text{MgSO}_4(\text{aq})$; FB 6 is $\text{Al}_2(\text{SO}_4)_3(\text{aq})$; FB 7 is $(\text{NH}_4)_2\text{SO}_4(\text{aq})$				
3	(a)	MMO Collection	Give one mark for each of the following:	
			I for FB 4 – tests (i) and (iv)	1
			II for FB 5 – tests (i) and (iv)	1
			III for FB 6 – tests (i) and (iv)	1
			IV for FB 7 – tests (i), (iii) and (iv)	1
			V Give one mark for any change/darkening of the initial precipitate in test (ii) for FB 4 to a qualified brown. <i>The darkening may be described in test (i) or in test (iv)</i>	1
			VI Describes the test on gas for ammonia in test (iii) for any solution that has no precipitate in either part test of (i) and is warmed. <i>The test for ammonia is expected with FB 7</i> <i>Do not award (VI) if the test is carried out with a solution in which a precipitate had formed at any stage</i> or <i>If a solution in which no precipitate is formed is not warmed with sodium hydroxide</i>	1
[6]				

Results required with $\text{NaOH}(\text{aq})$ and $\text{NH}_3(\text{aq})$ for the award of marks I to IV in 3(a)

test		observations			
		FB 4	FB 5	FB 6	FB 7
(i)	addition of NaOH	off-white, pale brown, buff or beige precipitate <i>Do not accept cream or equivalent colour precipitates</i>	white precipitate	white precipitate	No precipitate or no change <i>Do not accept clear on its own as an observation; clear solution is acceptable</i>
	further addition of NaOH	precipitate insoluble	precipitate insoluble	precipitate soluble	no precipitate or no change <i>(may be left blank)</i>
(iii)	warming solution with NaOH				any reference to a gas being evolved or reference to red litmus turning blue
(iv)	addition of NH_3	as NaOH	as NaOH	as NaOH	as NaOH
	further addition of NH_3	as NaOH	as NaOH	precipitate insoluble	as NaOH

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(b)	ACE Conclusions	Do not accept any ion other than Mn^{2+}, Mg^{2+}, Al^{3+} or NH_4^+ in any section. Marks I to III Ions must be correct, including charge, if a symbol has been given. – <u>no ecf in this section.</u>		
		Award <u>I only</u> if one ion only is identified from correct observations.	1	
		Award <u>I and II</u> if two ions only are identified from correct observations.	1	
		Award <u>I, II and III</u> if all four cations are identified from correct observations. <i>The 4th cation may be identified by elimination from incomplete supporting evidence.</i>	1	
		A deduction of Mn^{2+} is allowed from a cream ppt with NaOH(aq) and NH_3 (aq) IV Award this mark if the supporting evidence fits the ion identified and the practical performed for at least three of the four ions <u>Allow ecf on ion order for mark IV.</u> (Mg^{2+} and Al^{3+} are most likely to be interchanged depending on “solubility in excess” observations.	1	[4]

Minimum evidence required in observations for the ion identity marks I, II and III.

In some cases, identification may be allowed from incomplete observations. There must, however, be no observations that are contrary to those expected with any “correctly” identified ion.

The same criteria will be applied to “candidate’s supporting evidence in awarding mark IV.

Candidates are not permitted to introduce (from the Qualitative Analysis Notes) supporting evidence that is not given in the observations.

Mn^{2+}	off-white precipitate with each reagent, or off-white precipitate turning brown with either of the reagents identification of the ion is allowed from an incorrect observation of a cream or yellow-white precipitate – one ion is known to be Mn^{2+}
Mg^{2+}	white precipitate, insoluble in (excess) NaOH
Al^{3+}	white precipitate, soluble in (excess) NaOH
NH_4^+	no precipitate/no change with either reagent or ammonia, alkaline gas or gas turning red litmus blue evolved

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(c)	MMO Collection	Records no precipitate/no reaction with each of the reagents.	1	[1]
(d)	ACE Conclusions	States that Pb^{2+} /lead(II) would give similar results. <i>Award this mark providing there are no contrary observations for the solution identified as containing Al^{3+}</i>	1	[1]
(e)	MMO Collection	Records a white ppt in (i) Records a yellow precipitate or precipitate turning yellow in (ii) .	1 1	[2]
(f)	ACE Conclusions	Award one mark for any attempt to describe replacement of Cl by I in the ppt.	1	[1]
				[Total: 15]

**MARK SCHEME for the October/November 2010 question paper
for the guidance of teachers**

9701 CHEMISTRY

9701/35

Paper 3 (Advanced Practical Skills),
maximum raw mark 40

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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Question	Sections	Indicative material	Mark	
1 (a)	PDO Layout	I Volume given for Rough titre. and accurate titre details tabulated.	1	
	MMO Collection	II Follows instructions – initial and final burette readings recorded for Rough titre and initial and final burette readings and volume of FA 2 added recorded for each accurate titre and headings should match readings. <i>Do not award this mark if: 50(.00) is used as an initial burette reading; more than one final burette reading is 50.(00); any burette reading is greater than 50.(00)</i>	1	
	MMO Decisions	III Has two uncorrected, accurate titres within 0.1 cm^3 <i>Do not consider the Rough even if ticked. Do not award this mark if having performed two titres within 0.1 cm^3 a further titration is performed which is more than 0.10 cm^3 from the closer of the initial two titres, unless a fourth titration, within 0.1 cm^3 of the third titration has also been carried out.</i>	1	
	PDO Recording	IV All accurate burette readings (initial and final) recorded to nearest 0.05 cm^3 <i>Assess this mark on burette readings only</i>	1	
	MMO Quality	V, VI and VII Round any burette readings to the nearest 0.05 cm^3 . Check and correct subtractions in the titre table. Select the “best” titre using the hierarchy: two identical; titres within 0.05 cm^3 ; titres within 0.1 cm^3 ; etc. Award <u>V, VI and VII</u> for a difference from Supervisor within 0.20 cm^3 Award <u>V and VI only</u> for a difference of $0.20+ \text{ cm}^3 - 0.30 \text{ cm}^3$ Award <u>V only</u> for a difference of $0.30+ - 0.50 \text{ cm}^3$ <i>If the “best” titres are $\geq 0.50 \text{ cm}^3$ apart cancel one of the Q marks.</i>	3	[7]

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(b)	ACE Interpretation	Calculates the mean, correct to 2 decimal places from any accurate titres within 0.20 cm^3. <i>The third decimal place may be rounded to the nearest 0.05 cm^3.</i> <i>A mean of exactly .x25 or .x75 is allowed but the candidate may round up or down to the nearest 0.05 cm^3.</i> <i>If ALL burette readings are given to 1 decimal place then the mean can be given to 1 decimal place if numerically correct without rounding.</i> <i>Mean of 24.3 and 24.4 = 24.35 (✓)</i> <i>Mean of 24.3 and 24.4 = 24.4 (✗)</i> <i>Titres to be used in calculating the mean must be clearly shown – in an expression or ticked in the titration table.</i>	1	[1]
(c)	ACE Interpretation	I Correctly evaluates $\frac{10.00}{40} = 0.25(0)$ II Uses answer (i) $\times \frac{\text{mean titre}}{1000}$ in step (ii) and answer (ii) $\times \frac{1000}{10}$ in step (iii) <i>If an answer, with no working, is given in any section allow if correct.</i>	1 1	[2]
	Total		[Total: 10]	

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2	(a)	PDO Recording	I Has correct headings (minimum three) and units in the weighing table in (2)(a) and correct units in the titration table in (2)(b) <i>Acceptable units are /g, (g), mass in grams, mass in g; similarly /cm³,</i> II All three balance reading are read with constant precision (same no of decimal places) and to at least 1 decimal place	1 <
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(e)	ACE Conclusions	Explains one of the following: If 5.5 g of CaCO ₃ had been used the titre would be too small/not enough HCl remains for the <u>titration</u> (not 'all the acid has reacted') or Difficult/takes too long to dissolve 5.5 g of solid/it will not all dissolve in <u>150 cm³</u> (of acid) or Excessive/too fast effervescence/fizzing/rate of gas evolved or Acid spray	1	[1]
(f)	ACE Interpretation	(i) If balance displays to 1 decimal place: error in balance reading is ± 0.05 g or $\pm 0.1(0)$ g error in mass of FA 3 is ± 0.1 g or ± 0.2 g If balance displays to 2 decimal places: error in balance reading is ± 0.005 g or ± 0.01 g error in mass of FA 3 is ± 0.01 g or ± 0.02 g If balance displays to 3 decimal places: error in balance reading is ± 0.0005 g or 0.001 g error in mass of FA 3 is ± 0.001 g or ± 0.002 g (ii) Correctly evaluates to at least 2 significant figures: candidate's error in mass of FA 3 mass of FA 3 used $\times 100$	1 1	[2]
(g)	ACE Conclusions ACE Improvements	(i) Gives correct equation for the thermal decomposition of calcium carbonate including state symbols (ii) Outlines: weigh container weigh container + solid (heating and) weighing again repeated (heating and) weighing to constant mass or weigh container weighing container + solid (heating and) measuring gas volume when no further increase and cooled to room temperature / use of $pV = nRT$ / $\frac{PV}{T} = \text{constant}$	1 1	[2]
	Total			[14]

Page 6	Mark Scheme: Teachers' version	Syllabus	Paper
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FA 7 is $\text{Fe}_2(\text{SO}_4)_3(\text{aq})$; FA 8 is $\text{CrCl}_3(\text{aq})$; FA 9 is $\text{ZnI}_2(\text{aq})$ [$\text{ZnCl}_2 + \text{KI}$]				
3 (a)	PDO Layout	I (Tabulates) observations clearly, showing: observation when each reagent is first added and observation when reagent added to <u>excess</u> (if there is a ppt)	1	
	MMO Collection	II, III and IV 1 mark for correct observations in each of the columns or rows representing FA 7, FA 8 and FA 9 or 1 mark for correct observations in the row or column representing a reagent added (initial and excess count as one row/column)	3	
	ACE Conclusions	Award V only if one ion only is correctly identified	1	
		Award V and VI if all three ions are correctly identified from candidate's observations. Allow ecf*	1	
				[6]

Minimum for observations marks:

Solution	FA 7	FA 8	FA 9
NaOH	red-brown/brown/rust ppt insoluble (in excess)	grey-green ppt <u>soluble/dissolves</u> (in excess) giving a dark green solution	White/milky white ppt soluble/dissolves (in excess)
NH ₃	red-brown ppt insoluble (in excess) (suitable qualified brown)	grey-green ppt insoluble (in excess)	White/milky white ppt soluble/dissolves (in excess)

Minimum for conclusions marks: (with incomplete but not CON observations)

- FA 7** red-brown ppt with either;
FA 8 grey-green ppt with either/(dark) green solution with excess NaOH;
FA 9 white ppt soluble in excess NH₃.

* ecfs allowed

- FA 8** allow Fe^{2+} if green ppt insoluble in excess NaOH (no grey-green ppts)
FA 9 allow Al^{3+} **and** Pb^{2+} if white ppt insoluble in excess NH₃
FA 9 allow Ba^{2+} **and** NH_4^+ if no ppt with either
FA 9 allow Mg^{2+} if white ppt insoluble in excess of both

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(b)	MMO Decisions	I Selects barium chloride or barium nitrate for the test in step (i) <i>Do not allow Ba^{2+} alone</i> <i>$Ba^{2+}(aq)$ or soln containing Ba^{2+} (ions) is acceptable</i>	1	
	MMO Collection	II Records white/off-white precipitate with <u>only</u> FA 7	1	
	MMO Decisions	III Selects silver nitrate or lead nitrate in (ii) to add to the solutions (that do not contain sulfate) <i>Do not allow Ag^+ or Pb^{2+} alone</i> <i>Aqueous ions or solutions containing the ion are acceptable as above</i>	1	
	MMO Collection	IV Appropriate observations FA 8 white ppt with Ag^+ /white ppt or no ppt with Pb^{2+} FA 9 yellow ppt with either <i>Ignore observations with any solution candidate has identified as sulfate</i>	1	
	ACE Conclusions	V FA 8 is chloride, FA 9 is iodide Credit if the supporting evidence fits the ion identified and the practical performed for FA 8 and FA 9 provided there is no CON observation in (i) <i>Do not credit if Ag^+ gives a ppt with FA 7</i> Marks IV and V may be awarded from FA 8 white ppt chloride (IV) FA 9 yellow ppt iodide (V)	1	
				[5]

Other possibilities:

Two white ppts with aqueous Ba^{2+} then remaining solution tested with aqueous Ag^+/Pb^{2+}
This would score marks **I**, **III** and may score one of **IV** or **V**

Aqueous Ba^{2+} gives positive result with solution other than **FA 7** and tests with aqueous Ag^+/Pb^{2+} performed

(This would score marks **I** and **III**)

Ignore observation and conclusion with **FA 7**

Award correct observation and valid conclusion for third ion thus scoring one of **IV** or **V**

Aqueous Ba^{2+} gives positive result with all three solutions

Award mark **I**, and mark **III** may be awarded for selection of aqueous Ag^+/Pb^{2+} **or** statement that no further testing is required **but no other marks can be awarded** in this section.

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FA 10 is NaNO ₃ (s); FA 11 is NaNO ₂ (s)				
(c) (i)	MMO Collection	I Solid/FA 10 melts/to a liquid/solution (on heating)	1	
		II Observes <u>bubbles</u> of gas in liquid/solution or Liquid/solution turns yellow/pale yellow	1	
	MMO Decisions	III Describes an appropriate test <u>in either (i) or (ii)</u> for any of the following <u>gases</u> : O ₂ , CO ₂ , NH ₃ or SO ₂ <i>There must be a reference to gas being evolved before this mark can be awarded.</i>	1	
	MMO Collection	IV Positive identification of oxygen gas in (i): glowing splint rekindles/relights/glows brighter (<i>gas evolved rekindles a glowing splint would gain marks III and IV</i>) (<i>'glowing splint rekindles' would gain mark III not IV</i>)	1	
	(ii)	V On adding acid to residue to FA 11, observes brown/yellow-brown gas (<i>not yellow, orange or red-brown</i>) or blue solution (<i>allow greenish blue</i>)	1	
Total				[5]
			[16]	

**MARK SCHEME for the October/November 2010 question paper
for the guidance of teachers**

9701 CHEMISTRY

9701/36

Paper 3 (Advanced Practical Skills), maximum raw mark 40

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Question	Sections	Indicative material	Mark	
1 (a)	PDO layout	I Volume given for Rough titre and accurate titre details tabulated.	1	
	MMO Collection	II Follows instructions - dilutes 45.50 – 46.50 cm ³ FB 1 and initial and final burette readings recorded for Rough titre and initial and final burette readings and volume of FB 2 added recorded for each accurate titre <i>Headings should match readings.</i> <i>Do not award this mark if:</i> <i>50(.00) is used as an initial burette reading;</i> <i>more than one final burette reading is 50.(00);</i> <i>any burette reading is greater than 50.(00)</i>	1	
	MMO Decisions	III Has two uncorrected, accurate titres within 0.1 cm ³ <i>Do not consider the Rough even if ticked.</i> <i>Do not award this mark if having performed two titres within 0.1 cm³ a further titration is performed which is more than 0.10 cm³ from the closer of the initial two titres, unless a fourth titration, within 0.1 cm³ of the third titration (or first two) has also been carried out.</i>	1	
	PDO Recording	IV All accurate burette readings (initial and final) recorded to nearest 0.05 cm ³ (Accurate titration & dilution tables) <i>Assess this mark on burette readings only</i> For candidates and Supervisor scale titre for 46.00 cm ³ FB 1 diluted. Calculate titre $\times \frac{46.00}{\text{volume of FB1 added}}$ Calculate difference in Supervisor and candidate scaled values and award "quality" marks as below. [If candidate has not recorded a volume diluted, use 46.00 cm ³]	1	

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	MMO Quality	V, VI and VII Round any burette readings to the nearest 0.05 cm³. Check and correct subtractions in the titre table. Select the “best” titre using the hierarchy: two identical; titres within 0.05 cm³; titres within 0.1 cm³; etc. Award V, VI and VII for a difference from Supervisor within 0.20 cm³ Award V and VI only for a difference of 0.20+ cm³ – 0.30 cm³ Award V only for a difference of 0.30+ – 0.50 cm³ <i>If the “best” titres are ≥ 0.50 cm³ apart cancel one of the Q marks.</i>	3	
(b)	ACE Interpretation	Calculates the mean, correct to 2 decimal places (third decimal place rounded to the nearest 0.05 cm³) from any accurate titres within 0.20 cm³. <i>A mean of exactly .×25 or .×75 is allowed but the candidate may round up or down to the nearest 0.05 cm³.</i> <i>If ALL burette readings are given to 1 decimal place then the mean can be given to 1 decimal place if numerically correct without rounding.</i> <i>Mean of 24.3 and 24.4 = 24.35 (✓)</i> <i>Mean of 24.3 and 24.4 = 24.4 (✗)</i> Titres to be used in calculating the mean must be clearly shown – in an expression or ticked in the titration table.	1	[7]
(c)	ACE Interpretation	I Expression correct in step (i) $\frac{\text{volume diluted}}{1000} \times 0.125$ II Uses answer to (i) $\times \frac{25}{250}$ in step (ii) III Uses answer to (ii) $\times 2$ in step (iii) and answer to (iii) $\times \frac{1000}{\text{titre}}$ in step (iv) <i>If an answer, with no working, is given in any section allow if correct.</i>	1 1 1	
	PDO Display	IV Appropriate working shown in a minimum of 3 sections. V 3 to 5 significant figures in final answers to all sections attempted – minimum of 3 final answers required to qualify for the award of this mark.	1 1	[5]

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(d)	ACE Interpretation	(i) For Student A explains that final burette reading was also 0.05 cm ³ greater than the true value (“error” in same direction) <i>Ignore parallax error</i> <i>Not errors cancel – reason needed</i>	1	[2]
		(ii) For Student B explains that final burette reading was 0.05 cm ³ greater than the true value (“error” in opposite direction) <i>Not errors compound each other/add up</i>	1	
(e)	ACE Conclusions	(i) Explains that carbon dioxide is acidic (and its absorption reverses the colour change of the indicator)	1	[2]
	ACE Improvements	(ii) Puts acid/ FB 3 in burette and pipettes NaOH/ FB 2 into flask or Heat the solution/Use hot solution	1	
[Total: 17]				

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2	(a)	PDO Recording	I	Records results in a single table for both experiments. No repetition of headings	1	[4]	
		MMO Quality	II	Titre for either Flask A or B within 0.50 cm ³ of Supervisor	1		
			III	Titre for either Flask A or B within 0.30 cm ³ of Supervisor	1		
			IV	Titre for both Flask A and B within 0.30 cm ³ of Supervisor	1		
	(b)	ACE Interpretation	(i)	Calculates a volume of 200 cm ³ in step (i)	1	[2]	
			(ii)	Correctly calculates titre x 5 for each flask	1		
	(c)	ACE Conclusions	Mark consequentially to practical results Chooses expt with lower titre – less remains (or converse argument) or higher value in (b)(iii) <i>Allow ecf</i>			1	[1]
	(d)	ACE Conclusions	Comparison of candidate's K_c values Judgement on constancy or otherwise Supports/does not support equilibrium			1	[1]
[Total: 8]							

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FB 7 is $\text{Fe}(\text{NH}_4)_2(\text{SO}_4)_2(\text{aq})$; FB 8 is $\text{Na}_2\text{SO}_4(\text{aq})$; FB 9 is $\text{CaCl}_2(\text{aq})$					
3 (a)	MMO Decisions	I	Selects sodium hydroxide as reagent (<u>Not</u> if + Al) and describes (warming the solution and) <u>testing any gas evolved</u> with red litmus/pH paper	1	
	MMO Collection	II	Records positive test for ammonia gas with FB 7 only <i>Must link gas/NH_3 with positive test (Allow even if Al mentioned in I)</i>	1	
	MMO Decisions	III	Selects barium chloride or nitrate together with HCl or HNO_3 <i>Do not accept Ba^{2+} as a reagent</i> <i>Accept $\text{Ba}^{2+}(\text{aq})$ or a solution containing Ba^{2+} ions</i>	1	
	MMO Collection	IV	White ppt, persisting in acid with FB 7 and with FB 8 <i>Allow from unspecified strong acid provided there is no ppt with FB 9.</i>	1	
	MMO Conclusions	V	Mark consequentially to observations for solutions containing NH_4^+ and SO_4^{2-} ecf allowed here but not with other identities <i>Allow from strong acid or from H_2SO_4 if clearly added after $\text{Ba}^{2+}(\text{aq})$</i>	1	
(b)	PDO Layout	I	(Tabulates) observations clearly, showing: observation when each reagent is first added and observation when reagent added to <u>excess</u> if there is a ppt	1	
	MMO Collection	II, III and IV	1 mark for correct observations in each of the columns or rows representing FB 7 , FB 8 and FB 9 or 1 mark for correct observations in the row or column representing a reagent added (initial and excess count as one row/column)	3	
					[5]
					[4]

Minimum observations

Solution	FB 7	FB 8	FB 9
NaOH	Green ppt insoluble (in excess)	no reaction/no change/no ppt <i>Not “–” words needed (Only penalise once)</i>	White ppt insoluble (in excess)
NH_3	Green ppt insoluble (in excess)	colourless <u>soln</u> /no reaction/no change/no ppt	No reaction/no change/no ppt

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(c)	ACE Conclusions	One mark for FB 7 and FB 9 containing Fe^{2+} and Ca^{2+} respectively provided no CON obs in (a) or (b) <i>No ecf</i> <i>Ignore FB 8, ignore supporting evidence</i>	1	[1]
FB 10 is $\text{CuCO}_3(\text{s})$				
(d) (i)	MMO Collection	I observes the <u>solid turning black</u> in step (i)	1	[5]
		II observes fluidity in solid layer in step (i) <i>Allow description of fluidised solid as "liquid"</i>	1	
	MMO Decisions	III describes an appropriate test for any of the following <u>gases</u> : O_2 , CO_2 , NH_3 or SO_2 (gas or O_2 /etc needed)	1	
	MMO Collection	IV lime water turns milky/cloudy/chalky <i>Gas or CO_2 turns limewater milky. scores III and IV</i>	1	
(ii)		V on adding acid to residue from FB 10 , observes green solution (on warming) <i>Ignore any residual solid</i> <i>Allow blue-green or bluish green</i> <i>Allow if (qualified) green solution turns blue on cooling</i> May award either III or IV here but only for gas tests for CO_2 or SO_2 or limewater observations	1	
				[Total: 15]