CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2013 series

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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International Examinations

Question	Sections	Indicative material	Mark	Total
1 (a)	PDO Layout	**I** The following data must be given • mass of solid used (**or** both weighings) • volume for rough titre (**or** both readings) • initial **and** final readings for two (or more) accurate titrations.	1	
	PDO Recording	**II** Appropriate headings for **all** data given in weighing **and** accurate titration tables **and** g and cm^3 units. • mass/weight (of) beaker (empty) • mass/weight (of) beaker + **FA 1**/solid • initial/start (burette) reading/volume • final/end (burette) reading/volume • titre **or** volume/**FA 2** used/added • unit: /cm^3 **or** (cm^3) **or** in cm^3 **or** cm^3 for **each** volume *If g and/or cm^3 units are not given in the heading, every entry in the table must have the correct unit.*	1	
	PDO Recording	**III** All **accurate** burette readings (including 0.00) are to the nearest 0.05 cm^3. *The need to record to 0.05 applies only to the burette readings and **not** to the recorded titres.* *Do **not** award this mark if:* • *50(.00) is used as an initial burette reading **or*** • *more than one final burette reading is 50.(00) **or*** • *any burette reading is greater than 50.(00).*	1	
	MMO Decision	**IV** There are two uncorrected **accurate** titres within 0.10 cm^3. *Do **not** include a reading if it is labelled "rough".* *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 further titration, within 0.1 cm^3 of any other, has also been carried out.* *Do **not** award the mark if any 'accurate' burette readings (apart from initial 0) are given to **zero** dp.*	1	

Question	Sections	Indicative material	Mark	Total
(a) (cont)	MMO Quality	Award **V**, **VI** and **VII** if $\delta \leq 0.03$ ($cm^3\ g^{-1}$) *i.e. three Q marks.* Award **V** and **VI** if $0.03 < \delta \leq 0.06$ *i.e. two Q marks.* Award **V**, only, if $0.06 < \delta \leq 0.10$ *i.e. one Q mark.* ***Spread penalty**: if the two "best" (corrected) titres used by the Examiner were ≥ 0.50 cm^3 apart, cancel **one** Q mark.*	1 1 1	[7]
(b)	MMO Decision	Check mean titre is correctly calculated from clearly selected values (ticks or working). • Candidate must average two (or more) titres where the **total** spread is ≤ 0.20 cm^3. • Working must be shown or ticks must be put next to the two (or more) accurate readings selected. • The mean should normally be quoted to 2 dp rounded to the nearest 0.01. [*e.g. 26.667 must be rounded to 26.67*] Two special cases where the mean may not be to 2 dp: allow mean to 3 dp only for 0.025 or 0.075 e.g. 26.325; allow mean to 1 dp if **all** accurate burette readings were given to 1 dp (*ignoring initial given as 0*) and the mean is exactly correct. [*e.g. 26.0 and 26.2 = 26.1 is correct* *but 26.0 and 26.1 = 26.1 is incorrect*.] Do **not** award this mark if: • the rough titre was used to calculate the mean; • candidate carried out only 1 accurate titration; • burette readings were incorrectly subtracted to obtain any of the accurate titre values; • **all** burette readings (resulting in titre values used in calculation of mean) are integers.	1	[1]
(c) (i)	ACE Interpretation	**I** Correctly calculates No. of moles of $KMnO_4 = 0.0200 \times {}^{(b)}/_{1000}$	1	
(ii)	ACE Conclusion	**II** $Fe^{2+} \rightarrow Fe^{3+} + e$ / $5Fe^{2+} \rightarrow 5Fe^{3+} + 5e$	1	
(iii) + (iv)	PDO Display	**III** Correct working shown in **(iii)** and **(iv)**. *The answer to **(i)** should be multiplied by 5 to give **(iii)**.* *The answer to **(iii)** should be multiplied by 10 to give **(iv)**.*	1	
(v)	ACE Interpretation	**IV** Correct calculation of relative formula mass. $M_r = {}^{\textbf{correct}\ \text{mass of}\ \textbf{FA 1}\ \text{used}}/_{\text{answer to}\ \textbf{(iv)}}$	1	

Question	Sections	Indicative material	Mark	Total
(v) (cont)	PDO Display	**V** All answers are quoted to 3 or 4 significant figures. A minimum of three answers is needed to qualify.	1	[5]
(d) (i)	ACE Interpretation	% error for pipette = $^{0.06}/_{25} \times 100 = 0.24\%$ (or 0.240%)	1	
(ii) + (iii)	ACE Interpretation	*If balance displays to 1 decimal place: error in balance reading is ±0.05 g or ±0.1(0) g.* *If balance displays to 2 decimal places: error in balance reading is ±0.005 g or ±0.01 g.* *If balance displays to 3 decimal places: error in balance reading is ±0.0005 g or ±0.001 g.* % error = $2 \times {}^{\text{balance error (above)}}/_{\text{mass of FA 1 used}} \times 100$ *Correct answer is **not** required, but if the "× 100" factor was omitted, a correctly calculated % error answer scores the mark.*	1	[2]
				[Total: 15]
2 (a)	MMO Collection	**I** The masses of **FA 5** used by the candidate were between 2.0–2.4 g (expt 1) and 1.5–1.9 g (expt 2).	1	
	PDO Display	**II** Suitable headings for a table or list, shown completely for at least one experiment carried out. If 2 experiments, all headings must be correct. • (mass of) empty crucible • (mass of) crucible + **FA 5** • (mass of) crucible + residue / **FA 5** after heating • (mass of) residue *(owtte)* • mass lost **or** (mass of) water lost. **and** unit was given "covering" every weighing; *Unit: /g **or** (g) **or** in grams **or** g following **each** weighing*	1	
	PDO Recording	**III** Records **all** weighings **consistently** to at least 1 dp. *A minimum of **three** weighings are needed.*	1	
	Accuracy (Q) marks for gravimetric experiment – 3 marks available Examiner checks working for mass of residue **and** mass of water and expresses the ratio $^{\text{mass of hydrated solid}}/_{\text{mass of water}}$ to 2 dp for **each** experiment. The expected ratio = $^{244}/_{36} = 6.78$.			

Question	Sections	Indicative material	Mark	Total
(a) (cont)	MMO Quality	Award **IV** if the ratio in expt **1** is between 6.30 and 7.25. Award **V** If the ratio in expt **2** is between 6.30 and 7.25. Award **VI** If the ratio in **both** of experiments **1** and **2** is between 5.90 and 7.65, inclusive.	1 1 1	[6]
(b) (i)	MMO Display	Correct expression for the number of moles of water lost (from mass as recorded) **or** correct answer.	1	
(ii)	ACE Interpretation	Correct expression for the number of moles of residue with **correct** masses of anhydrous salt **and** 208 **and** answer expressed to 2–4 sf **or** correct answer **and** 2–4 sf If only **one** expt carried out then **correct calculation** for number of moles of residue expressed to 2–4 sig fig.	1	
(iii)	ACE Interpretation	Correct calculation of **(i)** ÷ **(ii)** to give answer as an integer. (should be **x** = 2)	1	[3]
(c) (i)	ACE Improvements	Heat to constant **mass** (owtte)	1	
(ii)	ACE Interpretation	An **attempt** to "**scale**" mass loss to the mass of **FA 5** used **or** to calculate **x** separately for the two experiments.	1	
	ACE Conclusion	Uses calculated values to comment sensibly on the consistency the results.	1	[3]
				[Total: 12]
FA 6 is $(NH_4)_2Fe(SO_4)_2(s)$; **FA 7** is $Na_2CO_3(aq)$; **FA 8** is $Pb(NO_3)_2(aq)$; **FA 9** is $K_2CrO_4(aq)$				
3 (a) (i)	MMO Collection	Green precipitate **and** ppt insoluble in excess NaOH**/**ppt turning brown (in air / on standing).	1	
	MMO Decision	(When heated with NaOH) **gas** / NH_3 turns red litmus to blue.	1	
	MMO Collection	(With $BaCl_2$), white precipitate forms **and** insoluble in HCl.	1	
(ii)	ACE Conclusion	**FA 6** contains ammonium ions **and** sulfate ions. *(correct evidence needed for each ion in the observations table).*	1	
(iii)	ACE conclusion	$Fe^{2+} + 2OH \rightarrow Fe(OH)_2$	1	

Question	Sections	Indicative material	Mark	Total
(iv)	MMO collection	**Any two** of • Solid goes paler / loses green colour (at first) **and then** becomes brown (on strong heating) • Condensation / water vapour / steam produced • (Gas/NH_3) turns red litmus blue.	1 1	[7]
(b)	MMO collection	**FA 7 + FA 3** : Fizzing/effervescence **and** limewater goes milky.	1	
		FA 8 + FA 3 and **FA 8 + FA 7** : white precipitate obtained in **both** cases	1	
		FA 9 + FA 3: (solution) turns orange **FA 9 + FA 7**: statement of no change/yellow solution **FA 9 + FA 8**: (bright) yellow precipitate/solid (formed). *All three observations in the third column must be correct.*	1	
	ACE Conclusion	**FA 7** contains carbonate ions (evidence needed) / CO_3^{2}	1	
		FA 8 contains lead ions **or** barium ions (**or** both) (evidence needed) / Pb^{2+} / Ba^{2+}	1	
		FA 9 contains chromate(VI) ions / CrO_4^{2}	1	[6]
				[Total: 13]

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MARK SCHEME for the October/November 2013 series

9701 CHEMISTRY

9701/33 Paper 3 (Advanced Practical Skills) maximum raw mark 40

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Question	Sections	Indicative material	Mark	Total
1 (a)	PDO Layout	**I** The following data must be given • mass of solid used (**or** both weighings) • volume for rough titre (**or** both readings) • initial **and** final readings for two (or more) accurate titrations.	1	
	PDO Recording	**II** Appropriate headings for **all** data given in weighing **and** accurate titration tables **and** g and cm^3 units. • mass/weight (of) beaker (empty) • mass/weight (of) beaker + **FA 1**/solid • initial/start (burette) reading/volume • final/end (burette) reading/volume • titre **or** volume/**FA 2** used/added • unit: /cm^3 **or** (cm^3) **or** in cm^3 **or** cm^3 for **each** volume *If g and/or cm^3 units are not given in the heading, every entry in the table must have the correct unit.*	1	
	PDO Recording	**III** All **accurate** burette readings (including 0.00) are to the nearest 0.05 cm^3. *The need to record to 0.05 applies only to the burette readings and **not** to the recorded titres.* *Do **not** award this mark if:* • *50(.00) is used as an initial burette reading **or*** • *more than one final burette reading is 50.(00) **or*** • *any burette reading is greater than 50.(00).*	1	
	MMO Decision	**IV** There are two uncorrected **accurate** titres within 0.10 cm^3. *Do **not** include a reading if it is labelled "rough".* *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 further titration, within 0.1 cm^3 of any other, has also been carried out.* *Do **not** award the mark if any 'accurate' burette readings (apart from initial 0) are given to **zero** dp.*	1	

Question	Sections	Indicative material	Mark	Total
(a) (cont)	MMO Quality	Award **V**, **VI** and **VII** if $\delta \leq 0.03$ ($cm^3\ g^{-1}$) *i.e. three Q marks.* Award **V** and **VI** if $0.03 < \delta \leq 0.06$ *i.e. two Q marks.* Award **V**, only, if $0.06 < \delta \leq 0.10$ *i.e. one Q mark.* ***Spread penalty**: if the two "best" (corrected) titres used by the Examiner were ≥ 0.50 cm^3 apart, cancel **one** Q mark.*	1 1 1	[7]
(b)	MMO Decision	Check mean titre is correctly calculated from clearly selected values (ticks or working). • Candidate must average two (or more) titres where the **total** spread is ≤ 0.20 cm^3. • Working must be shown or ticks must be put next to the two (or more) accurate readings selected. • The mean should normally be quoted to 2 dp rounded to the nearest 0.01. [*e.g. 26.667 must be rounded to 26.67*] Two special cases where the mean may not be to 2 dp: allow mean to 3 dp only for 0.025 or 0.075 e.g. 26.325; allow mean to 1 dp if **all** accurate burette readings were given to 1 dp (*ignoring initial given as 0*) and the mean is exactly correct. [*e.g. 26.0 and 26.2 = 26.1 is correct* *but 26.0 and 26.1 = 26.1 is incorrect*.] Do **not** award this mark if: • the rough titre was used to calculate the mean; • candidate carried out only 1 accurate titration; • burette readings were incorrectly subtracted to obtain any of the accurate titre values; • **all** burette readings (resulting in titre values used in calculation of mean) are integers.	1	[1]
(c) (i)	ACE Interpretation	**I** Correctly calculates No. of moles of $KMnO_4 = 0.0200 \times {}^{(b)}/_{1000}$	1	
(ii)	ACE Conclusion	**II** $Fe^{2+} \rightarrow Fe^{3+} + e$ / $5Fe^{2+} \rightarrow 5Fe^{3+} + 5e$	1	
(iii) + (iv)	PDO Display	**III** Correct working shown in **(iii)** and **(iv)**. *The answer to **(i)** should be multiplied by 5 to give **(iii)**.* *The answer to **(iii)** should be multiplied by 10 to give **(iv)**.*	1	
(v)	ACE Interpretation	**IV** Correct calculation of relative formula mass. $M_r = {}^{\textbf{correct}\ \text{mass of}\ \textbf{FA 1}\ \text{used}}/_{\text{answer to}\ \textbf{(iv)}}$	1	

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(d) (i)	ACE Interpretation	% error for pipette = $^{0.06}/_{25} \times 100 = 0.24\%$ (or 0.240%)	1	
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				[Total: 15]
2 (a)	MMO Collection	**I** The masses of **FA 5** used by the candidate were between 2.0–2.4 g (expt 1) and 1.5–1.9 g (expt 2).	1	
	PDO Display	**II** Suitable headings for a table or list, shown completely for at least one experiment carried out. If 2 experiments, all headings must be correct. • (mass of) empty crucible • (mass of) crucible + **FA 5** • (mass of) crucible + residue / **FA 5** after heating • (mass of) residue *(owtte)* • mass lost **or** (mass of) water lost. **and** unit was given "covering" every weighing; *Unit: /g **or** (g) **or** in grams **or** g following **each** weighing*	1	
	PDO Recording	**III** Records **all** weighings **consistently** to at least 1 dp. *A minimum of **three** weighings are needed.*	1	
	Accuracy (Q) marks for gravimetric experiment – 3 marks available Examiner checks working for mass of residue **and** mass of water and expresses the ratio $^{\text{mass of hydrated solid}}/_{\text{mass of water}}$ to 2 dp for **each** experiment. The expected ratio = $^{244}/_{36} = 6.78$.			

Question	Sections	Indicative material	Mark	Total
(a) (cont)	MMO Quality	Award **IV** if the ratio in expt **1** is between 6.30 and 7.25. Award **V** If the ratio in expt **2** is between 6.30 and 7.25. Award **VI** If the ratio in **both** of experiments **1** and **2** is between 5.90 and 7.65, inclusive.	1 1 1	[6]
(b) (i)	MMO Display	Correct expression for the number of moles of water lost (from mass as recorded) **or** correct answer.	1	
(ii)	ACE Interpretation	Correct expression for the number of moles of residue with **correct** masses of anhydrous salt **and** 208 **and** answer expressed to 2–4 sf **or** correct answer **and** 2–4 sf If only **one** expt carried out then **correct calculation** for number of moles of residue expressed to 2–4 sig fig.	1	
(iii)	ACE Interpretation	Correct calculation of **(i)** ÷ **(ii)** to give answer as an integer. (should be **x** = 2)	1	[3]
(c) (i)	ACE Improvements	Heat to constant **mass** (owtte)	1	
(ii)	ACE Interpretation	An **attempt** to "**scale**" mass loss to the mass of **FA 5** used **or** to calculate **x** separately for the two experiments.	1	
	ACE Conclusion	Uses calculated values to comment sensibly on the consistency the results.	1	[3]
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FA 6 is $(NH_4)_2Fe(SO_4)_2(s)$; **FA 7** is $Na_2CO_3(aq)$; **FA 8** is $Pb(NO_3)_2(aq)$; **FA 9** is $K_2CrO_4(aq)$				
3 (a) (i)	MMO Collection	Green precipitate **and** ppt insoluble in excess NaOH**/**ppt turning brown (in air / on standing).	1	
	MMO Decision	(When heated with NaOH) **gas** / NH_3 turns red litmus to blue.	1	
	MMO Collection	(With $BaCl_2$), white precipitate forms **and** insoluble in HCl.	1	
(ii)	ACE Conclusion	**FA 6** contains ammonium ions **and** sulfate ions. *(correct evidence needed for each ion in the observations table).*	1	
(iii)	ACE conclusion	$Fe^{2+} + 2OH \rightarrow Fe(OH)_2$	1	

Question	Sections	Indicative material	Mark	Total
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(b)	MMO collection	**FA 7 + FA 3** : Fizzing/effervescence **and** limewater goes milky.	1	
		FA 8 + FA 3 and **FA 8 + FA 7** : white precipitate obtained in **both** cases	1	
		FA 9 + FA 3: (solution) turns orange **FA 9 + FA 7**: statement of no change/yellow solution **FA 9 + FA 8**: (bright) yellow precipitate/solid (formed). *All three observations in the third column must be correct.*	1	
	ACE Conclusion	**FA 7** contains carbonate ions (evidence needed) / CO_3^{2}	1	
		FA 8 contains lead ions **or** barium ions (**or** both) (evidence needed) / Pb^{2+} / Ba^{2+}	1	
		FA 9 contains chromate(VI) ions / CrO_4^{2}	1	[6]
				[Total: 13]

CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2013 series

9701 CHEMISTRY

9701/34 Paper 3 (Advanced Practical Skills 2), maximum raw mark 40

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Question	Sections	Indicative material	Mark	Total
1 (a)	MMO Collection	**I** Initial and final readings and titre value given for rough titre **and** initial and final readings for two (or more) accurate titrations (*minimum of 2 × 2 box*)	1	
	PDO Layout	**II** Appropriate headings and units for all accurate data **and** volume **FB 1** added recorded for each accurate titre. *Headings should match readings.* • initial/start (burette) reading/volume • final/end (burette) reading/volume • titre **or** volume/**FB 1** used/added *(but not "difference")* • unit: /cm^3 **or** (cm^3) **or** in cm^3 **or** cm^3 for **each** entry	1	
	PDO Recording	**III** **All** accurate burette readings recorded to 0.05 cm^3. *The need to record to 0.05 applies only to the burette readings and **not** to the recorded titres.* *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).*	1	
	MMO Decisions	**IV** Has two uncorrected accurate titres within 0.1 cm^3. *Do **not** include a reading if it is labelled "rough".* *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 further titration, within 0.1 cm^3 of any other, has also been carried out.* *Do **not** award the mark if any 'accurate' burette readings (apart from initial 0) are given to **zero** dp.*	1	

Question	Sections	Indicative material	Mark	Total
1 (a) (cont)	**For assessment of accuracy (Q) marks**, an Examiner rounds any burette readings to the nearest 0.05 cm^3, checks subtractions and then selects the **"best" titres** using the hierarchy: • two (or more) accurate identical titres (ignoring any that are labelled "rough"), *then* • two (or more) accurate titres within 0.05 cm^3, *then* • two (or more) accurate titres within 0.10 cm^3, *etc*. These best titres are used to calculate the mean titre, to nearest 0.01 cm^3.			
	MMO Quality	Award **V, VI** and **VII** for $\delta \leqslant 0.20$ cm^3 Award **V** and **VI** for $0.20 < \delta \leqslant 0.30$ cm^3 Award **V** for $0.30 < \delta \leqslant 0.50$ cm^3 Spread penalty: if the two 'best' titres used by the Examiner are $\geqslant 0.50$ cm^3 apart, cancel one Q mark. If Supervisor titre $\leqslant 15$ cm^3 then tolerances are 0.10, 0.20 and 0.30 cm^3.	3	[7]
1 (b)	MMO Decisions	Check mean titre is correctly calculated from clearly selected values (ticks or working). • Candidate must average two (or more) titres where the **total** spread is $\leqslant 0.20$ cm^3. • Working must be shown or ticks must be put next to the two (or more) accurate readings selected. • The mean should normally be quoted to 2 dp rounded to the nearest 0.01. [*e.g. 26.667 must be rounded to 26.67*] Two special cases where the mean may not be to 2 dp: allow mean to 3 dp only for 0.025 or 0.075 eg 26.325; allow mean to 1 dp if **all** accurate burette readings were given to 1 dp (ignoring initial given as 0) and the mean is exactly correct. [*e.g. 26.0 and 26.2 = 26.1 is correct* *but 26.0 and 26.1 = 26.1 is incorrect*.] Do **not** award this mark if: • the rough titre was used to calculate the mean; • candidate carried out only 1 accurate titration; • burette readings were incorrectly subtracted to obtain any of the accurate titre values; • **all** burette readings (resulting in titre values used in calculation of mean) are integers.	1	[1]

Question	Sections	Indicative material	Mark	Total
1 (c) (i) (ii)	ACE Interpretation	**I** Correctly calculates answer to $\frac{\textbf{(b)} \times 0.125}{1000}$ in **(i)** **and** $\frac{23.25 \times 0.125}{1000}$ 0.002906 (0.00291) in **(ii)**	1	
(iii)		**II** Correctly calculates answer to **(iii)** (ignore sf). If **(i)** < **(ii)** then answer must be negative.	1	
(iv) (v)	PDO Display	**III** Shows use of **(iii)** × 106 in **(iv)** **and** × 2 in **(v)**. (*This should be* **(iii)** × 2 *but allow* **(iv)** × 2.)	1	
(vi)	ACE Interpretation	**IV** Correct method [**(i)** – **(v)**] × 40 in **(vi)**	1	
(vii)		**V** Correct expression: $\frac{\textbf{(iv)}}{\textbf{[(iv)+(vi)]}} \times 100$ in **(vii)** **or** correct answer	1	[6]
	PDO Display	**VI** All quoted answers given to 3 or 4 significant figures except in **(iii)**. (*Minimum of 4 answers needed.*)	1	
				[Total 14]

Question	Sections	Indicative material	Mark	Total
2 (a)	PDO Layout	**I** Presents data in list/form in the space provided. Must have all four required weighings **and** attempt at mass of solid/**FB 4** **or** attempt at mass of carbon dioxide.	1	
	PDO Recording	**II** Gives all appropriate headings and units • mass/weight of flask + acid • mass of tube + **FB 4** • mass of flask + contents (owtte) • mass of tube + residue/mass of tube • mass of **FB 4** • mass of CO_2/mass lost (*minimum of four required pieces of information*) Units: /g or (g) or in g or g by **each** entry (*Ignore irrelevant data*)	1	
		II **All** recorded balance readings consistent to at least 1 decimal place. (*minimum of **three** balance readings*)	1	
	ACE Interpretation	**IV** Correctly calculates the mass of **FB 4** added and the mass of carbon dioxide evolved.	1	
	MMO Quality	**V and VI** Calculate $\frac{\textbf{mass FB 4}}{\textbf{mass of carbon dioxide}}$ to 3 significant figures and compare with Supervisor.		
		Award **V** and **VI** for a difference ≤ 0.20 Award **V** for a difference of $0.20 < \delta \leq 0.50$	2	[6]

Question	Sections	Indicative material	Mark	Total
2 (b)	ACE Interpretation	**(i)** Correctly calculates $\frac{\text{mass } CO_2 \text{ from } \mathbf{(a)} \times 106}{44}$ to 2 – 4 sf	1	[2]
		(ii) Correct expression $\frac{\mathbf{(b)(i)} \times 100}{\text{mass } \mathbf{FB\ 4} \text{ from } \mathbf{(a)}}$ **or** correct answer to 2–4 sf (*Do not penalise sf twice.*)	1	
2 (c) (i)	ACE Interpretation	Suggests a suitable significant source of error: • CO_2 remains dissolved in acid • Impossible to prevent all acid spray • Reaction does not go to completion/ CO_2 not diffused (owtte) from flask • Some **FB 4** sticks to the wall of the flask.	1	
(ii)	ACE Conclusions	Would lower %/decrease since less mass lost/CO_2 lost/ given out/evolved. Would raise %/increase since more mass lost. Would lower % since less mass lost/CO_2 produced. Would lower % since less mass lost/used or less CO_2 produced Explanation **must** follow source of error. **If** using 1dp balance then allow cannot tell whether the answer should be greater or smaller/% error could be either way	1	

Question	Sections	Indicative material	Mark	Total
2 (c)(iii)	ACE Improvement	Improvement suggested must be linked to the error (*even if imprecisely expressed*) identified in **(i)**. **Dissolved CO_2** Saturate the solution with CO_2 before experiment **or** use warm acid **or** use less acid. **Acid spray** Use taller container **or** cotton wool plug or bung with hole **or** collect gas in syringe **or** use less concentrated acid. **Going to completion** Keep weighing until mass does not go down further **or** leave for longer **or** swirl for longer **or** warm flask and contents **or** use more concentrated acid. **Sticks to side** Use beaker **or** wider-necked flask. **If** 1dp balance used then allow use balance to 2 or 3 dp.	1	[3]
				[Total 11]

Question	Sections	Indicative material	Mark	Total
FB 5 is $CuCO_3(s)$; **FB 6** is $Pb(NO_3)_2(s)$; **FB 7** is ethanedioic (oxalic) acid				
3 (a) (i)	MMO Collection	Blue solution with **FB 5** **and** colourless solution with **FB 6** **and** (rapid) fizzing/bubbling/effervescence with **FB 5**.	1	
	MMO Decisions	Describes the test on gas from **FB 5** with limewater with positive outcome **or** gas pops with lighted splint in **(b)(i)**.	1	

expected observations for **3(a)(ii)**

test	**FB 5**	**FB 6**
+ NaOH	(pale) blue ppt insoluble in excess	white ppt soluble in excess
+ NH_3	(pale) blue ppt (soluble in excess) forming deep/dark blue solution	white ppt insoluble in excess
+ KI	brown (yellow-brown/orange-brown, red-brown) ppt/solid/mixture **or** off-white ppt with brown solution	yellow ppt

Question	Sections	Indicative material	Mark	Total
3 (a) (ii)	MMO Collection	**FB 5** correct observations with NaOH **FB 5** correct observations with NH_3 **FB 6** correct observations with NaOH **and** ammonia KI correct observations with **FB 5 and FB 6**	1 1 1 1	[9]
(iii)	ACE Conclusions	**FB 5** contains Cu^{2+} **FB 6** contains Pb^{2+} (with some evidence)	1 1	
(iv)		CO_3^{2} is anion in **FB 5** as fizzing / positive limewater test **or** some valid statement about the anion in **FB 6** e.g. could not be carbonate/sulfite as no fizz / could be nitrate as lead nitrate soluble/ not halide/sulfate/sulfite as lead halide/ $PbSO_4$ insoluble **or** no anion tests carried out so no conclusion possible	1	

(b) (i)	MMO Collection ACE Conclusions	effervescence between solution and Mg ribbon manganate(VII) decolourised **FB 7** is an acid **and** a reducing agent.	1 1 1	
(ii)	MMO Collection	**(ii) Any two of** • condensation near mouth of tube **or** steam produced • liquid at bottom of tube/solid melts/solid dissolves/gives colourless solution • charring in the solid/turning black.	 1 1	
(iii)	ACE Conclusions	**(iii) FB 7** is organic **or** simple covalent/molecular **or FB 7** is hydrated/has water of crystallisation **or** undergoes thermal decomposition.	1	[6]
				[Total 15]

CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2013 series

9701 CHEMISTRY

9701/35 Paper 3 (Advanced Practical Skills 1), 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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CAMBRIDGE
International Examinations

Question	Sections	Indicative material	Mark	
1 (a)	PDO *Layout*	**I** Volume given for rough titre **and** accurate burette readings tabulated. (min of 2 × 2 box)	1	
	MMO *Collection*	**II** Initial and final burette readings recorded for rough titre **and** volume of **FA 2** added recorded for each accurate titre **and** acceptable headings and units in the accurate section. *Acceptable headings are initial (burette) reading/ initial volume/first reading/start reading* *Final (burette) reading/final volume/2nd reading/end reading* *Titre/volume used/volume added/**FA 2** added.(not difference or change in)* *Acceptable units are/cm^3/in cm^3/(cm^3)/cm^3 by each reading.*	1	
	PDO *Recording*	**III** **All** accurate burette readings recorded to nearest 0.05 cm^3. *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)*	1	
	MMO *Decisions*	**IV** Has two uncorrected, accurate titres within 0.1 cm^3. *Do not include a reading labelled 'rough'.* *Do not award this mark if, having performed 2 titres within 0.1 cm^3, a further titration is carried out which is > 0.1 cm^3 from the closer of the 2 initial titres unless further titrations, within 0.1 of any others, have also been carried out.* *Do not award the mark if any accurate burette readings (apart from initial zero) are given as integer.*	1	

	MMO *Quality*	**V, VI and VII** All burette readings should be rounded to the nearest $0.05\,cm^3$. Subtractions should be checked. Examiner then selects the 'best' titre using the hierarchy: two identical, titres within $0.05\,cm^3$ etc. These best titres should be used to calculate the mean titre to the nearest $0.01\,cm^3$. Award **V, VI and VII** for a difference from Supervisor $\leq 0.2\,cm^3$. Award **V and VI** for a difference from Supervisor $0.2 < \delta \leq 0.3\,cm^3$. Award **V** for a difference from Supervisor $0.3 < \delta \leq$ to $0.5\,cm^3$. *Spread penalty: if the two 'best' titres used by the Examiner are ≥ 0.50 cm^3 apart, cancel 1 Q mark.*	3	[7]
(b)	ACE *Interpretation*	Candidate calculates the mean correctly. Candidate must take the average of two (or more) titres where the total spread is $\leq 0.2\,cm^3$. Working must be shown or ticks must be placed next to the accurate titres selected. The mean should normally be shown to **2 dp**, rounded to the nearest $0.01\,cm^3$. Example 26.667 must be rounded to 26.67 and not 26.65 and 26.675 must be rounded to 26.68 and not 26.70. Two special cases where the mean may not be to 2 dp: Allow mean to 3dp only for 0.025 or 0.075 (e.g. 26.325) Allow mean to 1 dp if all accurate burette readings were given to 1 dp and the mean is exactly correct (e.g. 26.0 and 26.2 = 26.1 is correct but 26.0 and 26.1 = 26.1 is incorrect – should be 26.05) *Do not award this mark if:* *The rough titre was used to calculate the mean.* *The candidate performed only one accurate titration.* *Burette readings were incorrectly subtracted to obtain any of the accurate titre values.* *All burette readings (resulting in titre values used in calculation of mean) are integers.* *Note: the candidate's mean will sometimes be marked correct even if it is different from the mean calculated by the Examiner for the purpose of assessing accuracy.*	1	[1]

(c)	ACE *Interpretation*	**I** Correctly calculates moles of NaOH = $\frac{\textbf{(b)} \times 0.1}{1000}$ in **(i)** **and** $\frac{\textbf{(i)} \times 1000}{25.0}$ in **(ii)**	1	
		II $1.85 \times 4 = 7.40$ (g dm ^{3}) **and** **(iii)** in **(iv)** **(ii)**	1	
	PDO *Display*	**III** All answers to 3 or 4 sf (minimum of 3 answers)	1	
	ACE *Conclusions*	**IV** Acid with nearest M_r. Conclusion must correspond to M_r.	1	
	MMO *Decisions*	**V** Test – (aqueous) bromine / **acidified** $KMnO_4$ / **alkaline** $KMnO_4$. Expected result – decolorises / (goes) colourless) / decolorised / turns green.	1	
				[5]
				[Total: 13]

Question	Sections	Indicative material	Mark	
2 (a)	PDO *Layout*	**I** Records at least four different balance readings (including 2 after heating) in the correct space.	1	
	PDO *Recording*	**II** Gives all appropriate headings and units for all weighings.	1	
		III All recorded **balance** readings consistent to at least 1 decimal place.	1	
	MMO *Quality*	**IV** Evidence of reheating to constant mass. For balances reading to 1 dp two masses must be identical. For 2 or 3 dp balances, two masses must be within 0.05 g.	1	
		V and VI Examiner calculates $\frac{\text{mass residue}}{\text{mass of water}}$ to 3 significant figures. Award **V** and **VI** for a difference from Supervisor up to 0.10. Award **V** for a difference $0.10 < \delta \leq 0.30$.	2	[6]
(b) (i)	ACE *Interpretation*	**I** Calculation of mass of water and iron(II) sulfate	1	
		II M_rs of 18 and 151.9 / sum of A_rs if correctly used	1	
(ii)	PDO *Display* ACE *Interpretation*	**III** Calculation $x = \frac{\text{mass water} \times 151.9}{\text{mass } FeSO_4 \times 18}$ (or 8.439 / ratio used for Q) **and** final answer to nearest integer.	1	[3]

(c)	ACE *Interpretation*	Spitting / decomposition of anhydrous salt / stirring	1	
	ACE *Improvements*	If value of x is too high, the final mass of solid must be too low/ some solid sticks to stirrer / crucible was wet and this water lost on heating / any statement that says that too much water is lost (free standing mark)	1	
		Spitting – lid / larger container / heat **more** gently.	1	
		Decomposition – practical suggestion to control temperature.		
		No improvement possible for stirring losses (max 2)		[3]
				[Total: 12]
FA 5 = $Pb(NO_3)_2$; **FA 6** = $CaCl_2$; **FA 7** is $Al(NO_3)_3$; **FA 8** is $ZnSO_4$				
3 (a) (i)	MMO *Collection*	Sublimes / OWTTE / white smoke / white gas	1	
		Litmus paper to blue **and** ammonia evolved.	1	
(ii)	MMO *Collection*	Fizzing / bubbles / **gas** turns limewater milky	1	
(iii)	MMO *Collection*	Sodium hydroxide – no reaction. Silver nitrate – white precipitate **and** dissolves partly in nitric acid / does not dissolve in nitric acid / bubbles	1 1	
(iv)	ACE *Conclusions*	Anions – CO_3^{2} and Cl	1	
		Cation – NH_4^{+}	1	
(v)	MMO *Decisions*	(Aqueous) sodium hydroxide gives ammonia on heating	1	
(vi)	MMO *Collection*	White (precipitate) **and** barium carbonate. (ecf of barium sulfite if sulfite in **(iv)**)	1	[9]

(b) MMO *Collection*

test	*observations*			
	FA 5	**FA 6**	**FA 7**	**FA 8**
sodium hydroxide	white ppt	white ppt	white ppt	white ppt
excess	ppt dissolves	ppt remains	ppt dissolves	ppt dissolves
ammonia	white ppt	no reaction	white ppt	white ppt
excess	ppt remains		ppt remains	ppt dissolves
KI	yellow ppt	no reaction	no reaction	no reaction

(i) 1 mark for each correct vertical column
or
1 mark for each horizontal row (max 3 marks) 4

(ii) ACE *Conclusions*

FA 5 is Pb^{2+}, **FA 6** is Ca^{2+}, **FA 7** is Al^{3+}, **FA 8** is Zn^{2+}.
All correct scores 2 marks, 2 correct scores 1 mark. 2 [6]

[Total: 15]

CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2013 series

9701 CHEMISTRY

9701/36 Paper 3 (Advanced Practical Skills 2), maximum raw mark 40

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Question	Sections	Indicative material	Mark	Total
1 (a)	PDO layout	**I** The following data are given • mass of solid used (or both weighings) • volume used in rough titre (or both readings) • initial ***and*** final readings for **two** (or more) accurate titrations	1	
	PDO recording	**II** Acceptable/appropriate headings for **all** data given in weighing ***and*** accurate titration tables ***and*** g and cm^3 units. • mass/weight of beaker (empty) • mass of beaker + **FB 1**/solid • mass solid/**FB1** • initial/start/first (burette) reading/volume • final/end/second (burette) reading/volume • titre ***or*** volume used/added/**FB 5** added *(but not difference or change in volume)* • unit:/cm^3 ***or*** (cm^3) ***or*** in cm^3 ***or*** cm^3 *If g/cm^3 units are not given in the heading, every entry in the table must have the correct unit.*	1	
	PDO recording	**III** All ***accurate*** burette readings are to the nearest 0.05 cm^3. *The need to record to 0.05 only applies to the burette readings, including 0.00 cm^3 (if this was the initial reading),* *but it does **not** apply to the titre.* *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).*	1	
	MMO decision	**IV** There are two uncorrected accurate titres within 0.10 cm^3. *Do not include a reading if it is labelled "rough".* *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 further titrations, within 0.1 cm^3 of any other, has also been carried out.* *Do not award the mark if any accurate burette readings (apart from initial zero) are given as integers.*	1	
	MMO quality	Examiner calculates mean titre × mass **FB 1** for candidate and Supervisor. Award **V**, **VI** and **VII** if $\delta \leq 2$ (g cm^3) Award **V** and **VI** if $2 < \delta \leq 3$ Award **V**, only, if $3 < \delta \leq 5$. *Spread penalty: if two best titres used by the Examiner are ≥ 0.50 cm^3 apart, cancel one Q mark.*	1 1 1	[7]

1 (b)	MMO decision	Candidate calculates the mean correctly. Candidate must take the average two (or more) titres where the total spread is ≤ 0.2 cm^3. Working must be shown ***or*** ticks must be put next to the accurate titres selected. The mean should normally be quoted to **2 dp**, rounded to nearest 0.01 cm^3. Example 26.667 cm^3 must be rounded to 26.67 **not** 26.65 cm^3, 26.675 cm^3 must be rounded to 26.68 **not** 26.70 cm^3. Two special cases, where the mean may not be to 2 dp: Allow mean expressed to 3 dp, only for 0.025 or 0.075. Allow mean if expressed to 1 dp if all accurate burette readings were given to 1 dp (ignoring initial given as 0) and the mean is exactly correct e.g. 26.0 and 26.2 = 26.1 is correct but 26.0 and 26.1 = 26.1 is wrong – should be 26.05. *Do **not** award this mark if:* • *The rough titre was used to calculate the mean.* • *The candidate did only one accurate titration.* • *Burette readings were incorrectly subtracted to obtain any of the accurate titre values.* • *All burette readings (resulting in titre values used in calculation of mean) are integers.* ***Note**: the candidate's mean will sometimes be marked correct even if it is different from the mean calculated by the Examiner for the purpose of assessing accuracy.*	1	[1]
1 (c)	ACE interpretation	**I** Correctly calculates moles of $Na_2S_2O_3$ weighed in **(i)** = $\frac{\text{mass of } \mathbf{FB1} \text{ used}}{248.2}$	1	
		II Correct expression for moles of $Na_2S_2O_3$ used in **(ii)** = $\frac{\text{answer (i)} \times \text{mean titre}}{250}$	1	
		III Correct calculations/expression in **(iii) and (iv)** **(iii) :** no moles of I_2 = 0.5 × **(ii)**	1	
	PDO display	**IV** Correct expression in **(v)** Mass = answer **(iv)** × 40 ×158(.0) *(× 40 may be shown as × 1000/25)*	1	
	PDO display	**V All** quoted answers are given to 3 or 4 significant figures. *(minimum of three answers)*	1	[5]

1 (d)	ACE interpretation	error = 0.05 cm^3 in **(i)** **and** % error in volume of **FB 5** = $\frac{2 \times 0.05}{\text{vol of FB 5 used}}$ × 100 in **(ii)**	1	[1]
				[Total: 14]
2 (a)	MMO collection	**I** The masses of **FB 6** used by the candidate were between 2.0 – 2.4 g (expt 1) ***and*** 2.5 – 2.9 g (expt 2).	1	
	PDO display	**II** Suitable headings for a table or list, shown completely for at least one experiment. If 2 experiments, all headings must be correct. • (mass of) empty crucible • (mass of) crucible + **FB 6** • (mass of) crucible + residue/**FB 6** after heating • mass (water) lost or mass anhydrous remaining **and** unit covering every weighing. *Unit/g or (g) or in grams or g following each weighing.*	1	
	PDO recording	**III** Records **all** balance readings consistently to at least 1 dp *A minimum of **three** weighings are needed.*	1	
	MMO quality	Examiner calculates $\frac{\text{mass of hydrated salt}}{\text{mass of water}}$ for each experiment. Award **IV** if the ratio in expt **1** is between 0.95 and 1.15. Award **V** If the ratio in expt **2** is between 0.95 and 1.15. Award **VI** If the ratio in **both** of experiments **1** and **2** is between 0.85 and 1.25.	1 1 1	[6]
2 (b)	MMO quality	**(i)** An appropriate choice of the more accurate experiment, **and** justification of choice. Three possibilities: • *Experiment 2 uses a larger mass and has a greater **percentage** accuracy.* • *A reference to either experiment "spitting" or "frothing" during heating is a valid reason for nominating the other experiment.* • *Experiment 1 as smaller mass takes less heating.*	1	
	ACE interpretation	**(ii)** Correctly calculates number of moles of water = $\frac{\text{mass of water lost}}{18}$ *Ans to 2–4 sf* *Candidate must use the mass loss for the experiment thought to be more accurate. (If no choice is expressed in **(i)**, this should be expt 2.)*	1	
	ACE conclusion	**(iii)** **M**$SO_4.7H_2O(s) \rightarrow$ **M**$SO_4(s) + 7H_2O(g)$ *Allow (l) for water.*	1	

	ACE interpretation	**(iv) Correct answer calculated** n(**M**SO_4) = n(water) / 7 i.e. answer **(ii)** divided by 7 *Ans to 2–4 sf*	1	
	ACE interpretation	**(v) Method mark showing the numbers for the expression** Relative formula mass = mass of residue / no of moles *Mass of residue from same expt as mass of water* Ans to 2–4 sf	1	
	ACE interpretation	**(vi) Correct answer calculated** $A_r = M_r - 96.1$. Candidates are allowed to use 126.3 as the M_r. In this case, the A_r = 30.2. *Ans 2–4 sf* *Penalise sf once only within **(b)***	1	
	ACE conclusion	**(vii)** Correct identification of **M** as magnesium **and** explanation that this A_r is closest to value calculated. *Allow alternative identity of metal as ecf from A_r value.*	1	
	ACE conclusion	**(viii)** (**M** is divalent **but**) A*l* and Cr are both trivalent **or** (**M** forms 2+ ion whereas) A*l* and Cr are 3+ **or** sulfates of Cr/A*l* are not $CrSO_4$ and A*l*SO_4 *(ora) ref to both needed*	1	[8]
2 (c)	ACE Improvements	Cool in a desiccator **or** cool in closed container with a (named) drying agent	1	[1]
				[Total: 15]

FB 6 = $MgSO_4$; **FB 7** is H_2SO_4; **FB 8** is $Pb(NO_3)_2$; **FB 9** = KI

3 (a)	MMO collection	**(i)** White precipitate, insoluble in excess for **both** NaOH **and** NH_3	1	
	MMO decision	**(ii)** Use barium chloride/nitrate ***and*** hydrochloric/nitric acid	1	
	MMO collection	White precipitate formed, insoluble in acid.	1	
	ACE conclusion	**(iii)** $Ba^{2+} + SO_4^{2-} \rightarrow BaSO_4$	1	[4]
3 (b)	MMO collection	**(i)** One mark for each column	1	

	FB 7	**FB 8**	**FB 9**
Mg	Fizzing or tube gets hot/heat given out or Mg dissolves **and** (gas) pops with lighted splint	Black solid/ppt formed/Mg strip turns dark	No reaction
FB 7		White ppt	No reaction
FB 8			Yellow ppt

			1	
			1	
			1	
	ACE conclusion	**(ii)** **FB 7** is sulfuric acid **and** it is acidic (**or** H^+ ions are present) because it fizzes/hydrogen produced with magnesium.	1	
	MMO collection	**(iii)** Red-brown/brown/orange-brown/yellow-brown colour with KI (not red or orange or yellow) **and** blue or black colour with starch	1	
	ACE conclusion	Iodine produced **and** the anion in **FB 9** is iodide.	1	
	ACE conclusion	**(iv)** PbI_2 *or* AgI (or both) *Ecf possible for CrO_4^{2-} in **(iii)** with Ba^{2+} or Pb^{2+}*	1	[7]

[Total: 11]