Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CHEMISTRY **9701/33**

Paper 3 Advanced Practical Skills 1 **May/June 2017**

MARK SCHEME

Maximum Mark: 40

Published

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Question	Answer	Marks
1(a)	**I Correct headings** The following data are recorded in the space provided • mass of container with **FA 2** • mass of (empty) container • mass of **FA 2** '*Mass' must be stated for each piece of data.* *Unit / g (etc.) must be given for each piece of data.* *Subtraction for mass of FA 2 used must be correct.*	**1**
	II All the following data are recorded • two burette readings **and** titre for the rough titration • initial and final burette readings for **two** (or more) accurate titrations	**1**
	III Titre values recorded for accurate titrations, **and Appropriate headings** and units in the **accurate** titration table • initial / start (burette) reading / volume • final / end (burette) reading / volume • titre **or** volume / **FA 1 and** used / added • unit: / cm^3 **or** (cm^3) **or** in cm^3 (for each heading) **or** cm^3 unit given for each volume recorded	**1**
	IV All accurate burette readings are recorded to the nearest 0.05 cm^3. *The requirement to record to 0.05 applies to burette readings, including 0.00 cm^3 (if this was the initial reading), but it does **not** apply to the titre.* *This mark is **not** awarded 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**
	V The **final** accurate titre recorded is within 0.10 cm^3 of any other accurate titre. • *Do **not** include a reading if it is labelled "rough".* • *Do **not** award the mark if any 'accurate' burette readings (apart from initial 0 cm^3) are given to **zero** dp.*	**1**

Question	Answer	Marks
For assessment of accuracy (Q) marks, each Examiner should round any burette readings to the nearest 0.05 cm^3, check subtractions and then select 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 should be used to calculate the mean titre, expressed to nearest 0.01 cm^3. Calculate the candidate's ratio to 1 dp, as shown below. **Ratio = correct mean titre ÷ correct mass** Calculate the difference (δ) between the candidate's ratio and the supervisor's ratio. Accuracy marks are awarded as follows.		
1(a)	Award **VI**, **VII** and **VIII** if $\delta \leqslant$ **0.2** ($cm^3\ g^{-1}$)	**1**
	Award **VI** and **VII** if **0.2 <** $\delta \leqslant$ **0.4**	**1**
	Award **VI**, only, if **0.4 <** $\delta \leqslant$ **0.6**	**1**
	• ***Spread penalty****: if the two "best" (corrected) titres used by the Examiner were* $\geqslant$ *0.50* cm^3 *apart, maximum 2 accuracy marks.* • *If* ***only*** *a rough titration is shown, award Q marks based on that, maximum 2 accuracy marks.*	

Question	Answer	Marks
1(b)	**Candidate calculates the mean correctly.** • Candidate must take the average of two (or more) titres that are within a total spread of not more than 0.20 cm^3. • Working / explanation must be shown ***or*** ticks must be put next to the two (or more) accurate readings selected. • The mean should be quoted to **2 dp**, and be rounded to nearest 0.01 cm^3. *(e.g. 26.665 cm^3 must be rounded to 26.67 cm^3)* Two special cases, where the mean need not be to 2 dp: • Allow mean expressed to 3 dp **only** for 0.025 or 0.075 *(e.g. 26.325 cm^3)* • Allow mean if expressed to 1 dp, if **all** accurate burette readings (apart from initial 0) were given to 1 dp **and** the mean is **exactly** correct. *(e.g. 26.0 and 26.2 = 26.1 is allowed)* *(e.g. 26.0 and 26.1 = 26.1 is wrong – should be 26.05)* *This mark is not awarded 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 used to calculate the mean were recorded as integers* ***Note**: the candidate's mean will sometimes be marked correct even if it was different from the mean calculated by the Examiner for the purpose of assessing accuracy.*	**1**
1(c)(i)	No of moles of H_2SO_4 used = $0.05(0) \times {}^{(b)} / {}_{1000}$ to minimum 2 sf	**1**
1(c)(ii) and 1(c)(iii)	**2**$NaHCO_3$ + H_2SO_4 → Na_2SO_4 + **2**CO_2 + **2**H_2O **and** No of moles of $NaHCO_3$ = 2 × answer **(i)**	**1**

Question	Answer	Marks
1(c)(iv)	Mass of $NaHCO_3$ = answer **(iii)** × 10 × 84	**1**
1(c)(v)	% = answer **(iv)** / mass of **FA 2** used × 100	**1**
	All answers attempted in **(i)**, **(iii)**, **(iv)** & **(v)** are shown to 3 or 4 sf *Minimum 3 answers attempted to gain the mark*	**1**
1(c)(vi)	Any **one** of the following answers. • the impurity does not react **with (sulfuric) acid** / **FA 1** / **$NaHCO_3$** • the impurity is **not** alkaline / acidic • the impurity is neutral	**1**
1(c)(vii)	% error (= 0.1 / 250 × 100) = 0.04%	**1**
	Total:	**16**

Question	Answer	Marks
2(a)	**I** Four weighings recorded and correct headings given **and** mass of **FA 4** used and mass of residue recorded • (Mass of) crucible, (lid) • (Mass of) crucible, (lid) and **FA 4** (or 'contents before heating) • (Mass of) crucible, (lid) and contents / residue / **FA 4** after (first) heating • (Mass of) crucible, (lid) and contents / residue / **FA 4** after re-heating • (Mass of) **FA 4** • (Mass of) residue / **FA 5** / contents after heating *If 'mass' not written then 'g' must be with each entry.* *Use of lid must be consistent.*	**1**
	II • All weighings recorded to same decimal places (one or more). • Third and fourth weighings are within 0.05 g of each other *(or both equal if a one decimal place balance was used)* • Mass of **FA 4** and **FA 5** / residue must be correctly subtracted.	**1**

Question	Answer	Marks
2(a)	**III and IV:** • For assessment of accuracy, examiner must check and correct (if necessary) the masses of **FA 4** used and of residue (smaller mass) obtained by the supervisor and by the candidate. • Work out ratio $^{\textbf{mass of FA4}}/_{\textbf{mass of residue}}$ for the supervisor (2 dp) • Work out ratio $^{\textbf{mass of FA4}}/_{\textbf{mass of residue}}$ for candidate (2 dp) • Calculate the difference (δ) between these two ratios. Award **III** and **IV** if $\delta \leq 0.05$ Award **III** if $0.05 < \delta \leq 0.10$	**2**
2(b)(i) and 2(b)(ii)	**(i)** Mass $NaHCO_3$ = ($^{\%\text{ purity from }\textbf{1(c)(v)}}/_{100}$) × mass of **FA 4** used **and** **(ii)** Mass impurity = mass of **FA 4** – answer **(i)** **or** mass impurity = $^{\%\text{ impurity}}/_{100}$ x mass **FA 4**	**1**
2(b)(iii)	Mass of decomposition solid = mass of residue (**FA 5)** from table – mass of impurity **(ii) and** expressed to 2, 3 or 4 sig fig **or** mass of decomposition solid = mass of $NaHCO_3$ – mass **lost** on heating [**(i)** – (mass **FA 4** – mass **FA 5**)]	**1**
2(b)(iv)	Mass of residue obtained = answer **(iii)** × $^{84}/_{\text{answer }\textbf{(i)}}$	**1**

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Question	Answer	Marks
2(b)(v)	If correct, (84 g) $NaHCO_3$ would give **40** g residue / NaOH (*owtte*) **or** mole ratio 1:**1.3** (so not 1:1) **or** Answers could refer to mass / moles of CO_2	**1**
2(c)(i)	Lid reduces / stops absorption of water (vapour) by solid / residue / **FA 5** while cooling	**1**
2(c)(ii)	Repeat the experiment **and** ignore anomalous results / to obtain concordant / consistent results **or** cool in a desiccator **or** use larger mass of **FA 4** / contents / solid	**1**
2(d)(i)	Any **two** observations required • fizzing / effervescence / bubbling • gas turns limewater milky / chalky / cloudy white / white ppt • solid dissolves / colourless solution **forms** • rapid/brisk effervescence = 2 observations	**1**
2(d)(ii)	**FA 5** contains carbonate ion / CO_3^{2-} **and** reference to fizzing (with acid) **or** to CO_2 liberated (with acid) **or** positive limewater test **or** correct equation	**1**
2(d)(iii)	**2**$NaHCO_3(s) \rightarrow H_2O(g) + CO_2(g) +$ **$Na_2CO_3(s)$**	**1**
2(d)(iv)	(From equation) 84 g $NaHCO_3$ should give 0.5×106 g residue (= 53 g) **and** gives a (sensible) comment based on student's 52.3 g	**1**
	Total:	**14**

Question	Answer	Marks
	FA 6 is $MnCl_2$; **FA 7** is $Al_2(SO_4)_3$	
3(a)(i)	**Ba^{2+} test: all observations correct** • **FA 6** – no change / no reaction / no ppt / solution stays colourless **with both** • **FA 7** – white precipitate with Ba^{2+} **and** • white ppt (remains) / insoluble / no reaction with HNO_3	**1**
	$AgNO_3$ test: both observations correct • **FA 6** – white precipitate • **FA 7** – no change / no reaction / solution stays colourless / no ppt	**1**
	Na_2CO_3 test: both observations correct • **FA 6** – no reaction / solid does not dissolve / no effervescence • **FA 7** – fizzing / bubbling / effervescence / **or** gas / CO_2 turns limewater milky / chalky / cloudy white / (forms) white ppt	**1**
3(a)(ii)	**FA 7** has lower pH **and** gas / CO_2 given off / it fizzes (more rapidly if fizzing with both) with sodium carbonate	**1**

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Question	Answer	Marks
3(b)	**Reagents**: NaOH **and** NH_3 (names or correct formulae)	**1**
	Observations – (3 × 1 mark) • **FA 6** + NaOH : off-white / buff / beige / light brown ppt • **FA 6** + NH_3 : off-white / buff / beige / light brown ppt	**1**
	• **FA 6** : both ppts insoluble in excess **and** darken / turn brown with either	**1**
	• **FA 7** + NaOH : white ppt **and** soluble in excess • **FA 7** + NH_3 : white ppt **and** insoluble in excess	**1**
3(c)	**Conclusions** (one mark for each). • **FA 6** is $MnCl_2$ • **FA 7** is $Al_2(SO_4)_3$	**2**
	Total:	**10**