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CHEMISTRY **9701/33**

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

MARK SCHEME

Maximum Mark: 40

Published

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.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

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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**

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**

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**