

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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This document consists of **10** printed pages.

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Question	Answer	Marks
1(a)	<p>I Correct headings The following data are recorded in the space provided</p> <ul style="list-style-type: none"> • mass of container with FA 2 • mass of (empty) container • mass of FA 2 <p><i>'Mass' must be stated for each piece of data.</i> <i>Unit / g (etc.) must be given for each piece of data.</i> <i>Subtraction for mass of FA 2 used must be correct.</i></p>	1
	<p>II All the following data are recorded</p> <ul style="list-style-type: none"> • two burette readings and titre for the rough titration • initial and final burette readings for two (or more) accurate titrations 	1
	<p>III Titre values recorded for accurate titrations, and Appropriate headings and units in the accurate titration table</p> <ul style="list-style-type: none"> • initial / start (burette) reading / volume • final / end (burette) reading / volume • titre or volume / FA 1 and used / added • unit: / cm³ or (cm³) or in cm³ (for each heading) or cm³ unit given for each volume recorded 	1
	<p>IV All accurate burette readings are recorded to the nearest 0.05 cm³. <i>The requirement to record to 0.05 applies to burette readings, including 0.00 cm³ (if this was the initial reading), but it does not apply to the titre.</i> <i>This mark is not awarded if:</i></p> <ul style="list-style-type: none"> • 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
	<p>V The final accurate titre recorded is within 0.10 cm³ of any other accurate titre.</p> <ul style="list-style-type: none"> • Do not include a reading if it is labelled "rough". • Do not award the mark if any 'accurate' burette readings (apart from initial 0 cm³) are given to zero dp. 	1

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Question	Answer	Marks
<p>For assessment of accuracy (Q) marks, each Examiner should round any burette readings to the nearest 0.05 cm³, check subtractions and then select the “best” titres using the hierarchy:</p> <ul style="list-style-type: none"> • two (or more) accurate identical titres (ignoring any that are labelled “rough”), <i>then</i> • two (or more) accurate titres within 0.05 cm³, <i>then</i> • two (or more) accurate titres within 0.10 cm³, <i>etc.</i> <p>These best titres should be used to calculate the mean titre, expressed to nearest 0.01 cm³.</p> <p>Calculate the candidate’s ratio to 1 dp, as shown below. Ratio = correct mean titre ÷ correct mass</p> <p>Calculate the difference (δ) between the candidate’s ratio and the supervisor’s ratio. Accuracy marks are awarded as follows.</p>		
1(a)	Award VI, VII and VIII if $\delta \leq 0.2$ (cm ³ g ⁻¹)	1
	Award VI and VII if $0.2 < \delta \leq 0.4$	1
	Award VI , only, if $0.4 < \delta \leq 0.6$	1
	<ul style="list-style-type: none"> • Spread penalty: if the two “best” (corrected) titres used by the Examiner were ≥ 0.50 cm³ apart, maximum 2 accuracy marks. • If only a rough titration is shown, award Q marks based on that, maximum 2 accuracy marks. 	

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Question	Answer	Marks
1(b)	<p>Candidate calculates the mean correctly.</p> <ul style="list-style-type: none"> • Candidate must take the average of two (or more) titres that are within a total spread of not more than 0.20 cm³. • 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 cm³. (e.g. 26.665 cm³ must be rounded to 26.67 cm³) <p>Two special cases, where the mean need not be to 2 dp:</p> <ul style="list-style-type: none"> • Allow mean expressed to 3 dp only for 0.025 or 0.075 (e.g. 26.325 cm³) • 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) <p><i>This mark is not awarded if:</i></p> <ul style="list-style-type: none"> • 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 <p>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.</p>	1
1(c)(i)	No of moles of H ₂ SO ₄ used = 0.05(0) × ^(b) /1000 to minimum 2 sf	1
1(c)(ii) and 1(c)(iii)	<p>2NaHCO₃ + H₂SO₄ → Na₂SO₄ + 2CO₂ + 2H₂O and No of moles of NaHCO₃ = 2 × answer (i)</p>	1

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Question	Answer	Marks
1(c)(iv)	Mass of NaHCO_3 = answer (iii) $\times 10 \times 84$	1
1(c)(v)	$\% = \frac{\text{answer (iv)}}{\text{mass of FA 2 used}} \times 100$	1
	All answers attempted in (i), (iii), (iv) & (v) are shown to 3 or 4 sf <i>Minimum 3 answers attempted to gain the mark</i>	1
1(c)(vi)	Any one of the following answers. <ul style="list-style-type: none"> • 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)	$\% \text{ error} (= \frac{0.1}{250} \times 100) = 0.04\%$	1
	Total:	16

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Question	Answer	Marks
2(a)	<p>I Four weighings recorded and correct headings given and mass of FA 4 used and mass of residue recorded</p> <ul style="list-style-type: none"> • (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 <p><i>If 'mass' not written then 'g' must be with each entry. Use of lid must be consistent.</i></p>	1
	<p>II</p> <ul style="list-style-type: none"> • All <u>weighings</u> recorded to same decimal places (one or more). • Third and fourth weighings are within 0.05 g of each other <i>(or both equal if a one decimal place balance was used)</i> • Mass of FA 4 and FA 5 / residue must be correctly subtracted. 	1

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Question	Answer	Marks
2(a)	<p>III and IV:</p> <ul style="list-style-type: none"> • 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 $\frac{\text{mass of FA4}}{\text{mass of residue}}$ for the supervisor (2 dp) • Work out ratio $\frac{\text{mass of FA4}}{\text{mass of residue}}$ for candidate (2 dp) • Calculate the difference (δ) between these two ratios. <p>Award III and IV if $\delta \leq 0.05$ Award III if $0.05 < \delta \leq 0.10$</p>	2
2(b)(i) and 2(b)(ii)	<p>(i) Mass $\text{NaHCO}_3 = \left(\frac{\% \text{ purity from 1(c)(v)}}{100} \right) \times \text{mass of FA 4 used}$ and (ii) Mass impurity = mass of FA 4 – answer (i) or mass impurity = $\frac{\% \text{ impurity}}{100} \times \text{mass FA 4}$</p>	1
2(b)(iii)	<p>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)]</p>	1
2(b)(iv)	<p>Mass of residue obtained = answer (iii) $\times \frac{84}{\text{answer (i)}}$</p>	1

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Question	Answer	Marks
2(b)(v)	If correct, (84 g) NaHCO ₃ would give 40 g residue / NaOH (<i>owtte</i>) 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 <ul style="list-style-type: none"> • 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)	2NaHCO₃(s) → H₂O(g) + CO₂(g) + Na₂CO₃(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

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Question	Answer	Marks
FA 6 is $MnCl_2$; FA 7 is $Al_2(SO_4)_3$		
3(a)(i)	<p>Ba²⁺ test: all observations correct</p> <ul style="list-style-type: none"> • FA 6 – no change / no reaction / no ppt / solution stays colourless with both • FA 7 – white precipitate with Ba²⁺ and • white ppt (remains) / insoluble / no reaction with HNO₃ 	1
	<p>AgNO₃ test: both observations correct</p> <ul style="list-style-type: none"> • FA 6 – white precipitate • FA 7 – no change / no reaction / solution stays colourless / no ppt 	1
	<p>Na₂CO₃ test: both observations correct</p> <ul style="list-style-type: none"> • FA 6 – no reaction / solid does not dissolve / no effervescence • FA 7 – fizzing / bubbling / effervescence / or gas / CO₂ turns limewater milky / chalky / cloudy white / (forms) white ppt 	1
3(a)(ii)	<p>FA 7 has lower pH and gas / CO₂ given off / it fizzes (more rapidly if fizzing with both) with sodium carbonate</p>	1

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Question	Answer	Marks
3(b)	Reagents: NaOH and NH ₃ (names or correct formulae)	1
	Observations – (3 × 1 mark) <ul style="list-style-type: none"> • FA 6 + NaOH : off-white / buff / beige / light brown ppt • FA 6 + NH₃ : off-white / buff / beige / light brown ppt 	1
	<ul style="list-style-type: none"> • FA 6 : both ppts insoluble in excess and darken / turn brown with either 	1
	<ul style="list-style-type: none"> • FA 7 + NaOH : white ppt and soluble in excess • FA 7 + NH₃ : white ppt and insoluble in excess 	1
3(c)	Conclusions (one mark for each). <ul style="list-style-type: none"> • FA 6 is MnCl₂ • FA 7 is Al₂(SO₄)₃ 	2
	Total:	10