
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)	<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

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

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