
CHEMISTRY

9701/31

Paper 3 Advanced Practical Skills 1

October/November 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 All the following data is recorded</p> <ul style="list-style-type: none"> • both burette readings and the titre for the rough titration • initial and final burette readings for two (or more) accurate titrations <p><i>Headings and units are not required for this mark</i></p>	1
	<p>II 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 / value • final / end (burette) reading / volume / value • titre or volume / FA 4 and used / added • unit: / cm³ or (cm³) or in cm³ (for each heading) or cm³ unit given for each volume recorded 	1
	<p>III All accurate burette readings are 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></p> <p><i>Do not award this mark 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>IV The final accurate titre recorded is within 0.10 cm³ of any other accurate titre.</p>	1
	<p>Examiner rounds any accurate burette readings to the nearest 0.05 cm³, checks subtractions and then selects the “best” titres using the hierarchy:</p> <ul style="list-style-type: none"> • identical titres <i>then</i> • accurate titres within 0.05 cm³, <i>then</i> • 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. Examiner compares candidate’s mean titre value with that of the Supervisor.</p>	
	Award V , VI and VII if $\delta \leq 0.20$ (cm ³)	1
	Award V and VI if $0.20 < \delta \leq 0.40$	1
	Award V , only, if $0.40 < \delta \leq 0.60$	1

Question	Answer	Marks
1(b)	<p>Candidate must take the average of two (or more) titres that are within a total spread of not more than 0.20 cm³.</p> <ul style="list-style-type: none"> 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. 26.666 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 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>Do not award this mark 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 	1
1(c)(i)	<p>Correctly calculates</p> <p>No of moles of thiosulfate used = $0.105 \times \frac{\text{mean titre}}{1000}$ to 3 or 4 sf</p>	1
1(c)(ii) and (iii)	<p>Correct use of data in both parts</p> <p>(ii) moles I₂ = 0.5 × ans (i) and (iii) moles FA1 = 0.025 × 0.0197 (= 0.000493, 0.0004925)</p>	1

Question	Answer	Marks
1(c)(iv)	Correctly calculates answer, expressed as integer No of moles = $\frac{(ii)}{(iii)}$	1
1(c)(v)	Correct balancing and value of x First mark: integer in answer (iv) shown in front of I ₂ and correct number of moles of I ⁻ entered in equation	1
	Second mark: any equation fully balanced IO ₃ ⁻ + 5I ⁻ + 6H ⁺ → 3I ₂ + 3H ₂ O	1
1(c)(vi)	Oxidation state = 2x – 1.	1

Question	Answer	Marks
2(a)	I (i) (Goes) yellow (ii) (On cooling, becomes) white solid / residue / powder	1
	II: Table of data Appropriate headings: Mass of crucible and lid Mass of crucible, lid and FA 5 (or “contents before heating”) Mass of crucible, lid and residue / ZnO / contents after heating Mass of FA 5 used Mass of residue	1
	III: Weighings shown in list / table Six weighings all recorded in the space provided All weighings recorded to same number of decimal places (one or more)	1
	IV: Both masses of FA 5 and residue, correctly subtracted <ul style="list-style-type: none"> • Masses of FA 5 used recorded on pages 4 and 5, correctly subtracted • Masses of FA 5 used were between 2.1 – 2.5 and 1.5 – 1.9 g • Masses of residue recorded on page 5, correctly subtracted 	1
	Examiners check and correct (if necessary) the masses of FA 5 used and masses of ZnO obtained by the supervisor and by the candidate for both experiments. Examiners calculate the ratio $\frac{\text{mass of FA 5}}{\text{mass of ZnO}}$ for the supervisor and candidate for each experiment to 2 dp and take the average of the two to 2 dp. Examiner calculates δ the difference between these two ratios. Award V if δ for Expt 1 \leq 0.10 Award VI if δ for Expt 2 \leq 0.10	2
2(b)(i)	$M_r = 99.4$	1
2(b)(ii)	$M_r = 125.4 + 99.4y$	1
2(b)(iii)	No of moles = $\frac{\text{mass of FA 5 (expt 1)}}{\text{ans (ii)}}$	1

Question	Answer	Marks
2(b)(iv)	No of moles ZnO = $(1 + y) \times$ answer (iii)	1
2(b)(v)	Correctly calculates moles of ZnO <ul style="list-style-type: none">No of moles ZnO = $\frac{\text{mass of residue}}{81.4}$Answer must be expressed to 2 or more significant figures	1
2(b)(vi)	Use of (iv) = (v) with working shown and an answer to 1 dp	1
2(c)(i)	Heat (crucible and residue) to constant mass or cool in a desiccator	1
2(c)(ii)	Experiment 1 because (larger masses) have lower percentage error (in weighing).	1

Question	Answer	Marks											
3(a)	Tabulation of observations Clear presentation of results to show FA 6 , FA 7 and FA 8 with the reagents specified.	1											
	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%;"></th> <th style="width: 40%; text-align: center;">H₂SO₄</th> <th style="width: 50%; text-align: center;">NaOH</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">FA 6</td> <td>fizzing / bubbling or pale brown gas (formed) or yellow solution (formed) or goes yellow</td> <td>no reaction / no change / no ppt</td> </tr> <tr> <td style="text-align: center;">FA 7</td> <td>no reaction / no change</td> <td>on warming, gas / NH₃ turns litmus blue</td> </tr> <tr> <td style="text-align: center;">FA 8</td> <td>white precipitate</td> <td>no reaction / no change / no ppt or (faint) white ppt and insoluble in excess NaOH</td> </tr> </tbody> </table> <p>2 correct boxes for each mark</p>		H₂SO₄	NaOH	FA 6	fizzing / bubbling or pale brown gas (formed) or yellow solution (formed) or goes yellow	no reaction / no change / no ppt	FA 7	no reaction / no change	on warming, gas / NH ₃ turns litmus blue	FA 8	white precipitate	no reaction / no change / no ppt or (faint) white ppt and insoluble in excess NaOH
	H₂SO₄	NaOH											
FA 6	fizzing / bubbling or pale brown gas (formed) or yellow solution (formed) or goes yellow	no reaction / no change / no ppt											
FA 7	no reaction / no change	on warming, gas / NH ₃ turns litmus blue											
FA 8	white precipitate	no reaction / no change / no ppt or (faint) white ppt and insoluble in excess NaOH											
3(b)	Add silver nitrate followed by ammonia or silver nitrate and nitric acid (and ammonia)	1											
	FA 7 cream ppt and FA 8 no reaction / no change / no ppt	1											

Question	Answer	Marks
3(c)(i)	For FA 6 and FA 7 or FA 8 not identified in (b) as a halide uses NaOH + Al and there is evidence of heating mixture	1
	Observations for both compounds tested gas / ammonia turns (red) litmus blue	1
3(c)(ii)	Uses the same unknowns as (i) and adds a named dilute acid or correct formula Allow if “acid” on reagent line and correct formula given in table, or adds (acidified) potassium manganate(VII)	1
	<p>Observations: both must be correct for the reagent selected.</p> <p>If HCl or HNO₃ used</p> <ul style="list-style-type: none"> • with FA 6, fizzing / bubbling or pale brown gas (formed) or yellow solution (formed) or goes yellow • with FA 7, no reaction • with FA 8, no reaction <p>If H₂SO₄ used</p> <ul style="list-style-type: none"> • with FA 6, fizzing / bubbling or pale brown gas (formed) or yellow solution (formed) or goes yellow • with FA 7, no reaction • with FA 8, white precipitate <p>If acidified KMnO₄ used</p> <ul style="list-style-type: none"> • with FA 6, decolourised / <u>goes</u> colourless / loses purple colour • with FA 7, no reaction / KMnO₄ not decolourised (or stays purple) • with FA 8, white / pink (allow “pale purple”) precipitate formed 	1
3(d)	<p>Correct formulae of unknowns</p> <ul style="list-style-type: none"> • FA 6 is NaNO₂ • FA 7 is NH₄Br • FA 8 is Ba(NO₃)₂ / Ca(NO₃)₂ <p>three formulae correct = 2 marks one formula correct = 1 mark</p>	2