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CHEMISTRY **9701/31**

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.

Cambridge will not enter into discussions about these mark schemes.

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Question	Answer	Marks
1(a)	**I:** All the following data is recorded • rough titration: both burette readings **and** the titre • initial and final burette readings for **two** (or more) accurate titrations *Headings and units are **not** required for this mark*	**1**
	II: 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 used / added *(not "difference")* • unit: / cm^3 **or** (cm^3) **or** in cm^3 (for each heading) **or** cm^3 unit given for each volume recorded	**1**
	III: 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.* *Do **not** award this mark 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**
	IV: Final uncorrected titre is within 0.10 cm^3 of any previous uncorrected accurate titre.	**1**

Question	Answer	Marks
Examiner rounds any accurate burette readings to the nearest 0.05 cm^3, check subtractions and then select the "best" titres using the hierarchy: • identical titres *then* • accurate titres within 0.05 cm^3, *then* • 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. Examiner compares candidate's tire value with that of the Supervisor.		
	Award **V**, **VI** and **VII** if $\delta \leqslant$ **0.30** (cm^3)	**1**
	Award **V** and **VI** if **0.30** $< \delta \leqslant$ **0.50**	**1**
	Award **V**, only, if **0.50** $< \delta \leqslant$ **0.80**	**1**
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. 26.667 cm^3 must be rounded to 26.67 cm^3)*	**1**

Question	Answer	Marks
1(b)	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 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)* *Do **not** award this mark 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(c)(i)	No of moles of thiosulfate used = $0.110 \times {}^{\text{mean titre}}/_{1000}$ (expressed to 3 or 4 sig fig)	**1**
1(c)(ii) + (iii)	Equation balanced $I_2 + \mathbf{2}Na_2S_2O_3 \rightarrow Na_2S_4O_6 + \mathbf{2}NaI$ **and** no of moles of I_2 = 0.5 × ans. in (i)	**1**
1(c)(iv)	**Correct answer,** No of moles of copper(II) ions = 2 × answer (iii) **(**expressed to 3 or 4 sig fig)	**1**
1(c)(v)	$M_r = {}^{26.0}/_{\text{ans (iv)}} \times {}^{25}/_{1000}$	**1**
	Total:	**12**

Question	Answer	Marks
2(a)	**I: Table of data**, to include: • Unit "covering" all weighings, or given for each weighing • No repeat headings *(i.e. **not** two lists of weighings)* • Appropriate headings for the three weighings: Mass of crucible and lid Mass of crucible, lid and **FA 5** (or "contents before heating") Mass of crucible, lid and residue / CuO / contents after heating	**1**
	II: Weighings recorded • Six weighings recorded in the space provided. • All weighings recorded to same number of decimal places (one or more) • Label/heading to indicate which is Expt 1 and Expt 2	**1**
	III: Both masses of FA 5 and residue, correctly subtracted • Masses of **FA 5** used recorded on page 4, correctly subtracted • Masses of **FA 5** used were between 2.5 – 3.0 g and 1.5 – 2.0 g • Masses of residue recorded on page 4, correctly subtracted	**1**
	For assessment of accuracy, examiner must check and correct (if necessary) the masses of **FA 5** used and of CuO obtained by the supervisor and by the candidate for Experiment 1. • Examiner works out the ratio $^{\text{mass of FA5}}/_{\text{mass of CuO}}$ for the supervisor (2 dp) • Examiner works out the ratio (mass **FA 5**: mass CuO) for the candidate (2 dp) • Examiner calculates δ the difference between these two ratios. **Award IV and V if $\delta \leqslant 0.08$** **Award IV if $0.08 < \delta \leqslant 0.15$**	**2**
	VI: Observations made during heating Solid goes black / black residue (formed) **or** reference to blue/green flame	**1**
2(b)(i)	• No of moles CuO = $^{\text{mass of residue}}/_{79.5}$ • Answer must be correct and expressed to 3 or 4 sig fig	**1**

Question	Answer	Marks
2(b)(ii)	• No of moles of **FA 5** = $^{\text{answer (i)}}/_{2}$ • M_r = $^{\text{mass of FA 5 used}}/_{\text{no of moles of FA 5}}$	1
2(b)(iii)	M_r = $^{\text{mass of FA5 used in Expt} \times 79.5 \times 2}/_{\text{mass of residue (CuO)}}$	1
2(b)(iv)	M_r of **FA 5** calculated from A_r values = 239	1
2(b)(v)	Candidate should • correctly calculate the 2.5% of M_r in **(iv)** = 5.98 / 6.0, **and** • make a correct statement about the accuracy of the accepted formula, based on their result(s). **or** correctly calculate % difference for their result(s) from M_r in **(iv) and** correct comment	1
2(c)(i)	• heat (crucible and residue) to constant mass • heat more gently for longer period • cool in a desiccator	1
	• to ensure that decomposition (of **FA 5**) is complete **or** to ensure that all the residue is CuO • to prevent escape of dust / smoke / solid (during heating)	1
2(c)(ii)	Larger masses have lower percentage error in weighing	1
	Total:	**14**

Question	Answer	Marks
FA 6 is $Cu(NO_3)_2$; **FA 7** is $FeCl_3$		
3(a)(i)	• melts ***or*** dissolves ***or*** blue liquid / solution formed • condensation ***or*** steam / vapour produced • black residue / solid • brown gas / fumes • gas / oxygen relights a glowing spill *4 or 5 observations correct = 2 marks* *2 or 3 observations correct = 1 mark*	**2**
3(a)(ii)	**FA 6** is $Cu(NO_3)_2$	**1**
3(b)(i)	• with KI, **FA 7** gives a brown / red-brown / red / orange solution • with starch, blue / blue-black / dark colour	**1**
	• with **FA 6**, blue precipitate (formed) • on heating, (blue precipitate) turns black • With **FA 7**, red-brown / brown / rust ppt. (formed)	**1**
	• With **FA 6**, no reaction / no change / no ppt. • With **FA 7**, white precipitate formed	**1**
	• With **FA 6**, (pale) blue precipitate, then • deep/dark blue (solution) with excess • With **FA 7**, red-brown / brown / rust precipitate (forms)	**1**
	Mg test **Both observations correct** With **FA 6**, brown / black precipitate / solid formed **or** blue colour fades / disappears With **FA 7**, fizzing / bubbling / effervescence	**1**
	Test for hydrogen: (gas) “pops” with lighted splint	**1**

Question	Answer	Marks
3(b)(ii)	**FA 7** is acidic, because it fizzes / produces hydrogen with magnesium	**1**
3(b)(iii)	$Fe^{3+}(aq) + 3OH^{-}(aq) \rightarrow Fe(OH)_3(s)$	**1**
3(b)(iv)	Redox because iodine was produced (from iodide ions)	**1**
3(b)(v)	You can't be certain about the colour of the precipitate (with $AgNO_3$) due to the coloured solution / colour of **FA 7**. **or** You can't be sure whether the precipitate with $AgNO_3$ is white / AgC*l* or cream / AgBr	**1**
3(b)(vi)	Ammonia would react with the Fe^{3+} ions in **FA 7** (masking the effect of ammonia on AgC*l*) **or** The cation in **FA 7** gives a precipitate with ammonia (so the precipitate of AgC*l* would not appear to dissolve).	**1**
	Total:	**14**