
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.

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| Question | Answer | Marks |
|----------|--|----------|
| 1(a) | <p>I: All the following data is recorded</p> <ul style="list-style-type: none"> • rough titration: both burette readings and the titre • 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 • final / end (burette) reading / volume • titre or volume used / added (<i>not</i> “difference”) • unit: / cm³ or (cm³) or in cm³ (for each heading) <p>or cm³ unit given for each volume recorded</p> | 1 |
| | <p>III: All accurate burette readings are recorded to the nearest 0.05 cm³.</p> <p><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: Final uncorrected titre is within 0.10 cm³ of any previous uncorrected accurate titre.</p> | 1 |

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| Question | Answer | Marks |
|----------|--|----------|
| | <p>Examiner rounds any accurate burette readings to the nearest 0.05 cm^3, check subtractions and then select the “best” titres using the hierarchy:</p> <ul style="list-style-type: none"> • identical titres <i>then</i> • accurate titres within 0.05 cm^3, <i>then</i> • accurate titres within 0.10 cm^3, <i>etc.</i> <p>These best titres should be used to calculate the mean titre, expressed to nearest 0.01 cm^3.</p> <p>Examiner compares candidate’s titre value with that of the Supervisor.</p> | |
| | Award V , VI and VII if $\delta \leq 0.30 \text{ (cm}^3\text{)}$ | 1 |
| | Award V and VI if $0.30 < \delta \leq 0.50$ | 1 |
| | Award V , only, if $0.50 < \delta \leq 0.80$ | 1 |
| 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 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. • (<i>e.g. 26.667 cm^3 must be rounded to 26.67 cm^3</i>) | 1 |

| Question | Answer | Marks |
|------------------|---|-----------|
| 1(b) | <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>Do not award this mark if:</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(c)(i) | No of moles of thiosulfate used = $0.110 \times \frac{\text{mean titre}}{1000}$ (expressed to 3 or 4 sig fig) | 1 |
| 1(c)(ii) + (iii) | Equation balanced $\text{I}_2 + 2\text{Na}_2\text{S}_2\text{O}_3 \rightarrow \text{Na}_2\text{S}_4\text{O}_6 + 2\text{NaI}$ 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) | $M_r = \frac{26.0}{\text{ans (iv)}} \times \frac{25}{1000}$ | 1 |
| | Total: | 12 |

| Question | Answer | Marks |
|----------|--|-------|
| 2(a) | <p>I: Table of data, to include:</p> <ul style="list-style-type: none"> • Unit “covering” all weighings, or given for each weighing • No repeat headings (<i>i.e. not two lists of weighings</i>) • 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 |
| | <p>II: Weighings recorded</p> <ul style="list-style-type: none"> • 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 |
| | <p>III: Both masses of FA 5 and residue, correctly subtracted</p> <ul style="list-style-type: none"> • Masses of FA 5 used recorded on page 4, correctly subtracted • Masses of FA 5 used were between 2.5 – 3.0g and 1.5 – 2.0 g • Masses of residue recorded on page 4, correctly subtracted | 1 |
| | <p>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.</p> <ul style="list-style-type: none"> • Examiner works out the ratio $\frac{\text{mass of FA5}}{\text{mass of CuO}}$ 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. <p>Award IV and V if $\delta \leq 0.08$ Award IV if $0.08 < \delta \leq 0.15$</p> | 2 |
| | <p>VI: Observations made during heating Solid goes black / black residue (formed) or reference to blue/green flame</p> | 1 |
| 2(b)(i) | <ul style="list-style-type: none"> • No of moles CuO = $\frac{\text{mass of residue}}{79.5}$ • Answer must be correct and expressed to 3 or 4 sig fig | 1 |

| Question | Answer | Marks |
|-----------|--|-----------|
| 2(b)(ii) | <ul style="list-style-type: none"> No of moles of FA 5 = $\frac{\text{answer (i)}}{2}$ $M_r = \frac{\text{mass of FA 5 used}}{\text{no of moles of FA 5}}$ | 1 |
| 2(b)(iii) | $M_r = \frac{\text{mass of FA5 used in Expt 2} \times 79.5 \times 2}{\text{mass of residue (CuO)}}$ | 1 |
| 2(b)(iv) | M_r of FA 5 calculated from A_r values = 239 | 1 |
| 2(b)(v) | <p>Candidate should</p> <ul style="list-style-type: none"> 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). <p>or correctly calculate % difference for their result(s) from M_r in (iv) and correct comment</p> | 1 |
| 2(c)(i) | <ul style="list-style-type: none"> heat (crucible and residue) to constant mass heat more gently for longer period cool in a desiccator | 1 |
| | <ul style="list-style-type: none"> to ensure that decomposition (of FA 5) is complete or to ensure that <u>all</u> the residue is CuO to prevent escape of dust / smoke / solid (during heating) | 1 |
| 2(c)(ii) | Larger masses have lower <u>percentage</u> error in weighing | 1 |
| | Total: | 14 |

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| Question | Answer | Marks |
|--|--|----------|
| FA 6 is $\text{Cu}(\text{NO}_3)_2$; FA 7 is FeCl_3 | | |
| 3(a)(i) | <ul style="list-style-type: none"> • 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 <p><i>4 or 5 observations correct = 2 marks</i> <i>2 or 3 observations correct = 1 mark</i></p> | 2 |
| 3(a)(ii) | FA 6 is $\text{Cu}(\text{NO}_3)_2$ | 1 |
| 3(b)(i) | <ul style="list-style-type: none"> • with KI, FA 7 gives a brown / red-brown / red / orange solution • with starch, blue / blue-black / dark colour | 1 |
| | <ul style="list-style-type: none"> • with FA 6, blue precipitate (formed) • on heating, (blue precipitate) turns black • With FA 7, red-brown / brown / rust ppt. (formed) | 1 |
| | <ul style="list-style-type: none"> • With FA 6, no reaction / no change / no ppt. • With FA 7, white precipitate formed | 1 |
| | <ul style="list-style-type: none"> • With FA 6, (pale) blue precipitate, then • deep/dark blue (solution) with excess • With FA 7, red-brown / brown / rust precipitate (forms) | 1 |
| | <p>Mg test Both observations correct With FA 6, brown / black precipitate / solid formed or blue colour fades / disappears With FA 7, fizzing / bubbling / effervescence</p> | 1 |
| | Test for hydrogen: (gas) “pops” with lighted splint | 1 |

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| Question | Answer | Marks |
|-----------|--|-----------|
| 3(b)(ii) | FA 7 is acidic, because it fizzes / produces hydrogen with magnesium | 1 |
| 3(b)(iii) | $\text{Fe}^{3+}(\text{aq}) + 3\text{OH}^{-}(\text{aq}) \rightarrow \text{Fe}(\text{OH})_3(\text{s})$ | 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 / AgCl or cream / AgBr | 1 |
| 3(b)(vi) | Ammonia would react with the Fe^{3+} ions in FA 7 (masking the effect of ammonia on AgCl) or The cation in FA 7 gives a precipitate with ammonia (so the precipitate of AgCl would not appear to dissolve). | 1 |
| | Total: | 14 |