CAMBRIDGE
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Cambridge International AS & A Level

CHEMISTRY **9701/32**

Paper 3 Advanced Practical Skills 2 **May/June 2024**

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 International will not enter into discussions about these mark schemes.

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Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptions for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

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GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

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Science-Specific Marking Principles

1	Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.
2	The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored.
3	Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane/ethene, glucagon/glycogen, refraction/reflection).
4	The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.
5	'List rule' guidance (see examples below) For questions that require ***n*** responses (e.g. State **two** reasons …): • The response should be read as continuous prose, even when numbered answer spaces are provided. • Any response marked *ignore* in the mark scheme should not count towards ***n***. • Incorrect responses should not be awarded credit but will still count towards ***n***. • Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should **not** be awarded for any responses that are contradicted within the rest of the response. Where two responses contradict one another, this should be treated as a single incorrect response. • Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science.

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6 Calculation specific guidance

Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states 'show your working'.

For questions in which the number of significant figures required is not stated, credit should be awarded for correct answers when rounded by the examiner to the number of significant figures given in the mark scheme. This may not apply to measured values.

For answers given in standard form (e.g. $a \times 10^n$) in which the convention of restricting the value of the coefficient (a) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme.

Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.

7 Guidance for chemical equations

Multiples/fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme.

State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

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Question	Answer	Marks
1(a)	*One of:* • would not all form pentahydrate • some would dissolve • cannot (accurately) measure (change in) temperature of a solid.	**1**
1(b)	**I** Unambiguous headings and units covering all entries • (mass of) container + solid / **FB 1** • (mass of) container (+ residue) • initial thermometer reading / temperature (of water) • final / lowest thermometer reading / temperature (of solution) • (mass of) solid (used / added) / **FB 1** • change in temperature / ΔT Units: / g, (g), in g and / °C, (°C), in °C **II** All balance readings consistent to either 2 or 3 dp **AND** thermometer readings to .0 °C or.5 °C **AND** written in their table **AND** all subtractions correct	**4**
	Accuracy marks Calculate $\Delta T / \text{mass}$ to 2 decimal places for candidate and for supervisor. **III** Award if the candidate ratio is within 30% of the supervisor ratio **IV** Award if the candidate ratio is within 15% of the supervisor ratio	
1(c)(i)	Correctly calculates energy change = 4.18 × temperature change × 25 (J) **AND** answer given to 2–4 significant figures (ignore sign)	**1**

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Question	Answer	Marks
1(c)(ii)	**M1** Correctly uses amount of thiosulfate = $\frac{\text{candidate mass}}{248.2}$ mol **M2** Correct use of $\Delta H_2 = +\frac{\text{(c)(i)}}{\text{(moles of thiosulfate} \times 1000)}$ (kJ mol^{-1}) **AND** answer given to 2–4 significant figures	**2**
1(c)(iii)	**M1** diagram with two downward arrows **AND** correct labels $Na_2S_2O_3(s) + 5H_2O(l) \rightarrow Na_2S_2O_3.5H_2O(s)$ ΔH_3 or –8.1 ↘ ↙ ΔH_2 or (c)(ii) or (+)31.6 ($Na_2S_2O_3(aq)$) **M2** ΔH_1 = –8.1 – (answer to 1(c)(ii)) (default answer = –39.7)	**2**
1(d)	(temperature change is) less / decreased because reaction of anhydrous (sodium thiosulfate) is exothermic / causes a temperature increase	**1**

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Question	Answer	Marks
2(a)	**I** All the following data are recorded • two burette readings **AND** titre for the rough titration • initial and final burette readings for two (or more) accurate titrations **II** Appropriate headings and units shown in the accurate titration table **AND** titre values recorded for accurate titrations. • initial / start **AND** (burette) reading / volume • final / end **AND** (burette) reading / volume • titre **OR** volume / **FB 2 AND** used / added • unit: / cm^3 **OR** (cm^3) **OR** in cm^3 (for each heading) **OR** cm^3 unit given for each volume recorded **III** All accurate burette readings are recorded to the nearest 0.05 cm^3. **IV** The final accurate titre recorded is within 0.10 cm^3 of any other accurate titre.	**7**
	Accuracy marks Round all burette readings to the nearest 0.05 cm^3. Check and correct subtractions. Then select the 'best' titres using the hierarchy: • two (or more) accurate identical titres (ignoring any that are labelled 'rough'), *then* • two (or more) accurate titres within 0.05 cm^3, *then* • two (or more) 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. Calculate the Supervisor's mean titre to two decimal places. Calculate the candidate's mean titre to two decimal places. Calculate the difference (δ) between the candidate's titre and the supervisor's titre.	
	Award **V** if $\delta \leqslant 0.50$ cm^3 Award **VI** if $\delta \leqslant 0.30$ cm^3 Award **VII** if $\delta \leqslant 0.20$ cm^3 If supervisor's titre $\leqslant$ 10.00 cm^3 then halve the tolerances. If supervisor's titre $\leqslant$ 5.00 cm^3 then award for 0.15, 0.10 and 0.05 cm^3.	

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Question	Answer	Marks
2(b)	Correctly calculates the mean titre • 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 shown next to the two (or more) accurate readings selected. • The mean should be quoted to 2 decimal places **AND** be rounded correctly to nearest 0.01 cm^3.	**1**
2(c)(i)	answers for (c)(ii) and (c)(iii) are given to 3 or 4 significant figures **AND** answer to (c)(iv) value of *x* is an integer	**1**
2(c)(ii)	Correctly calculates amount of I_2 = $^{½\text{ (b)} \times 0.1}/_{1000}$ (mol)	**1**
2(c)(iii)	Correctly calculates amount of IO_x^- = $^{(25 \times 0.0140)}/_{1000} = 3.50 \times 10^{-4}$ (mol)	**1**
2(c)(iv)	**M1** Display of $^{\text{(c)(ii)}}/_{\text{(c)(iii)}}$ ratio **AND** correctly uses (c)(ii) and (c)(iii) ratio giving integer value for *x* **M2** Equation balanced for value of *x* from M1 *x* = **5**; $IO_5^- + 9I^- + 10H^+ \rightarrow 5I_2 + 5H_2O$ *x* = **4**; $IO_4^- + 7I^- + 8H^+ \rightarrow 4I_2 + 4H_2O$ *x* = **3**; $IO_3^- + 5I^- + 6H^+ \rightarrow 3I_2 + 3H_2O$ *x* = **2**; $IO_2^- + 3I^- + 4H^+ \rightarrow 2I_2 + 2H_2O$ *x* = **1**; $IO^- + I^- + 2H^+ \rightarrow I_2 + H_2O$	**2**
2(d)	**M1** volume of **FB 2** will be smaller **AND** as less iodine produced / less yield **M2** less change in oxidation state **OR** balanced equation of IO_2^- ($IO_2^- + 3I^- + 4H^+ \rightarrow 2I_2 + 2H_2O$)	**2**

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Question	Answer	Marks
	FB 7 is $Zn(NO_3)_2(aq)$, **FB 8** is $KI(aq)$ and **FB 9** is $Na_2CO_3(aq)$.	
3(a)(i)	**Test 1** • no (visible) change / no reaction / no ppt **Test 2** • white ppt • soluble in excess • negative litmus test / litmus stays red / no change / no reaction • fizzing • gas / NH_3 turns (damp red) litmus blue **Test 3** • white ppt • soluble in excess Two points needed for each mark.	**4**
3(a)(ii)	**M1** cation: Zn^{2+} after correct observations in Test 3 **M2** anions: NO_2^- or NO_3^- after correct ammonia gas observations in Test 2 with A*l*	**2**
3(a)(iii)	**EITHER** **M1** add (a few drops of) (acidified aqueous) $KMnO_4$ / potassium manganate(VII) **M2** no change or solution stays purple / pink **AND** anion is NO_3^- **OR** **M1** add named mineral acid **M2** no change / no bubbling / no brown gas / no blue solution **AND** anion is NO_3^-	**2**

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Question	Answer	Marks
3(b)(i)	**M1** table of results drawn with clear sections for test and for observations with each salt e.g. test as row-header and **FB 8** and **FB 9** as column-headers or vice versa **M2** reagents are (aqueous) silver nitrate **AND** a named acid **M3** *+ $AgNO_3(aq)$* **FB 8**: (pale) yellow ppt **AND** insoluble in (aqueous) NH_3 **AND** white to brown ppt with **FB 9** if tested **M4** *+ named acid* **FB 9**: effervescence / bubbling / fizzing **AND** gas / CO_2 gives white ppt with limewater	**4**
3(b)(ii)	**FB 8**: I^- **AND FB 9**: CO_3^{2-}	**1**
3(b)(iii)	*One of:* $Ag^+(aq) + I^-(aq) \rightarrow AgI(s)$ $2H^+(aq) + CO_3^{2-}(aq) \rightarrow H_2O(l) + CO_2(g)$ equation must match observation from 3(b)(i)	**1**

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