Cambridge Assessment International Education

Cambridge International AS & A Level

CHEMISTRY **9701/31**

Paper 3 Advanced Practical Skills 1 **October/November 2022**

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 descriptors 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.

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	<u>'List rule' guidance</u> 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)	**I** all the following data recorded • two burette readings and titre for rough titration • initial and final burette readings for two (or more) accurate titrations	**7**
	II titre values shown for accurate titrations **and** appropriate headings and units in the accurate titration table • initial / start **and** (burette) reading / volume • final / end **and** (burette) reading / volume • titre **or** volume **/ FA 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 to nearest 0.05 cm^3	
	IV the final accurate titre recorded is within 0.10 cm^3 of any other accurate titre	
	V, **VI**, **VII** award **V** if $\delta \leqslant 0.60$ (cm^3) award **VI** if $\delta \leqslant 0.40$ (cm^3) award **VII** if $\delta \leqslant 0.20$ (cm^3) where δ is the difference between the supervisor's and candidate's mean titre	
1(b)	**candidate calculates mean correctly to 2 decimal places** (dp) • 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 the nearest 0.01 cm^3	**1**
1(c)(i)	**significant figures** (sf) **all** quoted answers in **(c)(ii)** – **(c)(iv)** are expressed to 3 or 4 sf	**1**
1(c)(ii)	**correctly calculates amount of MnO_4^- used** amount of $MnO_4^- = \frac{0.02 \times \text{vol in } \textbf{(b)}}{1000}$ (mol)	**1**

Question	Answer	Marks
1(c)(iii)	**correctly uses equation and converts volume** amount of $(COO^-)_2$ that reacted = **(c)(ii)** $\times$ $\frac{5}{2}$ (mol) **and** concentration of $(COO^-)_2$ in **FA 1** = amount of $(COO^-)_2$ $\times$ $\frac{1000}{25}$ (mol dm^{-3})	**1**
1(c)(iv)	**correctly uses M_r = $\frac{\text{mass}}{\text{moles}}$** M_r = $\frac{10.14}{\text{concentration from}}$ **(c)(iii)**	**1**
1(c)(v)	**identity of M** M1: A_r of **M** = $\frac{M_r \text{ from } \textbf{(c)(iv)} - 124}{2}$ M2: identifies **M** as being the Group 1 element with the nearest A_r (Li $\leqslant$ 14.9; 15.0 $\leqslant$ Na $\leqslant$ 31.0; 31.1 $\leqslant$ K $\leqslant$ 62.3; 62.3 $\leqslant$ Rb $\leqslant$ 111.4; 111.4 $\leqslant$ Cs $\leqslant$ 250)	**2**
1(d)	**explanation for use of acid** to provide H^+ **and** for the reaction (to proceed) / as given in the equation / to acidify the $KMnO_4$	**1**

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Question	Answer	Marks
2(a)	M1: **table of readings** with unambiguous headings **and** correctly displayed units for all entries in the space for **Results** • (mass of) container + **FA 4** • (mass of) container (+ residue) • first / start / initial temperature / temperature of water • lowest / final temperature	**2**
	M2: **readings in 2(a)** • both thermometer readings shown to 0.0 °C or 0.5 °C • balance readings shown consistently to either 2 dp or to 3 dp • mass and temperature rise in **(a)** subtracted correctly and shown in the space for results	
2(b)(i)	**correctly calculates energy change** energy change = $25 \times 4.18 \times T$ fall (J) **and** answer to 2–4 sf	**1**
2(b)(ii)	**correctly calculates amount of FA 4** amount = $\text{mass FA 4} / 249.6$ (mol) **and** answer to 2–4 sf	**1**
2(b)(iii)	**correctly uses** $\textbf{(b)(i)} / \textbf{(b)(ii)}$ enthalpy change = $\dfrac{\textbf{(b)(ii)}}{\textbf{(b)(ii)} \times 1000}$ (kJ mol^{-1}) **and +** sign **and** answer to 2–4 sf	**1**
2(c)	**readings** mass of **FA 5** and temperature rise are correctly calculated two thermometer readings are both above 10 °C temperature rise is greater than T fall in **(a)**	**1**

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Question	Answer	Marks
2(d)(i)	**correct expressions shown for enthalpy change** • energy change = 25 × 4.18 × *T* change (J) • amount used = mass of **FA 5** used / 159.6 (mol) • ΔH = energy change / number of moles × 1000 (kJ mol^{-1}) • negative sign in answer	**2**
2(d)(ii)	**Hess's cycle calculation** correct calculation of ΔH = **(b)(iii)** − **(d)(i)** (kJ mol^{-1}) **and** some working shown e.g., equation as shown and 2 downward arrows with labelling / correct values from **(b)(iii)** and **(d)(i)** with correct signs	**1**
2(e)	**explanation for answer selected** box 1 ticked: ΔT is larger for **(b)(iii)** (ora) box 2 ticked: ΔT is the same for both experiments box 3 ticked: ΔT is larger for **(d)(i)** (ora)	**1**

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Question	Answer	Marks
	FA 6 is aqueous $Zn(NO_3)_2$ and KI; **FA 7** gives results for ethanal but is actually **butan-2-ol**	
3(a)(i)	**observations** **Test 1** M1: NaOH: white ppt **and** soluble in excess M2: Heat: no change / no (visible) reaction / litmus stays red **Test 2** M3: Al: fizz **and** NH_3 / gas turns (damp red) litmus blue **Test 3** M4: H_2O_2: brown / (darker) yellow / yellow-brown / orange-brown / red-brown (solution)	**4**
3(a)(ii)	possible cations: aluminium / Al^{3+} and zinc / Zn^{2+}	**1**
3(a)(iii)	identifying the cation M1: cation test: add (aqueous) ammonia M2: white ppt soluble in excess NH_3(aq) shows Zn^{2+}	**2**
3(a)(iv)	possible anions: any two from NO_3^-, NO_2^-, I^-	**1**
3(a)(v)	identifying the anion **if iodide in (iv)** M1: test: add (aqueous) silver nitrate / $AgNO_3$ M2: yellow ppt (insol in NH_3) shows I^- **if nitrite and nitrate (no iodide) in (iv)** M1: test: add (acidified aqueous) potassium manganate(VII) / $KMnO_4$ M2: purple / $KMnO_4$ solution turns (dark) yellow / yellow-brown / orange-brown / red-brown / brown / decolourised shows nitrite **OR** M1: add named (dilute) acid M2: no fizzing / no brown gas shows nitrate	**2**

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Question	Answer	Marks
3(b)(i)	M1: **Test 2** (triiodomethane test) (Pale) yellow ppt M2: **Test 3** add (acidified aqueous) potassium manganate(VII) purple / $KMnO_4$ decolourised	**2**
3(b)(ii)	any 2 of the following tests correct **Test 1:** does not contain –OH / not an alcohol / not a carboxylic acid / not hydroxyl group **Test 2**: contains $-CH_2C{=}O$ (or $-CH(OH)CH_3$) group **Test 3**: is an aldehyde (or a 1º or 2º alcohol)	**2**
3(b)(iii)	**FA 7** is ethanal / CH_3CHO	**1**

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