Cambridge Assessment International Education

Cambridge International AS & A Level

CHEMISTRY **9701/34**

Paper 3 Advanced Practical Skills 2 **October/November 2020**

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.

Cambridge International is publishing the mark schemes for the October/November 2020 series for most Cambridge IGCSE™, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

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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.

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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Penalise rounding errors (RE) or transcription errors (TE) once only on the paper.

Question	Answer	Mark
1(a)	**I** Four weighings written in the space provided **AND** All weighings are recorded to the same number of decimal places (minimum one dp). *Headings are not required for this mark but some indication needed regarding to what they refer.*	**1**
	II Appropriate headings and units (minimum four in the space provided **and** one must be for after heating) • mass of crucible and lid / g • mass of crucible, lid and **FB 1** / g • mass of crucible, lid and residue after first heating / g • mass of crucible, lid and residue after second heating / g • mass of **FB 1** (used) / g • mass of residue / anhydrous salt obtained / g Allow omission of lid but its use or omission must be consistent Allow 'solid' or 'contents' or 'anhydrous FB 1' for 'residue' Reject 'FB 1' for 'residue' Reject 'weight' Allow units displayed as / g or (g) or in gram(me)s in general mass heading or after every entry / heading	**1**
	III Masses of FB 1 and of residue are correctly subtracted **AND** Mass after 2nd heating is within 0.05 g of mass after first heating Note: the mass of residue must be calculated from the lower balance reading after heating Note: if a one dp balance was used, the two masses must be identical	**1**
	Check all subtractions, and use the corrected values (if necessary) *Calculate the ratio for supervisor* $\frac{\text{mass FB1}}{\text{mass residue}}$ *to 2 dp* *Write this value, ringed, on each candidate's script.* *Calculate the candidate's ratio* $\frac{\text{mass FB1}}{\text{mass residue}}$ *to 2 dp* *Calculate the* δ *value, the difference between these two ratios*	

Question	Answer	Mark
1(a)	Award **IV** only **if 0.05 < δ ⩽ 0.10**	**1**
	Award **V if δ ⩽ 0.05** *Default value for $Al_2(SO_4)_3 \bullet 16H_2O$ = 1.84* *Default value for $Al_2(SO_4)_3 \bullet 18H_2O$ = 1.95*	**1**
1(b)(i)	*Correctly calculates no of moles of water* Moles of water = $^{\text{correct mass loss}} / _{18}$ **AND** Answer is given to 2–4 significant figures Do not penalise sf more than once in **1(b)**.	**1**
1(b)(ii)	*Correct use of (b)(i) to calculate no of moles of residue* moles of residue = $^{\textbf{(b)(i)}} / _{16}$ **AND** answer given to 2–4 sf	**1**
1(b)(iii)	*Correct use of b(ii) to calculate M_r of anhydrous salt* M_r = $^{\text{mass of residue}} / _{\textbf{(b)(ii)}}$ **AND** answer given to 2–4 sf Allow ecf from calculated value in **1(a)**.	**1**
1(b)(iv)	*Correct expression to calculate A_r of metal* A_r = $^{[\textbf{(b)(iii)} - 3 \times 96.1]} / _{2}$ **AND** answer given to 3 or 4 sf *96.1 or 288.3 or 32.1 (or equivalent) must be seen in working.* *Allow expression to be shown in two (or more) steps* *Reject any extra working*	**1**

Question	Answer	Mark
1(b)(v)	*Identity of metal (aluminium). Metal must be an element in Group 13.* The metal must have the A_r closest to the value **calculated**. 0 < B* ⩽ 18.9 : 18.9 ⩽ **Al** ⩽ 48.3 : 48.4 ⩽ Ga ⩽ 92.2 : 92.3 ⩽ In ⩽ 159.6 : 159.6 ⩽ Tl ⩽ 300. * Allow B if the A_r is appropriate even though it is a non-metal. Allow Al^{3+} for Al, etc.	**1**
1(c)(i)	**Lid** prevents <u>solid</u> spitting or frothing out of crucible Allow **FB 1** / crystals / salt for solid	**1**
1(c)(ii)	**No**: because the final two readings were [almost] identical **and** showing that <u>no more water</u> can be driven off. **OR** **Yes**: because the final two readings were not equal **and** so it shows that <u>more water still needs to be driven</u> off. Allow No**:** because the residue mass changes **and** anhydrous salt / residue may decompose. Allow Yes: I need to reheat to check the accuracy as the mass has increased (on 2nd heating) Allow absence of No / Yes provided the answer can be inferred from the explanation. Reject 'yes' if final two weighings are identical.	**1**

Question	Answer	Mark
2(a)	**I** Minimum 6 temperatures recorded Reject if any temperature recorded is below 10.0 °C.	**1**
	II Precision of recording All thermometer readings recorded to .0 °C or to .5 °C **AND** volumes in Experiment 6 recorded to 0.05 cm^3	**1**
	III One extra reading chosen. • Volume of water + volume of **FB 3** = 10.00 cm^3. • Volume of **FB 3** must be between 2.50 and 7.50 cm^3 Reject if volume of FB 3 is within 0.50 cm^3 of prescribed values.	**1**
	Round all thermometer readings to nearest 0.5 °C, if necessary. *Calculate candidate's and supervisor's* ***temp rises at 6.00 cm³*** *added.* *Write supervisor's temperature rise in a ring on candidate's script.* *Work out δ the difference between candidate and supervisor rise.*	
	Award IV if 1.0 < $\delta \leqslant$ 2.0 °C	**1**
	Award V if δ is $\leqslant$ 1.0 °C ***Note:*** *Reduce tolerance bands to 0.5 °C and 1.0 °C if the supervisor's ΔT value is less than 10 °C*	**1**

Question	Answer	Mark
2(b)	**I** Graph axes • Linear scales chosen so that plotted points fill over half of the large grid line boxes (allowing for +3 °C 'extra' on the *y*-axis: 6 × 5 large squares) • Axes are unambiguously labelled with name **or** units. • If ΔT is plotted on *y*-axis, **only** mark **I** is forfeited.	**1**
	II Plotting **All** recorded points plotted (minimum 6) Reject if points that should be on a line are not on the line Reject if points are not within half a small square of the correct small square Reject if 'blobs' which are more than half a small square are plotted **or** if they are not correctly centred	**1**
	III Two straight lines drawn and extrapolated • Two straight lines <u>of best fit</u> drawn with a ruler (ignoring any points labelled as anomalous) • Lines give a sharp intersection / discontinuity at or above the highest T (unless labelled anomalous)	**1**
	IV Correct reading from on graph Volume of **FB 3** (giving T_{max}) correct to within half a small square **and** correctly expressed to 1 or 2 dp. Reject if the intersect is in a non-linear part of the scale.	**1**
2(c)(i)	Energy = **20** × 4.2 × temp **rise** (J) **and** answer given to 2–4 sf	**1**
2(c)(ii)	Moles = $^{\text{ans in } \mathbf{2(b)} \times 1.95}/_{1000}$ **and** answer given to 2–4 sf *Allow use of the default value (5.7 cm^3 gives answer of 1.112 × 10^{-2} mol)*	**1**
2(c)(iii)	Enthalpy change = $-\,^{\mathbf{(c)(i)}}/_{1000 \times \mathbf{(c)(ii)}}$ **and** answer given to 2–4 sf	**1**

Question	Answer	Mark
2(c)(iv)	$2NaOH(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$ Allow $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$	**1**
2(c)(v)	[NaOH] = **2(c)(ii)** $\times 2 \times {}^{1000}/_{10}$ **or** [NaOH] = 1.95 $\times$ vol acid $\times {}^{2}/_{10}$ Allow ecf from equation giving $NaHSO_4$ ($NaOH + H_2SO_4 \rightarrow NaHSO_4 + H_2O$) [NaOH] = 1.95 $\times$ vol acid $\times {}^{1}/_{10}$ Reject value from an incorrect equation in **(c)(iv)**	**1**
2(d)	One mark from the following points: • Use larger volumes of both **FB 2** and **FB 3** / (both) solutions / (both) reagents (reduces % error in volume measurement) • Measure initial temperature of water and **FB 3** (as well as **FB 2**) • Record initial temp for each experiment Allow increase concentrations of **FB 2** and **FB 3** / (both) solutions / (both) reagents	**1**

<table>
<tr><th>Question</th><th>Answer</th><th>Mark</th></tr>
<tr><td colspan="2">FB 4 is $Zn(NO_3)_2(aq)$; FB 5 is $Na_2SO_3(aq)$</td><td></td></tr>
<tr><td>3(a)</td><td>
<table>
<tr><th></th><th>FB 4 observations</th><th>FB 5 observations</th></tr>
<tr><td>Test 1
Na_2CO_3</td><td>white precipitate (formed) *
Reject white ppt soluble in excess</td><td>no reaction / no change / no ppt *</td></tr>
<tr><td rowspan="2">Test 2
NH_3</td><td>white precipitate and soluble in excess *</td><td>no reaction / no change / no ppt *</td></tr>
<tr><td colspan="2">Ignore any reference to NH_3 given off</td></tr>
<tr><td>Test 3
Ba^{2+}</td><td>no change / no reaction / no ppt *</td><td>white precipitate *
Reject soluble in excess</td></tr>
<tr><td>Test 4
HNO_3
then
$AgNO_3$</td><td>no change / no reaction / no bubbling
and
no change / no reaction / no ppt *
Ignore ‘no ppt’ on addition of acid, (mark not available)</td><td>no change / no reaction / no bubbling
and
no change / no reaction / no ppt *
Allow white / grey / brown ppt
Reject other colours</td></tr>
</table>
Two * = 1 mark (round down).
</td><td>4</td></tr>
</table>

<table>
<tr><th>Question</th><th>Answer</th><th>Mark</th></tr>
<tr><td>3(b)</td><td>
<table>
<tr><td></td><td>FB 4 observations</td><td>FB 5 observations</td></tr>
<tr><td>NaOH</td><td>white precipitate *
soluble in excess *</td><td>no change / no reaction / no ppt *</td></tr>
<tr><td>heat</td><td colspan="2">Ignore (but see box below)</td></tr>
<tr><td rowspan="4">Al</td><td>(more) effervescence / … *</td><td>(more) … / fizzing / bubbling *</td></tr>
<tr><td colspan="2">‘more’ must be stipulated if bubbling, etc., reported on heating</td></tr>
<tr><td>gas / NH_3 turns (red) litmus blue *</td><td>(gas / H_2) pops with a lighted splint *</td></tr>
<tr><td colspan="2">Reject gas test observation if NH_3 (or any other gas) was identified on heating alone</td></tr>
</table>
Two * = 1 mark (round down). maximum 3 marks
</td><td>3</td></tr>
</table>

Question	Answer	Mark
3(c)	(acidified) $KMnO_4$ Allow potassium manganate(VII) / potassium permanganate Allow: $K_2Cr_2O_7$ / potassium dichromate (Other oxidising reagents are possible)	**1**
	Explanation $KMnO_4$ is an oxidising agent / $KMnO_4$ can be reduced. Allow similar explanation for $K_2Cr_2O_7$ / other suitable oxidising agent	**1**
	Observations with $KMnO_4$ • **FB 4:** no reaction / no change / (purple solution) not decolourised / solution stays purple **AND** • **FB 5:** $KMnO_4$ turns colourless / decolourised **OR** purple → colourless / purple colour disappears *allow turns brown* *allow purple → brown / turns brown (ignore any ppt)* Observations with $K_2Cr_2O_7$ • **FB 4**: no reaction / no change / solution remains orange **AND** • **FB 5**: orange to green (solution)	**1**
3(d)	**FB 4:** cation is Zn^{2+}* anion is NO_3^-* **FB 5:** cation is unknown* **AND** at least one test on each unknown was attempted* anion is SO_3^{2-} Two * = 1 mark (round down). *If all names of ions are correct, award 1 mark. (zinc, nitrate, unknown, sulfite)*	**2**

Question	Answer	Mark
3(e)	$Zn^{2+}(aq) + 2OH^{-}(aq) \rightarrow Zn(OH)_2(s)$ **OR** $Zn^{2+}(aq) + CO_3^{2-}(aq) \rightarrow ZnCO_3(s)$ Allow ecf for any Group 2 cation or Al^{3+} identified in **(d)** for **FB 4**	**1**