Cambridge Assessment International Education

Cambridge International AS & A Level

CHEMISTRY **9701/31**

Paper 3 Advanced Practical Skills 1 **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.

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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.

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	‘List rule’ guidance 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.

Rounding errors (RE) and transcription errors (TE) are penalised only once in the paper.

Question	Answer	Mark
1(a)	**I** Four (or more) experiments completed **AND** Table on page 4 with correct headings showing • volume of **FA 1** • volume of water • time • rate Allow vol. Ignore V or **FA 1** alone. Ignore extra columns of data. Ignore data for this mark.	**1**
	II Correct units for all data (in heading or for each entry) • volume: in cm^3 or / cm^3 or (cm^3) or cm^3 • time: / s or (s) or s by each time Allow *in seconds* • rate: / s^{-1} or (s^{-1}) or s^{-1} Ignore factor of 1000	**1**
	III All times recorded to nearest second (minimum of 3 times) **AND** volumes of **FA 1** and water recorded to the nearest 0.05 cm^3	**1**
	IV **Three** additional experiments with volume **FA 1** not less than 6.00 cm^3, not more than 20.00 cm^3 and no volume less than 2.00 cm^3 close to another volume. Reject if further additional experiments carried out. Reject if all 3 additional experiments are between 20 and 10 cm^3.	**1**
	V Volumes of water chosen so that **FA1** + water = 20.00 cm^3 for additional experiments carried out. Reject if **FA 1** = 0 Reject if no times recorded.	**1**

Question	Answer	Mark
1(a)	**VI** Correctly calculates rate for **all** experiments and answer shown to 2–4 sf. Use of significant figures or decimal places does not have to be consistent. Allow for a minimum of 3 experiments attempted.	**1**
	Round times to the nearest second before awarding Q marks. Convert times recorded as decimals to seconds, e.g.1.42 (1:42) = 102 s **VII** Award if **all** candidate's times increase with decrease in volume of **FA 1**. Reject if fewer than 4 experiments carried out.	**1**
	Calculate candidate's ratio $\frac{\text{time for FA 1} = 10}{\text{time FA 1} = 20}$ *to 2 dp* *and record the value under the results table.*	
	VIII Award if ratio is between 3.20 and 4.80	**1**
	IX Award if ratio is between 3.50 and 4.50	**1**
	X Award if ratio is between 3.80 and 4.20	**1**
1(b)	**I** Linear scales that cover more than half the space in both directions including (0,0) **AND** axes correctly orientated and clearly labelled *If scale is non-linear then **II** is not available.*	**1**
	II Points plotted correctly. Points must be within half a small square of the correct position. If the point should be on a line it must be on the line and if it should not be on the line it must not be so. 'Blobs' should be less than half a small square across and be correctly centred. Reject if the scale is non-linear.	**1**

Question	Answer	Mark
1(b)	**III** Line of best fit drawn which ignores anomalous results identified by the candidate. The line may be a smooth curve or straight **AND** use a minimum of 3 points. Ignore points which are circled or labelled as anomalous. Reject if a point has been shown at the origin and the line of best fit does not pass within 5 small squares of (0,0).	**1**
1(c)	Correct lines drawn within 1 small square Allow if horizontal line drawn and some mark shown at 5.	**1**
	Rate must be read to within correct half a small square, compared with examiner-read value. **AND** Correctly calculates 1000 / rate **AND** answer correct to 2–4 sf or a whole number of seconds (unless penalised in **1(a)VI**). Reject if the portion of the scale used for the reading is non-linear.	**1**
1(d)(i)	Correctly calculates Expt 1: 20 cm^3 in total volume 60 cm^3 ⇒ 1.67×10^{-2} mol dm^{-3} Expt 2: 10 cm^3 in total volume 60 cm^3 ⇒ 0.83×10^{-2} mol dm^{-3}	**1**
	$\frac{20}{10} = \frac{1.67}{0.83}$ so directly proportional Allow directly proportional as total volume unchanged but volume of **FA 1 /** KI doubled / halved.	**1**
	*If neither mark is awarded, then allow a total of one mark in **(d)(i)** for a correct calculation of moles of KI in Experiments 1 and 2 (1×10^{-3} and 5×10^{-4} mol respectively).*	

Question	Answer	Mark
1(d)(ii)	Graph: comment must refer to the shape of the line drawn. Curve: as concentration / volume (of iodide ions) increases rate increases more / not directly proportional as line is a curve / not a straight line Straight line: rate is proportional to concentration (of iodide ions) / proportional as line has a positive gradient Reject directly proportional unless the straight line passes within 5 small squares of (0,0). **OR** Table: compares ratio of concentrations / volumes of **FA 1** with ratio of rates	**1**
	Reason: (plotted points give) line of increasing gradient (This mark is not available if a straight line was drawn.) **OR** t_2 greater than $2t_1$ (or similar correct comparison) e.g. 'not directly proportional as rate increases more than concentration / volume'	**1**
1(e)(i)	$S_2O_3^{2-}(aq) + 2H^+(aq) \rightarrow S(s) + SO_2(aq/g) + H_2O(l)$	**1**
1(e)(ii)	worse – less thio / **FA 3** left in the reaction mixture to react with iodine formed / so time decreased for each run (owtte) e.g. 'some **FA 2** reacts with **FA 3** before starting the experiment.' Allow: same – the concentration of thio / **FA 3** is very small so slow reaction with Fe^{3+} / acid / **FA 2** so negligible effect / similar decrease in concentration of thio / **FA 3** for each run so effects cancel better – quicker to transfer all the other reactants into the 1st beaker / takes more time to pour from measuring cylinder	**1**
1(f)(i)	Volumes of **FA 1**, **FA 3** and **FA 4** are unchanged.	**1**
	FA 2 + water = 20 cm^3 Reject if these volumes are unchanged from **Experiment 2** values.	**1**

Question	Answer	Mark
1(f)(ii)	Correctly calculates $t = 178 \times \frac{10}{\text{vol FA 2}}$ Reject if volumes **FA 2** + water ≠ 20 cm^3	**1**

Question	Answer	Marks
	FA 5 is $MnCl_2 \cdot 4H_2O(s)$; **FA 6** is $MnO_2(s)$; **FA 7** is KI(aq)	
2(a)(i)	Any **three** observations on heating **FA 5**: • initially pink crystals • (on gentle heating) solid turns white / paler (pink) • condensation / water droplets / water vapour / misty fumes [1] • (gas) turns (damp blue) litmus red • melts / liquid formed / dissolves • (solid / liquid) turns brown / ochre / yellow-brown [2] • residue is dark brown / black **solid** [3] [1] Allow steam [2] Reject red-brown [3] Reject ppt Ignore bubbles of gas Ignore incorrect positive gas tests	**3**
2(a)(ii)	**FA 6** + H_2O_2: Effervescence / bubbling / fizzing	**1**
	(Gas / O_2) relights glowing splint	**1**

Question	Answer	Mark
2(a)(iii)	Observations using **FA 5**(aq): + NaOH: off-white / beige / buff / pale / light brown ppt **AND** one of: insoluble in excess **or** darkens on standing / turns brown / darker brown	**1**
	+ H_2O_2: (fizz, etc.) Ignore this box unless there is a ppt + NaOH: dark brown / black ppt Reject if ppt is formed with H_2O_2 **or** if ppt dissolves in excess NaOH Allow additional mark for gas relights glowing splint if not awarded in **(a)(ii)**.	**1**
2(b)(i)	Selects for halide: (aqueous) $AgNO_3$ / silver nitrate **and** (followed by) NH_3 / (aqueous) ammonia Ignore preliminary use of nitric acid.	**1**
	Selects for anion containing sulfur: (aqueous) $BaCl_2$ / $Ba(NO_3)_2$ or names **and** HCl / HNO_3 or names Reject if use of sulfuric acid is shown.	**1**
	If neither mark is awarded, allow 1 mark for: *$AgNO_3$ / silver nitrate – halide* ***AND** $BaCl_2$ / $Ba(NO_3)_2$ (or name) – S-anion* *Reject if use of sulfuric acid with Ba^{2+} salt is shown.*	

<table>
<tr><th>Question</th><th>Answer</th><th>Mark</th></tr>
<tr><td>2(b)(ii)</td><td>Expected observations:
<table>
<tr><td></td><td>FA 5</td><td>FA 7</td></tr>
<tr><td>+ Ag^+</td><td>white ppt *</td><td>(pale) yellow ppt *</td></tr>
<tr><td>+ NH_3</td><td>(ppt) colour darkens / off-white / buff / beige / pale brown *</td><td>(ppt) insoluble *</td></tr>
<tr><td>+ Ba^{2+}</td><td>no change / no ppt / no reaction / not needed *</td><td>no change / no ppt / no reaction / not needed *</td></tr>
<tr><td>+ H^+</td><td>ignore</td><td>ignore</td></tr>
</table>
Two * = 1 mark (round down).
Allow 1 mark for the following observations with NH_3(aq) if $AgNO_3$(aq) was not selected:
FA 5: off-white / beige / buff / pale / light brown ppt
AND
FA 7: no reaction</td><td>3</td></tr>
<tr><td>2(b)(iii)</td><td>One box = one * Two * = 1 mark (round down).
<table>
<tr><td></td><td>FA 5</td><td>FA 7</td></tr>
<tr><td>cation</td><td>Mn^{2+}</td><td>unknown</td></tr>
<tr><td>anion</td><td>Cl^-</td><td>I^-</td></tr>
</table>
Ignore K^+ for FA 7.
Allow names (manganese(II), unknown, chloride, iodide) for 1 mark.</td><td>2</td></tr>
</table>

Question	Answer	Mark
2(b)(iv)	**FA 5** + Cl_2: no reaction / no (visible) change Allow turns black / dark brown if Mn^{2+} identified.	**1**
	FA 7 + Cl_2: solution turns yellow / brown **or** black / dark grey ppt Allow ecf for bromide for either (not both) **FA 5 or FA 7**: solution turns yellow / red-brown / brown. Allow solution turns orange for either Br^- or I^-. Allow no reaction / no (visible) change if SO_3^{2-} / SO_4^{2-} identified.	**1**