Cambridge Assessment International Education

Cambridge International AS & A Level

CHEMISTRY	**9701/22**
Paper 2 AS Structured Questions	**October/November 2020**
MARK SCHEME	
Maximum Mark: 60	

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.

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:

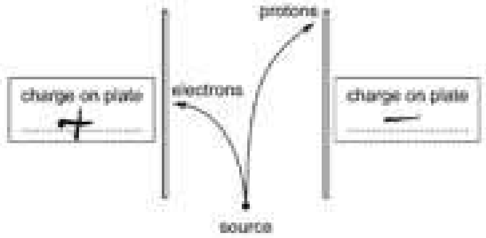
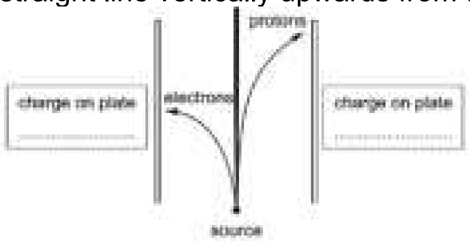
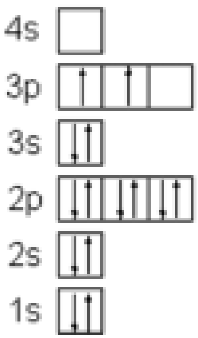
Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

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	<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	<u>Calculation specific guidance</u> 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	<u>Guidance for chemical equations</u> 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.

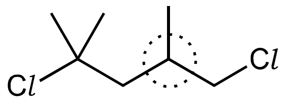
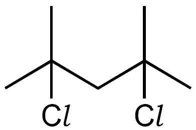
<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>1(a)(i)</td><td>positive / + on left AND negative / – on right

</td><td>1</td></tr>
<tr><td>1(a)(ii)</td><td>straight line vertically upwards from the source

</td><td>1</td></tr>
<tr><td>1(b)(i)</td><td>
<table>
<tr><td>type of orbital</td><td>s</td><td>p</td><td>d</td></tr>
<tr><td>number of orbitals</td><td>4</td><td>9</td><td>5</td></tr>
</table>
</td><td>3</td></tr>
<tr><td>1(b)(ii)</td><td>

</td><td>2</td></tr>
</table>

Question	Answer	Marks
1(b)(iii)	5	**1**
1(b)(iv)	Award one mark for each correct bullet point – max 3 marks • nuclear charge increases • extra electron(s) in inner shell / n=3 /d-subshell / d- orbital • increased shielding (of 4s electrons by electrons in n=3 / 3^{rd} shell / 3d) • (overall) **similar** nuclear attraction (for outer electron)	**3**
1(c)	*answer in terms of* ***subatomic particles*** *in the* ***nucleus*** same (number of) protons **AND** different (number of) neutrons	**1**

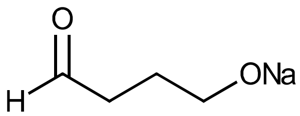
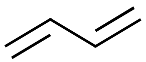
Question	Answer	Marks
2(a)	more acidic / less basic (from Na to S across period)	**1**
2(b)	**M1:** increases (from Na to S / across period)	**2**
	M2: increasing (number of) **valence** electrons **OR** (number of) electrons in **outer** (electron) shell increases	
2(c)	see table below	**2**

reaction	**name** of product
sodium oxide with water	sodium hydroxide
phosphorus(V) oxide with water	phosphoric(V) acid

Question	Answer	Marks
2(d)	**M1:** *identification of forces broken during melting of phosphorus(V) oxide* intermolecular forces in phosphorus(V) oxide (are broken)	3
	M2: *identification of force broken during melting of magnesium oxide* electrostatic forces of attraction between (many oppositely charged) **ions** in magnesium oxide	
	M3: *statement linking difference in strength of appropriate forces described in M1& M2 to explain difference in melting point* (only) **intermolecular forces** weaker than forces (of attraction) between ions / ionic bonds	
2(e)(i)	$Al_2O_3 + 6HCl \rightarrow 2AlCl_3 + 3H_2O$	1
2(e)(ii)	$Al_2O_3 + 2NaOH + 3H_2O \rightarrow 2NaAl(OH)_4$	1
2(f)	**M1:** giant	2
	M2: covalent **AND** tetrahedral / four Si—O bonds	
2(g)(i)	$Na_2O + SiO_2 \rightarrow Na_2SiO_3$	1
2(g)(ii)	$Na_2CO_3 \rightarrow Na_2O + CO_2$	1

Question	Answer	Marks
3(a)(i)	$P_4 + 10Cl_2 \rightarrow 4PCl_5$	1
3(a)(ii)	simple / molecular AND covalent	1
3(b)(i)	steamy / misty fumes	1
3(b)(ii)	$PCl_5 + 4H_2O \rightarrow H_3PO_4 + 5HCl$	1
3(b)(iii)	0 to 4	1
3(c)(i)	$LiAlH_4$ OR lithium tetrahydridoaluminate((III))	1
3(c)(ii)	**M1:** molecule with a non super-(im)posable mirror image	2
	M2: 	
3(c)(iii)		1
3(d)(i)	**M1:** (trigonal) pyramidal	2
	M2: 107	
3(d)(ii)	**M1:** proton / H^+ donor	2
	M2: partially dissociates (in solution)	

Question	Answer	Marks
3(d)(iii)	**method 1** **M1:** *show the number of mol gas produced from 0.241 g NCl_3* *[$M_r(NCl_3)$ = 120.5 1 mol NCl_3 produces 2 mol gas]* $n = 2 \times 0.241 / 120.5$ OR $n = 0.0040$ (mol gas produced.)	**4**
	M2: *correct conversion of T to Kelvin, V to m^3 and correct value of R*	
	M3: *use of equation P = nRT / V with M2 values for n, R, T and V to find pressure of mol gas produced* increase in $p = nRT/V = \dfrac{0.0040 \times 8.31 \times 293}{250 \times 10^{-6}}$ $= 3.90 \times 10^4$	
	M4: *$= 1.00 \times 10^5$ + M3 (Pa)* total pressure $= 1.00 \times 10^5 + 3.90 \times 10^4$ $= 1.39 \times 10^5$ (Pa)	
	method 2 **M1:** *calculate the produced from 0.241 g NCl_3* 0.003 (mol) Cl_2 **AND** 0.001 (mol) N_2	
	M2: *conversion of T to Kelvin, V to m^3 and correct value of R in all PV/RT equations used* **M3:** *use of equation PV / RT= n for both calculations or a combined equation with M2 values for R,T and V to find partial pressure for each of the gases* $ppCl_2$ = 29217.96 AND ppN_2 = 9739.32	
	M4: *Use P_{total} = pp unreacted gas + $ppCl_2$ + ppN_2* $1 \times 10^5 + 2.92 \times 10^4 + 9.74 \times 10^3 = 138\,940$	

Question	Answer	Marks
4(a)(i)	oxidation	**1**
4(a)(ii)	**M1:** potassium dichromate[(VI)] **M2:** acid(ified) AND (heat under) **reflux**	**2**
4(a)(iii)	*structure of **H***  OR $CHO(CH_2)_2CH_2O^- Na^+$	**1**
4(a)(iv)	(formation of) silver mirror / ppt	**1**
4(a)(v)	esterification	**1**
4(b)(i)	positional (isomerism) / regioisomerism	**1**
4(b)(ii)	**M1:** add aqueous alkaline iodine	**2**
	M2: G no change **AND J** yellow ppt	
4(b)(iii)	reducing agent	**1**
4(b)(iv)	(1,3-)butadiene OR buta(-1,3-)diene OR 	**1**

Question	Answer	Marks
4(c)	<table><tr><th>reagent</th><th>result with P</th><th>result with Q</th></tr><tr><td>$Br_2(aq)$</td><td>no change / **stays** orange</td><td>no change / **stays** orange</td></tr><tr><td>2,4-DNPH</td><td>no change</td><td>orange ppt</td></tr><tr><td>Na_2CO_3</td><td>effervescence</td><td>no change</td></tr></table> Award one mark for every two correct observations.	**3**
4(d)(i)	X is C=O **AND** Z is C—O	**1**
4(d)(ii)	hexanoic acid	**1**
4(d)(iii)	$C_{12}H_{20}O_2$	**1**