Cambridge International AS & A Level

Cambridge Assessment International Education
Cambridge International Advanced Subsidiary and Advanced Level

CHEMISTRY **9701/22**

Paper 2 AS Structured Questions **October/November 2018**

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 2018 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

Cambridge Assessment International Education

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**:

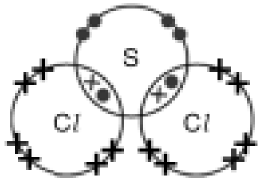
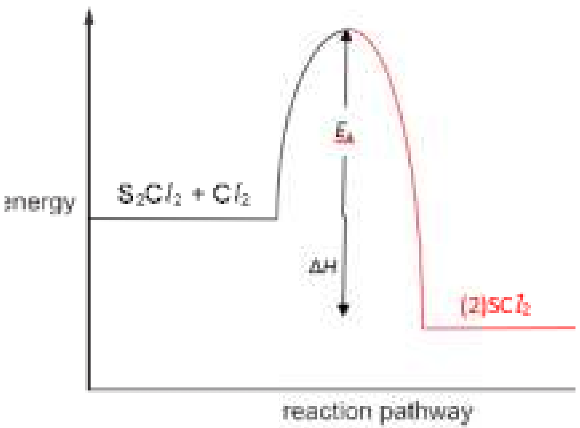
- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can 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.

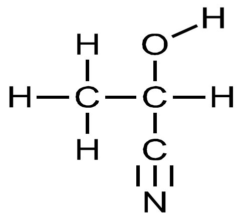
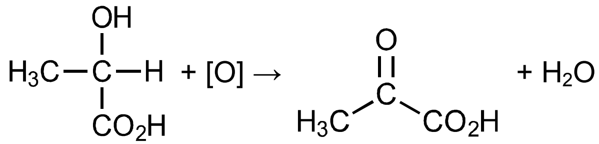
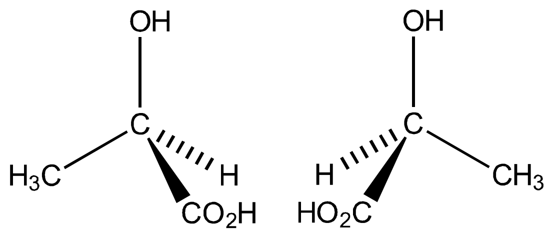
Question	Answer	Marks
1(a)	<table><tr><td>particle</td><td>relative mass</td><td>relative charge</td><td>location</td><td>total number in an atom of ^{197}Au</td></tr><tr><td>electron</td><td>0.0005</td><td>–1</td><td>**shell(s)** [1]</td><td>79</td></tr><tr><td>neutron</td><td>**1.(001)** [1]</td><td>**0** [1]</td><td>nucleus</td><td>**118** [1]</td></tr></table>	**4**
1(b)	metallic	**1**
1(c)(i)	**M1** (atoms of the same element) with the same proton / atomic number [1] **M2** (but) different number of neutrons/mass number [1]	**2**
1(c)(ii)	same number of electrons/electronic structure	**1**
1(d)(i)	(100 – 56.36 – 25.14) = 18.5(0)	**1**
1(d)(ii)	**M1** correct use of ^{63}Cu and ^{65}Cu and their % abundance [1] **M2** ÷ (56.36 + 25.14) **AND** answer correct to two decimal places [1]	**2**

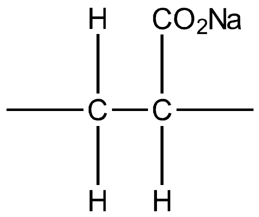
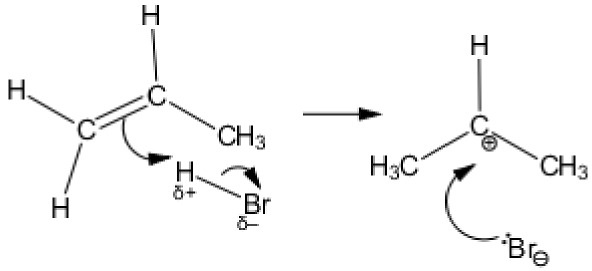
<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>2(a)</td><td>
<table>
<tr><td>Na</td><td>Mg</td><td>Al</td><td>Si</td><td>P</td></tr>
<tr><td>metallic</td><td>metallic</td><td>metallic</td><td>covalent</td><td>covalent</td></tr>
<tr><td>Na_2O</td><td>MgO</td><td>Al_2O_3</td><td>SiO_2</td><td>P_4O_{10}</td></tr>
<tr><td>NaCl</td><td>$MgCl_2$</td><td>$AlCl_3$</td><td>$SiCl_4$</td><td>PCl_5</td></tr>
</table>
[1] for each correct row</td><td>3</td></tr>
<tr><td>2(b)(i)</td><td>
</td><td>1</td></tr>
<tr><td>2(b)(ii)</td><td>

M1 profile for exothermic reaction [1]
M2 identification of ΔH and E_a [1]</td><td>2</td></tr>
<tr><td>2(c)(i)</td><td>graph rises to maximum for Si, then falls</td><td>1</td></tr>
</table>

Question	Answer	Marks
2(c)(ii)	**Max. 3 from:** • increasing strength of metallic bond; Na < Mg < A*l* OR stronger attraction between delocalised electrons and (positive) ion so melting point of Na < Mg < A*l* • Si is giant covalent **AND** it has the highest melting point due to breaking / presence of strong (covalent) bonds OR Si requires the most energy because the covalent bonds in Si are stronger than metallic bonds (in Na / Mg / A*l*) • P and S have weak(er) intermolecular forces / induced dipoles / van der Waals forces (than covalent / metallic bonds) so have low(er) melting points • $S_{(8)}$ has stronger / more intermolecular forces / van der Waals forces / induced dipoles than $P_{(4)}$ so melting point of $S_{(8)}$ is higher	**3**
2(d)	$P_4O_{10} + 6H_2O \rightarrow 4H_3PO_4$	**1**
2(e)	**M1** acid rain [1] **M2** any of the following [1] • lowers pH / increases acidity of rivers / lakes / oceans / water supplies / seas / soil / ground water • kills / harms / damages fish / coral / aquatic life / plants / crops / trees or deforestation • leaches (toxic) aluminium (ions / salts) from soil (into rivers/lakes) • leaches away soil nutrients / soil unfit for agriculture • damages / weathers / erodes / destroys buildings / statues • causes breathing difficulties	**2**
2(f)	**M1** process of 'first ionisation energy' involves the loss/removal of an electron [1] **M2** Mg and A*l* **AND** S and P (in either order) [1] **M3** For A*l* **<u>3</u>p** (orbital / sub-level / sub-shell) is higher in energy / further from the nucleus / more shielded (than Mg) [1] *ora* **M4** For S the pair of electrons in the (3)**p-orbital** repel [1] *ora*	**4**

Question	Answer	Marks
3(a)	ΔH_r = (–692.9)+3(–61.8)- (–182.1) –3(–204.6) = –82.4 (kJ mol^{-1}) **M1** ΔH_r = *x*(–692.9) + *y*(–61.8) –*v*(–182.1) –*w*(–204.6) where *x y v* and *w* are integers ⩾1 [1] **M2** use of correct stoichiometry where *x* =1 *y* =3 *v* =1 and *w*=3 [1] **M3** –82.4 [1]	**3**
3(b)(i)	1 mark for each bullet, max 3 • particles / molecules have (mass but) negligible size / volume (compared to total volume of gas / container) • no / negligible forces / interactions between particles / molecules • collision between particles / molecules are elastic • gas obeys (all) basic gas laws	**3**
3(b)(ii)	**M1** particles / molecules are (so) close [1] **M2** particle / molecule size becomes significant [1] OR <u>repulsive</u> forces between particle / molecules become significant	**2**
3(c)(i)	$CHCl_3 + \frac{1}{2}O_2 \rightarrow COCl_2 + HCl$	**1**
3(c)(ii)	**M1** **X** marked on peak at 1670–1740 cm^{-1} [1] **M2** $CHCl_3$ has no C=O [1]	**2**
3(c)(iii)	(It / $CHCl_3$ has a) peak at 2850–2950 (cm^{-1}) OR carbonyl dichloride spectrum has no peak 2850–2950 (cm^{-1})	**1**

Question	Answer	Marks
4(a)(i)		**1**
4(a)(ii)	dehydration	**1**
4(a)(iii)		**1**
4(a)(iv)	$Na_2Cr_2O_7$ / $K_2Cr_2O_7$ **AND** (dilute) H_2SO_4 / H^+(aq) / acidified	**1**
4(b)(i)	(Molecules that are) non-super(im)posable mirror images	**1**
4(b)(ii)	 **M1** correct 3-d drawing of one isomer of Q [1] **M2** correct pair of 3-d structures of the optical isomers of Q [1]	**2**

Question	Answer	Marks
4(c)	 OR $-CH_2CH(CO_2Na)-$	**3**
4(d)(i)	**M1** I experiences a (greater positive) inductive effect due to more alkyl groups OR I contains more electron donating alkyl groups (than II) [1] **M2** which stabilises the charge / reduces the charge (on the ion/intermediate) OR spreads the charge across the ion / molecule / intermediate [1]	**2**
4(d)(ii)	 **M1** curly arrow from double bond to H of H—Br [1] **M2** curly arrow from H—Br bond to Br **AND** correct dipole on H—Br [1] **M3** curly arrow from lone pair on Br^- to C^+ [1]	**3**
4(d)(iii)	nucleophilic substitution	**1**
4(e)(i)	$CH_3COCO_2H + 6[H] \rightarrow CH_3CHOHCH_2OH + H_2O$ **M1** correct organic product $CH_3CHOHCH_2OH$ [1] **M2** [H] present as reactant with H_2O as product and balancing [1]	**2**
4(e)(ii)	$1s^2\ 2s^2\ 2p^6\ (3s^0)$	**1**

Question	Answer	Marks
4(e)(iii)	Ions/elements have more shells / energy levels (as the group is descended)	**1**