Cambridge International AS & A Level

Cambridge Assessment International Education
Cambridge International Advanced Subsidiary and Advanced Level

CHEMISTRY **9701/22**

Paper 2 AS Level Structured Questions **May/June 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 May/June 2018 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**:

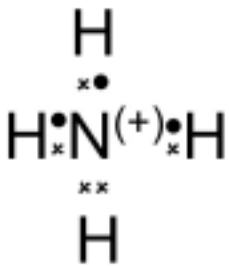
- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can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

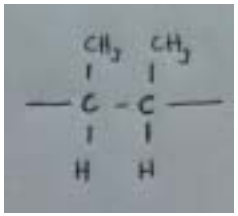
Rules must be applied consistently e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

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)(i)	$Mg + 2H_2O \rightarrow Mg(OH)_2 + H_2$	**1**
1(a)(ii)	the product / $Mg(OH)_2$ sparingly soluble / slightly soluble / less soluble (than NaOH)	**1**
1(b)(i)	*any two from:* • (from Mg to Ba) larger (atomic) radius / more shells / more shielding • electron(s) are less tightly held (by nucleus) / less attracted (to nucleus) • ionisation energy / ies decrease(s) / electron(s) lost (more) easily (down the group) • lower activation energy (for the reactions down the group)	**2**
1(b)(ii)	white light / white flame	**1**
	white smoke / white solid	**1**
	$2Mg(s) + O_2(g) \rightarrow 2MgO(s)$	**1**
1(b)(iii)	$Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$	**1**
1(b)(iv)	*any two from:* • increasing (cation) size / (cat)ionic radius increases / increasing size of atoms • overall charge on (cation) is constant / (+)2 / decreasing charge density of (+2 charged cation) • number of delocalised / outer / valence electrons (per atom) remains the same / 2 • increased shielding	**2**
	decreasing (strength of) attraction between (cat)ion / nucleus / nuclear charge **AND** delocalised electron(s)	**1**

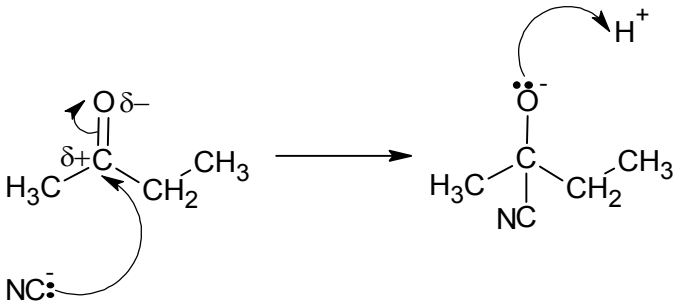
Question	Answer	Marks
2(a)	*option 1:* the mass of (all the atoms/ions in) a formula (unit) / molecule OR the (weighted) average / (weighted) mean mass of (all the atoms / ions in) the formula (unit) / molecule [1] relative / compared to 1 / 12 (the mass of an atom) of carbon–12 OR on a scale in which a carbon–12 (atom / isotope) has a (mass) of (exactly) 12 (units) [1] *option 2:* mass of one mol of a compound / formula (unit) / molecule [1] relative / compared to 1 / 12 (the mass) of 1 mol of C-12 OR in which one mol C-12 (atom / isotope) is (a mass of exactly) 12 g [1]	**2**
2(b)(i)		
	4 shared pairs only (any symbols) (in NH_4)	**1**
	3 × dot-and-cross bonds AND 1 × 2 crosses (in NH_4)	**1**
2(b)(ii)	tetrahedral	**1**
	109–109.5° (inclusive)	**1**

Question	Answer	Marks
2c(i)	*in any order explain meaning of:* *weak* partially ionises / incompletely dissociates (into ions) *Bronsted-Lowry acid* is a proton donor / H^+ (ion) donor / hydrogen ion donor	**2**
2c(ii)	$NH_4^+(aq) + H_2O(l) \rightleftharpoons NH_3(aq \text{ or } g) + H_3O^+(aq)$	
	all correct species and balancing	**1**
	correct state symbols	**1**
2(d)(i)	$MnO_4^- + \mathbf{5}Fe^{2+} + \mathbf{8}H^+ \rightarrow Mn^{2+} + \mathbf{5}Fe^{3+} + \mathbf{4}H_2O$	**1**
2(d)(ii)	(Fe^{2+} is a) reducing agent / reductant provides/donates electron(s) / loses electron(s) / increases its oxidation number / (Fe^{2+}) becomes Fe^{3+}	**2**
2(d)(iii)	4×10^{-4} / 0.0004	**1**
2(d)(iv)	2×10^{-3} / 0.002	**1**
2(d)(v)	392	**1**
2(d)(vi)	6	**1**

Question	Answer	Marks
3(a)(i)	combustion	**1**
3(a)(ii)	$C_8H_{18} + 12½O_2 \rightarrow 8CO_2 + 9H_2O$	
	correct species	**1**
	correct balancing	**1**
3(b)(i)	cracking	**1**
3(b)(ii)	-$CH(CH_3)CH(CH_3)$- OR 	
	even number of C's in correct backbone with 'end bonds' AND no C=C	**1**
	CH_3 and H on each of two C drawn for 1 repeat unit only AND all the carbons must be tetravalent	**1**
3(b)(iii)	addition	**1**
3c(i)	catalytic converter / catalyst	**1**
3c(ii)	$2CO + NO_2 \rightarrow 2CO_2 + ½N_2$	**1**

Question	Answer	Marks
3c(iii)	(photochemical) smog / fog / haze OR global dimming	**1**
3(d)(i)	*any 2 from:* lowers pH / increases acidity of rivers / lakes / oceans / seas / soil kills/harms fish OR harms / kills coral / plants / crops / trees leaches (toxic) aluminium (ions / salts) from soil (into rivers / lakes) leaches away soil nutrients damages / weathers / erodes buildings / statues	**2**
3(d)(ii)	$NO_2 + SO_2 \rightarrow NO + SO_3$	**1**
	$SO_3 + H_2O \rightarrow H_2SO_4$	**1**
3(d)(iii)	(it is) regenerated / not used up / undergoes temporary chemical change / recovered unchanged	**1**
	$NO + ½O_2 \rightarrow NO_2$	**1**

Question	Answer	Marks
4(a)(i)	iodoform / tri-iodomethane	**1**
4(a)(ii)	butanone	**1**

Question	Answer	Marks
4(b)	$CH_3CH_2CH_2CHO$	**1**
	$(CH_3)_2CHCHO$	**1**
4(c)(i)	reduction	**1**
4(c)(ii)	$NaBH_4$ / sodium borohydride OR $LiAlH_4$ / lithium aluminium hydride	**1**
4(d)(i)		
	lone pair on C of CN^- and curly arrow to C of C=O	**1**
	correct dipole on C=O and curly arrow from = to O	**1**
	correct intermediate anion	**1**
	curly arrow from lone pair on O to H^+	**1**

Question	Answer	Marks
4(d)(ii)	optical	**1**
4(d)(iii)	(X has a) chiral centre / asymmetric carbon atom OR (X has a) C atom attached to four different groups / atoms / chains	**1**
	non-super(im)posable mirror images	**1**
4(e)(i)	*M1 is for the process of taking the % of each element and dividing by its relative atomic mass.* $\frac{\text{C}}{\frac{51.3}{12}}$ $\frac{\text{H}}{\frac{9.40}{1}}$ $\frac{\text{N}}{\frac{12.0}{14}}$ $\frac{\text{O}}{\frac{27.3}{16}}$ OR 4.28 9.40 0.857 1.71 *M2 is for dividing the smallest %/A_r into each of the remaining values to produce the correct ratio.* $\frac{4.28}{0.857}$ $\frac{9.40}{0.857}$ $\frac{0.857}{0.857}$ $\frac{1.71}{0.857}$ OR 4.9942 : 10.9685 : 1 : 1.9953	**2**
4(e)(ii)	$C_5H_{11}NO_2$ **AND** because the EFM = RFM	**1**