

CAMBRIDGE INTERNATIONAL EXAMINATIONS

Cambridge International Advanced Subsidiary and Advanced Level

MARK SCHEME for the October/November 2014 series

9701 CHEMISTRY

9701/21

Paper 2 (AS Structured Questions), maximum raw mark 60

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.

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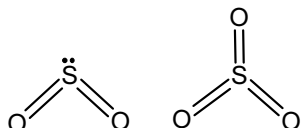
Page 2	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – October/November 2014	9701	21

Question	Mark Scheme	Marks	Total
1 (a) (i)	increasing distance of (outer) electron(s) from nucleus OR increasing distance of outer / valence shell from nucleus	1	[3]
	increased shielding / screening (from inner shells)	1	
	reduces attraction	1	
(ii)	(3 rd electron for each in) inner / lower energy level / shell / closer to nucleus (than first two) / less shielding	1	[2]
	(large) increase in nuclear attraction	1	
(b) (i)	$(1s^2 2s^2 2p^6) 3s^2 3p^6 3d^{10} 4s^2 4p^6 5s^2$	1	[1]
(ii)	four isotopes owtte	1	[1]
(iii)	$\frac{(84 \times 0.56) + (86 \times 9.86) + (87 \times 7) + (88 \times 82.58)}{100}$	1	[2]
	= 87.7 (must be 3 sig figs)	1	
(c) (i)	(a species that) gains / takes electron(s)	1	[1]

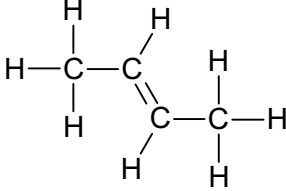
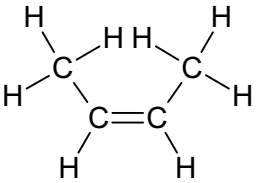
Page 3	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – October/November 2014	9701	21

Question	Mark Scheme	Marks	Total
(ii)	Ba Cl O $\frac{45.1}{137}$ $\frac{23.4}{35.5}$ $\frac{31.5}{16}$ $\frac{0.329}{0.329}$ $\frac{0.659}{0.329}$ $\frac{1.969}{0.329}$ 1.00 2.00 5.98/6 emp form = BaCl₂O₆	1 1 1	[3]
(d) (i)	X = Mg(OH)₂ Y = MgO Z = Mg(NO₃)₂	1 1 1	[3]
(ii)	reagent = nitric acid MgO + 2HNO₃ → Mg(NO₃)₂ + H₂O	1 1	[2]
(iii)	Heat/thermal decomposition	1	[1]
(iv)	Mg + 2H₂O → Mg(OH)₂ + H₂ 2Mg(NO₃)₂ → 2MgO + 4NO₂ + O₂	1 1	[2]
			[21]

Page 4	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – October/November 2014	9701	21

Question	Mark Scheme	Marks	Total
2 (a)	$4\text{FeS}_2 + 11\text{O}_2 \rightarrow 2\text{Fe}_2\text{O}_3 + 8\text{SO}_2$	1 1	[2]
(b) (i)	Very exothermic/gets very hot OR creates (acid/ H_2SO_4) spray/mist/fog/fumes	1	1
(ii)	$\text{SO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{H}_2\text{S}_2\text{O}_7$ $\text{H}_2\text{S}_2\text{O}_7 + \text{H}_2\text{O} \rightarrow 2\text{H}_2\text{SO}_4$	1 1	[2]
(c) (i)	 M1 SO_2 correct M2 SO_3 correct	1+1	[2]
(ii)	115–120° bent / non-linear 120° trigonal planar	1 1	[2]
(d) (i)	Advantage = higher rate Greater KE/energy/speed/collision frequency/proportion of successful collisions/more particles with $E > E_a$ Disadvantage – reduced yield/less product (Forward reaction) exothermic AND (hence in accordance with LCP) equilibrium/reaction shifts left (to counteract inc T) ora	1 1 1 1	[4]
(ii)	$K_p = \frac{p\text{SO}_3^2}{p\text{SO}_2^2 \times p\text{O}_2}$	1	[1]

Page 5	Mark Scheme	Syllabus	Paper
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Question	Mark Scheme	Marks	Total
(iii)	$ \begin{array}{ccc} 2\text{SO}_2(\text{g}) & + & \text{O}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g}) \\ 2 & 2 & 0 \\ (-1.8) & (-0.9) & \\ 0.2 & 1.1 & 1.80 \end{array} $ $ \begin{aligned} x\text{SO}_3 &= 1.8/3.1 = 0.581 \\ x\text{SO}_2 &= 0.2/3.1 = 0.065 \\ x\text{O}_2 &= 1.1/3.1 = 0.355 \end{aligned} $ $ K_p = \frac{0.581^2 \times (2 \times 10^5)^2}{0.065^2 \times (2 \times 10^5)^2 \times 0.355 \times 2 \times 10^5} = 1.13 \times 10^{-3} \text{ Pa}^{-1} $	1 1 1 1+1	[5]
			[19]
3 (a)	P ; $\text{CH}_2 = \text{C}(\text{CH}_3)_2$ Q ; $\text{CH}_3\text{CH}_2\text{CH} = \text{CH}_2$ R ; $\text{CH}_3\text{CH} = \text{CHCH}_3$ S ; $(\text{CH}_3)_2\text{CO}$	1 1 1 1	[4]
(b) (i)	(Different molecules with) the same (molecular and) structural formula different arrangements of atoms (in space)/ different displayed formula	1 1	 [2]
(ii)	 trans-but-2-ene  cis-but-2-ene	1 1	 [2]

Page 6	Mark Scheme	Syllabus	Paper
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Question	Mark Scheme	Marks	Total
(c)	reagent; NaBH ₄ or LiAlH ₄ or names	1	[2]
	product; propan-2-ol	1	
			[10]
4 (a)	CH ₃ CH ₂ CO ₂ H + 4[H] → CH ₃ CH ₂ CH ₂ OH + H ₂ O	1+1	[2]
(b) (i)	Oxidation	1	[1]
(ii)	Sodium/potassium dichromate or correct formula	1	[2]
	H ⁺ /acidified and (heat under) reflux	1	
(c)	2 CH ₃ CH ₂ CO ₂ H + CaCO ₃ → (CH ₃ CH ₂ CO ₂) ₂ Ca + H ₂ O + CO ₂	1+1	[2]
(d) (i)	CH ₃ CO ₂ H	1	[2]
	warm/hot/high temperature/heat/reflux AND concentrated sulfuric acid	1	
(ii)	water (or hydrogen chloride or ethanoic acid)	1	[1]
			[10]

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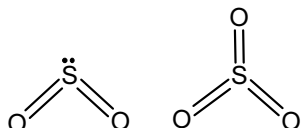
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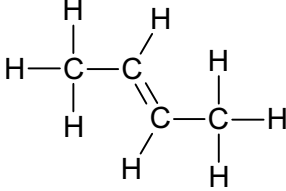
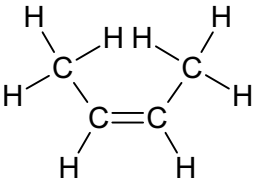
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(d) (i)	X = Mg(OH)₂ Y = MgO Z = Mg(NO₃)₂	1 1 1	[3]
(ii)	reagent = nitric acid MgO + 2HNO₃ → Mg(NO₃)₂ + H₂O	1 1	[2]
(iii)	Heat / thermal decomposition	1	[1]
(iv)	Mg + 2H₂O → Mg(OH)₂ + H₂ 2Mg(NO₃)₂ → 2MgO + 4NO₂ + O₂	1 1	[2]
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(b) (i)	Very exothermic/gets very hot OR creates (acid/ H_2SO_4) spray/mist/fog/fumes	1	1
(ii)	$\text{SO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{H}_2\text{S}_2\text{O}_7$ $\text{H}_2\text{S}_2\text{O}_7 + \text{H}_2\text{O} \rightarrow 2\text{H}_2\text{SO}_4$	1 1	[2]
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	product; propan-2-ol	1	
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(b) (i)	Oxidation	1	[1]
(ii)	Sodium/potassium dichromate or correct formula	1	[2]
	H ⁺ /acidified and (heat under) reflux	1	
(c)	2 CH ₃ CH ₂ CO ₂ H + CaCO ₃ → (CH ₃ CH ₂ CO ₂) ₂ Ca + H ₂ O + CO ₂	1+1	[2]
(d) (i)	CH ₃ CO ₂ H	1	[2]
	warm/hot/high temperature/heat/reflux AND concentrated sulfuric acid	1	
(ii)	water (or hydrogen chloride or ethanoic acid)	1	[1]
			[10]

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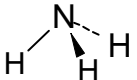
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Question	Mark Scheme	Marks	Total
1 (a) (i)	increasing distance of (outer/highest energy) electron(s) from nucleus OR increasing distance of outer/valence shell from nucleus	1	[3]
	increased shielding / screening (from inner shells)	1	
	reduces attraction	1	
(ii)	increasing cation charge / effective nuclear charge OR decreasing number of electrons compared with protons	1	[2]
	increase in attraction	1	
(b)	(boiling point) increases (down the group)	1	[4]
	increasing number of electrons (in molecules) down group	1	
	increasing strength of / more van der Waals' forces (allow correct alternatives to van der Waals' forces)	1	
	so more energy needed to overcome (the forces)	1	
(c) (i)	$\begin{array}{cc} \text{F} & \text{I} \\ \frac{42.8}{19} & \frac{57.2}{127} \\ \hline \frac{2.253}{0.450} & \frac{0.450}{0.450} \end{array}$	1	[3]
	5 1 / IF ₅	1	
	EF = MF or IF ₅ = 222	1	

Page 3	Mark Scheme	Syllabus	Paper
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(ii)	 (Yes) as electronegativities are different	1	
		1	[2]
(d) (i)	W = NaClO; X = NaClO ₃ ; Y = HCl; Z = AgCl	1 1 1 1	[4]
(ii)	$3\text{Cl}_2 + 6\text{NaOH} \rightarrow 5\text{NaCl} + \text{NaClO}_3 + 3\text{H}_2\text{O}$ M1: correct species M2: balanced equation	1 1	[2]
(iii)	0 to –1 (0 to) +5	1 1	[2]
(iv)	$\text{Ag}^+(\text{aq}) + \text{Cl}^-(\text{aq}) \rightarrow \text{AgCl}(\text{s})$		[1]
			[23]

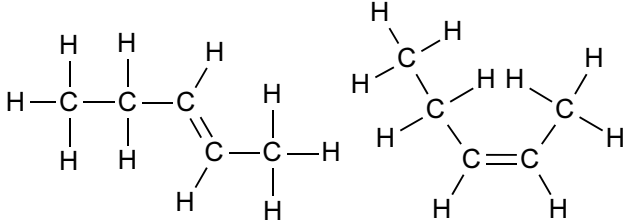
Page 4	Mark Scheme	Syllabus	Paper
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Question	Mark Scheme	Marks	Total
2 (a)	$\text{CH}_4 + \text{H}_2\text{O} \rightarrow \text{CO} + 3\text{H}_2$	1	[1]
(b)	Label on graph indicating catalysed and uncatalysed E_a OR statement E_a catalysed is lower (than E_a uncatalysed) owtte Reference to catalyst creating alternative mechanism / reaction pathway / route Idea that more molecules have sufficient energy (to react) so greater chance / frequency of <u>successful</u> collisions	1 1 1 1	[4]
(c)	 angle = 107° shape = (trigonal) pyramid(al)	1 1 1	[3]
(d) (i)	Advantage = higher rate Greater Kinetic Energy / speed / collision frequency / proportion of successful collisions Disadvantage – reduced yield / less product / more reactants (Forward reaction) exothermic AND (hence in accordance with Le Chatelier's Principle) equilibrium / reaction shifts left (to counteract increasing temp) ora	1 1 1 1	[4]
(ii)	$K_p = \frac{p\text{NH}_3^4}{p\text{N}_2 \times p\text{H}_2^3}$	1	[1]

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(iii)	$\begin{array}{ccc} \text{N}_2(\text{g}) + & 3\text{H}_2(\text{g}) \rightleftharpoons & 2\text{NH}_3(\text{g}) \\ 2 & 3 & 0 \\ (-0.8) & (-1.6 \times 3/2) & \\ \underline{1.2} & \underline{0.6} & 1.60 \end{array}$ $x\text{NH}_3 = 1.6/3.4 (= 0.471)$ $x\text{N}_2 = 1.2/3.4 (= 0.353)$ $x\text{H}_2 = 0.6/3.4 (= 0.176)$ $K_p = \frac{0.471^2 \times (2 \times 10^7)^2}{0.353 \times 2 \times 10^7 \times 0.176^3 \times (2 \times 10^7)^3} = 2.88 \times 10^{-13} \text{ Pa}^{-2}$	1 1 1+1	 [5]
			[18]

Page 6	Mark Scheme	Syllabus	Paper
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Question	Mark Scheme	Marks	Total
3 (a)	P: $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}=\text{CH}_2$ Q: $\text{CH}_3\text{CH}_2\text{CH}=\text{CHCH}_3$ R: $\text{CH}_3\text{CH}_2\text{C}(\text{CH}_3)=\text{CH}_2$ S: $\text{CH}_3\text{CH}=\text{C}(\text{CH}_3)_2$ T: $\text{CH}_3\text{CH}_2\text{COCH}_3$	1 1 1 1 1	[5]
(b) (i)	(Different molecules with the) same (molecular and) structural formula different arrangements of <u>atoms</u> (in space)	1 1	 [2]
(ii)	 trans-pent-2-ene cis-pent-2-ene	1 1	 [2]
(c)	butan-2-ol	1	[1]
			[10]

