CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2014 series

9701 CHEMISTRY

9701/22 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.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

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Cambridge is publishing the mark schemes for the May/June 2014 series for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level components and some Ordinary Level components.

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International Examinations

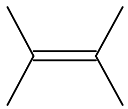
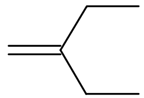
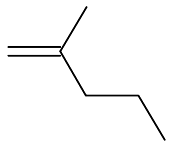
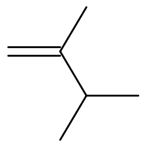
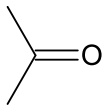
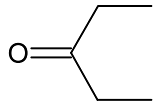
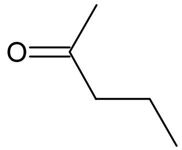
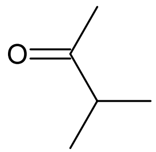
Question	Answers	Mark	Total
1 (a)	The (total) number of protons and neutrons (in the nucleus of an atom)	1	1
(b) (i)	Mass of an atom(s) or isotope relative to $\frac{1}{12}$ (the mass) of (an atom of) carbon–12 **OR** relative to carbon–12 which is (exactly) 12 (units) allow a correct expression	1 1	2
(ii)	^{79}Br ^{81}Br 78.92x 80.92(100–x) where x = % abundance of ^{79}Br so $\frac{78.92x + 80.92(100 - x)}{100}$ = 79.9 x = 51 hence $^{79}Br : ^{81}Br$ = 51 : 49	1 1 1	3

Question	Answers	Mark	Total
(c)	A: $\frac{4.31}{A_r}$ Br: $\frac{95.69}{79.9}$ = 1 : 3		
	So $\frac{95.69/79.9}{4.31/A_r}$ = 3	1	
	$A_r = \frac{3 \times 4.31 \times 79.9}{95.69}$ = 10.796 = 10.8 to 3 s.f.	1	
	3 sig figs	1	3
	allow alternative correct methods		
(d) (i)	Mg: bright / white light / flame **OR** white solid / smoke	1	
	$Mg + \frac{1}{2}O_2 \rightarrow MgO$ allow correct multiples	1	
	S: blue flame **OR** white / steamy fumes **OR** yellow solid disappears	1	
	$S + O_2 \rightarrow SO_2$ allow correct multiples	1	4
(ii)	$Al_2O_3 + 2NaOH + 7H_2O \rightarrow 2NaAl(OH)_4(H_2O)_2$ **OR** $Al_2O_3 + 2NaOH + 3H_2O \rightarrow 2NaAl(OH)_4$ **OR** $Al_2O_3 + 2NaOH \rightarrow 2NaAlO_2 + H_2O$ **OR** $Al_2O_3 + 2OH^- + 7H_2O \rightarrow 2[Al(OH)_4(H_2O)_2]^-$ **OR** $Al_2O_3 + 2OH^- + 3H_2O \rightarrow 2[Al(OH)_4]^-$ **OR** $Al_2O_3 + 2OH^- \rightarrow 2AlO_2^- + H_2O$	1	
	$Al_2O_3 + 6HCl \rightarrow 2AlCl_3 + 3H_2O$ allow correct ionic equations	1	2

Question	Answers	Mark	Total
(e)	shape of PCl_5 =(trigonal) bipyramid(al) bond angles in PCl_5 = 120° and 90°	1 1	 2
			17
2 (a) (i)	(The $C_2O_4^{2-}$ ions) lose electrons owtte / ora	1	1
(ii)	$2MnO_4^-(aq) + 5C_2O_4^{2-}(aq) + \mathbf{16}H^+(aq) \rightarrow \mathbf{2Mn^{2+}}(aq) + 10CO_2(aq) + \mathbf{8}H_2O(l)$	1+1+1	3
(b) (i)	$\frac{20.0 \times 0.100}{1000} = 2(.00) \times 10^{-3}$ (mol)	1	1
(ii)	$MnO_4^- : C_2O_4^{2-} = 2 : 5$ so amount of $C_2O_4^{2-} = (5/2) \times 2.00 \times 10^{-3} = 5(.00) \times 10^{-3}$ (mol) ecf from **(b)(i)**	1	1
(iii)	$5.00 \times 10^{-3} \times 250/25 = 0.05(0)$ (mol) ecf from **(b)(ii)**	1	1
(iv)	amount = mass / M_r so M_r = mass / amount = 6.30 / 0.05 = 126 ecf from **(b)(iii)**	1	1
(v)	126 – 90 = 36 36 / 18 = 2.00 $x = 2$ Ecf from **(b)(iv)** if suitable	1	1
			9

Question	Answers	Mark	Total
3 (a) (i)	metallic bonding	1	
	strength of attraction / metallic bonding increases (Na–A*l*) / more energy is needed to break ‘bonds’	1	
	due to increasing cation charge / charge density / increasing number of delocalised electrons / decreasing ionic radius	1	3
(ii)	van der Waals’ (forces)	1	
	are greatest / more in sulfur / relative magnitude of forces S > P > C*l* > Ar	1	
	because sulfur has the greatest number of electrons / as no. of electrons (in the molecules) decreases	1	3
(iii)	Covalent bond(s) broken **OR** (Si has a) giant covalent (structure)	1	1
(b) (i)	Nuclear charge (in Ar) greater (than C*l*) **AND** same shielding owtte	1	1
(ii)	p subshell / orbital in A*l* at higher energy (than s subshell in Mg) **ora** **OR** p subshell / orbital more shielded **ora**	1	1
(iii)	repulsion due to electron pair (in same / p orbital)	1	1
			10

Question	Answers	Mark	Total
4 (a)	physical: fractional distillation / fractionation chemical: crack(ing) (allow: reforming, isomerisation, thermal decomposition, desulfurisation)	1 1	2
(b) (i)	Strong (C–C and C–H) bonds / high bond energies Non-polar / C and H have similar electronegativities	1 1	2
(ii)	109.5° **AND** 120° (117° – 122°)	1	1
(iii)	ethane = tetrahedral ethene = trigonal planar	1	1
(iv)	4 × σ / single bonds on Cs in ethane **AND** 3 × σ and 1 × π on Cs in ethene **OR** 2 × single and 1 × double on Cs in ethene allow from suitable labelled diagram	1	1
(c) (i)	$Cl_2 \rightarrow 2Cl\bullet$ $C_2H_6 + Cl\bullet \rightarrow \bullet C_2H_5 + HCl$ $\bullet C_2H_5 + Cl_2 \rightarrow C_2H_5Cl + Cl\bullet$ $\bullet C_2H_5 + Cl\bullet \rightarrow C_2H_5Cl$ correct alternative terminations allowed initiation, propagation, termination (correctly assigned)	1 1 1 1 1	5
(ii)	$\bullet C_2H_5 + \bullet C_2H_5 \rightarrow C_4H_{10}$	1	1
			13

Question	Answers	Mark	Total
5 (a) (i)	decolourisation of bromine: P is an alkene / contains C=C / is unsaturated hot conc. manganate(VII): breaks C=C **OR** single product implies P is symmetrical **OR** single organic product implies terminal $=CH_2$ as methanal is oxidised to CO_2 2,4–DNPH confirms >C=O / carbonyl / ketone in Q no reaction with Tollens': Q is not an aldehyde / is a ketone	1 1 1 1	 **4**
(ii)	    (2,3–)dimethylbut–2–ene, 2–ethylbut(–1–)ene, 2–methylpent–1–ene, (2,3–)dimethylbut(–1–)ene	1 1	 **2**
(iii)	    propan(–2–)one / acetone, pentan–3–one, pentan–2–one, 3–methylbutan(–2–)one ecf possible on **(a)(ii)**	1 1	 **2**
(b)	any 3 of $CH_3CH=C(CH_3)C_2H_5$ $CH_3CH=CHCH_2CH_2CH_3$ $CH_3CH=CHCH(CH_3)_2$ $C_2H_5CH=CHC_2H_5$	 1 1 1 1	 **max 3**
			11