

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.

Cambridge will not enter into discussions about these mark schemes.

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

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| Question | Answers | Mark | Total |
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| (c) | $\frac{A}{A_r} \quad \frac{Br}{79.9} = 1:3$ $\text{So } \frac{95.69/79.9}{4.31/A_r} = 3$ $A_r = \frac{3 \times 4.31 \times 79.9}{95.69} = 10.796 = 10.8 \text{ to 3 s.f.}$ <p>3 sig figs</p> <p>allow alternative correct methods</p> | <p>1</p> <p>1</p> <p>1</p> | 3 |
| (d) (i) | <p>Mg: bright/white light/flame OR white solid/smoke</p> $\text{Mg} + \frac{1}{2} \text{O}_2 \rightarrow \text{MgO}$ <p>allow correct multiples</p> <p>S: blue flame OR white/steamy fumes OR yellow solid disappears</p> $\text{S} + \text{O}_2 \rightarrow \text{SO}_2$ <p>allow correct multiples</p> | <p>1</p> <p>1</p> <p>1</p> <p>1</p> | 4 |
| (ii) | $\text{Al}_2\text{O}_3 + 2\text{NaOH} + 7\text{H}_2\text{O} \rightarrow 2\text{NaAl}(\text{OH})_4(\text{H}_2\text{O})_2 \text{ OR}$ $\text{Al}_2\text{O}_3 + 2\text{NaOH} + 3\text{H}_2\text{O} \rightarrow 2\text{NaAl}(\text{OH})_4 \text{ OR}$ $\text{Al}_2\text{O}_3 + 2\text{NaOH} \rightarrow 2\text{NaAlO}_2 + \text{H}_2\text{O} \text{ OR}$ $\text{Al}_2\text{O}_3 + 2\text{OH}^- + 7\text{H}_2\text{O} \rightarrow 2[\text{Al}(\text{OH})_4(\text{H}_2\text{O})_2]^- \text{ OR}$ $\text{Al}_2\text{O}_3 + 2\text{OH}^- + 3\text{H}_2\text{O} \rightarrow 2[\text{Al}(\text{OH})_4]^- \text{ OR}$ $\text{Al}_2\text{O}_3 + 2\text{OH}^- \rightarrow 2\text{AlO}_2^- + \text{H}_2\text{O}$ $\text{Al}_2\text{O}_3 + 6\text{HCl} \rightarrow 2\text{AlCl}_3 + 3\text{H}_2\text{O}$ <p>allow correct ionic equations</p> | <p>1</p> <p>1</p> | 2 |

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| 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) | $2MnO_4^-(aq) + 5C_2O_4^{2-}(aq) + 16H^+(aq) \rightarrow 2Mn^{2+}(aq) + 10CO_2(aq) + 8H_2O(l)$ | 1+1+1 | 3 |
| (b) (i) | $\frac{20.0 \times 0.100}{1000} = 2(.00) \times 10^{-3} \text{ (mol)}$ | 1 | 1 |
| (ii) | $MnO_4^- : C_2O_4^{2-} = 2 : 5$ so amount of $C_2O_4^{2-} = (5/2) \times 2.00 \times 10^{-3} = 5(.00) \times 10^{-3} \text{ (mol)}$ ecf from (b)(i) | 1 | 1 |
| (iii) | $5.00 \times 10^{-3} \times 250/25 = 0.05(0) \text{ (mol)}$ 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 |

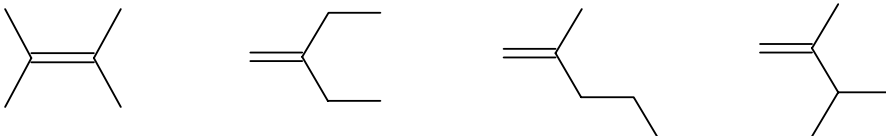
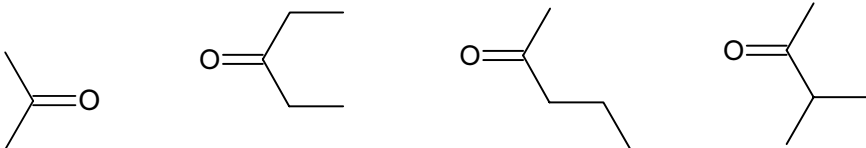
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| Question | Answers | Mark | Total |
|-----------|--|------|-----------|
| 3 (a) (i) | metallic bonding | 1 | 3 |
| | strength of attraction / metallic bonding increases (Na–Al) / more energy is needed to break 'bonds' | 1 | |
| | due to increasing cation charge / charge density / increasing number of delocalised electrons / decreasing ionic radius | 1 | |
| (ii) | van der Waals' (forces) | 1 | 3 |
| | are greatest / more in sulfur / relative magnitude of forces $S > P > Cl > Ar$ | 1 | |
| | because sulfur has the greatest number of electrons / as no. of electrons (in the molecules) decreases | 1 | |
| (iii) | <u>Covalent</u> bond(s) broken OR (Si has a) giant covalent (structure) | 1 | 1 |
| (b) (i) | Nuclear charge (in Ar) greater (than Cl) AND same shielding owtte | 1 | 1 |
| (ii) | p subshell / orbital in Al 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 |

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| Question | Answers | Mark | Total |
|----------|--|--------|-----------|
| 4 (a) | physical: <u>fractional</u> distillation/fractionation | 1 | 2 |
| | chemical: crack(ing) (allow: reforming, isomerisation, thermal decomposition, desulfurisation) | 1 | |
| (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) | $Cl_2 \rightarrow 2Cl\cdot$ | 1 | 5 |
| | $C_2H_6 + Cl\cdot \rightarrow \cdot C_2H_5 + HCl$ | 1 | |
| | $\cdot C_2H_5 + Cl_2 \rightarrow C_2H_5Cl + Cl\cdot$ | 1 | |
| | $\cdot C_2H_5 + Cl\cdot \rightarrow C_2H_5Cl$ | 1 | |
| | correct alternative terminations allowed | | |
| | initiation, propagation, termination (correctly assigned) | 1 | |
| (ii) | $\cdot C_2H_5 + \cdot C_2H_5 \rightarrow C_4H_{10}$ | 1 | 1 |
| | | | 13 |

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| Question | Answers | Mark | Total |
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| 5 (a) (i) | <p>decolourisation of bromine: P is an alkene / contains C=C / is unsaturated</p> <p>hot conc. manganate(VII): breaks C=C OR single product implies P is symmetrical OR single organic product implies terminal =CH₂ as methanal is oxidised to CO₂</p> <p>2,4-DNPH confirms >C=O / carbonyl / ketone in Q</p> <p>no reaction with Tollens': Q is not an aldehyde / is a ketone</p> | <p>1</p> <p>1</p> <p>1</p> <p>1</p> | 4 |
| (ii) |  <p>(2,3-)dimethylbut-2-ene, 2-ethylbut(-1-)ene, 2-methylpent-1-ene, (2,3-)dimethylbut(-1-)ene</p> | <p>1</p> <p>1</p> | 2 |
| (iii) |  <p>propan(-2-)one / acetone, pentan-3-one, pentan-2-one, 3-methylbutan(-2-)one ecf possible on (a)(ii)</p> | <p>1</p> <p>1</p> | 2 |
| (b) | <p>any 3 of</p> <p>CH₃CH=C(CH₃)C₂H₅ CH₃CH=CHCH₂CH₂CH₃ CH₃CH=CHCH(CH₃)₂ C₂H₅CH=CHC₂H₅</p> | <p>1</p> <p>1</p> <p>1</p> <p>1</p> | max 3 |
| | | | 11 |