

CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Level

MARK SCHEME for the October/November 2013 series

9701 CHEMISTRY

9701/41

Paper 4 (A2 Structured Questions), maximum raw mark 100

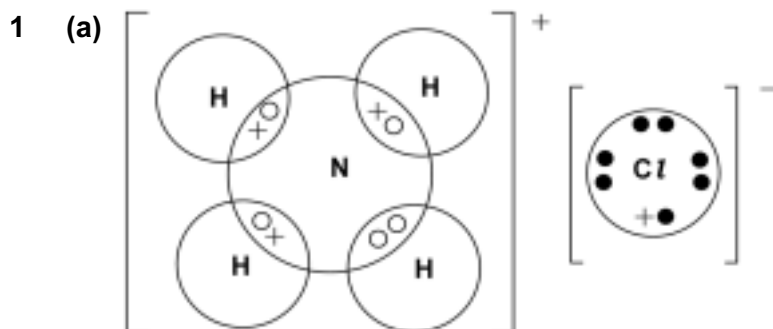
This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, 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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8 e⁻ around chlorine

[1]

1 H-electron (+) on the Cl⁻ ion

[1]

3 covalent (oo) and one dative (oo) around N

[1]

[3]

(b) (i) it would react (with H₂SO₄)

[1]

(ii) CaO + H₂O → Ca(OH)₂

[1]

(iii) CaO absorbs more water or CaO has greater affinity for water

[1]

[3]

(c) (i) 2Ca(NO₃)₂ → 2CaO + 4NO₂ + O₂

[1]

(ii) (Down the group, the nitrates)

become more stable/stability increases

[1]

because the size/radius of ion (M²⁺) increases

[1]

thus causing less polarisation/distortion
of the anion/NO₃⁻/N-O bond

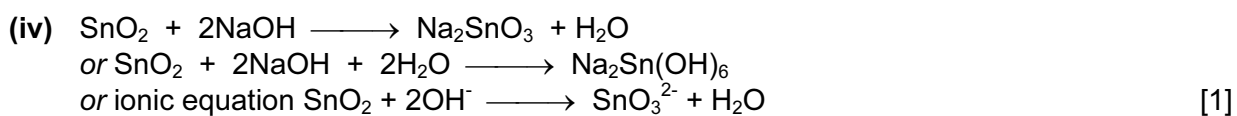
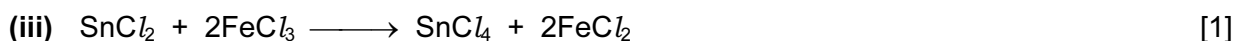
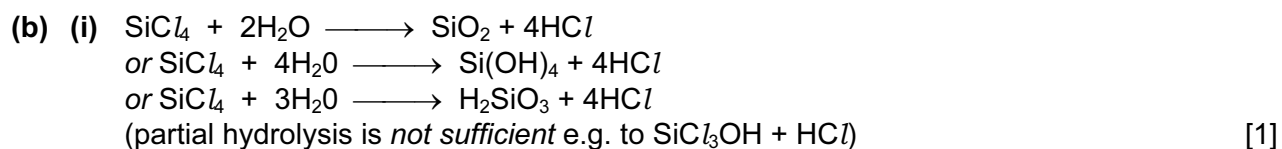
[1]

[4]

[Total: 10]

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- 2 (a) (i) Si-Si bonds are weaker (than C-C bonds) [1]
- (ii) metallic (Sn) is weaker than (giant) covalent (Ge) [1]
- [2]



[4]

[Total: 6]

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- 3 (a) (i) $\text{NH}_3 + \text{HZ} \longrightarrow \text{NH}_4^+ + \text{Z}^-$ [1]
 $\text{CH}_3\text{OH} + \text{HZ} \longrightarrow \text{CH}_3\text{OH}_2^+ + \text{Z}^-$ [1]
- (ii) $\text{NH}_3 + \text{B}^- \longrightarrow \text{NH}_2^- + \text{BH}$ [1]
 $\text{CH}_3\text{OH} + \text{B}^- \longrightarrow \text{CH}_3\text{O}^- + \text{BH}$ [1]
- [4]
- (b) (i) a reaction that can go in either direction [1]
- (ii) **rate** of forward = **rate** of backward reaction [1]
or forward/back reactions occurring but concentrations of all species do not change [1]
- [2]
- (c) (i) a solution that resists changes in pH [1]
when small quantities of acid or base/alkali are added [1]
- (ii) in the equilibrium system $\text{HZ} + \text{H}_2\text{O} \rightleftharpoons \text{Z}^- + \text{H}_3\text{O}^+$ [1]
addition of acid: reaction moves to the left
or H^+ combines with Z^- **and** forms HZ [1]
addition of base: the reaction moves to the right
or H^+ combines with OH^- **and** more Z^- formed [1]
- [5 max 4]
- (d) (i) $[\text{H}^+] = \sqrt{(0.5 \times 1.34 \times 10^{-5})} = 2.59 \times 10^{-3} \text{ (mol dm}^{-3}\text{)}$ [1]
pH = **2.59/2.6** (min 1 d.p) ecf [1]
- (ii) $\text{CH}_3\text{CH}_2\text{CO}_2\text{H} + \text{NaOH} \longrightarrow \text{CH}_3\text{CH}_2\text{CO}_2\text{Na} + \text{H}_2\text{O}$ [1]
- (iii) $n(\text{acid})$ in $100 \text{ cm}^3 = 0.5 \times 100/1000 = 0.05 \text{ mol}$
 $n(\text{acid})$ remaining = $0.05 - 0.03 = 0.02 \text{ mol}$
 $[\text{acid remaining}] = \mathbf{0.2} \text{ (mol dm}^{-3}\text{)}$ [1]
likewise, $n(\text{salt}) = 0.03 \text{ mol}$
 $[\text{salt}] = \mathbf{0.3} \text{ (mol dm}^{-3}\text{)}$ [1]
- (iv) $\text{pH} = 4.87 + \log(0.3/0.2) = \mathbf{5.04-5.05}$ ecf [1]
- [6]
- (e) **G** is $\text{CH}_3\text{CH}_2\text{COCl}$
H is SOCl_2 or PCl_5
J is NaCl [2]
(or corresponding Br compounds for **G**, **H** and **J**; $\text{CH}_3\text{CH}_2\text{COBr}$, SOBr_2 , NaBr)

[Total: 18]

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- 4 (a) (the energy change) when 1 mol of bonds is broken in the gas phase [1]
[1]

[2]

- (b) (i) (C-X bond energy) decreases/becomes weaker (from F to I) [1]

due to bond becoming longer/not such efficient orbital overlap [1]

- (ii) (as the bond energy of C-X decreases) the halogenalkanes become more reactive (answer must imply that it is from F to I) [1]

[3]

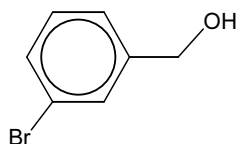
- (c) The C-Cl bond is weaker than the C-F and C-H bonds or C-Cl bond (E = 340) and C-H (E = 410) [1]

so is (easily) broken to form Cl[•]/Cl radicals/Cl atoms [1]

causing the breakdown of O₃ into O₂ [1]

[3]

- (d) Cl-CH₂CH₂-CO₂H [1]
HO-CH₂CH₂CH₂-Cl [1]



[1]

[3]

- (e) (i) light/UV/hν or 300°C [1]

- (ii) (free) radical substitution [1]

- (iii) $\Delta H = E(\text{C-H}) - E(\text{H-Cl}) = 410 - 431 = -21 \text{ kJ mol}^{-1}$ [1]

- (iv) $\Delta H = E(\text{C-H}) - E(\text{H-I}) = 410 - 299 = +111 \text{ kJ mol}^{-1}$ ecf [1]

- (v) The reaction with iodine is endothermic or ΔH is positive or requires energy [1]

- (vi) $\text{Cl}_2 \longrightarrow 2\text{Cl}^\bullet$ [1]



[8]

[Total: 19]

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5 (a) (i) **many** monomers form a polymer [1]

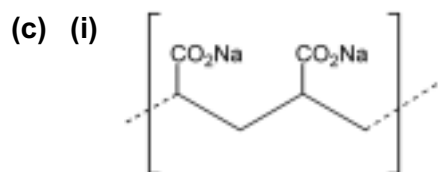
(ii) addition [1]

(iii) C=C/double/ π bond is broken **and** new C-C single bonds s are formed
or double bond breaks and forms single bonds with other monomers [1]

[3]

(b) propenoic acid [1]

[1]

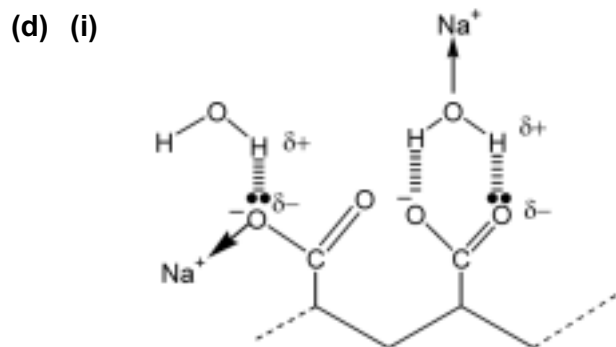


carbon chain **and** CO₂H
at least one sodium salt [1]

[1]

(ii) 120° to 109(.5)° [1]
due to the change from a trigonal/sp² carbon to a tetrahedral/sp³ carbon [1]

[4]



Any four:

hydrogen bond **labelled**

water H-bonded to O through H atom

δ^+/δ^- shown on each end of a H-bond

lone pair shown on O⁻ or C=O or H₂O on a **correct H-bond**

Na⁺ shown as coordinated to a water molecule [3]

[3]

(ii) Solution became paler **and** Cu⁽²⁺⁾ swapped with Na⁽⁺⁾
or darker in colour **and** polymer absorbs water [1]

[1]

[4]

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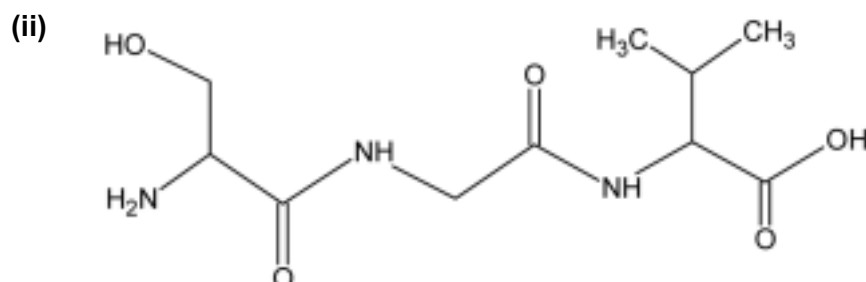
- (e) (i) alkene(1), amide(1) [2]
- (ii) NH_3 [1]
- (iii) H_2O [1]
- (iv) HCl (aq)/ H_3O^+ **and** heat/reflux (**not** warm) [1]
or OH^- (aq), heat and acidify [5]

[Total: 17]

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Section B

6 (a) (i) **six/6** (gsv, sgv, gvs, vgs, svg, vsg) [1]



two **displayed** peptide bonds [1]
correct formula of peptide [1]

(iii) valine (**allow** glycine) [1]

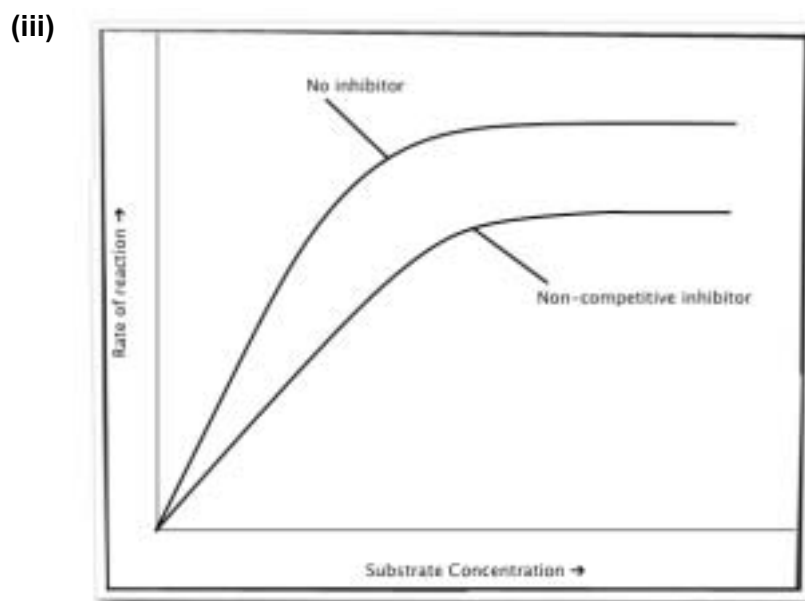
(iv) *any two of:*
hydrogen bonds **and** CO_2H or OH or NH_2 or CONH or CO or NH or CO_2^-
ionic bonds **and** NH_3^+ or CO_2^-
van der Waals' **and** $-\text{CH}_3$ or $-\text{H}$ 2 × [1]

[6]

(b) (i) same shape/structure as substrate [1]

(inhibitor) competes/blocks/binds/bonds to **active site**
or substrate cannot bind to **active site** [1]

(ii) binds with enzyme **and** changes shape/3D structure (of enzyme/active site) [1]



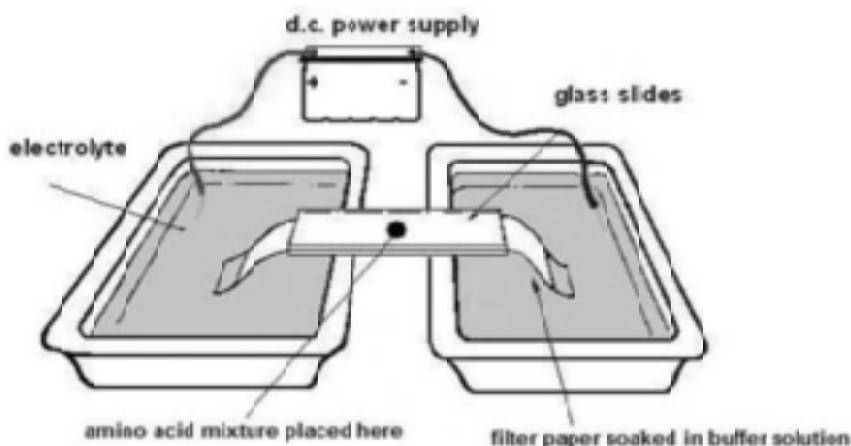
[1]

[4]

[Total: 10]

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7 (a)



power supply (idea of complete circuit)
 electrolyte/buffer solution
 gel/filter paper/absorbent paper
 (amino acid) sample/mixture [centre of plate]

4 × [1]

[4]

(b) any two from:

size/ M_r (of the amino acid species)
 charge (on the amino acid species)
 temperature

2 × [1]

[2]

(c) Ratio of the concentration of a solute in each of two (immiscible) solvents
 or equilibrium constant representing the distribution of a solute between two solvents
 or $PC = [X]_a/[X]_b$ (at a constant temperature)

[1]

[1]

(d) (i) $K_{pc} = [Z \text{ in ether}]/[Z \text{ in } H_2O]$ – allow reverse ratio
 $40 = (x/0.05)/((4-x)/0.5)$

[1]

= 3.2 g

ecf [1]

(ii) First extraction

$40 = (x/0.025)/((4-x)/0.5)$

x = 2.67 g

ecf [1]

(iii) Second extraction: 1.33g remain in solution

Second extraction

$40 = (y/0.025)/((1.33-y)/0.5)$

y = 0.887 g

mass extracted = 2.67 + 0.89 = 3.56/3.6 g

ecf [1]

[4]

[Total: 11]

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- 8 (a) (i)** (nitrates are) soluble [1]
- (ii)** Ba⁽²⁺⁾ **and** Pb⁽²⁺⁾ [1]
- SO₄⁽²⁻⁾ [1]
- BaCO₃/PbCO₃/CaSO₄ are insoluble [1]
- [4]**
- (b) (i)** fertilisers/animal manure [1]
- (ii)** washing powder/detergents/fertilisers/animal manure [1]
- (iii)** growth/production of algae/weeds/plants
or eutrophication [1]
- [3]**
- (c) (i)** *any one of:*
- $2\text{SO}_2 + \text{O}_2 \longrightarrow 2\text{SO}_3$ **and** $\text{SO}_3 + \text{H}_2\text{O} \longrightarrow \text{H}_2\text{SO}_4$
- or $\text{SO}_2 + \text{NO}_2 \longrightarrow \text{SO}_3 + \text{NO}$ **and** $\text{SO}_3 + \text{H}_2\text{O} \longrightarrow \text{H}_2\text{SO}_4$
- or $\text{SO}_2 + \frac{1}{2}\text{O}_2 + \text{H}_2\text{O} \longrightarrow \text{H}_2\text{SO}_4$ [1]
- (ii)** roasting sulfide ores/extraction of metals from sulfide ores [1]
- [2]**
- [Total: 9]**