

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

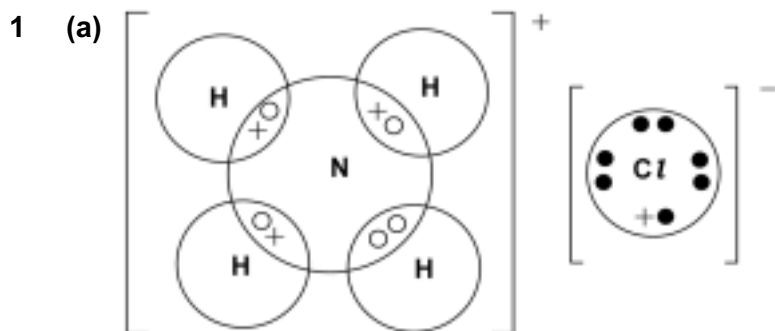
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8 e⁻ around chlorine [1]

1 H–electron (+) on the Cl⁻ ion [1]

3 covalent (ox) 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]
- (b) (i) $\text{SiCl}_4 + 2\text{H}_2\text{O} \longrightarrow \text{SiO}_2 + 4\text{HCl}$
or $\text{SiCl}_4 + 4\text{H}_2\text{O} \longrightarrow \text{Si(OH)}_4 + 4\text{HCl}$
or $\text{SiCl}_4 + 3\text{H}_2\text{O} \longrightarrow \text{H}_2\text{SiO}_3 + 4\text{HCl}$
(partial hydrolysis is *not sufficient* e.g. to $\text{SiCl}_3\text{OH} + \text{HCl}$) [1]
- (ii) $\text{PbCl}_4 \longrightarrow \text{PbCl}_2 + \text{Cl}_2$ [1]
- (iii) $\text{SnCl}_2 + 2\text{FeCl}_3 \longrightarrow \text{SnCl}_4 + 2\text{FeCl}_2$ [1]
- (iv) $\text{SnO}_2 + 2\text{NaOH} \longrightarrow \text{Na}_2\text{SnO}_3 + \text{H}_2\text{O}$
or $\text{SnO}_2 + 2\text{NaOH} + 2\text{H}_2\text{O} \longrightarrow \text{Na}_2\text{Sn(OH)}_6$
or ionic equation $\text{SnO}_2 + 2\text{OH}^- \longrightarrow \text{SnO}_3^{2-} + \text{H}_2\text{O}$ [1]
- [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]

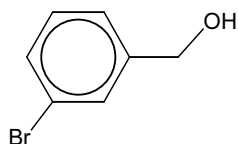
- (c) The C-Cl bond is weaker than the C-F **and** C-H bonds or C-Cl bond (E = 340) **and** C-H (E = 410) [1]

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]

$\text{CH}_3\text{CH}_2^\bullet + \text{Cl}_2 \longrightarrow \text{CH}_3\text{CH}_2\text{Cl} + \text{Cl}^\bullet$ [1]

$\text{CH}_3\text{CH}_2^\bullet + \text{Cl}^\bullet \longrightarrow \text{CH}_3\text{CH}_2\text{Cl}$ [1]

[8]

[Total: 19]

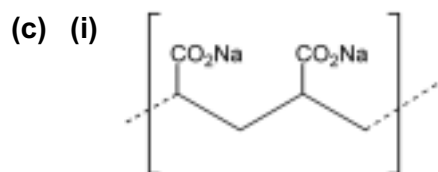
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- 5 (a) (i) **many** monomers form a polymer [1]
(ii) addition [1]
(iii) C=C/double/ π bond is broken **and** new C-C single bonds are formed or double bond breaks and forms single bonds with other monomers [1]

[3]

(b) propenoic acid [1]

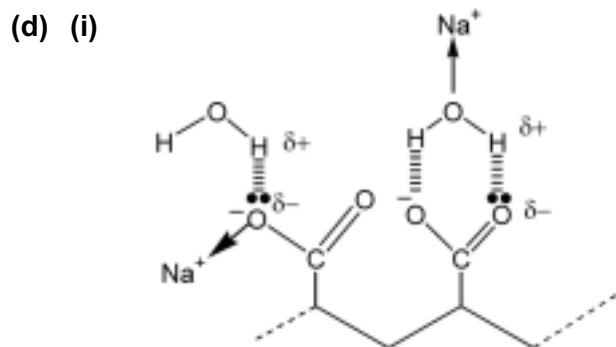
[1]



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

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

[4]

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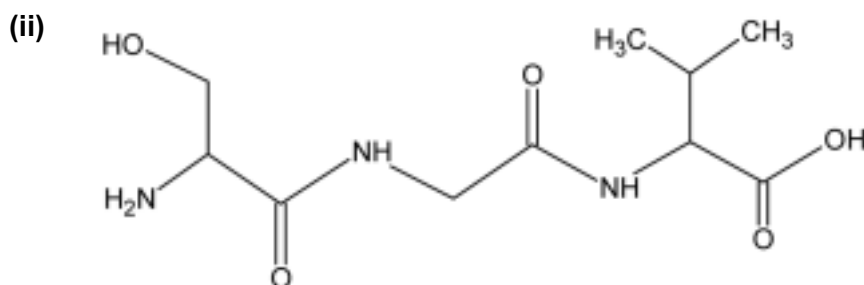
- (e) (i) alkene(1), amide(1) [2]
- (ii) NH_3 [1]
- (iii) H_2O [1]
- (iv) HCl (aq)/ H_3O^+ **and** heat/reflux (**not** warm) [1]
 or OH^- (aq), heat and acidify [5]

[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]

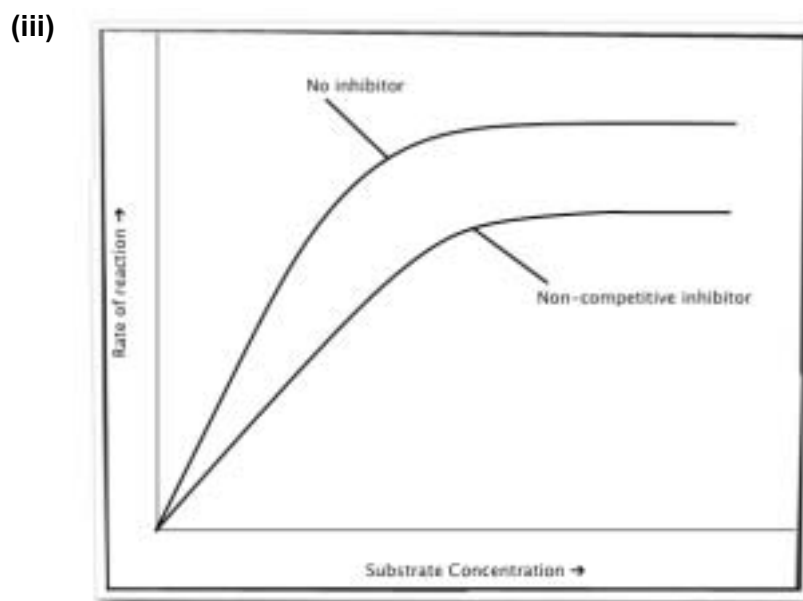
(iv) *any two of:*
 hydrogen bonds **and** CO₂H or OH or NH₂ or CONH or CO or NH or CO₂⁻
 ionic bonds **and** NH₃⁺ or CO₂⁻
 van der Waals' **and** -CH₃ or -H 2 × [1]

[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]



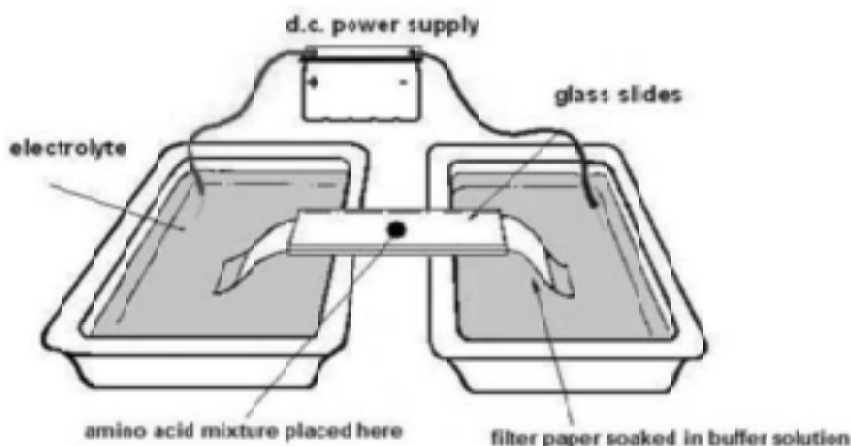
[1]

[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]