

**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

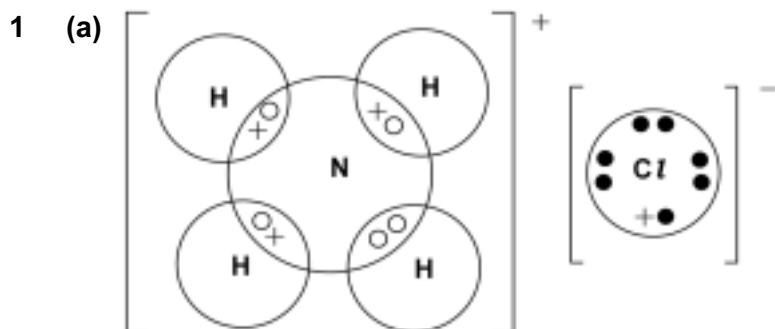
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8 e<sup>-</sup> around chlorine

[1]

1 H–electron (+) on the Cl<sup>-</sup> ion

[1]

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

[1]

[3]

(b) (i) it would react (with H<sub>2</sub>SO<sub>4</sub>)

[1]

(ii) CaO + H<sub>2</sub>O → Ca(OH)<sub>2</sub>

[1]

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

[1]

[3]

(c) (i) 2Ca(NO<sub>3</sub>)<sub>2</sub> → 2CaO + 4NO<sub>2</sub> + O<sub>2</sub>

[1]

(ii) (Down the group, the nitrates)

become more stable/stability increases

[1]

because the size/radius of ion (M<sup>2+</sup>) increases

[1]

thus causing less polarisation/distortion of the anion/NO<sub>3</sub><sup>-</sup>/N-O bond

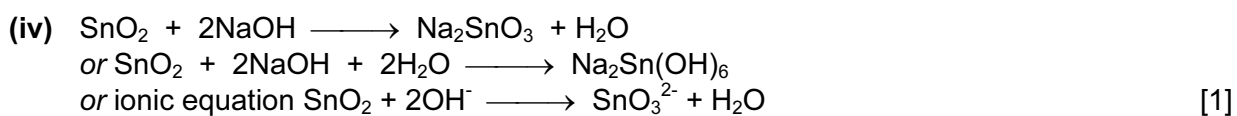
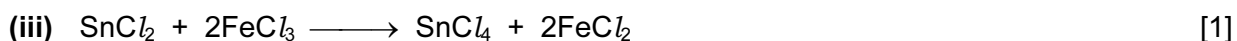
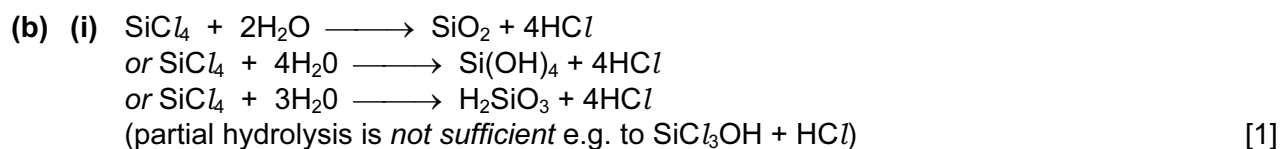
[1]

[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  
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  $\text{H}^+$  combines with  $\text{Z}^-$  **and** forms  $\text{HZ}$  [1]  
addition of base: the reaction moves to the right  
or  $\text{H}^+$  combines with  $\text{OH}^-$  **and** more  $\text{Z}^-$  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  $\text{SOCl}_2$  or  $\text{PCl}_5$   
**J** is  $\text{NaCl}$  [2]  
(or corresponding Br compounds for **G**, **H** and **J**;  $\text{CH}_3\text{CH}_2\text{COBr}$ ,  $\text{SOBr}_2$ ,  $\text{NaBr}$ )

[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]

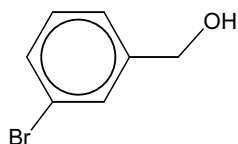
so is (easily) broken to form Cl<sup>•</sup>/Cl radicals/Cl atoms [1]

causing the breakdown of O<sub>3</sub> into O<sub>2</sub> [1]

[3]

(d) Cl-CH<sub>2</sub>CH<sub>2</sub>-CO<sub>2</sub>H [1]

HO-CH<sub>2</sub>CH<sub>2</sub>CH<sub>2</sub>-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  $\Delta H$  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]

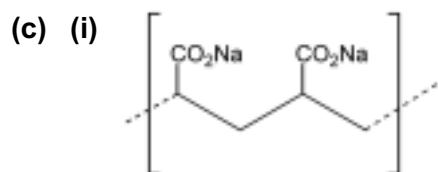
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- 5 (a) (i) **many** monomers form a polymer [1]  
(ii) addition [1]  
(iii) C=C/double/ $\pi$  bond is broken **and** new C-C single bonds are formed or double bond breaks and forms single bonds with other monomers [1]

[3]

(b) propenoic acid [1]

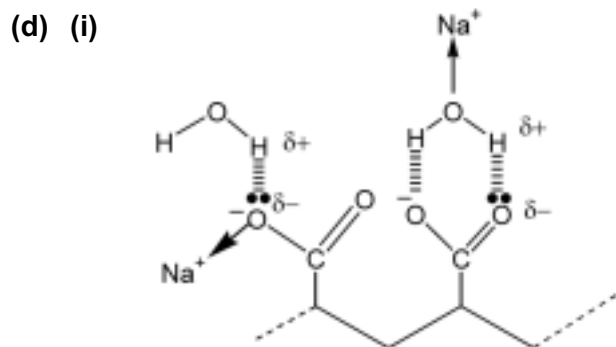
[1]



carbon chain **and** CO<sub>2</sub>H [1]  
**at least** one sodium salt [1]

- (ii) 120° to 109(.5)° [1]  
due to the change from a trigonal/sp<sup>2</sup> carbon to a tetrahedral/sp<sup>3</sup> carbon [1]

[4]



Any four:  
hydrogen bond **labelled**  
water H-bonded to O through H atom  
 $\delta^+/\delta^-$  shown on each end of a H-bond  
lone pair shown on O<sup>-</sup> or C=O or H<sub>2</sub>O on a **correct H-bond**  
Na<sup>+</sup> shown as coordinated to a water molecule [3]

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

[4]

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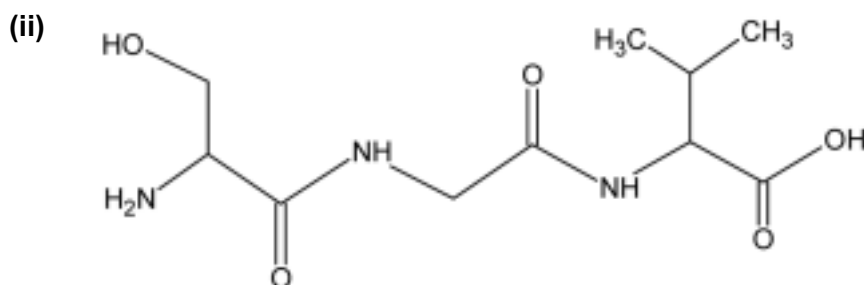
- (e) (i) alkene(1), amide(1) [2]
- (ii)  $\text{NH}_3$  [1]
- (iii)  $\text{H}_2\text{O}$  [1]
- (iv)  $\text{HCl}$  (aq)/ $\text{H}_3\text{O}^+$  and heat/reflux (**not** warm) [1]  
or  $\text{OH}^-$  (aq), heat and acidify [5]

[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]

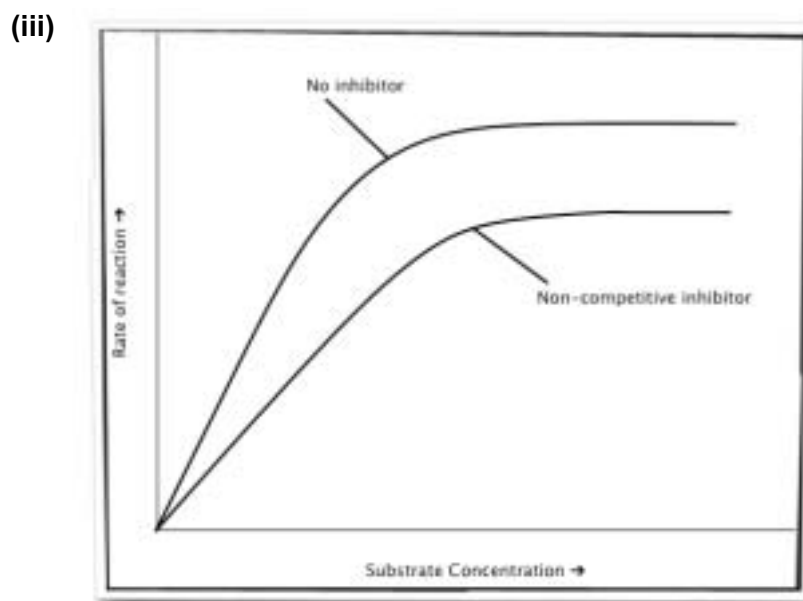
(iv) *any two of:*  
 hydrogen bonds **and** CO<sub>2</sub>H or OH or NH<sub>2</sub> or CONH or CO or NH or CO<sub>2</sub><sup>-</sup>  
 ionic bonds **and** NH<sub>3</sub><sup>+</sup> or CO<sub>2</sub><sup>-</sup>  
 van der Waals' **and** -CH<sub>3</sub> or -H 2 × [1]

[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]

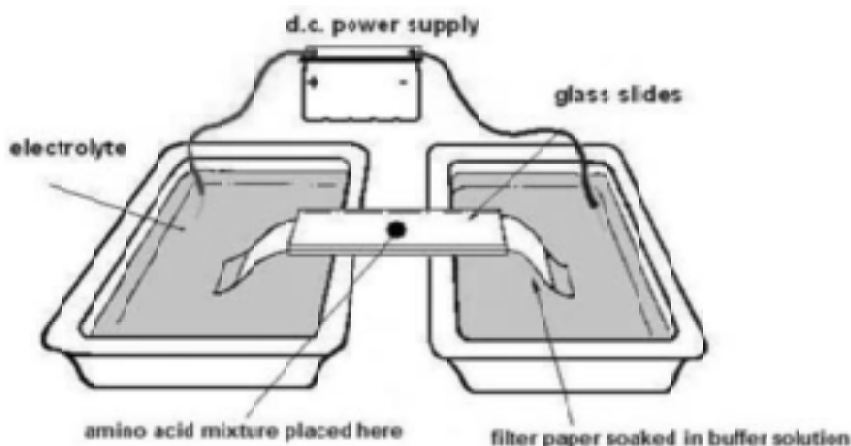
[4]

[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)  $K_{pc} = [Z \text{ in ether}]/[Z \text{ in H}_2\text{O}]$  – 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<sup>(2+)</sup> and Pb<sup>(2+)</sup> [1]
- SO<sub>4</sub><sup>(2-)</sup> [1]
- BaCO<sub>3</sub>/PbCO<sub>3</sub>/CaSO<sub>4</sub> 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]**