

**CAMBRIDGE INTERNATIONAL EXAMINATIONS**

**GCE Advanced Level**

## **MARK SCHEME for the May/June 2014 series**

### **9701 CHEMISTRY**

**9701/42**

Paper 4 (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.

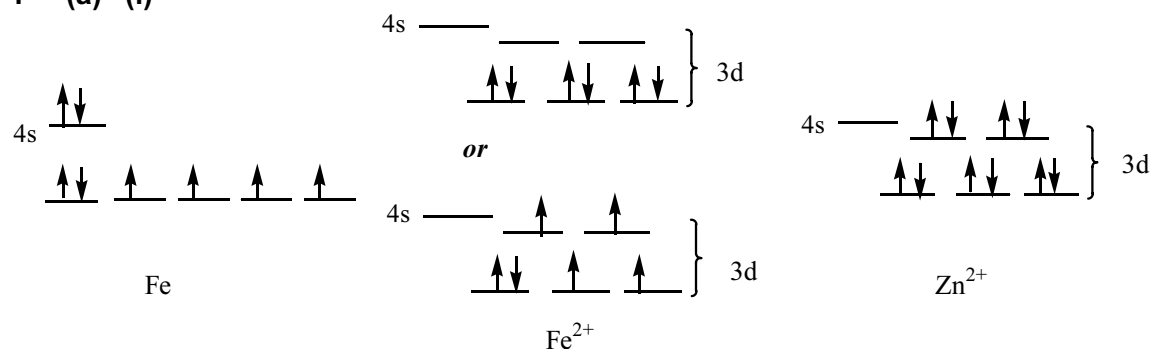
Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

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.

Page 2	Mark Scheme	Syllabus	Paper
	GCE A LEVEL – May/June 2014	9701	42

1 (a) (i)



[2]

(ii) (colour due to absorbance of visible light)  
due to **electron** promoted (from lower) to upper **orbital/energy level**

[1]

in Zn<sup>2+</sup> there's no space in higher orbital for the electron to go *or* completely filled **d**-orbitals/shell

[1]

4

(b) (i) yellow is due to [CuCl<sub>4</sub>]<sup>2-</sup>

[1]

reaction is ligand displacement/exchange

[1]

(ii) (solution goes blue) due to [Cu(H<sub>2</sub>O)<sub>6</sub>]<sup>2+</sup>

[1]

blue **ppt. or (s)**  
of Cu(OH)<sub>2</sub> *or* [Cu(H<sub>2</sub>O)<sub>4</sub>(OH)<sub>2</sub>] etc.

[1]

[1]

purple *or* deep/dark blue **solution or (aq)**  
due to [Cu(NH<sub>3</sub>)<sub>4</sub>]<sup>2+</sup> *or* [Cu(NH<sub>3</sub>)<sub>4</sub>(H<sub>2</sub>O)<sub>2</sub>]<sup>2+</sup>

[1]

[1]

7

(c) (i) 2KI + K<sub>2</sub>S<sub>2</sub>O<sub>8</sub> → 2K<sub>2</sub>SO<sub>4</sub> + I<sub>2</sub> *or*  
ionic: 2I<sup>-</sup> + S<sub>2</sub>O<sub>8</sub><sup>2-</sup> → 2SO<sub>4</sub><sup>2-</sup> + I<sub>2</sub>

[1]

(ii) Fe<sup>2+</sup> is a **homogeneous catalyst**

[1]

(iii) equations: 2Fe<sup>2+</sup> + S<sub>2</sub>O<sub>8</sub><sup>2-</sup> → 2Fe<sup>3+</sup> + 2SO<sub>4</sub><sup>2-</sup>  
2Fe<sup>3+</sup> + 2I<sup>-</sup> → 2Fe<sup>2+</sup> + I<sub>2</sub>

*or* verbal equivalent, e.g. reactants are both negative ions, so repel each other *or* Fe<sup>2+</sup> can be oxidised by S<sub>2</sub>O<sub>8</sub><sup>2-</sup> **and** Fe<sup>3+</sup> can be reduced by I<sup>-</sup>

[1]

3

[Total: 14]

Page 3	Mark Scheme	Syllabus	Paper
	GCE A LEVEL – May/June 2014	9701	42

- 2 (a) **A:** voltmeter *or* V *or* potentiometer [1]
- B:** platinum *or* Pt [1]
- C:** 1 mol dm<sup>-3</sup> **and** H<sup>+</sup> *or* HCl (*or* 0.5 M H<sub>2</sub>SO<sub>4</sub>) [1]
- D:** lead (metal) *or* Pb [1]
- 4**
- (b) (i) a ✓ in the box next to **-0.17 V** [1]  
a comment that the [Pb<sup>2+</sup>] has decreased **plus** a description of the outcome, e.g. as [Pb<sup>2+</sup>] decreases (from 1 mol dm<sup>-3</sup>), Pb<sup>2+</sup>(aq) + 2e<sup>-</sup> ⇌ Pb(s) goes over to the left hand side, *or* as [Pb<sup>2+</sup>] decreases, Pb<sup>2+</sup> is less likely to be reduced [1]
- (ii) (K<sub>sp</sub> =) [Pb<sup>2+</sup>][Cl<sup>-</sup>]<sup>2</sup> [1]
- (iii) if [PbCl<sub>2</sub>] = 3.5 × 10<sup>-2</sup>, [Pb<sup>2+</sup>] = 3.5 × 10<sup>-2</sup> and [Cl<sup>-</sup>] = 7.0 × 10<sup>-2</sup>  
so K<sub>sp</sub> = (3.5 × 10<sup>-2</sup>) × (7.0 × 10<sup>-2</sup>)<sup>2</sup> = **1.715 (1.7) × 10<sup>-4</sup> mol<sup>3</sup> dm<sup>-9</sup>** (≥2sf) [1] + [1]
- 5**
- (c) (i) the (M<sup>2+</sup>/M) E<sup>o</sup> for the two elements are very similar *or* are -0.13 and -0.14 V [1]  
E<sup>o</sup> (Sn<sup>4+</sup>/Sn<sup>2+</sup>) = 0.15 V **and** E<sup>o</sup> (Pb<sup>4+</sup>/Pb<sup>2+</sup>) = 1.69 V [1]  
so Sn<sup>2+</sup> is quite easily oxidised (to Sn<sup>4+</sup>) **or** is a stronger reductant **or** Pb<sup>2+</sup> is not easily oxidised (to Pb<sup>4+</sup>) **or** Pb<sup>4+</sup> is a stronger oxidant **or** Pb<sup>4+</sup> is easily reduced [1]
- (ii) e.g. PbCl<sub>2</sub> + Zn → Pb + ZnCl<sub>2</sub> (*or* ionic) [1]  
(other acceptable reductants: Fe, Mg, Ca but **not** Na or K)
- Sn<sup>2+</sup> + Br<sub>2</sub> → Sn<sup>4+</sup> + 2Br<sup>-</sup> [1]  
(other acceptable oxidants: VO<sup>2+</sup>, Cr<sub>2</sub>O<sub>7</sub><sup>2-</sup>, Ag<sup>+</sup>, Cl<sub>2</sub>, Br<sub>2</sub>, F<sub>2</sub>, Fe<sup>3+</sup>, MnO<sub>4</sub><sup>-</sup>)
- 5**
- (d) (i) Pb<sup>2+</sup>(g) + 2Cl<sup>-</sup>(g) → PbCl<sub>2</sub>(s) [1]
- (ii) ΔH<sub>f</sub> = ΔH<sub>at</sub> + E(Cl - Cl) + 1<sup>st</sup> IE + 2<sup>nd</sup> IE + 2 × E<sub>A</sub>(Cl) + LE  
-359 = 195 + 242 + 716 + 1450 - 2 × 349 + LE  
LE = 2 × 349 - 359 - 195 - 242 - 716 - 1450  
LE = **-2264** (kJ mol<sup>-1</sup>) [3]
- (iii) LE(PbCl<sub>2</sub>) > LE(PbBr<sub>2</sub>) *or* more exothermic *or* stronger lattice [1]  
because Cl<sup>-</sup>/chloride anion has smaller radius/size than Br<sup>-</sup>/bromide [1]

**6**

**[Total: 20]**

Page 4	Mark Scheme	Syllabus	Paper
	GCE A LEVEL – May/June 2014	9701	42

- 3 (a) (i) B and D [1] + [1]
- (ii) D [1]
- 3**
- (b) heat with dilute  $\text{H}^+(\text{aq})$  or  $\text{H}_2\text{SO}_4(\text{aq})$  [1]
- 1**
- (c) (i)  $K_a$  larger than that for ethanol because  
the ethanoate ion/ $\text{CH}_3\text{CO}_2^-$  is stabilised by charge delocalisation  
*or*  
the O–H bond is weakened due to its proximity to C=O/carbonyl group *or*  
the second electronegative/oxygen atom [1]
- $K_a$  smaller than that for chloroethanoic acid because  
electron-withdrawing/electronegative chlorine (atom) makes the anion more  
stable *or* O–H bond weaker *or* H more easily lost [1]
- (ii)  $[\text{H}^+] = \sqrt{([\text{CH}_3\text{CO}_2\text{H}] \times K_a)} = \sqrt{(0.1 \times 1.75 \times 10^{-5})} = \mathbf{1.32(3) \times 10^{-3}}$  ( $\text{mol dm}^{-3}$ ) [1]
- $\text{pH} = -\log_{10}[\text{H}^+] = \mathbf{2.88}$  (2.9) [1]
- 4**
- (d) (i)  $n(\text{NaOH})$  at start =  $0.1 \times 20/1000 = 2.0 \times 10^{-3}$  mol  
 $n(\text{NaOH})$  at finish =  $\mathbf{1.0 \times 10^{-3}}$  mol [1]
- (ii) this is in  $30 \text{ cm}^3$  of solution,  
so  $[\text{NaOH}]$  at finish =  $1.0 \times 10^{-3}/0.030 = \mathbf{3.3(3) \times 10^{-2}}$   $\text{mol dm}^{-3}$  ( $\geq 2$  s.f.) ecf  
from (i) [1]
- (iii)  $[\text{H}^+] = K_w/[\text{OH}^-] = 1 \times 10^{-14}/3.33 \times 10^{-2} = 3.0 \times 10^{-13}$   $\text{mol dm}^{-3}$   
 $\text{pH} = -\log_{10}[\text{H}^+] = \mathbf{12.5(2)}$  [1]
- or*  $\text{pOH} = -\log_{10}(3.33 \times 10^{-2}) = 1.48$   
 $\text{pH} = \text{p}K_w - \text{pOH} = 14 - 1.48 = \mathbf{12.5(2)}$  [1]
- (iv) pH/vol curve: start at pH 2.88 (2.9) ecf [1]
- vertical (over at least 2 pH units) portion at  $V = 10 \text{ cm}^3$  [1]
- levels off at  $\text{pH } 12.5 \pm 0.3$  ecf [1]
- (v) indicator is thymolphthalein [1]
- 7**
- [Total: 15]**

Page 5	Mark Scheme	Syllabus	Paper
	GCE A LEVEL – May/June 2014	9701	42

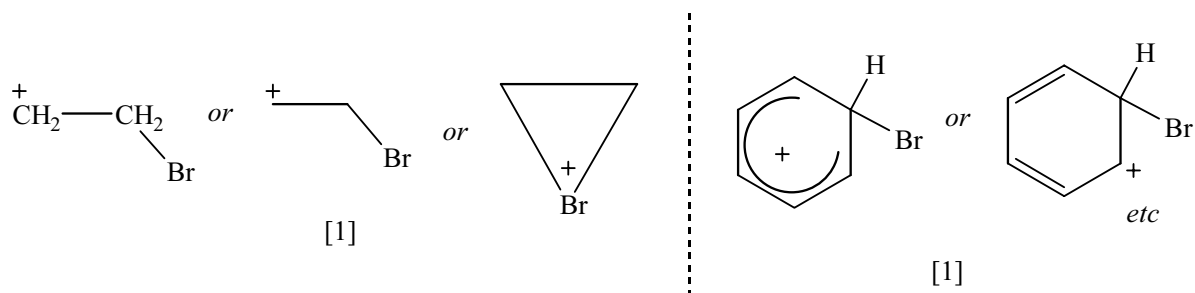
4. (a) (i) addition  
AND  
(ii) substitution [1]

1



1

- (c) (i) The two intermediate cations:



- (ii) The ring (of  $\pi$  electrons) in benzene is a stable configuration or is unchanged after the reaction. [1]

3

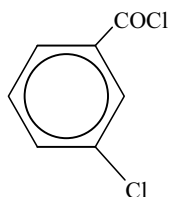
- (d) E is benzoic acid [1]

reaction 1: heat with  $\text{KMnO}_4$  (+  $\text{OH}^-$  or  $\text{H}^+$ ) [1]

reaction 2: heat with  $\text{Cl}_2 + \text{AlCl}_3$  or  $\text{FeCl}_3$  [1]

3

- (e) G is [1]



reaction 3:  $\text{SOCl}_2$  or  $\text{PCl}_5$  [1]

reaction 4:  $\text{LiAlH}_4$  [1]

3

[Total: 11]

Page 6	Mark Scheme	Syllabus	Paper
	GCE A LEVEL – May/June 2014	9701	42

5. (a) (i) Na reacts with  $-OH$  or hydroxyl/ alcohol groups [1]

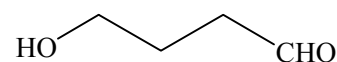
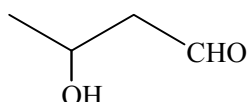
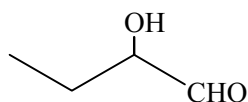
(ii) Fehling's solution reacts with  $-CHO$  or aldehyde groups [1]

2

(b) alkene or  $C=C$  or carbon double bond or phenol or phenylamine [1]

1

(c)  $CH_3CH_2CH(OH)CHO$        $CH_3CH(OH)CH_2CHO$        $HOCH_2CH_2CH_2CHO$



[1] + [1] + [1]

3

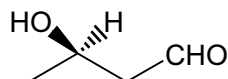
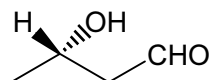
(d) (i) the  $CH_3CH(OH)$  group or the  $CH_3CO$  group or methyl secondary alcohol or methyl ketone [1]

(ii)  $CH_3CH(OH)CH_2CHO$  [1]

2

(e) (i) optical isomerism [1]

(ii)



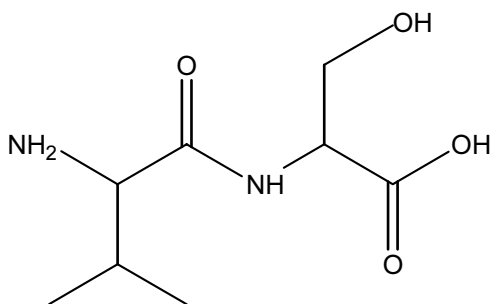
[1]

2

[Total: 10]

Section B

6. (a) (i)



Peptide bond correct [1]  
 Rest of structure correct (skeletal, displayed or structural formula, or a mix)

(ii) Condensation *or* nucleophilic substitution *or* addition-elimination [1]

(iii) Water/H<sub>2</sub>O [1]

4

(b)

DNA	RNA
Contains deoxyribose	Contains ribose
Contains thymine/T	Contains uracil/U
Double strand/chain/helix <i>or</i> two strands	Single strand/chain

[3]

3

(c) (i) (met) - leu - thr - pro - glu [1]

(ii) Mutations *or* addition/insertion/deletion/substitution/replacement (of a base) [1]

(iii) Changing A (*or* the 14th base) into U [1]

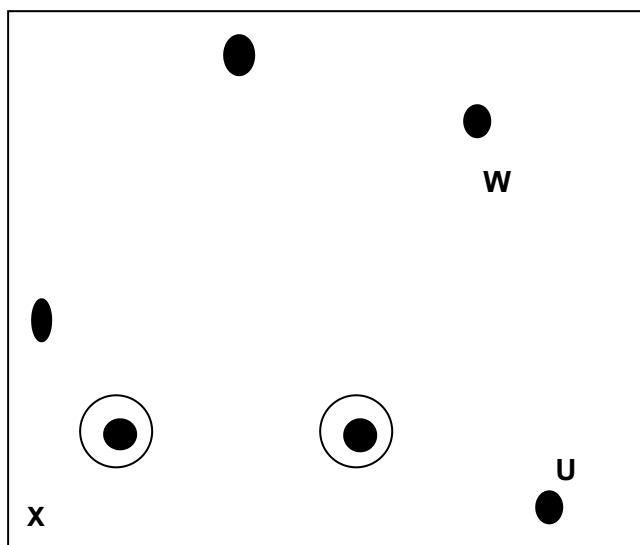
3

[Total: 10]

Page 8	Mark Scheme	Syllabus	Paper
	GCE A LEVEL – May/June 2014	9701	42

- 7 (a) (i) (Electrophoresis): the size / shape /  $M_r$  of the amino acid *or* its charge [1]
- (ii) (Paper chromatography): the partition of the amino acid between, *or* the relative solubility of the compound in, the 2 phases *or* solvent/water and stationary phase/filter paper. [1]
- 2**
- (b) Use ninhydrin as a locating agent [1]
- 1**
- (c) The  $R_f$  value *or* retardation/retention factor *or* the distance travelled by the acid compared to that travelled by a standard sample of the amino acid [1]
- 1**
- (d) **R** – glutamic acid; **S** – glycine; **T** – lysine  $3 \times [1]$
- 3**

(e)



$3 \times [1]$

**3**

**[Total: 10]**



Page 9	Mark Scheme	Syllabus	Paper
	GCE A LEVEL – May/June 2014	9701	42

8. (a) (i) Any addition polymer (e.g. polyethene, polypropene, polystyrene, PVC, PTFE, PVA, *Teflon*) [1]

(ii) Any condensation polymer (e.g. polyamide, polyester, nylon, *Terylene*, PET, PLA, *Kevlar*, *Nomex*) [1]

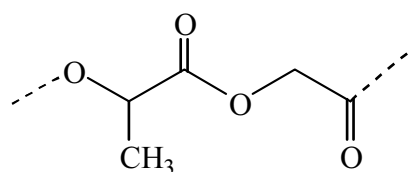
2

(b) Hydrolysis or nucleophilic substitution [1]

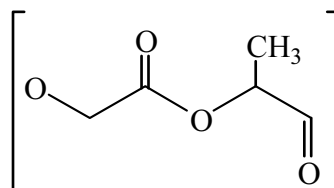
Ester and amide/peptide or  $-\text{CO}_2-$  and  $-\text{CONH}-$  [1]

2

(c)



or



Correct ester linkage [1]

$\text{CH}_3$  side chain on only one monomer unit [1]

2

(d) Plant materials do not generally contain unsaturated hydrocarbons/alkenes/ $\text{C}=\text{C}$  [1]

1

(e) (i) Y van der Waals' forces [1]

Z hydrogen bonding [1]

(ii) Z, because it can form hydrogen bonds with water or it contains polar CO and NH groups [1]

3

[Total: 10]