

MARK SCHEME for the May/June 2010 question paper
for the guidance of teachers

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 must be read in conjunction with the question papers and the report on the examination.

- CIE will not enter into discussions or correspondence in connection with these mark schemes.

CIE is publishing the mark schemes for the May/June 2010 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.



Page 2	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2010	9701	41

1 (a) P: burns with white / yellow flame *or* copious white smoke / fumes produced (1)



S: burns with blue flame / choking / pungent gas produced (1)



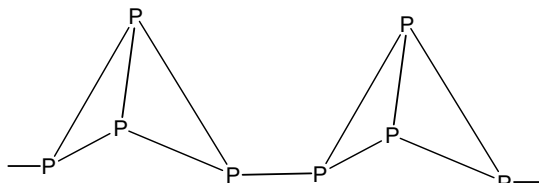
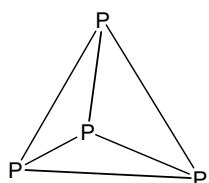
(b) (i) $2 \text{Ca}_3(\text{PO}_4)_2 + 6 \text{SiO}_2 + 10 \text{C} \longrightarrow 1 \text{P}_4 + 6 \text{CaSiO}_3 + 10 \text{CO}$ (2)

(ii)

allotrope	type of structure	type of bonding
white	simple / molecular	covalent
red	giant / polymeric	covalent

(4)

(iii)



(in each case P has to be trivalent. Many alternatives allowable for the polymeric red P) (2)

(8 max 7) [7]

[Total: 11]

Page 3	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2010	9701	41

- 2 (a) coloured ions / compounds (1)
 variable oxidation states (1)
 formation of complexes (1)
 catalytic activity (4 max 3) [3]
- (b) (green is $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$)
 ppt is $\text{Ni}(\text{OH})_2$ (1)
 blue solution is $[\text{Ni}(\text{NH}_3)_6]^{2+}$ or $[\text{Ni}(\text{NH}_3)_4]^{2+}$ or $[\text{Ni}(\text{NH}_3)_4(\text{H}_2\text{O})_2]^{2+}$ (1)
 formed by ligand exchange (1)
 $\text{Ni}^{2+} + 2\text{OH}^- \longrightarrow \text{Ni}(\text{OH})_2$ (1)
 $\text{Ni}(\text{OH})_2 + 6\text{NH}_3 \longrightarrow [\text{Ni}(\text{NH}_3)_6]^{2+} + 2\text{OH}^-$ (1) [4]
 (5 max 4)
- (c) $M_r = 58.7 + 48 + 6 + 28 + 32 = 172.7$ (173) (1)
 $n(\text{Ni}) = 4.00 / 172.7 = 0.0232$ mol (1)
 $\text{mass}(\text{Ni}) = 0.0232 \times 58.7 = 1.36\text{g}$
 $\text{percentage} = 100 \times 1.36 / 3.4 = 40.0\%$ (1) [3]

[Total: 10]

- 3 (a) PbO_2 decomposed into PbO (and O_2). (SnO_2 is stable) [1]
- (b) (i) PbCl_4 dissociates into Cl_2 and PbCl_2 (white solid)
 or $\text{PbCl}_4 \longrightarrow \text{PbCl}_2 + \text{Cl}_2$ or in words
 (1) (1)
 $\text{Cl}_2 + 2\text{KI} \longrightarrow 2\text{KCl} + \text{I}_2$ (1)
 $E^\circ(\text{Cl}_2/\text{Cl}^-)$ is more positive than $E^\circ(\text{I}_2/\text{I}^-)$ (1)
- (ii) SnCl_4 is more stable than PbCl_4 / answers using E° accepted (1)
 (5 max 4) [4]
- (c) (i) $\begin{array}{c} \text{Cl} \text{ : } \ddot{\text{C}} \text{ : } \text{Cl} \\ + \quad - \end{array}$ or $\text{Cl} \equiv \ddot{\text{C}} - \text{Cl}$ (1)
 bent or non-linear or angle = $100-140^\circ$ (1)
- (ii) $\text{CCl}_2 + \text{H}_2\text{O} \longrightarrow \text{CO} + 2\text{HCl}$ (1) [3]

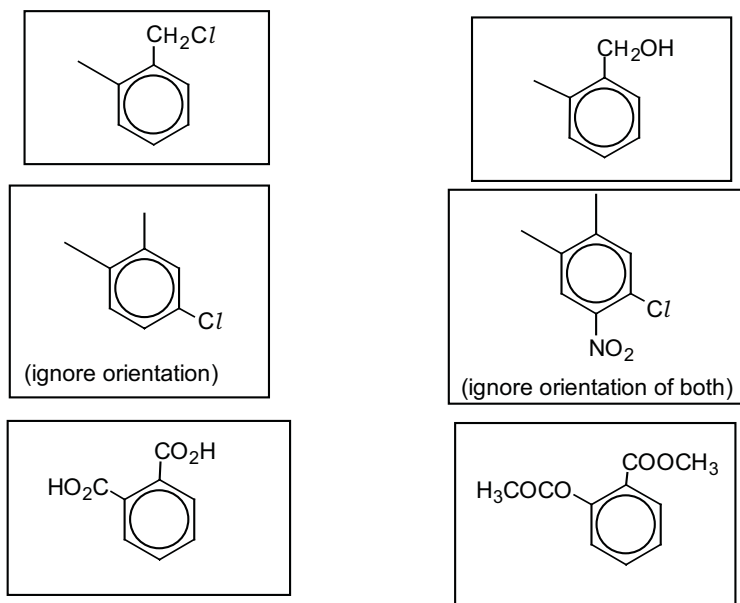
[Total: 8]

Page 4	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2010	9701	41

- 4 (a) hydrogen bonding (1)
- diag: $\text{NH}_2\text{CH}_2\text{CH}_2\text{OH} \cdots \text{OHCH}_2\text{CH}_2\text{NH}_2$ or $\text{NH}_2\text{CH}_2\text{CH}_2\text{OH} \cdots \text{NH}_2\text{CH}_2\text{CH}_2\text{OH}$
(i.e. H-bond from OH group to either OH or NH_2) (1) [2]
- (b) propylamine is more basic than phenylamine (1)
because lone pair on N is delocalised over ring in phenylamine (so less available for protonation)
or the propyl group is electron-donating, so the lone pair is more available (1) [2]
- (c) $\text{HOCH}_2\text{CH}_2\text{NH}_2 + \text{H}^+ \longrightarrow \text{HOCH}_2\text{CH}_2\text{NH}_3^+$
or $\text{HOCH}_2\text{CH}_2\text{NH}_2 + \text{HCl} \longrightarrow \text{HOCH}_2\text{CH}_2\text{NH}_3^+\text{Cl}^-$
or $\text{HOCH}_2\text{CH}_2\text{NH}_2 + \text{H}_2\text{O} \longrightarrow \text{HOCH}_2\text{CH}_2\text{NH}_3^+\text{OH}^-$
(reaction with any acceptable Bronsted acid accepted) [1]
- (d) (i) X is $\text{CH}_3\text{CH}_2\text{CN}$ (1)
- (ii) step 1 is KCN in ethanol, heat [HCN negates] (1)
step 2 is $\text{H}_2 + \text{Ni} / \text{Pt}$ or LiAlH_4 or Na in ethanol [NOT NaBH_4 or Sn/HCl] (1) [3]
- (e) ethanolamine:
Na effervescence / bubbles produced
or $\text{Cr}_2\text{O}_7^{2-} / \text{H}^+$ colour turns from orange to green
or $\text{MnO}_4^- / \text{H}^+$ purple colour disappears
or $\text{PCl}_3 / \text{PCl}_5 / \text{SOCl}_2$ (1) steamy fumes (1)
- phenylamine:
 $\text{Br}_2(\text{aq})$ decolourises / white ppt formed
or $\text{HNO}_2 / \text{H}^+$ at $T < 10^\circ\text{C}$, then phenol in NaOH (1) coloured dye formed (1) [4]

[Total: 12]

7



[6]

[Total: 6]

8 (a)

Block letter	Identity of compound
J	Deoxyribose (NOT “sugar” or “pentose”)
K	Guanine
L	Phosphate
M	Thymine

All 4 correct score 3 marks, 3 score 2, 2 score 1

[3]

(b) hydrogen bonds (1) between the bases (1)

[2]

- (c)
- 1 RNA is a single strand; DNA is double strand
 - 2 RNA contains ribose; DNA contains deoxyribose
 - 3 RNA contains uracil; DNA contains thymine
 - 4 RNA is shorter than DNA

(1)

(1)

(1)

(1)

(4 max 3) [3]

(d) mRNA – copies the DNA gene sequence
or forms a template for a particular polypeptide / in protein synthesis

(1)

tRNA – carries amino acids to the ribosome

(1)

[2]

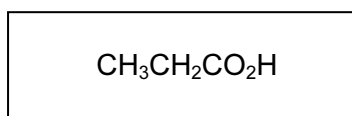
[Total: 10]

Page 7	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2010	9701	41

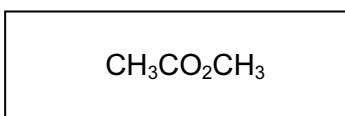
- 9 (a) spinning proton produces two spin states / magnetic moments (1)
these can align with or against an applied magnetic field (1) [2]

- (b) field experienced by protons is influenced by adjacent atoms / protons are in two different chemical environments (1)
peaks are in the area ratio 3 : 1 (methyl to –OH protons) (1)
or are at 0.5 – 6.0δ and 3.3 – 4.0δ (1) [2]

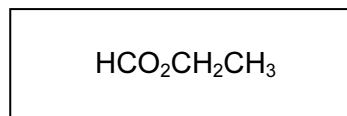
- (c) (i)



propanoic acid



methyl ethanoate



ethyl methanoate

all for (2) two for (1)

- (ii) compound is $\text{CH}_3\text{CO}_2\text{CH}_3$ or methyl ethanoate (1)
the other two compounds each have 3 different proton environments, but the spectrum shows only 2 peaks. (1)

A is OCH_3 , B is CH_3CO (1)

- (iii) compound – propanoic acid or ethyl methanoate (1)
the –OH proton or the H–CO proton (1) [6]

- (d) (i) distance between atoms / bond lengths / bond angles (1)

- (ii) hydrogen atoms (1) [2]

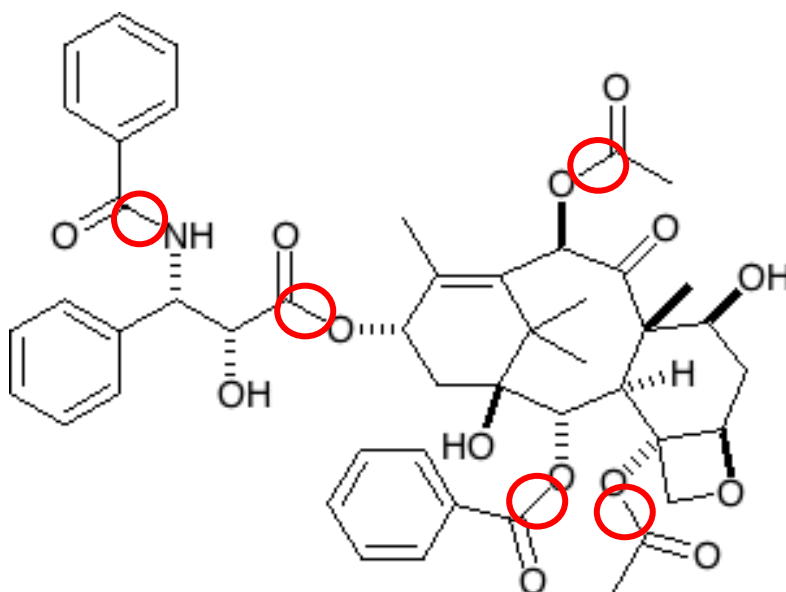
[Total: 12 max 10]

[Total: 10]

Page 8	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2010	9701	41

10 (a) ester or amide (allow nitrile) [1]

(b)



amide (1) + any one ester (1) [2]
allow whole groups circled

- (c) (i) hydrophilic drug at **C** (1)
hydrophobic drug at **B** both needed (1)
- (ii) (at **A**) the drug would be exposed to attack / breakdown / digestion (1) [3]
- (d) (i) at one of the –OH groups (1)
- (ii) volume of sphere can be large *or* one PEG molecule can only carry 1 or 2 drug molecules (1)
or can carry different types of drug [2]
- (e) more economic (1)
less chance of side-effects / side effects reduced / less chance of allergic reaction (1)
less risk of harming healthy tissue / organs / less chance of an overdose (1)
(3 max 2) [2]

[Total: 10]

MARK SCHEME for the May/June 2010 question paper
for the guidance of teachers

9701 CHEMISTRY

9701/42

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 must be read in conjunction with the question papers and the report on the examination.

- CIE will not enter into discussions or correspondence in connection with these mark schemes.

CIE is publishing the mark schemes for the May/June 2010 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.



Page 2	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2010	9701	42

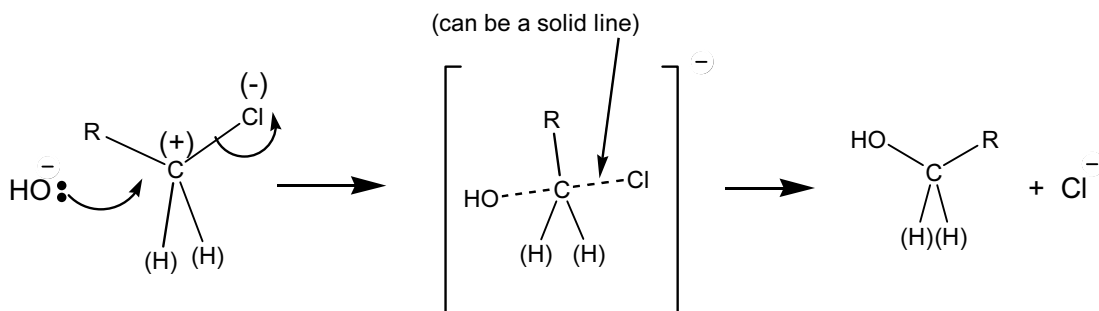
1 (a) $\text{C}_6\text{H}_5\text{-COCH}_2\text{OH}$ or $\text{C}_8\text{H}_8\text{O}_2$ and NaCl or Cl^- (1) + (1) [2]

(b) (i) the exponent / power to which a concentration is raised in the **rate equation**
(or in an equation, e.g. "a" in the equ: $\text{rate} = k[\text{A}]^a$) (1)

(ii) from 1 and 2: rate increases by 50% as does $[\text{RCI}]$, so $\text{rate} \propto [\text{RCI}]^1$ (1)
from 1 and 3: $\text{rate} \propto [\text{NaOH}]^1$ (1)

(iii) $(\text{rate} =) k[\text{RCI}][\text{OH}^-]$ (1)

(iv)



marking points:

- (+) or δ^+ on C **and** (-) or δ^- on Cl (1)
- lone pair **and** charge on: OH^- (1)
- curly arrow from OH (lone pair) to $(\delta^+)\text{C}$, **and either** a curly arrow breaking C-Cl bond **or** 5-valent transition state (ignore charge) (1)
- $\text{S}_{\text{N}}1$ alternative for last mark (only award mark if candidate's rate equation shows first order reaction): curly arrow breaking C-Cl bond **and** carbocation intermediate. (1)

[7]

(c) (i) (add RCI / RCOCl to) (aq) Ag^+ / AgNO_3 *or* named indicator (e.g. MeOr) *or* use pH probe (1)

White ppt appears (faster with RCOCl) *or* turns acidic colour (e.g. red) *or* shows pH decrease (1)

if water is the only reagent, and no pH meter used: award only the second mark, for "steamy / white fumes"

(ii) ($\text{C}=\text{O}$ is polarised /) carbon is more δ^+ than in R-Cl *or* carbon is positive *or* RCOCl can react via addition-elimination
(mention of electronegativity on its own is not enough for the mark) (1) [3]

[Total: 12]

Page 3	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2010	9701	42

- 2 (a) less soluble down group (1)
- lattice energy and hydration energies both decrease (i.e. become less negative) (1)
- but H.E. decreases more (than L.E.) *or* change in H.E. outweighs L.E. (1)
- so ΔH_{sol} becomes more endothermic / less exothermic (1) [4]
- (b) (i) for Mg: $\Delta H = 2993 - 1890 - (2 \times 550) = (+)3 \text{ (kJ mol}^{-1}\text{)}$ (1)
- for Sr: $\Delta H = 2467 - 1414 - (2 \times 550) = -47 \text{ (kJ mol}^{-1}\text{)}$ (1)
- (ii) Sr(OH)_2 should be **more** soluble in water, **and** ΔH is more exothermic / negative (1)
- Assuming “other factors” (e.g. ΔS , *or* temperature etc.) are the same (1)
- (iii) Sr(OH)_2 should be **less** soluble in hot water, **because** ΔH is negative / exothermic (1) [5]
- (c) (i) $K_{\text{sp}} = [\text{Ca}^{2+}][\text{OH}^-]^2$ (needs the charges) units: $\text{mol}^3\text{dm}^{-9}$ (1) + (1)
- (ii) $n(\text{H}^+) = n(\text{OH}^-) = 0.05 \times 21/1000 = 1.05 \times 10^{-3} \text{ mol in } 25 \text{ cm}^3$
- $[\text{OH}^-] = 1.05 \times 1000/25 = 4.2 \times 10^{-2} \text{ (mol dm}^{-3}\text{)}$ (1)
- $[\text{Ca}^{2+}] = 2.1 \times 10^{-2} \text{ (mol dm}^{-3}\text{)}$ (1)
- $K_{\text{sp}} = 2.1 \times 10^{-2} \times (4.2 \times 10^{-2})^2 = 3.7 \times 10^{-5}$ (1)
- (iii) **less** soluble in NaOH due to the common ion effect *or* equilibrium is shifted to the l.h.s. by high $[\text{OH}^-]$ (NOT just a mention of Le Chat^r on its own) (1) [6]

[Total: 15]

Page 4	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2010	9701	42

- 3 (a) SiF_4 is symmetrical *or* tetrahedral *or* bonds are at 109° *or* has no lone pair *or* 4 electron pairs shared equally *or* all Si-F dipoles cancel out, **or** SF_4 has a lone pair (on S). (1) [1]

(b)

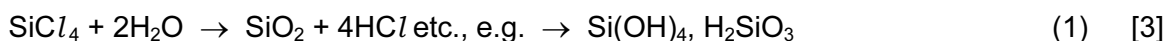
compound	molecule has an overall dipole	molecule does not have an overall dipole
BCl_3		✓
PCl_3	✓	
CCl_4		✓
SF_6		✓

mark row-by-row,

(2) [2]

- (c) (i) Si **and** B have empty / available / low-lying orbitals *or* C does not have available orbitals (allow "B is electron deficient" but not mention or implication of d-orbital on B) (1)

- (ii) $\text{BCl}_3 + 3\text{H}_2\text{O} \rightarrow \text{H}_3\text{BO}_3 + 3\text{HCl}$ *or* $2\text{BCl}_3 + 3\text{H}_2\text{O} \rightarrow \text{B}_2\text{O}_3 + 6\text{HCl}$ (1)



- (d) (i) $\text{Si}_3\text{Cl}_8\text{O}_2$ (this has $M_r = 84 + 280 + 32 = 396$) *or* $\text{Si}_4\text{Cl}_4\text{O}_9$ *or* $\text{Si}_8\text{Cl}_4\text{O}_2$ (1)

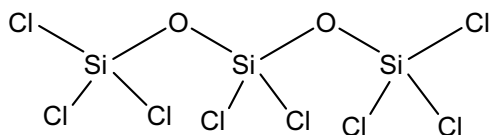
(ii)

mass number	structure
133	Cl_3Si
247	$\text{Cl}_3\text{Si-O-SiCl}_2$
263	$\text{Cl}_3\text{Si-O-SiCl}_2\text{-O}$

(3)

(if correct structures are **not** given for last 2 rows, you can award (1) mark for **two** correct molecular formulae:
either $\text{Si}_2\text{Cl}_5\text{O} + \text{Si}_2\text{Cl}_5\text{O}_2$ *or* $\text{Si}_3\text{Cl}_3\text{O}_8 + \text{Si}_3\text{Cl}_3\text{O}_9$ *or* $\text{Si}_7\text{Cl}_3\text{O} + \text{Si}_7\text{Cl}_3\text{O}_2$)

(iii)



allow ecf on the structure drawn in the third row of the table in (ii)
but any credited structure must show correct valencies for Si, Cl and O. (1) [5]

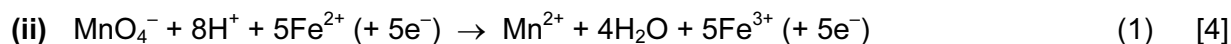
[Total: 11]

Page 5	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2010	9701	42

- 4 (a) Cr^{3+} : $1s^2 2s^2 2p^6 \dots 3s^2 3p^6 3d^3$ (1)
 Mn^{2+} : $1s^2 2s^2 2p^6 \dots 3s^2 3p^6 3d^5$ (1)
 (allow (1) out of (2) for $3s^2 3p^6 4s^2 3d^1$ and $3s^2 3p^6 4s^2 3d^3$) [2]

(b) (i) any three of the following points:

- initial (pale) green (solution)
- fades to (almost) colourless (allow yellow)
- then (permanent faint) pink
- finally (deep) purple (3)

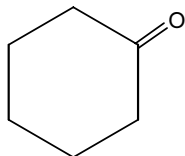


- (c) E° values: $\text{O}_2 + 4\text{H}^+ / 2\text{H}_2\text{O} = +1.23\text{V}$ $\text{Fe}^{3+} / \text{Fe}^{2+} = +0.77\text{V}$
 $\text{O}_2 + 2\text{H}_2\text{O} / 4\text{OH}^- = +0.40\text{V}$ $\text{Fe}(\text{OH})_3 / \text{Fe}(\text{OH})_2 = -0.56\text{V}$ (2)

$E^\circ_{\text{cell}} = +0.46\text{V}$ (allow -0.37) in acid, but $+0.96\text{V}$ in alkali or $E^\circ(\text{OH}^-) > E^\circ(\text{H}^+)$ (1)

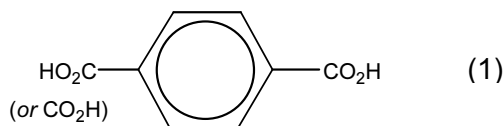
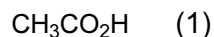
If E_{cell} is more positive it means a greater likelihood of reaction (1) [4]

(d)

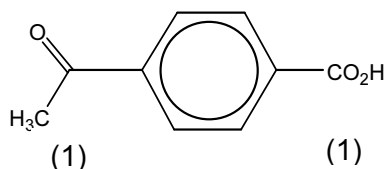


(1)

and

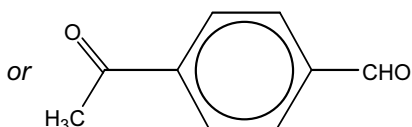


(1)



(1)

(1)



[5]

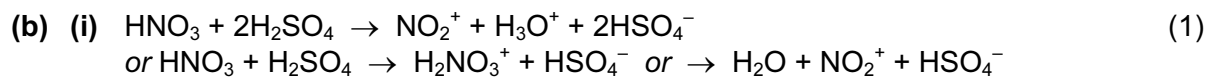
- (e) (i) $(\text{CH}_3)_2\text{C}(\text{OH})-\text{CH}_2\text{OH}$ (1)

- (ii) reaction I: (cold dilute) KMnO_4 ("cold" not needed, but "hot" or "warm" negates) (1)
 reaction II: $\text{Cr}_2\text{O}_7^{2-} + \text{H}^+ + \text{distil}$ (1) [3]

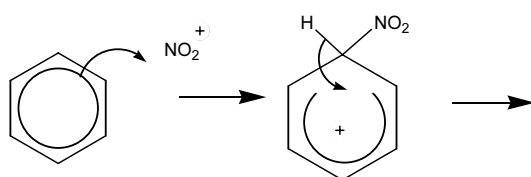
[Total: 18 max 17]

Page 6	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2010	9701	42

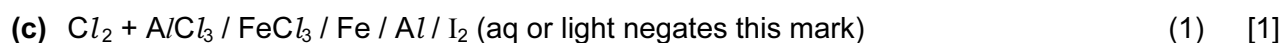
- 5 (a) (i) because the carbons are sp^2 / trigonal planar / bonded at 120° or are joined by π bonds / orbitals (1)
- (ii) because the π electrons / double bonds are delocalised / in resonance or electrons are evenly distributed / spread out (1) [2]



- (ii) electrophilic substitution mechanism: (1)



curly arrows from benzene to NO_2^+ , **and** showing loss of H^+ (1)
correct intermediate (with "+" in the 'horse-shoe') (1) [4]

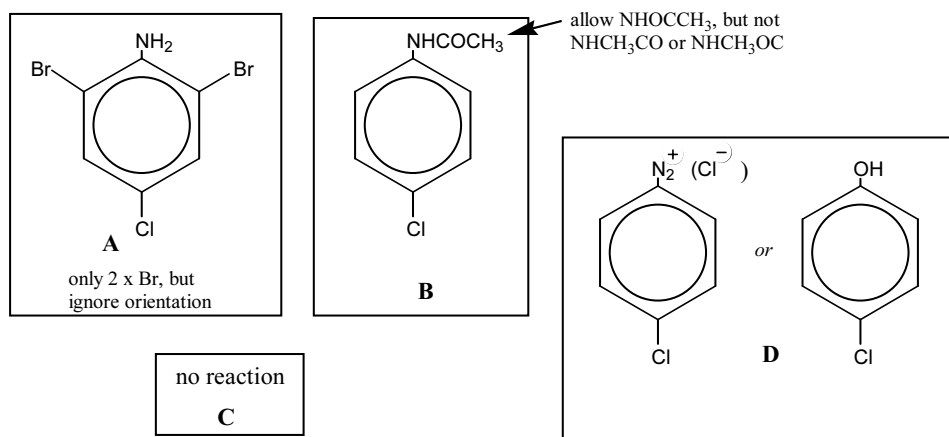


- (d) (i) **Y** is chlorobenzene (1) **Z** is 4-chloronitrobenzene (1) (2)

- (ii) $\text{Sn} / \text{Fe} + (\text{conc}) \text{HCl}$ (1)

HCl is **conc**, **and** second step is to add $\text{NaOH}(\text{aq})$ (1)

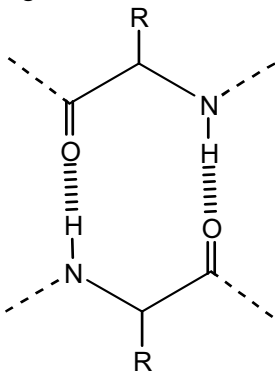
- (iii)



(4) [8]

[Total: 15]

Page 7	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2010	9701	42

- 6 (a) (i) Primary – the **amino acid** sequence / order / chain
or diag. e.g. NH-C-CO-NH-C-CO
or amino acids bonded by covalent / amide / peptide bonds (1)
- (ii) Tertiary – the coiling / folding of the protein / polypeptide chain due to interactions between side-chains on the amino acids *or* the structure which gives the protein its 3-D / globular shape (1) [2]
- (b) (i) Diagram:
Minimum is CH₂S-SCH₂ (1)
- (ii) Oxidation / dehydrogenation / redox (1)
- (iii) Hydrogen / H bonds; ionic interactions / bonds *or* ion-dipole *or* salt bridges; van der Waals' *or* id-id *or* induced / instantaneous dipole forces (ignore hydrophobic interactions) (2) [4]
- (c) (i) Hydrogen bonds (1)
- (ii) Correct new strand present (see below) needed
Diagram showing C=O bonding to N-H in new strand... ✓
...and N-H bonding to C=O in new strand ✓
e.g.
- 
- New strand must contain a minimum of two amino acid residues in a single chain. Deduct a penalty of –(1) for any wrong H-bond **only** if (2) marks have already been scored. (2) [3]
- (d) There are bonds *or* S-S bridges / linkages **between the layers / sheets** (in β-keratin) (but only van der Waals interactions between the layers in silk) (1) [1]

[Total: 10]

Page 8	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2010	9701	42

- 7 (a) The amino acid is uncharged / neutral / a zwitterion *or* charges balance / are equal (NOT “is non-polar”)

It is equally attracted by the anode / + and the cathode / – *or* attracted by neither

The pH of the buffer is at the isoelectric point/IEP of the amino acid *any two* ✓✓ (2) [2]

- (b) (at pH 10), $\text{H}_2\text{NCH}_2\text{CO}_2^-$ *or* $\text{NH}_2\text{CH}_2\text{COO}^-$ (1) [1]

(c)

amino acid	relative size	charge
A	small(est) (1)	–ve
B	large(st) (3)	–ve
C	middle (2)	+ve

(numbers are OK to show relative sizes)

Mark each row (3) [3]

- (d) (i) lys – val – ser – ala – gly – ala – gly – asp (2)

(ii) gly – ala – gly (1)

(iii) aspartic acid (*or* lysine) (1) [4]

[Total: 10]

Page 9	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2010	9701	42

- 8 (a) Reaction II – since electrons are used up / required / gained / received (from external circuit) (1) [1]
- (b) $\text{Pb}^{2+} + 2\text{e}^- \rightarrow \text{Pb}$ $E^\ominus = -0.13\text{V}$
 $\text{PbO}_2 + 4\text{H}^+ + 2\text{e}^- \rightarrow \text{Pb}^{2+} + 2\text{H}_2\text{O}$ $E^\ominus = +1.47\text{V}$
two correct $E^\ominus$ values (1)
- Cell voltage is **1.6(0)** (V) (1) [2]
- (c) (i) 3(+) (1)
- (ii) They are less heavy / poisonous / toxic / polluting *or* are safer due to no (conc) H_2SO_4 within them (1) [2]
- (d) (i) Platinum or graphite / carbon (1)
- (ii) They need large quantities of **compressed** gases which take up space *or* the hydrogen would need to be **liquefied** *or* the reactant is (highly) **flammable** / **explosive** / **combustible** (1) [2]
- (e) *Glass:* saves **energy** – the raw materials are easily accessible / cheap *or* making glass is energy-intensive (1)
- Steel:* saves **energy** – extracting iron from the ore *or* mining the ore is energy intensive *or* saves a **resource** – iron **ore** (NOT just “iron”) is becoming scarce *either one* (1)
- Plastics:* saves a valuable / scarce **resource**: (crude) **oil** / **petroleum** (1) [3]

[Total: 10]

**MARK SCHEME for the May/June 2010 question paper
for the guidance of teachers**

9701 CHEMISTRY

9701/43

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 must be read in conjunction with the question papers and the report on the examination.

- CIE will not enter into discussions or correspondence in connection with these mark schemes.

CIE is publishing the mark schemes for the May/June 2010 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.



Page 2	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2010	9701	43

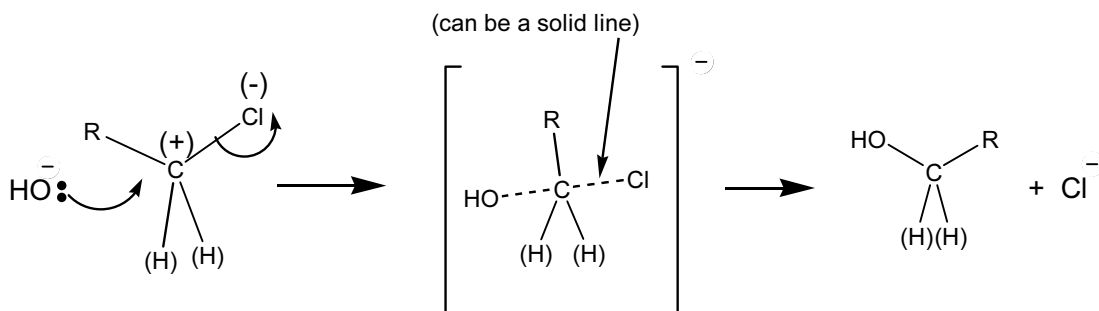
1 (a) $\text{C}_6\text{H}_5\text{-COCH}_2\text{OH}$ or $\text{C}_8\text{H}_8\text{O}_2$ and NaCl or Cl^- (1) + (1) [2]

(b) (i) the exponent / power to which a concentration is raised in the **rate equation**
(or in an equation, e.g. "a" in the equ: $\text{rate} = k[\text{A}]^a$) (1)

(ii) from 1 and 2: rate increases by 50% as does $[\text{RCI}]$, so $\text{rate} \propto [\text{RCI}]^1$ (1)
from 1 and 3: $\text{rate} \propto [\text{NaOH}]^1$ (1)

(iii) $(\text{rate} =) k[\text{RCI}][\text{OH}^-]$ (1)

(iv)



marking points:

- (+) or δ^+ on C **and** (–) or δ^- on Cl (1)
- lone pair **and** charge on: OH^- (1)
- curly arrow from OH (lone pair) to $(\delta^+)\text{C}$, **and either** a curly arrow breaking C-Cl bond **or** 5-valent transition state (ignore charge) (1)
- $\text{S}_{\text{N}}1$ alternative for last mark (only award mark if candidate's rate equation shows first order reaction): curly arrow breaking C-Cl bond **and** carbocation intermediate. (1)

[7]

(c) (i) (add RCI / RCOCl to) (aq) Ag^+ / AgNO_3 *or* named indicator (e.g. MeOr) *or* use pH probe (1)

White ppt appears (faster with RCOCl) *or* turns acidic colour (e.g. red) *or* shows pH decrease (1)

if water is the only reagent, and no pH meter used: award only the second mark, for "steamy / white fumes"

(ii) (C=O is polarised /) carbon is more δ^+ than in R-Cl *or* carbon is positive *or* RCOCl can react via addition-elimination
(mention of electronegativity on its own is not enough for the mark) (1) [3]

[Total: 12]

Page 3	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2010	9701	43

- 2 (a) less soluble down group (1)
- lattice energy and hydration energies both decrease (i.e. become less negative) (1)
- but H.E. decreases more (than L.E.) *or* change in H.E. outweighs L.E. (1)
- so ΔH_{sol} becomes more endothermic / less exothermic (1) [4]
- (b) (i) for Mg: $\Delta H = 2993 - 1890 - (2 \times 550) = (+)3 \text{ (kJ mol}^{-1}\text{)}$ (1)
- for Sr: $\Delta H = 2467 - 1414 - (2 \times 550) = -47 \text{ (kJ mol}^{-1}\text{)}$ (1)
- (ii) Sr(OH)_2 should be **more** soluble in water, **and** ΔH is more exothermic / negative (1)
- Assuming “other factors” (e.g. ΔS , *or* temperature etc.) are the same (1)
- (iii) Sr(OH)_2 should be **less** soluble in hot water, **because** ΔH is negative / exothermic (1) [5]
- (c) (i) $K_{\text{sp}} = [\text{Ca}^{2+}][\text{OH}^-]^2$ (needs the charges) units: $\text{mol}^3\text{dm}^{-9}$ (1) + (1)
- (ii) $n(\text{H}^+) = n(\text{OH}^-) = 0.05 \times 21/1000 = 1.05 \times 10^{-3} \text{ mol in } 25 \text{ cm}^3$
- $[\text{OH}^-] = 1.05 \times 1000/25 = 4.2 \times 10^{-2} \text{ (mol dm}^{-3}\text{)}$ (1)
- $[\text{Ca}^{2+}] = 2.1 \times 10^{-2} \text{ (mol dm}^{-3}\text{)}$ (1)
- $K_{\text{sp}} = 2.1 \times 10^{-2} \times (4.2 \times 10^{-2})^2 = 3.7 \times 10^{-5}$ (1)
- (iii) **less** soluble in NaOH due to the common ion effect *or* equilibrium is shifted to the l.h.s. by high $[\text{OH}^-]$ (NOT just a mention of Le Chat^r on its own) (1) [6]

[Total: 15]

Page 4	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2010	9701	43

- 3 (a) SiF_4 is symmetrical *or* tetrahedral *or* bonds are at 109° *or* has no lone pair *or* 4 electron pairs shared equally *or* all Si-F dipoles cancel out, **or** SF_4 has a lone pair (on S). (1) [1]

(b)

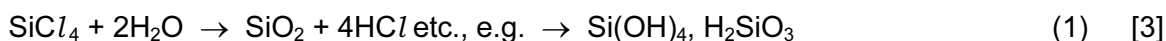
compound	molecule has an overall dipole	molecule does not have an overall dipole
BCl_3		✓
PCl_3	✓	
CCl_4		✓
SF_6		✓

mark row-by-row,

(2) [2]

- (c) (i) Si **and** B have empty / available / low-lying orbitals *or* C does not have available orbitals (allow "B is electron deficient" but not mention or implication of d-orbital on B) (1)

- (ii) $\text{BCl}_3 + 3\text{H}_2\text{O} \rightarrow \text{H}_3\text{BO}_3 + 3\text{HCl}$ *or* $2\text{BCl}_3 + 3\text{H}_2\text{O} \rightarrow \text{B}_2\text{O}_3 + 6\text{HCl}$ (1)



- (d) (i) $\text{Si}_3\text{Cl}_8\text{O}_2$ (this has $M_r = 84 + 280 + 32 = 396$) *or* $\text{Si}_4\text{Cl}_4\text{O}_9$ *or* $\text{Si}_8\text{Cl}_4\text{O}_2$ (1)

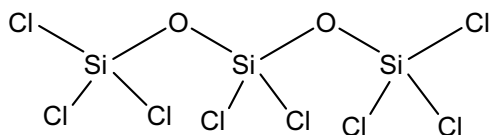
(ii)

mass number	structure
133	Cl_3Si
247	$\text{Cl}_3\text{Si-O-SiCl}_2$
263	$\text{Cl}_3\text{Si-O-SiCl}_2\text{-O}$

(3)

(if correct structures are **not** given for last 2 rows, you can award (1) mark for **two** correct molecular formulae:
either $\text{Si}_2\text{Cl}_5\text{O} + \text{Si}_2\text{Cl}_5\text{O}_2$ *or* $\text{Si}_3\text{Cl}_3\text{O}_8 + \text{Si}_3\text{Cl}_3\text{O}_9$ *or* $\text{Si}_7\text{Cl}_3\text{O} + \text{Si}_7\text{Cl}_3\text{O}_2$)

(iii)



allow ecf on the structure drawn in the third row of the table in (ii)
but any credited structure must show correct valencies for Si, Cl and O. (1) [5]

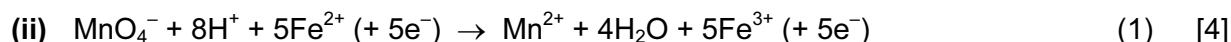
[Total: 11]

Page 5	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2010	9701	43

- 4 (a) Cr^{3+} : $1s^2 2s^2 2p^6 \dots 3s^2 3p^6 3d^3$ (1)
 Mn^{2+} : $1s^2 2s^2 2p^6 \dots 3s^2 3p^6 3d^5$ (1)
 (allow (1) out of (2) for $3s^2 3p^6 4s^2 3d^1$ and $3s^2 3p^6 4s^2 3d^3$) [2]

(b) (i) any three of the following points:

- initial (pale) green (solution)
- fades to (almost) colourless (allow yellow)
- then (permanent faint) pink
- finally (deep) purple (3)

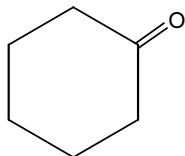


- (c) E° values: $\text{O}_2 + 4\text{H}^+ / 2\text{H}_2\text{O} = +1.23\text{V}$ $\text{Fe}^{3+} / \text{Fe}^{2+} = +0.77\text{V}$
 $\text{O}_2 + 2\text{H}_2\text{O} / 4\text{OH}^- = +0.40\text{V}$ $\text{Fe}(\text{OH})_3 / \text{Fe}(\text{OH})_2 = -0.56\text{V}$ (2)

$E^\circ_{\text{cell}} = +0.46\text{V}$ (allow -0.37) in acid, but $+0.96\text{V}$ in alkali or $E^\circ(\text{OH}^-) > E^\circ(\text{H}^+)$ (1)

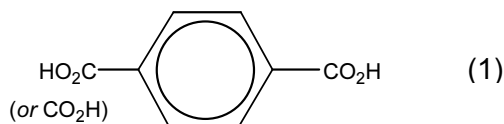
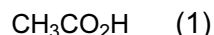
If E_{cell} is more positive it means a greater likelihood of reaction (1) [4]

(d)

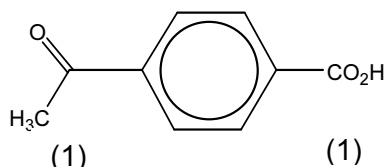


(1)

and

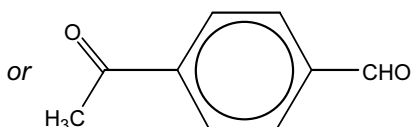


(1)



(1)

(1)



[5]

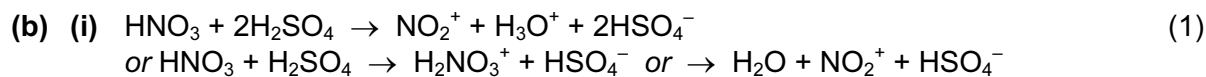
- (e) (i) $(\text{CH}_3)_2\text{C}(\text{OH})-\text{CH}_2\text{OH}$ (1)

- (ii) reaction I: (cold dilute) KMnO_4 ("cold" not needed, but "hot" or "warm" negates) (1)
 reaction II: $\text{Cr}_2\text{O}_7^{2-} + \text{H}^+ + \text{distil}$ (1) [3]

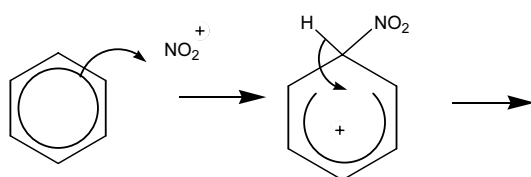
[Total: 18 max 17]

Page 6	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2010	9701	43

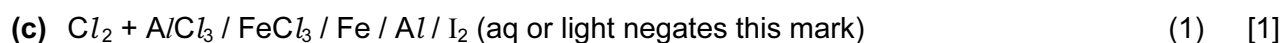
- 5 (a) (i) because the carbons are sp^2 / trigonal planar / bonded at 120° or are joined by π bonds / orbitals (1)
- (ii) because the π electrons / double bonds are delocalised / in resonance or electrons are evenly distributed / spread out (1) [2]



- (ii) electrophilic substitution mechanism: (1)

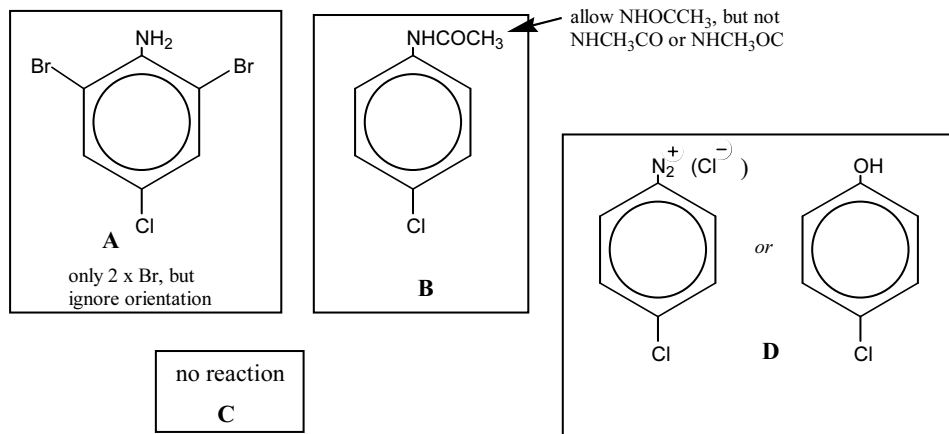


curly arrows from benzene to NO_2^+ , **and** showing loss of H^+ (1)
correct intermediate (with "+" in the 'horse-shoe') (1) [4]



HCl is **conc**, **and** second step is to add $\text{NaOH}(\text{aq})$ (1)

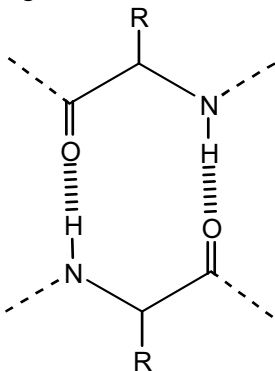
(iii)



(4) [8]

[Total: 15]

Page 7	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2010	9701	43

- 6 (a) (i) Primary – the **amino acid** sequence / order / chain
or diag. e.g. NH-C-CO-NH-C-CO
or amino acids bonded by covalent / amide / peptide bonds (1)
- (ii) Tertiary – the coiling / folding of the protein / polypeptide chain due to interactions between side-chains on the amino acids *or* the structure which gives the protein its 3-D / globular shape (1) [2]
- (b) (i) Diagram:
Minimum is CH₂S-SCH₂ (1)
- (ii) Oxidation / dehydrogenation / redox (1)
- (iii) Hydrogen / H bonds; ionic interactions / bonds *or* ion-dipole *or* salt bridges; van der Waals' *or* id-id *or* induced / instantaneous dipole forces (ignore hydrophobic interactions) (2) [4]
- (c) (i) Hydrogen bonds (1)
- (ii) Correct new strand present (see below) needed
Diagram showing C=O bonding to N-H in new strand... ✓
...and N-H bonding to C=O in new strand ✓
e.g.
- 
- New strand must contain a minimum of two amino acid residues in a single chain. Deduct a penalty of –(1) for any wrong H-bond **only** if (2) marks have already been scored. (2) [3]
- (d) There are bonds *or* S-S bridges / linkages **between the layers / sheets** (in β-keratin) (but only van der Waals interactions between the layers in silk) (1) [1]

[Total: 10]

Page 8	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2010	9701	43

- 7 (a) The amino acid is uncharged / neutral / a zwitterion *or* charges balance / are equal (NOT “is non-polar”)

It is equally attracted by the anode / + and the cathode / – *or* attracted by neither

The pH of the buffer is at the isoelectric point/IEP of the amino acid *any two* ✓✓ (2) [2]

- (b) (at pH 10), $\text{H}_2\text{NCH}_2\text{CO}_2^-$ *or* $\text{NH}_2\text{CH}_2\text{COO}^-$ (1) [1]

(c)

amino acid	relative size	charge
A	small(est) (1)	–ve
B	large(st) (3)	–ve
C	middle (2)	+ve

(numbers are OK to show relative sizes)

Mark each row (3) [3]

- (d) (i) lys – val – ser – ala – gly – ala – gly – asp (2)

(ii) gly – ala – gly (1)

(iii) aspartic acid (*or* lysine) (1) [4]

[Total: 10]

Page 9	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2010	9701	43

- 8 (a) Reaction II – since electrons are used up / required / gained / received (from external circuit) (1) [1]
- (b) $\text{Pb}^{2+} + 2\text{e}^- \rightarrow \text{Pb}$ $E^\ominus = -0.13\text{V}$
 $\text{PbO}_2 + 4\text{H}^+ + 2\text{e}^- \rightarrow \text{Pb}^{2+} + 2\text{H}_2\text{O}$ $E^\ominus = +1.47\text{V}$
two correct $E^\ominus$ values (1)
- Cell voltage is **1.6(0)** (V) (1) [2]
- (c) (i) 3(+) (1)
- (ii) They are less heavy / poisonous / toxic / polluting *or* are safer due to no (conc) H_2SO_4 within them (1) [2]
- (d) (i) Platinum or graphite / carbon (1)
- (ii) They need large quantities of **compressed** gases which take up space *or* the hydrogen would need to be **liquefied** *or* the reactant is (highly) **flammable** / **explosive** / **combustible** (1) [2]
- (e) *Glass:* saves **energy** – the raw materials are easily accessible / cheap *or* making glass is energy-intensive (1)
- Steel:* saves **energy** – extracting iron from the ore *or* mining the ore is energy intensive *or* saves a **resource** – iron **ore** (NOT just “iron”) is becoming scarce *either one* (1)
- Plastics:* saves a valuable / scarce **resource**: (crude) **oil** / **petroleum** (1) [3]

[Total: 10]