

**MARK SCHEME for the October/November 2011 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.

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

Cambridge is publishing the mark schemes for the October/November 2011 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.

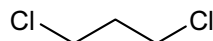
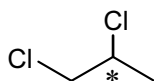
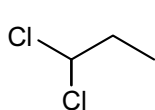


Page 2	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A LEVEL – October/November 2011	9701	41

- 1 (a) (i) *either* burn or shine light/uv on mixture of $H_2 + Cl_2$ *but* NOT heat [1]
- (ii) red/orange/brown colour of bromine decolourises/disappears
steamy/misty/white fumes produced
container gets warm/hot [2]
- (iii) $H-H = 436$ $Cl-Cl = 244$ $H-Cl = 431$
 $\Delta H = 436 + 244 - 2(431) = -182 \text{ kJ mol}^{-1}$ [2]
- $H-H = 436$ $Br-Br = 193$ $H-Br = 366$
 $\Delta H = 436 + 193 - 2(366) = -103 \text{ kJ mol}^{-1}$ [2]
- (iv) H-Br bond is weaker than the H-Cl bond – allow converse. [1]
[8]

- (b) (i) light [1]
- (ii) bonds broken = C-H & I-I = $410 + 151 = 561$
bonds made = C-I & H-I = $240 + 299 = 539$
 $\Delta H = 561 - 539 = +22 \text{ kJ mol}^{-1}$ [2]
- (iii) The overall reaction is endothermic *or* no strong bonds/only weak bonds are formed *or* high E_{act} [1]
[4]
- (c) (i) homolytic fission is the breaking of a bond to form (two) radicals/neutral species/odd-electron species [1]
- (ii) $\bullet CH_2Cl$ [1]
the C-Br bond is the weakest or needs least energy to break/breaks most easily [1]
[3]

(d)



4 structures: [2]
2 or 3 structures: [1]

Correct chiral atom identified

[1]
[3]

[Total: 18]

Page 3	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A LEVEL – October/November 2011	9701	41

- 2 (a) (i) Order w.r.t. $[\text{CH}_3\text{CHO}] = 1$ [1]
Order w.r.t. $[\text{CH}_3\text{OH}] = 1$ [1]
Order w.r.t. $[\text{H}^+] = 1$ [1]
- (ii) rate = $k[\text{CH}_3\text{CHO}][\text{CH}_3\text{OH}][\text{H}^+]$ [1]
- (iii) units = $\text{mol}^{-2} \text{dm}^6 \text{s}^{-1}$ [1]
- (iv) rate will be $2 \times 4 = 8$ times as fast as reaction 1 (relative rate = 8) [1]
[6]

(b)

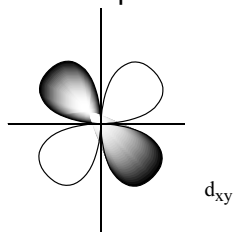
	$[\text{CH}_3\text{CHO}]$ /mol dm ⁻³	$[\text{CH}_3\text{OH}]$ /mol dm ⁻³	$[\text{H}^+]$ /mol dm ⁻³	[acetal A] /mol dm ⁻³	$[\text{H}_2\text{O}]$ /mol dm ⁻³
at start	0.20	0.10	0.05	0.00	0.00
at equilibrium	$(0.20 - x)$	$(0.10 - 2x)$	0.05	x	x
at equilibrium	0.175	0.05	0.05	0.025	0.025

- (i) 3 values in second row 3 x [1]
- (ii) 4 values in third row 4 x [1]
- (iii) $K_c = \frac{[\text{acetal A}][\text{H}_2\text{O}]}{[\text{CH}_3\text{CHO}][\text{CH}_3\text{OH}]^2}$ [1]
units = $\text{mol}^{-1} \text{dm}^3$ [1]
- (iv) $K_c = 0.025^2 / (0.175 \times 0.05^2) = \mathbf{1.4(3)}$ ($\text{mol}^{-1} \text{dm}^3$) [1]
[max 9]

[Total: 15]

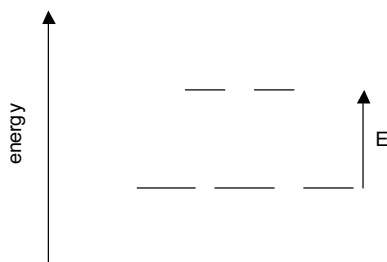
Page 4	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A LEVEL – October/November 2011	9701	41

- 3 (a) for example.... also allow d_{z^2}



shape (4 lobes) [1]
correct label e.g. d_{xy} [1]
[2]

- (b) (i)



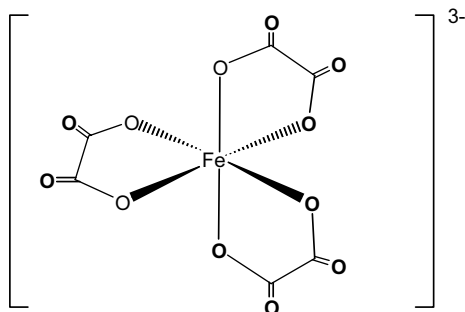
Marks are for 5 degenerate orbitals [1]
and 3:2 split [1]

- (ii) colour due to the absorption of light NOT emitted light [1]
 $E = hf$ or photon's energy = E in above diagram [1]
electron promoted from lower to higher orbital [1]

size of ΔE depends on the ligand [1]
as ΔE changes, so does f in $E = hf$ [1]
[7]

- (c) (i) O.N.(carbon) = +3 ($4 \times (-2) + 2x = -2$, thus $2x = +6$) [1]
(ii) O.N. = +3 [1]

- (iii)



[2]

- (iv) $2 K_3Fe(C_2O_4)_3 \rightarrow 3 K_2C_2O_4 + 2 FeC_2O_4 + 2 CO_2$ [2]
Or $K_3Fe(C_2O_4)_3 \rightarrow \underline{3/2} K_2C_2O_4 + FeC_2O_4 + CO_2$

[max 5]

[Total: 14]

Page 5	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A LEVEL – October/November 2011	9701	41

- 4 (a) (i) $\text{C}_2\text{H}_5\text{NH}_2 + \text{HA} \rightarrow \text{C}_2\text{H}_5\text{NH}_3^+ + \text{A}^-$ (HA can be H_2O , HCl etc.) [1]
Allow $\rightleftharpoons$ instead of arrow

(ii)

most basic		least basic
ethylamine	ammonia	phenylamine

[1]

- (iii) ethylamine > NH_3 due to electron-donating ethyl/alkyl group [1]
phenylamine < NH_3 due to delocalisation of lone pair over ring [1]
[4]

- (b) (i) $\text{C}_6\text{H}_5\text{OH} + \text{OH}^- \rightarrow \text{C}_6\text{H}_5\text{O}^- + \text{H}_2\text{O}$ (or with $\text{Na}^+/\text{H}_2\text{O}/\text{A}^-$) [1]

- (ii) pKa of nitrophenol is smaller/ K_a is larger because it's a stronger acid/dissociates more than phenol [1]
stronger because the anionic charge is spread out moreover the NO_2 group or NO_2 is electron-withdrawing [1]

- (iii) pKa = 1.0 [1]

- (iv) Nitro group increases acidity / electron-withdrawing groups increase acidity [1]
[5]

- (c) (i) **B** is phenyldiazonium cation, $\text{C}_6\text{H}_5\text{--N}^+\equiv\text{N}$ [1]

(ii)

reaction	reagent(s)	conditions
Step 1	$\text{NaNO}_2 + \text{HCl}$ or HNO_2 [1]	$T < 10^\circ\text{C}$ [1]
Step 2	$\text{H}_2\text{O} / \text{aq}$	heat/boil/$T > 10^\circ$ (both) [1]
Step 3	HNO_3 NB $\text{HNO}_3(\text{aq})$ OK for both	dilute (both) [1]

[4]

[5]

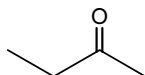
[Total: 14]

Page 6	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A LEVEL – October/November 2011	9701	41

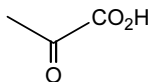
- 5 (a) (i) C=C double bonds / alkenes
- (ii) –OH groups / accept alcohols or acids
- (iii) CH₃CO– or CH₃CH(OH)– groups
- (iv) carbonyl, >C=O, groups / accept aldehydes and ketones

4 × [1]
[4]

(b)



D

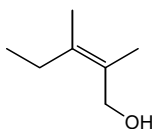


E

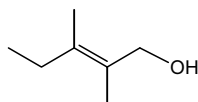
2 × [1]

[2]

(c) isomers of C



cis



trans

correct structure (excl. stereochemistry)

[1]

cis and trans drawn correctly

[1]

type of isomerism is **cis-trans or geometrical isomerism**

[1]

[3]

[Total: 9]

Page 7	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A LEVEL – October/November 2011	9701	41

6 (a) (i) $2\text{H}_2\text{NCH}_2\text{CO}_2\text{H} \rightarrow \text{H}_2\text{NCH}_2\text{CONHCH}_2\text{CO}_2\text{H} + \text{H}_2\text{O}$ [1]

(ii) Skeletal formula required [1]
[2]

(b) (i) α helix [1]
 β pleated sheet [1]

(ii) Students should choose one of the structures below

For α helix:

Need to show a helix
with $\text{C}=\text{O} \cdots \text{H}-\text{N}$
between turns

For β pleated sheet:

Need to show two parallel 'zig-zag'
strands with $\text{C}=\text{O} \cdots \text{H}-\text{N}$ between
them

Whichever is chosen, overall structure [1] position of H bonds [1]

[4]

(c)

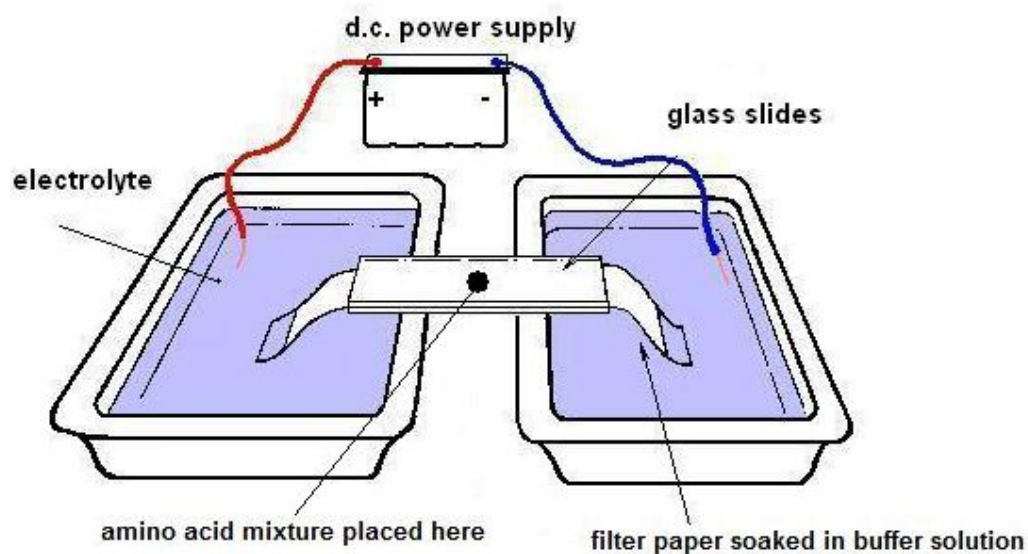
amino acid residue 1	amino acid residue 2	type of bonding
$-\text{HNCH}(\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{NH}_2)\text{CO}-$	$\text{HNCH}(\text{CH}_2\text{CH}_2\text{CO}_2\text{H})\text{CO}-$	Ionic bonds or hydrogen bonds
$-\text{HNCH}(\text{CH}_3)\text{CO}-$	$-\text{HNCH}(\text{CH}_3)\text{CO}-$	van der Waals'
$-\text{HNCH}(\text{CH}_2\text{SH})\text{CO}-$	$-\text{HNCH}(\text{CH}_2\text{SH})\text{CO}-$	Disulfide bonds
$-\text{HNCH}(\text{CH}_2\text{OH})\text{CO}-$	$-\text{HNCH}(\text{CH}_2\text{CO}_2\text{H})\text{CO}-$	Hydrogen bonds

[4]

[Total: 10]

Page 8	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A LEVEL – October/November 2011	9701	41

- 7 (a) Sketch and label the apparatus used to carry out electrophoresis e.g



Marks: power supply / electrolyte + filter paper / buffer / acid mixture central

4 × [1]
[4]

- (b) (i) pH of the buffer [1]
Charge on the amino acid species [1]
- (ii) Size of the amino acid species / M_r [1]
Voltage applied [1]
Magnitude of the charge (on the amino acid species) [1]
Temperature [1]
(max 3)
[max 3]
- (c) (i) They have insufficient electron density / only one electron [1]
(ii) Sulfur [1]
because it has the greatest atomic number / number of electrons [1]
[3]

[Total: 10]

Page 9	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A LEVEL – October/November 2011	9701	41

8 (a)

traditional material	modern polymer used
Paper/cardboard/wood/leaves hessian/hemp/jute steel/aluminium	PVC in packaging
Cotton/wool/linen	<i>Terylene</i> in fabrics
Glass/china/porcelain/earthenware metal/leather	Polycarbonate bottle

3 → 2 marks, 2 → 1 mark
[2]

- (b) Reasons: Plastics/polymers pollute the environment for a long time do not decompose/
biodegrade quickly [1]
They are mainly produced from oil [1]
Produce toxic gases on burning [1]
max two

Strategy 1: Recycle polymer waste / use renewable resources [1]
Strategy 2: Develop biodegradable polymers [1]
[max 3]

- (c) PVC [1]
Combustion would produce HCl / dioxins as a pollutant [1]
or
nylon/acrylic [1]
Combustion would produce HCN [1]
[2]

- (d) (i) Polythene (or other addition polymer) [1]

- (ii) Addition polymerisation [1]

The polymer chains don't have strong bonds between them – easy to melt [1]
Could be answered with a suitable diagram **[3]**

[Total: 10]

**MARK SCHEME for the October/November 2011 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.

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

Cambridge is publishing the mark schemes for the October/November 2011 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 A LEVEL – October/November 2011	9701	42

1 (a) (i) *either* burn or shine light/uv on mixture of $H_2 + Cl_2$ *but* NOT heat [1]

(ii) red/orange/brown colour of bromine decolourises/disappears
steamy/misty/white fumes produced
container gets warm/hot [2]

(iii) $H-H = 436$ $Cl-Cl = 244$ $H-Cl = 431$
 $\Delta H = 436 + 244 - 2(431) = -182 \text{ kJ mol}^{-1}$ [2]

$H-H = 436$ $Br-Br = 193$ $H-Br = 366$
 $\Delta H = 436 + 193 - 2(366) = -103 \text{ kJ mol}^{-1}$ [2]

(iv) H-Br bond is weaker than the H-Cl bond – allow converse. [1]
[8]

(b) (i) light [1]

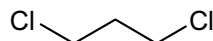
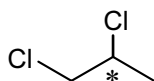
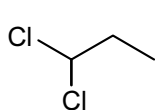
(ii) bonds broken = C-H & I-I = $410 + 151 = 561$
bonds made = C-I & H-I = $240 + 299 = 539$
 $\Delta H = 561 - 539 = +22 \text{ kJ mol}^{-1}$ [2]

(iii) The overall reaction is endothermic *or* no strong bonds/only weak bonds are formed *or* high E_{act} [1]
[4]

(c) (i) homolytic fission is the breaking of a bond to form (two) radicals/neutral species/odd-electron species [1]

(ii) $\bullet CH_2Cl$ [1]
the C-Br bond is the weakest or needs least energy to break/breaks most easily [1]
[3]

(d)



4 structures: [2]
2 or 3 structures: [1]

Correct chiral atom identified [1]
[3]

[Total: 18]

Page 3	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A LEVEL – October/November 2011	9701	42

- 2 (a) (i) Order w.r.t. $[\text{CH}_3\text{CHO}] = 1$ [1]
Order w.r.t. $[\text{CH}_3\text{OH}] = 1$ [1]
Order w.r.t. $[\text{H}^+] = 1$ [1]
- (ii) rate = $k[\text{CH}_3\text{CHO}][\text{CH}_3\text{OH}][\text{H}^+]$ [1]
- (iii) units = $\text{mol}^{-2} \text{dm}^6 \text{s}^{-1}$ [1]
- (iv) rate will be $2 \times 4 = 8$ times as fast as reaction 1 (relative rate = 8) [1]
[6]

(b)

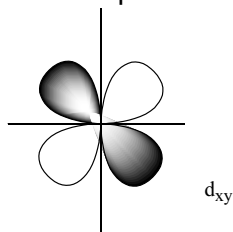
	$[\text{CH}_3\text{CHO}]$ /mol dm ⁻³	$[\text{CH}_3\text{OH}]$ /mol dm ⁻³	$[\text{H}^+]$ /mol dm ⁻³	[acetal A] /mol dm ⁻³	$[\text{H}_2\text{O}]$ /mol dm ⁻³
at start	0.20	0.10	0.05	0.00	0.00
at equilibrium	$(0.20 - x)$	$(0.10 - 2x)$	0.05	x	x
at equilibrium	0.175	0.05	0.05	0.025	0.025

- (i) 3 values in second row 3 x [1]
- (ii) 4 values in third row 4 x [1]
- (iii) $K_c = \frac{[\text{acetal A}][\text{H}_2\text{O}]}{[\text{CH}_3\text{CHO}][\text{CH}_3\text{OH}]^2}$ [1]
units = $\text{mol}^{-1} \text{dm}^3$ [1]
- (iv) $K_c = 0.025^2 / (0.175 \times 0.05^2) = \mathbf{1.4(3)}$ ($\text{mol}^{-1} \text{dm}^3$) [1]
[max 9]

[Total: 15]

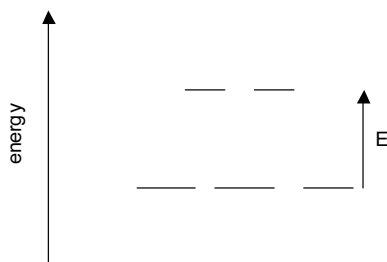
Page 4	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A LEVEL – October/November 2011	9701	42

3 (a) for example.... also allow d_{z^2}



shape (4 lobes) [1]
correct label e.g. d_{xy} [1]
[2]

(b) (i)



Marks are for 5 degenerate orbitals [1]
and 3:2 split [1]

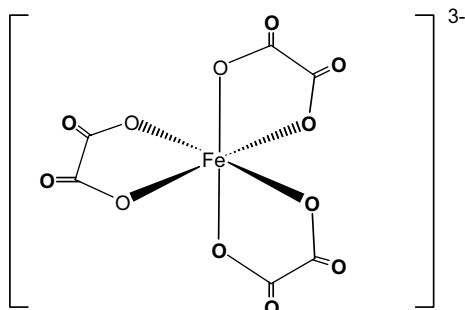
(ii) colour due to the absorption of light NOT emitted light [1]
 $E = hf$ or photon's energy = E in above diagram [1]
electron promoted from lower to higher orbital [1]

size of ΔE depends on the ligand [1]
as ΔE changes, so does f in $E = hf$ [1]
[7]

(c) (i) O.N.(carbon) = +3 ($4 \times (-2) + 2x = -2$, thus $2x = +6$) [1]

(ii) O.N. = +3 [1]

(iii)



[2]

(iv) $2 K_3Fe(C_2O_4)_3 \rightarrow 3 K_2C_2O_4 + 2 FeC_2O_4 + 2 CO_2$ [2]
Or $K_3Fe(C_2O_4)_3 \rightarrow \underline{3/2} K_2C_2O_4 + FeC_2O_4 + CO_2$

[max 5]

[Total: 14]

Page 5	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A LEVEL – October/November 2011	9701	42

- 4 (a) (i) $\text{C}_2\text{H}_5\text{NH}_2 + \text{HA} \rightarrow \text{C}_2\text{H}_5\text{NH}_3^+ + \text{A}^-$ (HA can be H_2O , HCl etc.) [1]
Allow $\rightleftharpoons$ instead of arrow

(ii)

most basic		least basic
ethylamine	ammonia	phenylamine

[1]

- (iii) ethylamine > NH_3 due to electron-donating ethyl/alkyl group [1]
phenylamine < NH_3 due to delocalisation of lone pair over ring [1]
[4]

- (b) (i) $\text{C}_6\text{H}_5\text{OH} + \text{OH}^- \rightarrow \text{C}_6\text{H}_5\text{O}^- + \text{H}_2\text{O}$ (or with $\text{Na}^+/\text{H}_2\text{O}/\text{A}^-$) [1]

- (ii) pK_a of nitrophenol is smaller/K_a is larger because it's a stronger acid/dissociates more than phenol [1]
stronger because the anionic charge is spread out moreover the NO_2 group or NO_2 is electron-withdrawing [1]

- (iii) pK_a = 1.0 [1]

- (iv) Nitro group increases acidity / electron-withdrawing groups increase acidity [1]
[5]

- (c) (i) **B** is phenyldiazonium cation, $\text{C}_6\text{H}_5\text{—N}^+\equiv\text{N}$ [1]

(ii)

reaction	reagent(s)	conditions
Step 1	$\text{NaNO}_2 + \text{HCl}$ or HNO_2 [1]	$T < 10^\circ\text{C}$ [1]
Step 2	$\text{H}_2\text{O} / \text{aq}$	heat/boil/$T > 10^\circ$ (both) [1]
Step 3	HNO_3 NB $\text{HNO}_3(\text{aq})$ OK for both	dilute (both) [1]

[4]

[5]

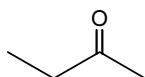
[Total: 14]

Page 6	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A LEVEL – October/November 2011	9701	42

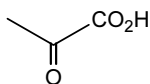
- 5 (a) (i) C=C double bonds / alkenes
- (ii) –OH groups / accept alcohols or acids
- (iii) CH₃CO– or CH₃CH(OH)– groups
- (iv) carbonyl, >C=O, groups / accept aldehydes and ketones

4 × [1]
[4]

(b)



D

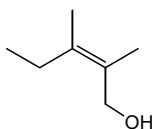


E

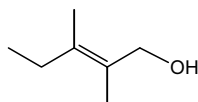
2 × [1]

[2]

(c) isomers of C



cis



trans

correct structure (excl. stereochemistry)

[1]

cis and trans drawn correctly

[1]

type of isomerism is **cis-trans or geometrical isomerism**

[1]

[3]

[Total: 9]

Page 7	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A LEVEL – October/November 2011	9701	42

6 (a) (i) $2\text{H}_2\text{NCH}_2\text{CO}_2\text{H} \rightarrow \text{H}_2\text{NCH}_2\text{CONHCH}_2\text{CO}_2\text{H} + \text{H}_2\text{O}$ [1]

(ii) Skeletal formula required [1]
[2]

(b) (i) α helix [1]
 β pleated sheet [1]

(ii) Students should choose one of the structures below

For α helix:

Need to show a helix
with $\text{C}=\text{O} \cdots \text{H}-\text{N}$
between turns

For β pleated sheet:

Need to show two parallel 'zig-zag'
strands with $\text{C}=\text{O} \cdots \text{H}-\text{N}$ between
them

Whichever is chosen, overall structure [1] position of H bonds [1]

[4]

(c)

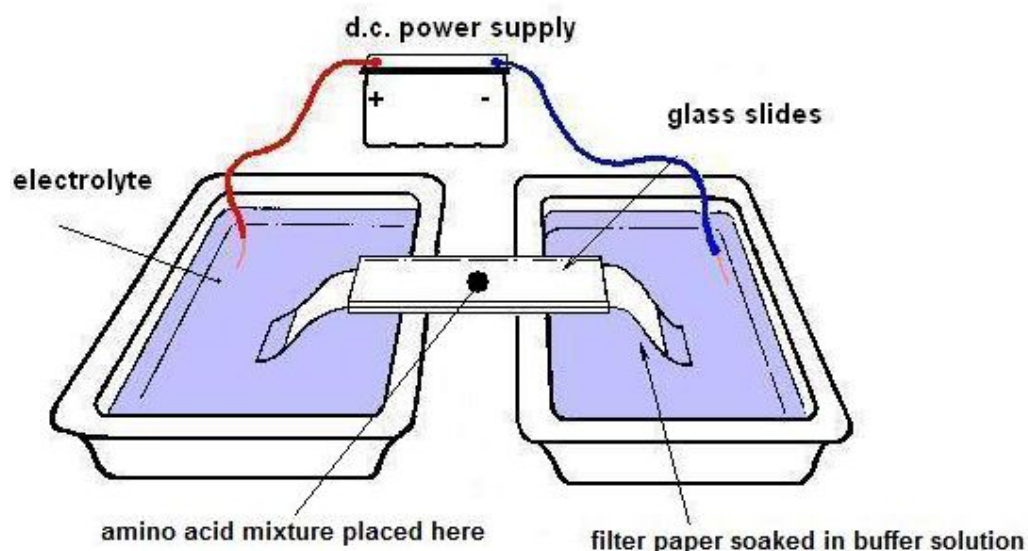
amino acid residue 1	amino acid residue 2	type of bonding
$-\text{HNCH}(\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{NH}_2)\text{CO}-$	$\text{HNCH}(\text{CH}_2\text{CH}_2\text{CO}_2\text{H})\text{CO}-$	Ionic bonds or hydrogen bonds
$-\text{HNCH}(\text{CH}_3)\text{CO}-$	$-\text{HNCH}(\text{CH}_3)\text{CO}-$	van der Waals'
$-\text{HNCH}(\text{CH}_2\text{SH})\text{CO}-$	$-\text{HNCH}(\text{CH}_2\text{SH})\text{CO}-$	Disulfide bonds
$-\text{HNCH}(\text{CH}_2\text{OH})\text{CO}-$	$-\text{HNCH}(\text{CH}_2\text{CO}_2\text{H})\text{CO}-$	Hydrogen bonds

[4]

[Total: 10]

Page 8	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A LEVEL – October/November 2011	9701	42

- 7 (a) Sketch and label the apparatus used to carry out electrophoresis e.g



Marks: power supply / electrolyte + filter paper / buffer / acid mixture central

4 × [1]
[4]

- (b) (i) pH of the buffer [1]
Charge on the amino acid species [1]
- (ii) Size of the amino acid species / M_r [1]
Voltage applied [1]
Magnitude of the charge (on the amino acid species) [1]
Temperature [1]
(max 3)
[max 3]
- (c) (i) They have insufficient electron density / only one electron [1]
(ii) Sulfur [1]
because it has the greatest atomic number / number of electrons [1]
[3]

[Total: 10]

Page 9	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A LEVEL – October/November 2011	9701	42

8 (a)

traditional material	modern polymer used
Paper/cardboard/wood/leaves hessian/hemp/jute steel/aluminium	PVC in packaging
Cotton/wool/linen	<i>Terylene</i> in fabrics
Glass/china/porcelain/earthenware metal/leather	Polycarbonate bottle

3 → 2 marks, 2 → 1 mark
[2]

- (b) Reasons: Plastics/polymers pollute the environment for a long time do not decompose/
biodegrade quickly [1]
They are mainly produced from oil [1]
Produce toxic gases on burning [1]
max two

Strategy 1: Recycle polymer waste / use renewable resources [1]
Strategy 2: Develop biodegradable polymers [1]
[max 3]

- (c) PVC [1]
Combustion would produce HCl / dioxins as a pollutant [1]
or
nylon/acrylic [1]
Combustion would produce HCN [1]
[2]

- (d) (i) Polythene (or other addition polymer) [1]

- (ii) Addition polymerisation [1]

The polymer chains don't have strong bonds between them – easy to melt [1]
Could be answered with a suitable diagram **[3]**

[Total: 10]

**MARK SCHEME for the October/November 2011 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.

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

Cambridge is publishing the mark schemes for the October/November 2011 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 A LEVEL – October/November 2011	9701	43

- 1 (a) Cr^{3+} : $1s^2 2s^2 2p^6 3s^2 3p^6 3d^3$ [1]
 Mn^{2+} : $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$ [1]
[2]

- (b) (i) Any two from
• H^+ is on the oxidant/L.H. side of each of the $\frac{1}{2}$ -equations, *or* H^+ is a reactant
• (increasing $[\text{H}^+]$) will make $E^\ominus$ more positive
• (increasing $[\text{H}^+]$) will drive the reaction over to the R.H./reductant side *or* forward direction
[1] + [1]

- (ii) KMnO_4 : Purple/violet to colourless (allow very pale pink) [1]
 $\text{K}_2\text{Cr}_2\text{O}_7$ Orange to green [1]
[4]

- (c) (i) $\text{MnO}_2 + \text{SO}_2 \longrightarrow \text{MnSO}_4$ (*or* $\text{Mn}^{2+} + \text{SO}_4^{2-}$) [1]
manganese changes/is reduced from +4 to +2 [1]
sulfur changes/is oxidised from +4 to +6 [1]

- (ii) **No effect**, because H^+ does not appear in the overall equation *or* its effect on the $\text{MnO}_2/\text{Mn}^{2+}$ change is cancelled out by its effect on the $\text{SO}_2/\text{SO}_4^{2-}$ change [1]
[4]

- (d) (i) $\text{MnO}_2 + 4\text{H}^+ + \text{Sn}^{2+} \longrightarrow \text{Mn}^{2+} + 2\text{H}_2\text{O} + \text{Sn}^{4+}$ [1]

- (ii) $n(\text{MnO}_4^-) = 0.02 \times 18.1/1000 = 3.62 \times 10^{-4} \text{ mol}$ [1]
 $n(\text{Sn}^{2+}) = 3.62 \times 10^{-4} \times 5/2 = 9.05 \times 10^{-4} \text{ mol}$ [1]
 $n(\text{Sn}^{2+})$ that reacted with $\text{MnO}_2 = (20 - 9.05) \times 10^{-4} = 1.095 \times 10^{-3} \text{ mol}$ [1]
reaction is 1:1, so this is also $n(\text{MnO}_2)$
mass of $\text{MnO}_2 = 1.095 \times 10^{-3} \times (54.9+16+16) = 0.0952 \text{ g}$ [1]
 $\Rightarrow$ **95% – 96%**; 2 or more s.f. [1]
[6]

[Total: 16]

Page 3	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A LEVEL – October/November 2011	9701	43

- 2 (a) (i) A molecule/ion/species with a lone pair (of electrons) or electron pair donor...
.... that bonds to a metal ion/transition element.... [1]
- (ii) ...by means of a dative/coordinate (covalent) bond [1]
[2]
- (b) (i) straight line from (0, 0.01) to point at (350, 0.0028) with all points on the line [1]
- (ii) order w.r.t. $\text{Cr}(\text{CO})_6$ is 1 **and** order w.r.t. PR_3 is zero [1]
because (a) $\text{Cr}(\text{CO})_6$ graph has a constant half-life (which is 700 s)
or construction lines on graph showing this) [1]
because (b) PR_3 graph is a straight line (of constant slope) or line shows a constant rate
of reaction or no change in rate or shows a linear decrease [1]
- (iii) rate = $k[\text{Cr}(\text{CO})_6]$ [1]
 $k = (0.9 - 1.1) \times 10^{-3} \text{ (s}^{-1}\text{)}$ (one or more s.f.) [1]
either $\text{rate}_0 = 0.01/1020 = 9.8 \times 10^{-6} \text{ mol sec}^{-1}$ when $[\text{Cr}(\text{CO})_6] = 0.01 \text{ mol dm}^{-3}$
so $k = 9.8 \times 10^{-6}/0.01 = 9.8 \times 10^{-4}$
or $t_{1/2} \approx 700 \text{ sec}$
 $k = 0.693/700 = 9.9 \times 10^{-4}$
- (iv) (units of k are) sec^{-1} [1]
- (v) N.B. the chosen mechanism must be consistent with the rate equation in (iii). Thus:
either if rate = $k[\text{Cr}(\text{CO})_6]$
mechanism **B** is consistent [1]
because it's the only mechanism that does NOT involve PR_3 in its slow/rate-determining
step or only $\text{Cr}(\text{CO})_6$ is involved in slow step or $[\text{PR}_3]$ does not affect the rate [1]
- or
- if rate = $k[\text{Cr}(\text{CO})_6][\text{PR}_3]$, then
mechanism **A** or **C** or **D** is consistent [1]
because both reactants are involved in slow step [1]
[9]

[Total: 11]

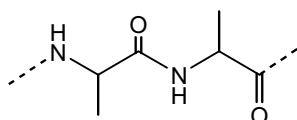
Page 4	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A LEVEL – October/November 2011	9701	43

3 (a) (i) E is $\text{CH}_3\text{CH}(\text{NH}_2)\text{CN}$ [1]

(ii) $\text{C}_6\text{H}_5\text{CH}_2\text{CHO}$ [1]
[2]

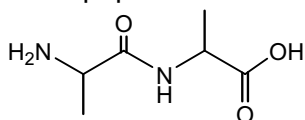
(b) (i) a polymer/polypeptide of amino acids, (joined by peptide bonds)
(allow 'chain' of amino acids' but not 'sequence': the idea of 'many' has to be conveyed) [1]

(ii)



peptide bond shown in full ($\text{C}=\text{O}$) in an ala-ala fragment in a chain [1]
two repeat units [1]

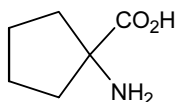
Allow peptide bond shown in full ($\text{C}=\text{O}$) in a dipeptide ala-ala for 1 mark



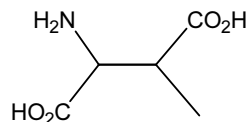
[3]

(c) (i) HCl or H_2SO_4 or NaOH or H^+ or OH^- reagents [1]
+ heat and $\text{H}_2\text{O}/\text{aq}$ (allow H_3O^+).
If T is quoted, $80\text{ }^\circ\text{C} < T < 120\text{ }^\circ\text{C}$. NOT warm. conditions [1]

(ii)



and



(if a structural formula, it must have all H atoms) allow protonated or deprotonated versions [1] + [1]

[max 3]

Page 5	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A LEVEL – October/November 2011	9701	43

(d) (i) $\text{NH}_3^+ - \text{CH}(\text{CH}_3) - \text{CO}_2^-$ [1]

(ii)

compound	zwitterion

[3]

[4]

(e) (i) A buffer is a solution whose pH stays **fairly** constant *or* which maintains **roughly** the same pH *or* which resists/minimises changes in pH [1]
when **small/moderate** amounts of acid/ H^+ or alkali/ OH^- are added [1]

(ii) $\text{NH}_2\text{CH}(\text{CH}_3)\text{CO}_2\text{H} + \text{H}(\text{Cl}) \longrightarrow {}^+\text{NH}_3\text{CH}(\text{CH}_3)\text{CO}_2\text{H} (+ \text{Cl}^-)$ [1]

(iii) blood contain HCO_3^- (or in an equation) [1]
which absorbs H^+ *or* equn $\text{H}^+ + \text{HCO}_3^- \longrightarrow \text{H}_2\text{CO}_3 (\text{H}_2\text{O} + \text{CO}_2)$ [1]
or absorbs OH^- *or* equn $\text{OH}^- + \text{HCO}_3^- \longrightarrow \text{CO}_3^{2-} + \text{H}_2\text{O}$ [1]

(iv) $[\text{CH}_3\text{CO}_2\text{Na}] = 0.05$ $[\text{CH}_3\text{CO}_2\text{H}] = 0.075$ [1]
 $\text{pH} = 4.76 + \log (0.05/0.075) = \mathbf{4.58}$ *or* $\mathbf{4.6}$ [1]

[7]

[Total: 19]

Page 6	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A LEVEL – October/November 2011	9701	43

4 (a) $\text{Ca}(\text{NO}_3)_2 \longrightarrow \text{CaO} + 2\text{NO}_2 + \frac{1}{2} \text{O}_2$ [1]
[1]

(b) (down the group) nitrates become **more stable** or require a higher temperature to decompose [1]
as size/radius of (cat)ion increases or charge density of ion decreases [1]
so polarisation/distortion of anion/nitrate decreases [1]
[3]

(c) (i) $\text{Li}_2\text{CO}_3 \longrightarrow \text{Li}_2\text{O} + \text{CO}_2$ [1]

(ii) radius of Li ion/ Li^+ is less than that of Na ion/ Na^+ (or polarising power of M^+ is greater) [1]

(iii) Brown/orange fumes/gas would be evolved or glowing splint relights [1]
Since the nitrate is likely to be thermally unstable or decomposes (just like the carbonate) or the balanced equation: $2\text{LiNO}_3 \longrightarrow \text{Li}_2\text{O} + 2\text{NO}_2 + \frac{1}{2}\text{O}_2$ [1]
[4]

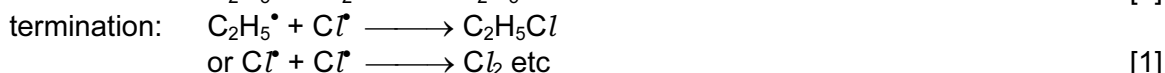
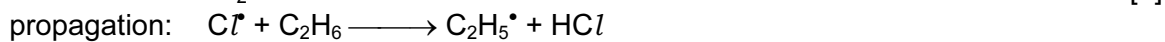
[Total: 8]

Page 7	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A LEVEL – October/November 2011	9701	43

- 5 (a) Alkanes are non-polar *or* have no dipole *or* C–H bonds are strong *or* C and H have similar electronegativities [1]
[1]

- (b) (i) (free) radical substitution *or* substitution by homolytic fission [1]

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



all 3 names [1]

(iii)

structural formula of by-product	formed by
$\text{CH}_2\text{Cl}-\text{CH}_2\text{Cl}$ (or isomer)	further substitution
$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$	(termination of 2 ×) $\text{C}_2\text{H}_5^\bullet$
$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Cl}$ (or isomer)	substitution of C_4H_{10} by-product

[3]

accept in the “formed by” column the formulae of radicals that will produce the compound in the “by-product” column, or the reagents, e.g. $\text{C}_4\text{H}_9^\bullet + \text{Cl}_2$ *or* $\text{C}_4\text{H}_9^\bullet + \text{Cl}^\bullet$ *or* $\text{C}_4\text{H}_{10} + \text{Cl}_2$ (giving $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Cl}$).

do not allow anything more *Cl*-substituted than **dichlorobutane**.

N.B. $\text{C}_2\text{H}_5\text{Cl}$ is the **major** product, not a **by**-product, so do not allow $\text{C}_2\text{H}_5\text{Cl}$.

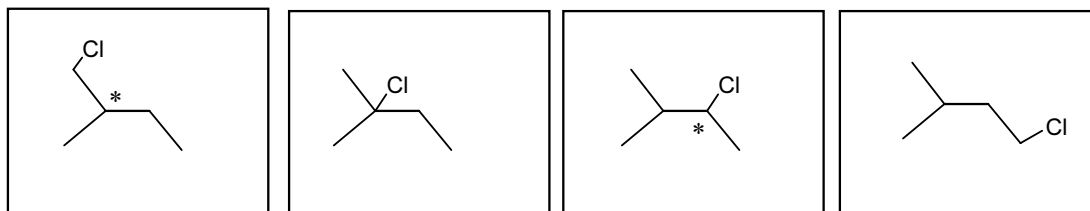
- (iv) J/K = **2.3 : 1** *or* 7:3 *or* 21:9 [2]

(reason: straightforward relative rate suggests 21:1, but there are 9 primary to 1 tertiary, so divide this ratio by 9. $21/9 = 2.33$)

allow [1] mark if J/K ratio is given as 21:1;

[10]

(c)



4 isomers $4 \times [1]$

2 chiral atoms identified correctly, even in incorrect structures

[1] + [1]

[max 5]

[Total: 16]

Page 8	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A LEVEL – October/November 2011	9701	43

- 6 (a) (i) **K**, because it is the (only) one to contain nitrogen *or* it's an amino acid *or* because it contains CO₂H *or* NH groups [1]
- (ii) molecule: **J**, polymer: RNA (**not** DNA) [1]
or molecule: **L**, polymer: starch, cellulose, glycogen *or* polysaccharide (**not** carbohydrate) [2]
- (b) (i) Covalent bonding [1]
(ii) Hydrogen bonding [1]
(iii) Ionic/electrovalent bonding *or* disulphide/–S–S– bonding *or* van der Waals' forces [1]
[3]
- (c) (i) Enzymes [1]
(ii) • change in pH
• increase in T (NOT decrease; T > 40 °C *or* “too high” are OK)
• addition of heavy metal ions *or* specific, e.g. Hg²⁺, Ag⁺, Pb²⁺ etc.
any two bullet points [1] + [1]
- change in pH disrupts ionic bonds
or metal ions disrupt ionic bonds
or metal ions disrupt –S–S– bonds
or heating disrupts hydrogen bonds
any one [1]
- This changes: the 3D structure *or* shape of the enzyme *or* the active site [1]
[**max 4**]
[**Total: 9**]

Page 9	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A LEVEL – October/November 2011	9701	43

7 (a)

structural information	analytical technique
three-dimensional arrangement of atoms and bonds in a molecule	X-ray crystallography/diffraction
chemical environment of protons in a molecule	NMR (spectroscopy) only
identity of amino acids present in a polypeptide	Electrophoresis / chromatography / mass spectrometry

[1] + [1] + [1]
[3]

(b) (i) **paper chromatography;**

The components **partition** between the solvent/moving phase and the water/liquid stationary phase *or* separation relies on different solubilities (of components) in the moving solvent and the stationary water phase. [1]

(ii) **thin-layer chromatography.**

Separation depends on the differential **adsorption** of the components onto the solid particles/phase *or* Al_2O_3 *or* SiO_2 . [1]

[2]

(c) (i) No. of carbon atoms present = $\frac{0.2 \times 100}{5.9 \times 1.1} = 3.08$ hence 3 carbons [1]

(ii) Bromine [1]

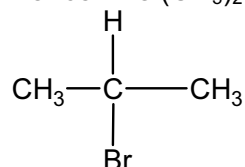
(iii) **One** bromine is present as there is only an M+2 peak / no M+4 peak *or* the M and M+2 peaks are of similar height [1]

(iv) *NMR spectrum shows a single hydrogen split by many adjacent protons and 6 protons in an identical chemical environment. This suggests...*

two $-CH_3$ groups and a lone proton attached to the central carbon atom [1]

Empirical formula of **N** is C_3H_7Br [1]

Hence **N** is $(CH_3)_2CHBr$ *or*



[1]

[6]

[Total: 11]

Page 10	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A LEVEL – October/November 2011	9701	43

- 8 (a) (i) Soluble form would be most effective [1]
- (ii) **Q**, since the 'mini-pills'/granules/powder have a larger surface area
or **P**, because it has no protective casing [1]
- (iii) The gel coat stops it being broken down while passing through the upper part of the digestive system/stomach
or the gel coat is stable to stomach acid. [1]
[3]
- (b) The drug is taken quickly/directly to the target
or more accurate dosing can be achieved [1]
- When the drug is taken by mouth it has to pass through the stomach/intestine wall to get into the bloodstream. or some is digested/lost to the system [1]
[2]
- (c) (i) condensation (polymerisation) [1]
- (ii) hydrogen bonds or van der Waals' [1]
- (iii) It would change the overall shape of the (drug) molecule
The 'fit' into the active site would be less effective [1] + [1]
- (iv) Hydrolysis [1]
[5]
- [Total: 10]