www.PapaCambridge.com

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Level

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.

www.PapaCambridge.com

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

(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

ΔH = 436 + 244 – 2(431) = –182 kJ mol^{-1} [2]

H-H = 436 Br-Br = 193 H-Br = 366

ΔH = 436 + 193 – 2(366) = –103 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
ΔH = 551 – 539 = +22 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]

www.PapaCambridge.com

2 **(a)** **(i)** Order w.r.t. $[CH_3CHO] = 1$
Order w.r.t. $[CH_3OH] = 1$
Order w.r.t. $[H^+] = 1$

(ii) rate = $k[CH_3CHO][CH_3OH][H^+]$ [1]

(iii) units = $mol^{-2}\ dm^6\ s^{-1}$ [1]

(iv) rate will be 2 × 4 = 8 times as fast as reaction 1 (relative rate = 8) [1]

[6]

(b)

	$[CH_3CHO]$ /mol dm^{-3}	$[CH_3OH]$ /mol dm^{-3}	$[H^+]$ /mol dm^{-3}	[acetal **A**] /mol dm^{-3}	$[H_2O]$ /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 = {[acetal **A**][H_2O]}/{[CH_3CHO][CH_3OH]^2} [1]
units = $mol^{-1}dm^3$ [1]

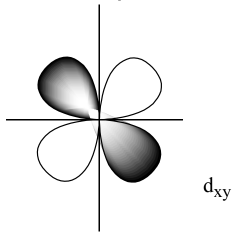
(iv) $K_c = 0.025^2/(0.175 \times 0.05^2)$ = **1.4(3)** ($mol^{-1}\ dm^3$) [1]

[max 9]

[Total: 15]

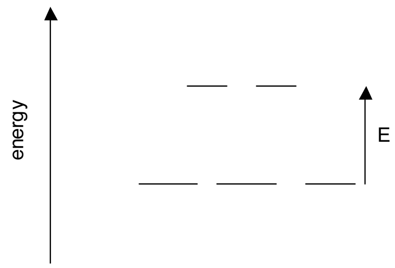
www.PapaCambridge.com

3 **(a)** for example.... also allow d_{z2}



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]

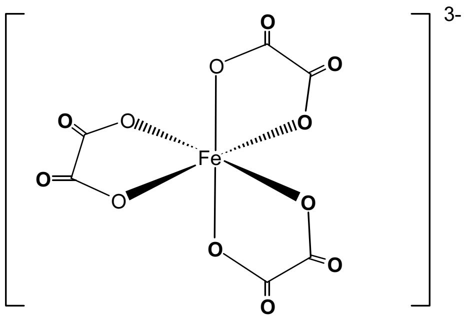
(ii) colour due to the absorption of light NOT emitted light [1]
E = hf *or* photon's energy = E in above diagram [1]
electron promoted from lower to higher orbital [1]

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

[max 5]

[Total: 14]

www.PapaCambridge.com

4 (a) (i) $C_2H_5NH_2 + HA \rightarrow C_2H_5NH_3^+ + A^-$ (HA can be H_2O, HCl etc.)
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) $C_6H_5OH + OH^- \rightarrow C_6H_5O^- + H_2O$ (*or* with $Na^+/H_2O/A^-$) [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, $C_6H_5–N^+≡N$ [1]

(ii)

reaction	reagent(s)	conditions
Step 1	**$NaNO_2$ + HCl or HNO_2** [1]	**T < 10°C** [1]
Step 2	**H_2O / aq**	**heat/boil/T > 10°** (both) [1]
Step 3	**HNO_3 NB HNO_3(aq) OK for both**	**dilute** (both) [1]

[4]
[5]

[Total: 14]

www.PapaCambridge.com

5 **(a)** **(i)** C=C double bonds / alkenes

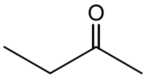
(ii) –OH groups / accept alcohols or acids

(iii) CH_3CO– or $CH_3CH(OH)$– groups

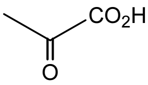
(iv) carbonyl, >C=O, groups / accept aldehydes <u>and</u> ketones 4 × [1]

[4]

(b)



D

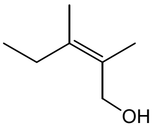


E

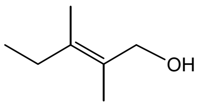
2 × [1]

[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]

www.PapaCambridge.com

6 **(a)** **(i)** $2H_2NCH_2CO_2H \rightarrow H_2NCH_2CONHCH_2CO_2H + H_2O$

(ii) Skeletal formula required

[

(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 C=O - - - H-N
between turns

For β pleated sheet:
Need to show two parallel 'zig-zag'
strands with C=O - - - H-N between
them

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

[4]

(c)

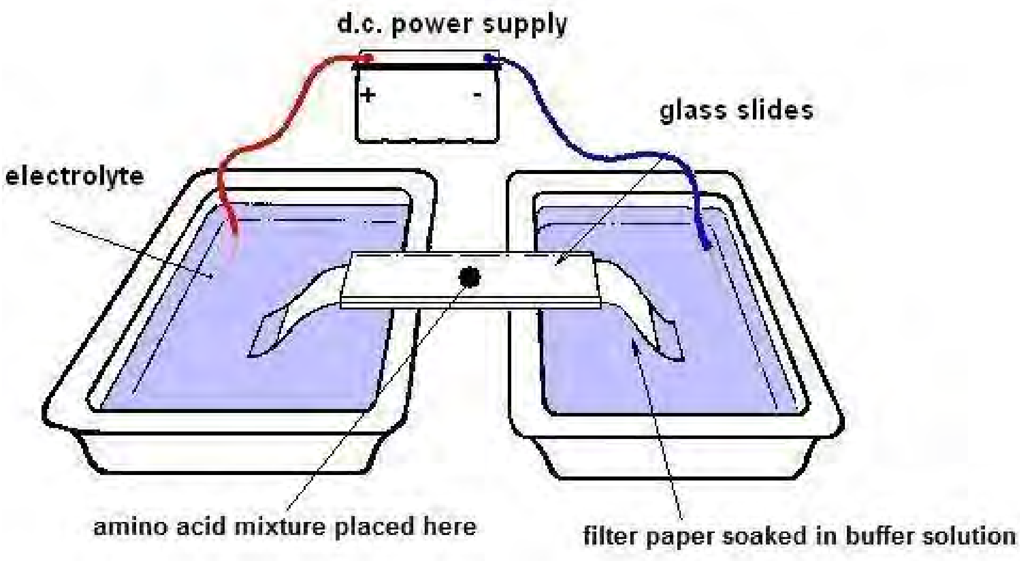
amino acid residue 1	amino acid residue 2	type of bonding
$–HNCH(CH_2CH_2CH_2CH_2NH_2)CO–$	$HNCH(CH_2CH_2CO_2H)CO–$	Ionic bonds or hydrogen bonds
$–HNCH(CH_3)CO–$	$–HNCH(CH_3)CO–$	van der Waals'
$–HNCH(CH_2SH)CO–$	$–HNCH(CH_2SH)CO–$	Disulfide bonds
$–HNCH(CH_2OH)CO–$	$–HNCH(CH_2CO_2H)CO–$	Hydrogen bonds

[4]

[Total: 10]

www.PapaCambridge.com

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]

www.PapaCambridge.com

8 (a)

traditional material	modern polymer used
Paper/cardboard/wood/leaves hessian/hemp/jute steel/aluminium	PVC in packaging
Cotton/wool/linen	*Terylene* 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 HC*l* / 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]