

CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Level

MARK SCHEME for the October/November 2012 series

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.

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Page 2	Mark Scheme	Syllabus	Paper
	GCE A LEVEL – October/November 2012	9701	41

1 (a) SiCl_4 : white solid or white/steamy fumes [1]



PCl_5 : fizzes or white/steamy fumes [1]



(b) (i) $\text{MnO}_4^- + 8\text{H}^+ + 5\text{Fe}^{2+} \longrightarrow \text{Mn}^{2+} + 4\text{H}_2\text{O} + 5\text{Fe}^{3+}$ [1]

(ii) 5 : 1

(iii) $n(\text{MnO}_4^-) = 0.02 \times 15/1000 = 3 \times 10^{-4} \text{ (mol)}$ [1]

(iv) $n(\text{Fe}^{2+}) = 5 \times 3 \times 10^{-4} = 1.5 \times 10^{-3} \text{ (mol)}$ ecf from (i) or (ii) [1]

(v) $[\text{Fe}^{2+}] = 1.5 \times 10^{-3} \times 1000/2.5 = 0.6 \text{ (mol dm}^{-3}\text{)}$ ecf from (iv) [1]

(vi) In the original solution, there was 0.15 mol of Fe^{3+} in 100 cm^3 .
In the partially-used solution, there is 0.06 mol of Fe^{2+} in 100 cm^3 .

So remaining $\text{Fe}^{3+} = 0.15 - 0.06 = 0.09 \text{ mol}$. ecf from (v) [1]

This can react with 0.045 mol of Cu, which = $0.045 \times 63.5 = 2.86 \text{ g}$ of copper. ecf [1]

[6]

(c) bonds broken are Si-Si and $\text{Cl-Cl} = 222 + 244 = 466 \text{ kJ mol}^{-1}$

bonds formed are $2 \times \text{Si-Cl} = 2 \times 359 = 718 \text{ kJ mol}^{-1}$

$\Delta H = -252 \text{ kJ mol}^{-1}$ [2]

[2]

(d) (i) $\text{Ca}_2\text{Si} + 6\text{H}_2\text{O} \longrightarrow 2\text{Ca(OH)}_2 + \text{SiO}_2 + 4\text{H}_2$ [1]

(ii) silicon has been oxidised **AND** hydrogen has been reduced [1]

[2]

[Total: 14]

Page 3	Mark Scheme	Syllabus	Paper
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- 2 (a) (i) A = CuSO₄ [1]
 B = silver [1]
- (ii) salt bridge [1]
 voltmeter [1]
- [4]
- (b) (i) $0.80 - 0.34 = (+) 0.46 \text{ V}$ [1]
- (ii) If $E_{\text{cell}} = 0.17$, this is 0.29 V less than the standard $E^\ominus$,
 so $E_{\text{Ag electrode}}$ must = $0.80 - 0.29 = 0.51 \text{ V}$ [1]
- (iii) $0.51 = 0.80 + 0.06 \log [\text{Ag}^+]$, so $[\text{Ag}^+] = 10^{(-0.29/0.06)} = \underline{1.47 \times 10^{-5}} \text{ mol dm}^{-3}$ ecf from (ii) [1]
- [3]
- (c) (i) $K_{\text{sp}} = [\text{Ag}^+]^2 [\text{SO}_4^{2-}]$ [1]
 units = $\text{mol}^3 \text{ dm}^{-9}$ ecf on K_{sp} [1]
- (ii) $[\text{SO}_4^{2-}] = [\text{Ag}^+]/2$ $K_{\text{sp}} = (1.6 \times 10^{-2})^2 \times 0.8 \times 10^{-2} = \underline{2.05 \times 10^{-6}} (\text{mol}^3 \text{ dm}^{-9})$ [1]
- [3]
- (d) AgCl white [1]
 AgBr cream [1]
 AgI yellow [1]
- Solubility decreases down the group [1]
- [4]
- (e) solubility decreases down the group [1]
 as M^{2+} /ionic radius increases [1]
 both lattice energy and hydration(solvation) energy to decrease [1]
 enthalpy change of solution becomes more endothermic [1]
- [4]
- [Total: 18]

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3 (a) (i) heterogeneous: different states **AND** homogeneous: same state [1]

(ii) the correct allocation of the terms *heterogeneous* and *homogeneous* to common catalysts [1]

example of heterogeneous, e.g. Fe (in the Haber process) linked to correct system [1]

equation, e.g. $\text{N}_2 + 3\text{H}_2 \longrightarrow 2\text{NH}_3$ [1]

how catalyst works, adsorption (onto the surface) [1]

ecf for non-iron catalyst

example of homogeneous, e.g. Fe^{3+} or Fe^{2+} (in $\text{S}_2\text{O}_8^{2-} + \text{I}^-$) linked to correct system [1]

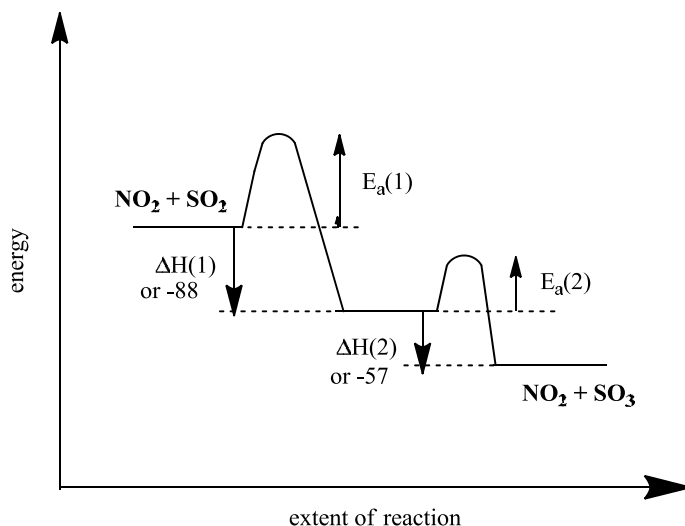
equation, e.g. $\text{S}_2\text{O}_8^{2-} + 2\text{I}^- \longrightarrow 2\text{SO}_4^{2-} + \text{I}_2$ [1]

how catalyst works, e.g. $\text{Fe}^{3+} + \text{I}^- \longrightarrow \text{Fe}^{2+} + \frac{1}{2}\text{I}_2$ [1]

ecf for non-iron catalyst

[8]

(b)



both E_a shown, with $E_a(1) > E_a(2)$ [1]

both ΔH shown, with $\Delta H(1) > \Delta H(2)$ [1]

[2]

[Total: 10]

Page 5	Mark Scheme	Syllabus	Paper
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4 (a) $\text{K}_2\text{Cr}_2\text{O}_7 + \text{H}^+ + \text{heat}$ under reflux [1]

(b) nucleophilic substitution [1]

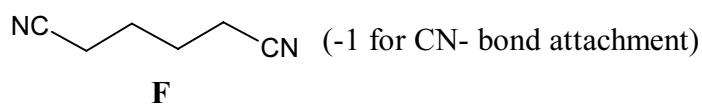
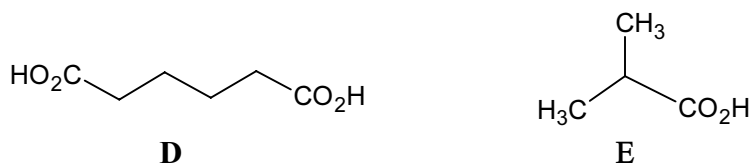
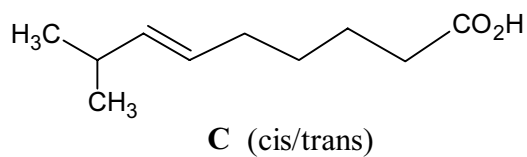
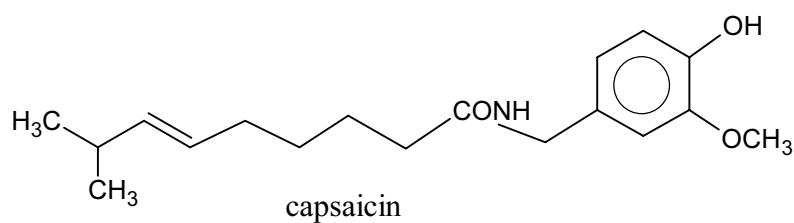
(c) heat under reflux + aqueous HCl [1]

(d) alkene [1]

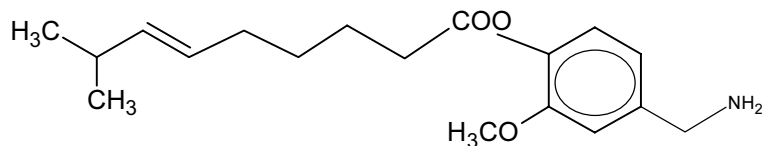
(e) amide or ester [1]

[5]

(f)



alternative structure for capsaicin



ecf 5 × [1]

[5]

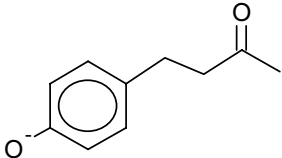
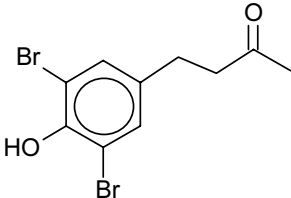
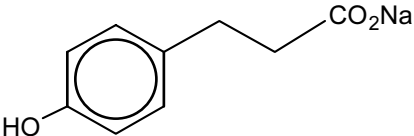
[Total: 10]

Page 6	Mark Scheme	Syllabus	Paper
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5 (a) phenol [1]
ketone [1]

[2]

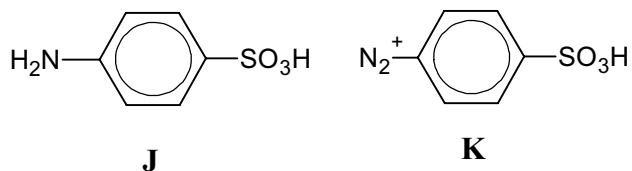
(b)

reagent	observation	structure of product	type of reaction
sodium metal	effervescence /bubbles/fizzing		<i>redox</i>
aqueous bromine	decolourises or white ppt.		<i>electrophilic substitution</i>
aqueous alkaline iodine	yellow ppt.		<i>oxidation</i>

[2]

[8]

(c) (i)



[1] + [1]

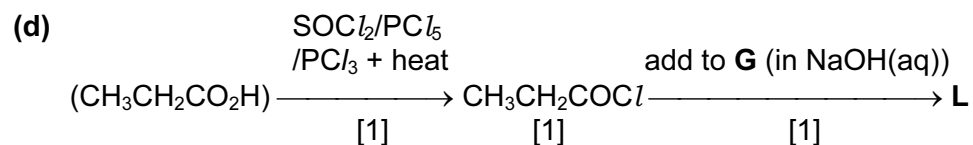
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(ii) step 1: $\text{NaNO}_2 + \text{HCl}$ or HNO_2 [1]

at $T < 10^\circ\text{C}$ [1]

step 2: (add **K** to a solution of **G**) in aqueous NaOH [1]

[5]



ecf from CH_3COOH [3]

[Total: 18]

Section B

6 (a)

bonding	structure involved
disulfide bonds between parts of the chain	tertiary
hydrogen bonds in a β -pleated sheet	secondary
ionic bonds between parts of the chain	tertiary
peptide links between amino acids	primary

zero/one correct only → [0], two correct only → [1], three correct only → [2] all four correct [3]

[3]

(b) labelled diagrams such as:



Competitive **any two** from:

- complementary shape to substrate / able to bind to active site of enzyme
- so preventing the substrate from binding / able to compete with substrate
- can be overcome by increasing [substrate]

2 × [1]



Non-competitive: **any two** from:

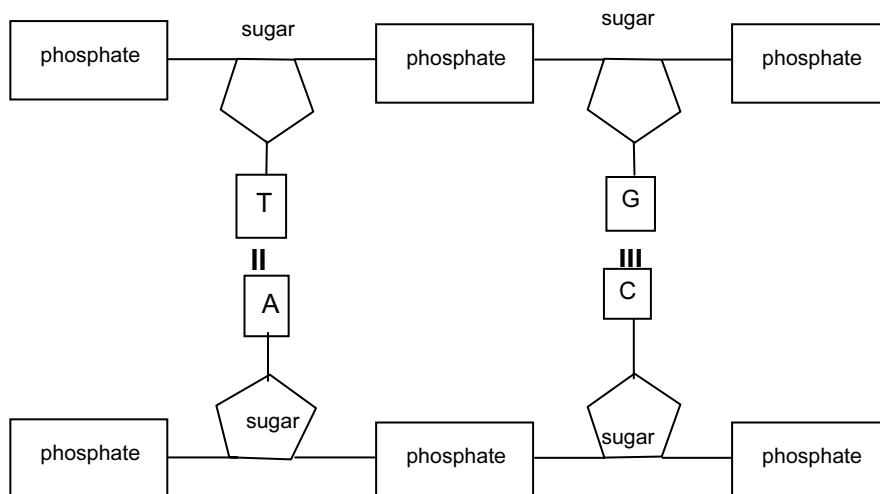
- binds elsewhere in the enzyme than active site / at an allosteric site
- this changes the shape of the active site
- cannot be removed by increasing [substrate]

2 × [1]

[4]

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(c)



A and C **and** other strand correct

H-bonds labelled

adenine **AND** cytosine

[1]

[1]

[1]

[3]

[Total: 10]

7 (a) (i) Electrophoresis

[1]

(ii) Using a restriction enzyme.

[1]

(iii) The phosphate group.

[1]

[3]

(b) (i) **X labelled** correctly on diagram.

[1]

(ii) Suspect 2 **AND** matches crime scene 1 or matches at least one crime scene.

[1]

[2]

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(c) P is $\text{CH}_3\text{CO}_2\text{CH}_2\text{CH}_3$ [1]

any **four** of:

- 3 different (proton) environments
- (M and M+1 data shows no of carbons present is) $(100 \times 0.22)/(1.1 \times 5.1) = 4$ carbons
- the NMR spectrum shows 8 hydrogens leaving 32 mass unit or 2 oxygen **or** $M_r = 88$ **and** (molecular formula is) $\text{C}_4\text{H}_8\text{O}_2$
- 4 peaks/quartet (at 4.1) shows an adjacent $3\text{H}/\text{CH}_3$
- 3 peaks/triplet (at 1.3) shows an adjacent $2\text{H}/\text{CH}_2$
- (peak at) 2.0/singlet shows CH_3CO (group)
- (peak at) 4.1/quartet **and** 1.3/triplet shows presence of ethyl/ CH_3CH_2 (group)

4 × [1]

[5]

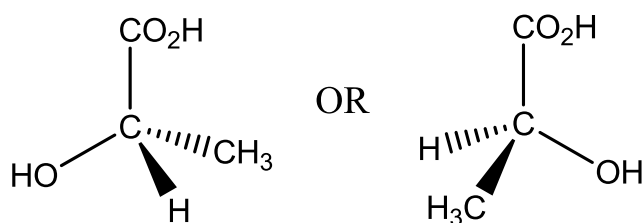
[Total: 10]

8 (a) (i) It could denature the enzyme **or** alter the 3D structure/tertiary structure/shape of active site. [1]

(ii) condensation [1]

[2]

(b)



or correct diagram of the S isomer

[1]

[1]

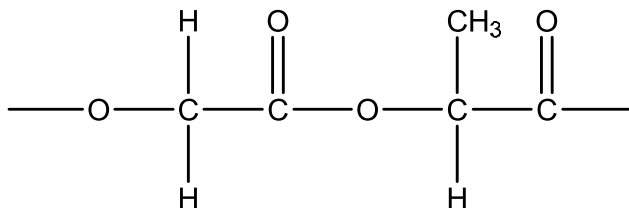
(c) (i) (Acid present would) hydrolyse the ester (linkage) [1]

(ii) (Hot water would) **soften** (the container) [1]

[2]

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(d) (i)



ester linkage shown

[1]

rest of repeat unit correct (ONE)

[1]

(ii) van der Waals' from CH₃/methyl group

[1]

permanent dipole-dipole from ester group

[1]

(iii) Accept any sensible physical property suggestion e.g. different melting point *or* different density *or* different solubility.

[1]

[5]

[Total: 10]

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PCl_5 : fizzes or white/steamy fumes [1]



(b) (i) $\text{MnO}_4^- + 8\text{H}^+ + 5\text{Fe}^{2+} \longrightarrow \text{Mn}^{2+} + 4\text{H}_2\text{O} + 5\text{Fe}^{3+}$ [1]

(ii) 5 : 1

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3 (a) (i) heterogeneous: different states **AND** homogeneous: same state [1]

(ii) the correct allocation of the terms *heterogeneous* and *homogeneous* to common catalysts [1]

example of heterogeneous, e.g. Fe (in the Haber process) linked to correct system [1]

equation, e.g. $\text{N}_2 + 3\text{H}_2 \longrightarrow 2\text{NH}_3$ [1]

how catalyst works, adsorption (onto the surface) [1]

ecf for non-iron catalyst

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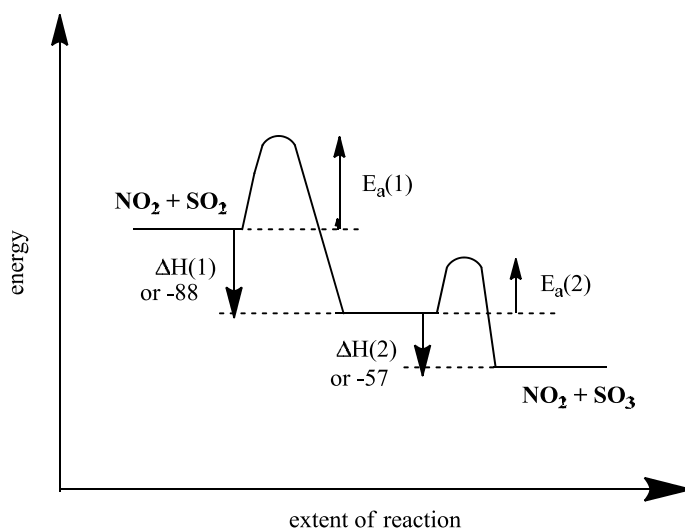
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how catalyst works, e.g. $\text{Fe}^{3+} + \text{I}^- \longrightarrow \text{Fe}^{2+} + \frac{1}{2}\text{I}_2$ [1]

ecf for non-iron catalyst

[8]

(b)



both E_a shown, with $E_a(1) > E_a(2)$ [1]

both ΔH shown, with $\Delta H(1) > \Delta H(2)$ [1]

[2]

[Total: 10]

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(b) nucleophilic substitution [1]

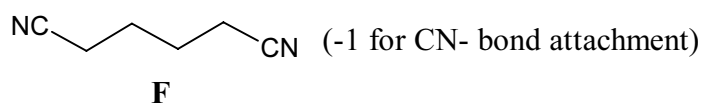
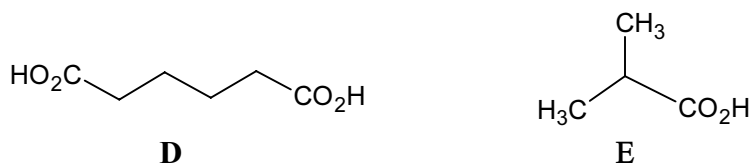
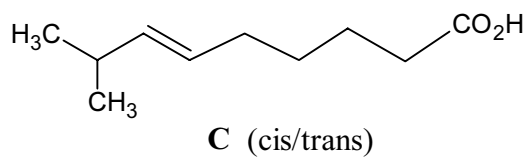
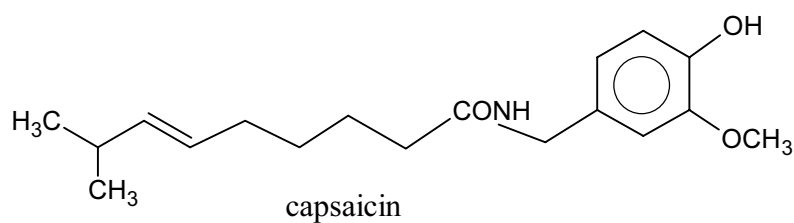
(c) heat under reflux + aqueous HCl [1]

(d) alkene [1]

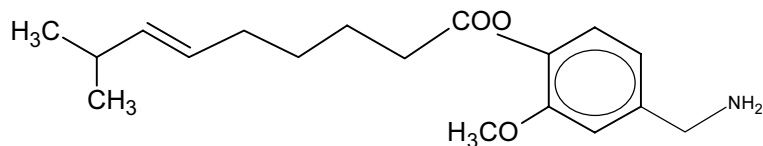
(e) amide or ester [1]

[5]

(f)



alternative structure for capsaicin



ecf 5 × [1]

[5]

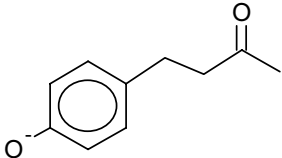
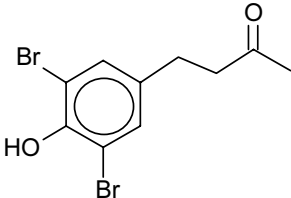
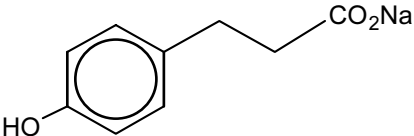
[Total: 10]

Page 6	Mark Scheme	Syllabus	Paper
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5 (a) phenol [1]
ketone [1]

[2]

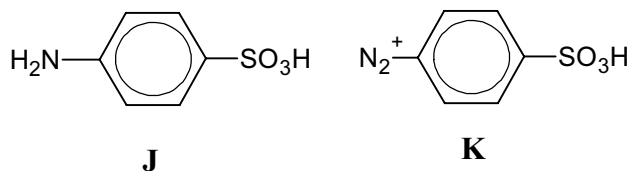
(b)

reagent	observation	structure of product	type of reaction
sodium metal	effervescence /bubbles/fizzing		<i>redox</i>
aqueous bromine	decolourises or white ppt.		<i>electrophilic substitution</i>
aqueous alkaline iodine	yellow ppt.		<i>oxidation</i>

[2]

[8]

(c) (i)



[1] + [1]

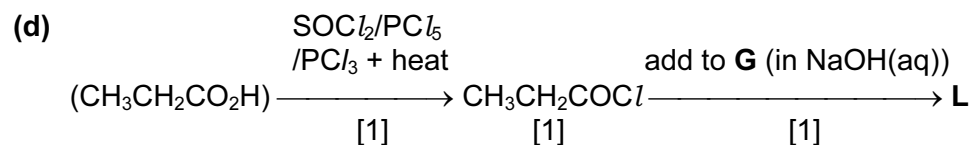
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(ii) step 1: $\text{NaNO}_2 + \text{HCl}$ or HNO_2 [1]

at $T < 10^\circ\text{C}$ [1]

step 2: (add **K** to a solution of **G**) in aqueous NaOH [1]

[5]



ecf from CH_3COOH [3]

[Total: 18]

Section B

6 (a)

bonding	structure involved
disulfide bonds between parts of the chain	tertiary
hydrogen bonds in a β -pleated sheet	secondary
ionic bonds between parts of the chain	tertiary
peptide links between amino acids	primary

zero/one correct only $\rightarrow$ [0], two correct only $\rightarrow$ [1], three correct only $\rightarrow$ [2] all four correct [3]

[3]

(b) labelled diagrams such as:



Competitive **any two** from:

- complementary shape to substrate / able to bind to active site of enzyme
- so preventing the substrate from binding / able to compete with substrate
- can be overcome by increasing [substrate]

2 $\times$ [1]



Non-competitive: **any two** from:

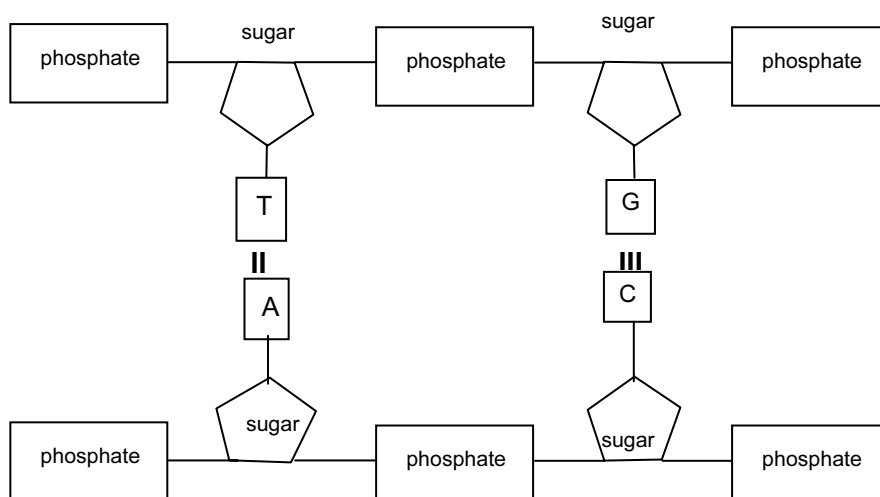
- binds elsewhere in the enzyme than active site / at an allosteric site
- this changes the shape of the active site
- cannot be removed by increasing [substrate]

2 $\times$ [1]

[4]

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(c)



A and C **and** other strand correct

H-bonds labelled

adenine **AND** cytosine

[1]

[1]

[1]

[3]

[Total: 10]

7 (a) (i) Electrophoresis

[1]

(ii) Using a restriction enzyme.

[1]

(iii) The phosphate group.

[1]

[3]

(b) (i) **X labelled** correctly on diagram.

[1]

(ii) Suspect 2 **AND** matches crime scene 1 or matches at least one crime scene.

[1]

[2]

Page 10	Mark Scheme	Syllabus	Paper
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(c) P is $\text{CH}_3\text{CO}_2\text{CH}_2\text{CH}_3$ [1]

any **four** of:

- 3 different (proton) environments
- (M and M+1 data shows no of carbons present is) $(100 \times 0.22)/(1.1 \times 5.1) = 4$ carbons
- the NMR spectrum shows 8 hydrogens leaving 32 mass unit or 2 oxygen **or** $M_r = 88$ **and** (molecular formula is) $\text{C}_4\text{H}_8\text{O}_2$
- 4 peaks/quartet (at 4.1) shows an adjacent $3\text{H}/\text{CH}_3$
- 3 peaks/triplet (at 1.3) shows an adjacent $2\text{H}/\text{CH}_2$
- (peak at) 2.0/singlet shows CH_3CO (group)
- (peak at) 4.1/quartet **and** 1.3/triplet shows presence of ethyl/ CH_3CH_2 (group)

4 × [1]

[5]

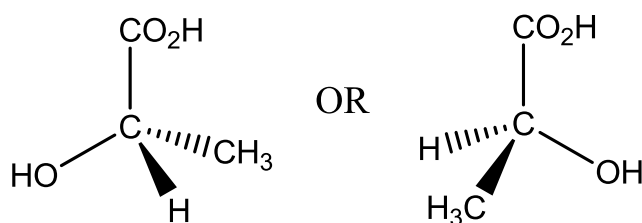
[Total: 10]

8 (a) (i) It could denature the enzyme **or** alter the 3D structure/tertiary structure/shape of active site. [1]

(ii) condensation [1]

[2]

(b)



or correct diagram of the S isomer

[1]

[1]

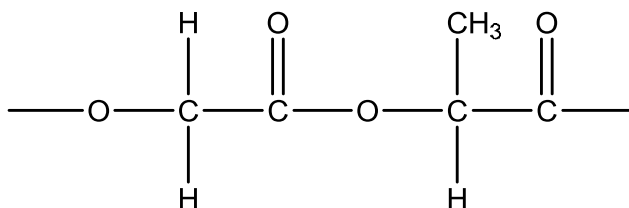
(c) (i) (Acid present would) hydrolyse the ester (linkage) [1]

(ii) (Hot water would) **soften** (the container) [1]

[2]

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(d) (i)



ester linkage shown

[1]

rest of repeat unit correct (ONE)

[1]

(ii) van der Waals' from CH₃/methyl group

[1]

permanent dipole-dipole from ester group

[1]

(iii) Accept any sensible physical property suggestion e.g. different melting point *or* different density *or* different solubility.

[1]

[5]

[Total: 10]

CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Level

MARK SCHEME for the October/November 2012 series

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

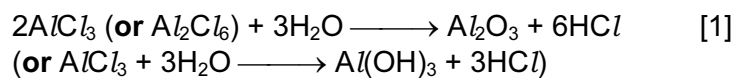
Cambridge will not enter into discussions about these mark schemes.

Cambridge is publishing the mark schemes for the October/November 2012 series for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level components and some Ordinary Level components.

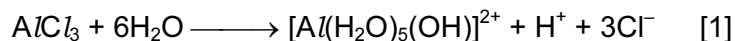
Page 2	Mark Scheme	Syllabus	Paper
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1 (a) MgCl_2 : forms a (colourless) solution **or** dissolves. [1]

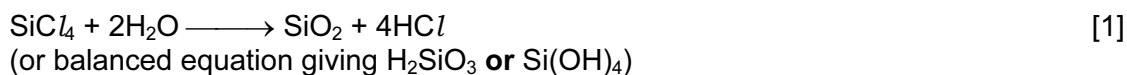
AlCl_3 : produces a white ppt **or** steamy fumes [1]



or forms a (colourless) solution **or** dissolves [1]



SiCl_4 : produces a white ppt **or** steamy fumes [1]



[Total: 5]

(b) (i) $n(\text{NaCl}) = 1.10/58.5 = 1.88 \times 10^{-2} \text{ mol}$ [1]
 $n(\text{KCl}) = 0.90/74.6 = 1.21 \times 10^{-2} \text{ mol}$ [1]

total $n(\text{Cl}^-) = 3.08$ or 3.09 or $3.1 \times 10^{-2} \text{ mol}$ [2 or more sig. figs.] allow ecf

(ii) $\text{Ag}^+(\text{aq}) + \text{Cl}^-(\text{aq}) \longrightarrow \text{AgCl(s)}$ [1]

(iii) moles sampled for the titration = $3.09 \times 10^{-2} \times 10/1000 = 3.09 \times 10^{-4} \text{ mol}$ ecf [1]

this equals $n(\text{Ag}^+)$, so vol of $\text{AgNO}_3 = 3.09 \times 10^{-4} \times 1000/0.02 = \mathbf{15.5 \text{ cm}^3}$ ecf [1]

[Total: 5]

1) (c) (i) bonds broken are C–H and I–I = $410 + 151 = 561 \text{ kJ mol}^{-1}$ (all bonds = 5731 kJ mol^{-1})
bonds formed are C–I and H–I = $240 + 299 = 539 \text{ kJ mol}^{-1}$ (all bonds = 5709 kJ mol^{-1})
 $\Delta H = \mathbf{+22 \text{ kJ mol}^{-1}}$ [2]

(ii) $4 \text{ HI} + 2 \text{ HNO}_3 \longrightarrow 2 \text{ I}_2 + \text{N}_2\text{O}_3 + 3 \text{ H}_2\text{O}$ (or double) [1]

N: (is reduced from) **5 to 3**

I: (is oxidised from) **–1 to 0** [1]

[Total: 4]

[TOTAL: 14]

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- 2 (a) catalyst: any two from the following three bullets for [1] mark:
- speeds up/increases (NOT alters or changes) the rate of a reaction
 - lowers energy barrier/ E_{act} **or** offers a lower energy pathway
 - is not used up **or** remains unchanged **or** does not alter its mass/concentration **or** does not appear in stoichiometric equation **or** is regenerated

[1]

homogeneous: (catalyst and reactants) in the same phase/state [1]

[Total: 2]

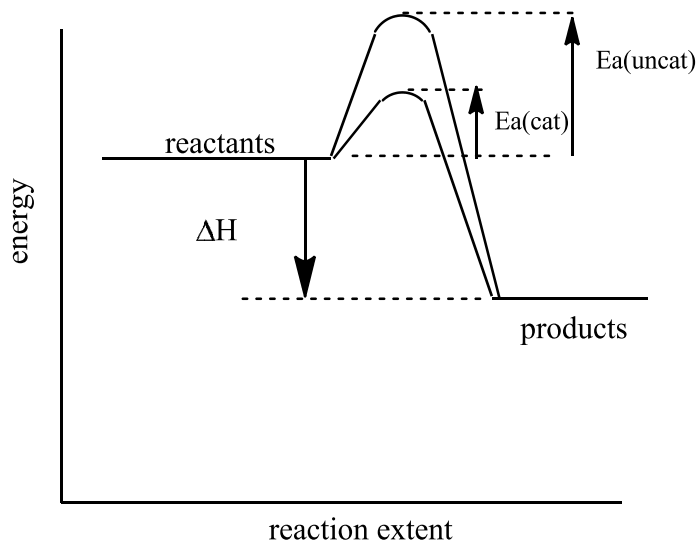
- (b) (i) e.g. car exhausts/engines **or** aeroplanes **or** lightning **or** burning fuels **or** power stations [1]

nitrogen reacts with oxygen **or** $\text{N}_2 + \text{O}_2$ [1]

- (ii) $\text{NO}_2 + \text{SO}_2 \longrightarrow \text{NO} + \text{SO}_3$
 $\text{NO} + \frac{1}{2} \text{O}_2 \longrightarrow \text{NO}_2$
 $\text{SO}_3 + \text{H}_2\text{O} \longrightarrow \text{H}_2\text{SO}_4$
 $4\text{NO}_2 + 2\text{H}_2\text{O} + \text{O}_2 \rightarrow 4\text{HNO}_3$ **or** $3\text{NO}_2 + \text{H}_2\text{O} \rightarrow 2\text{HNO}_3 + \text{NO}$ (any 3 equations) $3 \times [1]$

[Total: 5]

(c)



- ΔH shown as negative [1]
 both E_a labelled and correct – i.e. for the forward reaction [1]
 $E_a(\text{cat}) < E_a(\text{uncat})$ [1]

[Total: 3]

[TOTAL: 10]

Page 4	Mark Scheme	Syllabus	Paper
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3 (a) $(1s^2 2s^2 2p^6) 3s^2 3p^6 3d^9$ [1]

[Total: 1]

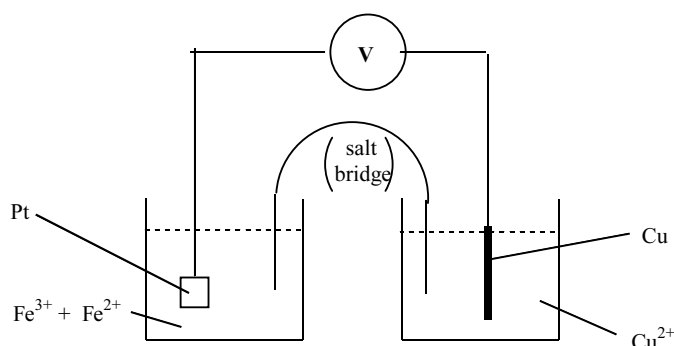
(b) (i) electron / orbitals near ligands are at a higher energy [1]
due to repulsion from ligand lone pairs [1]

(ii) when an electron moves to higher orbital / energy level **or** is promoted [1]
it absorbs a photon **or** light (mention of light being *emitted* negates this mark) [1]

(iii) (different ligands produce) different (sizes of) energy gap **or** ΔE [1]

[Total: 5]

(c)



solutions at 1 mol dm^{-3} (1 M) and 298(K)/25°C [1]

salt bridge and voltmeter [1]

platinum/carbon/graphite electrode [1]

(this mark is negated by inclusion of H_2 around the electrode)

copper electrode [1]

$\text{Fe}^{3+}/\text{Fe}^{2+}$ mixture **and** Cu^{2+} **or** CuSO_4 etc [1]

[Total: 5]

(d) Parts (i) – (iii) have to correspond to each other.

either

or

	<i>either</i>	<i>or</i>
(i)	ligand exchange/substitution/displacement/replacement	precipitation/acid-base/deprotonation
(ii)	$[\text{Cu}(\text{H}_2\text{O})_6]^{2+} + 4\text{NH}_3 \rightarrow [\text{Cu}(\text{H}_2\text{O})_2(\text{NH}_3)_4]^{2+} + 4\text{H}_2\text{O}$ or $[\text{Cu}(\text{H}_2\text{O})_6]^{2+} + 4\text{NH}_3 \rightarrow [\text{Cu}(\text{NH}_3)_4]^{2+} + 6\text{H}_2\text{O}$ or $[\text{Cu}(\text{H}_2\text{O})_6]^{2+} + n\text{NH}_3 \rightarrow [\text{Cu}(\text{H}_2\text{O})_{6-n}(\text{NH}_3)_n]^{2+} + n\text{H}_2\text{O}$	$\text{Cu}^{2+} + 2\text{NH}_3 + 2\text{H}_2\text{O} \rightarrow \text{Cu}(\text{OH})_2 + 2\text{NH}_4^+$ or $\text{Cu}^{2+} + 2\text{NH}_4\text{OH} \rightarrow \text{Cu}(\text{OH})_2 + 2\text{NH}_4^+$ or $[\text{Cu}(\text{H}_2\text{O})_6]^{2+} + 2\text{NH}_3 \rightarrow [\text{Cu}(\text{H}_2\text{O})_4(\text{OH})_2] + 2\text{NH}_4^+$
(iii)	turns purple or deep/dark/royal blue	forms a pale blue ppt

[1] + [1] + [1]

Page 5	Mark Scheme	Syllabus	Paper
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- (iv) $E^\ominus$ will decrease/ be less positive/more negative...
 ...because $[\text{Cu}^{2+}]$ decreases **or** $\text{Cu}^{2+} + 2\text{e}^- \rightleftharpoons \text{Cu}$ shifts to the LHS **or**
 $E^\ominus[\text{Cu}(\text{NH}_3)_4]^{2+} = -0.05\text{V}$ **or** $[\text{Cu}(\text{NH}_3)_4]^{2+}$ is more stable. [1]

[Total: 4]

- (e) (i) aldehyde [1]

- (ii) red ppt./solid [1]

- (iii) $2\text{Cu}^{2+} + \text{CH}_3\text{CHO} + 5\text{OH}^- \rightarrow \text{Cu}_2\text{O} + \text{CH}_3\text{CO}_2^- + 3\text{H}_2\text{O}$ [1]

[Total: 3]

- (f) $\text{pH} = \text{p}K_a + \log [\text{salt}]/[\text{acid}] = -\log(9.3 \times 10^{-4}) + \log (0.8/0.5)$
 $= 3.032 + 0.204 = \mathbf{3.23/3.24}$ (3 or more sig. figs.) [2]

[Total: 2]

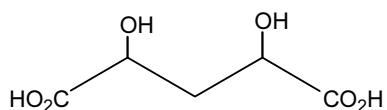
[TOTAL: 20]

- 4 (a) (i) ketone/carbonyl [NOT aldehyde] [1]

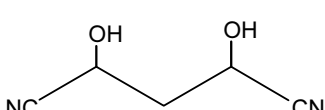
- (ii) carboxylic acid (name of group needed. NOT 'carboxyl') [1]

[Total: 2]

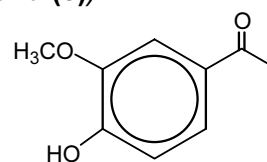
- (b) (i) (allow structural, displayed or skeletal formulae in (b), (c) and (e))



B



C



D

[1] + [1] + [1]

- (ii) heat/reflux/boil/hot/ $T > 60^\circ\text{C}$ in H_3O^+ **or** aqueous/dilute $\text{H}^+/\text{HCl}/\text{H}_2\text{SO}_4$ (**NOT** HNO_3) [1]

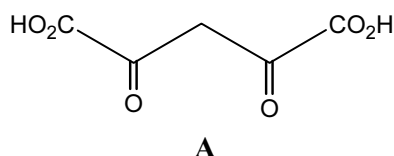
[Total: 4]

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(c) (i) reduction/redox (allow nucleophilic addition **or** hydrogenation, as appropriate from (ii)) [1]

(ii) NaBH_4 **or** LiAlH_4 **or** $\text{H}_2 + \text{Ni/Pt}$ **or** $\text{Na} + \text{ethanol}$ [1]

(iii)



[1]

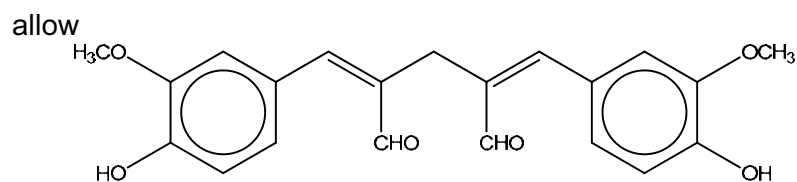
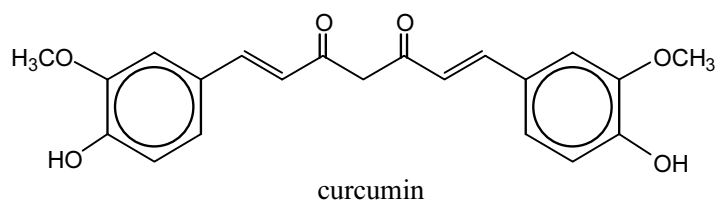
[Total: 3]

(d) (i) alkene/ $\text{C}=\text{C}/\text{C}-\text{C}$ double bond [1]

(ii) phenol **and** alkene/ $\text{C}=\text{C}/\text{C}-\text{C}$ double bond [1]

[Total: 2]

(e)



complete formula

[2]

[Total: 2]

[TOTAL: 13]

5 (a) (i) contains a lone pair on N (that can react with H^+) [1]

(ii) e.g. $\text{C}_2\text{H}_5\text{NH}_2 + \text{H}(\text{Cl}) \longrightarrow \text{C}_2\text{H}_5\text{NH}_3^+ (\text{Cl}^-)$ [1]

or $\text{C}_2\text{H}_5\text{NH}_2 + \text{H}_3\text{O}^+ \longrightarrow \text{C}_2\text{H}_5\text{NH}_3^+ + \text{H}_2\text{O}$

or $\text{C}_2\text{H}_5\text{NH}_2 + \text{H}_2\text{O} \longrightarrow \text{C}_2\text{H}_5\text{NH}_3^+ + \text{OH}^-$ etc

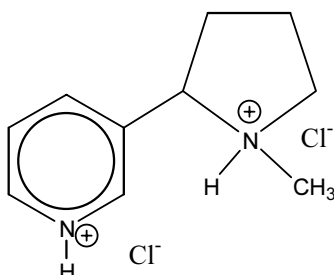
e.g. $\text{C}_2\text{H}_5\text{NH}_2 + \text{CH}_3\text{Br} \longrightarrow \text{C}_2\text{H}_5\text{NHCH}_3 + \text{HBr}$

or $\text{C}_2\text{H}_5\text{NH}_2 + \text{CH}_3\text{COCl} \longrightarrow \text{CH}_3\text{CONHC}_2\text{H}_5 + \text{HCl}$ [1]

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- (iii) the lone pair (on N) in phenylamine overlaps with ring **or** is delocalised [1]
 electron density of N is reduced **or** N becomes more positive **or** lone pair is less available [1]

(iv)

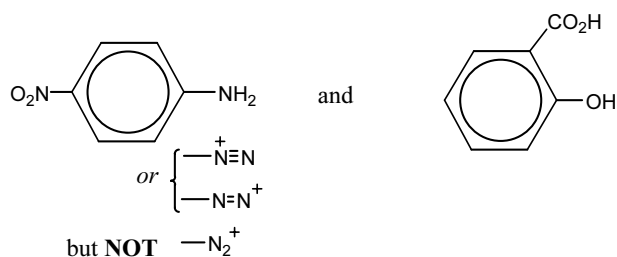


[1] + [1]

[7 max 6]

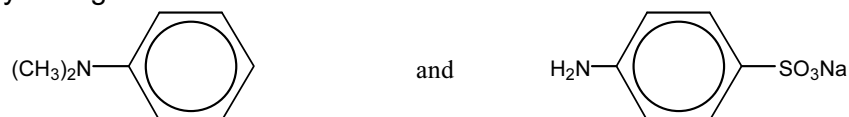
- (b) (i) $\text{NaNO}_2 + \text{HCl}/\text{H}^+$ **or** HNO_2 (HNO_3 or NO_3^- negates this mark) [1]
 $-10^\circ\text{C} < T \leq 10^\circ\text{C}$ **or** 'less than 10°C ' [1]

(ii) alizarin yellow R:



[1] + [1]

methyl orange:



(NH_2 alternatives as above)

[1] + [1]

- (iii) makes the molecule (more) hydrophilic/soluble in water (due to H-bonding or ionic solvation) [1]
or increases its melting point [1]

[Total: 7]

[TOTAL: 13]

Page 8	Mark Scheme	Syllabus	Paper
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- 6 (a) It has no chiral centre/asymmetric carbon/optical isomers **or** is not optically active [1]

[Total: 1]

- (b) (i) structure – α -helix or β -(pleated) sheet [1]

hydrogen (bonding) (for either) [1]

- (ii) any two pairs from the following:

<i>bonding</i>	<i>possible amino acid</i>
van der Waals'	ala, gly, leu, ile, val, pro, phe, try, met
ionic	asp, arg, glu, his, lys
disulfide bond	cysteine
hydrogen bond	asn, asp, arg, gln, glu, his, lys, ser, thr, try, tyr

[1] + [1]

[1] + [1]

(candidates can identify amino acids by name, three-letter abbreviation, formula of sidechain or formula of whole amino acid)

[Total: 6]

- (c) (globular proteins/enzymes need) polar/H-bonding/ionic (side chains) so as to....
....enhance their solubility **or** as part of their active site **or** to help their catalytic activity [1]

[Total: 1]

- (d) (i) A – T [1]
C – G [1]

- (ii) (start **or** met) – **gly – ser – leu – ala – ser** – (stop)
If an amino acid is shown before gly, then it must be met.
correct sequence of the 5 **in bold** [2]

- (iii) leu would be replaced by val [1]

[Total: 5]

[TOTAL: 13]

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- 7 (a) (i) No. of carbon atoms present in **J** is $\frac{100 \times 1.3}{1.1 \times 23.5} = 5$ carbons (must show working) [1]

(NMR spectrum shows) **10 H** (atoms present) (no reasoning need be shown) [1]

- (ii) Oxygen **or** O_2 **or** O [1]

- (iii) **J** is $(CH_3CH_2)_2C=O$ [1]

any one from:

quartet/4 peaks (at δ 2.5) shows an adjacent CH_3 **or** 3 adjacent H

triplet/3 peaks (at δ 1.1) shows an adjacent CH_2 **or** 2 adjacent H

two (chemical/hydrogen) environments

pair of peaks in ratio 6 :4 are (two) ethyl groups **or** the triplet + quartet shows an ethyl group

δ 2.5 implies there's a CH_2 next to $C=O$ [1]

[Total: 5]

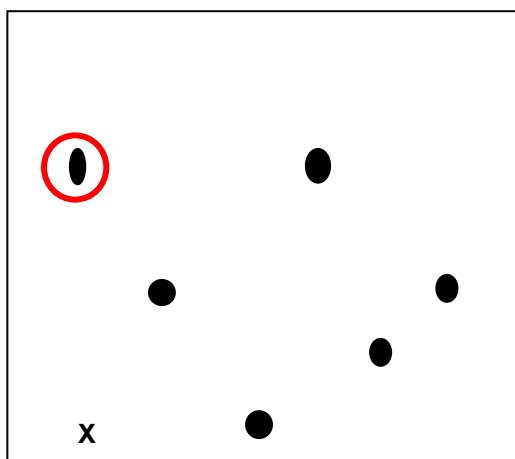
- (b) (i)

<i>technique</i>	<i>physical method</i>
paper chromatography	partition
thin-layer chromatography	adsorption
gas-liquid chromatography	partition

[2]

- (ii) 4 [1]

- (iii)



correct spot circled [1]

- (iv) 3 [1]

[Total: 5]

[TOTAL: 10]

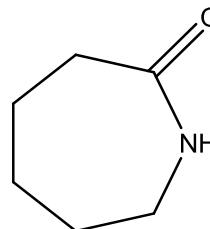
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8 (a) **A** monomers: $\text{H}_2\text{N}-(\text{CH}_2)_6-\text{NH}_2$ and $\text{HO}_2\text{C}-(\text{CH}_2)_4-\text{CO}_2\text{H}$ **or** $\text{ClCO}(\text{CH}_2)_4\text{COCl}$ [1]

Condensation **or** nucleophilic substitution **or** addition-elimination [1]

B monomer: $\text{H}_2\text{C}=\text{CHCH}_3$ [1]

Addition (NOT additional) [1]



C monomer: $\text{H}_2\text{N}-(\text{CH}_2)_5-\text{CO}_2\text{H}$ **or** $\text{H}_2\text{N}-(\text{CH}_2)_5-\text{COCl}$ **or** [1]

Condensation [1]

[max 5]

(b) (i) Need a statement from both columns for [1] mark.

(a)	(b)
more compact packing in A chains closer in A chains further apart in B	stronger (inter-chain) forces in A hydrogen bonding in A weaker (inter-chain) or van der Waals' forces in B B contains side-chain/branched chains

[1]

(ii) Polymer **B** – van der Waals'/London (dispersion) forces/induced-instantaneous/induced dipoles
NOT just 'dipole' [1]

[Total: 2]

[TOTAL: 7]