

CAMBRIDGE INTERNATIONAL EXAMINATIONS

Cambridge International Advanced Level

MARK SCHEME for the May/June 2015 series

9701 CHEMISTRY

9701/41

Paper 4 (Structured Questions), maximum raw mark 100

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

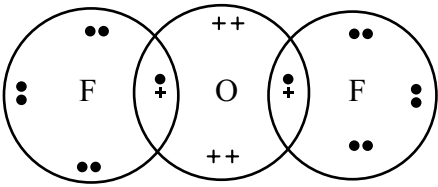
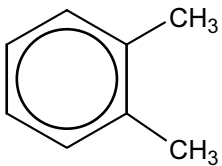
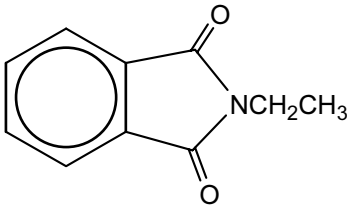
Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge will not enter into discussions about these mark schemes.

Cambridge is publishing the mark schemes for the May/June 2015 series for most Cambridge IGCSE[®], Cambridge International A and AS Level components and some Cambridge O Level components.

® IGCSE is the registered trademark of Cambridge International Examinations.

Page 2	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – May/June 2015	9701	41

Question	Marking point	Marks
1 (a)	oxygen: $(1s^2) 2s^2 2p^4$ fluorine: $(1s^2) 2s^2 2p^5$	1
(b) (i)	F_2O / OF_2	1
(ii)		1
(iii)	bent or non-linear	1
(c) (i)	$E^\ominus$ values: $F_2 / F^- = 2.87\text{ V}$ and $Cl_2 / Cl^- = 1.36\text{ V}$ fluorine (has the more positive $E^\ominus$ so) is more oxidising	1 1
(ii)	redox	1
(iii)	$ClF + 2KBr \longrightarrow KCl + KF + Br_2$	1
[Total: 8]		
2 (a) (i)	hydrogen chloride or HCl	1
(ii)	either $(RCOCl)$ has two electron-withdrawing groups/atoms, making the more δ^+ /electron deficient or $(RCOCl)$ has an oxygen, making the carbon more δ^+ /electron deficient or $(RCOCl)$ has two electron-withdrawing groups, weakening the C–Cl bond	1
(b) (i)	 P  Q	1 1
(ii)	step 1: heat with $MnO_4^- / KMnO_4$ (+ acid or alkali) step 2: PCl_3 + heat or $SOCl_2$ or PCl_5 step 4: $LiAlH_4$ (in dry ether)	1 1 1
[Total: 7]		

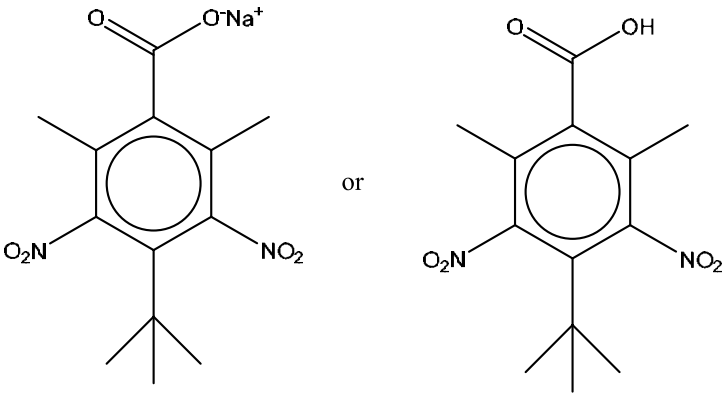
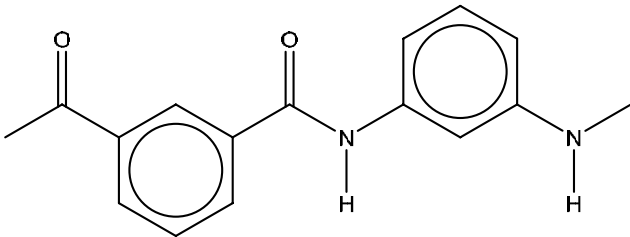
Page 3	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – May/June 2015	9701	41

3	(a)	(i)	<table><tr><td>isotope</td><td>relative abundance</td></tr><tr><td>^{24}Mg</td><td>78–79</td></tr><tr><td>^{25}Mg</td><td>10</td></tr><tr><td>^{26}Mg</td><td>12–11</td></tr></table> (total must add up to 100 %)	isotope	relative abundance	^{24}Mg	78–79	^{25}Mg	10	^{26}Mg	12–11	1
		isotope	relative abundance									
		^{24}Mg	78–79									
		^{25}Mg	10									
		^{26}Mg	12–11									
(ii)	e.g. $0.78 \times 24 + 0.10 \times 25 + 0.12 \times 26 = 24.34$	1										
(b)	(i)	nitrates become more stable (down the group)	1									
		as the ionic radius increases or charge density on cation/ion decreases	1									
		decreasing its ability to distort/polarise the NO_3^- /nitrate ion	1									
	(ii)	$4\text{LiNO}_3 \longrightarrow 2\text{Li}_2\text{O} + 4\text{NO}_2 + \text{O}_2$	1									
	(iii)	the charge density of the other cations are too small (to polarise the anion sufficiently so the anion is more stable)	1									
[Total: 7]												
4	(a)	(i)	$K_{\text{sp}} = [\text{Ag}^+(\text{aq})]^2[\text{SO}_4^{2-}(\text{aq})]$ and units: $\text{mol}^3\text{dm}^{-9}$	1								
		(ii)	$K_{\text{sp}} = (2 \times 0.025)^2 \times (0.025) = 6.25 \times 10^{-5}$	1								
	(b)	1 1 1 1										
	(c)	(i)	$E^\ominus_{\text{cell}} (= 0.80 - 0.77 =) (+)0.03\text{V}$ and Ag^+/Ag or Ag/silver or right	1								
		(ii)	E_{cell} would be less positive/more negative because the $[\text{Ag}^+(\text{aq})]$ (in the Ag electrode) is less than 1.0 mol dm^{-3}	1								
		(iii)	• no change	1								

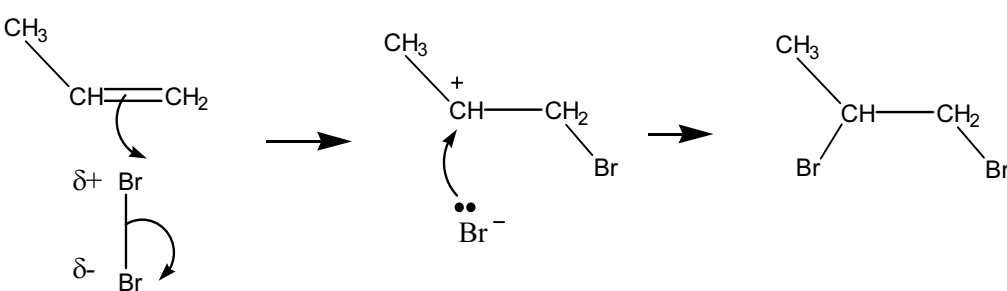
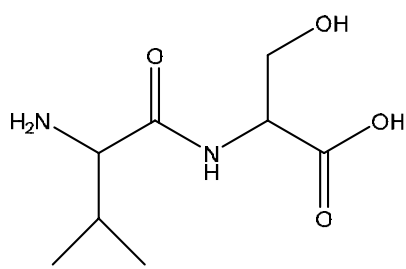
Page 4	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – May/June 2015	9701	41

	more negative/less positive	1								
(iv)	the $[\text{Ag}^+(\text{aq})]$ will decrease $E_{\text{electrode}}$ becomes less positive or due to the common ion effect	1								
(d)	$[\text{Fe}^{3+}(\text{aq})] = 0.2 \text{ mol dm}^{-3}$ $[\text{H}^+] = \sqrt[3]{(c.K_a)} = \sqrt[3]{(0.2 \times 8.9 \times 10^{-4})}$ or $1.33 \times 10^{-2} \text{ (mol dm}^{-3}\text{)}$ $\text{pH} = -\log([\text{H}^+]) = \mathbf{1.9}$ (or 1.87–1.89)	1 1								
[Total: 13]										
5 (a)	<table border="1"><tr><td></td><td>protons</td><td>electrons</td><td>neutrons</td></tr><tr><td>$^{14}\text{C}^{2-}$</td><td>6</td><td>8</td><td>8</td></tr></table>		protons	electrons	neutrons	$^{14}\text{C}^{2-}$	6	8	8	1 1
	protons	electrons	neutrons							
$^{14}\text{C}^{2-}$	6	8	8							
(b)	CCl_4 : no reaction GeCl_4 and SnCl_4 : for each steamy fumes evolved <i>or</i> white solid produced $\text{GeCl}_4 + 2\text{H}_2\text{O} \longrightarrow \text{GeO}_2 + 4\text{HCl}$ $\text{SnCl}_4 + 2\text{H}_2\text{O} \rightarrow \text{SnO}_2 + 4\text{HCl}$	1 1 1 1								
(c)	Ge/Sn use d-orbitals or Ge/Sn have low lying d orbitals or carbon cannot expand its octet or carbon cannot accommodate more than 4 bonded pairs	1								
(d)	$\text{Sn}^{4+}/\text{Sn}^{2+} = +0.15\text{V}$ and $\text{Pb}^{4+}/\text{Pb}^{2+} = +1.69\text{V}$ and $\text{Cl}_2/\text{Cl}^- = +1.36\text{V}$ Sn^{2+} is oxidised by Cl_2 because its $E^\ominus$ is less positive/more negative or Sn^{2+} is a good reducing agent due to its smaller E value than Cl_2 ora or Pb^{4+} is a stronger oxidising agent than Cl_2 so Pb^{2+} with Cl_2 reaction is not feasible or Sn^{4+} is a weaker oxidising agent than Cl_2 so Sn^{2+} with Cl_2 reaction is feasible $\text{SnCl}_2 + \text{Cl}_2 \longrightarrow \text{SnCl}_4$ or $\text{Sn}^{2+} + \text{Cl}_2 \longrightarrow \text{Sn}^{4+} + 2\text{Cl}^-$ or $\text{SnCl}_2 + \text{Cl}_2 + 2\text{H}_2\text{O} \longrightarrow \text{SnO}_2 + 4\text{HCl}$	1 1 1								
(e) (i)	F = Le	1								
(ii)	moles of $\text{O}_2(\text{g}) = 130/24000 = 5.417 \times 10^{-3} \text{ mol}$ moles of electrons needed = $4 \times 5.417 \times 10^{-3}$ or $2.17 \times 10^{-2} \text{ mol}$ no. of coulombs passed = $1.2 \times 30 \times 60$ or 2160 C no. of electrons passed = $2160/1.6 \times 10^{-19}$ or 1.35×10^{22} no. of electrons per mole = $1.35 \times 10^{22}/2.17 \times 10^{-2} = \mathbf{6.2 \times 10^{23} \text{ (mol}^{-1}\text{)}}$	1 1 1 1								
[Total: 15]										

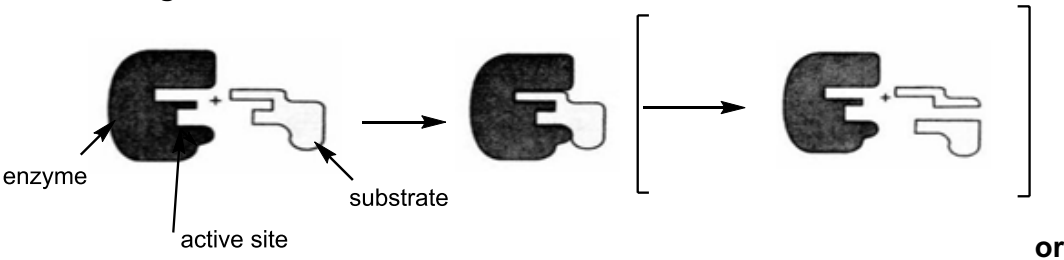
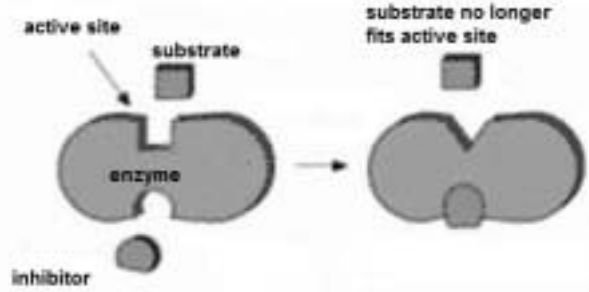
Page 5	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – May/June 2015	9701	41

6	(a) (i)	CH ₃ COCl or ethanoyl chloride	1
	(ii)	electrophilic substitution	1
	(iii)	conc HNO ₃ and conc H ₂ SO ₄	1
	(iv)	CHI ₃ 	1 1
	(b) (i)		1
	(ii)	polyamide or condensation	1
	(iii)	H ₂ O/water	1
	(iv)	Sn/Fe + HCl + conc/aq/heat/warm	1
	(v)	harder or more dense or stronger or higher m.pt or tougher or more rigid due to cross-linking or more H-bonding between the chains	1
			[Total: 10]

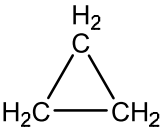
Page 6	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – May/June 2015	9701	41

7	(a) (i)	heat with catalyst or heat with $\text{Al}_2\text{O}_3/\text{SiO}_2$	1								
	(ii)	B is $\text{CH}_3\text{CH}_2\text{CH}_3$	1								
	(iii)	C is $\text{CH}_2=\text{CHCH}_2\text{CH}_2\text{CH}_3$ D and E are $\text{CH}_3\text{CH}=\text{CHCH}_2\text{CH}_3$ (one shown as cis, the other as trans) F is $\text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{H}$ G is $\text{CH}_3\text{CO}_2\text{H}$ H is $\text{CH}_3\text{CH}_2\text{CO}_2\text{H}$	1 1 1								
	(iv)	geometrical <i>or</i> cis-trans <i>or</i> E–Z	1								
	(b) (i)	No particular conditions or in the dark	1								
	(ii)	electrophilic addition	1								
	(iii)		1 1								
[Total: 10]											
8	(a) (i)	condensation	1								
	(ii)		2								
	(iii)	any two side-chain interactions mentioned with group <table border="1" data-bbox="293 1733 1305 2013"><tr><td>ionic attractions / bonds</td><td>between CO_2^- and NH_3^+</td></tr><tr><td>van der Waals</td><td>between alkyl / aryl / non-polar groups or valine</td></tr><tr><td>hydrogen(H) bonding</td><td>between OH, NH_2, COOH, NH or serine</td></tr><tr><td>S-S or disulfide bonds or disulfur bond / bridge</td><td>between SH groups or cysteine</td></tr></table>	ionic attractions / bonds	between CO_2^- and NH_3^+	van der Waals	between alkyl / aryl / non-polar groups or valine	hydrogen(H) bonding	between OH , NH_2 , COOH , NH or serine	S-S or disulfide bonds or disulfur bond / bridge	between SH groups or cysteine	2
ionic attractions / bonds	between CO_2^- and NH_3^+										
van der Waals	between alkyl / aryl / non-polar groups or valine										
hydrogen(H) bonding	between OH , NH_2 , COOH , NH or serine										
S-S or disulfide bonds or disulfur bond / bridge	between SH groups or cysteine										

Page 7	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – May/June 2015	9701	41

(b) (i)	labelled diagrams  in words - the enzyme has a specific shape or substrate shape is complementary to active site - the substrate bonds/binds/fits to the active site or other substrates do not fit into active site	1 1
(ii)	labelled diagrams  or in words - inhibitor binds to enzyme away from the active site or inhibitor binds to allosteric site - this changes the shape (or structure) of the active site - substrate no longer fits the active site	1 1 1
[Total: 10]		
9 (a) (i)	use restriction enzymes or using an enzyme to break (the DNA) down into smaller fragments	1
(ii)	use the polymerase chain reaction or use DNA polymerase to replicate/ copy (the sample of DNA)	1
(iii)	- amino acids have different charges due to their side-chain/ R group/ pH/ CO_2^- and NH_3^+ groups - DNA fragments have negatively-charge phosphates(or PO_4) or DNA has PO_4^{3-} groups	1 1

Page 8	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – May/June 2015	9701	41

(iv)	A piece of leather from an Egyptian tomb		1
	A sample of skin from a mummified body		
	A fragment of ancient pottery	X	
	A piece of wood from a Roman chariot		
(b) (i)	the electron density in the molecule or positions of atoms or interatomic distance / spacing between the atoms		1
(ii)	phosphorus has the most electrons or phosphorus has the highest electron density		1
(c) (i)	equilibrium constant (for the solution) of a solute between two (immiscible) solvents or ratio of the concentration of the solute in (each of the) two solvents or ratio of the solubility of the solute in (each of the) two solvents		1
(ii)	$\frac{x}{(25/1000)}$ $\frac{(0.0042-x)}{(25/1000)}$ $x = 0.0252 - 6x$ $x = \mathbf{0.0036g}$		1 1
[Total: 10]			
10 (a) (i)	any three of the following structures CH ₃ CH ₂ CH ₃ CH ₃ CH=CH ₂ CH ₃ C≡CH CH ₂ =C=CH ₂ 		2
(ii)	K since it has the greatest % of hydrocarbons / carbon-containing compounds or 99.6 % of it is burnt for energy		1
(iii)	any two from - reacted with lime / CaO / soda lime / Ca(OH)₂ / KOH / NaOH / - liquefied under pressure / ≥5 atm - dissolved in water under pressure / ≥5 atm		2
(b) (i)	have a shorter carbon / hydrocarbon chain or shorter hydrocarbon or fewer carbon atoms in its chain or have high H / C ratio		1
(ii)	Coal		1

Page 9	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – May/June 2015	9701	41

	produces the largest amount of SO ₂ or largest combined amount of SO ₂ and NO ₂	
(iii)	they burn at higher temperatures or release more heat on burning	1
(iv)	CO – the gas is toxic/poisonous or references to Hb and ability to carry oxygen	1
	CO ₂ – the gas contributes to global warming	1
[Total: 10]		

CAMBRIDGE INTERNATIONAL EXAMINATIONS

Cambridge International Advanced Level

MARK SCHEME for the May/June 2015 series

9701 CHEMISTRY

9701/42

Paper 4 (Structured Questions), maximum raw mark 100

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

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

Cambridge will not enter into discussions about these mark schemes.

Cambridge is publishing the mark schemes for the May/June 2015 series for most Cambridge IGCSE[®], Cambridge International A and AS Level components and some Cambridge O Level components.

® IGCSE is the registered trademark of Cambridge International Examinations.

Page 2	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – May/June 2015	9701	42

1 (a) fluorine: $1s^2 2s^2 2p^5$ [1]

sulfur: $1s^2 2s^2 2p^6 3s^2 3p^4$

(b) (i) $2HCl \longrightarrow H_2 + Cl_2$ [1]

(ii) bond energies: HF (562) is **stronger** than HCl (431) [1]
or F_2 (158) is **weaker** than Cl_2 (244)

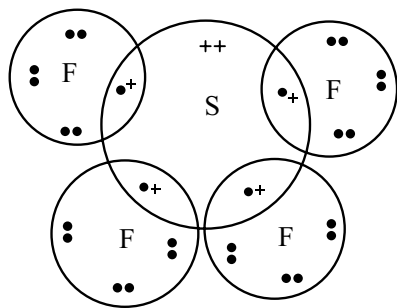
(c) *electronegativity:* [2]

The attraction by an atom/nucleus/element of the electrons in a bond or a shared pair or a molecule

bond polarity:

..is due to atoms/elements of **different** electronegativities at each end of a bond

(d) (i)



(ii) Yes, it will have a dipole moment, [3]

either because it has an uneven distribution of electrons *or* because it contains a lone pair

or the S–F dipoles don't cancel *or* molecule is not symmetrical *or* diagram of see-saw shape.

(allow an ecf for "no dipole" if their structure in (d)(i) has **no** lone pair)

(e) Sulfur can use its d-orbitals *or* has low-lying / accessible / available d-orbitals *or* can expand its octet. [1]

(allow reverse argument for oxygen; do NOT allow just "sulfur has d-orbitals")

(f) (i) Burning of **fossil** fuels *or* coal / oil / petrol / natural gas (NOT methane *or* hydrocarbons) *or* volcanoes *or* roasting / burning sulfide ores

(ii) Acid rain [2]

[Total: 11]

Page 3	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – May/June 2015	9701	42

2 (a) $A_r = 204 \times 0.019 + 206 \times 0.248 + 207$ [2]

$= 207.21$

(correct ans = [2])

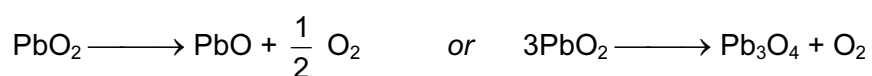
The **last** answer written by the candidate needs to be written with 2 d.p. to get the last mark.

(b) (i) Tin(II) oxide is more basic than tin(IV) oxide [1]
or tin(II) oxide is less acidic than tin (IV) oxide

(ii) e.g. $\text{SnO} + 2\text{HCl} \longrightarrow \text{SnCl}_2 + \text{H}_2\text{O}$ (or ionic or with H_2SO_4) [2]
 $\text{SnO}_2 + 2\text{NaOH} \longrightarrow \text{Na}_2\text{SnO}_3 + \text{H}_2\text{O}$ (or ionic or with KOH etc.)

(iii) SnO_2 stays the same (white) or is stable or no reaction [3]

PbO_2 changes colour (from brown/black to yellow/orange/red)



[Total: 8]

Page 4	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – May/June 2015	9701	42

3 (a) $^{33}\text{P}^-$ [2]

(b) Solubility decreases (from Mg to Ba *or* down the group) [4]

Both lattice energy / ΔH_{latt} and enthalpy change of hydration / ΔH_{hyd} are involved

enthalpy change of hydration **decreases more** than lattice energy

So enthalpy change of solution / ΔH_{sol} becomes more endothermic *or* more positive *or* less exothermic *or* less negative (NOT ΔH_{sol} decreases, or increases)

(c) precipitate / solid CaSO_4 would form [2]
 due to the **common ion effect** *or* K_{sp} is exceeded *or* the following equilibrium shifted over to the right $\text{Ca}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightleftharpoons \text{CaSO}_4(\text{s})$

(d) charge passed = $1.8 \times 40 \times 60$ (= 4320 C) [4]

$n(\text{e}^-)$ = $4320 / 96500$ (= 4.477×10^{-2} mol) ecf

$n(\text{Cr})$ = $0.776 / 52$ (= 1.492×10^{-2} mol) ecf

n = $4.477 \times 10^{-2} / 1.492 \times 10^{-2} = 3.00$ (=3)

[Total: 12]

Page 5	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – May/June 2015	9701	42

- 4 (a) (i) a solution that resists / minimises a change in its pH *or helps* maintain its pH..... [2]
 (NOT any of: "maintains pH"; "keeps pH constant"; "no change in pH")
when small amounts of acid/H⁺ or base/OH⁻ are added (**both** acid and base are needed)
- (ii) HCO₃⁻ reacts with H⁺ ions as follows: [2]

$$\text{HCO}_3^- + \text{H}^+ \longrightarrow \text{H}_2\text{CO}_3 \text{ (or } \text{H}_2\text{O} + \text{CO}_2\text{)}$$
 and with OH⁻ ions thus:

$$\text{HCO}_3^- + \text{OH}^- \longrightarrow \text{CO}_3^{2-} + \text{H}_2\text{O}$$
 (the equation arrows can be equilibrium arrows, as long as HCO₃⁻ is on the left)
- (iii) (pK_a = -log(K_a) = 7.21) [2]

$$\text{pH} = \text{pK}_a + \log([\text{base}]/[\text{acid}]) = 7.21 + \log(0.5/0.3)$$

$$= \mathbf{7.43 \text{ (7.4)}}$$
- (b) (i) K_{sp} = [Ag⁺]³[PO₄³⁻] **and** units: mol⁴dm⁻¹² [1]
- (ii) call [PO₄³⁻] = x, then [Ag⁺] = 3x, and K_{sp} = 27x⁴ [3]

$$x = (\text{K}_{\text{sp}}/27)^{1/4} = (1.25 \times 10^{-20}/27)^{1/4} = 4.64 \times 10^{-6} \text{ mol dm}^{-3}$$

$$[\text{Ag}^+] = 3x = \mathbf{1.39 \times 10^{-5} \text{ (mol dm}^{-3}\text{)}} \quad (\text{allow } \mathbf{1.4 \times 10^{-5}})$$
- (c) H₃PO₃ + 2Fe³⁺ + H₂O $\longrightarrow$ H₃PO₄ + 2Fe²⁺ + 2H⁺ [2]

$$E_{\text{cell}} = 0.77 - (-0.28) = (+)\mathbf{1.05 \text{ V}}$$
or 3H₃PO₃ + 3H₂O + 2Fe³⁺ $\longrightarrow$ 3H₃PO₄ + 6H⁺ + 2Fe

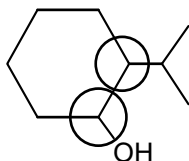
$$E_{\text{cell}} = -0.04 - (-0.28) = (+)\mathbf{0.24 \text{ V}}$$

[Total: 12]

Page 6	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – May/June 2015	9701	42

5 (a) (i) $\text{H}_2 + \text{Pt}$ or $\text{H}_2 + \text{Ni/Pd} + \text{heat/warm}$ or $50^\circ < T < 500^\circ\text{C}$ [1]

(ii)

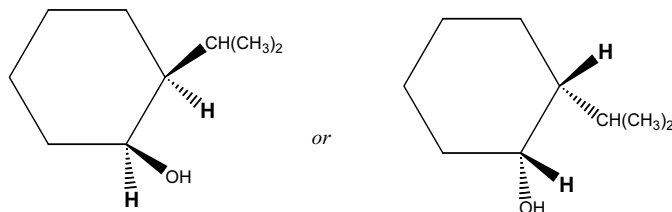


[1]

(iii) $2^2 = 4$

[1]

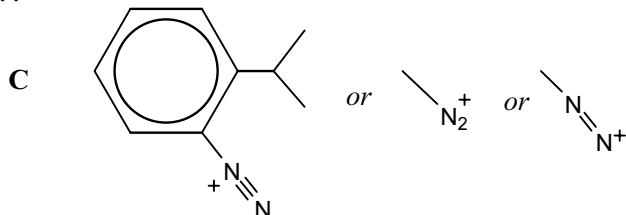
(iv)



2 Hs have to be on the **same side** of the ring. Allow $-\text{C}_3\text{H}_7$ or $-\text{R}$ for $-\text{CH}(\text{CH}_3)_2$

[1]

(b) (i)



[1]

(ii) step 1: **conc** $\text{HNO}_3 + \text{H}_2\text{SO}_4$ (@ $25^\circ\text{C} < T < 60^\circ\text{C}$ – see below) ("aq" negates) [4]

step 2: $\text{Sn/Fe} + \text{HCl}$

step 3: HNO_2 or $\text{NaNO}_2 + \text{HCl}$ (@ $T < 10^\circ\text{C}$ – see below)

both temperatures correct for steps 1 + 3 (temperature not required for step 2)

(inclusion of the word "heat" or "reflux" in step 3 negates the temperature mark)

(c)

[5]

HBr	no reaction	
Na		
NaOH(aq)		no reaction

[Total: 14]

Page 7	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – May/June 2015	9701	42

6 (a) There are three acceptable alternatives – follow each column down vertically:

(i) D is	RCOCl	$\text{RCOOCH}_2\text{CH}_3$	$\text{RCO}_2^- \text{NH}_4^+$
(ii) step 1	SOCl_2 (or PCl_3 or PCl_5)	ethanol (e.g.) + conc H_2SO_4	NH_3
(ii) step 2	NH_3 (NaOH negates this mark)		heat
(ii) step 3	LiAlH_4 (aq) negates (NOT NaBH_4 ; $\text{Sn} + \text{HCl}$ etc.)		

(b) (i) amine (other groups negate) [1]

(ii) phenol **and** carboxylic acid (**both** needed) [1]

(iii) [4]

compound	first functional group	second functional group
E	amide	alcohol
F	amine	carboxylic acid
G	amine	ester
H	amide	phenol

(iv) Mark this in the following way. For each structure of **E**, **F**, **G** and **H**: [4]

- check whether the structure fits the molecular formula $\text{C}_8\text{H}_9\text{NO}_2$, i.e. that it has: **one** nitrogen, **two** oxygens and **eight** carbons.
- check that it contains the two groups that the candidate's answers to part (ii) says it contains.

[Total: 13]

Page 8	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – May/June 2015	9701	42

- 7 (a) L – it is the only compound that is an amino acid *or* can **form** (NOT *contain*) [1]
 –NH–CO– / amide / peptide linkages / bonds
or
 it contains an N atom / NH₂ group / CO₂H group
- (b) mark both parts of this together – max [4] from the following six points [4]
 M1 mRNA is complementary to *or* a copy of (a portion of) DNA
 M2 mRNA encodes the sequence of amino acids in proteins *or* each of its codons (base triplets) codes for one amino acid
 M3 mRNA binds to / associates with the ribosome
 M4 tRNAs are **specific** to their amino acids
 M5 tRNA contains an **anticodon** *or* bonds to the codon / mRNA through base pairing *or* **translates** the RNA code into the amino acid sequence
 M6 tRNA carries the amino acid to the ribosome / mRNA
- (c) max [3] from the following six points. [3]
 M1 the pH of that area of the protein would change
 M2 protein becomes less hydrophilic / soluble *or* more hydrophobic
 M3 fewer hydrogen bonds *or* more van der Waals' (id–id) forces
 M4 fewer ionic bonds form
 M5 the tertiary structure / folding / (3D) shape (of the protein) would change
 M6 the active site would be different / less efficient

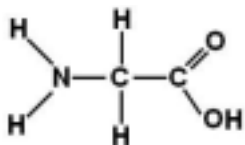
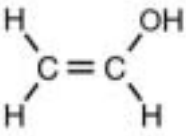
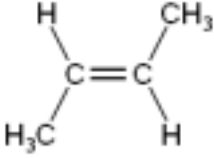
[Total: 8]

Page 9	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – May/June 2015	9701	42

- 8 (a) (i) The **nucleus/proton** of a hydrogen atom has **spin** [1]
- (ii) Hydrogen doesn't have enough electrons/electron density [1]
- (iii) S/sulfur – it has the greatest number of electrons *or* highest electron density [1]
- (b) (i) 12 protons (=9+2+1) [1]
- (ii) The group responsible for this peak is –OH (allow NH) [2]
The D in D₂O **exchanges** with the H in –OH *or* H is **replaced** by D
or "–OH → –OD",
- (iii) The adjacent carbon atom has no hydrogen atoms bonded to it [1]
- (iv) Methyl/CH₃ group [1]
- (v) P is (CH₃)₃C–CH₂OH [1]
- (c) (i) $n = \frac{100 \times (M+1)}{1.1 \times M} = \frac{100 \times 0.5}{1.1 \times 9.3} = 50/10.23$ [1]
= 4.89 hence **5** carbons
- (ii) (Ratio of ⁷⁹Br:⁸¹Br is 1 : 1), [1]
hence ratio of M : M+2 : M+4 is **1 : 2 : 1**
- (iii) Molecular formula of **R** is C₅H₁₀Br₂ [1]

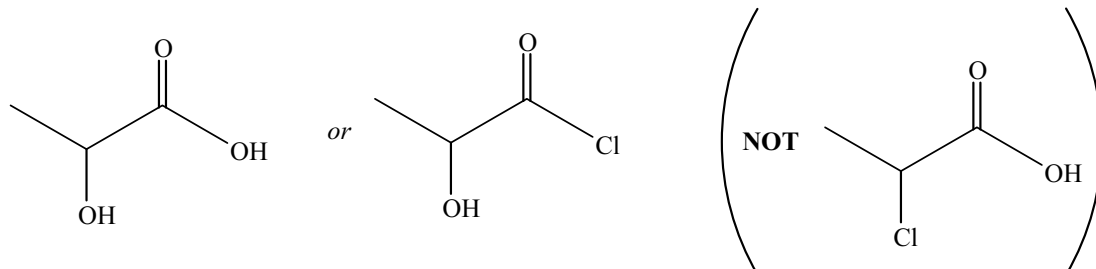
[Total: 12]

9 (a) [3]

monomer	addition	condensation	both
		✓	
	✓		
	✓		

(b) polythene is non-polar *or* its bonds are non-polar
so not (easily) **hydrolysed** [2]

(c) (i) [1]



(Allow displayed, skeletal, part-skeletal, structural etc.)

(ii) The **ester** (or –COO–) linkage/bond is hydrolysed *or* reacts with water [1]

(d) Polythene has (weak) van der Waals' (*or* id–id) forces [3]
 PVC has **stronger** van der Waals' forces *or* additional dipole forces
 Nylon has (strong) hydrogen bonding

[Total: 10]

CAMBRIDGE INTERNATIONAL EXAMINATIONS

Cambridge International Advanced Level

MARK SCHEME for the May/June 2015 series

9701 CHEMISTRY

9701/43

Paper 4 (Structured Questions), maximum raw mark 100

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

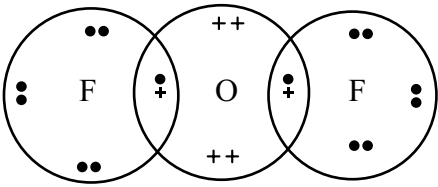
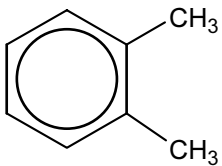
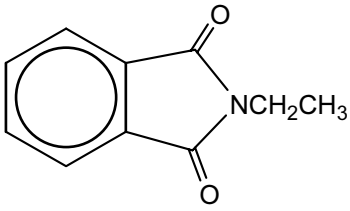
Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge will not enter into discussions about these mark schemes.

Cambridge is publishing the mark schemes for the May/June 2015 series for most Cambridge IGCSE[®], Cambridge International A and AS Level components and some Cambridge O Level components.

® IGCSE is the registered trademark of Cambridge International Examinations.

Page 2	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – May/June 2015	9701	43

Question	Marking point	Marks
1 (a)	oxygen: $(1s^2) 2s^2 2p^4$ fluorine: $(1s^2) 2s^2 2p^5$	1
(b) (i)	F_2O / OF_2	1
(ii)		1
(iii)	bent or non-linear	1
(c) (i)	$E^\ominus$ values: $F_2 / F^- = 2.87\text{ V}$ and $Cl_2 / Cl^- = 1.36\text{ V}$ fluorine (has the more positive $E^\ominus$ so) is more oxidising	1 1
(ii)	redox	1
(iii)	$ClF + 2KBr \longrightarrow KCl + KF + Br_2$	1
[Total: 8]		
2 (a) (i)	hydrogen chloride or HCl	1
(ii)	either $(RCOCl)$ has two electron-withdrawing groups/atoms, making the more δ^+ /electron deficient or $(RCOCl)$ has an oxygen, making the carbon more δ^+ /electron deficient or $(RCOCl)$ has two electron-withdrawing groups, weakening the C–Cl bond	1
(b) (i)	 P  Q	1 1
(ii)	step 1: heat with $MnO_4^- / KMnO_4$ (+ acid or alkali) step 2: PCl_3 + heat or $SOCl_2$ or PCl_5 step 4: $LiAlH_4$ (in dry ether)	1 1 1
[Total: 7]		

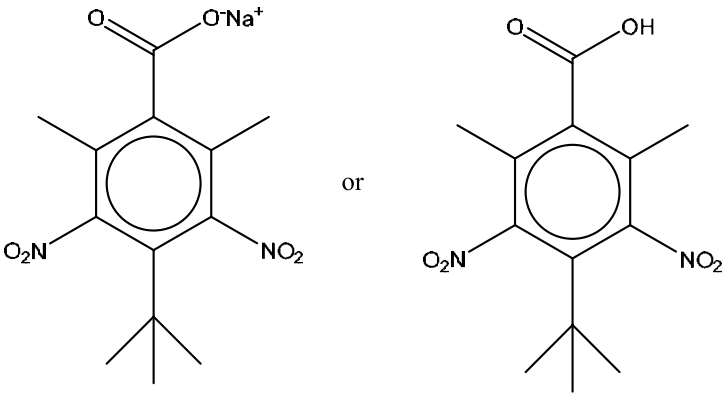
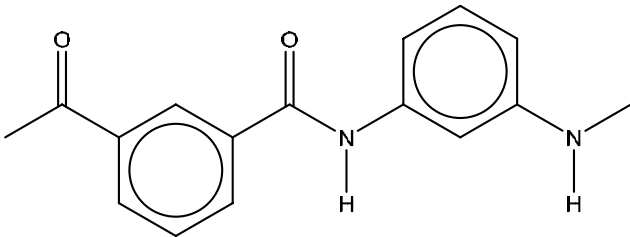
Page 3	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – May/June 2015	9701	43

3	(a)	(i)	<table><tr><td>isotope</td><td>relative abundance</td></tr><tr><td>^{24}Mg</td><td>78–79</td></tr><tr><td>^{25}Mg</td><td>10</td></tr><tr><td>^{26}Mg</td><td>12–11</td></tr></table> (total must add up to 100 %)	isotope	relative abundance	^{24}Mg	78–79	^{25}Mg	10	^{26}Mg	12–11	1
		isotope	relative abundance									
		^{24}Mg	78–79									
		^{25}Mg	10									
		^{26}Mg	12–11									
(ii)	e.g. $0.78 \times 24 + 0.10 \times 25 + 0.12 \times 26 = 24.34$	1										
(b)	(i)	nitrates become more stable (down the group)	1									
		as the ionic radius increases or charge density on cation/ion decreases	1									
		decreasing its ability to distort/polarise the NO_3^- /nitrate ion	1									
	(ii)	$4\text{LiNO}_3 \longrightarrow 2\text{Li}_2\text{O} + 4\text{NO}_2 + \text{O}_2$	1									
	(iii)	the charge density of the other cations are too small (to polarise the anion sufficiently so the anion is more stable)	1									
[Total: 7]												
4	(a)	(i)	$K_{\text{sp}} = [\text{Ag}^+(\text{aq})]^2[\text{SO}_4^{2-}(\text{aq})]$ and units: $\text{mol}^3\text{dm}^{-9}$	1								
		(ii)	$K_{\text{sp}} = (2 \times 0.025)^2 \times (0.025) = 6.25 \times 10^{-5}$	1								
	(b)	<pre>graph TD; A["2Ag+(g) + SO4^2-(g)"] -- "ΔH°latt" --> B["Ag2SO4(s)"]; B -- "ΔH°sol" --> C["Ag2SO4(aq) or 2Ag+(aq) + SO4^2-(aq)"]; A -- "ΔH°hyd" --> C;</pre>	1 1 1 1									
	(c)	(i)	$E^\ominus_{\text{cell}} (= 0.80 - 0.77 =) (+)0.03\text{V}$ and Ag^+/Ag or Ag/silver or right	1								
		(ii)	E_{cell} would be less positive/more negative because the $[\text{Ag}^+(\text{aq})]$ (in the Ag electrode) is less than 1.0 mol dm^{-3}	1								
		(iii)	• no change	1								

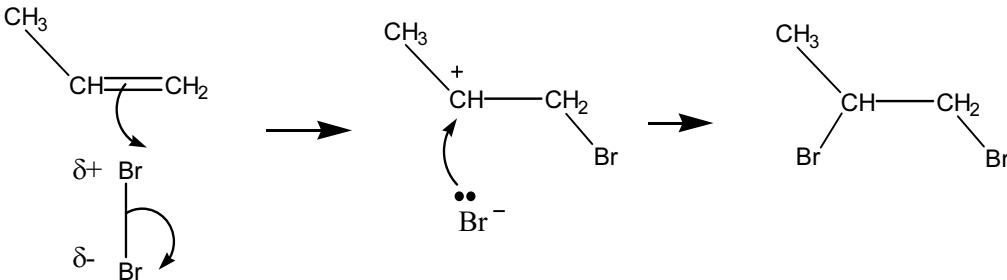
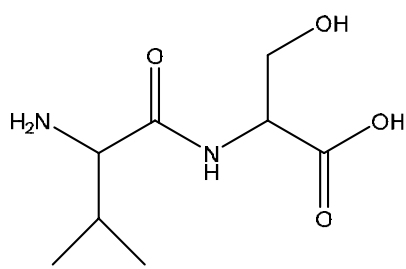
Page 4	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – May/June 2015	9701	43

	more negative/less positive	1								
(iv)	the $[\text{Ag}^+(\text{aq})]$ will decrease $E_{\text{electrode}}$ becomes less positive or due to the common ion effect	1								
(d)	$[\text{Fe}^{3+}(\text{aq})] = 0.2 \text{ mol dm}^{-3}$ $[\text{H}^+] = \sqrt{(c.K_a)} = \sqrt{(0.2 \times 8.9 \times 10^{-4})}$ or $1.33 \times 10^{-2} \text{ (mol dm}^{-3}\text{)}$ $\text{pH} = -\log([\text{H}^+]) = \mathbf{1.9}$ (or 1.87–1.89)	1 1								
[Total: 13]										
5 (a)	<table border="1"><tr><td></td><td>protons</td><td>electrons</td><td>neutrons</td></tr><tr><td>$^{14}\text{C}^{2-}$</td><td>6</td><td>8</td><td>8</td></tr></table>		protons	electrons	neutrons	$^{14}\text{C}^{2-}$	6	8	8	1 1
	protons	electrons	neutrons							
$^{14}\text{C}^{2-}$	6	8	8							
(b)	CCl_4 : no reaction GeCl_4 and SnCl_4 : for each steamy fumes evolved <i>or</i> white solid produced $\text{GeCl}_4 + 2\text{H}_2\text{O} \longrightarrow \text{GeO}_2 + 4\text{HCl}$ $\text{SnCl}_4 + 2\text{H}_2\text{O} \rightarrow \text{SnO}_2 + 4\text{HCl}$	1 1 1 1								
(c)	Ge/Sn use d-orbitals or Ge/Sn have low lying d orbitals or carbon cannot expand its octet or carbon cannot accommodate more than 4 bonded pairs	1								
(d)	$\text{Sn}^{4+}/\text{Sn}^{2+} = +0.15\text{V}$ and $\text{Pb}^{4+}/\text{Pb}^{2+} = +1.69\text{V}$ and $\text{Cl}_2/\text{Cl}^- = +1.36\text{V}$ Sn^{2+} is oxidised by Cl_2 because its $E^\ominus$ is less positive/more negative or Sn^{2+} is a good reducing agent due to its smaller E value than Cl_2 ora or Pb^{4+} is a stronger oxidising agent than Cl_2 so Pb^{2+} with Cl_2 reaction is not feasible or Sn^{4+} is a weaker oxidising agent than Cl_2 so Sn^{2+} with Cl_2 reaction is feasible $\text{SnCl}_2 + \text{Cl}_2 \longrightarrow \text{SnCl}_4$ or $\text{Sn}^{2+} + \text{Cl}_2 \longrightarrow \text{Sn}^{4+} + 2\text{Cl}^-$ or $\text{SnCl}_2 + \text{Cl}_2 + 2\text{H}_2\text{O} \longrightarrow \text{SnO}_2 + 4\text{HCl}$	1 1 1								
(e) (i)	F = Le	1								
(ii)	moles of $\text{O}_2(\text{g}) = 130/24000 = 5.417 \times 10^{-3} \text{ mol}$ moles of electrons needed = $4 \times 5.417 \times 10^{-3}$ or $2.17 \times 10^{-2} \text{ mol}$ no. of coulombs passed = $1.2 \times 30 \times 60$ or 2160 C no. of electrons passed = $2160/1.6 \times 10^{-19}$ or 1.35×10^{22} no. of electrons per mole = $1.35 \times 10^{22}/2.17 \times 10^{-2} = \mathbf{6.2 \times 10^{23} \text{ (mol}^{-1}\text{)}}$	1 1 1 1								
[Total: 15]										

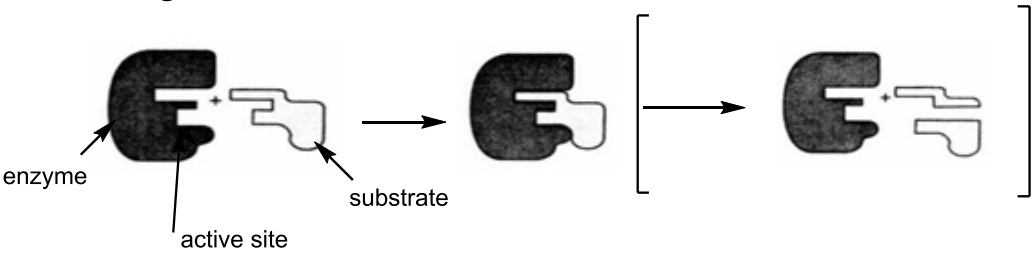
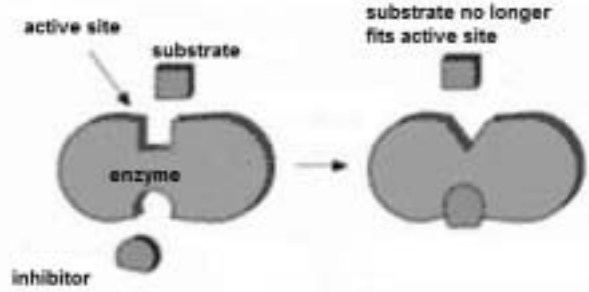
Page 5	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – May/June 2015	9701	43

6	(a) (i)	CH ₃ COCl or ethanoyl chloride	1
	(ii)	electrophilic substitution	1
	(iii)	conc HNO ₃ and conc H ₂ SO ₄	1
	(iv)	CHI ₃ 	1 1
	(b) (i)		1
	(ii)	polyamide or condensation	1
	(iii)	H ₂ O/water	1
	(iv)	Sn/Fe + HCl + conc/aq/heat/warm	1
	(v)	harder or more dense or stronger or higher m.pt or tougher or more rigid due to cross-linking or more H-bonding between the chains	1
			[Total: 10]

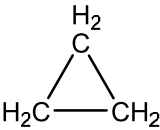
Page 6	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – May/June 2015	9701	43

7	(a) (i)	heat with catalyst or heat with $\text{Al}_2\text{O}_3/\text{SiO}_2$	1								
	(ii)	B is $\text{CH}_3\text{CH}_2\text{CH}_3$	1								
	(iii)	C is $\text{CH}_2=\text{CHCH}_2\text{CH}_2\text{CH}_3$ D and E are $\text{CH}_3\text{CH}=\text{CHCH}_2\text{CH}_3$ (one shown as cis, the other as trans) F is $\text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{H}$ G is $\text{CH}_3\text{CO}_2\text{H}$ H is $\text{CH}_3\text{CH}_2\text{CO}_2\text{H}$	1 1 1								
	(iv)	geometrical <i>or</i> cis-trans <i>or</i> E–Z	1								
	(b) (i)	No particular conditions or in the dark	1								
	(ii)	electrophilic addition	1								
	(iii)		1 1								
[Total: 10]											
8	(a) (i)	condensation	1								
	(ii)		2								
	(iii)	any two side-chain interactions mentioned with group <table border="1" data-bbox="293 1733 1305 2013"><tr><td>ionic attractions / bonds</td><td>between CO_2^- and NH_3^+</td></tr><tr><td>van der Waals</td><td>between alkyl / aryl / non-polar groups or valine</td></tr><tr><td>hydrogen(H) bonding</td><td>between OH, NH_2, COOH, NH or serine</td></tr><tr><td>S-S or disulfide bonds or disulfur bond / bridge</td><td>between SH groups or cysteine</td></tr></table>	ionic attractions / bonds	between CO_2^- and NH_3^+	van der Waals	between alkyl / aryl / non-polar groups or valine	hydrogen(H) bonding	between OH , NH_2 , COOH , NH or serine	S-S or disulfide bonds or disulfur bond / bridge	between SH groups or cysteine	2
ionic attractions / bonds	between CO_2^- and NH_3^+										
van der Waals	between alkyl / aryl / non-polar groups or valine										
hydrogen(H) bonding	between OH , NH_2 , COOH , NH or serine										
S-S or disulfide bonds or disulfur bond / bridge	between SH groups or cysteine										

Page 7	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – May/June 2015	9701	43

(b) (i)	labelled diagrams  in words - the enzyme has a specific shape or substrate shape is complementary to active site - the substrate bonds/binds/fits to the active site or other substrates do not fit into active site	1 1
(ii)	labelled diagrams  or in words - inhibitor binds to enzyme away from the active site or inhibitor binds to allosteric site - this changes the shape (or structure) of the active site - substrate no longer fits the active site	1 1 1
[Total: 10]		
9 (a) (i)	use restriction enzymes or using an enzyme to break (the DNA) down into smaller fragments	1
(ii)	use the polymerase chain reaction or use DNA polymerase to replicate/ copy (the sample of DNA)	1
(iii)	- amino acids have different charges due to their side-chain/ R group/ pH/ CO₂⁻ and NH₃⁺ groups - DNA fragments have negatively-charge phosphates(or PO₄) or DNA has PO₄³⁻ groups	1 1

Page 8	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – May/June 2015	9701	43

(iv)	A piece of leather from an Egyptian tomb		1
	A sample of skin from a mummified body		
	A fragment of ancient pottery	X	
	A piece of wood from a Roman chariot		
(b) (i)	the electron density in the molecule or positions of atoms or interatomic distance / spacing between the atoms		1
(ii)	phosphorus has the most electrons or phosphorus has the highest electron density		1
(c) (i)	equilibrium constant (for the solution) of a solute between two (immiscible) solvents or ratio of the concentration of the solute in (each of the) two solvents or ratio of the solubility of the solute in (each of the) two solvents		1
(ii)	$\frac{x}{(25/1000)}$ $\frac{(0.0042-x)}{(25/1000)}$ $x = 0.0252 - 6x$ $x = \mathbf{0.0036g}$		1 1
[Total: 10]			
10 (a) (i)	any three of the following structures CH ₃ CH ₂ CH ₃ CH ₃ CH=CH ₂ CH ₃ C≡CH CH ₂ =C=CH ₂ 		2
(ii)	K since it has the greatest % of hydrocarbons / carbon-containing compounds or 99.6 % of it is burnt for energy		1
(iii)	any two from - reacted with lime / CaO / soda lime / Ca(OH)₂ / KOH / NaOH / - liquefied under pressure / ≥5 atm - dissolved in water under pressure / ≥5 atm		2
(b) (i)	have a shorter carbon / hydrocarbon chain or shorter hydrocarbon or fewer carbon atoms in its chain or have high H / C ratio		1
(ii)	Coal		1

Page 9	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – May/June 2015	9701	43

	produces the largest amount of SO ₂ or largest combined amount of SO ₂ and NO ₂	
(iii)	they burn at higher temperatures or release more heat on burning	1
(iv)	CO – the gas is toxic/poisonous or references to Hb and ability to carry oxygen	1
	CO ₂ – the gas contributes to global warming	1
[Total: 10]		