OCR
RECOGNISING ACHIEVEMENT

GCE

Chemistry

Advanced GCE **A2 7882**

Advanced Subsidiary GCE **AS 3882**

Mark Schemes for the Units

January 2007

3882/7882/MS/R/07J

Oxford Cambridge and RSA Examinations

OCR (Oxford Cambridge and RSA Examinations) is a unitary awarding body, established by the University of Cambridge Local Examinations Syndicate and the RSA Examinations Board in January 1998. OCR provides a full range of GCSE, A level, GNVQ, Key Skills and other qualifications for schools and colleges in the United Kingdom, including those previously provided by MEG and OCEAC. It is also responsible for developing new syllabuses to meet national requirements and the needs of students and teachers.

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by Examiners. It does not indicate the details of the discussions which took place at an Examiners' meeting before marking commenced.

All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the Report on the Examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

Any enquiries about publications should be addressed to:

OCR Publications
PO Box 5050
Annersley
NOTTINGHAM
NG15 0DL

Telephone: 0870 870 6622
Facsimile: 0870 870 6621
E-mail: publications@ocr.org.uk

CONTENTS

Advanced GCE Chemistry (7882)

Advanced Subsidiary GCE Chemistry (3882)

MARK SCHEME ON THE UNITS

Mark Scheme 2811
January 2007

Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ____ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument	
Question	**Expected Answers**	**Marks**
1 (a) (i)	(atoms of) **same element/same atomic number**….. with different numbers of neutrons/different masses ✓	**[1]**
(b) (i)	<table><tr><th rowspan="2">isotope</th><th rowspan="2">percentage composition</th><th colspan="3">number of</th></tr><tr><th>protons</th><th>neutrons</th><th>electrons</th></tr><tr><td>^{85}Rb</td><td>71 to 73</td><td>37</td><td>48</td><td>37</td></tr><tr><td>^{87}Rb</td><td>27 to 29</td><td>37</td><td>50</td><td>37</td></tr></table> mark must add up to 100 ✓ ie 1 mark for each atomic structure; 1 for % compositions.	✓ ✓ **[3]**
(ii)	$A_r = \frac{(85 \times 72) + (87 \times 28)}{100}$ / 85.56 ✓ = 85.6 ✓ 2nd mark for significant figures 71/29: 85.58 = 85.6 73/27: 85.54 = 85.5	**[2]**
(c)	carbon-12/^{12}C ✓	**[1]**
(d)	atomic radii of Rb > atomic radii of elements above/ Rb has electrons in shell further from nucleus / Rb has more shells ✓ Rb has **more** shielding ✓ (***'more'** is essential)* (increased) nuclear charge is outweighed / despite increased nuclear charge …..by at least one of the factors above/ less attraction/ held less tightly ✓	**[3]**
(e) (i)	**Simplest (whole number) ratio** of atoms/moles/elements ✓	**[1]**
(ii)	ratio Rb : Ag : I = 7.42/85.5 : 37.48/108 : 55.10/127 or 0.0868 : 0.347 : 0.434 or 1 : 4 : 5 ✓ = $RbAg_4I_5$ ✓	**[2]**
		Total: 13

Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ____ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument			
Question			**Expected Answers**	**Marks**
2	**(a)**	**(i)**	8-14 ✓	**[1]**
		(ii)	$Ca(OH)_2(aq) + CO_2(g) \longrightarrow CaCO_3(s) + H_2O(l)$ *1st mark for species in equation* ✓ *2nd mark for rest with st symbols* ✓ Allow H_2O as either 'l' or 'aq'	**[2]**
		(iii)	precipitate disappears/goes clear/goes colourless ✓ $Ca(HCO_3)_2$ $CaH_2C_2O_6$ ✓	**[2]**
	(b)	**(i)**	$1s^2 2s^2 2p^6 3s^2 3p^6$ ✓	**[1]**
		(ii)	3 ✓	**[1]**
		(iii)	10 ✓	**[1]**
		(iv)	'dot-and-cross' of Ca^{2+} with either 8 electrons or no electrons. ✓ 'dot-and-cross' of $2OH^-$ correct ✓ N.B. H electron and Ca electrons can look the same.	**[2]**
	(c)	**(i)**	Heat $CaCO_3$ ✓ $CaCO_3 \longrightarrow CaO + CO_2$ ✓ Add water to CaO (or + H_2O in equation) ✓ $CaO + H_2O \longrightarrow Ca(OH)_2$ ✓	**[4]**
	(d)		neutralising (acid) soils/neutralising sewage/ softening water in water treatment/ neutralising acid water✓	**[1]**
				Total: 15

Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ___ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument			
Question		**Expected Answers**		**Marks**
3 **(a)** **(i)**		**attraction** between oppositely charges ions ✓		**[1]**
(ii)		shared pair of electrons ✓✓ *'shared electrons' scores 1 mark only*		**[2]**
(b) **(i)**		attraction of an **atom/element** for electrons ✓ in a (covalent) bond/bonded pair ✓		**[2]**
(ii)		one element attracts bonded pair more /is more electronegative than other ✓ ⟶ δ– on more electronegative atom and δ+ on less electronegative element in example ✓ *May need to look for these marks in (c) if not given here.*		**[2]**
(c)		H-bond shown between H of one molecule and O, N or F of another ✓ H-bond shown going to a lone pair ✓		**[2]**
				Total: 9

Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ____ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument	
Question	**Expected Answers**	**Marks**
4 (a)	<table><tr><td>element</td><td>structure</td><td>bonding</td><td></td></tr><tr><td>Mg</td><td>giant</td><td>metallic</td><td>✓</td></tr><tr><td>Si</td><td>giant</td><td>covalent</td><td>✓</td></tr><tr><td>S</td><td>simple</td><td>covalent</td><td>✓</td></tr></table> 1 mark for each correct row	**[3]**
(b)	Si has strong forces between atoms/ covalent bonds are broken ✓ P has weak forces between molecules/ intermolecular forces/van der Waals' forces are broken ✓	**[2]**
(c)	From Na → Al, no of **delocalised** electrons increases ✓ charge on positive ion increases/ ionic size decreases/ charge density increases ✓ attraction between + ions and electrons increases/ metallic bonding gets stronger ✓	**[2 max]**
		Total: 7

Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ____ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument		
Question		**Expected Answers**	**Marks**
5	**(a)** **(i)**	12 x 50/1000 = 0.600 mol ✓	**[1]**
	(ii)	4 mol HCl ⟶ 1 mol Cl_2 / moles Cl_2 = 0.15 mol ✓ vol of Cl_2 = 0.15 x 24 = 3.60 dm^3 ✓ *2nd mark is consequential on molar ratio given*	**[2]**
	(b)	Evidence that the oxidation number of Mn has reduced **and** one of the oxidation numbers correct (ie MnO_2: ox no of Mn = +4 or $MnCl_2$: ox no of Mn = +2 ✓ The **other** oxidation number of Mn is correct, ie in MnO_2: ox no of Mn = +4 **or** in $MnCl_2$: ox no of Mn = +2 ✓	**[2]**
	(c) **(i)**	$2Na(s) + Cl_2(g) \longrightarrow 2NaCl(s)$ ✓✓ 1st mark for equation 2nd mark for state symbols	**[2]**
	(ii)	Giant ionic (lattice) or 3D ✓ with alternating Na^+ and Cl^- ✓	**[2]**
		With Br^-, goes yellow/orange/red ✓ *'precipitate' makes this incorrect.* With I^-, goes purple/brown/brown ✓ *'precipitate' should be ignored* $Cl_2 + 2Br^- \longrightarrow Br_2 + 2Cl^-$ ✓ $Cl_2 + 2I^- \longrightarrow I_2 + 2Cl^-$ ✓ Or full equations using soluble halides, eg NaBr If both equations given with correct species but not balanced, award 1 mark reactivity trend: Cl more reactive than both Br and I/ Cl is the most reactive ✓ Cl (atoms) are smaller (ora) / attraction for electrons or electron affinity is greater / Cl is a stronger oxidising agent ✓ *ignore any reference to 'electronegativity'.*	**[6]**
		QoWC: At least 2 sentences in which the meaning is clear. ✓	**[1]**
			Total: 16

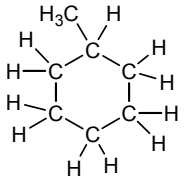
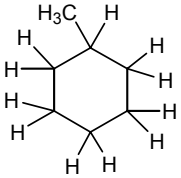
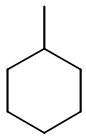
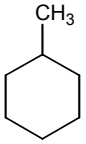
Mark Scheme 2812
January 2007

Q1

(a) separation by (differences in) boiling point ✓

(b) $C_7H_{16} \longrightarrow C_4H_{10} + C_3H_6$ ✓

(c) (i) Any of

✓

(ii) $C_7H_{16} \longrightarrow C_7H_{14} + H_2$ (or by structural formula) ✓

(d) (i) 2,2-dimethylpentane ✓

(ii) 3-methylhexane, 3,3 dimethylpentane or (3)-ethylpentane in any unambiguous form. ✓✓

(iii) 2,2,3-trimethylbutane ✓

(iv) if branched, difficult to pack/less surface interaction/less points of contact ✓
less van der Waals' forces/ less intermolecular bonds/less energy needed to boil ✓

(e) (i) (A fuel whose feedstock is obtained) from a plant/animal excrement ✓

(ii) fossil fuels are non-renewable because they take millions of years to form/
ethanol is renewable because the plant (sugar beet, cane) can be re-grown ✓

[Total: 12]

Q2

(a) (i) $C_6H_{12}O_6$ (aq) $\longrightarrow$ $2C_2H_5OH(l)$ or (aq) + $2CO_2(g)$ balanced equation ✓
state symbols can be awarded only if equation shows $C_6H_{12}O_6$, C_2H_5OH and CO_2 ✓

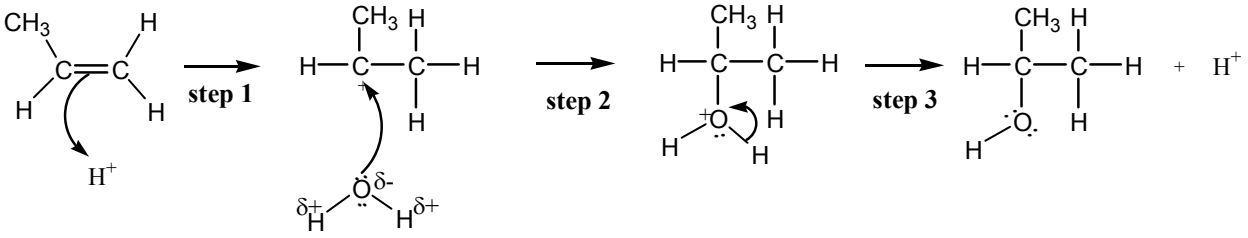
(ii) anaerobic, aqueous, temp range 25 – 40 ^oC/warm to just above room temp ✓✓

(iii) no more bubbles/gas/CO_2 ✓

(b) (i) phosphoric acid/H^+/sulphuric acid ✓

(ii) lone/electron pair of electrons acceptor ✓

(c) (i)



Step 1 curly arrow from π-bond to H^+ ✓
Step 2 curly arrow from lone pair on the $O^{\delta-}$ to C+ ✓
Step 3 curly arrow from O—H bond to O+ ✓

(ii) catalyst … no marks because it is **not** consumed/used up in the reaction/owtte ✓

(d) $CH_3CH(OH)CH_3$ + $4½O_2$ $\longrightarrow$ $3CO_2$ + $4H_2O$ ✓✓
/C_3H_8O

(1 mark if correct formula for all four chemicals and 1 mark for correct balancing)

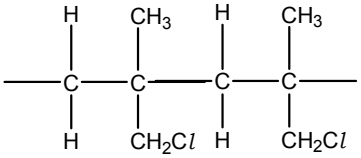
(e) ethanoic acid/ CH_3COOH/CH_3COCl ✓

[Total: 14]

Q3

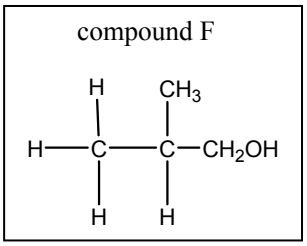
(a) 3-chloro(-2-)methylprop-1-ene/1-chloro(-2-)methylprop-2-ene ✓

(b)

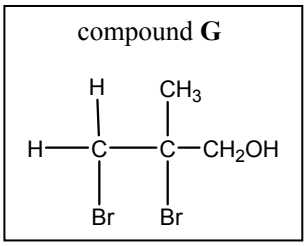


Backbone of 4 carbons and a reasonable attempt gets 1 mark. ✓✓

(c) (i)

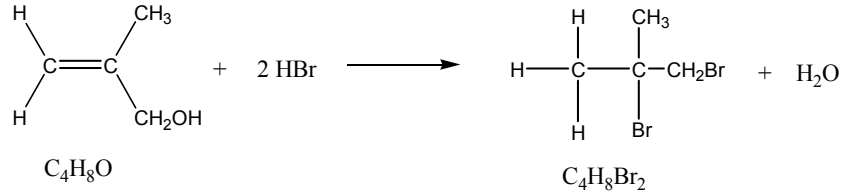


✓



✓

(ii)



C_4H_8O $C_4H_8Br_2$

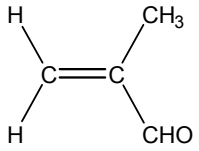
✓✓

1 mark for HBr

(iii) $Cr_2O_7^{2-}$ ✓

$H^+$and reflux ✓

(iv)



/ methylprop-2-enal ✓

(d) **infra-red**

(alcohol)**E** would show absorption 3230 – 3550 cm^{-1} ✓

(carboxylic acid) **I** would show **either** an absorption 1680 – 1750 cm^{-1} **or** 2500 – 3300 cm^{-1} ✓

I contains C=O at approx 1700 cm^{-1} but **E** doesn't get both marks ✓✓

[Total: 12]

Q4

(a) (i) uv/sunlight/high temperature (range 400 – 700 ^{o}C) ✓

(ii) $Cl_2 \longrightarrow 2Cl\bullet$ ✓

$C_4H_{10} + Cl\bullet \longrightarrow HCl + \bullet C_4H_9/C_4H_9\bullet$ ✓

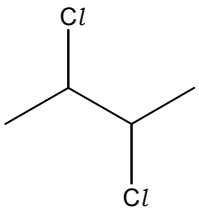
$\bullet C_4H_9/C_4H_9\bullet + Cl_2 \longrightarrow C_4H_9Cl + Cl\bullet$ ✓

(iii) any two free radicals from (a) (ii) ✓

(iv) homolytic (fission) ✓

(b) (i) 2,3-dichlorobutane ✓

(ii)



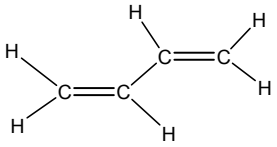
✓

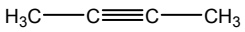
(iii) any dichlorobutane **except** 2,3-dichlorobutane. ✓

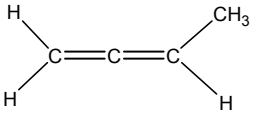
(c) (i) ethanol ✓

(ii) elimination ✓

(iii) any one from:







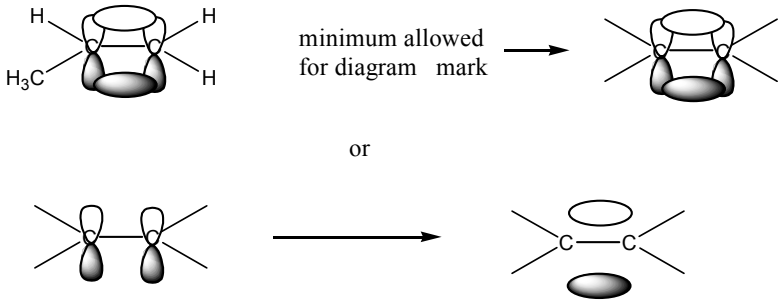
✓

[Total: 12]

Q5

Bonding: π-bond formed by overlap of (adjacent) p-orbitals/π-bond labelled on diagram ✓

diagram to show formation of the π-bond ✓



2

Shape/bond angles:

tetrahedral around the CH_3 ✓

bond angle = $109^o28^/$ (109-110^o) ✓

trigonal planar around each C in the C=C ✓

bond angle = 120^o (118-122^o) ✓

4

Cis-trans

cis & trans correctly labelled eg but-2-ene ✓
require a double bond because it restricts rotation ✓
each C in the C=C double bond must be bonded to two different atoms or groups ✓

3

QWC Allow mark for well constructed answer and use of **three** terms like:
orbital, tetrahedral, trigonal, planar, rotation, spatial, stereoisomers, geometric ✓

[Total: 10]

Mark Scheme 2813/01
January 2007

Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ____ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument

Question	Expected Answers	Marks
1 (a) (i)	$MgCO_3(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + CO_2(g) + H_2O(l)$ balancing ✓ state symbols ✓	2
(ii)	$MgCO_3 + 2H^+ \rightarrow Mg^{2+} + CO_2 + H_2O$/ $CO_3^{2-} + 2H^+ \rightarrow CO_2 + H_2O$ ✓	1
(b)	(as the reaction proceeds) the concentration decreases ✓ (rate) of collision decreases ✓ reaction stops when all of one reagent is used up ✓	3
(c) (i)	sketch to show slower rate of production ie less steep (must not be straight line)✓ final volume the same but reached later ✓	2
(ii)	rate is slower **because** weak acid is partially ionised/ dissociated ✓ lower **concentration** of H^+ in weak/ higher **concentration** of H^+ in strong/ HCl ✓	2
		Total: 10

Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ____ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument

Question	Expected Answers	Marks
2 (a)	$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$ formulae ✓ balancing ✓ ignore state symbols	2
(b)	(enthalpy/ energy/ heat change) when 1 mole of substance/ element/ compound ✓ (NOT absorbed) is completely burnt/ burnt in excess oxygen ✓ under standard conditions (if conditions stated they must be correct) ✓	3
(c) (i)	use of $mc\Delta T$ ✓ 200 X 4.18 X 50.3 correct answer ✓ 42.1/ 42.0/42 (2 or more sig figs) final answer must be in kJ for 2nd mark	2
(ii)	moles = $\frac{1.00}{44}$ = 0.0227/ 0.023✓	1
(iii)	$\frac{42.1}{0.0227}$ = 1850 (kJ mol^{-1}) ✓ sign ie – ✓	2
(d)(i)	cycle ✓ multipliers x – 2219 = 3(–394) + 4(–286) ✓ answer –107 (kJ mol^{-1})✓	3
(ii)	carbon and hydrogen would react to give more than 1 product/ do not react together easily/ the reaction has a high activation energy ✓	1
		Total 14

Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ____ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument	
Question	**Expected Answers**	**Marks**
3 (a)	any two from **rate** of forward reaction = **rate** reverse reaction ✓ macroscopic properties remain constant/ concentrations remain constant ✓ closed system needed ✓	2
(b) (i)	a substance that alters the rate of a reaction without being used up / a substance that lowers the activation energy (for a reaction) by providing an alternative route ✓	1
(ii)	catalyst is in the same state/ phase as reactants ✓	1
(iii)	H^+ ✓	1
(iv)	they alter the rate of the forward and the reverse reaction **by the same amount** ✓	1
(c) (i)	axes labelled y as number/ fraction/ % of molecules/ particles and x as energy/ enthalpy/ velocity/ speed ✓ correct shape to include origin, hump and position wrt x axis ✓	2
(ii)	two vertical lines **drawn** both to the RHS of hump (at least one labelled *E*a) (labels reversed cannot score) ✓ greater proportion of collisions have energy greater than *E*a/ more molecules exceed *E*a ✓	2
		Total 10

Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ____ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument	
Question	**Expected Answers**	**Marks**
4 a)	pressure 50 – 1000 atm ✓ temperature 200 – 600^{o}C ✓	2
b)	**rate** (increased) pressure increases rate because molecules are closer together/ more concentrated ✓ (increased) temperature increases rate because molecules are moving faster/ have more energy ✓ **equilibrium** increased pressure pushes equilibrium to RHS ✓ because fewer (gas) moles/ molecules on RHS ✓ increased temperature pushes equilibrium to LHS ✓ because (forward) reaction is exothermic ✓ **compromise** if temperature is **too** high, low yield ✓ if temperature is **too** low, slow rate ✓ if pressure is too high, increased costs/ safety issues ✓	9 Total: 11

Mark Scheme 2813/03
January 2007

AS Practical Exam 2813/03
Jan 2007: Mark Scheme

Skill P: 16 marks (out of 19 available)

G Gas collection method – 9 marks

G1 Adds measured quantity of sulphuric acid to known mass of baking powder [1]

G2 Collects the gas in a gas syringe/measuring cylinder/inverted burette [1]
or measures total mass of materials at start, then mass loss after reaction

G3 Uses excess dilute sulphuric acid ***and*** states reason for excess [1]

G4 Draws a neat accurate diagram of apparatus (using a ruler) [1]
If mass loss method is described, a wool plug must be shown

G5 "Inner tube" (or equivalent) used to prevent premature start of reaction [1]

G6 Waits until no more gas collected before measuring volume of gas. [1]
A specific observation is required (fizzing stops or syringe plunger stops moving)
Mass loss: measurement must be to constant mass (aw)

G7 Repeats whole experiment until volumes of gas are consistent/takes mean [1]

G8 CO_2 is [slightly] soluble in water (or acid) [1]

G9 Uses water/acid pre-saturated with CO_2
or uses hot water ***or*** uses acid that is more concentrated
or states that syringe collection is more accurate since less water involved [1]

C Calculations etc – 6 marks

C1 **Background theory**: baking powder liberates CO_2 when heated ***or*** when acidified.
and the CO_2 produced makes dough/cakes/bread (etc) rise. [1]

C2 Researches typical % mass of $NaHCO_3$ in baking powder (stating source of info)
or states three components of baking powder (starch, bicarb and an organic acid)
or realises that method assumes that no other type of carbonate is present [1]

C3 **Equation** for reaction: $2NaHCO_3 + H_2SO_4 \rightarrow Na_2SO_4 + 2CO_2 + 2H_2O$ [1]

C4 **Calculates** suitable mass of $NaHCO_3$ so that syringe is not over-filled with gas [1]

C5 **Calculates** suitable volume ***or*** concentration of sulphuric acid to use [1]
Calculation must implicitly use a correct mole ratio

C6 **Calculates % $NaHCO_3$** in baking powder from mass used and volume of gas [1]
*Accept an intelligible calculation leading to any answer **below** 100%*

S Sources etc – 4 marks

S1 Researches hazard of ***and*** explains a safety measure for the sulphuric acid [1]

Sulphuric acid is corrosive if > 1.5M (and irritant at lower concentrations)
Treat any gross overstatement of hazard as a CON

S2 References to two secondary sources quoted as footnotes or at end. [1]

- *Books must have chapter or page numbers*
- *An Internet reference must go beyond the first slash of web address*
- *Accept one <u>specific</u> reference a page in "Hazcards"*

S3 **QWC**: text is legible and spelling, punctuation and grammar are accurate [1]

*Accept not more than **five** different errors in legibility, spelling, punctuation or grammar.*

- *Treat ICT slip in text (eg "cm3") as one error.*
- *Don't penalise an error that has already been penalised in an equation.*

S4 **QWC**: information is organised clearly and accurately [1]

Can you say "yes" to all three of the following questions?

- *Is a word count given and between 450 and 1050 words?*
  Accept a total word count or any word numbering in the margin
- *Is scientific language used correctly? Allow **one** error, only, without penalty.*
  Is there any error of terminology - eg "strong" for "concentrated"?
  Is there an incorrect chemical formula in the text?
  If units are quoted in text or in calculations are they [normally] correct?
- *Is the description written logically, coherently and without undue repetition?*

AS Practical Test (Part B)

Page 3 – *8 marks* (Part 1)

First three weighings listed or tabulated [1]
Unit, g, must be shown somewhere against the weighings.

Fourth weighing (after re-heat) shown ***and*** is within 0.01 g of third weighing [2]
Give **one** *mark if fourth mass is within 0.02 g of third mass*

Mass of $NaHCO_3$ used ***and*** mass of residue obtained [1]
These must both be subtracted correctly and given to 2 (or 3) dp)

Accuracy of % mass obtained [3]
Calculate ***mean supervisor's %*** $^{\text{mass of residue}}/_{\text{mass of NaHCO3}}$ *to nearest 1 dp.*
Then calculate ***candidate's*** *% mass in the same way.*
Answers of candidate and supervisor % are within 1.0% → **3 marks**:
within 2.0% → **2 marks**:
within 4.0% → **1 mark**

Safety: yellow flame is visible/easily seen [1]

Page 4 – *3 marks* (Part 2)

2(a) Lime water goes milky/cloudy [1]

Solid does not change colour
or white residue/solid formed after heating *(allow "white precipitate")*
or condensation produced *or* drops of liquid formed [higher up the test tube]
or after some time, lime water begins to go colourless again [1]

Carbon dioxide produced *(allow formula)* [1]

Page 5 – *6 marks* (Parts 2 + 3)

2(b)(i) Fizzing/bubbling observed [1]
Do not allow "gas produced", but allow "colourless gas produced"

(ii) Residue is sodium carbonate [1]

Reason for deduction:
Either: only sodium carbonate reacts with acid to give off gas/carbon dioxide
Or sodium oxide/hydroxide produce no gas when acid is added [1]

3(a) [sodium hydrogen carbonate → water] + sodium carbonate + carbon dioxide [1]
Both products must be correct. Words are required – it is a "word equation"

3(b) M_r of $NaHCO_3$ = 84 [1]

no of moles of $NaHCO_3$, correctly calculated from candidate's data [1]
Answer must be correct to 3 sig fig

Page 6 – *4 marks* (Part 3)

3(c) M_r of Na_2CO_3 = 106 [1]
Allow ecf to candidate's answer in 3(a), either NaOH = 40 or Na_2O = 62

Number of moles of residue, correctly calculated from candidate's data [1]

3(d) Ratio = 2:1 [1]

3(e) Equation fully correct: $2NaHCO_3 \rightarrow Na_2CO_3 + CO_2 + H_2O$ [1]

Page 8 – *4 marks* (Part 4)

4(a) Both temperatures clearly labelled ***and*** recorded to 0.5°C *(ie one decimal place)* [1]

Temperature drop correctly worked out ***and*** unit shown (somewhere) [1]

Accuracy – 2 marks [2]
- Candidate's temperature drop within 0.8°C of supervisor's **mean → 2** marks
- Candidate's temperature drop within 1.5°C of supervisor's **mean → 1** mark

Page 9 – *5 marks* (Part 4)

4(b) Temperature change/fall shown in formula [1]

Heat absorbed, correctly calculated (= 105 x temp fall) [1]

4(c) No of moles of HCl = 0.025 [1]

4(d) $\Delta H/kJ = {}^{heat}/_{no\ of\ moles} \times {}^{1}/_{1000}$
This is a method mark [1]

ΔH value calculated: correct answer is expressed in kJ, to 2 or 3 sf. [1]
Positive sign is not required, but penalise a negative sign with the answer

Pages 10 + 11 – *14 marks* *(maximum, out of 19).* Part 5

5(a) **2 marks** *(but 1 on question paper)*

Constant mass *or* third and fourth mass readings should be [nearly] equal [1]

To ensure that the solid has completely reacted/decomposed [1]

5(b) **4 marks** (*but 3 on question paper*)

Yellow flame contains soot/carbon. [1]

A deposit of soot would increase the mass of the crucible and residue [1]

Yellow flame has a lower temperature
or yellow flame heat is [too] gentle [compared to a cone flame] [1]

Heating would be required for a longer period
or the $NaHCO_3$ might not decompose [completely] *(owtte)* [1]

5(c) 2 marks

Potential error = 0.02 g, because two readings are involved [1]

% error = $^{0.02}/_{\text{mass of NaHCO3}}$ x 100 (ignore sf) [1]
Give 1 mark (out of 2) for use of 0.01 in this expression

5(d) 2 marks

Repeat experiment ***and*** take mean/ignore anomalous results [1]

Consistent readings are evidence of reliability [1]

5(e) **9 marks** (*but 6 on question paper*)

*Mark the best **three** strands from those below*

.

- Heat gains *(accept "losses")* during reaction [1]

  These result from convection ***or*** conduction [1]

  Use a lid ***or*** thermos flask *or* thicker/better/more insulation/calorimeter [1]

- Loss of [acid] spray during reaction [1]

  Use a lid ***or*** bigger cup ***or*** acid that is more dilute [1]

- Inaccuracy of the thermometer ***or*** temperature drop is [too] small [1]

  This results in a high percentage error in the measurement [1]
  Allow a reasonable attempt to calculate % error for thermometer

  Use acid that is more concentrated [to increase the temperature change]
  or use a thermometer reading to 0.1oC ***or*** one more accurately <u>calibrated</u> (*owtte)* [1]

- There were still some bubbles/fizzing when the final temp reading was taken [1]

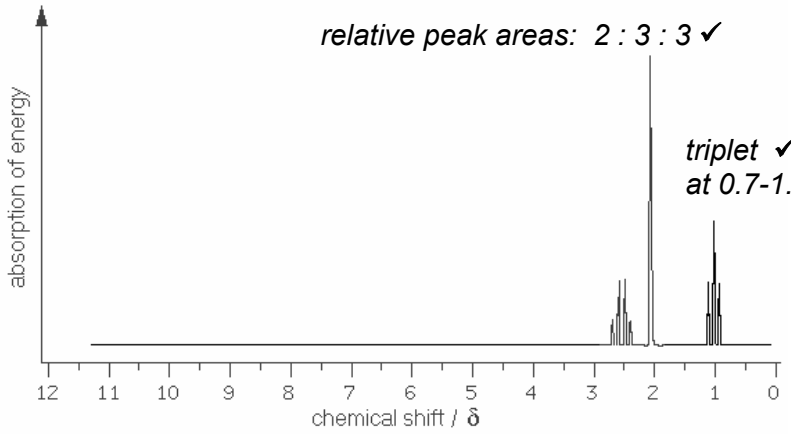
  This shows that the reaction had not finished [1]

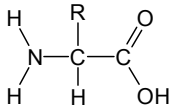
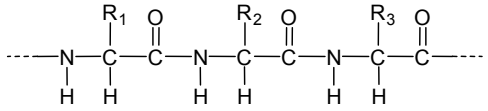
  Use $NaHCO_3$ with greater surface area/ more powdered
  or use acid that is more concentrated [1]

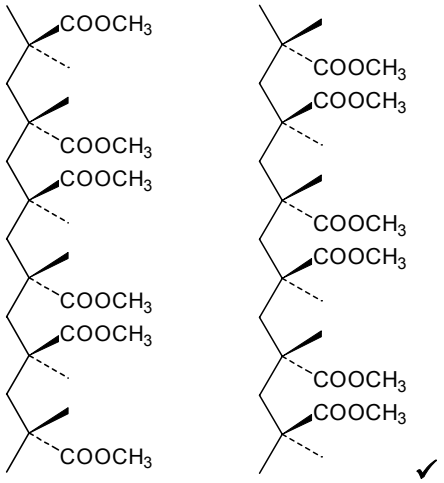
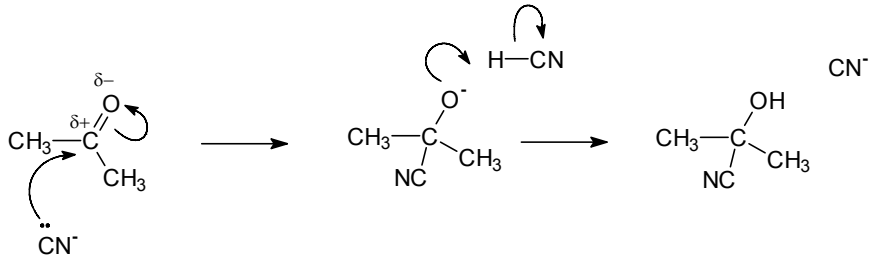
- Pipette/burette is more accurate than a measuring cylinder *(owtte)* [1]

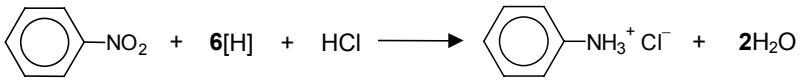
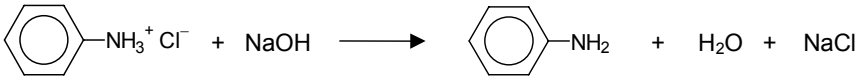
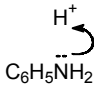
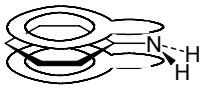
  Sensible % error for one piece of apparatus correctly calculated [1]

Mark Scheme 2814
January 2007

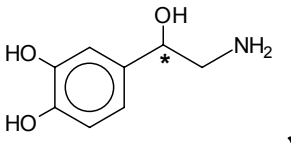
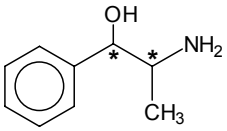
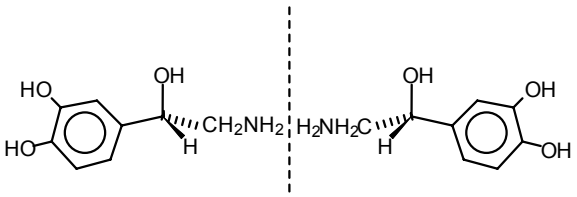
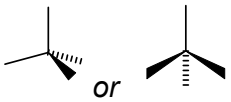
Qu. No.		Marks
1 (a) (i)	*Tollens' reagent / ammoniacal silver nitrate* ✓ *silver mirror / precipitate* ✓ *butanoate / butanoic acid / unambiguous formula or structure* ✓	**[3]**
(ii)	***Any of:*** *Br_2 - decolourises – (electrophilic) addition* *Na – fizzes – redox* *$SOCl_2$ /PCl_5 /acid chloride – white fumes – substitution/chlorination* *carboxylic acid + conc H_2SO_4 /acid chloride – sweet smell – esterification/ condensation* *test* ✓**-** *observation* ✓ *- type of reaction* ✓ ***NOT*** *2-4DNPH to give no precipitate*	**[3]**
(b)	*recrystallise /purify (the precipitate)* ✓ *measure melting point* ✓ *compare with known values* ✓	**[3]**
(c) (i)	*the peak is due to the CH_3CO- group* ✓ *not split, so next to a C with no protons / has no neighbouring proton /* *δ value is in the range 2.0 – 2.9* ✓	**[2]**
(ii)	*adjacent to a C with three protons / to a CH_3* ✓	**[1]**
(iii) and **(iv)**	*relative peak areas: 2 : 3 : 3* ✓  *triplet* ✓ *at 0.7-1.6* ✓ *mark any additional incorrect peaks first*	**[3]**
		[Total: 15]

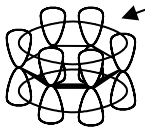
Qu. No.		Marks
2	***General formula of an α-amino acid*** *$RCH(NH_2)COOH$* /  ✓ ***Diagram to show length of polypeptide / repeat unit*** *– eg*  ***with:*** *displayed peptide bond* ✓ *correct structure with a minimum of two amino acids joined (can be scored by a dipeptide)* ✓ *idea of polymerisation shown by 'end bonds'* ✓ *loss of water* ✓ *relate variety to different R groups / sequence of amino acids* ✓ ***AW*** ***Quality of written communication:*** *correct organisation and use of* ***both*** *of the terms:* *<u>condensation polymer</u>(isation) and <u>peptide bond/link</u>* ✓	**[7]**
		[Total: 7]

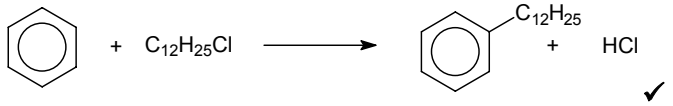
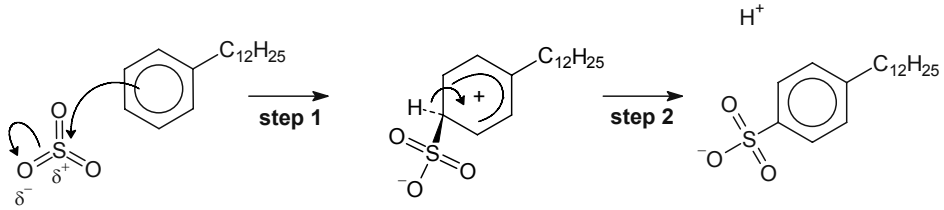
Qu. No.		Marks
3 (a)	*addition* ✓ *NOT "additional"*	[1]
(b) (i)	**either** **or**  ✓	[1]
(ii)	*isotactic* ✓ *group is on the same side / has the same 3-D spatial arrangement (along the chain)* ✓ ***AW***	[2]
(c) (i)	***stage 2*** *HCl/H_2SO_4* ✓ *presence of water implied – eg dilute /aq / suitable named concentration* ***and*** *warm/heat/reflux* ✓ *second mark is dependent on the first* ***stage 4*** *CH_3OH* ✓ *reflux/distil with conc H_2SO_4* ✓	[4]
(ii)	*add an extra carbon / lengthen the carbon chain* ✓	[1]
(d) (i)	*nucleophilic addition* ✓	[1]
(ii)	*eg*  *curly arrow breaking C=O* ✓ *(dipole not essential)* *curly arrow from lone pair of $:CN^-$ to the correct carbon* *structure of the intermediate* ✓ *curly arrow $–O^-$ to H^+ / HCN / H_2O* ✓ *(second curly arrow not essential)*	[4]
		[Total: 14]

Qu. No.		Marks
4 (a) (i)		
	H_2O as product ✓ *balancing* ✓	[2]
(ii)	*reducing agent* ✓	[1]
(b)		
	(or as the ionic equation without Na^+ or Cl^-)	
	$C_6H_5NH_2$ ✓ *balanced* ✓	[2]
(c)	*moles $C_6H_5NO_2$ used = **0.0300** (mol)* ✓	
	*theoretical yield of $C_6H_5NH_2$ = **2.79(3)** (g)* ✓ *or ecf*	
	*actual 72.1% yield = **2.014** (g) / (calculator value 2.013753)* ✓ *or ecf*	
	*to three sig figs = **2.01** (g)* ✓ *or ecf*	[4]
(d)	***Primary amines as bases***	
	lone pair on N ✓	
	lone pair is donated to the H^+ / dative covalent bond ✓	
	***or** both marks can be shown by a suitable diagram – eg* 	
	Why phenylamine is weaker	
	*lone pair /electrons move away from the N in phenylamine towards the benzene ring **AW*** ✓	*(ignore references to ethylamine or to the inductive effect)*
	because the lone pair on the N is (partially) delocalised around the benzene ring	
	or diagram to show – eg  ✓	
	so is less available to donate / lower electron density on N ✓	[5]
		[Total: 14]

Qu. No.		Marks
5 (a)	$CH_3COOH + SOCl_2 \longrightarrow CH_3COCl + SO_2 + HCl$ / $CH_3COOH + PCl_5 \longrightarrow CH_3COCl + POCl_3 + HCl$ ***reactants*** ✓ ***products*** ✓	[2]
(b)	$CH_3COCl + H_2O \longrightarrow CH_3COOH + HCl$ ✓	[1]
(c)	***Any three of:*** • *absorption at 2500-3300(cm^{-1}) for O-H (in COOH)* • *absorption at 1000-1300 (cm^{-1}) for C-O* • *absorption at 1680-1750 / below 1750 (cm^{-1}) for C=O* • *no peak at ~600 (cm^{-1}) / no C-Cl peak* ***ANY 3** out of **4** marks* ✓✓✓	[3]
(d)	*ethanoic acid because:* M_r *= 60* ✓ *60 = m/e value / mass of the molecular ion / furthest right peak / correct peak indicated on the spectrum* ***or*** *any valid evidence based on the the absence of peaks due to Cl or valid fragmentation peaks that would distinguish them* ✓	[2]
		[Total: 8]

Qu. No.		Marks
6 (a) (i)	*bromine / sodium hydroxide (solution) / $FeCl_3$* ✓ ***NOT** indicators*	[1]
(ii)	*OH / phenol group in noradrenaline circled* ✓	[1]
(iii)	*decolourises /white ppt / dissolves (in water better) / violet* ✓	[1]
(b) (i)	 ✓  ✓	[2]
(ii)	*optical (isomerism)* ✓	[1]
(iii)	*(stereo)isomers are non-superimposable (mirror images) / the molecule is asymmetric / the carbon has four different groups attached* ✓  *for the 3-D bonds allow:*  *or* *but **NOT**:*  *one 3-D isomer with all groups correct* ✓ *second isomer is a mirror image of a resonable attempt at 3-D* ✓	[3]
(c)	***Any three of:*** • *only one stereoisomer has the right 3-D shape / shape similar to noradrenaline / is (pharmacologically) active **ora*** • *presence of other (inactive) stereoisomers: will increase the amount needed for the dose* • *may give harmful side effects* • *may increase cost of separation* ***ANY 3** out of **4** marks* ✓✓✓	[3]
		[Total: 12]

Qu. No.		Marks
7	***Discussion of the □-bonding*** *p-orbitals overlap* ✓ *above and below the ring* ✓ *(to form) π-bonds / orbitals* ✓ *(π-bonds / electrons) are <u>delocalised</u>* ✓ ***4** marks* ***Other valid points – any two of:*** • *ring is planar I* • *C-C bonds are equal length / have intermediate length/strength between C=C and C-C /* • *σ-bonds are between C-C and/or C-H* • *bond angles are 120°* ***MAX 2** out of **4** marks* ✓✓ ***Quality of written communication*** *two or more sentences with correct spelling, punctuation and grammar* *any of the first three marks are available from a labelled diagram* *eg* *π-bonds* 	**[6]** **[1]**
		[Total: 7]

Qu. No.		Marks
8 (a) (i)	$C_{12}H_{25}Cl/Br$ ✓	
	$AlCl_3$ / $FeBr_3$ etc ✓	[2]
(ii)	 ✓	[1]
(iii)	*H on benzene is replaced / swapped / substituted by $C_{12}H_{25}$ / another group* ✓	[1]
(b) (i) and (ii)		
	structure of intermediate ✓✓ *(deduct one mark for each error)*	
	curly arrows ✓✓✓	[5]
(c) (i)	*hydrolysis* ✓	
	(sorbitan monolaurate is an) ester ✓	
	broken down to form an alcohol and carboxylic acid/salt ✓ ***AW*** / *equation to show the reaction*	[3]
(ii)	*sorbitan monolaurate is made from a renewable resource / not based on crude oil* ✓ ***AW***	[1]
		[Total: 13]

Mark Scheme 2815/01
January 2007

Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ____ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument		
Question	**Expected answers**	**Marks**	**Additional guidance**
1 (a)	Increase in the number of electrons in the outer shell (in the atom of the element in Period 3) / increase in oxidation number of the element in Period 3 (1)	1	
(b)	Ions are not able to move / aw (1)	1	**Ignore** reference to electrons
(c) (i)	$Al_2O_3 + 6HCl \rightarrow 2AlCl_3 + 3H_2O$ / $Al_2O_3 + 6H^+ \rightarrow 2Al^{3+} + 3H_2O$ (1)	1	**Allow** Al^{3+} and Cl^- as products **Not** Al_2Cl_6 **Ignore** State symbols
(ii)	$Al_2O_3 + 3H_2O + 6NaOH \rightarrow 2Na_3Al(OH)_6$	1	
(d)	Lots of covalent bonds / many covalent bonds (1) have to be broken which needs a large amount of energy (1)	2	**Allow** network structure (1)
(e)	(Reacts with water) to form an acidic solution / $P_4O_{10} + 6H_2O \rightarrow 4H_3PO_4$ (1)	1	**Ignore** it is acidic
		Total = 7	

Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ____ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument		
Question	**Expected answers**	**Marks**	**Additional guidance**
2 (a)	Oxidation because oxidation state of Hg changes from 0 to +2 so oxidation (1) Reduction because oxidation number of O changes from -1 to -2 (1) Or Correct identification of all the oxidation numbers (1) Correct identification of oxidation and reduction (1)	2	**Allow** ecf for the identification of oxidation and reduction from wrong oxidation numbers
(b)	Does not have an incomplete set of d electrons / does not have a partially filled d orbital / does not have a partially filled d sub-shell / ora (1)	1	**Allow** use of 3d
(c) (i)	Correct 'dot and cross' diagram (1) H x O O x H	1	**Ignore** inner shell of oxygen atoms
(ii)	Idea that lone pair repulsion is greater than bond pair repulsion / 2 bonded pairs and two lone pairs (1) Bond angle of 104^{o} – 105^{o} (1)	2	**Allow** any bond angle between 95 to 106^{o} (1) **Allow** ecf from wrong 'dot and cross' diagram
		Total = 6	

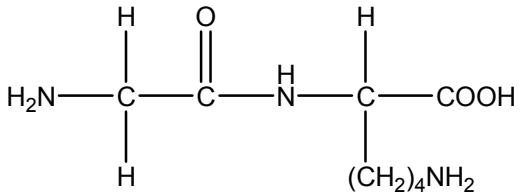
Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ____ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument		
Question	**Expected answers**	**Marks**	**Additional guidance**
3 (a)	Mole ratio Fe : C*l* = 2.99 : 9.01 (1); Empirical formula = $FeCl_3$ (1); Molecular formula = Fe_2Cl_6 (1) Alternatively Mole ratio of Fe to compound is 2.99 : 1.44 (1) So formula of compound is Fe_2Cl_x (1) Molecular formula = Fe_2Cl_6 (1)	3	
(b)	Simple molecular / simple covalent (1) Idea that if giant structure then it would have a high melting point / idea that simple structure because it melts easily / idea that covalent or molecular chlorides are hydrolysed to give an acidic solution (1)	2	**Not** ionic bonding
(c) (i)	$(1s^2 2s^2 2p^6) 3s^2 3p^6 3d^6$ (1)	1	
(ii)	Octahedral shape with some indication of three dimensions (1); Bond angle 90^o (1)	2	**Allow** use of wedges and dotted lines to indicate three dimensions **Allow** three dimensions if at least two bond angles of 90^o are shown that clearly demonstrate 3D **If two different bond angles** do not award bond angle mark
(iii)	Green / olive green / dark-green / green-blue ppt (1) $Fe^{2+}(aq) + 2OH^-(aq) \rightarrow Fe(OH)_2(s)$ (1)	2	**Allow** solid instead of precipitate Allow solid or precipitate to be awarded from the state symbol in $Fe(OH)_2(s)$

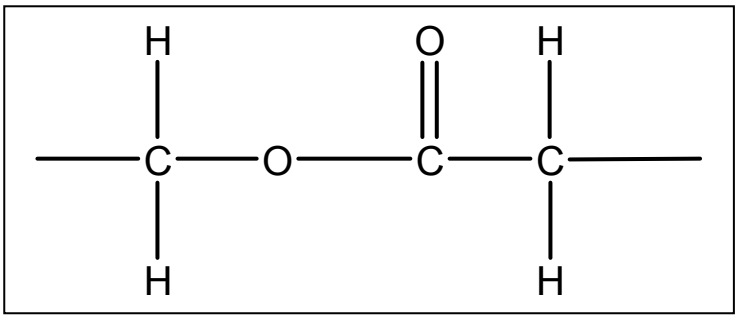
Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ____ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument		
Question	**Expected answers**	**Marks**	**Additional guidance**
3 (d) (i)	$Fe(H_2O)_6^{3+} + SCN^- \rightarrow [Fe(H_2O)_5(SCN)]^{2+} + H_2O$ (1)	1	
(ii)	**Any five from** Known amounts or volumes of $FeCl_3$ and KSCN (and water) are mixed together (1) Absorbance of solution is measured (1) Idea of a fair test (same overall volume and changing the volumes of the other reagents in a logical way) (1) Volumes or amounts of reagents that give maximum absorbance are determined (1) Molar ratio of reagents calculated / moles of substances must be calculated (1) The molar ratio should be one to one (1)	5	**Allow** marks from an appropriate graph
(e) (i)	$MnO_2 + 4H^+ + 2Fe^{2+} \rightarrow Mn^{2+} + 2H_2O + 2Fe^{3+}$ (1)	1	**Ignore** state symbols
(ii)	Moles of Fe^{2+} that reacted with MnO_2 = 0.02 – 0.0123 = 0.0077 (1) Mass of MnO_2 = 0.00385 x 86.9 = 0.335 (1) % purity = 66.4% (1) Alternatively Moles of MnO_2 in 0.504 = 0.00580 So moles of Fe^{2+} that should react with this is 0.0116 (1) Moles of Fe^{2+} that reacted with MnO_2 = 0.02 – 0.0123 = 0.0077 (1) % purity = 66.4% (1)	3	**Allow** ecf within question **Allow** 66.4 – 66.5
		Total = 20	

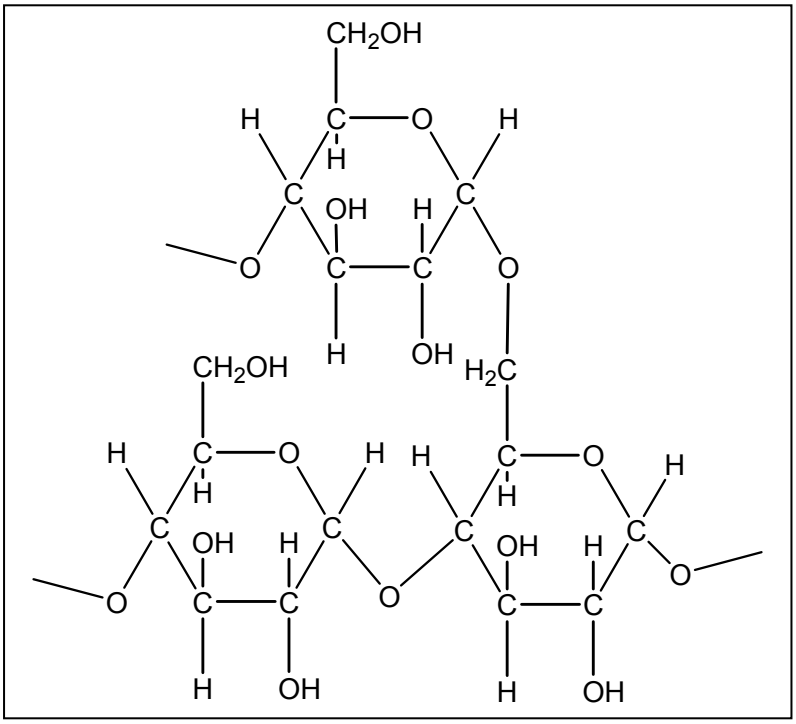
Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ____ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument		
Question	**Expected answers**	**Marks**	**Additional guidance**
4	**Definition – maximum 3 marks** $Mg^{2+}(g) + 2Cl^-(g) \rightarrow MgCl_2(s)$ (1) The enthalpy change that accompanies the formation of one mole of a solid (compound) (1); from its constituent gaseous ions (1) **Born-Haber cycle – maximum 5 marks** Correct formulae on cycle (1) Correct state symbols (1) Use of 2 moles of Cl(g) ie 246 (1) Use of 2 moles of $Cl^-(g)$ 1.e. 698 (1) -2526 kJ mol^{-1} (1) **Comparison – maximum 3 marks** **Any three from** Na^+ has a larger radius than Mg^{2+} / ora (1) Br^- has a larger radius than Cl^- / ora (1) Na^+ has a lower charge than Mg^{2+} / ora (1) Strongest attraction is between Mg^{2+} and Cl^- / $MgCl_2$ has the strongest attraction between its ions / ora (1) **Or** Na^+ has a lower charge density than Mg^{2+} / ora (1) Br^- has a lower charge density than Cl^- / ora (1) Strongest attraction between ions which have the highest charge density / $MgCl_2$ has the strongest attraction between its ions / ora (1) **And QWC** One mark for correct spelling, punctuation and grammar in at least two sentences (1)	12	**Allow** marks from an equation **Allow** energy released / energy change **Not** energy required **Allow** ionic compound / salt Every formula must have the correct state symbol at least once **Allow** -2403 / -2875 (2) **Allow** -2752 (1) Unit **required** Penalise the use of incorrect particle only once within the answer. Penalise it the first time an incorrect particle is mentioned

Mark Scheme 2815/02
January 2007

Abbreviations, annotations and conventions used in the Mark Scheme			/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ____ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument	
1	**(a)**	**(i)**	$HOH_2CCHOHCHOHCH_2CHO$ Accept displayed .✓	**1**
		(ii)	Any two points.✓✓ AW. • Both are condensation polymers of nucleotides/ contain monomers with base, sugar and phosphate. • Sugar-phosphate polymer/backbone or mention of phosphodiester links. • Base attached to sugar. • Both contain the bases ACG.	**2**
		(iii)	Base uracil/U in RNA but thymine/T in DNA✓ Double helix in DNA/single strand in RNA✓	
	(b)		DNA is a much longer molecule✓ AW Any two.	**2**
			Four points from the following.✓✓✓✓.AW. • Double helix unwinds with breaking of hydrogen bonds/ mention of enzyme helicase. • The base pairs are CG and AT. • Exposed bases become hydrogen bonded to complementary bases on free nucleotides/ mention of nucleotide triphosphates/ both strands act as templates for replication • Incoming nucleotides attached to growing chain by a (phosphate) ester link / the joining of each nucleotide is catalysed by DNA polymerase • Semi-conservation replication/ each of the two resulting double helices contains one original strand and one newly synthesised strand	**4**
	(c)	**(i)**	In the genetic code the triplets UCU and UUC code for different amino acids✓ - accept any similar argument that refers to actual bases on the m-RNA or t-RNA. This results in different t-RNA bringing different amino acids to same place on m-RNA/ use of term translation.✓AW	**2**
		(ii)	Possibility of hydrogen bonding✓ with serine's OH sidechain ✓ - give mark for van der Waals with phenylalanine if either of these two is missed. This can lead to (a different tertiary structure and) wrong shape for active site.✓	**3**
		(iii)	TAAAGACCA ✓ ignore numbering.	**1**
			Total	**15**

Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ____ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument	
Question	**Expected Answers**	**Marks**
3 (a)		
(b)	**✓ for CONH and ✓ for rest. Accept reverse order.**	**2**
	At low pH –COO^- becomes –COOH/ uncharged ✓ **At high pH -NH_3+ becomes -NH_2 /uncharged ✓** **If they suggest uncharged versions at pH 7, give one only of these marks. Allow use of amine and carboxyl groups which are not on sidechains.** **Ionic attractions disrupted by changes.✓** **(Independent mark)**	**3**
(c) (i)	**Inhibitor does not compete for active site/binds somewhere other than on the active site.✓**	**1**
(ii)	**Heavy metal ion replaces hydrogen on the cysteine or** **accept a formula –NHCH(CH_2SAg)CO ✓. Hg^{2+} similarly.**	**2**
(d) (i)	**This changes shape of enzyme/active site✓.**	
(ii)	**Four proteins/polypeptides✓, <u>each</u> with a haem group/Fe^{2+}✓, aggregate to form complete haemoglobin/ are held together by weak attractions (accept one example of these)✓. AW**	**3**
	The iron ion/atom combine <u>reversibly✓</u> with oxygen/O_2 ✓but not plain O. Accept reference to binding at high O_2 concentrations and vice versa for second mark. AW	**2**
	Total	**13**

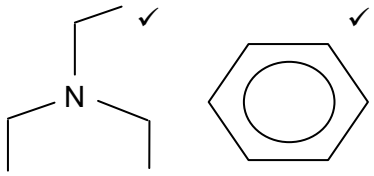
Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ____ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument	
Question	**Expected Answers**	**Marks**
2 (a) (i)	 **The spare bonds at each end are optional.✓**	**1**
(ii)	**Triglyceride has a fatty/carboxylic acid esterified/attached instead of the phosphate ✓. Accept triglyceride has three fatty acids attached, but not simply has no phosphate.**	**1**
(iii)	 **Hydrophilic/polar etc Hydrophobic/nonpolar etc** **Both labels for ✓.**	**1**
(b)	**Active site has (specific)shape to fit the/substrate phospholipid ✓ Accept answer based on R grops in active e site matching those on substrate.** **Catalytic site is in correct position to catalyse hydrolysis of the C_2 ester group only / when bound to active site only the C_2 ester is in correct position to be hydrolysed ✓. AW .**	**2**
(c)	**To remove/hydrolyse fat stains✓.**	**1**
(d) (i)	**Higher substrate concentration leads to increased number of collisions per unit time/ plenty of free active sites therefore rate = k[S] . ✓ AW**	**1**
(ii)	**All the active sites are in use✓; adding more substrate cannot increase rate/ rate depends on rate at which products leave the active site/ [E] is limiting factor/ reaction is zero order with respect to S✓.AW**	**2**
	Total	**9**

Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ____ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument	
Question	**Expected Answers**	**Marks**
4 (a)	 **A correct glycosidic link ✓** **Correct stereochemistry for each link ✓✓** **They need all but one of the C_1 and C_4 hydrogen atoms to score both stereochemistry marks but can score 1 mark if only two are missing.** **Skeletal structures accepted.**	**3**
(b)	• **linear/straight chain polymer** • **hydrogen bonded to neighbouring chain** • **hydrogen bonding between OH groups (any drawing here must be correct)** • **microfibrils make up fibres with great tensile strength** • **insoluble** **Any four of these points.**	**4**
	QWC At least two sentences in which meaning is clear, and in which there are fewer than two mistakes of spelling, punctuation and grammar.✓	**1**
	Total	**8**
	Paper Total	**45**

Mark Scheme 2815/04
January 2007

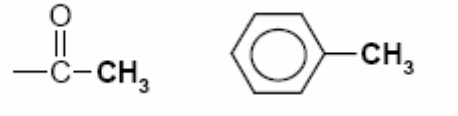
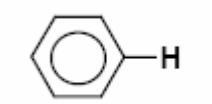
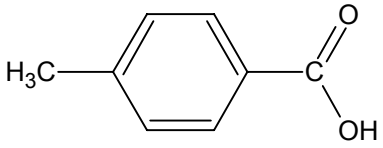
Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ____ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument	
Question	**Expected Answers**	**Marks**
1 (a)	R_f value is distance moved by a component/spot/solute divided by distance moved by solvent. ✓ Retention time is the time between injection and emergence (or detection) of a component. ✓	**2**
(b) (i)	Partition / adsorption ✓	**1**
(ii)	Role of gas: carrier gas / mobile phase / to carry to sample through the chromatography column ✓ Role of liquid: stationary phase ✓	**2**
(iii)	Trace with two peaks drawn ✓	**1**
(iv)	Measure **area** under each peak ✓ Find total area ✓ % = (area of one peak/total area) x 100% ✓	**3**
(c) (i)	^{37}Cl / ^{81}Br / Cl or Br isotopes that differ by mass of two (either ^{37}Cl or ^{81}Br) or contains isotopes with 2 extra neutrons ✓	**1**
(ii)	If similar height halogen is bromine / bromine isotopes have similar / same abundance ✓ If in ratio 3 : 1 then halogen is chlorine / chlorine isotopes are in abundance ratio 3 : 1 ✓	**2**
		Total: 12

Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ____ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument	
Question	**Expected Answers**	**Marks**
2 (a)		
(i)	Energy levels are quantised / energy levels are discrete / specific gap between energy levels in the H atom ✓	**1**
(ii)	Electrons fall / drop back ✓ *from* higher levels *to* <u>different</u> energy levels ✓	**2**
(iii)	Convergence limit signifies the fall of an electron from (n =) infinity to a particular energy level / wavelength at which the electron is at the edge of the atom / point at which the atom is ionised / point at which electron orbitals or lines merge or close together ✓	**1**
(iv)	Electron in ground state / n = 1 / lowest energy level / Lyman series can be used ✓	**1**
(v)	Multiply by 1000 and divide by L to give J per atom $1312 \times 1000 / 6.02 \times 10^{23} = 2.179 \times 10^{-18}$ J E = hf so f = E/h $f = 2.179 \times 10^{-18}$ J / 6.63×10^{-34} J s $= 3.287 \times 10^{15}$ s^{-1} $\lambda = c/f = 3.0 \times 10^{8}$ m s^{-1} / 3.287×10^{15} s^{-1} $= 9.126 \times 10^{-8}$ m 9.13×10^{-8} m answer to three sig figs (allow 9.12 for answer kept in calculator) Use of correct formulae as above or using $E = hc/\lambda$ ✓ Correct use of L ✓ Correct answer of 9.126×10^{-8} m (allow 9.12 or 9.13)✓ Answer to 3 sig figs ✓	**4**

Question	Expected Answers	Marks
(b) (i)	 ✓ ✓ NOTE: mark incorrect answers first	**2 (1 for each molecule circled)**
(ii)	Electronic / electron transitions / any mention of electrons being involved ✓	**1**
	From low to high energy levels / to excited states n to pi* / pi to pi* ✓	**1**
		Total: 13

Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ____ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument	
Question	**Expected Answers**	**Marks**
3 (a)	IR **Similarities** **Any 2 of the following three peaks (must give the quoted range)** peak corresponding to OH in all three(3230 – 3550 cm^{-1}) ✓ peak corresponding to NH in all three(3100 – 3500 cm^{-1}) ✓ peak corresponding to CO in all three (1000 – 1300 cm^{-1}) ✓ **Differences** only shown in the fingerprint region ✓ **Mass Spec** **similarities** M_r (75)/ base peak will be the same ✓ M + 1 peak same ✓ **Differences** Fragmentation pattern may show differences between isomers / specific example, eg CH_3^+ at m/e 15 ✓ **QWC** Use of any two terms from: functional group / amino group / hydroxy group / fingerprint / fragmentation / fragment ion(s) / base peak or molecular ion / M + 1 peak / m/e	**2 max** **1** **1** **1** **1** **(MAX 5)** **1**
(b)	Glycine $C_2H_5NO_2$ Molecular mass = (12.000 x 2) + (1.0078 x 5) + 14.0031 + (15.9949 x 2) = 75.0319 ✓ isomers of aminopropanol C_3H_9NO molecular mass = (12.000 x 3) + (1.0078 x 9) + 14.0031 + 15.9949 = 75.0682 ✓	**1** **1**
		Total: 8

Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ____ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument	
Question	**Expected Answers**	**Marks**
4 (a)	(M : M + 1 = 74.6 : 6.5) No. of carbon atoms = (6.5 x 100) / (74.6 x 1.1) ✓ = 7.92 therefore eight carbons / C_8 ✓	**2**

Question	Expected Answers	Marks
4 (b)	**Infrared spectrum** Presence of sharp peak at approx. 1700 cm-1 indicates C=O ✓ Peak(s) at approx. 1300 cm^{-1} consistent with C-O ✓ (broad) peak at 2500-3300 cm^{-1} shows O-H (<u>not alcohol</u>) present ✓ **NMR** Three sets of peaks means three chemical environments ✓ Total of 8 hydrogen atoms present (allow if indicated in formula of compound) ✓ Peaks at approx. 2.3 ppm could be any one of:  ✓ peaks at 7.3 and 7.9 ppm are:  /aromatic protons ✓ but peak area is 4 which means C_6H_4 ✓ peak at approx. 12.5 ppm is: -COOH ✓ **Mass spectrum** M_r = 136 ✓ Base peak at m/e = 91 produced by loss of –COOH (136 – 45) OR peak at m/e = 119 shows loss of –OH (136 – 17) ✓ Data suggests structure is:  ✓ (1,2- or 1,3- isomers equally acceptable) (allow ecf as $C_6H_5CH_2COOH$ if nmr deduction was for C_6H_5-CH_2- at 2.3 ppm)	**1** **1** **1** **1** **1** **1** **1** **1** **1** **1** **1** **Maximum 9** **1**
		Total: 12

Mark Scheme 2815/06
January 2007

Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ____ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument

Question	Expected Answers	Marks
1 (a) (i)	**+3**	**1**
(ii)	**Cis and trans forms drawn in 3-D (only award these marks if C has been chosen)**	**2**
(iii)	**Type of isomerism is cis-trans/geometric**	**1**
(b) (i)	**(concentrated) hydrochloric acid/sodium chloride/ Other suitable named ionic chloride but *not* just chloride or Cl^-**	**1**
(ii)	**Ligand substitution / ligand exchange**	**1**
		Total: 6

Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ____ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument	
Question	**Expected Answers**	**Marks**
2 (a)	**Emf/voltage/potential difference (of electrochemical cell) comprising a (Cu/Cu^{2+}) half cell combined with a standard hydrogen electrode**	**1**
	1 atm, 1 mol.dm^{-3}, 298K (all 3 needed but can transfer mark if stated in (b))	**1**
	Salt bridge and voltmeter	**1**
(b)	**Platinum electrode dipping into 1 mol dm^{-3} H^+**	**1**
	Hydrogen gas feed	**1**
	(Accept a suitable alternative standard electrode)	**1**
	(See additional sheet for diagram)	
(c) (i)	**Decolorised / add starch which is decolorised** **Allow blue/black→ white or brown → white** **Do not allow colourless**	**1**
(ii)	**moles $S_2O_3^{2-}$ = 23.20x0.100/1000 = 0.00232 moles**	
	$Cu^{2+} \equiv S_2O_3^{2-}$ / moles Cu^{2+} = 0.00232 moles	**1**
	But 25 cm^3 of original = 10x 0.00232 = 0.0232 moles	**1**
	Concentration of original = 1000 x 0.0232 / 25	**1**
		1
(iii)	**Because concentration of Cu^{2+} is less than 1 mol dm^{-3} / less than standard**	
	equilibrium moves to left (reducing +ve value of E)	**1**
		1
		Total: 13

Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ____ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument	
Question	**Expected Answers**	**Marks**
3 (a)	**d-orbitals split**	**1**
	3 lower, 2 higher (accept diagram) in octahedral complexes	**1**
	visible light/light/energy absorbed to promote an electron from lower to higher orbital	**1**
	different ligands cause a different energy gap	**1**
	colour/frequency/wavelength of light absorbed depends on size of energy gap ΔE	**1**
	colour transmitted is complementary to colour absorbed / light transmitted is colour we see	**1**
	Quality of written communication: **Award 1 mark for the correct use of at least 3 of the following terms:** **orbitals, visible (light), absorbed, transmitted, complementary, splitting, energy gap, d_{xy} etc,** **ΔE = hf, photon, frequency, wavelength**	**1**
(b)	**Yellow complex (accept ligand X)**	**1**
	Because max absorbance is in blue region (of visible light) / yellow is complementary colour to maximum absorbance (blue)	**1**
	Allow violet and blue light absorbed	
		Total: 9

Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ____ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument	
Question	**Expected Answers**	**Marks**
4 (a) (i)	**Stainless steel + corrosion resistance or alloys for tools + hardness or other named alloy/use/property** **Allow chrome plating with attractive or barrier to corrosion**	**1**
(ii)	**Chromium $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$ (allow….$4s^1 3d^5$)**	**1**
(b) (i)	**$Cr_2O_7^{2-} + 14H^+ + 6Fe^{2+} \rightarrow 2Cr^{3+} + 6Fe^{3+} + 7H_2O$**	**1**
	$Cr_2O_7^{2-}$ / Cr^{3+} has more positive electrode potential	**1**
	Therefore $Cr_2O_7^{2-}$ is the stronger oxidising agent which oxidises Fe^{2+} to Fe^{3+} (ora)	**1**
(ii)	**Emf = (+) 0.56 V**	**1**
(c) (i)	**Orange to yellow**	**1**
(ii)	**Hydroxide ions react with or remove H^+ ions**	**1**
	Position of equilibrium moves to the right (to produce more H^+ions and CrO_4^{2-} which is yellow)	**1**
		Total: 9

Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ____ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument	
Question	**Expected Answers**	**Marks**
5 (a)	**For colour, need at least 1 d-electron and a space in higher energy d-orbital for it to be promoted to.**	**1**
	Cu^+ has no space / has a full d-sub shell.	**1**
(b) (i)	**Pigment (accept dye) / colouring paints**	**1**
(ii)	**Dative covalent/co-ordinate**	**1**
(c)	**Red-brown solid is copper / Cu**	**1**
	Blue solution is $[Cu(H_2O)_6]^{2+}$ / $Cu^{2+}(aq)$ / $CuCl_2$	**1**
	$2CuCl \rightarrow Cu + CuCl_2$ / $2Cu^+ \rightarrow Cu + Cu^{2+}$	**1**
	Cu(I) compounds are unstable in solution / Disproportionate or explained.	**1**
		Total: 8

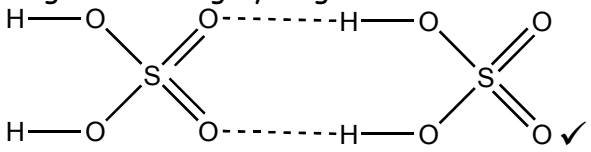
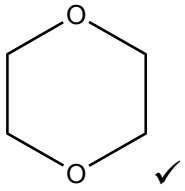
Mark Scheme 2816/01
January 2007

Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ____ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument	
Question	**Expected Answers**	**Marks**
1 (a) (i)	H_2: Exp 2 has 2.5 times $[H_2]$ as Exp 1 and rate increases by 2.5 ✓, so order = 1 with respect to H_2 ✓	**[2]**
	NO: Exp 3 has 3 x [NO] as Exp 2; and rate has increased by $9 = 3^2$ ✓, so order = 2 with respect to NO ✓	**[2]**
QWC	At least two complete sentences where the meaning is clear.	**[1]**
(ii)	rate = $k[NO]^2\,[H_2]$ ✓	**[1]**
(iii)	$k = \frac{\text{rate}}{[NO]^2\,[H_2]} / \frac{2.6}{0.10^2 \times 0.20}$ ✓ = 1300 ✓ units: $dm^6\ mol^{-2}\ s^{-1}$ ✓ allow 1 mark for 7.69×10^{-4} or 1.3×10^{x} (x not 3)	**[3]**
(b) (i)	$1½O_2(g) \longrightarrow O_3(g)$/ $O_2(g) + ½O_2(g) \longrightarrow O_3(g)$✓ NO is a catalyst ✓ as it is (used up in step 1 and) regenerated in step 2/ not used up in the overall reaction✓ allow 1 mark for 'O/NO_2 with explanation of regeneration.'	**[3]**
(ii)	Rate = $k[NO]\,[O_3]$ ✓ Species in rate equation match those reactants in the slow step / rate determining step ✓	**[2]**
		Total: 14

Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ____ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument		
Question		**Expected Answers**	**Marks**
2	**(a)**	$K_c = \frac{[PCl_3]\,[Cl_2]}{[PCl_5]}$ ✓	**[1]**
	(b) **(i)**	PCl_5 > 0.3 mol dm^{-3} ; PCl_3 and Cl_2 < 0.3 mol dm^{-3} ✓	**[1]**
	(ii)	At start, system is out of equilibrium with too much PCl_3 and Cl_2 and not enough PCL_5 / $\frac{0.3 \times 0.3}{0.3}$ = 0.3 is greater than K_c = 0.245 mol dm^{-3} ✓	**[1]**
	(c) **(i)**	K_c does not change as temperature is the same ✓	**[1]**
	(ii)	Fewer moles on left hand side ✓ system moves to the left to compensate for increase in pressure by producing less molecules ✓	**[2]**
	(d) **(i)**	K_c decreases (as more reactants than products)✓	**[1]**
	(ii)	Forward reaction is exothermic/ reverse reaction is endothermic ✓ equilibrium ⟶ left to oppose increase in energy/ because K_c decreases ✓	**[2]**
	(e) **(i)**	$4PCl_5 + 10MgO \longrightarrow P_4O_{10} + 10MgCl_2$ ✓	**[1]**
	(ii)	100g P_4O_{10} = $\frac{100}{284}$ / 0.35(2) mol ✓ moles PCl_5 needed = 4 x 0.352 = 1.408/1.4 mol ✓ mass PCl_5 = 1.4(08) x 208.5 = 293.568 / 294 g/ 291.9 g ✓ ✓ for use of 284 for P_4O_{10} and 208.5 for PCl_5 73.4/72.975/72.3 g scores 3 marks (no use of '4' factor) 18.35 g from dividing by 4 scores 3 marks	**[4]**
			Total: 14

Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ____ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument	
Question	**Expected Answers**	**Marks**
3 (a) (i)	Ionic product ✓	**[1]**
(ii)	$K_w = [H^+(aq)]\,[OH^-(aq)]$ ✓ *state symbols not needed*	**[1]**
(b)	moles of HCl = $\frac{5 \times 10^{-3} \times 21.35}{1000} = 1.067 \times 10^{-4}$ mol ✓ moles of $Ca(OH)_2 = \frac{1.067 \times 10^{-4}}{2} = 5.34 \times 10^{-5}$ mol ✓ concentration of $Ca(OH)_2 = 40 \times 5.34 \times 10^{-5}$ $= 2.136 \times 10^{-3}$ mol dm^{-3} ✓ 2 marks for 4.27×10^{-3}/ 8.54×10^{-3} mol dm^{-3} (no factor of 4)	**[3]**
(c)	$[OH^-] = 2 \times 2.7 \times 10^{-3} = 5.4 \times 10^{-3}$ mol dm^{-3} ✓ $[H^+(aq)] = \frac{K_w}{[OH^-(aq)]} = \frac{1.0 \times 10^{-14}}{5.4 \times 10^{-3}} = 1.85 \times 10^{-12}$ mol dm^{-3} ✓ pH = –log (1.85×10^{-12}) = 11.73/11.7 ✓ ecf is possible for pH mark providing that the $[H^+]$ value has been derived from $K_w/[OH^-]$ If pOH method is used, pOH = 2.27. would get 1st mark, pH = 14 – 2.27 = 11.73 gets 2nd mark. Commonest mistake will be to not double OH^{--} and to use 2.7×10^{-3} This gives ecf answer of 11.43/11.4, worth 2 marks. pH = 11.13 from dividing by 2: worth 2 marks	**[3]**
(d)	8 ✓	**[1]**
		Total: 9

Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ____ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument	
Question	**Expected Answers**	**Marks**
4 (a)	$Ca_3(PO_4)_2 + 2H_2SO_4 \longrightarrow Ca(H_2PO_4)_2 + 2CaSO_4$ ✓	**[1]**
(b)	$H_2PO_4^-(aq) \rightleftharpoons H^+(aq) + HPO_4^{2-}(aq)$ / $H_2PO_4^-(aq) \rightleftharpoons 2H^+(aq) + PO_4^{3-}(aq)$ ✓ (or equivalent with H_2O forming H_3O^+)	**[1]**
(c) (i)	HPO_4^{2-} ✓	**[1]**
(ii)	H_3PO_4 ✓	**[1]**
(iii)	$H_2PO_4^-$ produced $Ca(H_2PO_4)_2$ or on LHS of an attempted equilibrium equation ✓ 2 equations/equilibria to shown action of buffer ✓✓ from: $H_2PO_4^- + H^+ \rightleftharpoons H_3PO_4$ / $H_2PO_4^- \rightleftharpoons H^+ + HPO_4^{2-}$/ $H_2PO_4^- + OH^- \rightleftharpoons H_2O + HPO_4^{2-}$ / $H^+ + OH^- \rightleftharpoons H_2O$	**[3]**
		Total: 7

Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ____ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument	
Question	**Expected Answers**	**Marks**
5 (a)	Sulphuric acid molecules form hydrogen bonds ✓ Diagram showing hydrogen bonds between molecules:  or H bond from H–O to O–H (as in water) . hydrogen bonds break (on boiling) ✓	**[3]**
(b)	Correct equation for a metal ✓ Correct equation for a carbonate ✓ Correct equation for a base ✓	**[3]**
(c) (i)	$SO_4^{2-} \longrightarrow H_2S$: S from +6 to –2 ✓ $I^- \longrightarrow I_2$: I from –1 to 0 ✓	**[2]**
(ii)	$10H^+ + SO_4^{2-} + 8I^- \longrightarrow 4I_2 + H_2S + 4H_2O$ ✓	**[1]**
(d)	***A***: *CO* ✓ $HCOOH/H_2CO_2 \longrightarrow CO + H_2O$ ✓ **B**: *C* ✓ $C_{12}H_{22}O_{11} \longrightarrow 12C + 11H_2O$ ✓ ***C***: $C_4H_8O_2$ ✓ $2C_2H_6O_2 \longrightarrow C_4H_8O_2 + 2H_2O$ ✓ Structure:  ✓ accept any sensible structure of $C_4H_8O_2$	**[2]** **[2]** **[3]**
		Total: 16

Mark Scheme 2816/03
January 2007

PLAN (A)

A Test for iron(III) ions (3 marks)

A1 Add [hot] acid to dissolve the iron(III) oxide [1]

A2 Add thiocyanate ions to produce a red colouration [1]
Use of Hexacyanoferrate(II) ions, going blue, is an acceptable alternative

A3 Chemical equation correct: $[Fe(H_2O)_6]^{3+} + SCN^- \rightarrow [Fe(SCN)(H_2O)_5]^{2+} + H_2O$ [1]
Allow equation for Fe^{3+} without water ligands

B Mass of zinc carbonate (7 marks)

B1 Shake/stir the calamine mixture ***and*** measure out a known volume/mass of it [1]

B2 Add excess of specified acid
and statement/implication that $ZnCO_3$ gives off a gas but $Zn(OH)_2$ does not [1]
*B2 is **not** awarded if candidate heats the reacting mixture*

B3 Neat diagram of apparatus showing suitable method of gas measurement [1]
Collection in gas syringe, inverted burette or measuring cylinder is acceptable
Measurement of mass loss method requires [cotton] wool plug to be shown
*Gas absorption requires use of soda lime **or** a concentrated aqueous alkali*

B4 Measure volume of gas produced when fizzing stops/ volume stops increasing [1]
Mass loss method requires weighing to constant mass to be described
Gas absorption method also requires weighing to constant mass

B5 **One** accuracy precaution [1]
- Use of "inner tube" or similar ***and*** reason/ how it is used
- Repeat, until consistent readings are obtained ***or*** take mean
- Use of acid/water pre-saturated with CO_2 to reduce solubility of the gas

B6 Equation for reaction: $ZnCO_3 + 2HCl \rightarrow ZnCl_2 + CO_2 + H_2O$
and links mass of $ZnCO_3$ used to capacity of gas collector by calculation [1]
Absorption method must calculate minimum mass of active absorbent needed

B7 Calculation of the [minimum] volume/concentration of acid required [1]

C % by mass of zinc carbonate (5 marks)

C1 Filters a known mass/volume of calamine to collect the [suspended] solid. [1]

C2 Uses Buchner/ reduced pressure filtration
or filters with high quality filter paper ***or*** filters more than once
or is aware of the problem that some solid may go through filter paper [1]

C3 Uses a pre-weighed filter paper ***and*** washes the solid collected [with water] [1]

C4 Dries the solid to constant mass in an oven [at low temperature] ***or*** desiccator [1]

C5 Uses the mass of zinc carbonate from "**B**" and mass of residue obtained to deduce %. [1]
Specimen calculation with figures for B is needed for mark C5

S Safety and sources (4 marks)

S1 Hazard researched for the acid used in the procedure, plus safety measure [1]
No mark if hazard is overstated of

S2 References to two secondary sources quoted as footnotes ***or*** at end. [1]
Books must have page numbers
Internet reference must go beyond the first slash of web address
Accept one specific reference to Hazcards without any qualification

S3 QWC: text is legible and spelling, punctuation and grammar are accurate [1]
Allow mark for not more than five errors in spelling, punctuation or grammar.

S4 QWC: information is organised clearly and coherently [1]
- *Is a word count given and within the limits 450 – 1050 words?*
  Accept a total word count or any word numbering in the margin
- *Is scientific language used correctly – allow one error without penalty.*
- *Are the descriptions of both parts of the method presented logically?*

TEST (B)

Page 3 (Part 1) Measurements (6 marks)

Black solid/residue formed ***or*** green/turquoise → black colour change [1]

Four weighings clearly listed, recorded to 2 (or 3) d.p., ***and*** unit given somewhere [1]

Fourth weighing is within 0.02 g of the third *(ie constant mass)* [1]
If the mass increases, it must be within 0.01g

Mass of residue ***and*** mass of malachite both shown (***and*** correctly subtracted) [1]

Accuracy [2]
Calculate the supervisor's % $^{\text{mass of residue}}/_{\text{mass of malachite}}$ *(to one decimal place)*
Calculate candidate's % $^{\text{mass of residue}}/_{\text{mass of malachite}}$
If % mass of residue is within 1.5% of supervisor's % value → 2 marks
If % mass of residue is within 3.0% of supervisor's % value → 1 mark

Page 4 (Part 2) Calculation of M_r of malachite (5 marks)

(a) "2" shown in front of CuO **[1]**

(b) M_r of CuO = 79.5 **[1]**

Moles of CuO = $^{\text{mass of residue}}/_{79.5}$ correctly calculated **[1]**

(c) ***n***(malachite) = 0.5 x ***n***(CuO) **[1]**
This [first] mark cannot be awarded ecf to a 1:1 ratio in the equation above.

M_r of malachite correctly calculated [= $^{\text{mass}}/_{\text{number of moles}}$] **[1]**

Page 6 (Part 3) Observations (2 marks)

Fizzing/ effervescence/ bubbles produced
and malachite dissolves ***or*** blue solution produced **[1]**

Yellow/mustard/brown precipitate/solid forms **[1]**
State word is required

Page 7 (Part 3) Titration readings (10 marks)

Mass readings **[1]**

Check the following <u>four</u> points. Award <u>one</u> mark if all criteria are met

- Both mass readings must be listed with **units** shown (somewhere)
- All masses should be recorded to two (or three) decimal places
- Subtraction to give mass of **Y** must be correct.
- Labelling of the masses must have minimum of the words "bottle"/"container"

Presentation of titration data **[2]**

All 5 correct → 2 marks: 4 correct → 1 mark

- Correctly labelled table (initial and final - *aw*) used to record burette data
- Trial titre is shown *and* clearly labelled *(eg by "T" or "R" but <u>not</u> by "1")*
- All "accurate" burette data are quoted to 0.05 cm^3 (ie 2 decimal places)
- All subtractions are correct *(these must be checked)*
- Units, cm^3 or ml, must be given somewhere (once in or alongside the table is sufficient)

Self-consistency of titres [1]

Candidate's two accurate titres should agree within 0.15 cm^3.

Mean titre correctly calculated, with "cm^3 or ml" unit given [1]
*Mean should be correctly calculated and quoted to **two** d.p.*
*Do **not** penalise absence of units again, if already done in the previous section.*

<u>Accuracy</u> *– 5 marks are available* [5]

$$T = \text{candidate's adjusted mean titre} \times {}^{\text{supervisor's mass}}/_{\text{candidate's mass}}$$

T is within 0.30 cm^3 of mean supervisor's value	→	[5 marks]
T is within 0.50 cm^3 of mean supervisor's value	→	[4]
T is within 0.70 cm^3 of mean supervisor's value	→	[3]
T is within 0.90 cm^3 of mean supervisor's value	→	[2]
T is within 1.20 cm^3 of mean supervisor's value	→	[1 mark]

Spread penalty:

Spread is defined as the difference between the titres used by candidate to compute the mean *or* the difference between the two closest accurate titres (whichever is the greater).

- *if accurate readings differ by more than 0.50 cm^3, subtract 1 mark*
- *if accurate readings differ by more than 0.70 cm^3, subtract 2 marks*
- *if accurate readings differ by more than 0.90 cm^3, subtract 3 marks*
- *if accurate readings differ by more than 1.20 cm^3, subtract 4 marks*
- *if accurate readings differ by more than 1.50 cm^3, subtract 5 marks*

There are no negative marks for accuracy: the minimum is 0 (out of the 5 marks available).

Pages 8 + 9 (Part 4) **Calculation from titration** **(7 marks)**

(a) n(thiosulphate) = $^{20}/_{248}$ **x** $^{\text{mean titre}}/_{1000}$ **[1]**

This mark is a "method" mark for knowing how to calculate n as above

(b) ***n***(iodine) correctly calculated **[1]**

Expected answer = 0.5 x (a) = approx 0.0009 mol

(c) ***n***($CuSO_4$) = "b" x 2 x 10 **[1]**

This is a "method" mark for using mole ratio and scaling up

(d) M_r of malachite = $^{\text{mass of x used}}/_{\text{number of moles}}$ = $^{2m}/_{(c)}$ **[1]**

This method *mark is awarded to candidates for quoting correct figures*

M_r of malachite correctly calculated from answer (c) **[1]**

Expect answer of approximately 230

Give 1 mark ecf for an Mr resulting from an incorrect use of the 1:2 mole ratio

(e) Mass of $CuCO_3.Cu(OH)_2$ = 221 **[1]**

or correct calculation of mass of water (= M_r – 221)

n = $^{(250\ -\ 221)}/_{18}$ = 1.6(1) *(if data supplied was used)* **[1]**

Most candidates will use their own Mr to calculate n.

Pages 10 - 12 (Part 5) **Evaluation** **(14 marks)**

Award maximum 14 marks: 17 marking points are available.

(a) **5 marks**

(i) Cooling with a lid reduces/prevents absorption of water [vapour] **[1]**

(ii) The aim is to achieve "constant mass" **[1]**

This ensures that decomposition was complete ***or*** reaction has finished **[1]**

Allow reference to all of the water [of crystallisation] being driven off

(iii) Repeat the <u>whole</u> procedure **[1]**

Results should be consistent/very similar/the same to show reliability **[1]**

(b) **6 marks maximum** available *(but only 5 on Question Paper):*

*Mark the best **three** strands (each 2 marks)*
Marking points can be awarded in (a)(iii)

- In **Part 1**, the procedure is simpler ***or*** there are fewer measurements needed **[1]**

  So **Part 1** has less cumulative error *(ora)* **[1]**

- In the titration the end-point [colour change] is inaccurate/imprecise **[1]**

  The colours grey and off-white are similar
  or the grey colour disappears gradually, not suddenly **[1]**

- In **Part 1** the [percentage] error is high because some masses are small **[1]**

  Use larger quantity of malachite ***or*** a balance reading to 3 d.p. **[1]**

- Titration is repeated (but the mass loss experiment was not) **[1]**

  Consistent ***or*** accurate titres were obtained with 0.1 cm^3 **[1]**

- % error for use of burette/pipette is lower than that for the balance
  or titration equipment is accurately calibrated **[1]**

  Reasonable attempt at a % accuracy calculation to justify this statement **[1]**

(c) **6 marks available** *(but only 4 on Question paper)*

Balanced equation: $CuCO_3 + H_2SO_4 \rightarrow CuSO_4 + CO_2 + H_2O$ **[1]**

No of moles of sulphuric acid used = $^{1 \times 10}/_{1000} = 0.01$
or volume of acid = $^{0.01 \times 1000}/_{1} = 10\ cm^3$ **[1]**

$Cu(OH)_2 + H_2SO_4 \rightarrow CuSO_4 + 2H_2O$ **[1]**

Combined equation: $CuCO_3.Cu(OH)_2.nH_2O + 2H_2SO_4 \rightarrow 2CuSO_4 + CO_2 + (n+3)H_2O$
Scores both equation marks. Allow 1 mark if "H_2O" is balanced wrongly

10 cm^3 of H_2SO_4 are needed to react with [0.01 mol of] $Cu(OH)_2$ in malachite
or 20 cm^3 of 1.0 mol dm^{-3} H_2SO_4 are required to react fully with malachite **[1]**

H_2SO_4 (0.03 mol) is an excess quantity **[1]**

Excess acid ensures that all of the malachite reacts/dissolves **[1]**

Advanced GCE Chemistry (3882/7882)
January 2007 Assessment Series

Unit Threshold Marks

Unit		Maximum Mark	a	b	c	d	e	u
2811	Raw	60	47	41	35	29	23	0
	UMS	90	72	63	54	45	36	0
2812	Raw	60	47	41	35	30	25	0
	UMS	90	72	63	54	45	36	0
2813A	Raw	120	94	85	76	67	59	0
	UMS	120	96	84	72	60	48	0
2813B	Raw	120	94	85	76	67	59	0
	UMS	120	96	84	72	60	48	0
2813C	Raw	120	89	80	71	63	55	0
	UMS	120	96	84	72	60	48	0
2814	Raw	90	73	66	59	52	46	0
	UMS	90	72	63	54	45	36	0
2815A	Raw	90	66	59	52	45	39	0
	UMS	90	72	63	54	45	36	0
2815C	Raw	90	68	60	52	45	38	0
	UMS	90	72	63	54	45	36	0
2815E	Raw	90	67	59	52	45	38	0
	UMS	90	72	63	54	45	36	0
2816A	Raw	120	96	86	76	66	56	0
	UMS	120	96	84	72	60	48	0
2816B	Raw	120	96	86	76	66	56	0
	UMS	120	96	84	72	60	48	0
2816C	Raw	120	90	79	68	57	46	0
	UMS	120	96	84	72	60	48	0

Specification Aggregation Results

Overall threshold marks in UMS (*i.e.* after conversion of raw marks to uniform marks)

	Maximum Mark	A	B	C	D	E	U
3882	300	240	210	180	150	120	0
7882	600	480	420	360	300	240	0

The cumulative percentage of candidates awarded each grade was as follows:

	A	B	C	D	E	U	Total Number of Candidates
3882	14.6	35.2	53.6	77.1	92.7	100.0	401
7882	16.5	59.1	78.3	93.0	98.3	100.0	136

437 Candidates aggregated this series.

For a description of how UMS marks are calculated see:
http://www.ocr.org.uk/exam_system/understand_ums.html

Statistics are correct at the time of publication.

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

OCR Customer Contact Centre

(General Qualifications)
Telephone: 01223 553998
Facsimile: 01223 552627
Email: helpdesk@ocr.org.uk

www.ocr.org.uk

For staff training purposes and as part of our quality assurance programme your call may be recorded or monitored

Oxford Cambridge and RSA Examinations
is a Company Limited by Guarantee
Registered in England
Registered Office; 1 Hills Road, Cambridge, CB1 2EU
Registered Company Number: 3484466
OCR is an exempt Charity

OCR (Oxford Cambridge and RSA Examinations)
Head office
Telephone: 01223 552552
Facsimile: 01223 552553