

**Chemistry**

Advanced GCE A2 7882

Advanced Subsidiary GCE AS 3882

**Mark Schemes for the Units**

---

**January 2007**

**3882/7882/MS/R/07J**

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.

© OCR 2007

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](mailto:publications@ocr.org.uk)

## CONTENTS

### Advanced GCE Chemistry (7882)

### Advanced Subsidiary GCE Chemistry (3882)

#### MARK SCHEME ON THE UNITS

<b>Unit</b>	<b>Content</b>	<b>Page</b>
2811	Foundation Chemistry	1
2812	Chains and Rings	7
2813/01	How Far? How Fast? / Experimental Skills 1 Written Paper	13
2813/03	How Far? How Fast? / Experimental Skills 1 Practical Examination	19
2814	Chain, Rings and Spectroscopy	27
2815/01	Trend and Patterns	37
2815/02	Biochemistry	43
2815/04	Methods of Analysis and Detection	49
2815/06	Transition Elements	57
2816/01	Unifying Concepts in Chemistry/Experimental Skills 2 Written Paper	63
2816/03	Unifying Concepts in Chemistry/Experimental Skills 2 Practical Examination	69
*	Grade Thresholds	75



**Mark Scheme 2811**  
**January 2007**

<b>Abbreviations, annotations and conventions used in the Mark Scheme</b>	/ = 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 <u>      </u> = (underlining) key words which <b>must</b> be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument																			
<b>Question</b>	<b>Expected Answers</b>	<b>Marks</b>																		
1 (a) (i)	(atoms of) <b>same element/same atomic number</b> ..... with different numbers of neutrons/different masses ✓	[1]																		
(b) (i)	<table border="1" data-bbox="480 613 1273 927"> <thead> <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> </thead> <tbody> <tr> <td><sup>85</sup>Rb</td> <td>71 to 73</td> <td>37</td> <td>48</td> <td>37</td> </tr> <tr> <td><sup>87</sup>Rb</td> <td>27 to 29</td> <td>37</td> <td>50</td> <td>37</td> </tr> </tbody> </table> <p style="text-align: center;">must add mark up to 100 ✓</p>	isotope	percentage composition	number of			protons	neutrons	electrons	<sup>85</sup> Rb	71 to 73	37	48	37	<sup>87</sup> Rb	27 to 29	37	50	37	✓ ✓ [3]
isotope	percentage composition			number of																
		protons	neutrons	electrons																
<sup>85</sup> Rb	71 to 73	37	48	37																
<sup>87</sup> Rb	27 to 29	37	50	37																
(ii)	ie 1 mark for each atomic structure; 1 for % compositions. $A_r = \frac{(85 \times 72) + (87 \times 28)}{100} / 85.56 \checkmark$ $= 85.6 \checkmark$ 2nd mark for significant figures 71/29: 85.58 = 85.6 73/27: 85.54 = 85.5	[2]																		
(c)	carbon-12/ <sup>12</sup> 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 <b>more</b> shielding ✓ ( <i>'more' is essential</i> )  (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)	<b>Simplest (whole number) ratio</b> 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 <sub>4</sub> I <sub>5</sub> ✓	[2]																		
		<b>Total: 13</b>																		

<b>Abbreviations, annotations and conventions used in the Mark Scheme</b>	/ = 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 <b>must</b> be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument	
<b>Question</b>	<b>Expected Answers</b>	<b>Marks</b>
2 (a) (i)	8-14 ✓	[1]
(ii)	$\text{Ca(OH)}_2(\text{aq}) + \text{CO}_2(\text{g}) \longrightarrow \text{CaCO}_3(\text{s}) + \text{H}_2\text{O}(\text{l})$ <i>1st mark for species in equation ✓</i> <i>2nd mark for rest with st symbols ✓</i> Allow H <sub>2</sub> O as either 'l' or 'aq'	[2]
(iii)	precipitate disappears/goes clear/goes colourless ✓  $\text{Ca(HCO}_3)_2$ $\text{CaH}_2\text{C}_2\text{O}_6$ ✓	[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 <sup>2+</sup> with either 8 electrons or no electrons. ✓ 'dot-and-cross' of 2OH <sup>-</sup> correct ✓ N.B. H electron and Ca electrons can look the same.	[2]
(c) (i)	Heat CaCO <sub>3</sub> ✓ $\text{CaCO}_3 \longrightarrow \text{CaO} + \text{CO}_2$ ✓ Add water to CaO (or + H <sub>2</sub> O in equation) ✓ $\text{CaO} + \text{H}_2\text{O} \longrightarrow \text{Ca(OH)}_2$ ✓	[4]
(d)	neutralising (acid) soils/neutralising sewage/ softening water in water treatment/ neutralising acid water ✓	[1]
		<b>Total: 15</b>

Question	Expected Answers	Marks
<b>Abbreviations, annotations and conventions used in the Mark Scheme</b> / = 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 <b>must</b> be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument		
<b>3</b>		
(a) (i)	attraction between oppositely charged ions ✓	[1]
(ii)	shared pair of electrons ✓✓ <i>'shared electrons' scores 1 mark only</i>	[2]
(b) (i)	attraction of an <b>atom/element</b> for electrons ✓ in a (covalent) bond/bonded pair ✓	[2]
(ii)	one element attracts bonded pair more /is more electronegative than other ✓ → $\delta^-$ on more electronegative atom and $\delta^+$ on less electronegative element in example ✓ <i>May need to look for these marks in (c) if not given here.</i>	[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]
		<b>Total: 9</b>



<b>Abbreviations, annotations and conventions used in the Mark Scheme</b>	/ = 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 <b>must</b> be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument																	
<b>Question</b>	<b>Expected Answers</b>	<b>Marks</b>																
4 (a)	<table border="1" data-bbox="496 566 1203 775"> <thead> <tr> <th>element</th> <th>structure</th> <th>bonding</th> <th></th> </tr> </thead> <tbody> <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> </tbody> </table> <p>1 mark for each correct row</p>	element	structure	bonding		Mg	giant	metallic	✓	Si	giant	covalent	✓	S	simple	covalent	✓	[3]
element	structure	bonding																
Mg	giant	metallic	✓															
Si	giant	covalent	✓															
S	simple	covalent	✓															
(b)	<p>Si has strong forces between atoms/ covalent bonds are broken ✓</p> <p>P has weak forces between molecules/ intermolecular forces/van der Waals' forces are broken ✓</p>	[2]																
(c)	<p>From Na → Al, no of <b>delocalised</b> electrons increases ✓</p> <p>charge on positive ion increases/ ionic size decreases/ charge density increases ✓</p> <p>attraction between + ions and electrons increases/ metallic bonding gets stronger ✓</p>	[2 max]																
		<b>Total: 7</b>																

<b>Abbreviations, annotations and conventions used in the Mark Scheme</b>	/ = 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 <u>      </u> = (underlining) key words which <b>must</b> be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument	
<b>Question</b>	<b>Expected Answers</b>	<b>Marks</b>
5 (a) (i)	12 x 50/1000 = 0.600 mol ✓	[1]
	(ii)	
	4 mol HCl → 1 mol Cl <sub>2</sub> / moles Cl <sub>2</sub> = 0.15 mol ✓ vol of Cl <sub>2</sub> = 0.15 x 24 = 3.60 dm <sup>3</sup> ✓ <i>2nd mark is consequential on molar ratio given</i>	[2]
	(b)	
	Evidence that the oxidation number of Mn has reduced <b>and</b> one of the oxidation numbers correct (ie MnO <sub>2</sub> : ox no of Mn = +4 or MnCl <sub>2</sub> : ox no of Mn = +2 ✓ The <b>other</b> oxidation number of Mn is correct, ie in MnO <sub>2</sub> : ox no of Mn = +4 <b>or</b> in MnCl <sub>2</sub> : ox no of Mn = +2 ✓	[2]
	(c) (i)	
	2Na(s) + Cl <sub>2</sub> (g) → 2NaCl(s) ✓✓ 1st mark for equation 2nd mark for state symbols	[2]
	(ii)	
	Giant ionic (lattice) or 3D ✓ with alternating Na <sup>+</sup> and Cl <sup>-</sup> ✓	[2]
	With Br <sup>-</sup> , goes yellow/orange/red ✓ <i>'precipitate' makes this incorrect.</i>  With I <sup>-</sup> , goes purple/brown/brown ✓ <i>'precipitate' should be ignored</i>  Cl <sub>2</sub> + 2Br <sup>-</sup> → Br <sub>2</sub> + 2Cl <sup>-</sup> ✓ Cl <sub>2</sub> + 2I <sup>-</sup> → I <sub>2</sub> + 2Cl <sup>-</sup> ✓ 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 ✓ <i>ignore any reference to 'electronegativity'.</i>	[6]
	QoWC: At least 2 sentences in which the meaning is clear. ✓	[1]
		<b>Total: 16</b>

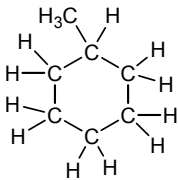
**Mark Scheme 2812**  
**January 2007**

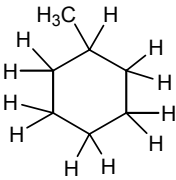
2812

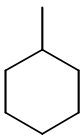
Mark Scheme

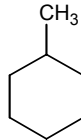
January 2007

## 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]

2812

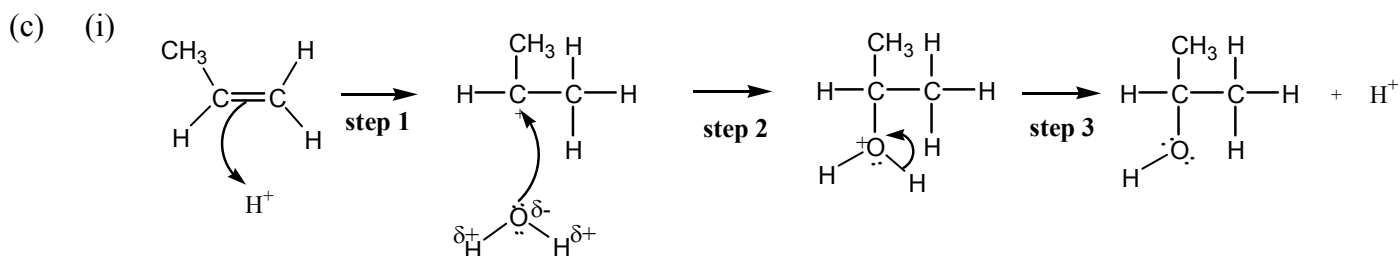
Mark Scheme

January 2007

## Q2

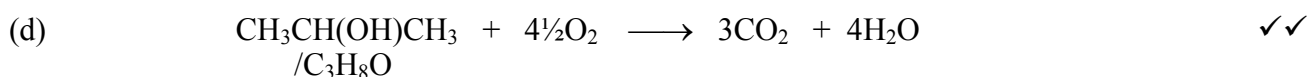
- (a) (i)  $C_6H_{12}O_6(aq) \longrightarrow 2C_2H_5OH(l) \text{ or } (aq) + 2CO_2(g)$  balanced equation ✓  
 state symbols can be awarded only if equation shows  $C_6H_{12}O_6$ ,  $C_2H_5OH$  and  $CO_2$  ✓
- (ii) anaerobic, aqueous, temp range 25 – 40 °C/warm to just above room temp ✓✓
- (iii) no more bubbles/gas/ $CO_2$  ✓

- (b) (i) phosphoric acid/ $H^+$ /sulphuric acid ✓
- (ii) lone/electron pair of electrons acceptor ✓



- Step 1 curly arrow from  $\pi$ -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 ✓



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

- (e) ethanoic acid/  $CH_3COOH/CH_3COCl$  ✓

[Total: 14]

2812

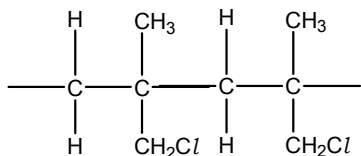
Mark Scheme

January 2007

Q3

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

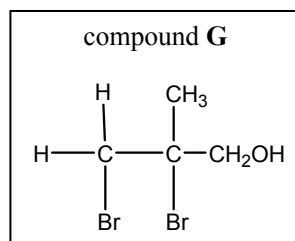
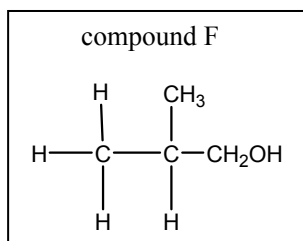
(b)



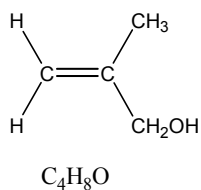
Backbone of 4 carbons  
and a reasonable attempt  
gets 1 mark.

✓✓

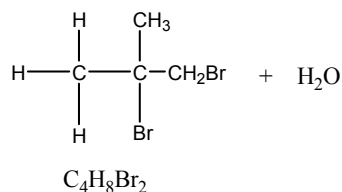
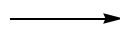
(c) (i)



(ii)



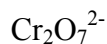
+ 2 HBr



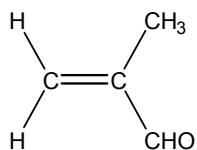
✓✓

1 mark for HBr

(iii)

 $\text{H}^+$  and reflux ✓

(iv)



/ methylprop-2-enal ✓

(d) **infra-red**(alcohol) **E** would show absorption  $3230 - 3550 \text{ cm}^{-1}$  ✓(carboxylic acid) **I** would show **either** an absorption  $1680 - 1750 \text{ cm}^{-1}$  **or**  $2500 - 3300 \text{ cm}^{-1}$  ✓**I** contains  $\text{C}=\text{O}$  at approx  $1700 \text{ cm}^{-1}$  but **E** doesn't get both marks ✓✓

[Total: 12]

2812

Mark Scheme

January 2007

## Q4

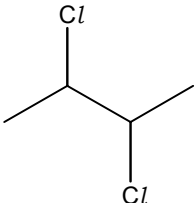
(a) (i) uv/sunlight/high temperature (range 400 – 700 °C) ✓

(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) ✓

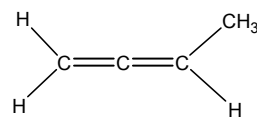
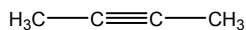
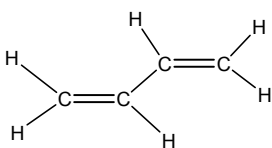
(b) (i) 2,3-dichlorobutane ✓

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

(c) (i) ethanol ✓

(ii) elimination ✓

(iii) any one from:



✓

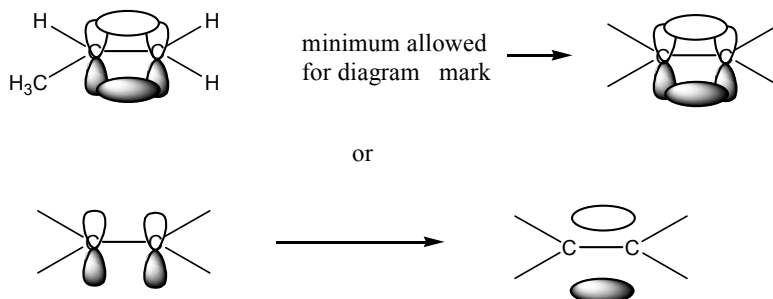
[Total: 12]

2812

Mark Scheme

January 2007

Q5

**Bonding:**  $\pi$ -bond formed by overlap of (adjacent) p-orbitals/ $\pi$ -bond labelled on diagram ✓diagram to show formation of the  $\pi$ -bond ✓

2

**Shape/bond angles:**tetrahedral around the  $\text{CH}_3$  ✓bond angle =  $109^\circ 28'$  ( $109$ - $110^\circ$ ) ✓trigonal planar around each C in the  $\text{C}=\text{C}$  ✓bond angle =  $120^\circ$  ( $118$ - $122^\circ$ ) ✓

4

**Cis-trans***cis* & *trans* correctly labelled eg but-2-ene ✓

require a double bond because it restricts rotation ✓

each C in the  $\text{C}=\text{C}$  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 <u>      </u> = (underlining) key words which <b>must</b> be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument	
Question	Expected Answers	Marks
<b>1</b> (a) (i)	$\text{MgCO}_3(\text{s}) + 2\text{HCl}(\text{aq}) \rightarrow \text{MgCl}_2(\text{aq}) + \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$ balancing ✓ state symbols ✓	2
(ii)	$\text{MgCO}_3 + 2\text{H}^+ \rightarrow \text{Mg}^{2+} + \text{CO}_2 + \text{H}_2\text{O}/$ $\text{CO}_3^{2-} + 2\text{H}^+ \rightarrow \text{CO}_2 + \text{H}_2\text{O} \checkmark$	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 <b>because</b> weak acid is partially ionised/ dissociated ✓ lower <b>concentration</b> of $\text{H}^+$ in weak/ higher <b>concentration</b> of $\text{H}^+$ 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 <u>      </u> = (underlining) key words which <b>must</b> 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 $mc\Delta T$ ✓ $200 \times 4.18 \times 50.3$ correct answer ✓ 42.1/ 42.0/42 (2 or more sig figs) final answer must be in kJ for 2 <sup>nd</sup> mark	2
(ii)	moles = $\frac{1.00}{44}$ = 0.0227/ 0.023 ✓	1
(iii)	$\frac{42.1}{0.0227}$ = 1850 (kJ mol <sup>-1</sup> ) ✓ sign ie – ✓	2
(d)(i)	cycle ✓ multipliers $x - 2219 = 3(-394) + 4(-286)$ ✓ answer $-107$ (kJ mol <sup>-1</sup> ) ✓	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 <u>     </u> = (underlining) key words which <b>must</b> be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument	
Question	Expected Answers	Marks
<b>3 (a)</b>	any two from <b>rate of forward reaction = rate reverse reaction ✓</b> macroscopic properties remain constant/ concentrations remain constant ✓ closed system needed ✓	2
<b>(b) (i)</b>	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
<b>(ii)</b>	catalyst is in the same state/ phase as reactants ✓	1
<b>(iii)</b>	H <sup>+</sup> ✓	1
<b>(iv)</b>	they alter the rate of the forward and the reverse reaction <b>by the same amount</b> ✓	1
<b>(c) (i)</b>	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
<b>(ii)</b>	two vertical lines <b>drawn</b> 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





**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<sub>2</sub> is [slightly] soluble in water (or acid) [1]
- G9 Uses water/acid pre-saturated with CO<sub>2</sub> [1]  
**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<sub>2</sub> when heated **or** when acidified. [1]  
**and** the CO<sub>2</sub> produced makes dough/cakes/bread (etc) rise.
- C2 Researches typical % mass of NaHCO<sub>3</sub> in baking powder (stating source of info) [1]  
**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
- C3 **Equation** for reaction:  $2\text{NaHCO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{SO}_4 + 2\text{CO}_2 + 2\text{H}_2\text{O}$  [1]
- C4 **Calculates** suitable mass of NaHCO<sub>3</sub> 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<sub>3</sub> 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 specific 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<sub>3</sub> 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** %  $\frac{\text{mass of residue}}{\text{mass of NaHCO}_3}$  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<sub>3</sub> = 84 [1]
- no. of moles of NaHCO<sub>3</sub>, 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  $\text{Na}_2\text{CO}_3 = 106$  [1]  
*Allow ecf to candidate's answer in 3(a), either  $\text{NaOH} = 40$  or  $\text{Na}_2\text{O} = 62$*
- Number of moles of residue, correctly calculated from candidate's data [1]
- 3(d) Ratio = 2:1 [1]
- 3(e) Equation fully correct:  $2\text{NaHCO}_3 \rightarrow \text{Na}_2\text{CO}_3 + \text{CO}_2 + \text{H}_2\text{O}$  [1]

**Page 8 – 4 marks (Part 4)**

- 4(a) Both temperatures clearly labelled **and** recorded to  $0.5^\circ\text{C}$  (*ie one decimal place*) [1]  
 Temperature drop correctly worked out **and** unit shown (somewhere) [1]
- Accuracy** – 2 marks [2]
- Candidate's temperature drop within  $0.8^\circ\text{C}$  of supervisor's **mean** → 2 marks
  - Candidate's temperature drop within  $1.5^\circ\text{C}$  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 (=  $105 \times \text{temp fall}$ ) [1]
- 4(c) No of moles of  $\text{HCl} = 0.025$  [1]
- 4(d)  $\Delta H/\text{kJ} = \frac{\text{heat}}{\text{no of moles}} \times \frac{1}{1000}$  [1]  
*This is a method mark*
- $\Delta H$  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]

2813/03

Mark Scheme

January 2007

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  $\text{NaHCO}_3$  might not decompose [completely] (*owtte*) [1]

**5(c) 2 marks**

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

% error =  $\frac{0.02}{\text{mass of NaHCO}_3} \times 100$  (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]

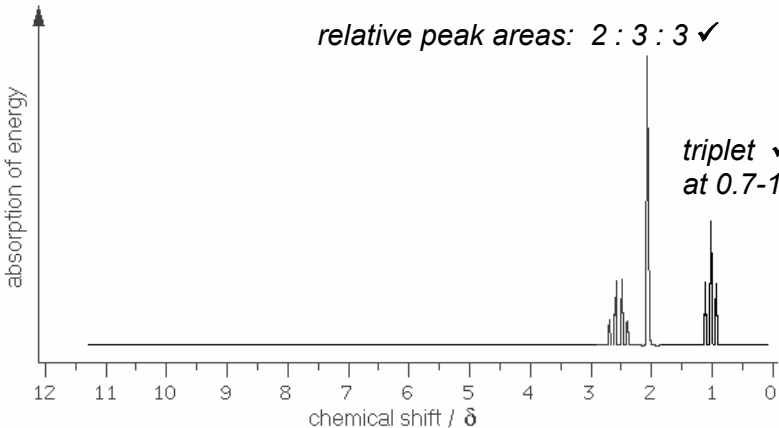
**5(e)** 9 marks (*but 6 on question paper*)

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

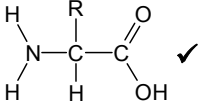
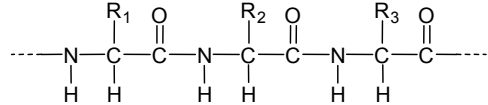
- Heat gains (*accept "losses"*) during reaction [1]
  - These result from convection **or** conduction [1]
  - Use a lid **or** thermos flask *or* thicker/better/more insulation/calorimeter [1]
- Loss of [acid] spray during reaction [1]
  - Use a lid **or** bigger cup **or** acid that is more dilute [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 calibrated (*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<sub>3</sub> 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]

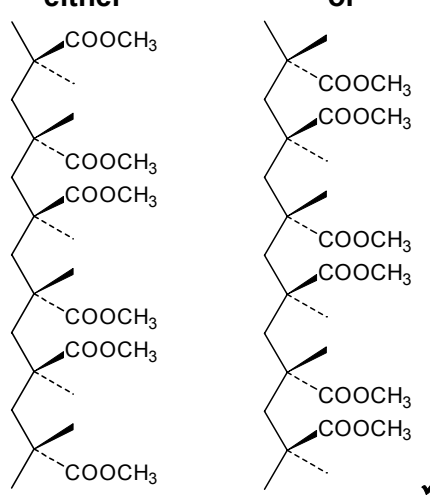
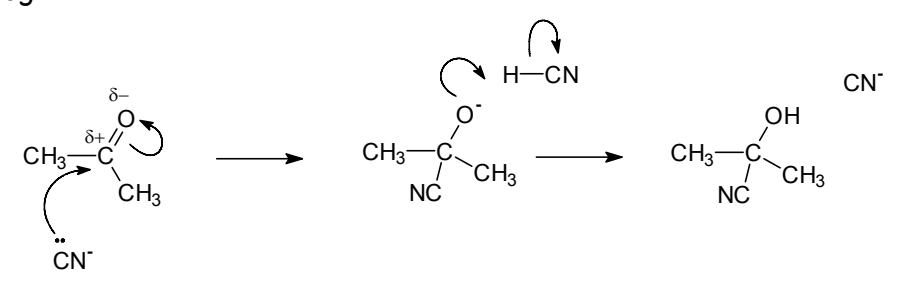


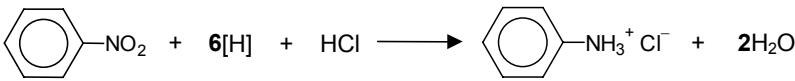
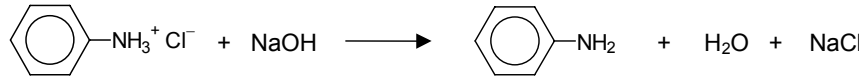


**Mark Scheme 2814**  
**January 2007**

Qu. No.		Marks
1 (a) (i)	<p><i>Tollens' reagent / ammoniacal silver nitrate ✓</i></p> <p><i>silver mirror / precipitate ✓</i></p> <p><i>butanoate / butanoic acid / unambiguous formula or structure ✓</i></p> <p><b>(ii) Any of:</b></p> <p><i>Br<sub>2</sub> - decolourises – (electrophilic) addition</i></p> <p><i>Na – fizzes – redox</i></p> <p><i>SOCl<sub>2</sub> / PCl<sub>5</sub> / acid chloride – white fumes –</i>  <i>substitution/chlorination</i></p> <p><i>carboxylic acid + conc H<sub>2</sub>SO<sub>4</sub> / acid chloride – sweet smell –</i>  <i>esterification/ condensation</i></p> <p><i>test ✓ - observation ✓ - type of reaction ✓</i></p>	<p>[3]</p> <p><b>NOT</b>  2-4DNPH to  give no  precipitate</p> <p>[3]</p>
(b)	<p><i>recrystallise /purify (the precipitate) ✓</i></p> <p><i>measure melting point ✓</i></p> <p><i>compare with known values ✓</i></p>	<p>[3]</p>
(c) (i)	<p><i>the peak is due to the CH<sub>3</sub>CO- group ✓</i></p> <p><i>not split, so next to a C with no protons / has no neighbouring proton /</i>  <i>δ value is in the range 2.0 – 2.9 ✓</i></p>	<p>[2]</p>
(ii)	<p><i>adjacent to a C with three protons / to a CH<sub>3</sub> ✓</i></p>	<p>[1]</p>
(iii) and (iv)	<p><i>relative peak areas: 2 : 3 : 3 ✓</i></p>  <p><i>mark any additional incorrect peaks first</i></p>	<p>[3]</p>
		<p>[Total: 15]</p>

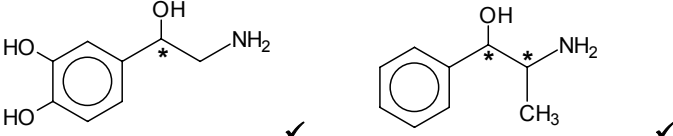
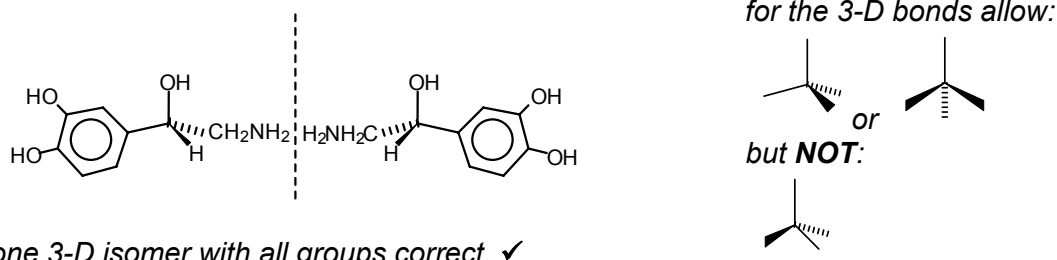


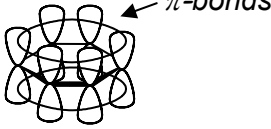
Qu. No.		Marks
2	<p data-bbox="288 331 783 360"><b>General formula of an <math>\alpha</math>-amino acid</b></p> <p data-bbox="288 376 778 479"><math>RCH(NH_2)COOH</math> /  ✓</p> <p data-bbox="288 573 1075 602"><b>Diagram to show length of polypeptide / repeat unit – eg</b></p> <p data-bbox="288 618 778 721"></p> <p data-bbox="288 770 357 799"><b>with:</b></p> <p data-bbox="288 837 624 866">displayed peptide bond ✓</p> <p data-bbox="288 904 1054 969">correct structure with a minimum of two amino acids joined (can be scored by a dipeptide) ✓</p> <p data-bbox="288 1008 900 1037">idea of polymerisation shown by 'end bonds' ✓</p> <p data-bbox="288 1075 485 1104">loss of water ✓</p> <p data-bbox="288 1142 1086 1207">relate variety to different R groups / sequence of amino acids ✓ <b>AW</b></p> <p data-bbox="288 1308 767 1337"><b>Quality of written communication:</b></p> <p data-bbox="288 1344 1011 1408">correct organisation and use of <b>both</b> of the terms: <u>condensation polymer(isation)</u> and <u>peptide bond/link</u> ✓</p>	[7]
[Total: 7]		

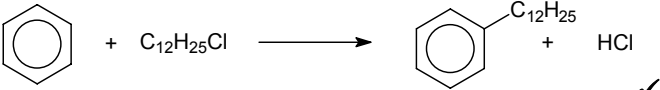
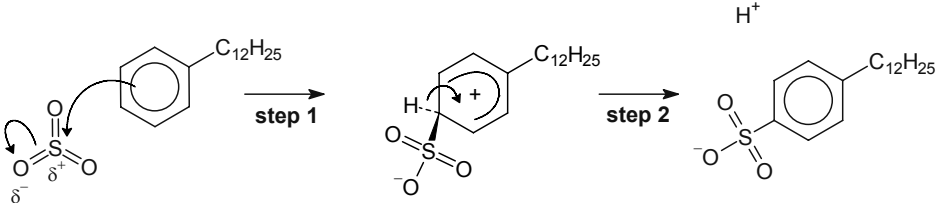
Qu. No.		Marks
3 (a)	<p><i>addition</i> ✓ <span style="float: right;"><i>NOT "additional"</i></span></p>	[1]
(b) (i)	<p><b>either</b> <span style="margin-left: 150px;"><b>or</b></span></p> 	[1]
(ii)	<p><i>isotactic</i> ✓  <i>group is on the same side / has the same 3-D spatial arrangement (along the chain)</i> ✓ <b>AW</b></p>	[2]
(c) (i)	<p><b>stage 2</b>  <i>HCl/H<sub>2</sub>SO<sub>4</sub></i> ✓  <i>presence of water implied – eg dilute /aq / suitable named concentration and warm/heat/reflux</i> ✓</p> <p><b>stage 4</b>  <i>CH<sub>3</sub>OH</i> ✓  <i>reflux/distil with conc H<sub>2</sub>SO<sub>4</sub></i> ✓</p> <p style="text-align: right;"><i>second mark is dependent on the first</i></p>	[4]
(ii)	<p><i>add an extra carbon / lengthen the carbon chain</i> ✓</p>	[1]
(d) (i)	<p><i>nucleophilic addition</i> ✓</p>	[1]
(ii)	<p><i>eg</i></p>  <p><i>curly arrow breaking C=O</i> ✓ (<i>dipole not essential</i>)  <i>curly arrow from lone pair of :CN<sup>-</sup> to the correct carbon</i>  <i>structure of the intermediate</i> ✓  <i>curly arrow –O<sup>-</sup> to H<sup>+</sup> / HCN / H<sub>2</sub>O</i> ✓ (<i>second curly arrow not essential</i>)</p>	[4]
<b>[Total: 14]</b>		

Qu. No.		Marks
4 (a) (i)	 <p><math>\text{C}_6\text{H}_5\text{NO}_2 + 6[\text{H}] + \text{HCl} \longrightarrow \text{C}_6\text{H}_5\text{NH}_3^+ \text{Cl}^- + 2\text{H}_2\text{O}</math></p> <p><math>\text{H}_2\text{O}</math> as product ✓    balancing ✓</p>	[2]
(ii)	<p>reducing agent ✓</p>	[1]
(b)	 <p><math>\text{C}_6\text{H}_5\text{NH}_3^+ \text{Cl}^- + \text{NaOH} \longrightarrow \text{C}_6\text{H}_5\text{NH}_2 + \text{H}_2\text{O} + \text{NaCl}</math></p> <p>(or as the ionic equation without <math>\text{Na}^+</math> or <math>\text{Cl}^-</math>)</p> <p><math>\text{C}_6\text{H}_5\text{NH}_2</math> ✓    balanced ✓</p>	[2]
(c)	<p>moles <math>\text{C}_6\text{H}_5\text{NO}_2</math> used = <b>0.0300</b> (mol) ✓</p> <p>theoretical yield of <math>\text{C}_6\text{H}_5\text{NH}_2</math> = <b>2.79(3)</b> (g) ✓ or ecf</p> <p>actual 72.1% yield = <b>2.014</b> (g) / (calculator value 2.013753) ✓ or ecf</p> <p>to three sig figs = <b>2.01</b> (g) ✓ or ecf</p>	[4]
(d)	<p><b>Primary amines as bases</b></p> <p>lone pair on N ✓</p> <p>lone pair is donated to the <math>\text{H}^+</math> / dative covalent bond ✓</p> <p>or both marks can be shown by a suitable diagram – eg</p>  <p><b>Why phenylamine is weaker</b></p> <p>lone pair /electrons move away from the N in phenylamine towards the benzene ring <b>AW</b> ✓</p> <p>because the lone pair on the N is (partially) delocalised around the benzene ring</p> <p>or diagram to show – eg</p>  <p>so is less available to donate / lower electron density on N ✓</p> <p>(ignore references to ethylamine or to the inductive effect)</p>	[5]
<b>[Total: 14]</b>		

Qu. No.		Marks
5 (a)	$\begin{array}{l} \text{CH}_3\text{COOH} + \text{SOCl}_2 \longrightarrow \text{CH}_3\text{COCl} + \text{SO}_2 + \text{HCl} / \\ \text{CH}_3\text{COOH} + \text{PCl}_5 \longrightarrow \text{CH}_3\text{COCl} + \text{POCl}_3 + \text{HCl} \\ \text{reactants } \checkmark \qquad \qquad \qquad \text{products } \checkmark \end{array}$	[2]
(b)	$\text{CH}_3\text{COCl} + \text{H}_2\text{O} \longrightarrow \text{CH}_3\text{COOH} + \text{HCl} \checkmark$	[1]
(c)	<p><b>Any three of:</b></p> <ul style="list-style-type: none"> <li>• absorption at 2500-3300(<math>\text{cm}^{-1}</math>) for O-H (in COOH)</li> <li>• absorption at 1000-1300 (<math>\text{cm}^{-1}</math>) for C-O</li> <li>• absorption at 1680-1750 / below 1750 (<math>\text{cm}^{-1}</math>) for C=O</li> <li>• no peak at ~600 (<math>\text{cm}^{-1}</math>) / no C-Cl peak</li> </ul> <p style="text-align: right;"><b>ANY 3 out of 4 marks ✓✓✓</b></p>	[3]
(d)	<p>ethanoic acid because:</p> <p><math>M_r = 60 \checkmark</math></p> <p>60 = <math>m/e</math> value / mass of the molecular ion / furthest right peak / correct peak indicated on the spectrum</p> <p><b>or</b></p> <p>any valid evidence based on the the absence of peaks due to Cl or valid fragmentation peaks that would distinguish them ✓</p>	[2]
<b>[Total: 8 ]</b>		

Qu. No.		Marks
6 (a) (i)	<i>bromine / sodium hydroxide (solution) / FeCl<sub>3</sub></i> ✓	[1]
(ii)	<i>OH / phenol group in noradrenaline circled</i> ✓	[1]
(iii)	<i>decolourises /white ppt / dissolves (in water better) / violet</i> ✓	[1]
(b) (i)		[2]
(ii)	<i>optical (isomerism)</i> ✓	[1]
(iii)	<i>(stereo)isomers are non-superimposable (mirror images) / the molecule is asymmetric / the carbon has four different groups attached</i> ✓	[1]
	 <p><i>one 3-D isomer with all groups correct</i> ✓</p> <p><i>second isomer is a mirror image of a reasonable attempt at 3-D</i> ✓</p>	[3]
(c)	<p><b>Any three of:</b></p> <ul style="list-style-type: none"> <li>• <i>only one stereoisomer has the right 3-D shape / shape similar to noradrenaline / is (pharmacologically) active ora</i></li> <li>• <i>presence of other (inactive) stereoisomers: will increase the amount needed for the dose</i></li> <li>• <i>may give harmful side effects</i></li> <li>• <i>may increase cost of separation</i></li> </ul> <p style="text-align: center;"><b>ANY 3 out of 4 marks</b> ✓✓✓</p>	[3]
<b>[Total: 12]</b>		

Qu. No.		Marks
7	<p><b>Discussion of the <math>\pi</math>-bonding</b></p> <p><i>p-orbitals overlap</i> ✓</p> <p><i>above and below the ring</i> ✓</p> <p><i>(to form) <math>\pi</math>-bonds / orbitals</i> ✓</p> <p><i>(<math>\pi</math>-bonds / electrons) are <u>delocalised</u></i> ✓</p> <p><b>Other valid points – any two of:</b></p> <ul style="list-style-type: none"> <li>• <i>ring is planar</i> /</li> <li>• <i>C-C bonds are equal length / have intermediate length/strength between C=C and C-C /</i></li> <li>• <i><math>\sigma</math>-bonds are between C-C and/or C-H</i></li> <li>• <i>bond angles are 120°</i></li> </ul> <p style="text-align: right;"><b>MAX 2 out of 4 marks</b> ✓✓</p> <p><b>Quality of written communication</b> <i>two or more sentences with correct spelling, punctuation and grammar</i></p>	<p>any of the first three marks are available from a labelled diagram eg</p>  <p style="text-align: right;"><b>4 marks</b></p> <p style="text-align: right;"><b>[6]</b></p> <p style="text-align: right;"><b>[1]</b></p>
<b>[Total: 7]</b>		

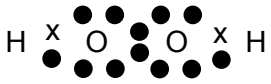
Qu. No.		Marks
8 (a) (i)	<p><math>C_{12}H_{25}Cl/Br</math> ✓</p> <p><math>AlCl_3 / FeBr_3</math> etc ✓</p>	[2]
(ii)		[1]
(iii)	<p><math>H</math> on benzene is replaced / swapped / substituted by <math>C_{12}H_{25}</math> / another group ✓</p>	[1]
(b) (i) and (ii)	 <p>structure of intermediate ✓✓ (deduct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





**Mark Scheme 2815/01**  
**January 2007**

<b>Abbreviations, annotations and conventions used in the Mark Scheme</b>	/ = 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 <b>must</b> be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument		
<b>Question</b>	<b>Expected answers</b>	<b>Marks</b>	<b>Additional guidance</b>
<b>1 (a)</b>	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>(b)</b>	Ions are not able to move / aw (1)	1	<b>Ignore</b> reference to electrons
<b>(c) (i)</b>	$\text{Al}_2\text{O}_3 + 6\text{HCl} \rightarrow 2\text{AlCl}_3 + 3\text{H}_2\text{O}$ / $\text{Al}_2\text{O}_3 + 6\text{H}^+ \rightarrow 2\text{Al}^{3+} + 3\text{H}_2\text{O}$ (1)	1	<b>Allow</b> $\text{Al}^{3+}$ and $\text{Cl}^-$ as products <b>Not</b> $\text{Al}_2\text{Cl}_6$ <b>Ignore</b> State symbols
<b>(ii)</b>	$\text{Al}_2\text{O}_3 + 3\text{H}_2\text{O} + 6\text{NaOH} \rightarrow 2\text{Na}_3\text{Al}(\text{OH})_6$	1	
<b>(d)</b>	Lots of covalent bonds / many covalent bonds (1) have to be broken which needs a large amount of energy (1)	2	<b>Allow</b> network structure (1)
<b>(e)</b>	(Reacts with water) to form an acidic solution / $\text{P}_4\text{O}_{10} + 6\text{H}_2\text{O} \rightarrow 4\text{H}_3\text{PO}_4$ (1)	1	<b>Ignore</b> it is acidic
		<b>Total = 7</b>	

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 <u>      </u> = (underlining) key words which <b>must</b> be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument	Mark s	Additional guidance
Question	Expected answers	Mark s	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	<b>Allow</b> 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	<b>Allow</b> use of 3d
(c) (i)	Correct 'dot and cross' diagram (1)  	1	<b>Ignore</b> 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° – 105° (1)	2	<b>Allow</b> any bond angle between 95 to 106° (1) <b>Allow</b> ecf from wrong 'dot and cross' diagram
		<b>Total</b> = 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 <u>      </u> = (underlining) key words which <b>must</b> 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)	$\text{Fe}(\text{H}_2\text{O})_6^{3+} + \text{SCN}^- \rightarrow [\text{Fe}(\text{H}_2\text{O})_5(\text{SCN})]^{2+} + \text{H}_2\text{O}$ (1)	1	
(ii)	<b>Any five from</b> Known amounts or volumes of $\text{FeCl}_3$ and $\text{KSCN}$ (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	<b>Allow</b> marks from an appropriate graph
(e) (i)	$\text{MnO}_2 + 4\text{H}^+ + 2\text{Fe}^{2+} \rightarrow \text{Mn}^{2+} + 2\text{H}_2\text{O} + 2\text{Fe}^{3+}$ (1)	1	<b>Ignore</b> state symbols
(ii)	Moles of $\text{Fe}^{2+}$ that reacted with $\text{MnO}_2 = 0.02 - 0.0123 = 0.0077$ (1) Mass of $\text{MnO}_2 = 0.00385 \times 86.9 = 0.335$ (1) % purity = 66.4% (1)  Alternatively  Moles of $\text{MnO}_2$ in 0.504 = 0.00580 So moles of $\text{Fe}^{2+}$ that should react with this is 0.0116 (1) Moles of $\text{Fe}^{2+}$ that reacted with $\text{MnO}_2 = 0.02 - 0.0123 = 0.0077$ (1) % purity = 66.4% (1)	3	<b>Allow</b> ecf within question  <b>Allow</b> 66.4 – 66.5
		<b>Total = 20</b>	

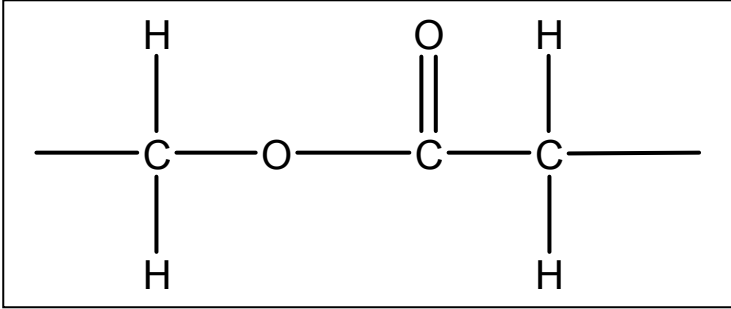

Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit <u>      </u> = (underlining) key words which <b>must</b> be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument		
Question	Expected answers	Marks	Additional guidance
4	<p><b>Definition – maximum 3 marks</b></p> $\text{Mg}^{2+}(\text{g}) + 2\text{Cl}(\text{g}) \rightarrow \text{MgCl}_2(\text{s}) \quad (1)$ <p>The enthalpy change that accompanies the formation of one mole of a solid (compound) (1);  from its constituent gaseous ions (1)</p> <p><b>Born-Haber cycle – maximum 5 marks</b></p> <p>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<sup>-</sup>(g) 1.e. 698 (1)  -2526 kJ mol<sup>-1</sup> (1)</p> <p><b>Comparison – maximum 3 marks</b></p> <p><b>Any three from</b>  Na<sup>+</sup> has a larger radius than Mg<sup>2+</sup> / ora (1)  Br<sup>-</sup> has a larger radius than Cl<sup>-</sup> / ora (1)  Na<sup>+</sup> has a lower charge than Mg<sup>2+</sup> / ora (1)  Strongest attraction is between Mg<sup>2+</sup> and Cl<sup>-</sup> / MgCl<sub>2</sub> has the strongest attraction between its ions / ora (1)</p> <p><b>Or</b></p> <p>Na<sup>+</sup> has a lower charge density than Mg<sup>2+</sup> / ora (1)  Br<sup>-</sup> has a lower charge density than Cl<sup>-</sup> / ora (1)  Strongest attraction between ions which have the highest charge density / MgCl<sub>2</sub> has the strongest attraction between its ions / ora (1)</p> <p><b>And QWC</b></p> <p>One mark for correct spelling, punctuation and grammar in at least two sentences (1)</p>	12	<p><b>Allow</b> marks from an equation  <b>Allow</b> energy released / energy change  <b>Not</b> energy required  <b>Allow</b> ionic compound / salt</p> <p>Every formula must have the correct state symbol at least once  <b>Allow</b> -2403 / -2875 (2)  <b>Allow</b> -2752 (1)  <b>Unit required</b></p> <p>Penalise the use of incorrect particle only once within the answer. Penalise it the first time an incorrect particle is mentioned</p>

**Mark Scheme 2815/02**  
**January 2007**

<b>Abbreviations, annotations and conventions used in the Mark Scheme</b>	/ = 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 <b>must</b> be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument	
<b>1</b>	<p>(a) (i) HOH<sub>2</sub>CCHOHCHOHCH<sub>2</sub>CHO Accept displayed .✓</p> <p>(ii) Any two points.✓✓ AW.</p> <ul style="list-style-type: none"> <li>• Both are condensation polymers of nucleotides/ contain monomers with base, sugar and phosphate.</li> <li>• Sugar-phosphate polymer/backbone or mention of phosphodiester links.</li> <li>• Base attached to sugar.</li> <li>• Both contain the bases ACG.</li> </ul> <p>(iii) Base uracil/U in RNA but thymine/T in DNA✓                  Double helix in DNA/single strand in RNA✓                  DNA is a much longer molecule✓ AW Any two.</p> <p>Four points from the following.✓✓✓✓.AW.</p> <ul style="list-style-type: none"> <li>• Double helix unwinds with breaking of hydrogen bonds/ mention of enzyme helicase.</li> <li>• The base pairs are CG and AT.</li> <li>• Exposed bases become hydrogen bonded to complementary bases on free nucleotides/ mention of nucleotide triphosphates/ both strands act as templates for replication</li> <li>• Incoming nucleotides attached to growing chain by a (phosphate) ester link / the joining of each nucleotide is catalysed by DNA polymerase</li> <li>• Semi-conservative replication/ each of the two resulting double helices contains one original strand and one newly synthesised strand</li> </ul> <p>(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</p> <p>(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.✓</p> <p>(iii) TAAAGACCA ✓ ignore numbering.</p> <p style="text-align: right;">Total</p>	<p>1</p> <p>2</p> <p>2</p> <p>4</p> <p>2</p> <p>3</p> <p>1</p> <p><b>15</b></p>



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 <b>must</b> be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument	
Question	Expected Answers	Marks
<p>3 (a)</p> <p>(b)</p> <p>(c) (i)</p> <p>(ii)</p> <p>(d) (i)</p> <p>(ii)</p>	$  \begin{array}{ccccccc}  & & \text{H} & & \text{O} & & \text{H} \\  & &   & &    & &   \\  \text{H}_2\text{N} & - & \text{C} & - & \text{C} & - & \text{N} & - & \text{C} & - & \text{COOH} \\  & &   & & & &   & & & & \\  & & \text{H} & & & & (\text{CH}_2)_4\text{NH}_2 & & & &   \end{array}  $ <p>✓ for CONH and ✓ for rest. Accept reverse order.</p> <p>At low pH <math>-\text{COO}^-</math> becomes <math>-\text{COOH}</math>/ uncharged ✓  At high pH <math>-\text{NH}_3^+</math> becomes <math>-\text{NH}_2</math>/ 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)</p> <p>Inhibitor does not compete for active site/binds somewhere other than on the active site. ✓</p> <p>Heavy metal ion replaces hydrogen on the cysteine or  accept a formula <math>-\text{NHCH}(\text{CH}_2\text{SAg})\text{CO}</math> ✓. <math>\text{Hg}^{2+}</math> similarly.</p> <p>This changes shape of enzyme/active site ✓.</p> <p>Four proteins/polypeptides ✓, <u>each</u> with a haem group/<math>\text{Fe}^{2+}</math> ✓, aggregate to form complete haemoglobin/ are held together by weak attractions (accept one example of these) ✓. AW</p> <p>The iron ion/atom combine <u>reversibly</u> ✓ with oxygen/<math>\text{O}_2</math> ✓ but not plain O. Accept reference to binding at high <math>\text{O}_2</math> concentrations and vice versa for second mark. AW</p> <p style="text-align: right;">Total</p>	<p>2</p> <p>3</p> <p>1</p> <p>2</p> <p>3</p> <p>2</p> <p>13</p>

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 <u>      </u> = (underlining) key words which <b>must</b> be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument	
Question	Expected Answers	Marks
2 (a) (i)	<div style="text-align: center; border: 1px solid black; padding: 10px; width: fit-content; margin: 0 auto;">  </div> <p style="text-align: center;">The spare bonds at each end are optional.✓</p>	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)	<div style="text-align: center; margin-bottom: 5px;">  </div> 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 groups in active site matching those on substrate. Catalytic site is in correct position to catalyse hydrolysis of the C <sub>2</sub> ester group only / when bound to active site only the C <sub>2</sub> 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
	<b>Total</b>	9

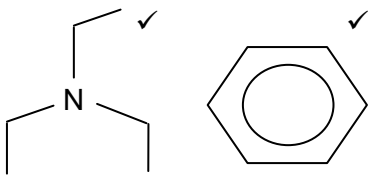
Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit <u>      </u> = (underlining) key words which <b>must</b> be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument	
Question	Expected Answers	Marks
<p>4 (a)</p> <div data-bbox="456 607 1249 1317" style="border: 1px solid black; padding: 10px; margin: 10px auto; width: fit-content;"> </div>	<p>A correct glycosidic link ✓  Correct stereochemistry for each link ✓✓  They need all but one of the C<sub>1</sub> and C<sub>4</sub> hydrogen atoms to score both stereochemistry marks but can score 1 mark if only two are missing.  Skeletal structures accepted.</p> <ul style="list-style-type: none"> <li>• linear/straight chain polymer</li> <li>• hydrogen bonded to neighbouring chain</li> <li>• hydrogen bonding between OH groups (any drawing here must be correct)</li> <li>• microfibrils make up fibres with great tensile strength</li> <li>• insoluble</li> </ul> <p>Any four of these points.  QWC At least two sentences in which meaning is clear, and in which there are fewer than two mistakes of spelling, punctuation and grammar.✓</p> <p style="text-align: right;">Total</p> <p style="text-align: right;">Paper Total</p>	<p style="text-align: center;">3</p> <p style="text-align: center;">4</p> <p style="text-align: center;">1</p> <p style="text-align: center;">8</p> <p style="text-align: center;">45</p>
<p>(b)</p>		



**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 <u>      </u> = (underlining) key words which <b>must</b> be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument	
Question	Expected Answers	Marks
1 (a)	<p><math>R_f</math> value is distance moved by a component/spot/solute divided by distance moved by solvent. ✓</p> <p>Retention time is the time between injection and emergence (or detection) of a component. ✓</p>	2
(b) (i)	Partition / adsorption ✓	1
(ii)	<p>Role of gas: carrier gas / mobile phase / to carry to sample through the chromatography column ✓</p> <p>Role of liquid: stationary phase ✓</p>	2
(iii)	Trace with two peaks drawn ✓	1
(iv)	<p>Measure <b>area</b> under each peak ✓</p> <p>Find total area ✓</p> <p><math>\% = (\text{area of one peak} / \text{total area}) \times 100\%</math> ✓</p>	3
(c) (i)	$^{37}\text{Cl}$ / $^{81}\text{Br}$ / Cl or Br isotopes that differ by mass of two (either $^{37}\text{Cl}$ or $^{81}\text{Br}$ ) or contains isotopes with 2 extra neutrons ✓	1
(ii)	<p>If similar height halogen is bromine / bromine isotopes have similar / same abundance ✓</p> <p>If in ratio 3 : 1 then halogen is chlorine / chlorine isotopes are in abundance ratio 3 : 1 ✓</p>	2
		<b>Total: 12</b>

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 <u>      </u> = (underlining) key words which <b>must</b> be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument	
Question	Expected Answers	Marks
<b>2</b> (a)	<p>(i) Energy levels are quantised / energy levels are discrete / specific gap between energy levels in the H atom ✓</p> <p>(ii) Electrons fall / drop back ✓ <i>from higher levels to <u>different</u> energy levels</i> ✓</p> <p>(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 ✓</p> <p>(iv) Electron in ground state / n = 1 / lowest energy level / Lyman series can be used ✓</p> <p>(v) Multiply by 1000 and divide by L to give J per atom  <math>1312 \times 1000 / 6.02 \times 10^{23} = 2.179 \times 10^{-18} \text{ J}</math></p> $E = hf \text{ so } f = E/h$ $f = 2.179 \times 10^{-18} \text{ J} / 6.63 \times 10^{-34} \text{ J s}$ $= 3.287 \times 10^{15} \text{ s}^{-1}$ $\lambda = c/f = 3.0 \times 10^8 \text{ m s}^{-1} / 3.287 \times 10^{15} \text{ s}^{-1}$ $= 9.126 \times 10^{-8} \text{ m}$ $9.13 \times 10^{-8} \text{ m answer to three sig figs}$ (allow 9.12 for answer kept in calculator) <p>Use of correct formulae as above or using <math>E = hc/\lambda</math> ✓  Correct use of L ✓  Correct answer of <math>9.126 \times 10^{-8} \text{ m}</math> (allow 9.12 or 9.13) ✓  Answer to 3 sig figs ✓</p>	<p>1</p> <p>2</p> <p>1</p> <p>1</p> <p>4</p>

Question	Expected Answers	Marks
(b) (i)	 <p data-bbox="368 495 874 528">NOTE: mark incorrect answers first</p>	2 (1 for each molecule circled)
(ii)	<p data-bbox="368 600 1190 667">Electronic / electron transitions / any mention of electrons being involved ✓</p> <p data-bbox="368 667 1062 701">From low to high energy levels / to excited states</p> <p data-bbox="368 701 659 734">n to pi* / pi to pi* ✓</p>	1  1
		<b>Total: 13</b>





<b>Abbreviations, annotations and conventions used in the Mark Scheme</b>	/ = 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 <b>must</b> be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument	
<b>Question</b>	<b>Expected Answers</b>	<b>Marks</b>
4 (a)	(M : M + 1 = 74.6 : 6.5) No. of carbon atoms = $(6.5 \times 100) / (74.6 \times 1.1)$ ✓ = 7.92 therefore eight carbons / C <sub>8</sub> ✓	2





**Mark Scheme 2815/06**  
**January 2007**

<b>Abbreviations, annotations and conventions used in the Mark Scheme</b>	/ = 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 <u>      </u> = (underlining) key words which <b>must</b> be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument	
<b>Question</b>	<b>Expected Answers</b>	<b>Marks</b>
<b>1</b> (a) (i)  (ii)  (iii)  (b) (i)  (ii)	<b>+3</b>  <b>Cis and trans forms drawn in 3-D (only award these marks if C has been chosen)</b>  <b>Type of isomerism is cis-trans/geometric</b>  <b>(concentrated) hydrochloric acid/sodium chloride/ Other suitable named ionic chloride but <u>not</u> just chloride or Cl<sup>-</sup></b>  <b>Ligand substitution / ligand exchange</b>	<b>1</b>  <b>2</b>  <b>1</b>  <b>1</b>  <b>1</b>  <b>Total: 6</b>

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





<b>Abbreviations, annotations and conventions used in the Mark Scheme</b>	/ = 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 <b>must</b> be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument	
Question	Expected Answers	Marks
<b>4</b> (a) (i)  (ii)  (b) (i)  (ii)  (c) (i)  (ii)	<b>Stainless steel + corrosion resistance or alloys for tools + hardness or other named alloy/use/property</b> <b>Allow chrome plating with attractive or barrier to corrosion</b> <b>Chromium <math>1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1</math> (allow....<math>4s^1 3d^5</math>)</b>  <b><math>Cr_2O_7^{2-} + 14H^+ + 6Fe^{2+} \rightarrow 2Cr^{3+} + 6Fe^{3+} + 7H_2O</math></b> <b><math>Cr_2O_7^{2-} / Cr^{3+}</math> has more positive electrode potential</b> <b>Therefore <math>Cr_2O_7^{2-}</math> is the stronger oxidising agent which oxidises <math>Fe^{2+}</math> to <math>Fe^{3+}</math> (ora)</b> <b>Emf = (+) 0.56 V</b>  <b>Orange to yellow</b>  <b>Hydroxide ions react with or remove <math>H^+</math> ions</b> <b>Position of equilibrium moves to the right (to produce more <math>H^+</math> ions and <math>CrO_4^{2-}</math> which is yellow)</b>	   <b>1</b> <b>1</b>  <b>1</b> <b>1</b>  <b>1</b> <b>1</b>  <b>1</b>  <b>1</b>  <b>1</b>  <b>Total: 9</b>

<b>Abbreviations, annotations and conventions used in the Mark Scheme</b>	/ = 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 <u>      </u> = (underlining) key words which <b>must</b> be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument	
Question	Expected Answers	Marks
5 (a)  (b) (i)  (ii)  (c)	For colour, need at least 1 d-electron and a space in higher energy d-orbital for it to be promoted to. Cu <sup>+</sup> has no space / has a full d-sub shell.  Pigment ( accept dye) / colouring paints  Dative covalent/co-ordinate  Red-brown solid is copper / Cu Blue solution is [Cu(H <sub>2</sub> O) <sub>6</sub> ] <sup>2+</sup> / Cu <sup>2+</sup> (aq) / CuCl <sub>2</sub> 2CuCl → Cu + CuCl <sub>2</sub> / 2Cu <sup>+</sup> → Cu + Cu <sup>2+</sup> Cu(I) compounds are unstable in solution / Disproportionate or explained.	1 1  1  1 1 1 1  <b>Total: 8</b>

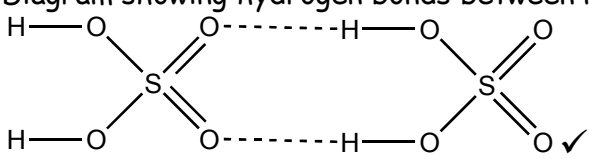
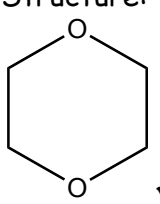
**Mark Scheme 2816/01**  
**January 2007**



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 <u>      </u> = (underlining) key words which <b>must</b> be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument	
Question	Expected Answers	Marks
2 (a)	$K_c = \frac{[PCl_3][Cl_2]}{[PCl_5]} \checkmark$	[1]
(b) (i)	$PCl_5 > 0.3 \text{ mol dm}^{-3}$ ; $PCl_3$ and $Cl_2 < 0.3 \text{ mol dm}^{-3} \checkmark$	[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 $K_c = 0.245 \text{ mol dm}^{-3} \checkmark$	[1]
(c) (i)	$K_c$ does not change as temperature is the same $\checkmark$	[1]
(ii)	Fewer moles on left hand side $\checkmark$ system moves to the left to compensate for increase in pressure by producing less molecules $\checkmark$	[2]
(d) (i)	$K_c$ decreases (as more reactants than products) $\checkmark$	[1]
(ii)	Forward reaction is exothermic/ reverse reaction is endothermic $\checkmark$ equilibrium $\longrightarrow$ left to oppose increase in energy/ because $K_c$ decreases $\checkmark$	[2]
(e) (i)	$4PCl_5 + 10MgO \longrightarrow P_4O_{10} + 10MgCl_2 \checkmark$	[1]
(ii)	$100g P_4O_{10} = \frac{100}{284} / 0.35(2) \text{ mol } \checkmark$ moles $PCl_5$ needed = $4 \times 0.352 = 1.408/1.4 \text{ mol } \checkmark$ mass $PCl_5 = 1.4(08) \times 208.5 = 293.568 / 294 \text{ g} / 291.9 \text{ g } \checkmark$ $\checkmark$ 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

<b>Abbreviations, annotations and conventions used in the Mark Scheme</b>	/ = 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 <u>      </u> = (underlining) key words which <b>must</b> be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument	
<b>Question</b>	<b>Expected Answers</b>	<b>Marks</b>
3 (a) (i)	Ionic product ✓	[1]
(ii)	$K_w = [H^+(aq)][OH^-(aq)]$ ✓ <i>state symbols not needed</i>	[1]
(b)	moles of HCl = $\frac{5 \times 10^{-3} \times 21.35}{1000} = 1.067 \times 10^{-4} \text{ mol}$ ✓  moles of Ca(OH) <sub>2</sub> = $\frac{1.067 \times 10^{-4}}{2} = 5.34 \times 10^{-5} \text{ mol}$ ✓  concentration of Ca(OH) <sub>2</sub> = $40 \times 5.34 \times 10^{-5}$ = $2.136 \times 10^{-3} \text{ mol dm}^{-3}$ ✓ 2 marks for $4.27 \times 10^{-3} / 8.54 \times 10^{-3} \text{ mol dm}^{-3}$ (no factor of 4)	[3]
(c)	$[OH^-] = 2 \times 2.7 \times 10^{-3} = 5.4 \times 10^{-3} \text{ mol dm}^{-3}$ ✓ $[H^+(aq)] = \frac{K_w}{[OH^-(aq)]} = \frac{1.0 \times 10^{-14}}{5.4 \times 10^{-3}} = 1.85 \times 10^{-12} \text{ mol dm}^{-3}$ ✓  pH = $-\log(1.85 \times 10^{-12}) = 11.73/11.7$ ✓  ecf is possible for pH mark providing that the [H <sup>+</sup> ] 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 <sup>-</sup> and to use $2.7 \times 10^{-3}$ 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]
		<b>Total: 9</b>

<b>Abbreviations, annotations and conventions used in the Mark Scheme</b>	/ = 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 <u>      </u> = (underlining) key words which <b>must</b> be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument	
<b>Question</b>	<b>Expected Answers</b>	<b>Marks</b>
4 (a)	$\text{Ca}_3(\text{PO}_4)_2 + 2\text{H}_2\text{SO}_4 \longrightarrow \text{Ca}(\text{H}_2\text{PO}_4)_2 + 2\text{CaSO}_4$ ✓	[1]
(b)	$\text{H}_2\text{PO}_4^-(\text{aq}) \rightleftharpoons \text{H}^+(\text{aq}) + \text{HPO}_4^{2-}(\text{aq})$ / $\text{H}_2\text{PO}_4^-(\text{aq}) \rightleftharpoons 2\text{H}^+(\text{aq}) + \text{PO}_4^{3-}(\text{aq})$ ✓ (or equivalent with $\text{H}_2\text{O}$ forming $\text{H}_3\text{O}^+$ )	[1]
(c) (i)	$\text{HPO}_4^{2-}$ ✓	[1]
(ii)	$\text{H}_3\text{PO}_4$ ✓	[1]
(iii)	$\text{H}_2\text{PO}_4^-$ produced $\text{Ca}(\text{H}_2\text{PO}_4)_2$ or on LHS of an attempted equilibrium equation ✓ 2 equations/equilibria to shown action of buffer ✓✓ from: $\text{H}_2\text{PO}_4^- + \text{H}^+ \rightleftharpoons \text{H}_3\text{PO}_4$ / $\text{H}_2\text{PO}_4^- \rightleftharpoons \text{H}^+ + \text{HPO}_4^{2-}$ / $\text{H}_2\text{PO}_4^- + \text{OH}^- \rightleftharpoons \text{H}_2\text{O} + \text{HPO}_4^{2-}$ / $\text{H}^+ + \text{OH}^- \rightleftharpoons \text{H}_2\text{O}$	[3]
		<b>Total: 7</b>

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 <u>      </u> = (underlining) key words which <b>must</b> be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument	
Question	Expected Answers	Marks
5 (a)	<p>Sulphuric acid molecules form hydrogen bonds ✓</p> <p>Diagram showing hydrogen bonds between molecules:</p>  <p>or H bond from H-O to O-H (as in water)</p> <p>hydrogen bonds break (on boiling) ✓</p>	[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)	<p><b>A:</b> CO ✓  <math>HCOOH/H_2CO_2 \longrightarrow CO + H_2O</math> ✓</p> <p><b>B:</b> C ✓  <math>C_{12}H_{22}O_{11} \longrightarrow 12C + 11H_2O</math> ✓</p> <p><b>C:</b> <math>C_4H_8O_2</math> ✓  <math>2C_2H_6O_2 \longrightarrow C_4H_8O_2 + 2H_2O</math> ✓</p> <p>Structure:</p>  <p>accept any sensible structure of <math>C_4H_8O_2</math></p>	[2] [2] [3]
		Total: 16



**Mark Scheme 2816/03**  
**January 2007**

2816/03

Mark Scheme

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:  $[\text{Fe}(\text{H}_2\text{O})_6]^{3+} + \text{SCN}^- \rightarrow [\text{Fe}(\text{SCN})(\text{H}_2\text{O})_5]^{2+} + \text{H}_2\text{O}$  [1]  
*Allow equation for  $\text{Fe}^{3+}$  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  $\text{ZnCO}_3$  gives off a gas but  $\text{Zn}(\text{OH})_2$  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  $\text{CO}_2$  to reduce solubility of the gas
- B6 Equation for reaction:  $\text{ZnCO}_3 + 2\text{HCl} \rightarrow \text{ZnCl}_2 + \text{CO}_2 + \text{H}_2\text{O}$  [1]  
**and** links mass of  $\text{ZnCO}_3$  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 [1]  
**or** is aware of the problem that some solid may go through filter paper
- 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]

2816/03

Mark Scheme

January 2007

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

**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 %  $\frac{\text{mass of residue}}{\text{mass of malachite}}$  (to one decimal place)*

*Calculate candidate's %  $\frac{\text{mass of residue}}{\text{mass of malachite}}$*

*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 =  $\frac{\text{mass of residue}}{79.5}$  correctly calculated [1]

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

$M_r$  of malachite correctly calculated [ =  $\frac{\text{mass}}{\text{number of moles}}$  ] [1]



**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  $0.50 \text{ cm}^3$ , subtract 1 mark
- if accurate readings differ by more than  $0.70 \text{ cm}^3$ , subtract 2 marks
- if accurate readings differ by more than  $0.90 \text{ cm}^3$ , subtract 3 marks
- if accurate readings differ by more than  $1.20 \text{ cm}^3$ , subtract 4 marks
- if accurate readings differ by more than  $1.50 \text{ cm}^3$ , 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)  $n(\text{thiosulphate}) = \frac{20}{248} \times \text{mean titre} / 1000$  [1]  
*This mark is a "method" mark for knowing how to calculate n as above*
- (b)  $n(\text{iodine})$  correctly calculated [1]  
*Expected answer =  $0.5 \times (a) = \text{approx } 0.0009 \text{ mol}$*
- (c)  $n(\text{CuSO}_4) = \text{"b"} \times 2 \times 10$  [1]  
*This is a "method" mark for using mole ratio and scaling up*
- (d)  $M_r$  of malachite =  $\frac{\text{mass of X used}}{\text{number of moles}} = \frac{2m}{(c)}$  [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  $M_r$  resulting from an incorrect use of the 1:2 mole ratio*
- (e) Mass of  $\text{CuCO}_3 \cdot \text{Cu}(\text{OH})_2 = 221$  [1]  
**or** correct calculation of mass of water (=  $M_r - 221$ )
- $n = \frac{(250 - 221)}{18} = 1.6(1)$  (if data supplied was used) [1]  
*Most candidates will use their own  $M_r$  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 whole 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<sup>3</sup> [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:  $\text{CuCO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{CuSO}_4 + \text{CO}_2 + \text{H}_2\text{O}$  [1]

No of moles of sulphuric acid used =  $\frac{1 \times 10}{1000} = 0.01$

**or** volume of acid =  $\frac{0.01 \times 1000}{1} = 10 \text{ cm}^3$  [1]

$\text{Cu}(\text{OH})_2 + \text{H}_2\text{SO}_4 \rightarrow \text{CuSO}_4 + 2\text{H}_2\text{O}$  [1]

*Combined equation:  $\text{CuCO}_3 \cdot \text{Cu}(\text{OH})_2 \cdot n\text{H}_2\text{O} + 2\text{H}_2\text{SO}_4 \rightarrow 2\text{CuSO}_4 + \text{CO}_2 + (n+3)\text{H}_2\text{O}$*

*Scores both equation marks. Allow 1 mark if "H<sub>2</sub>O" is balanced wrongly*

10 cm<sup>3</sup> of H<sub>2</sub>SO<sub>4</sub> are needed to react with [0.01 mol of] Cu(OH)<sub>2</sub> in malachite

**or** 20 cm<sup>3</sup> of 1.0 mol dm<sup>-3</sup> H<sub>2</sub>SO<sub>4</sub> are required to react fully with malachite [1]

H<sub>2</sub>SO<sub>4</sub> (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
<b>3882</b>	300	240	210	180	150	120	0
<b>7882</b>	600	480	420	360	300	240	0

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

	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>E</b>	<b>U</b>	<b>Total Number of Candidates</b>
<b>3882</b>	14.6	35.2	53.6	77.1	92.7	100.0	401
<b>7882</b>	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](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](mailto:helpdesk@ocr.org.uk)

**[www.ocr.org.uk](http://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