

Chemistry (Salters)

Advanced GCE **A2 7887**

Advanced Subsidiary GCE **AS 3887**

Combined Mark Schemes and Reports on the Units

January 2006

3887/7887/MS/R/06J

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 2006

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 (Salters) (7887)

Advanced Subsidiary GCE Chemistry (Salters) (3887)

MARK SCHEME ON THE UNITS

Unit	Content	Page
2848	Chemistry of Natural Resources	1
2849	Chemistry of Materials	7
2850	Chemistry for Life	13
2854	Chemistry by Design	19

REPORTS ON THE UNITS

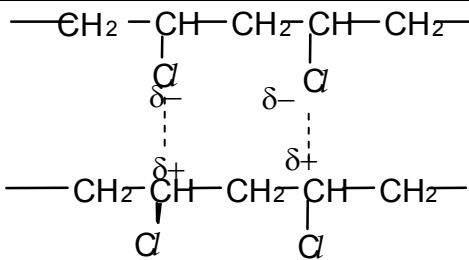
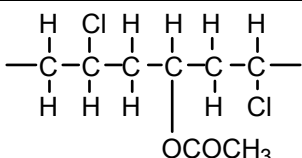
*

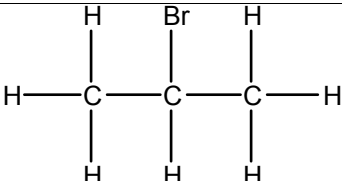
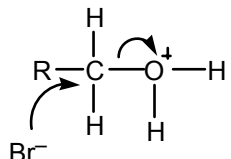
Unit	Content	Page
*	Chief Examiner's Report	28
2848	Chemistry of Natural Resources	29
2849	Chemistry of Materials	34
2850	Chemistry for Life	39
2854	Chemistry by Design	41
2855	Individual Investigation	43
*	Grade Thresholds	45

Mark Scheme 2848
January 2006

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 must be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument
---	---

Question	Expected Answers	Marks
1 a i	air/ oxygen/O ₂ (plus nothing else) (1); (blister) copper/Cu <i>NOT pure copper</i> (IGNORE + sulphur dioxide/SO ₂ /slag <i>only</i>) (1)	2
1 a ii	liquid/(l)/molten	1
1 a iii	1% = 1 x 1000000/100 = 10 ⁴ /10000 (1)	1
1 a iv	purification/refining/electrolysis/making brass <i>NOT smelting</i>	1
1 b i	+1 (1); 0 (1); 0 (1); +4 (1) <i>ALLOW 1+ and 4+ or 1 and 4 for (1)</i>	4
1 b ii	redox/ oxidation/ reduction	1
1 b iii	copper(I) sulphide <i>ignore gaps ecf from oxidation state in (i)</i>	1
1 c i	11 electrons (1) 4s ¹ 3d ¹⁰ <i>or reversed</i> (1);	2
1 c ii	d/allow D <i>IGNORE transition metals</i>	1
1 d i	methyl orange/ phenolphthalein <i>allow small spelling errors and other suitable acid-base indicators. NOT Universal indicator or litmus</i>	1
1 d ii	21.2 x 0.00100/1000 (1) = 2.12 x 10 ⁻⁵ <i>ecf if one error</i> (1)	2
1 d iii	same answer as (ii)	1
1 d iv	Answer to d(iii) x 40 [2.12 x 10 ⁻⁵ x 1000/25 = 8.48 x 10 ⁻⁴ mol dm ⁻³] (1) <i>Do not accept rounding to 1sf.</i>	1
1 e	<p> sulphur dioxide/SO₂; <i>plus three from</i> dissolves in rain/causes acid rain; damages trees/plants/ lakes/ fish/buildings/human health/ leaches aluminium; reacts with oxygen and water converts it to sulphuric acid </p> <p><i>IGNORE greenhouse gases and photochemical smog</i></p> <p> QWC: 2 sentences, spelling, punctuation and grammar correct (1 error) <i>ALLOW "Sulphur dioxide" alone at the start.</i> Underline first two errors. </p>	4 1
	Total	24

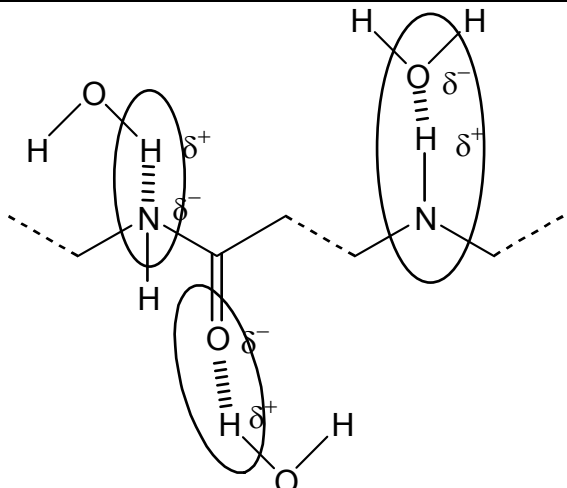
2 a	(drain)pipes/ window <u>frames (AW)</u> / doors/ roofing <i>Must be part of fabric of house.</i>	1
2 b i	(1 -)chloroethene <i>correct spelling required</i>	1
2 b ii	electrophilic (1); addition (1) <i>extra selections are CON</i>	2
2 b iii	elimination (1)	1
2 b iv	addition (polymerisation) <i>NOT additional</i>	1
2 c i	permanent dipole–(permanent) dipole <i>no others</i>	1
2 c ii	 <p>$\delta+$, $\delta-$ correct (1); indication of attraction between correct groups(1)</p>	2
2 d i	 <p>(or different order) (2); one error (1) <i>allow less displayed</i> <i>allow monomer units reversed</i> <i>connection to OCOCH₃ must be through O</i></p>	2
2 d ii	copolymer	1
2 e	chains can slide/move over each other (AW implying relative movement) (1) intermolecular / permanent dipole–permanent dipole (<i>allow abbreviations</i>) forces weaker (<i>NOT fewer</i>) (1) working over longer distance (AW implying greater separation) (1)	3
2 f i	hydrogen (1); Ni, hot/ Pt (room T and P <i>ALLOW high T</i>) (1) <i>second mark depends on first</i>	2
2 f ii	primary (1) as OH attached to CH ₂ / C with OH attached to one other C/OH at end of chain/only one R group (1)	2
2 f iii	aldehyde <i>ALLOW carbonyl</i>	1
2 f iv	(potassium/sodium) dichromate/ correct formula (1); (sulphuric) acid <i>IGNORE conc</i> (1) heat/ raised temp (<i>ALLOW reflux</i>) <i>provided dichromate mentioned</i> (1);	3
2 g i	M_r vinyl chloride = 62.5, ethanol = 46 (1);	1
2 g ii	moles vinyl chloride = 10/62.5 (= 0.16) moles ethanol = 1.5/46 (= 0.0326/0.033) <i>ecf</i> (1)	1
2 g iii	= moles vinyl chloride (0.16)	1
2 g iv	% = 0.0326 x 100/0.16 = 20% (<i>ecf, eg ALLOW 21% if 0.033 moles ethanol used</i>) (1) 2 sf (1) <i>mark separately provided number follows from some working shown</i>	2
2 h i	water (1); <i>plus one from:</i> catalyst with high temp and press; catalyst of sulphuric/phosphoric acid <i>depends on first</i>	2
2 h ii	yield low/ more steps/ chlorine/hydrogen chloride dangerous/ pollutant <i>NOT cost-related</i>	1
	Total	31

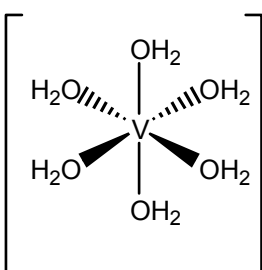
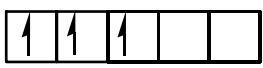

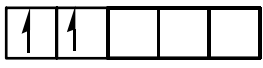

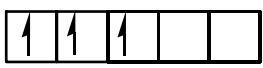

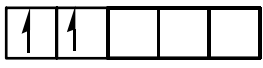

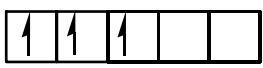

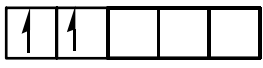

3 a i	halogenoalkane/bromoalkane (1) <i>ALLOW haloalkane</i>	1
3 a ii	 <p>(1); 2-bromopropane <i>ecf</i> for 1-bromopropane (1) <i>ignore positions of dashes, commas and spaces</i></p>	2
3 b i	aerosol <u>propellants</u> / blowing agents/ refrigerants (coolants)/ air conditioning <u>coolants</u> / fire extinguishers	1
3 b ii	<p><i>three from</i> not broken down/ unreactive in troposphere; broken down (AW) in stratosphere; by <u>high energy/frequency</u> uv/radiation; which cause homolytic fission/photodissociation chlorine atoms/radicals; break down ozone - catalysis implied</p> <p><i>two from</i> C–Br bond weaker (than C–Cl); can be broken by lower energy/ frequency uv/visible/light/radiation;</p> <p><i>or</i> contains C–H bonds; which cause it to be more reactive</p> <p>broken down/react in troposphere/before reaching stratosphere.</p> <p>QWC: Logical and at least three words from list used correctly troposphere, stratosphere, uv, radiation, radical, catalyse/catalyst, homolytic fission, photodissociation</p>	6
3 b iii	<p><i>two from</i> boiling point/volatility; flammability; toxicity/harm to health; cost of <u>manufacture</u> (AW); (un)reactivity/stability/ease of disposal. IGNORE greenhouse gases Mark all suggestions</p>	2
3 c i	<p>CH₃CH₂CH₂OH/C₃H₇OH/C₃H₈O. <i>ALLOW propan-1-ol if formula correct in equation</i></p>	1
3 c ii	<p>CH₃CH₂CH₂OH (<i>etc as above</i>)(l/aq) + HBr (g/aq) → CH₃CH₂CH₂Br (<i>etc</i>)(l/aq) + H₂O (l) (1) for equation correct; <i>ecf</i> for incorrect R group (1) for state symbols (<i>if first mark scored</i>)</p>	2
3 c iii	(anhydrous) sodium sulphate/ <i>other suitable salt (unless clearly hydrated)</i> /silica gel NOT conc. sulphuric, soda lime	1
3 c iv	(fractional) distillation	1
3 c v	 <p>intermediate complete (<i>ignore +</i>) ALLOW + on C (1); bromide attack (1); arrow from bond to O⁽⁺⁾ (1)</p>	3
	Total	20

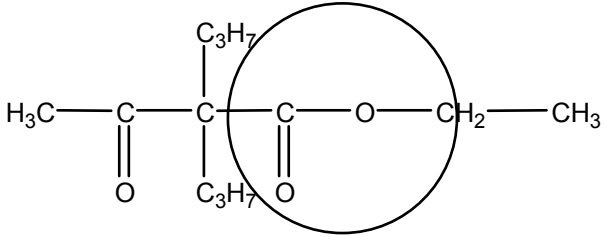
4 a	alternative hydrocarbons (e.g. diesel)/ oxygenates/ lean burn engines/ more complete combustion (AW)/ hybrid engines/ fuel injection/oxygen sensors /reduced drag/ lighter cars (AW)	1
4 b	wind power/ wave power/ tidal power/ biomass/ nuclear/ geothermal/ hydroelectric/ solar power/cells/panels	1
4 c i	Sun (1); uv/visible / high frequency/ high energy end of spectrum/ between visible and X-ray (1)	2
4 c ii	makes bonds/molecules vibrate (more) (1); turned into kinetic energy/ move around faster <u>which increases temperature</u> (1)	2
4d i	Increased CO ₂ levels in troposphere/CO ₂ (g) moves <u>equilibrium</u> (position) in equation 4.1 to right* (1) Increased CO ₂ (aq) moves <u>equilibrium</u> (position) of equation 4.2 to right* (1) <i>*or <u>equilibrium producing identified products</u></i> “equilibrium moves to right” scores 1 of first 2 HCO ₃ ⁻ increases (1)	3
4 d ii	rate of forward reaction = rate of back reaction (1); <i>and one from:</i> <u>concentrations</u> of reactants and products remain constant ; closed system	2
4 d iii	system not closed/ CO ₂ (g) moves away from surface/CO ₂ (aq) ionises (AW)	1
4 e	SiO ₂ giant covalent/ network solid/ lattice/ whole structure held together by covalent bonds (1) <i>IGNORE “intermolecular”</i> CO ₂ molecular (AW) (1) <u>weak</u> intermolecular forces (<i>can be named and can be abbreviated</i> <i>ALLOW permanent dipole - permanent dipole</i>)/less energy needed to separate molecules/ bonds in SiO ₂ are stronger (1)	3
	Total	15

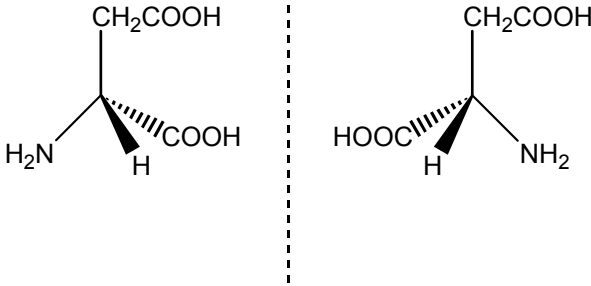
**Mark Scheme 2849
January 2006**

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 must be used to gain credit
	ecf	= error carried forward
	AW	= alternative wording
ora	= or reverse argument	

Question	Expected answers	Marks
1 (a)	Improve properties / demand greater than nature can supply / reduce cost (1).	1
1 (b)	$\begin{array}{c} \text{H} & & \text{O} \\ & & \\ \text{H}-\text{N} & -(\text{CH}_2)_5- & \text{C}-\text{OH} \end{array}$ -COOH <i>allow</i> -COCl (1); -NH ₂ (1) ONE of the groups must have the (CH ₂) ₅ for the second mark.	2
1 (c) (i)	1,4-diaminobutane diaminobutane <i>allow butyl/butan(e)diamine</i> (1); 1,4 (1). <i>ecf</i> , 1,6-diaminohexane for 1 mark	2
1 (c) (ii)	Any two from the following four points: lower <i>T_g</i> / <i>T_m</i> / strength/ rigidity <i>ora</i> (2). NOT b.p. nor density.	2
1 (d) (i)	3 x 10 ⁴ / 198 (1); 150–152 (1) <i>ecf for M_r</i> .	2
1 (d) (ii)	(Secondary) amide (1) NOT peptide.	1
1 (d) (iii)	There will be greater number of hydrogen bonds (1); between chains (1); greater energy needed (to enable chains to move/flow) (1).	3
1 (e) (i)	$\begin{array}{c} \text{NH}_3^+ \text{---} \text{CH}_2\text{---CH}_2\text{---CH}_2\text{---CH}_2\text{---NH}_3^+ \\ \text{HO---C(=O)---(CH}_2)_4\text{---C(=O)---OH} \end{array}$ <i>may not be skeletal</i> (1); (1). <i>ecf for C chain from (b)</i> .	2
1 (e) (ii)	 Any one of the three atom arrangements above (1); Correct partial charges (1).	2
Total		17

Question	Expected answers	Marks									
2 (a) (i)	+5 (1) <i>accept</i> 5+.	1									
2 (a) (ii)	hydrogen electrode (1); detailed drawing not required but should have H ₂ gas and H ⁺ (aq). a half-cell made from Pt (or C) dipping into a solution VO ₂ ⁺ and VO ²⁺ ions (1); conditions given as 1 mol dm ⁻³ /1M concentrations, 1 atmosphere pressure and 298 K (1); salt bridge dipping in solutions(1); voltmeter correctly connected (1).	5									
2 (b) (i)	0.74 V (1).	1									
2 (b) (ii)	B V^{2+} / V^{3+} (<i>may give more detail of half-cells</i>) because it has the more negative/less positive electrode potential AW in terms of reducing agent/oxidizing agent or electron transfer (1).	1									
2 (c) (i)	$V^{3+} + e \rightleftharpoons V^{2+}$ (1).	1									
2 (c) (ii)	$V^{2+} + VO_2^+ + 2H^+ \rightarrow V^{3+} + VO^{2+} + H_2O$ Correct vanadium species in both reactants and products (1); equation given balanced correctly (1).	2									
2 (d) (i)	<div style="text-align: center;"> $3+$  </div> <p>Octahedral arrangement of ligands (1); O in H₂O bonded to V for all ligands (1). <i>Ignore charge on ion.</i></p>	2									
2 (d) (ii)	<div style="text-align: center;"> <table border="0"> <tr> <td></td> <td style="text-align: center;">3d</td> <td style="text-align: center;">4s</td> </tr> <tr> <td>V</td> <td style="text-align: center;">  </td> <td style="text-align: center;">  </td> </tr> <tr> <td>V³⁺</td> <td style="text-align: center;">  </td> <td style="text-align: center;">  </td> </tr> </table> </div> <p>Correct arrangement for V (1); correct arrangement for V³⁺ (1).</p>		3d	4s	V			V³⁺			2
	3d	4s									
V											
V³⁺											
2 (d) (iii)	Ligands cause/interact with d orbital/energy levels AW (1); to split into two groups / $E = h\nu$ or in words (1); visible light/frequencies absorbed to excite electrons (1); rest of visible light transmitted as colour AW (1).	4									
Total		19									

Question	Expected answers	Marks															
3 (a)	2-propylpentanoic acid <i>pentanoic acid</i> (1) <i>2-propyl</i> (1) allow 2-propan(e) or propyl-2-/ <i>Dipropylethanoic/dipropanethanoic acid gains 1 mark.</i>	2															
3 (b)	 <p><i>Allow if only COO/both attached C atoms is/are circled.</i></p>	1															
3 (c) (i)	Prevent loss of product D /volatile reactants/gases (1).	1															
3 (c) (ii)	(Fractional) distillation (1).	1															
3 (c) (iii)	Add dilute hydrochloric/sulphuric/ acid (1). NOT conc.	1															
3 (c) (iv)	(Potassium) ethanoate/ $\text{CH}_3\text{COO}^- (\text{K}^+)$ (1).	1															
3 (d)	$\text{C}_2\text{H}_5\text{OH}$ (1); Any two from three : relative molar mass = 46 (1); since peak furthest right is due to molecular ion(<i>may be shown on diagram</i>) (1); any one use of fragmentation pattern e.g. peak at 29, due to ethyl group /difference between peaks at 29 and 45 = 16, suggests O present (1).	3															
3 (e)	<table border="1" data-bbox="331 1032 1246 1368"> <thead> <tr> <th>chemical shift from spectrum</th> <th>type of proton</th> <th>relative intensity</th> </tr> </thead> <tbody> <tr> <td>1.0</td> <td>CH_3</td> <td>9</td> </tr> <tr> <td>1.4</td> <td>CH_2</td> <td>8</td> </tr> <tr> <td>2.2</td> <td>$\text{O}=\text{CCH}_3$</td> <td>3</td> </tr> <tr> <td>3.7</td> <td>$\text{CH}_2\text{OC}=\text{O}/$ $\text{CH}_3\text{OC}=\text{O}$</td> <td>2</td> </tr> </tbody> </table> <p>two</p> <p>types of proton correctly identified (1); all four correct gains second mark (1); correct relative intensities (1).</p>	chemical shift from spectrum	type of proton	relative intensity	1.0	CH_3	9	1.4	CH_2	8	2.2	$\text{O}=\text{CCH}_3$	3	3.7	$\text{CH}_2\text{OC}=\text{O}/$ $\text{CH}_3\text{OC}=\text{O}$	2	3
chemical shift from spectrum	type of proton	relative intensity															
1.0	CH_3	9															
1.4	CH_2	8															
2.2	$\text{O}=\text{CCH}_3$	3															
3.7	$\text{CH}_2\text{OC}=\text{O}/$ $\text{CH}_3\text{OC}=\text{O}$	2															
3 (f)	(Broad) peak around $2500\text{--}3200\text{ cm}^{-1}$ (1) indicates OH (in carboxylic acid) (1); (Strong) peak around $1700\text{--}1725\text{ cm}^{-1}$ (1) indicates C=O (in carboxylic acid) (1).	4															
3 (g)	<i>Any two of the following points:</i> Solids are easier to administer; taste/smell reduced; not acidic; not corrosive; easier to make sure correct dosage, more soluble in water (1 mark for each point).	2															
Total		19															
Question	Expected answers	Marks															
4 (a) (i)	Stereoisomerism/optical (isomerism) (1).	1															

4 (a) (ii)	<p>(Molecule has) an asymmetric carbon atom / chiral centre / carbon bonded to four different atoms/groups / mirror image is non-superimposable (1);</p>  <p>Correct 3D structural formula for one enantiomer(1); mirror image (1).</p>	3
4 (b) (i)	<p>850 ± 25 (1) years for 1st reading; 850 ± 25 years for 2nd reading and 3rd reading not greater than 925 (1) <i>units need to be present for at least one of the readings to gain both marks;</i> suitable construction on graph to show calculation of half-life (1).</p>	3
4 (b) (ii)	Half-life is constant (1).	1
4 (b) (iii)	<p>Rate = k x [L-aspartic acid]; [L-aspartic acid] (1); Rate = k (1).</p>	2
4 (b) (iv)	s ⁻¹ /yr ⁻¹ /time ⁻¹ (1).	1
4 (b) (v)	k is the rate of reaction (1).	1
4 (c)	Zwitterion (1).	1
4 (d) (i)	$K_c = \frac{[\text{ion F}] \cdot [\text{H}^+]}{[\text{ion E}]}$ 'ion' not necessary for mark (1).	1
4 (d) (ii)	<p>[H⁺]² = 1.38 x 10⁻⁴ x 0.50 (1); [H⁺] = 8.30 or 8.31 x 10⁻³ mol dm⁻³ (1); 2 or 3 sig. figs (1).</p>	3
4 (e)	<p>Order/sequence of amino acids (in protein chain) (1); shape taken up by protein chain e.g. folding of chains AW (1);</p> <p>the (extra) COOH/COO⁻ in aspartic acid (1) ; forms/increases the hydrogen bonding/ ion- dipole forces/interactions with water (molecules) (1);</p> <p>charged groups on side/R groups of substrates (may give example -NH₃⁺ / COO⁻ groups) (1); can attract charged groups/(may give example -NH₃⁺ / COO⁻ groups) in the active sites/AW of enzymes (1). <i>Accept polar side chains for charged groups but 1 mark not 2.</i></p> <p>QWC See next page (1).</p>	7
Total		24

Question	Expected answers	Marks
5 (a)	Any answer relating to railway tracks, points, frogs etc.(1).	1
5 (b) (i)	To remove sulphur (1).	1
5 (b) (ii)	Blowing oxygen through (1); turns the carbon to carbon dioxide <i>accept</i> carbon monoxide (1).	2
5 (c) (i)	Acidic (oxide) (1).	1
5 (c) (ii)	$6\text{CaO} + \text{P}_4\text{O}_{10} \rightarrow 2\text{Ca}_3(\text{PO}_4)_2$ correct formula for P_4O_{10} / P_2O_5 (1); correct formula for CaO rest correct (1).	3
5 (c) (iii)	Correct amount of P added later AW (1).	1
5 (d)	To remove (dissolved) oxygen (1).	1
5 (e)	Analysing mixtures of steels/ sorting out different steels/ removing non steel materials/rust from the scrap/cleaning steel/contains unwanted elements (1).	1
Total		11

**Guidelines for the Award of S(P)AG QWC marks
in Salters paper 2849 Jan 2006**

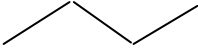
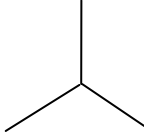
- 1** The QWC mark is graded at 'E/U', and it is therefore expected that the majority of candidates will be awarded this mark.
- 2** Award the mark if there is only one error in spelling, (punctuation) or grammar in **any two relevant sentences**. A repeated mis-spelling of the same word would count as one error; a repeated grammatical error (*e.g. no verb*) would count each time.
- 3** Ignore all but the most blatant errors involving commas, because their use varies with individual preference.
- 4** There should be at least two sentences in the answer. These should start with a capital letter but do not penalise lack of full stops at the end.
- 5** Allow bullet points, provided each point is a sentence (or more), *i.e.* not note form. Bullet points need capitals at the start but not full stops at the end.
- 6** Give the benefit of the doubt where unsure; especially avoid penalising obscure grammatical points.

**Mark Scheme 2850
January 2006**

1 a i	<p>Similarity: Same no./amount/of protons/electrons/atomic number/ (NOT A_r or same atomic charge)</p> <p>Difference; Different no./amount/ of neutrons/different mass no/masses/atomic mass/one (more) neutron(1);</p> <p>(use of 'it' or 'they' is fine)</p> <p>(or specific numbers e.g. both have one proton- zero and one neutrons)</p>	2
1 a ii	<p>$2\text{}^1_1\text{H} \rightarrow \text{}^4_2\text{He}$ correct/consistent symbol(1); top and bottom add up(1);</p> <p>NB other possibilities, see example below, but must show fusion</p> <p>e.g. $\text{}^3_2\text{He} + \text{}^1_0\text{n}$ scores 2 must be <u>correct symbols</u> e.g. not HE</p>	2
1 a iii	<p>(Light) nuclei (1) (fuse/join/come together)(1); NOT atoms</p> <p>to form a <u>heavier</u> nucleus/atom/element or larger <u>nucleus</u>(1)</p> <p>any reference to bonding is a CON</p>	2
1 b i	<p>Like/positive charges/protons(1)</p> <p>(ignore references to ions unless neg –CON); repel(1)</p>	2
1 b ii	<p><u>High/extreme</u> pressure/gravity/density(1); Not – lots of pressure</p> <p><u>high/extreme</u> temp/extreme heat/energy/KE(1) allow high temp and pressure</p> <p>(2 marks) NOT intense temperature</p>	2
1 c i	<p>H_2 (with or without proton or mass number)(1); D / $\text{}^2_1\text{H}$ (1); <u>or in words</u></p> <p>e.g. hydrogen with an extra neutron symbols to right OK</p> <p>NB a cation shown(1); - give this mark if cation shown in c i or cii(1);</p>	3
1 c ii	<p>For peak at 3- HD/T (1); for peak at 4 – D_2/HT (1)</p> <p>Allow <u>one mark max.</u> for reference to possible existence of an</p> <p>(heavier) isotope of (hydrogen) NB $\text{}^4_1\text{H}$ is a CON</p> <p>NOT contamination</p>	2
1 c iii	<p>(relative) abundance/amount(of that isotope)/proportion AW NOT concentration</p> <p>NOT intensity</p>	1
	Total	16

2 a	s aq(1) both correct	1
2 b	<u>Any</u> of: Reactivity/ease of ion formation/thermal stability of carbonates base strength of oxides/hydroxides	1
2 c i	[Mg] ²⁺ 2[Cl] ⁻ charges both correct(1); no electrons around Mg (allow 8) (1); (NB covalent structure – zero) eight, with <u>one different</u> around Cl(1); 2Cl ⁻ ions(1); either separate or x2	4
2 c ii	Acid-base/alkali/neutralization/exothermic(1)	1
2 d	Delocalized/'sea'/free electrons(1); can move/mobile(1);	2
2e	Mark the <u>process</u> (in any order) i.e. divide by 100(1); multiply by 1000(1); (x10 gets both these marks) divide by 24(1); sig figs(mark separately)(1); <u>0.054 scores all four</u> NB CON wrong figure at start – looking for digits 13 (some using 1.0)	4
2f	3000 – 3200 (1)	1
2g	Graph A(1); Any two from the following three: successive IE's get bigger/higher/harder to remove electrons/ AW(1); big jump in/so much energy needed on electron 3 removed/Group 2 elements have two outer shell electrons (easier to remove)(1); Hard(er) to remove electron from inner shell/(energy) level /nearer nucleus(1) Answer D could get first of above points only i.e. MAX 1 mark Answers B or C - zero	3
	Total	17

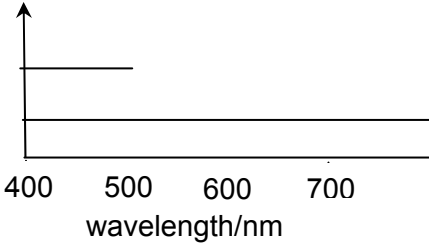
Question	Expected Answers	Marks
3 a i	Reactants label to left of products(1); Reactants label below products(1); <u>single</u> headed 'vertical' arrow going up, labelled in words or using ΔH (1) ecf for products below reactants	3
3 a ii	Endothermic(1);	1
3 b i	$\sum \Delta H_f$ products(1); $\sum \Delta H_f$ reactants(1); correct combination of values i.e. $-980 - (-1014)$ (1); ecf on above answer <u>with</u> sign (+34 scores all 4) ecf on above	4
3 b ii	Any <u>four</u> of the following five: Mass/weight of ammonium bicarbonate(1); Ignore references to mass after reaction Vol./mass of HCl (1) NOT volume of reactants; Concentration of HCl(1); Starting temperature(1); finishing temps(1); NB (temp change/ ΔT scores two) mass of reactants on its own = 1 mark; temp increase – 1 mark only	4
3 b iii	Entropies increase from solids to gases(1) ; ORA disorder/no. of ways of arranging/randomness increase in same way(1)AW ignore nature of particle, except electron (0) More moles/molecules/ of product (1); more products OK gases/liquids from solids(1)	4
3 c i	$4\text{Fe(s)} + 3\text{O}_2\text{(g)} \rightarrow 2\text{Fe}_2\text{O}_3\text{(s)}$ <u>correct</u> balanced equation allow multiples etc.(1); states(1)	2
3 c ii	Catalyst/increases conductivity/absorb energy/moderates, AW/inc. surface area/ reduces rate(1)	1
	Total	19

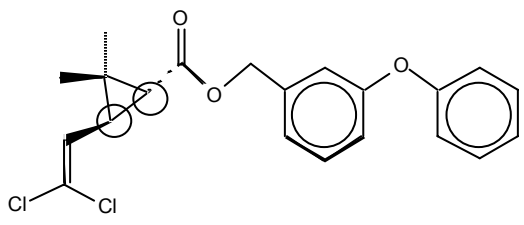
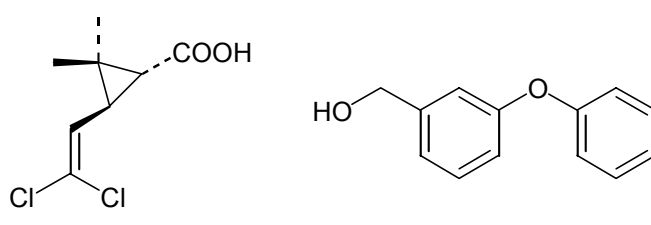
4 a i	C_nH_{2n+2} or 'x'	1
4 a ii	Easier to store/transport/space needed reduced/handle/denser AW(1)	1
4 b i	Any skeletal formula(more than three C) (1); Dots or blobs CON this mark <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  butane </div> <div style="text-align: center;">  methylpropane (1);allow 2-methylpropane (allow slight mis-spellings e.g. methly) </div> <div style="text-align: center;"> both correct (1) </div> </div>	3
4 b ii	(structural) isomers(1) NOT isomerism	1
4 c i	$5(\text{dm}^3)$ oxygen(1); ecf $5 \times 100/20$ (or 5×5) = $25(\text{dm}^3)$ (1) $25 = 2$ marks	2
4 c ii	Volume of a gas depends on temp/pressure; AW (1)	1
4 c iii	CO – toxic/poisonous/photochemical smog(1); NOT harmful/health hazard/acid rain/greenhouse	1
4 c iv	Inefficient/waste of petrol/(photochemical)smog(unless in previous answer)/irritant/asthma/greenhouse gas/global warming/produces ozone/any specific hydrocarbon e.g. benzene carcinogenic(1);	1
4 c v	Bonds broken, energy in/endermich(1); formed, energy out/exo(1); more out than in/more exo- than endo-thermic(1) AW (independent)	3
4 d	Small(er) molecules/chains (ignore references to branched)autogas/ petrol has $C_5 - C_7$ hydrocarbons(1); less/reduces/ tendency to autoignite/knock/pre-ignite(1);NOT stops avoids damage to engine(1); higher compression ratio/power/efficiency possible (1)	4
4 e i	$1000/44$ (1); $1000/44 \times 2220$ (1) ; ecf for correct answer (between 50,390 and 51,160 depending on rounding)(1) ;	3
4 e ii	Low(er) M_r /small(er) molecules(1)more moles/molecules(per kg) (1)ORA	2
	Total	23

**Mark Scheme 2854
January 2006**

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 must be used to gain credit
	ecf	= error carried forward
	AW	= alternative wording
ora	= or reverse argument	

Question	Expected Answers	Marks
1 a	idea of <u>contrast</u> , e.g. "lettering/it absorbs more light"; "white stands out better"	1
1 b i	NiSO ₄ /NiCl ₂ /Ni(NO ₃) ₂ NaH ₂ PO ₂ or potassium salt but NOT acid	2
1 b ii	pH goes down (1); H ⁺ formed (1)	2
1 b iii	H ₃ PO ₃	1
1 c i	0 (1); +1 (1); +3(1); one mark for second two if signs follow numbers	3
1 c ii	Redox – oxidation states change (unless refers to element other than P) / P/H ₂ PO ₂ ⁻ is both oxidised and reduced /exchange of electrons/ no proton exchange NOT just reference to oxidation and/or reduction.	1
1 d i	nitrogen dioxide/nitrogen(IV) (di)oxide IGNORE gaps	1
1 d ii	Ni + 2HNO ₃ → NiO + 2NO ₂ + H ₂ O (2) Balanced equation with water molecules and/or hydrogen ions not cancelled(1)	2
1 e	Reacts with acids (to neutralise them)/ accepts protons (1) <i>IGNORE references to alkali/solubility</i> reactants correct for NiO + HCl/HNO ₃ /H ₂ SO ₄ /H ⁺ (1) correct equation (1)	3
1 f i	complete reaction (with water)/ fully dissociated/ almost fully dissociated/ Ka > 1 (1) <i>IGNORE references to ability to donate protons</i> HNO ₃ (ignore "+aq") → H ⁺ + NO ₃ ⁻ or reaction with H ₂ O to give H ₃ O ⁺ (1) <i>ALLOW equation for other strong acids. Accept "general" acid such as HA, provided there is an arrow rather than an equilibrium sign.</i>	2
1 f ii	pH = 2 (1)	1

1 g	 <p data-bbox="319 459 1117 521">line starting and continuing parallel across to 700 at least (1); super black line more than half-way below black paint (1)</p>	2
	Total	21

2 a i	$C_{21}H_{20}O_3Cl_2$ (2) completely correct (order immaterial) (1) one error;	2
2 a ii	two from: ether, alkene, chloro(alkene)/halo/halogeno NOT cycloalkane	2
2 a iii	 (1) each	2
2 a iv	2 (chlorine) atoms/same groups (ora) on one carbon (of double bond)	1
2 b i	$CH_3-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-OH$ Allow more structured (1) NOT C-H-O	1
2 b ii	four from: A large K_{ow} means more in fat/octan-1-ol/non-polar solvents B octan-1-ol "resembles" fat/ is non-polar; C pesticides must be more soluble in fat than water/ easily absorbed in fat/organic; D they can pass from spraying solution (into insect)/ not leached off/ insoluble in water/ high concentrations not needed;. E in the fatty tissues of insect they do damage	4
2 c	 or shown skeletally (1) (1) Allow sodium salt of acid.	2
2 d	two from higher K_{ow} ; smaller quantities have the same effect; break down quicker/ more completely/ in water more specific on certain pests (AW) inactive when outside insects	2
2 e i	radical <i>ignore substitution</i> (1) (uv) light (1);	2
2 e ii	Br , H (1) in either order.	1
2 e iii	$CN^-/KCN/HCN$	1
	Total	20

3 a i	(1×10^{-8}) (1); mol dm ⁻³ (1) <i>mark separately provided conc. is 10⁻⁷ or smaller</i>	2
3 a ii	$K_w = [H^+] \times [OH^-]$ <i>stated or implied</i> (1); $[OH^-] = 1 \times 10^{-6}$ (mol dm ⁻³) <i>units not essential</i> (1)	2
3 b	<p><i>five from the following:</i></p> <p>CO₂ A CO₂ has instantaneous dipole-induced dipole between molecules; B CO₂ forms hydrogen bonds with water (2); B Reference to permanent/induced dipole - permanent/induced dipole (1); C detail of imf, eg diagram;</p> <p>ions D electrostatic forces between ions; E ions form ion-dipole bonds with water (or description); F hydration description; G detail (eg diagram);</p> <p>reasons H water forms hydrogen bonds with itself; J more hydrogen bonds broken than made for CO₂/ imf in water stronger than in CO₂; K imf between ions and water stronger than hydrogen bonds/ stronger than imf in CO₂;</p> <p>QWC Written in sentences, spelling, punctuation and grammar correct <i>(allow one error)</i> SEE QWC rules</p>	5
3 c	(i) lattice energy/enthalpy (1) (ii) enthalpy (change) of hydration/solvation (1) (iii) enthalpy (change) of solution (1) <i>allow symbols, e.g. ΔH</i>	3
3 d	ΔS_{tot} must be positive for process to occur ΔS_{sys} must be positive (1); and greater than $\Delta H/T$ (1)	3
3 e i	$K_a = [H^+] [HCO_3^-]/[CO_2]$ (1)	1
3 e ii	$\frac{[HCO_3^-]}{[CO_2]} = K_a/[H^+]$ (1) <i>stated or implied, ecf from c(i)</i> $= 4.5 \times 10^{-7} / 1 \times 10^{-8}$ (1) <i>ecf from first mark if all four quantities given;</i> $= 45$ (1) <i>ecf if any marks scored previously</i>	3
3 e iii	M_r NaHCO ₃ = 84 <i>stated or implied</i> (1); $[NaHCO_3] = [CO_2]$ <i>stated or implied</i> (1) $= 3.3 \times 10^{-2} \times 84 = 2.8$ g (1) <i>ALLOW 2.78</i>	3
3 e iv	(H ⁺ added) Equilibrium (position) moves to left (1); restoring pH/pH does not change much (AW) (1) because $[HCO_3^-]$ large (similar to $[CO_2]$)/acts as sink for H ⁺ (1)	3
	Total	26

5 a i	They make black together/ they can make any colour/ they are (sub) primaries	1
5 a ii	Decompose at 400 °C	1
5 b i	azo	1
5 b ii	<i>four from:</i> delocalised electrons; ring; above and below ring of carbons/plane of atoms; six electrons/ one electron from each carbon is not involved in other bonding; not attached to particular carbons/spread out over <u>all carbons</u> /benzene ring	4
5 c i	solubility (in water)/ acidity	1
5 c ii	<u>conc</u> sulphuric acid (1); reflux <i>if sulphuric acid mentioned</i> (1)	2
5 c iii	hydrogen on ring is replaced (by $-\text{SO}_3\text{H}$) (1)	1
5 c iv	positive ion/molecule with partial positive charge (1); attracted to area of negative charge/high electron density (1); accept pair of electrons to form a bond (1)	3
5d	excitation of electrons/ movement from lower to higher energy level (1); absorbs in visible (1); transmits the complementary colour (1); $(\Delta)E = h\nu$ / energy difference related to frequency (1), <i>2 maximum if emission is described</i>	4
	Total	18

Report on the Units

January 2006

Chief Examiner's Report

Once again, it is pleasing to report an increase in numbers in 2850, 2848 and 2849 for the January session.

Unit 2848 performed normally for January, after being found very hard by candidates in the Summer session. Units 2850 and 2849 were found to be harder than usual in a January session. In all units, candidates seemed to be less good at recalling chemical information. This may reflect the shorter revision time available for January units. There was also a lack of understanding of the important Storyline detail, especially in 2849. Perhaps this was caused by the extra material in the A2 part of the course leaving less time for revision but candidates must have knowledge of this important area if they are to do themselves justice in the January session.

There were, however, some candidates who showed a really good knowledge and understanding of the material of the course and were able to apply this most effectively. Their papers were a pleasure to mark.

The synoptic unit 2854 was sat by just a few re-taking candidates, who did not find it very easy, especially the parts where an understanding of general chemistry was required. Investigations were submitted by a very few Centres. There was concern that nearly half of these had to be moderated downwards. The hope is that all Centres will carefully match their Investigations to the general mark schemes in the Summer session.

2848 – Chemistry of Natural Resources

General Comments

Candidates' marks covered a wide range, from single figures to the early eighties, although marks above seventy were rare. There was no indication that candidates had a problem with the length of the paper. Answer spaces that were left blank indicated a lack of knowledge and understanding rather than time constraints.

Good attempts were made at most calculation questions, although candidates do need to remember the importance of setting out their answers clearly and stating what is being calculated at each stage. This would make it easier for Examiners to follow the candidates' answers and award marks, particularly in cases where an error has been made. Those candidates who did set out answers clearly gained credit from the 'error carried forward' rules if they had made a mistake.

Marks were generally much lower on questions that required candidates to name an inorganic compound, give reagents and conditions for organic reactions or to show a reaction mechanism.

Comments on Individual Questions

Question 1

This was the highest scoring question for many candidates.

- a)
- i) Most answered this correctly, although some found difficulty extracting the correct information from the stem of the question.
 - ii) This was generally answered well, with the most common mistake being 'solid'.
 - iii) Many correct answers were given here, although some got confused and scaled by 100/1000000 instead of the required inverse.
 - iv) Although answers here usually gained credit, a significant minority were vague answers that showed a lack of understanding of the information that was given previously.
- b)
- i) A significant number of candidates scored all four marks here, showing a good grasp of the method for working out oxidation states. Some, however, failed to appreciate that the oxidation state for an uncombined element is zero. There was also some confusion over the value for copper, which was often given as +2.
 - ii) Most candidates gained the mark here by identifying this as a redox reaction.
 - iii) This question was generally poorly answered. Many gave the answer as 'copper sulphate' (with or without a value for the copper's oxidation state), while others gave 'copper sulphide' but forgot to include the I. Some candidates, who had correctly calculated the copper's oxidation state in (ii), still gave the name incorrectly as 'copper(II) sulphide'.

Tip

Inclusion of the term 'systematic' with regard to names of inorganic compounds will usually mean the name requires an oxidation state to be included in the answer.

- c)
- i) Most got the mark for showing eleven extra electrons, but relatively few scored the second mark for the correct arrangement.
 - ii) Almost all candidates scored here.
- d)
- i) A range of appropriate answers was accepted, but a significant minority could not suggest a suitable indicator here, with Universal Indicator being a common incorrect answer. Correct answers were accepted with a relaxation of spelling rules, particularly for those who chose phenolphthalein.
 - ii) There were a good number of correct answers here, with candidates remembering the equation for calculating moles in a solution and the fact that the volume needs to be in dm^3 . The most common mistake that cost one of the marks was from those who forgot to divide the volume by 1000.
 - iii) A significant number of candidates did not understand the link between the answer required here and their answer to (ii). Those who did sometimes benefited from the 'error carried forward' rules.
 - iv) A greater proportion of candidates appreciated the connection between their answer to (iii) and the value required here. Again, credit was often gained due to 'error carried forward' rules.
- e) This question was well answered, with most realising that the pollutant was sulphur dioxide and going on to gain good marks, including the extra mark for quality of written communication. A few misinterpreted the rubric and gave a use for the sulphur dioxide, rather than a way of turning it into a useful substance.

Numerical answers: 1a 10^4 1dii 2.12×10^{-5} 1diii 2.12×10^{-5} 1div 8.48×10^{-4}

Question 2

This question was often well done, with the exception of those parts that required candidates to show knowledge of organic syntheses, which were generally poorly attempted.

- a) Most scored the mark here.
- b)
- i) Most candidates also gained this mark.
 - ii) Most got at least one mark here for addition. Many also got the second mark, with 'substitution' being a common incorrect alternative.
 - iii) A high proportion of candidates scored here.
 - iv) Most got this mark, with a few incorrectly giving the answer as additional, rather than addition.
- c)
- i) Fewer candidates scored here, with hydrogen bonding being a common error. Also, some candidates gave an abbreviated answer pd-pd, which gained no credit.
 - ii) Most gained a mark here for showing an intermolecular force in the correct place. Fewer got the mark for indicating the positions of the partial charges. Many candidates scored here, even if they had given an incorrect answer in the previous part of the question. A few

did not score because they showed a covalent bond forming, instead of indicating an intermolecular force.

Tip

Practice identifying the intermolecular forces between various pairs of molecules. Remember not to abbreviate the names of intermolecular forces on the examination paper.

- d)
- This was generally well understood. Many good answers were seen here, with many scoring both marks and with few failing to gain any credit. Common mistakes were incorrectly attaching the OCOCH_3 group to the chain via the C rather than the O, or forgetting to show the bonds at either end of the chain.
 - This was not generally well known. A significant number of candidates quoted addition again, or gave 'A-B type polymer'.
- e)
- This was often well answered, with many gaining two or three marks. There were a good number of excellent answers, with precise descriptions and good use of technical terms. Those who scored less well, or failed to score at all, gave answers that often included a quotation from the question about not packing together so well, without explaining what this meant. These answers tended to suggest fewer intermolecular forces, rather than weaker and discussed molecule movements without giving an indication of relative movements of the polymer chains.
- f)
- This was generally very poorly attempted, with most candidates showing a lack of knowledge of organic reactions and their conditions. Answers often had suggested reaction conditions with no reagent.
 - Most candidates correctly identified this as primary, but poor wording in their answers often meant they did not score the mark for explaining why it was primary. Candidates need to avoid the use of 'it' in exam answers ('it is on the end of the chain').
 - Few gained the mark here, which is disappointing when this functional group is shown and named in the n.m.r. table on the students' Data Sheet.
 - The most able candidates tended to score all three marks for their answer. As in (i), most did not score well, illustrating a lack of knowledge of organic reactions.
- g)
- The majority of candidates scored this mark.
 - Many gained the mark here, but a common error was giving the number of moles of ethanol inaccurately.
 - Many failed to score this mark because they thought that an equal mass of ethanol was formed, rather than an equal number of moles.
 - Most scored at least one here, with a significant number gaining both marks, although this was often as a result of error carried forward rules from previous parts of the question. Some failed to score the second mark because they did not give their answer to two significant figures, as was required.
- h)

- i) Answers to this question were generally poor, showing a lack of knowledge of organic reactions and their conditions, with few gaining a mark here.
- ii) This was generally well done, with a majority scoring the mark for a sensible suggestion, often focusing on the low percentage yield.

Numerical answers 2gi 62.5, 46 2gii 0.16, 0.326 2giii 0.16 2giv20%

Question 3

This question showed a lack of knowledge and understanding of organic syntheses and reaction mechanisms.

- a)
 - i) Most gained the mark here.
 - ii) Many candidates misread this question, even though the word isomer appeared in bold type, and gave the full structural formula for 1-bromopropane. In these cases, many scored the second mark for the name under the 'error carried forward' rules.
- b)
 - i) Most scored the mark here for refrigerant or aerosol propellant, with only a few giving vague answers like 'aerosols' or 'refrigerators'.
 - ii) This proved a good question for the most able candidates, who scored well on both parts of the question and gained the mark for quality of written communication by using a range of key technical terms accurately. Some of the weaker candidates gained credit for answers to the first part, although answers tended to be rather vague and did not lead to the QWC mark being awarded. Good answers to the second part, explaining why n-propyl bromide might be less of a threat, were much rarer, with a common mistake being to suggest that the compound has stronger bonds than the CFC's and so is less likely to break down. Some candidates showed a poor knowledge of the names for parts of Earth's atmosphere, referring to the CFC reacting in the ozone layer, rather than the stratosphere and some candidates went up the wrong path completely and discussed issues of global warming.
 - iii) A good number of correct responses were seen here, with candidates being more specific (e.g.: cost of manufacture, toxicity) and wording answers more carefully than has sometimes been the case on questions like this in the past.
- c)
 - i) Many gained the mark here for either C_3H_8O or C_3H_7OH , although a common error was to give the name rather than the requested formula.
 - ii) It was common for at least one mark to be gained here for a correct equation and many went on to score the second mark for state symbols too.
 - iii) Few scored here, showing a lack of knowledge of basic practical techniques.
 - iv) This mark was rarely awarded, with many giving answers such as recrystallisation as an incorrect response, even when they had correctly identified the physical state of the product as liquid in a previous answer.
 - v) It was extremely rare for a candidate to score any marks here, showing a generally very poor understanding of organic reaction mechanisms. A few gained the mark for showing attack by the bromide ion and some good candidates correctly completed the intermediate by showing the hydrogen bonded to the oxygen. Many left this completely unanswered.

Question 4

The quality of answers to this question was very varied.

a) Most gained this mark for a clearly worded suggestion such as more complete combustion or use of lean burn engines.

b) Again, the majority of candidates scored this mark.

c)

i) Most got the first mark for stating that the energy comes from the Sun. Fewer gained the second mark; in many cases this was because they misread the question and described the position of infrared in the electromagnetic spectrum.

ii) Most candidates gained the first mark for increased vibration, but fewer went on to link this to increased kinetic energy that was the cause of higher temperatures.

d)

i) Many good answers were given in which candidates scored all three marks for clear descriptions of the effect of the increased concentration of aqueous carbon dioxide on the position of equilibrium and its impact on both reactions. Those who mentioned equilibrium usually scored at least two.

ii) Many gained one mark for stating that the forward and backward reactions are going at the same rate, but it was less common to see the second mark being scored for mentioning the effect on the concentrations or that the system must be closed.

iii) Only the best candidates scored the mark here for suggesting that the system is not closed.

e) A large number of good answers were seen here, with clear comparisons being made between the structures and the strength of forces involved, although candidates were sometimes careless in their use of technical terms when describing structures. Weaker candidates often gave answers that dealt with carbon and silicon rather than their oxides.

2849 – Chemistry of Materials

General Comments

All Assistant Examiners reported that the paper was set at the appropriate level of difficulty and was a good test of the candidates' knowledge and understanding over a wide range of topics. The questions allowed candidates from the whole ability range to gain credit. Only a few examples of very low scores were seen, the range of marks indicated that the paper was able to discriminate effectively. There was no evidence that the new paper formatting now in use compromised the candidates in constructing effective responses. Neither were there any signs of candidates running out of time; no blank spaces or deterioration of writing in the final questions were noticeable.

As in January 2005, it was noted that many candidates across the ability range did not seem to have had time to revise fully for this unit at this time. Candidates' difficulties involved confusing the need to describe a reaction or process with an explanation of why it happens. Some were muddled in their responses to the spectroscopy questions, confusing infrared and nuclear magnetic resonance data, whilst others brought mass spectrometry into the wrong frame. Poor attention to information and data contained within a question was also responsible for many lost marks.

Some candidates' marks in longer answers were limited by their ability to express themselves clearly and grammatically in English, with legible handwriting. Many candidates find the writing of chemical formulae difficult and attention must be paid to this important skill.

With one notable exception (see comment below) the calculations were tackled effectively and answers written to an appropriate number of significant figures.

It was pleasing to see a good improvement in the understanding of colour and knowledge of electrode processes.

Many low marks for the last question highlighted the lack of coverage by many centres of the specification material found largely in the *Storylines*.

Comments on Individual Questions

- 1)
 - (a) Too many thought natural fibres were non-renewable and would 'run out'.
 - (b) Most candidates got this correct; those that didn't tended to copy out the repeating unit and failed to add the extra atoms to each end.
 - (c) In part (i) answers based on a six-carbon chain were not uncommon. Some confusion of *Stanyl* with nylon-6,6 and nylon-6, which caused incorrect responses.

Many answered the second part of the question by attempting to explain why the properties were different without saying what the properties were.

Teacher's tip

Candidates need practice in 'reading' questions carefully so that they answer the question asked. In this case 'Describe' not 'Explain' indicates the type of response required.

- (d) Many calculated the relative molecular mass incorrectly but then used it correctly although it was common to see answers given to several decimal places. Others decided the answer was 2, probably interpreting the question as asking for the number of different monomers used to form the polymer.

Some gave 'peptide' alone instead of 'amine' and thus failed to gain the mark.

Most gained marks on the final part. Attention should be drawn to the fact that the essential point is the strength of forces between chains and that melting point is related to the amount of energy required to separate the chains.

- (e) Few remembered or recognised that the diamine would be in its ionic form, whilst a significant number suggested that the diol chloride would form. The diagrams to show water hydrogen bonding to the polymer were generally excellent. A few drew a water molecule which was hydrogen bonded to two distant oxygen or nitrogen atoms, and there were still some HO₂ molecules around.

- 2) (a) Only good candidates were able to get both the sign and number correct for the oxidation state of vanadium.

Generally, in part (ii), the standard of drawing was acceptable although a number of candidates were unaware of how to represent a cell using platinum as an electrode for the mixed vanadium salt cell. Also many candidates did not know how to draw a Standard Hydrogen Electrode. It would be nice to see greater use of rulers and pencils showing that candidates had a pride in what they do. Standard conditions were often omitted. Very few got two correct vanadium ions or a platinum electrode. The marks here were very centre dependant.

- (b) Most were able to calculate the electrode potential of the cell, 1.26 V being the common error, sometimes even by the ablest candidates.
- (c) In part (i) ionic equations with electrons on both sides of the equation were common though the answer was often correct.

A great many correct answers for this more complex reaction were seen although candidates seemed unaware of the necessity to balance charge as well as symbols. V³⁺ and V²⁺ were often written on the wrong side of the equation.

- (d) Many candidates could represent the octahedral shape of the complex well, some knew how to use the straight line/wedge/dotted line method although some used a variation on the recognised method.

Showing the oxygen atom of the water molecule bonded to the central cation at each point of the octahedron was less accurate particularly on the right hand side of the diagram. A significant minority were not aware that water was the ligand in a hydrated ion.

Some errors in the number of electrons used for the electron structures of V and V³⁺ were seen, but a number of candidates forgot that it is the 4s electrons that are first lost when ionisation occurs. Also it was common for candidates to take more than three electrons away when drawing the V³⁺ ion when the V atom was correctly identified.

Many candidates knew that colour of transition metals ions is due to the absorption and transmission of light. However, the most common error was to assume that the absorbed light was re-emitted as complementary light when the excited electron fell back to the ground state.

Only the better candidates recognised that it was the interaction between the ligand and the d orbitals that resulted in the energy level split that allowed electrons to be excited.

- 3) (a) This was a difficult question but there were many good attempts and some marks were gained. Many based their answer on heptanoic acid, whilst others did not include the C of the carboxyl group in their carbon count.
- (b) Generally good but a significant minority failed to recognise the ester link with many selecting the ketone or one atom or bond within the ester.
- (c) Most candidates were able to describe why refluxing is carried out though 'to prevent evaporation' was a common mistake.

Many failed to use the information in the stem and thought that the method of obtaining a pure sample of **D** was recrystallisation.

The conversion of the salts to their acids was a problem for most candidates. They thought that it necessitated refluxing, mistaking the reaction for hydrolysis. Not many gained the mark for use of an acid.

The ethanoate ion was correctly identified by name and by formula by the better candidates, although ethanoic acid or ethanol was frequently seen.

- (d) This mass spectrometry was generally well answered; although a number of candidates knew the spectrum represented ethanol they did not draw its structural formula. Use of the data to support their selection was good. A significant number thought that the peak at 46 was due to ¹³C. Also very few used their knowledge of organic chemistry to work out what **D** was, given that they had been told it was a product of ester hydrolysis. Some thought the compound was methanoic acid. A significant number of candidates did not attempt this at all; this was centre dependant.
- (e) Good answers were seen here even by weak candidates although the relative intensity of the various protons was not answered well. Many also lost a mark by failing to correctly represent protons next to the ester group.

- (f) Good answers were seen here also even by weak candidates although when quoting the wave numbers few candidates included the units. Many also included information about the C–O single bond. Candidates were also guilty of using incorrect data from the Data Sheet. Some candidates did not appear to realise that the carboxylic acid functional group is made up of two parts. Some described how to carry out infrared experimentally, rather than explain its use. Some tried to write about n.m.r.
- (g) A frequent error in this type of question is to refer to the wrong substance and this was true here although the increase in water solubility, lack of smell and the fact that it is a solid was well recognised. A significant number of students did not seem to have considered carefully the information given at the start of the question.

- 4 (a) Most candidates recognised this as stereoisomerism although a few misread the question and simply repeated the name for the acid. A few thought that it represented geometrical isomerism.

Good examples of accurately drawn mirror images were seen although some candidates chose to draw two-dimensional versions. A frequent error was to write N_2H instead of NH_2 , and join the COOH to the chiral carbon via the H. Weaker candidates did not know how to use the wedge/dotted line to imply a 3-D effect in their diagrams. Not every candidate who could draw the correct mirror images could explain isomerism.

- (b) Suitable construction lines were generally clearly shown, but there was much sloppiness resulting in their quoted values being outside the acceptable level of accuracy. A large number of candidates failed to calculate the half-life correctly or put the units in; they gave cumulative values for the 2nd and 3rd values.

Most candidates knew that a reaction is first-order if the half-lives are constant, even if in their answer they were not. This did not seem to bother them.

Candidates often did not know how to interpret the information and write a correct rate expression, many included the d isomer in their equation and a few confused this with writing an expression for the equilibrium constant. Many missed out the rate constant.

Few candidates knew how to work out the units of the rate constant correctly. The commonest incorrect answer was $\text{mol dm}^{-3} \text{s}^{-1}$.

Again, few candidates knew the significance of the relationship being tested here and correct answers were rare. It was usually the ablest who scored here.

- (c) Over 90% of candidates could name the zwitterions though perhaps only half of these could spell it correctly.
- (d) Most got the expression for the equilibrium constant correct, those that got it wrong missed out the H^+ or quoted the equation upside down.

Although many answers were quoted to the correct number of significant figures many candidates got this question wrong. This was because they divided by 2 instead of square rooting even when they were starting with the correct expression for the equilibrium constant. It was disappointing to see this on such a large scale.

- (e) This question proved a very good discriminator and some really good answers were seen. Most candidates scored the marks for describing the primary and secondary structures of proteins. Many failed to appreciate that in a protein the zwitterion no longer exists and so used the +/- charge on the zwitterions to explain solubility and its effect on enzyme action. Many candidates knew the ability to hydrogen bond to water gave solubility but did not identify the extra carboxylate group as the source of the hydrogen bonding. Many also failed to realise that the aspartic acid is locked into a chain and therefore the amino group is not available to hydrogen bond.

Many candidates failed to read the 'how' in the last part and simply gave the traditional, biological, account of lock and key sites.

The QWC mark was gained by most candidates.

- 5 Probably the hardest question for most, yet very centre dependant. It was clear that some centres had covered this work in good detail with their candidates understanding the steelmaking process. Many gained only one or two marks overall, usually one of these was for 'rail tracks' in (a).

- (b) Many candidates thought that magnesium was added to the pig iron to harden it rather than to remove sulphur as magnesium sulphide.

Although the use of oxygen to remove carbon was well known a number of candidates thought that air was used. The formation of CO rather than CO₂ was the usual explanation.

- (c) Very few candidates knew that phosphorus oxide is an acidic oxide and many different terms were recorded as the answer here, mostly referring to redox.
- (d) Most candidates knew the formula of calcium oxide but few could write the formula of phosphorus(V) oxide correctly. Even less knew the formula of calcium phosphate.

The addition of phosphorus at the end of the process to gain the desired percentage component was reasonably well remembered but less so the reason for the addition of aluminium. Many candidates thought that aluminium made the steel lighter, harder, or improved its anti-rusting properties. These two questions were also often left undone.

- (e) This last question was not answered well, many vague answers were seen. Most referred to impurities but failed to identify why/how this was a problem for the chemists. A few remembered something about copper extraction from AS and had chemists discovering suitable bacteria to break down steel, since it was non-biodegradable.

2850 – Chemistry for Life

General Comments

This paper proved more challenging than those in recent sessions and the lower grade boundaries reflected this. The mark scheme was eased to try to allow candidates a wider range of acceptable answers. Nevertheless all suggested responses were met by the candidature and a very wide range of marks, from single figures to 70+, was achieved. Calculations again were broadly well done but disappointingly some of the more standard knowledge-based questions were poorly answered, such as explaining why fuel burning is exothermic in terms of bond breaking and making.

Examiners did express some concern that there appeared to be some very weak candidates entered for this early session and perhaps the more stretching nature of some of the questions on this paper highlighted the problem.

Questions 2 and 4 showed the widest range of marks, with some bunching on questions 1 and 3.

Time once more did not seem an issue.

Comments on Individual Questions

Q 1 This short question provided candidates with relatively easy marks until part (c) which was designed to allow the better candidates the chance to use their thinking skills and previous GCSE knowledge. A small but significant minority, not all resit candidates, did have some success in this section.

(c) This part question was graded at the higher mark grades and the hope was that candidates would make the leap from their GCSE knowledge of diatomic hydrogen gas to suggest possible combinations that would result in the appropriate mass peaks. Many candidates did come up with sensible suggestions although rarely did the Examiners see full marks in this section. One of the marking points was for showing, on any of the suggested particles, a positive charge. This point was only scored by a very small number of candidates.

Q 2 Candidates often found this question difficult and there was a wide range of marks. Parts (c), and particularly (d), were very Centre dependant.

(a) This was not a classification exercise. It was hoped that candidates would spot 'precipitates' in the stem and be aware that this was not likely to indicate a gas, liquid or indeed solution.

(b) A common error was 'thermal decomposition' (of what?).

(c) Very disappointing. Large numbers of candidates drew covalent structures and some hedged their bets and drew both. The question was however very Centre dependent with candidates from several Centres getting full marks.

Tip for candidates

Put square brackets, [], around dot-cross diagrams representing ions and make sure you put the correct ion charges outside the brackets. (See the *Ideas* book.)

(d) Very Centre dependent, but a common error was to suggest that the electricity was carried by the electrons.

Report on the Units taken in January 2006

- (e) This question discriminated well. There were still problems with significant figures.
- (g) Those choosing the correct graph (A), generally then went on to gain all the marks. A common wrong answer was graph D but a mark was made available for suggesting why the ionisation energies should increase.

Numerical answers: 2(e) 0.054; 2(f) 3000 – 3200

Q 3 This proved a fairly straightforward question for many candidates.

- (a)(i) A surprising number of candidates drew diagrams representing an exothermic reaction and double headed arrows were a common error when labelling the enthalpy change of reaction.
- (b)(i) Generally well answered. Common errors include missing the sign off the final answer and wrongly combining the sums of reactant and product enthalpies of formation.
 - (ii) This was not intended as a difficult question for candidates and many realised that measurements such as temperature change and the mass or volume of the appropriate reactants would be required. However a common wrong response was to suggest that the number of moles of a reactant should be measured, failing to realise that this would be a calculated value from measurements of mass etc.
 - (iii) Most candidates had little difficulty in gaining three marks, with the mark for indicating there were more moles of product commonly being the elusive fourth.
- (c)(i) Straightforward for most candidates.
 - (ii) A fairly wide range of suggestions were given credit.

Numerical answer: 3(b)(i) +34

Q 4 Not generally a high scoring question. Parts (c)(i), (c)(iv) and (e)(i) and (ii) proved most difficult.

- (a) Fine.
- (b) Although many candidates got full marks a sizeable minority produced structural formulae instead of skeletal.
- (c)(i) Not well answered. Many candidates failed to realize that the mole ratio translated to the same ratio by volume, with spurious use of 24dm^3 often creeping in.
 - (ii) The mark scheme merely required the fact that changes in temperature and pressure affect gas volumes. Discussion in terms of rate was a common wrong answer.
 - (v) Rather disappointing with many candidates getting totally confused about which process requires energy and which releases it. The use of scientific language was also generally poor.
- (d) Reasonably answered. A common mistake was to relate the higher octane number for autogas to chain branching rather than shorter molecules.
- (e)(i) A considerable number of candidates simply multiplied the enthalpy change of combustion of propane by propane's M_r value, failing to convert the 1.0 kg into moles as a first step.
 - (ii) A simple answer in terms of the greater number of molecules of autogas compared to petrol was all that was required here (although more sophisticated answers were given credit), following the ideas in the 'Developing Fuels' storyline (assignment 2).

Numerical answers: 4(c)(i) 25; 4(e) 50,000–52,000 depending on rounding

2854 – Chemistry by Design

General Comments

This paper was taken by 74 candidates only, the vast majority of these retaking the paper after their second sixth-form year. Candidates showed that they had worked hard on the concepts of the final Salters units. Some came unstuck on the more synoptic questions requiring general chemical understanding. Calculations were often correct and good attempts were made at the long-answer parts.

Comments on Individual Questions

Question 1

Candidates found this question quite hard as, in many places, it tested chemical understanding rather than defined topics. In part (a), the idea of *contrast* was needed and many candidates scored this. They found part (b)(i) very difficult and hardly any scored here. Part (b)(ii) was negotiated successfully by most, though part (b)(iii) caused difficulties, with some candidates giving the formulae of non-phosphorus acids. Part (c)(i) was much better. In part (c)(ii) most candidates picked redox but failed to give sufficient reason. Mention of oxidation states, or certain other details, were needed to score here. Most candidates scored on part (d)(i), but the commonest answer to part (b)(ii) had a balanced equation but without the water cancelled – this only scored partial credit. Scoring on part (e) was variable, with good candidates scoring all three marks. In part (f)(i), most candidates answered in terms of complete dissociation and many gave a correct equation. The vast majority of candidates scored in part (f)(ii). Part (g) was often correct. The commonest error was not to extend the line drawn beyond the 500 mark.

Question 2

This question was also found hard, even though it was more focussed on the organic chemistry in *Aspects of Agriculture and Medicines by Design*.

In part (a)(i), many candidates found the number of hydrogen atoms difficult to count and quite a number misidentified the number of carbon atoms as well. Part (a)(ii) was done better, though ‘ketone’ was quite often identified, erroneously. Most could identify one of the two chiral carbons correctly (which one varied) but relatively few got both. Part (a)(iv) was often answered in terms of the double bond’s ability to rotate. Correct answers were relatively rare. Part (b)(i) was usually correct and most candidates scored several marks but not all in part (b)(ii). The link between octan-1-ol and fat was seldom made. Part (c) had a much higher success rate and most candidates could suggest at least one correct property in part (d). Candidates did not gain credit where they suggested properties that current modern pesticides already possessed. In part (e)(i), very few candidates realised that this was *radical* bromination. Perhaps as a result, many thought that both **X** and **Y** were bromine in part (e)(ii). Part (e)(iii) was better done, though it was clear that some candidates could not easily make the link to the reaction shown on the Data Sheet.

Question 3

This question was mainly from the *Oceans* topic and candidates often found it slightly easier. Parts (a)(i) and (ii) were often correct. Part (b) caused a lot of problems. The majority of candidates described the forces between water molecules and ions as hydrogen bonds. Some talked about the fact that it was difficult to break the strong covalent bonds in carbon dioxide when it dissolved. Most candidates mentioned the intermolecular forces between carbon dioxide and water (about half of these describing them correctly as hydrogen bonds) and many mentioned that they were weaker than the intermolecular forces between ions and water. Ideas of having to break down the ionic lattice or compensate for the hydrogen bonds between water molecules were seldom found. In part (c), the most commonly scored mark was for lattice enthalpy with hydration/solvation and solution enthalpies often being missing or muddled. Few really got to grips

with part (d). Many, however, scored one mark for saying that ΔS_{sys} would be positive. Part (e)(i) was almost invariably correct and many managed to make the re-arrangement and the substitution to get the correct ratio in part (e)(ii). Again, the mass calculation was often correct in part (e)(iii). In part (e)(iv) many candidates scored marks for the effect of H^+ on the equilibrium and the fact that the pH remained constant. Very few related this to the large concentration of HCO_3^- , however.

Numerical answers: (a)(i) $1 \times 10^{-8} \text{ mol dm}^{-3}$ (a)(ii) $1 \times 10^{-6} \text{ mol dm}^{-3}$ (e)(ii) 45
(e)(iii) 2.8 g

Question 4

This question was found more accessible by the candidates. Many scored on parts (a) and (b) and the most common error in part (c) was the failure to express the answer to two significant figures. Most candidates scored some or all of the marks in part(d)(i), losing credit, in some cases, for not specifically mentioning equilibrium. In part (d)(ii), candidates must be aware that answers in terms of cost alone seldom score much credit. Here one mark was possible just for mentioning expense (with some discussion) but for full credit the cost of maintaining the pressure or building the high-pressure plant was necessary and this was rarely seen. Part (e)(i) was usually well done, with few square brackets in sight. The calculation in part (d)(ii) was usually correct, though some missed the negative index in "atm⁻¹". Part (f)(i) was usually correct but in part (f)(ii) relatively few candidates realised that the O–H absorption could not be used because of water vapour in the breath. Part (g)(i) and part (g)(ii) were usually correct. The standard of diagram drawing was not good but many candidates scored two or three marks. The commonest errors were horizontal condensers and sealed apparatus. Part (i) was often done well, particularly the infrared section. Most candidates scored something on the n.m.r. section, but there was a tendency to identify a peak at chemical shift 0.8–1.2 rather than 2.2. Candidates were given credit if they *implied* that both compounds gave two peaks but they had to be more precise about the fact that the *relative intensities* of the peaks were 3:1.

Numerical answers: (c) 1.6 kg (e)(ii) $5.4 \times 10^{-3} \text{ atm}^{-1}$

Question 5

This was another good question for many and showed overall a sound understanding of 'Colour by Design'. Part (a) was often correct but the name of the group (azo) was not always known. Part (b)(ii) was better done than in previous sessions. Most candidates said where the electrons came from but fewer indicated the shape and position of the delocalised electrons. Part (c)(i) and (ii) were usually correct, the omission of 'concentrated' being the commonest error in the latter part. Some failed to mention that it was a *hydrogen* atom that was substituted in part (c)(iii). The description of electrophile was done fairly well, though few scored the mark for the covalent bond that forms. Part (d) was again better done than in earlier sessions. Candidates who avoided talking about the *emission* of light when the excited electron drops back usually scored at least three marks. The mark most often missed was the relation between the *difference* of the energy levels and the frequency of the light.

2855 – Individual Investigation

General Comments

The entry for this component was very small, consisting of only eleven candidates from seven Centres. Other Centres had made entries but these were made in error or the candidates were withdrawn after the entry had been made.

In over half the Centres the marks awarded by the Centre were felt to be wholly appropriate. In other cases the marks awarded by Centres were inappropriate as the marking descriptors at the levels selected had not been clearly met.

In examples of good practice, Centres explained why specific marks had been awarded in each skill area by matching candidate performance against specific coursework descriptors. In less good practice, explanations were given in much more general terms and did not make clear why higher marks had not been given.

Few of the Centres included documentary evidence with the moderation sample to support the award of marks for the manipulating strand of the implementing skill area. This should refer to key features of candidate's performance such as safe working, handling of equipment and materials, attention to detail including the accuracy of measurements, ability to solve problems and time management.

Comments on Individual Skill Areas

Planning

To meet the descriptors at level 11 it is necessary for candidates to include fine detail of their plan. This might, for example, describe preliminary experiments undertaken to decide on suitable conditions to use, explain why a particular range of conditions have been chosen or describe how a specific temperature was maintained throughout an experiment or how several readings enabled an average temperature to be calculated. Such fine detail is particularly important where an investigation is chosen that is well documented and where basic methods are readily available. It is also necessary at this level to include a comprehensive account of the chemical ideas which have been researched during preparation for the investigation. It is, for example, expected that candidates will refer to the Arrhenius equation when planning experiments to explore the effect of temperature on rate of reaction and the Nernst equation when making use of electrode potentials. Risk assessments of acids and alkalis should be appropriate to the concentrations of the solutions used.

References

It has become increasingly common for candidates to include references to the internet. These should contain a brief description of the content of the link and not simply be a complicated web address.

Implementing

Where a titration is used during an investigation, all burette reading should be recorded and not just the titres. Where titres are very low, it is expected that candidates will dilute one of the solutions and carry out further titrations to generate higher titre values. If this is not done, then the data will not be of sufficient quality to meet the descriptor for the recording strand of implementing at level 8. The quantity of data collected and reported is expected to be that which might reasonably be expected from between 15 and 20 hours spent in the laboratory. Data collected

from preliminary experiments should be recorded and will contribute to the overall amount of data collected.

Analysing

In some cases, candidates did not meet the higher level descriptors because they did not clearly link their conclusions with underlying chemical knowledge and ideas. Some candidates did not take sufficient care in their choice of tangents drawn on graphs in order to find the initial rate of reaction.

Evaluating

The calculation of uncertainties associated with measurements has improved over the past few sessions, but some candidates do not consider all types of measurements that they have made. Currently, however, it is the identification of limitations of experimental procedures that is less well done and which prevents candidates from accessing the highest mark levels.

**Advanced GCE Chemistry (Salters) (3887/7887)
January 2006 Assessment Session**

Unit Threshold Marks

Unit		Maximum Mark	a	b	c	d	e	u
2848	Raw	90	65	58	51	44	37	0
	UMS	120	96	84	72	60	48	0
2849	Raw	90	65	58	51	44	37	0
	UMS	90	72	63	54	45	36	0
2850	Raw	75	52	46	40	34	28	0
	UMS	90	72	63	54	45	36	0
2854	Raw	120	85	76	67	58	50	0
	UMS	120	96	84	72	60	48	0
2855	Raw	90	76	68	60	52	44	0
	UMS	90	72	63	54	45	36	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
3887	300	240	210	180	150	120	0
7887	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
3887	13.5	32.5	55.6	80.4	96.3	100.0	390
7887	25.5	61.8	85.5	94.5	100.0	100.0	66

456 Candidates aggregated this session.

For a description of how UMS marks are calculated see:
www.ocr.org.uk/OCR/WebSite/docroot/understand/ums.jsp

Statistics are correct at the time of publication.

Report on the Units taken in January 2006

Discover through examination

Examiner / Moderator Application Form

Become an examiner with



- ☆ **Improve Your Professional Status & Personal Development**
- ☆ **Help Your Students Improve Their Exam Results**
- ☆ **Boost Your Income**
- ☆ **Full Training & Support Provided**

Apply now and join the OCR examining team

Phone: 01223 552558 or visit www.ocr.org.uk

Email: examiner.recruitment@ocr.org.uk



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

OCR Information Bureau

(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

© OCR 2006

