

Oxford Cambridge and RSA Examinations



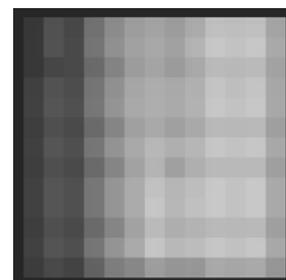
ADVANCED GCE
ADVANCED SUBSIDIARY GCE

A2 7887
AS 3887

CHEMISTRY (SALTERS)

COMBINED MARK SCHEME
AND REPORT FOR THE UNITS
JANUARY 2005

AS/A2



3887/7887/MS/R/05J

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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.

The report on the Examination provides information on the performance of candidates which it is hoped will be useful to teachers in their preparation of candidates for future examinations. It is intended to be constructive and informative and to promote better understanding of the syllabus content, of the operation of the scheme of assessment and of the application of assessment criteria.

Mark schemes and Reports should be read in conjunction with the published question papers.

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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	9
2850	Chemistry for Life	19
2854	Chemistry by Design	27

REPORT ON THE UNITS

Unit	Content	Page
*	Chief Examiner's Report	37
2848	Chemistry of Natural Resources	38
2849	Chemistry of Materials	41
2850	Chemistry for Life	46
2854	Chemistry by Design	49
2855	Individual Investigation	53
*	Grade Thresholds	55

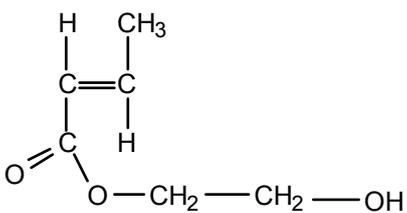
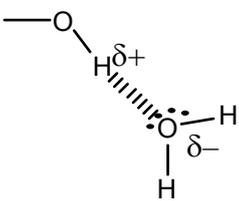
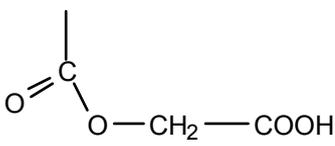


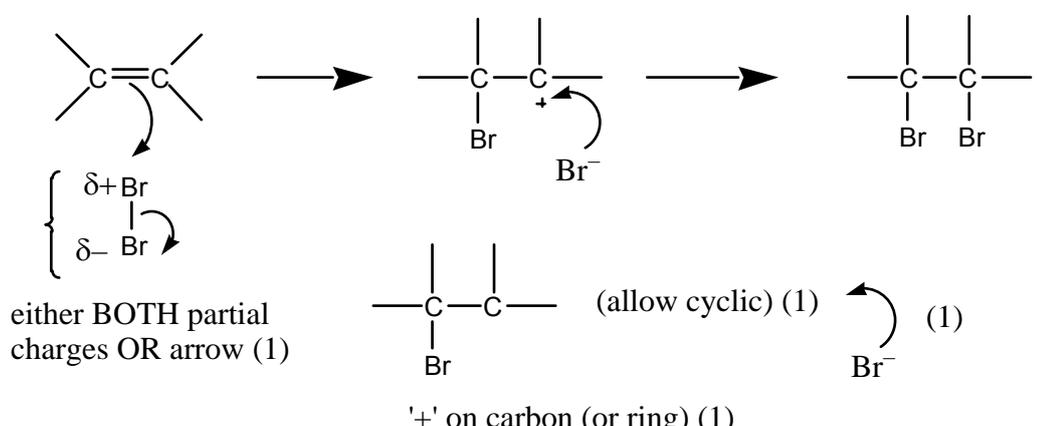
RECOGNISING ACHIEVEMENT

Mark Scheme 2848
January 2005

1 e ii	They are recycled/not used up/ <u>remain</u> unchanged (AW) (1); Catalysts provide a route with <u>lower activation enthalpy/energy</u> (<i>accept; They lower the activation e.</i>) (1)	2
1 e iii	CFCs/halogenoalkanes/ named halogenoalkanes <i>NOT chlorine</i>	1
1 e iv	radical(s)	1

2 a	copper(II) oxide (1); copper(I) oxide (1) <i>ignore gaps</i>	2
2 b i	$\text{CO}_3^{2-} + 2\text{H}^+ \rightarrow \text{CO}_2 + \text{H}_2\text{O}$ (2) $\text{CO}_3^- + \text{anyH}^+ \rightarrow \text{CO}_2 + \text{anything}$ scores (1) $\text{CO}_3^{2-} + \text{H}^+ \rightarrow \text{CO}_3^-$ (1) $\text{CO}_3^{2-} + 2\text{H}^+ \rightarrow \text{H}_2\text{CO}_3$ (1)	2
2 b ii	protons are transferred (AW) (1); carbonate/ CO_3^{2-} (<i>allow ecf on formula from (i)</i>) (1)	2
2 b iii	They are unaffected/ unreacted/spectator ions / they go from the lattice/malachite(1); They end up in solution/ form copper chloride (<i>but NOT "molecules" or copper-chlorine bonding implied</i>) (1)	2
2 c	$3s^2 3p^6 3d^{10} 4s^1 / 4s^1 3d^{10}$ (2) $3s^2 3p^6 3d^9 4s^2 / 4s^2 3d^9$ scores (1)	2
2 d i	M_r chalcopyrite = 184 (1) <i>stated or implied</i> $\% \text{Cu} = 64 \times 2 / 184 = 0.70(\%)$ [1] <i>2 sig figs (mark separately and award provided answer is less than 2%)</i> (1)	3
2 d ii	froth flotation <i>or a description (in which case ignore name)</i>	1
2 e i	$4\text{CuFeS}_2 + 10.5\text{O}_2 \rightarrow 4\text{Cu} + 2\text{FeO} + \text{Fe}_2\text{O}_3 + 8\text{SO}_2$ +2 0 0 +2 +3 +4 all correct (3); four/five correct (2); two/three correct (1) <i>Do not award third mark if signs follow numbers</i>	3
2 e ii	sulphur dioxide/ SO_2 (1); is toxic/harmful to life/causes respiratory problems/ causes acid rain (1) <i>IGNORE any other reasons given</i>	2
2 f i	$M_r \text{SO}_2 = 64$ (1) <i>stated or implied</i> $320/64 = 5$ (1)	2
2 f ii	Twice as many moles of NaOH as SO_2 <i>stated or implied</i> (1) (10 moles) volume = moles/conc. <i>stated or implied</i> (1) (10/0.5) calculation leading to answer (1) (20 dm ³)	3

3 a	 <p>double bond (1)</p> <p>completely correct (any chemically correct representation) (1)</p>	2
3 b	covalent/hydrogen (bonds)	1
3 c	 <p>hydrogen bond between H on one and O on other (1)</p> <p><i>allow dotted line but not continuous line</i></p> <p>at least one lone pair shown as starting point of bond (1)</p> <p>δ^+/δ^- shown correctly on O and H forming bond(1)</p> <p>(CON if OH^- shown, rather than $-\text{OH}$)</p> <p>straight line between two oxygens involved (1)</p> <p>(CON if OH_2 shown)</p>	4
3 d	<p>primary (1)</p> <p>attached to carbon which is attached to one carbon/attached to $-\text{CH}_2$ /end of chain(1)</p> <p><i>depends on first mark</i></p>	2
3 e i	 <p>$-\text{COOH}$ correct (can be displayed) (1)</p> <p>rest of structure correct (i.e. no extra CH_2) (1)</p> <p><i>OH on top bond scores (0)</i></p>	2
3 e ii	<p>(potassium) dichromate (1);</p> <p>(sulphuric) acid (1);</p> <p>reflux/ heat (AW) (<i>if first mark scored</i>) (1)</p>	3
3 f	<p>they are less abrasive (AW) to the eye/ they allow gases to pass through/more flexible</p> <p><i>allow more comfortable/can absorb tears/keep eyes moist/ last longer</i></p>	1

4 a i	brown/red/red-brown/brown-orange/red-orange (NOT orange) (1) liquid (1) <i>mark separately</i>	2
4 a ii	chlorine is more reactive because it displaces bromine/oxidises/takes electrons away from Br^- <i>ora reason must be given</i>	1
4 a iii	Br^- on left and Br/Br_2 and $\text{e}^{(-)}$ on right (only) scores (1) Completely correct: $2\text{Br}^- \rightarrow \text{Br}_2 + 2\text{e}^{(-)}$ (2) <i>electrons may be subtracted from LHS</i> <i>IGNORE state symbols</i>	2
4 a iv	oxidation (<i>ecf from a iii</i>) NOT redox	1
4 b	toxic (vapour)/ respiratory problems (1); corrosive/ dangerous to/blisters/damages skin (1)	2
4 c	$\text{Ag}^+(\text{aq}) + \text{Br}^-(\text{aq}) \rightarrow \text{AgBr}(\text{s})$ formation of AgBr (or another formula) (1); completely correct (1) <i>allow doubled</i> state symbols, provided $(\text{aq}) + (\text{aq}) \rightarrow (\text{s})$ (1)	3
4 d i	bromine is decolorised (1) NOT "clear"	1
4 d ii	 <p>either BOTH partial charges OR arrow (1)</p> <p>(allow cyclic) (1)</p> <p>'+' on carbon (or ring) (1)</p>	4
4 e i	light (<i>on its own or qualified "visible", "uv" "sun", "radiation"</i>)/u.v. (radiation)	1
4 e ii	homolytic	1
4 e iii	initiation	1
4 e iv	hydrogen bromide (<i>accept hydrobromic acid and HBr</i>) (1)	1
4 e v	bromoethane (1) <i>ALLOW 1-bromoethane</i>	1

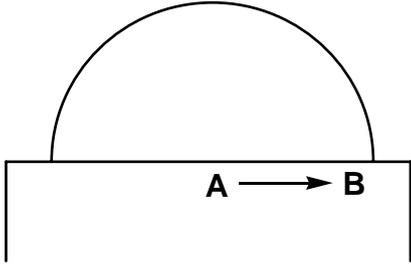
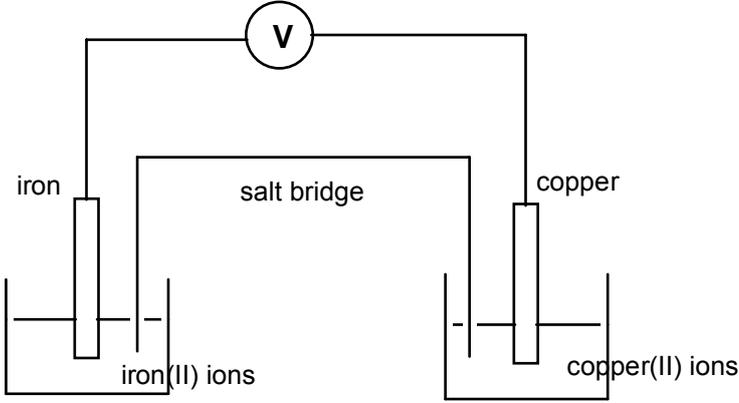


RECOGNISING ACHIEVEMENT

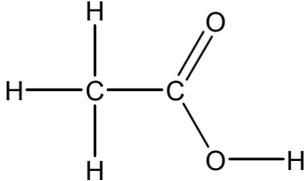
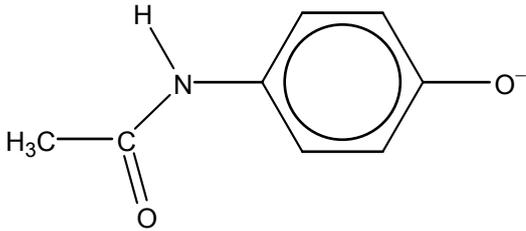
Mark Scheme 2849
January 2005

Question	Expected answers	Marks
1 (a)	Amino acids (1).	1
1 (b)	<p>1 mark for structure of organic ion and 1 mark for charge on amino group (2); 1 mark for chloride ion alone (1).</p>	3
1 (c) (i)	Asymmetric carbon atom / chiral centre (<i>carbon atom</i>) / carbon bonded to/ with AW 4 different atoms/groups (1).	1
1 (c) (ii)	Correct 3D structural formula for one enantiomer(1); Mirror images (1).	2
1 (d) (i)	<p>1 mark for one COOH group and one NH₂ group structure in molecule (1); 1 mark for rest correct for either structure (1).</p>	2
1 (d) (ii)	<p>1 mark for correct group (1).</p>	1
1 (e) (i)	<p>One mark each for points in bold and then any two others up to a total of 5 marks:</p> <p>Reaction/AW takes place at active site; active sites have specific shapes / enzyme contain hole or cleft with specific shape; due to the tertiary structure of the enzyme / way it folds; only one of the enantiomers will fit in the active site AW; interactions between arginine and active site weaken bonds; activation energy is lowered; high temperatures cause intramolecular forces to break and active site is lost; at low temperatures rate is slow since activation energy is not often reached.</p>	5
1 (e) (ii)	<p>Rate = $k \times [\text{arginine}] \times [\text{enzyme}]$ 1 mark for [arginine] and [enzyme] (1); 1 mark for rest correct (1); $\text{mol}^{-1} \text{dm}^3 \text{s}^{-1}$ (1).</p>	3

1 (e) (iii)	rate will not alter/rate does not depend on (1); as concentration (of arginine) increases/ concentration (of arginine) (1) AW.	2
Total mark		20

Question	Expected answers	Marks												
2 (a) (i)	Carbon (1).	1												
2 (b) (i)	$\text{Fe} \rightarrow \text{Fe}^{2+} + 2\text{e}^-$ Correct formulae for reactant and product (1); electrons balanced correctly and on RHS (1).	2												
2 (b) (ii)	$\text{O}_2 + 2\text{H}_2\text{O} + 4\text{e}^- \rightarrow 4\text{OH}^-$ Correct formulae reactants and product (1); electrons and formulae balanced correctly and on LHS (1). <i>Allow halved/doubled equation</i>	2												
2 (b) (iii)	 <p>Arrow correct direction (1); arrow only shown in steel (1).</p>	2												
2 (b) (iv)	Oxygen/air (concentration) is lower at A than B / ora (1).	1												
2 (c)	<table style="margin-left: auto; margin-right: auto;"> <tr> <td></td> <td style="text-align: center;">3d</td> <td style="text-align: center;">4s</td> </tr> <tr> <td>Fe</td> <td style="text-align: center;">  </td> <td style="text-align: center;">  </td> </tr> <tr> <td>Fe²⁺</td> <td style="text-align: center;">  </td> <td style="text-align: center;">  </td> </tr> <tr> <td>Fe³⁺</td> <td style="text-align: center;">  </td> <td style="text-align: center;">  </td> </tr> </table> <p>Correct number of electrons in Fe (<i>8 electrons</i>) (1); loss of 2 and 3 electrons respectively for Fe(II) and Fe(III) (1); correct arrangement for all 3 (1).</p>		3d	4s	Fe			Fe²⁺			Fe³⁺			3
	3d	4s												
Fe														
Fe²⁺														
Fe³⁺														
2 (d) (i)	 <p>metals connected to voltmeter only (1); correct solutions (1); salt bridge (1).</p>	3												
2 (d) (ii)	0.78 V (1).	1												

2 (d) (iii)	$\text{Cu}^{2+}(\text{aq}) + \text{Fe}(\text{s}) \rightarrow \text{Fe}^{2+}(\text{aq}) + \text{Cu}(\text{s})$ <p><i>Correct formulae (1); state symbols correct, allow for reverse reaction (1).</i></p>	2
2 (d) (iv)	<p>(Standard) electrode potential for Fe/Fe(II) is more negative than Cu/Cu(II) ora (1); means Fe is a stronger reducing agent than Cu ora / electrons will flow from Fe (atoms) to Cu(II) (ions) (1); additional/more AW Fe is converted into Fe(II) ions (and hence rust) (1).</p>	3
2 (e)	Rust layer no longer flaky/ layer adheres (more strongly) to steel / impermeable AW (1).	1
Total mark		21

Question	Expected answers	Marks
3 (a) (i)	<p>One mark each for points in bold and then any two others up to a total of 5 marks:</p> <p>Dissolve the sample in the minimum amount AW (1); of hot ethanol (1); filter (off any solid impurities) (1); leave (solution/filtrate) to cool/to form crystals (1); filter off crystals/decant solution (1); wash crystals and dry (1).</p> <p>QWC</p> <p><i>At least two readable and clear sentences with no more than one spelling, punctuation or grammatical error</i> (1).</p>	6
3 (a) (ii)	<p>Broad peak/absorbance around 3100 cm^{-1} indicates OH (in carboxylic acid) (1); Strong peak/absorbance around 1720 cm^{-1} indicates C=O (in carboxylic acid) (1); hence -COOH/ carboxylic acid (1). <i>The first two marks are for identifying the two important peaks, however much detail is given. These may be shown on the spectrum.</i></p>	3
3 (a) (iii)	 <p>Correct molecular formula (1); correct structure, OH not allowed (1).</p>	2
3 (a) (iv)	<p>M_r of acetaminophen = 151.0 (1); mass of pure acetaminophen in sample = 0.010×151.0 <i>i.e mol x M_r ecf but not if wrong compound is used to calculate M_r</i> (1); percentage = $(1.510 / 2.00) \times 100 = 75.5\%$ <i>ecf</i> (1).</p>	3
3 (b) (i)	Phenol/hydroxyl (1).	1
3 (b) (ii)	 <p>negative ion formed by proton loss (1); correct structure (1).</p>	2
3 (c) (i)	<p>Iron(III) chloride in solution is yellow <i>accept brown/ yellow or brown + orange/red</i> (1); phenacetin remains yellow/brown/colour does not change <i>ecf</i> (1); acetaminophen turns purple/violet (1).</p>	3

3 (c) (ii)

5

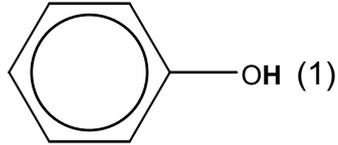
chemical shifts for **acetaminophen**

type of proton

relative intensity

4.5 -10.0 (1)

only one peak otherwise no marks



/phenolic OH

chemical shifts for **phenacetin**

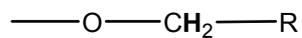
type of proton

relative intensity

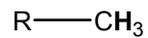
3.6

0.8-1.2 (1)

both peaks required



2



(1)

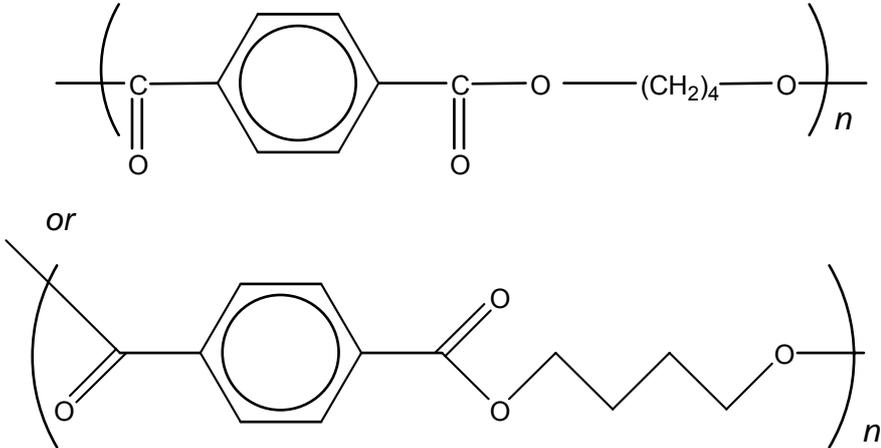
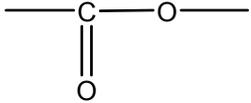
both proton types required

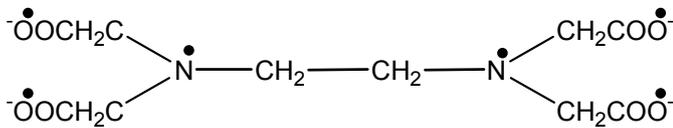
3

(1) *for relative intensities*

Total mark

25

Question	Expected answers	Marks
4 (a) (i)	A molecule is eliminated (often water) in the reaction AW (1); A big molecule/long chain forms from smaller molecules/monomers AW (1) <i>Do not accept 'polymer' for long chain etc.</i>	2
4 (a) (ii)	 <p>ester link correct (1); detail correct (1).</p>	2
4 (a) (iii)	 <p>(1).</p>	1
4 (b)	<p>One mark each for the two points in bold and then any one other up to a total of 3 marks:</p> <p>Polymers have crystalline/ordered and amorphous areas (1); in flexible/thermoplastic polymers chains can move past each other (1);</p> <p>when temperature is lowered/ temperature drops below T_g / then chains/structure eventually become(s) 'frozen'/have less energy (1);</p> <p>intermolecular forces unable to be broken therefore chains can no longer slide past each other (1);</p> <p>if force is applied chains can't move so material breaks (1).</p>	3
4 (d)	Use of copolymers/mixture of monomers (1); use of plasticisers/molecular lubricants (1).	2
Total mark		10

Question	Expected answers	Marks
5 (a)	Variable oxidation states (1).	1
5 (b)	 <p>1 mark for 6 marked sites (1); all correct (1).</p>	2
5 (c)	Octahedral (1).	1
5 (d) (i)	$K = \frac{[\text{Ni}(\text{edta})^{2-}(\text{aq})]}{[\text{Ni}(\text{H}_2\text{O})_6^{2+}(\text{aq})] \times [\text{edta}^{4-}(\text{aq})]}$ <p>Everything correct (2); Wrong way round (1) or only powers incorrect (1).</p>	2
5 (d) (ii)	Over to the right AW (1); K_{stab} is a large number / greater than 1(1).	2
5 (d) (iii)	Increasing temperature moves equilibrium position to the left AW (1); less (hydrated) Ni(II) ions are removed from solution/ less complex formed (1).	2
5 (e)	<p>Moles of edta solution = (Concentration x volume) 0.100 x 22.00/1000 (1); moles of edta = moles of Ni(II) (1); concentration of Ni(II) = 0.00220 x 1000/25.00 (1); = 0.0880 / 8.80 x 10⁻² 3 sig figs (1).</p>	4
Total mark		14



RECOGNISING ACHIEVEMENT

Mark Scheme 2850
January 2005

Abbreviations, annotations and conventions used in the Mark Scheme		/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit () = words which are not essential to gain credit _____ = (underlining) key words which must be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument
1 a i	53; 78; 53 respectively (one mark for each) (3) ecf on electron number from proton number	3
1 a ii	Same atomic no./element/number/amount of protons(1); different mass no./number/amount of neutrons(1) <i>NOT more neutrons</i>	2
1 a iii	2; -1; aluminium/lead; small (one mark each) mark individually	4
1 a iv	Weighted/Weighed/taking into account (relative) abundances/ Intensity/percentages(1); average/mean mass(1); of(naturally occurring) isotopes/atoms of different masses(1);	3
1 b	16,000 to 500 = 5 (half-lives) (1); (working shown gets this mark) 5 x 8days = 40days (ecf on half lives but not 'bare' answer of 48)(1)	2
		14

2 a i	Correct formulae(1 mark for each, must show <u>all</u> bonds) (2) ignore zig-zag (Allow 1 mark if <u>both</u> drawn correctly as skeletal)	2
a ii	Same molecular formula(1); different structure (1) (same number of each atom arranged in a different order scores 2) (<i>same <u>chemical</u> formula negates first mark</i>)	2
2 b i	M_r butane = 58 (1) ; moles = $36.0/58 = 0.62$ (1) (ecf from M_r) sig.figs(mark separately but must be on answer line if no working)(1)	3
2 b ii	$0.62 \times 24 = 15$ (14.88/14.9) (1) ecf from b i (ignore sig figs)	1
2 c i	Pressure builds up (1); leads to explosion/can bursts (1); mark separately	2
2 c ii	$C_4H_{10}(g) + 6.5O_2(g) \rightarrow 4CO_2(g) + 5H_2O(g)$ (or multiples) balancing (1); states (1) (1 or blank for C_4H_{10})	2
2 c iii	Bonds broken (1) $(3 \times 347) + (10 \times 413) + (6.5 \times 498) = (+)8408$ ecf on equation Bonds formed (1) $(8 \times 805) + (10 \times 464) = (-) 11080$ (numbers must follow on from student's equation) Overall enthalpy change from bonds broken/formed <u>with correct sign as follows from student values</u> (1) = $(-)2672$ ecf on bonds broken/formed Answer (ecf on above) per <u>mole</u> (1); (i.e. doubled answers, max. 3)	4
2 c iv	Same (1); same no. and type (1); of bonds broken and formed.(1)	3
2 d i	Aromatics must have at least 6 carbons/ based on benzene ring/4 or 5 not enough carbons (1)	1

2 d ii	No C or H atoms shown (1) (allow any \geq carbon skeletal formula eg methylbenzene, heptane etc) correct skeletal formula (1) (allow <u>one</u> mark for <u>correct</u> full/semi structural or dots)	2
2 d iii	More ways of arranging/more disorder(ed)/randomness (1); of particles/molecules (1); <i>NOT atoms</i>	2
		24

Question	Expected Answers	Marks
3 a i	$\text{Ra(s)} + 2\text{H}_2\text{O(l)} \rightarrow \text{H}_2\text{(g)} + \text{Ra(OH)}_2\text{(aq)}$ states (1); formulae (1); (HO ok) Balancing (1) (if RaO or RaOH or H used in equation allow balancing mark and state mark - must be (s) for RaO i.e. max 2)	3
3 a ii	Any 4 from : REACTIVITY: react by loss <u>outer</u> electrons/two electrons/to form <u>+2/2+</u> ions (last point sufficient on its own) SIZE : calcium/it is smaller atom/fewer e-shells/e's closer to nucleus (1) ATTRACTION : e's held more tightly/less shielding/greater/more attraction to nucleus (1); EASE OF LOSS : electrons harder to lose/get rid of/ion more difficult to form/more energy needed to remove electrons(1)	4 ora in all cases
3 b i	$\text{Na(g)} \rightarrow \text{Na}^+\text{(g)} + \text{e}^-$ state symbols (mark separately) (1); species (1) (Ignore <u>correct</u> isotopic symbols) (allow $\text{Na(g)} - \text{e}^- \rightarrow \text{Na}^+\text{(g)}$) (not β or ${}^0_{-1}\text{e}$)	2
3 b ii	electrons in <u>same shell/same</u> no. of shells/rings (1); <i>NOT energy level</i> nuclear charge bigger/greater nuclear/proton attraction/more protons/ e's held more tightly (1) <i>NOT more nucleons/magnetic attraction</i>	2
3 c i	1. F (1) and 2. E (1) respectively	2
3 c ii	Lines in exactly the same position/frequency/match up(1); energy transitions/quanta same/(1); (this second mark can be scored from diagram. But, treat diagrams with different up/down arrows as 'neutral') (1)	2
3 d i	(H_2S) lone pair (two dots) (1); (NH_3) lone pair (same symbol) (1); OCS (two dots /two crosses) (1)	3
3 d ii	H_2S (bent); NH_3 (trigonal pyramid); OCS (linear) (one mark each) (3) NB two labelled the same is CON	3
3 d iii	(Wedge bond) sticking out in front of (paper)/towards (1); dashed behind paper(1)AW (NB if reversed idea 3D = 1mark)	2
		23

Question	Expected Answers	Marks
4 a	Partially burnt fuel/incomplete combustion(of carbon) (1) Reaction between N ₂ and O ₂ /N and O/ nitrogen burns/combusts/oxidized by (oxygen)in air (1); independent of source of nitrogen Unburnt fuel (1)	3
4 b i	Advantage – less pollution (1) Disadvantage - gas (1) <i>See separate sheet of alternatives</i>	2
4 b ii	Advantage – higher ON (1) Disadvantage – corrosive/toxic/poisonous (1) <i>See separate sheet of alternatives</i>	2
4 c i	Heterogeneous (1)	1
4 c ii	Reactants/molecules adsorb on catalyst <u>or</u> absorbed onto catalyst <u>surface</u> (1) Bond/stick to <u>surface</u> (1) Bonds in reactants/molecules (weaken and) break (1) New/ bonds/products/molecules form (1) Products/new molecules/gases/leave/ diffuse away/ go into air/ from surface (1)	4
4 c iii	Poison adsorbs more strongly than reactants/doesn't get released/ can't get off (1); blocks/coats surface/ reactants can't get on/can't bond with surface (1);	2
		14

(Paper total 75)

Question 4b i & ii (supplementary mark sheet)

Hydrogen

Advantages	Disadvantages
(potentially) Plentiful source/renewable	Problem with storage/difficult to store/needs to be compressed/needs to be liquefied/high pressure fuel tank <i>NOT – needs to be refrigerated unless qualified</i>
(almost) Zero emissions/pollutants/only water produced/does not produce eg CO, CO ₂ , particulates	Expensive (at present)
Less danger of explosion/fire <u>because</u> diffuses/spreads out very quickly (i.e. qualified reason)	More danger of explosion/wider range of explosive limits
Higher energy density	Leaks easily/hard to contain/more difficult delivery system at pump
	Require (substantial) engine modification
<i>NOT – references to octane number</i>	<i>NOT – references to octane number</i>
<i>NOT – environmentally friendly</i>	

Methanol

Advantages	Disadvantages
Burns more cleanly/completely reduced/less emissions/pollutants/named pollutant <i>NOT – produces less harmful gases</i>	Toxic
High(er) octane number	Produces less energy(per litre)/lower energy density
Cheap(er)	Larger/heavier storage/fuel tanks needed
Less likely to explode	Absorbs moisture/water
<i>NOT - renewable</i>	Corrosive
	<i>NOT – still produces pollutants/named pollutant</i>
	<i>NOT – alcoholics may drink it</i>



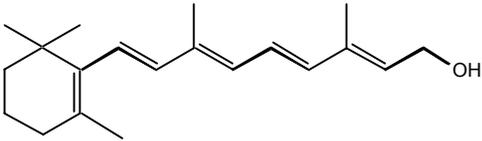
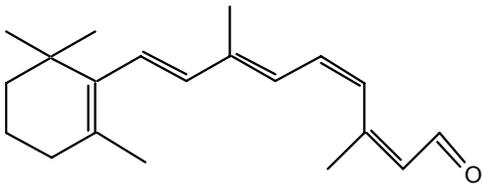
RECOGNISING ACHIEVEMENT

Mark Scheme 2854
January 2005

Abbreviations, annotations and conventions used in the Mark Scheme	/	= alternative and acceptable answers for the same marking point
	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	

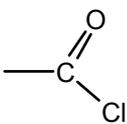
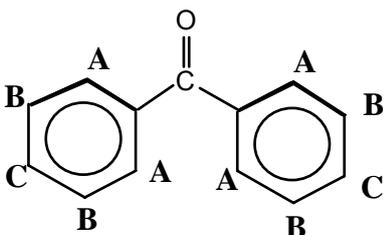
1 a i	carbon (1); hydrogen (1)	2
1 a ii	$\begin{array}{c} \text{CH}_2\text{OOCR} \\ \\ \text{CHOOCR} \\ \\ \text{CH}_2\text{OOCR} \end{array}$ <p>three OH groups reacted (1)</p> <p>ester groups correct (1)</p>	2
1 a iii	permanent dipole-permanent dipole (2); "dipole"/single "permanent dipole scores (1)	2
1 a iv	conc. sulphuric acid (1); heat/reflux (if first mark awarded) (1) (sulphuric acid + reflux scores 1)	2
1 b i	unsaturated/C=C double bonds	1
1 b ii	oxidative AW(1); cross-linking (1)	2
1 c i	<p>4 from</p> <p>hydrogen bond formed between H and O ;</p> <p>δ^+ on H and, δ^- on O/attract;</p> <p>linear O – H – O link;</p> <p>δ^- on O due to high electronegativity / difference in electronegativity between O and H;</p> <p>H-bond formed through lone pair on O;</p> <p>polarity of O-H bond in water or glycerol</p>	4
1 c ii	(water-soluble) many/strong (1); hydrogen bonds formed with water (1) (high boiling) hydrogen bond <u>between molecules</u> (1); lot of energy needed to separate molecules / overcome / break H-bonds(1)	4
1 d i	propene	1
1 d ii	crude oil / natural gas	1
1 d iii	substitution	1

1 d iv	NaOH	1
1 d v	$ \begin{array}{ccc} \text{CH}_2\text{OH} & & \text{CH}_2\text{OH} \\ & & \\ \text{CHCl} & \text{or} & \text{CHOH} \\ & & \\ \text{CH}_2\text{OH} & & \text{CH}_2\text{Cl} \end{array} $ <p>one Cl or OH on adjacent carbon atoms(1)</p> <p>OH group on remaining carbon atom (if first mark given) (1)</p>	2
1 d vi	<p>Mr glycerol = 92 <u>and</u> Mr propene = 42 (1)</p> <p>amount glycerol = 2/92 (= 0.0217 mol) and amount propene = 30/42 (= 0.714 mol) (stated or implied) / $\frac{42}{92} \times \frac{2}{30}$ (1) (allow ecf)</p> <p>% = 0.0217 x 100/0.714 = 3% / = 0.03 x 100 = 3% (1) (allow ecf)</p>	3

Question	Expected Answers	Marks
2 a i	C ₂₀ H ₂₈ O (1) for C and O; (1) for H	2
2 a ii	 <p data-bbox="424 584 528 622">-OH (1)</p> <p data-bbox="424 658 852 696">correct arrangement of bonds (1)</p>	2
2 a iii	alkene	1
2 b i	acidified/named acid/H ⁺ (1); (potassium/sodium) dichromate/Cr ₂ O ₇ ²⁻ (1); <u>distil</u> (1) (if dichromate mark given)	3
2 b ii	5	1
2 c	 <p data-bbox="424 1310 608 1348">idea of cis (1);</p> <p data-bbox="424 1384 852 1422">correct arrangement of bonds (1)</p>	2
2 d i	amine	1
2 d ii	nucleophilic (1); addition (1)	2
2 d iii	$ \begin{array}{c} \text{OH} \quad \text{H} \\ \quad \\ \text{R}-\text{C}-\text{N}-\text{opsin} \\ \\ \text{H} \end{array} $	1
2 e	<i>two from</i> protein has shape/tertiary structure (1); cis molecule fits into / has complementary shape to protein/cleft/allow active site (1); trans is different shape/does not fit (1)	2

2 f	<p>molecule has conjugated system/alternate double bonds; <i>and 4 from:</i> these allow delocalisation; energy level above ground state is closer; <u>electron</u> absorbs energy when moves up / <u>electron</u> moves to a higher energy level / <u>electron</u> becomes excited; $(\Delta)E = hv$; $(\Delta)E$ / energy difference (<i>allow frequency</i>) corresponds to absorption is in the visible region;</p> <p>(Maximum of 2 marks if emission is discussed or described)</p> <p>QWC 2 sentences, correct grammar, punctuation, spelling (1 error allowed)</p>	5
		1

4 a	$2\text{NO} + \text{O}_2 \rightarrow 2\text{NO}_2$	1
4 b	car engines/ lightning/power stations	1
4 c	+2 +2 +4 (1) each. <i>Max 2 if plus signs after numbers</i>	3
4 di	amount $\text{NO}_2 = 1(000)/46 (= 0.00217)$; mass $\text{HNO}_3 = 0.00217 \times 63 = 1.4 \text{ kg}$ or $\frac{63}{46} \times 1(000) = 1.4 \text{ kg}$ Mr correct (1); calculation (1); 2 sig figs <i>mark separately if some working shown</i> (1)	3
4 d ii	Advantage: fertilizer / increases nitrogen content (1). Disadvantage: <u>consequence</u> of being acid (1)	2
4 e	ionic (1); <i>plus two from:</i> solid (at room temperature) (1); crystalline (1) white (1); soluble in water (1) solution conducts/solid does not conduct (1)	3
4 f i	(negative) fewer molecules on right	1
4 f ii	ΔS_{surr} positive (1); less positive / smaller at high temps (1); ΔS_{tot} less positive at high temps (1)	3
4 g i	larger	1
4 g ii	Rate larger (1); but $[\text{N}_2\text{O}_2]$ lower at higher T (1); second effect outweighs first (1)	3
		21

5 a i	benzene	1
5 a ii		1
5 b	absorb (1); <u>uv</u> light/ <u>uv</u> radiation (1)	2
5 c	Friedel (1); Crafts (1)	2
5 d	3 from: (further) polarises (<i>accept breaks</i>) C–Cl bond; to create <u>electrophile</u> ; and AlCl ₄ ⁻ ; electrophile / C ₆ H ₅ CO ⁺ attacks benzene, liberating a <u>proton / H⁺</u>	3
5 e i	AlCl ₃ + 3H ₂ O → Al(OH) ₃ + 3HCl / 2AlCl ₃ + 3H ₂ O → Al ₂ O ₃ + 6HCl (1) for LHS; (1) for RHS; (1) for correct balancing <i>provided one other mark scored</i>	3
5 e ii	<i>two marks for any correct pair (mark for pollutant can be scored alone but NOT effect)</i> aluminium; forms toxic waste; HCl; toxic / acid aluminium; wasted benzene; toxic / carcinogenic	4
5 f i	2 pairs from: 1450-1650 (cm ⁻¹) (1); C-C bonds in arenes (1);, 1720–1725 (cm ⁻¹) (1); C=O (1);, 3000 – 3100 (cm ⁻¹) (1); C–H (1);	4
5 f ii	 all ten protons labelled in some way (1); correct letters (A,B,C) in any order (1) <i>correct letters on one ring only scores (1)</i>	2
		22



RECOGNISING ACHIEVEMENT

REPORT ON THE UNITS
January 2005

Chief Examiner's Report Salters Chemistry 3887/7887

General Comments

Once again, the numbers of candidates taking the units increased over the previous session. Some very good work was reported in many areas, especially from candidates taking the units for the first time.

Calculations were well done by some candidates, though others failed to show their working once again. This can result in serious loss marks when there are several marks for a calculation. There is still a wide-spread lack of understanding of significant figures which needs addressing.

Certain candidates produced good, well-structured answers to the parts requiring long answers. Others would benefit from drafting their answers in the margin, which the successful candidates often do.

The term "property" does not seem to be widely understood and many candidates would benefit from practice in writing the formulae of ionic compounds, having first carefully learnt the charges on the ions.

Most of the candidates for 2849 seem to have taken the longer syllabus in their stride, though there was evidence of relatively poor understanding of spectroscopy now that this is met for the first time at A2.

So few candidates took 2855 (The Investigation) that it was impossible to judge the effect of the new criteria on standards. The June session will be the first proper test of these. Centres should note that it was necessary in some cases to apply large negative moderation factors because the new criteria had not been properly applied and it is our fervent hope that this will not be necessary in the Summer.

2848: Chemistry of Natural Resources

General Comments

There was a range of marks for this paper from single figures to the eighties. However, many of the marks were in the region of 50% or below, which corresponds with this being almost exclusively a re-take paper.

Calculations were reasonable, as were longer answers, though some candidates did not take enough care over expressing their ideas. Writing a summary of a few points in the margin (and then crossing it through) is still recommended in such answers.

Candidates need to work especially at naming inorganic compounds, identifying intermolecular forces and writing reaction mechanisms.

Comments on Individual Questions

Question 1

This question was one of the highest-scoring for many candidates.

- a) (i) Most scored this very easy “settling-in” mark
(ii) Again, this was scored by most, but a few gave ‘ultraviolet’
- b) (i) This was often well done, with a greater proportion of candidates than previously gaining the mark for vibrating *more* .
(ii) Most candidates found the disadvantage fairly easy and scored two marks here. The idea that life would not have developed (as well) without the greenhouse effect was not so well understood and some very vague answers (eg ‘plants would grow better’) did not score.
There were quite a few answers which mentioned the ozone layer, which is disappointing given the whole thrust of the Atmosphere unit.
Most scored the quality of written communication mark, though there were some who seemed very careless about their presentation of this answer.

Tip Where “one mark is available for the quality of spelling, punctuation and grammar”, be sure to take care over the quality of your English. Write in fairly short sentences (not notes) and be sure to start a sentence with a capital letter and end it with a full stop! Check your spelling, as spelling errors in these parts will count against you.

- c) Many candidates did not express themselves clearly here. Some failed to talk about carbon dioxide molecules entering and leaving solution and others failed to mention that the two processes occurred at equal rates.
- d) (i) Most scored here, the commonest error being to say that the radiation was *reflected* rather than absorbed by the glass.
(ii) There were some examples of the ‘wrong’ equation (ozone reacting with an oxygen atom to give two oxygen molecules). Some erroneously used ‘uv’ rather than ‘hv’ to indicate the absorption of radiation.
- e) (i) Most got these equations right.
(ii) Again, many scored both marks here.
(iii) This was also usually negotiated successfully, with ‘CFCs’ being the commonest answer
(iv) Most scored here.

Question 2

This question caused more problems to candidates, especially the first page.

- a) Very few got either of these correct.

Tip Practise naming compounds of metals which have variable oxidation state.

- b) (i) This was not often correct, often because the formula of the carbonate ion was not known. Partial credit was given for equations using CO_3^- .
(ii) This was better. Most defined an acid/base reaction but not all identified the base correctly.
(iii) This turned out to be the hardest part on the paper. The answer which was hoped for would have showed an understanding that the copper ions went from the solid lattice to solution without any other change. The word 'spectator' was occasionally seen. Some said that the ions finished up in solution, for which credit was given provided they did not contradict themselves by saying that they *reacted* with the chloride ions.
- c) There were quite a few answers which were simply wrong. Many got $3d^8 4s^2$ but only a few spotted the subtlety of $3d^9 4s^1$.
- d) (i) Weaker candidates were disconcerted by there being two percentages here. Others did well but still overlooked the request for two significant figures. (Answer 0.70%)

Tip When reading through a question which asks for a certain number of significant figures, make an immediate note under the answer line, eg '2sf'. Otherwise it is easy to forget the instruction by the time you have done the calculation!

- (ii) Most knew this.
- e) (i) Most scored some but relatively few scored three, with quite a proportion of candidates putting zero for the oxidation state of the copper in chalcopyrite.
(ii) This was seldom incorrect.
- f) (i) Most could do this. (Answer 5 mol.)
(ii) The commonest errors here were to mishandle ' $v = n/c$ ' and not to spot the 2:1 ratio. With three marks available here, candidates would have been well-advised to explain what they were doing in order to gain partial credit if they made a small error. (Answer 20 dm^3)

Question 3

There were some easy parts in this question but also some which tested the candidates considerably.

- a) Most got this right, though some showed five-bonded carbons, including the double bond.
- b) Either covalent bonding or hydrogen bonding were accepted here and most gave one or the other.
- c) This was often well done. Some of the lone pairs did not correspond with the hydrogen bond direction and some failed to represent the $\text{O} \cdots \text{H}-\text{O}$ linearity.
- d) Most scored here. Many benefited from the relaxation of the mark scheme to allow 'it is on the end of the chain' as an explanation.
- e) (i) This was mostly fine, though some added an $-\text{OH}$ to the left-hand carbon.
(ii) This was either known or not. Those who had learnt it seldom made any serious mistakes and scored all three marks.
- f) There were a wide variety of sensible suggestions here, as one would hope for from Salters candidates, and they all scored. The 'true' answer (according to the manufacturers) is that it allows oxygen to permeate the lens and reach the cornea.

- g) (i) Here, some did not specify a *carbon-carbon* double bond and others spoke of 'restricted movement', rather than 'restricted rotation'. Many nominated the monomer as the *trans* isomer.
- (ii) Hydrogen bonding was a common erroneous answer. Most who identified permanent dipole – permanent dipole correctly also gave the full name which was required, rather than abbreviations.

Tip Practise identifying the intermolecular forces between various pairs of molecules. Then be sure to name them fully in Examination papers, without abbreviations.

- (iii) This question often found the candidates wanting. Ideas of 'chains sliding over each other more easily' to explain increased flexibility have appeared mark-schemes for this unit for some time now but candidates still omit them. The question hoped to steer candidates away from 'tangling side-chains' but it was only partially successful. Instructions to 'read the question' are too trite to put into a tip box but none the less apposite here. Candidates who 'compared the intermolecular forces between the chains' usually scored! Candidates who did not answer the question often failed to use correctly a sufficient number of relevant technical terms and thus lost the QWC mark as well, unfortunately.

Question 4

This was another question with some easy parts but also some more challenging ones.

- a) (i) Most, though not all, could do this.
- (ii) Most got the right idea, though some reversed it.
- (iii) This was often wrong, with 2Br rather than Br₂ or the electrons on the wrong side.
- (iv) This was usually correct. 'Error carried forward' was allowed from electrons on the wrong side of the equation.
- b) Most identified one reason, usually the toxicity, though there were some examples of vagueness here which did not score, eg 'dangerous'.. The corrosive nature of liquid bromine was less well known.
- c) There were a lot of errors here. Some did not know the charge on the silver ion.
- d) (i) Most got this correct, though there was the usual spate of 'clear' for 'colourless'
- (ii) Most candidates found this tricky, though they usually managed to score partial marks. Often overlooked was the polarisation of the bromine molecule. The attacking group on the carbocation was sometimes shown as δ⁻ rather than the full negative ion.
- e) (i) Many knew this, though some said 'heat'.
- (ii) This was also well done
- (iii) Some chose an answer other than 'initiation'.
- (iv) Most scored here.
- (v) This was usually correct, though a few 'bromoethenes' were seen. '1-bromoethane' was allowed.

2849: Chemistry of Materials

General Comments

This was the first appearance of the expanded unit 2849 replacing 2853. The extra organic chemistry content did not seem to have any noticeable effect on the performance of the candidates. All Assistant Examiners reported that the paper was set at an appropriate level and was a fair test of the candidates' knowledge and understanding. There was a good spread of marks which discriminated well between strong and weak candidates.

A good number of candidates had not yet developed the examination skills and strategies to achieve their full potential on an A2 paper. They will clearly improve by June and should gain higher grades on retaking the examination. Common difficulties involved an inability to distinguish between command words such as 'describe' and 'explain' or there was a complete misreading of the question resulting in no marks being gained. A large number were not able to use the Data Sheet effectively, some confusing infrared and nuclear magnetic resonance data. There were those who were examination aware, and not just the strongest candidates; command words and important data were highlighted whilst extended writing responses were planned in rough using the various blank areas throughout the examination booklet. It was a pleasure to see such clarity and purpose with due attention given to including relevant detail.

The unit contains chemistry that has biological implications. Unfortunately many candidates, obviously studying Biology, tended to use inappropriate terminology when answering such questions and thus missed out on including the chemical understanding required.

The quality of written communication was generally very good, with only a few, usually those with poor examination skills, failing to score the mark for the use of spelling, punctuation and grammar.

The understanding of the term 'appropriate number of significant figures' remains a mystery to most and is discussed later. This aspect apart, calculations were often of a high standard and many gained credit, even when answers were incorrect for showing the relevant steps in their working.

Comments on Individual Questions

- 1)
- (a) Generally correct though amines, amides or carboxylic acids were seen in about equal numbers.
 - (b) Well answered by the majority of candidates. Common errors were to form the acid chloride or to ionise the carboxylic acid.
 - (c) Usually correct but a few did not read part (i) carefully and gave 'optical isomerism' as the 'structural feature'.
In part (ii) the majority attempted to show a three dimensional structure using the dash-wedge convention. However not all thought about the approximate bond angles and ended up with structures having a square planar arrangement.
 - (d) The only problem here was that a few thought a 'dimer' meant show the repeating unit.
 - (e) Those who planned their response gave an excellent account answering with precision, accuracy and understanding.

However most lost marks through failing to plan and instead produced longwinded accounts of a previously learned response, using phraseology such as 'denature' and 'enzymes fitting the substrate' without any further explanation.

Candidates tended to picture enzymes as having specific shapes rather than focusing on the importance of the shape of the active site present in the enzyme. There was a failure too in not identifying one of the enantiomers of arginine as the specific substrate.

Most discussed the catalytic effect of the reaction in terms of collisions rather than in the effect the enzyme had on the activation energy for the reaction, which was rarely mentioned.

Most gained the mark for the correct terms for the arginine and enzyme concentrations but failed to include the prefix 'Rate=k', even though they were reminded to write an equation.

The ability to work out the correct units for k was poor; it was only the very best candidates who usually succeeded.

The worst aspect of the last part of the question was the poor English used to express the meaning of the term 'zero order'. Some chose to focus on an explanation why it is with enzymes that zero order reactions can occur.

- 2)
- (a) Surprisingly often incorrect. Most common elements, and a few exotics, were suggested.

- (b) The equation in part (i) was generally correct, yet a good number endeavoured to give the wrong way round. In part (ii), the equation proved more taxing and it was only those candidates who had studied the topic in depth who succeeded here.

Occasionally a candidate failed to draw on the diagram, perhaps because of its detachment from the question.

However a significant number of candidates did not appreciate that electrons do not flow through solutions.

Many answered the final part by rephrasing the question in stating that iron lost electrons at A rather than B. Few were able to deduce that there was a difference in oxygen concentration, but rather suggested that it was the difference in the water concentration which caused the iron to corrode.

- (c) Most students showed an excellent ability to construct electron configurations. If a mark was lost it was because 3d electrons were removed before the 4s.
- (d) Most candidates gained full marks on the first three parts of this question, only coming to grief when faced with constructing the explanation for the increased rate at which iron rusts in the presence of copper. In comparing the electrode potential data unacceptable terms such as higher and lower were often used, whilst the concept of electronegativity was often evoked. The final mark for indicating that this was an additional process was only gained by the very best candidates.
(Answer part d(ii) 0.78V)
- (e) A suitable correct answer was not often seen. It was clear from the type of response given that few understood the term 'physical property'.

- 3) (a) There were many excellent answers describing the recrystallisation process, though some were thoroughly confused; using reflux, forgetting to name the solvent and evaporating to dryness were all common errors. A minority left the question out altogether.

Although most candidates identified the infrared spectrum as belonging to a carboxylic acid, some were confused about the form of the spectrum and tried to assign values to the 'troughs' rather than the 'peaks'. Others indicated relevant 'peaks' but refrained from allocating them to particular functional groups.

Drawing the full structural formula of ethanoic acid was generally quite good, though it was fairly common to see shorthand –OH group.

The worst aspect of the calculation of the percentage purity was the inability of many candidates to calculate the M_r of acetaminophen correctly.
(Answer part a(iv) 75.5%)

- (b) Although some incorrectly identified the group in part (i) as an amide, many went on in part (ii) to give the correct structure. Also it was not uncommon to see the phenolic hydroxyl group identified incorrectly as an alcohol.

There were many good answers across the whole of the ability spectrum showing that acid-base reactions were understood. However, some candidates assumed that the amide group would hydrolyse at room temperature. Many others ended up with a covalent bond between oxygen and sodium, whilst some drew structures to show hydrogen bonding between the organic molecule and water.

- (c) In the Specification few organic reactions are mentioned as useful for structural diagnosis. So it was somewhat painful to see the answer table littered with all the colours of the rainbow in a seemingly random fashion. 'Clear' again appeared as an incorrect synonym for colourless.

Many candidates of all abilities could not apparently use the data sheet effectively. Good candidates would readily lose five marks whereas weaker ones would gratefully pocket five. More gained the first two marks than the other three because they seemed unable to understand the term 'relative intensity'. Some included all of the chemical shifts and often inserted the data in the incorrect column, whilst a few used infrared data.

It is clear that now infrared spectroscopy is no longer studied at AS, more practice in identifying functional groups and types of proton is required for candidates to become conversant with these two types of spectroscopy.

- 4 (a) The understanding of the term 'condensation' was excellent, but candidates were much less sure with 'polymerisation' and failed to gain a mark for writing about monomers joining to form a 'polymer'.

Most drew a correct ester linkage in the repeating unit correctly but some candidates fell down by either using the incorrect carbon chain or the wrong number of oxygen atoms at the ends of the unit.

- (b) Full marks here were a rare occurrence. Understanding the chemistry behind the properties of different types of polymer was definitely Centre dependent. It is clearly a difficult area and application of ideas of both molecular structure and intermolecular forces can easily lead to confusion unless the candidate has mastered the fundamentals. Answers were often contradictory involving a misconception that at low temperatures intermolecular forces are weaker and therefore polymers break, or chains are closer together and these forces, often called 'bonds' are stronger and therefore they will not break. Little reference was made to the energy available at lower temperatures. It was also common to see explanations totally phrased in terms of materials and their bulk properties rather than a consideration of the particles present.
- (c) Many had learned this knowledge but too many tried to give general explanations in terms of structure and intermolecular forces. This again usually led to confusion.

- 5
- (a) Usually good but 'unfilled d-shells' was often given as a property.
 - (b) Occasional errors in locating bonding sites on carbon atoms rather than nitrogen.
 - (c) Generally correct
 - (d) Most got the equilibrium expression the correct way round, though there were occasional mistakes involving powers and charges on ions.

Most candidates seemed to understand the aspect of equilibria raised in part (ii) quite well, though some indicated confusion by stating that the equilibrium moved to the left thus increasing the amount of products.

Many realised that in part (iii) the equilibrium moved to the left but did not offer any explanation for the second mark, being content to repeat the statement from the question.

- (e) Most candidates showed that they were able to manipulate concentration and volume data very effectively with many laying their working out quite impressively. However significant figures were an obvious failing. Perhaps the fact that their calculators would probably flag up 0.088 may have led them astray. However many gave their answer as 0.09 i.e. to one significant figure, so it was difficult to assess the reasoning applied. Whatever the cause, clearly some work is needed to differentiate between decimal places and significant figures and in choosing what figures are 'appropriate'. (Answer part e 0.0880 mol dm⁻³)

2850: Chemistry for Life

General Comments

The paper, in general terms, discriminated well and there was a wide range of marks scored by candidates, from below 20 to over 70. All questions were accessible to candidates with no 'dead marks'

Time did not appear a problem, however yet again some candidates appeared to have missed the questions on the back page, despite the 'turn over' prompt on the inside back page.

There was also an issue with the clarity of expression and use of appropriate scientific terms (even when given in the question stem), to those questions requiring a slightly longer, more considered response. For example, with Questions 2c (iv) and 3a (ii), many candidates resorted to a blanket use of any terminology vaguely relevant. Calculations were dealt with competently by a large number of candidates but the writing of correct balanced equations, with stating symbols, proved a very 'mixed bag.'

Comments on Individual Questions

Question 1

This was for most candidates the highest scoring question with the vast majority of candidates scoring at least 10 out of the possible 14 marks available.

Common errors included a discussion of isomers and not isotopes in (a) (ii). There was poor recall of the properties of alpha particles in (a) (iii) and many candidates did not realise the importance of isotopic abundance in (a) (iv).

Numerical answer (b) 40 days

Question 2

This question perhaps gave the greatest range of marks. Parts (a) and (b) were generally well answered but rather too many candidates tried to put a branch on the first carbon atom in (a) (i) and for some, the explanation of structural isomer in (a) (ii) lost somewhat in translation. The simple calculation in (b) (i) still found a few candidates dividing the M_r value by the actual mass, instead of the other way round.

Most students balanced the equation in (c) (ii) but many did not read the stem carefully enough and lost the 'state symbol' mark. The ensuing calculation was, in common with recent papers, competently done, however the calculation of 'bonds broken' was occasionally wrong because candidates either used 4 (C-C) bonds or forgot to include the O=O bonds. A sizable minority did not express their answer 'per mole'

Tip for Candidates

It is worth just sketching in the margin the structural formulae of the molecules involved in a bond enthalpy calculation. That way you are less likely to miss out some bonds or get the wrong number.

Part (c) (iv) showed a degree of differentiation with weaker candidates either getting it completely wrong or only obtaining the 'about the same' mark, and not being able to clearly explain their choice in terms of the number and type of bonds broken and formed.

Parts (d) (i) and (ii) were well answered by most candidates but there were still a few dots on skeletal diagrams.

Part (d) (iii) showed up the less able candidate with the increase in enthalpy commonly being put down to an increase in the total number of particles present on mixing.

Numerical answers: (b) (i) 0.62mol
(ii) 15 dm³
(c) (iii) -2672 kJ mol⁻¹

Question 3

This question was the least well answered on the paper, but often highlighted the more able candidates.

The balanced equation required in part (a) (i) proved difficult for many candidates, with various exotic offerings for the formula of radium hydroxide.

Teachers Tip

Practice is needed (still – see PE's report on 2848 last June) in using the formulae for common ions when constructing the formula of a named compound.

The clarity and precision of some candidates' answers to parts (a) (ii) and (b) (ii) left a lot to be desired and cost candidates marks (see 'General Comments' at the beginning of this report).

Tip for Candidates

It is worth sketching out your answer in the margin (then cross out), to those questions which say 'explain', keeping an eye on the marks on offer.
e.g. four marks = four appropriate statements.

Some candidates did not appear to know the appropriate state symbol used for equations representing ionisation enthalpies. (prt (b) (i)).

Part (c), the question on absorption and emission spectra, as usual proved tricky for candidates and although many got the appropriate letter for (c) (i) the explanation required in (c) (ii) proved much more elusive, with confusion between energy levels, and lines in the spectra, being all too common, even for the more able candidate.

The dot-cross diagrams in (d) (i) were well done but some candidates did not seem to realise the importance of lone pairs when deciding the shapes of simple molecules. Trigonal planar NH₃, and linear H₂S, were not uncommon.

Although many got Part (d) (iii) correct, it was yet another example of loose terminology for a number of candidates when describing the significance of the wedge and dotted line.

Question 4

Part (a) was in the main well answered, the most common error being 'incomplete combustion' as the answer to the presence of hydrocarbons in the exhaust.

Candidates were offered a wide range of answers to part (b) with the most common expected answers being those quoted in the 'Chemical Storylines'.

Teachers Tip

Make sure your students identify and revise those areas mentioned in the 'spec' which are specifically from the 'Storylines'. These are generally factual recall. They will be examined sometime!

Part (c) produced many good answers, some appearing to be almost verbatim quotes from the 'Chemical Ideas'

There were candidates however who went down the 'biological' route and there was, despite the provided terminology, still some vagueness in a number of candidates' answers to part (ii), particularly, as in previous years, in terms of describing the bond breaking process on the catalyst surface.

Part (iii) frequently generated only one of the two possible marks with weaker candidates often missing the irreversible nature of the adsorption of a catalyst poison.

2854: Chemistry by Design

The January 2005 examination had an entry of only 83 candidates (from 75 Centres) and therefore, as last year, it is not possible to draw any wide conclusions from the performance of this cohort. Marks (out of 120) ranged from 104 to 31, with about 15% of the candidates achieving 90 or more and the same percentage scoring less than 50. The paper showed, therefore, an appropriate degree of discrimination over the whole mark range, and also plenty of opportunity for candidates to achieve credit for what they had learned throughout their two years of Salters Advanced Chemistry.

Areas of the paper where most candidates performed well were:

- 1 the nature of hydrogen bonds;
- 2 calculation of percentage yield;
- 3 pH calculations;
- 4 oxidation state;
- 5 interpretation of infra red spectra.

Weaker topics were:

- 1 hydrogenation of unsaturated compounds;
- 2 absorption of radiation by a compound;
- 3 calculations involving powers of concentrations;
- 4 trends in ionic radii;
- 5 prediction of the properties of an ionic compound;
- 6 signs of enthalpy and entropy changes;
- 7 mechanism of a Friedel-Craft reaction.

Again the scores of an appreciable proportion of the candidates were limited by their inability to structure their answers and to express themselves clearly enough to respond to the tasks set. An obvious example of this was Question 1(c)(ii) which asked for explanations of the high boiling point and the water solubility of glycerol in terms of hydrogen bonding. Many candidates allowed the two threads in the answer to become totally twisted, so that it was difficult to decide what was known about hydrogen bonding in glycerol alone and in a solution of glycerol in water.

The paper contained a number of calculations and an appreciable number of candidates producing wrong answers, failed to gain some credit because they did not show in a logical way how those answers had been derived. There is clearly a message for future candidates in this point.

Comments on Individual Questions

Question 1

- (a) (i)(ii) Well-answered.
(iii) Too many candidates decided on "hydrogen bonds" as a knee-jerk response to questions of this kind.
(iv) Generally well-answered, although some candidates lost credit by failing to identify the need for concentrated sulphuric acid.
- (b) (i)(ii) Only stronger candidates produced the required responses.

- (c) (i) Most candidates scored well here, although there were some who think that hydrogen bonds are formed between two hydrogen atoms.
(ii) Only a small number of candidates scored full marks here. The failure of many others to do so was largely due to the lack of simple statements such as “glycerol molecules are linked to each other by hydrogen bonds” and “glycerol molecules (can) form hydrogen bonds with water molecules”.
- (d) All parts were generally well-answered, although a number of candidates suggested water as the appropriate reagent to replace $-Cl$ by $-OH$ in part (iv). The calculation in part (vi) produced full marks for a large proportion of candidates. (Answer 3%)

Question 2

- (a) (i) Only a small proportion of candidates scored both marks. A counting error was common (and easily made!) in this question.
(ii)(iii) Generally well-answered.
- (b) (i) Many candidates stated that “reflux” was a necessary condition here, without realising that the oxidation has to be stopped “half-way” at the aldehyde stage by distillation of the product immediately after formation.
(ii) Poorly answered, many candidates giving 10, 1 or even 0.5 as the answer.
- (c) A surprising number of candidates reproduced the structure of the trans form, instead of a cis configuration.
- (d) (i) Well-answered.
(ii) Pleasingly well-answered.
(iii) About half the candidates scored this mark, the most common error being to have four bonds to the nitrogen atom.
- (e) Many candidates achieved the two marks for this question, although this was a place in the paper where the relevant ideas were not clearly expressed.
- (f) Comparatively few candidates identified the link between a conjugated system and the ability to absorb visible light in this molecule. Descriptions of what happens when the molecule absorbs the light often foundered at the point where it was stated that a promoted electron then “falls back” with the emission of light.

Question 3

- (a) Surprisingly poorly answered. Responses such as SiO_2 and NO were common.
- (b) (i) Generally well-answered.
(ii) Pleasingly well-answered. (Answer $pH = 5.6$)
- (c) (i) Well-answered.
(ii) Some candidates ignored the fact that the concentration of aluminium ions was squared and that of the hydrogen ions was raised to the power of 6, in the K_c expression.

- (iii) (Answer $8.1 \times 10^{15} \text{ mol dm}^{-3}$)
An appreciable number of candidates scored all 3 marks here. Others, however, continued the trend in part (ii). (Answer $1 \times 10^{-4} \text{ mol dm}^{-3}$)
- (d) (i) Another question where lack of clarity of expression seemed to conceal the true level of candidates' understanding. Many candidates were able to describe the formation of the listed cations but some failed to move on to discuss their relative sizes in terms of attraction of electrons by nuclear protons.
(ii) Most candidates achieved the 2 marks here.

Question 4

- (a) Well-answered.
- (b) Universally well-answered.
- (c) Most candidates scored the 2 marks here.
- (d) (i) Generally well done, although some candidates did not express their answer to two significant figures. (Answer 1.4 kg)
(ii) Most candidates recognised that nitric acid would provide nitrate ions to the soil but a surprising number went beyond stating that it would make the soil "acid".
- (e) Very poorly answered. Most candidates tended to describe how ionic bonding arises, rather than the properties it is likely to provide for calcium nitrate.
- (f) (i) Generally well-answered.
(ii) Few candidates scored 3 marks here. Most seemed to realise that ΔS_{tot} has to be positive but an appreciable number failed to recognise that ΔH is negative for an exothermic reaction and therefore that ΔS_{surr} is positive.
- (g) (i) Generally well-answered.
(ii) Poorly answered. No candidate described the rate increasing with increase in temperature, with the consequence that there are two trends to be considered in this answer. Many answers described the effect of temperature on the amount of N_2O_2 , rather than the concentration.

Question 5

- (a) (i) Well-answered, although "benzene ring" appeared on some scripts.
(ii) Well-answered.
- (b) Some candidates described the "reflection" of uv radiation by a sunscreen.
- (c) Pleasingly well-answered.
- (d) A mixed response here, with some confusion about what the electrophile is in this reaction and what happens to the aluminium chloride in the mechanism.

- (e) (i) Generally well done.
- (ii) Most candidates achieved some credit for identifying the hazards of HCl but few were able to go beyond that.

- (f) (i) Generally well done, although the need to identify a specific bond as the cause of a particular absorption cost marks for some candidates.
- (ii) Very few candidates were able to classify the protons in the structure supplied and many candidates failed to identify where all of them are in the molecule.

2855: Individual Investigation

General Comments

The entry for this component was very small, consisting of only sixteen candidates from ten Centres. An additional 16 Centres had made entries but these were made in error (6 Centres) or the candidates were withdrawn after the entry had been made (10 Centres)

The standard of work covered a greater range than in the previous January session.

This was the first session in which the revised coursework marking descriptors were used in the assessment of candidate's work. Some Centres did not take sufficient account of the requirements of these descriptors and the marks awarded often represented a rather generous application of the descriptors.

In a small number of cases the marks awarded by Centres were inappropriate as the marking descriptors at the levels selected had clearly not been met. In other cases the marks were inappropriate because the lack of demand of the investigation had not been taken into account sufficiently. In these cases, the difference between the mark awarded by the Centre and the mark felt appropriate on moderation was in excess of 20, in an assessment component with a maximum mark of 90.

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.

Not all Centres included documentary evidence 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.

References:

A list of references should be included at the end of the planning section. To meet the descriptors at the highest level, these should contain detail such as page number and should be linked to the text, possibly by a numbering system. It is 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 web address.

Implementing

Where a titration is used during an investigation, all burette readings should be recorded and not just the titres. Where titres are very low, it is expected that candidates will dilute an appropriate solution 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.

Where there is considerable variability in recorded data for a particular set of conditions, it is expected that a candidate will repeat the experiment to meet the descriptors at level 11.

Analysing

In some cases, candidates did not meet the higher level descriptors because they reported the results of calculations rather than showing the steps involved. This also meant that they were not able to explain these steps clearly. On other cases, candidates did not meet the higher level descriptors because they did not clearly link their conclusions with underlying chemical knowledge and ideas.

Evaluating

The calculation of uncertainties associated with measurements has improved over the past few sessions. 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 2005 Assessment Session

Unit Threshold Marks

Unit		Maximum Mark	a	b	c	d	e	u
2848	Raw	90	68	60	53	46	39	0
	UMS	120	96	84	72	60	48	0
2849	Raw	90	68	60	53	46	39	0
	UMS	90	72	63	54	45	36	0
2850	Raw	75	60	53	47	41	35	0
	UMS	90	72	63	54	45	36	0
2854	Raw	120	87	77	68	59	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

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

	A	B	C	D	E	U	Total Number of Candidates
3887	13.0	31.4	55.9	79.1	94.1	100	398

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

	Maximum Mark	A	B	C	D	E	U
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
7887	32.1	64.2	86.4	96.3	100	100	91

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