

Chemistry (Salters)

Advanced GCE A2 7887

Advanced Subsidiary GCE AS 3887

Mark Schemes for the Units

January 2009

3887/7887/MS/R/09J

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

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CONTENTS

Advanced GCE Chemistry (Salters) (7887)

Advanced Subsidiary GCE Chemistry (Salters) (3887)

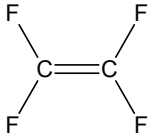
MARK SCHEME ON THE UNITS

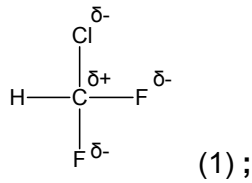
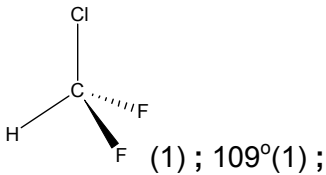
Unit/Content	Page
Abbreviations, annotations and conventions used in the detailed Mark Scheme.	1
2848 Chemistry of Natural Resources	2
2849 Chemistry of Materials	13
2850 Chemistry for Life	22
2854 Chemistry by Design	31
Grade Thresholds	40

Abbreviations, annotations and conventions used in the detailed Mark Scheme.

/	= alternative and acceptable answers for the same marking point
(1)	= separates marking points
not	= answers which are not worthy of credit
reject	= answers which are not worthy of credit
ignore	= statements which are irrelevant
allow	= answers that can be accepted
()	= words which are not essential to gain credit
<u> </u>	= underlined words must be present in answer to score a mark
(ecf)	= error carried forward
AW	= alternative wording
ora	= or reverse argument

2848 Chemistry of Natural Resources

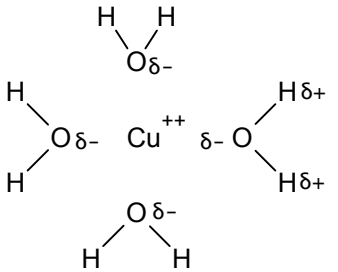

Question		Expected Answers	Marks	Additional Guidance	
1	(a)	 (1);	1	the correct shape for the molecule is not required for the mark can be $\text{CF}_2 = \text{CF}_2$ or $\text{F}_2\text{C} = \text{CF}_2$	
	(b)	(i)	$\text{CaF}_2 + \text{H}_2\text{SO}_4 \rightarrow \text{CaSO}_4 + 2\text{HF}$ or $\text{CaF}_2 + 2\text{H}_2\text{SO}_4 \rightarrow \text{Ca}(\text{HSO}_4)_2 + 2\text{HF}$ Formulae of products (1); Completely correct equation (1);	2	ignore state symbols accept FH
		(ii)	Substitution (1);	1	ignore type
		(iii)	Chlorodifluoromethane (1);	1	ignore numbers and dashes di must be included ignore simple spelling mistakes must be in correct alphabetical order

Question		Expected Answers	Marks	Additional Guidance
	(v)	 <p>(1);</p>	1	<p>must have chlorine and both fluorines labelled</p> <p>ignore δ^+ on hydrogen</p>
	(vi)	<p>Chlorine and fluorine pull electrons away from carbon (ora) (1);</p> <p>Mention of electronegativity (1);</p> <p>Fluorine <u>and</u> chlorine are more electronegative than carbon (ora) scores 2</p>	2	all 3 types of atoms must be mentioned for marking point
	(vii)	 <p>(1); 109°(1);</p>	2	<p>Shape must be 3-dimensional.</p> <p>accept 105-109.5°</p> <p>two bonds in same plane must be next to each other</p>
	(viii)	Polar because the charges / dipoles do not balance / cancel out / centre of positive and negative charges do not coincide (1);	1	
	(ix)	Permanent dipole – (permanent) dipole (1);	1	must be in words
(c)	(i)	Softens / flows / melts / can be <u>remoulded</u> when warmed / heated (1);	1	must have warmed or heated

Question		Expected Answers	Marks	Additional Guidance
	(ii)	$ \begin{array}{c} \text{F} \quad \text{F} \quad \text{F} \\ \quad \quad \\ \text{C} = \text{C} - \text{C} - \text{F} \\ \quad \quad \\ \text{F} \quad \quad \text{F} \end{array} \quad (1); $	1	accept $\text{CF}_2=\text{CFCF}_3$ or $\text{F}_2\text{C}=\text{CFCF}_3$
	(iii)	$ \begin{array}{c} \text{F} \quad \text{F} \quad \text{F} \quad \text{CF}_3 \\ \quad \quad \quad \\ -\text{C} - \text{C} - \text{C} - \text{C}- \\ \quad \quad \quad \\ \text{F} \quad \text{F} \quad \text{F} \quad \text{F} \end{array} $ <p>tetrafluoroethene residue (1); hexafluoropropene residue (1); 5 carbons with fluorines attached linked with single bonds – must have single bonds at each end (1);</p>	3	allow the monomer units joined in a different order.
	(iv)	Copolymer (1);	1	
		Total	24	

Question			Expected Answers	Marks	Additional Guidance
2	(a)	(i)	Addition / reduction / hydrogenation (1) ;	1	ignore type if addition reaction given but not polymerisation
		(ii)	Platinum catalyst (1) ; r.t.p. (1) ; or Nickel catalyst (1) ; High temperature / 100-200 ⁰ <u>and</u> pressure >1≤10atm (1) ;	2	must score catalyst mark to get condition mark condition must match catalyst
	(b)	(i)	288 / 24 (1) ; changing to the same units and evaluate (= 0.012) (1) ;	2	288/1000 or 24 x 1000
		(ii)	Answer to b (i) /0.002 (= 6) (1) ;	1	
		(iii)	Answer to b (ii) x 2 rounded to nearest whole number (=12) Or Answer to b (ii) rounded to the nearest whole number of double bonds (1) ; C ₃₀ H ₆₂ with the appropriate number of Hs subtracted (1) ; or Valid explanation of how the formula is worked out, without a formula (1) ;	2	correct answer to (b) (i) gives formula C ₃₀ H ₅₀
	(c)		Secondary (1) ; C to which OH is bonded is itself bonded to 2 other C's / one H on C to which OH is bonded / 2 alkyl groups on C (1) ;	2	independent marks can refer to R groups

Question		Expected Answers	Marks	Additional Guidance
	(d)	(i)		
			1	only one must be indicated
		(ii)	3	ignore dichromate oxidation state if dichromate written in words (allow minor spelling error). allow any inorganic acid ignore formula if correct name is given. heat mark is only awarded if candidate scores the dichromate mark
		Total	14	

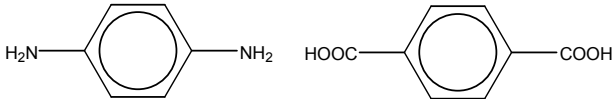
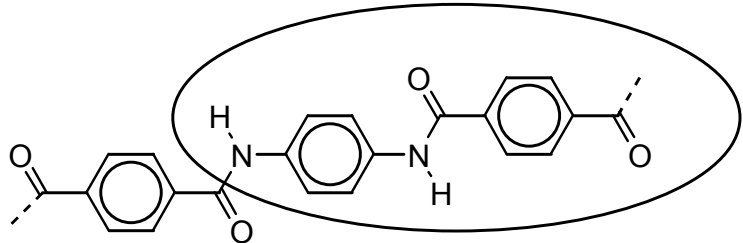
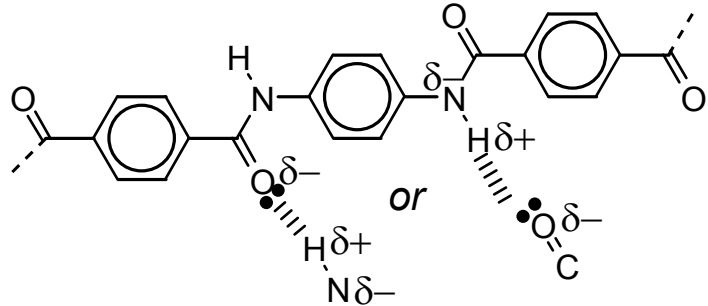
Question			Expected Answers	Marks	Additional Guidance
3	(a)	(i)	Copper (I) oxide (1);	1	
		(ii)	$\text{CO}_3^{2-} + 2\text{H}^+ \rightarrow \text{CO}_2 + \text{H}_2\text{O}$ H^+ for acid (1); rest of equation correct (1);	2	ignore state symbols
		(iii)	(Acts as) a proton / H^+ acceptor/ electron pair donor (1);	1	
		(iv)	 <p>At least three bent water molecules around an Cu^{2+} (can be  or triangle) (1);</p> <p>2 x H and 1 x O with the O facing the ion (1);</p> <p>$\delta+$ on at least one H, $\delta-$ on at least one O, $\delta-$ facing Cu^{2+} (1);</p>	3	
	(b)	(i)	Cu = +2 (1); Fe = +3 (1); S = +4 (1);	3	allow one mark if answers have number then sign (i.e. 2+, 3+ and 4+) or no sign
		(ii)	Copper (1); Oxidation state has decreased / it has gained electrons (1);	2	allow ecf from (b) (i) allow oxidation state becomes more negative mark independently

Question		Expected Answers	Marks	Additional Guidance
	(ii)	graduated / volumetric pipette (1) ;	1	
	(iii)	20.00 x 0.010 (1) ; /1000 and evaluate (= 2.00 x 10 ⁻⁴) (1) ;	2	
	(iv)	½ x answer to d(iii) (= 1.00 x 10 ⁻⁴) (1) ;	1	
	(v)	answer to d(iv) / 25.20 (1) ; x 1000 (= 3.968 x 10 ⁻³) (1) ; 3.97 x 10 ⁻³ to 3 sf (1) ;	3	allow sf mark for any 3 sig. fig. answer that follows from any calculation a completely correct answer on its own scores all marks, including the sf mark
		Total	31	

Question		Expected Answers	Marks	Additional Guidance	
4	(a)	(i)	(anhydrous) sodium sulphate <i>or other suitable salt</i> (1);	1	allow conc. H ₂ SO ₄ / silica gel
		(ii)	Nitrogen (1); Oxygen (1); Argon (1);	3	
	(b)	(i)	<i>Any two from:</i> Burning fossil fuels / named fossil fuel (1); Production of cement (1); Making iron in a blast furnace (1); Deforestation (1); Volcanic activity (1);	2	must refer to the process for the mark
		(ii)	<i>Any three from:</i> Makes their <u>bonds</u> vibrate (1); (vibrate) more (1); Turned into <u>kinetic energy</u> that increases temperature / releases heat (1); Energy re-emitted in all directions (1);	3	allow faster idea of transfer of energy is the key idea here
	(c)	(i)	Increased CO ₂ levels in troposphere / CO ₂ (g) moves <u>equilibrium</u> position in equation 4.1 to the right / to the products / named product (1); Increased CO ₂ (aq) moves <u>equilibrium</u> (position) of equation 4.2 to the right to the products / named product (1); HCO ₃ ⁻ (concentration) increases (1);	3	must mention equilibrium at least once in the answer to gain full credit can gain full credit if there is a statement of Le Chatelier's principle and this is then used in their answer
		(ii)	System is not closed / CO ₂ moves away from the surface / specific example of input or output of CO ₂ (1);	1	allow sealed system

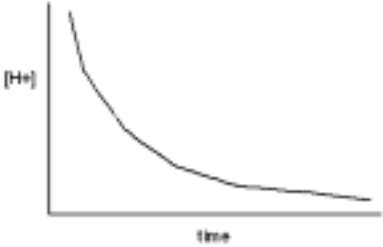
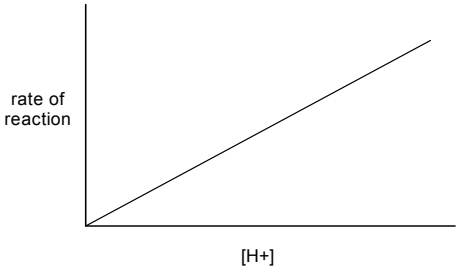
Question		Expected Answers	Marks	Additional Guidance
	(d)	(i)	Any one from: Photochemical smog ; Breathing difficulties / asthma attacks ; Weakens immune system ; Causes degradation of rubber / plastics / textiles / paint ;	1 do not allow harmful to humans / life
		(ii)	$O_2 \rightarrow 2O$ (1) ; $O + O_2 \rightarrow O_3$ (1) ;	2 ignore dots accept multiples
		(iii)	High frequency radiation / $h\nu$ / uv only present in the stratosphere (AW) (1) ; Bonds are broken / radicals are formed / photodissociation occurs / homolytic fission occurs (1) ;	2 accept a specific frequency is needed not strength / intensity / sufficient
	(e)	(i)	(The activation enthalpy in) step 1 is higher (ora) (1) ;	1
		(ii)	(Catalyst) is in the <u>same phase/state(gases)</u> as the <u>reactants</u> (1) ; NO is not used up in the reaction / NO is reformed / (chemically) unchanged (1) ;	2
Total			21	

2849 Chemistry of Materials

Question			Expected Answers	Marks
1	(a)	(i)	 <p style="text-align: center;">amine carboxyl/carboxylic acid</p> <p>one mark for each correct structure (2) ; one mark for each correct name (2) ; allow di- in front of name, dependent on having a correct functional group for the first mark.</p>	4
1	(a)	(ii)	 <p>repeating unit must contain both monomer units ;</p>	1
1	(b)		 <p>HB between correct atoms (1) ; correct charges shown on the 3 atoms(1) ; lone pair on electronegative atom hydrogen bonding to the H (1) ;</p>	3

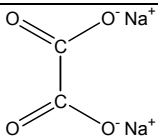
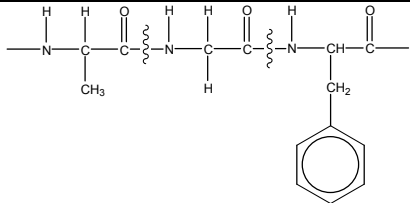
Question			Expected Answers	Marks
1	(c)	(i)	molecules (of twaron) are closer together (AW) (1) ; stronger interactions between chains / more hydrogen bonds in Twaron therefore polymer is stronger (AW) (1) ; not just 'polymer is stronger'	2
1	(c)	(ii)	at low temperatures / below T_g polymer becomes brittle / glassy (AW) (1) ; at higher temperatures / above T_m polymer softens / melts / turns to a liquid (1) ; ignore 'flexible'. at low temperatures (not enough energy for) chains to slide / move over one another (1) ; applied force causes chains to break (1) ; at high temperatures chains (have enough energy to) move freely (AW) (1) ; QWC – <i>see separate sheet</i> (1) ;	6
1	(d)		(moderately) concentrated acid / HCl / not conc. H_2SO_4 (1) ; heat under reflux / reflux (1) ;	2
Total:				18

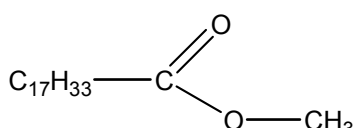
Question			Expected Answers	Marks
2	(a)		heating with a (vertical) condenser / boiling (AW) (1) ; con if distillation used ; do not allow 'heating' alone as given in question so that no vapour is lost / the vapour is condensed and returned to flask / no loss of volatiles (AW) (1) ;	2
2	(b)	(i)	(the mass) of the molecular ion peak/ last peak on right in spectrum (1) ; DHC will have a value (of 2 mass units) greater than capsaicin (1) ; dependent on first mark.	2
2	(b)	(ii)	DHC has two extra CH ₂ groups (AW) capsaicin has C=C (ora) (1) ; <i>plus any two of the following marking points:</i> peak at a chemical shift of 1.4 will be larger in DHC (1) ; capsaicin has a peak at a chemical shift of 4.5-6.0 due to -HC=CH- (1) ; capsaicin has a peak at a chemical shift of 2.3 due to C=C—CH ₂ -R (1) ;	3
2	(b)	(iii)	look for a strong peak at 3600-3640 / 3200-3600 cm ⁻¹ (due to O-H bond /phenol group) (1) ; units must be present, around 3600 is not sufficient.	1
2	(b)	(iv)	FeCl ₃ /iron(III) chloride (1) ; do not allow iron(III) ions by itself; purple/violet colour formed (1) ; do not allow pink or blue alone, ignore initial colour.	2
2	(c)	(i)	<i>Trans</i> (1) ;	1
2	(c)	(ii)	restricted rotation about C=C bond (1) ; different groups around the C=C bond (AW) <u>the two Hs</u> / the groups can be on the same side or opposite sides, can score by drawing a diagram (1) ;	2
2	(d)	(i)	titrate with (standard) alkali (AW) (1) ; titration alone does not score ; or use a pH meter (1) ; ignore universal / pH indicator.	1

Question			Expected Answers	Marks
2	(d)	(ii)	 <p>(1) ;</p>	1
2	(d)	(iii)	<p><u>measure</u> (AW) gradient (1) ; draw a tangent is not sufficient at different concentrations / at different time intervals (AW) (1) ;</p> <p>or</p> <p>measure at least 2 half-lives (1) ; may be shown on the diagram</p> <p>constant half life = 1st order (1) ; dependent on first mark</p>	2
2	(d)	(iv)	 <p>allow line if not through origin and no scales given.</p>	1
Total:				18

Question			Expected Answers	Marks
3	(a)	(i)	+5 (1) ;	1
3	(a)	(ii)	platinum (1) ;	1
3	(a)	(iii)	potassium / sodium nitrate / chloride / sulphate (1) ; accept formula.	1
3	(a)	(iv)	1.26 V (1) ; ignore sign	1
3	(a)	(v)	$V^{2+} + 2H^{+} + VO_2^{+} \rightarrow V^{3+} + VO^{2+} + H_2O$ Species correct (1) ; balanced and direction correct (1) ;	2
3	(b)	(i)	O_2/H^{+} has a more positive E^{\ominus} than (1) ; (ora) V^{2+} / V^{3+} and V^{3+} / VO^{2+} (AW) (1) ; may be shown by two equations; so it will oxidise V^{2+} to VO^{2+} (1) ; allow this 3rd mark if only V^{2+} is oxidised to V^{3+} ; which is blue (1) ; no ecf	4
3	(b)	(ii)	$H^{+}(aq)$ is needed for <u>oxygen</u> to act as the oxidising agent / react (AW) (1) ; allow 'oxygen needs $H^{+}(aq)$ to form water'.	1
3	(c)	(i)	<u>Ligand</u> exchange / substitution / displacement (1) ;	1
3	(c)	(ii)	Dative (covalent) / coordinate (1) ; covalent alone does not score.	1
3	(c)	(iii)	$V(H_2O)_6^{3+} = 6$, octahedral $VC/4^{-} = 4$, tetrahedral / square planar both numbers correct (1) ; one mark for each shape correct (2) ;	3
Total:				16

Question			Expected Answers	Marks
4	(a)	(i)	$\text{Fe} \rightarrow \text{Fe}^{2+} + 2\text{e}^-$ (1) ; ignore state symbols	1
4	(a)	(ii)	$\text{O}_2(\text{g})$ or (aq) + $2\text{H}_2\text{O}(\text{l}) + 4\text{e}^- \rightarrow 4\text{OH}^-(\text{aq})$ balanced equation (1) ; state symbols correct (1) ;	2
4	(a)	(iii)	oxygen (1) ; allow O_2	1
4	(a)	(iv)	$\text{Fe}^{3+} + 3\text{OH}^- \rightarrow \text{Fe}(\text{OH})_3$ correct species (1) ; balanced (1) ;	2
4	(b)	(i)	moles of manganate(VII) = $15.0 \times 0.00500 / 1000 = 7.50 \times 10^{-5}$ (1) ; moles of Fe(II) = $5 \times 7.50 \times 10^{-5} = 3.75 \times 10^{-4}$ (1) ; <i>for correct ratio</i> ; concentration of Fe(II) in sample = $10^3 / 25.0 \times 3.75 \times 10^{-4} = 0.015$ (1) ; allow 3rd mark if wrong expression in previous line is correctly calculated.	3
4	(b)	(ii)	MnO_4^- ions (are coloured purple and) at the end-point will turn the solution pale pink / act as the indicator (AW) self-indicating, solution turns a pale pink (1) ; do not allow ' MnO_4^- ions go from purple to colourless' alone	1
4	(c)	(i)	Acidity is caused by ionisation to form H^+ / proton (1) ; may be gained by equation; $[\text{H}^+]$ depends on stability of negative ion (AW) (1) ; may be implied; Electrons/negative charge more delocalised in RCOO^- than in RO^- (AW) delocalisation may be used to describe anions (1) ;	3

Question			Expected Answers	Marks
4	(c)	(ii)	 <p>Correct formula for salt (1) ; where Na⁺ is missing a correct ethanedioate ion scores 1, ignore '—' between Na and O; charges correct (1) ;</p>	2
4	(c)	(iii)	 <p>A correct bond (1) ;</p>	1
4	(c)	(iv)	<p>COOH (1) ; NH₃⁺ (1) ; ignore R groups etc.</p>	2
4	(c)	(v)	<p>enzymes form an <u>active site</u> / <u>cleft</u> in their structure (1) ; which has a <u>specific shape</u> / to which substrate can 'bond' (1) ; and in which the <u>substrate</u> / <u>disulphide group can fit</u> / <u>attach</u> (1) ;</p>	3
Total:				21

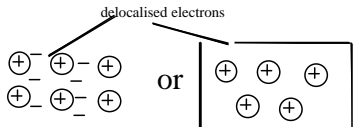
Question			Expected Answers	Marks
5	(a)	(i)	ethyl (1) ; propanoate (1) ;	2
5	(a)	(ii)	$\text{CH}_3\text{CH}_2\text{COOCH}_2\text{CH}_3 + \text{OH}^- \rightarrow \text{CH}_3\text{CH}_2\text{COO}^- + \text{C}_2\text{H}_5\text{OH}$ CH ₃ CH ₂ COO (allow CH ₃ CH ₂ COOH) (1) ; C ₂ H ₅ OH (1) ; charges on hydroxide ion and ethanoate correct (1) ;	3
5	(a)	(iii)	Add (excess) acid (HCl / H ₂ SO ₄ (aq)) (1) ; allow HCl / H ₂ SO ₄ , but not conc. H ₂ SO ₄ .	1
5	(a)	(iv)	<u>Concentrated</u> H ₂ SO ₄ (1) ;	1
5	(a)	(v)	 ester group correct (1) ; rest correct (1) ; any extended chain does not score.	2
5	(b)	(i)	$K_c = [\text{CH}_3\text{OH}] / [\text{CO}] \times [\text{H}_2]^2$ (1) ; units = dm ⁶ mol ⁻² (ecf) (1) ;	2
5	(b)	(ii)	14.5 = [CH ₃ OH] / (0.0900 x (0.110) ²) (1) ; (ecf) from part (i) for viable equation; <i>ecf for expression used for the calculation:</i> [CH ₃ OH] = 14.5 x 0.09 x 0.0121 (1) ; = 0.0158 (to 3 sig figs) (1) ; 0.016 scores 2, any expression for the second marking point evaluated correctly scores the sf mark (1)	3

Question			Expected Answers	Marks
5	(b)	(iii)	Equilibrium position is over to the right / products side (1) ;	1
5	(b)	(iv)	Temperature: K_c is larger / increases (1) ; pressure: K_c does not change / no effect (1) ;	2
Total				17

2850 Chemistry for Life

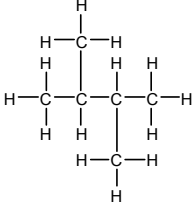
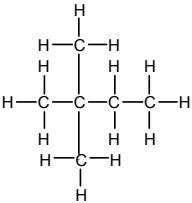
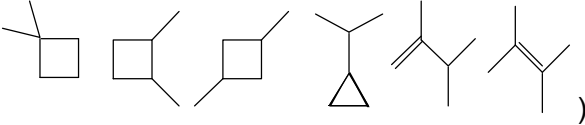
Question			Expected Answers	Marks	Additional Guidance
1	(a)	(i)	298K (1) ;	1	allow 25°C; must have unit; allow 'kelvin', 'celsius' centigrade etc
		(ii)	'products – reactants' (1) ; $\{(2 \times -394) + (3 \times -286)\} (= -1646) (1) ;$ $- (-278) (1) ;$ $= -1368 (1) ; (ecf)$	4	or correct ΔH expression from cycle. ignore signs for first two marking points third mark is for identifying -278 as the correct value ' -1368 ' alone scores all four marks fourth mark is for correct evaluation (including sign) of any previous expression, For guidance: -1646 with working scores 2 -402 (no "2" and "3") scores 3 $-1411, -1236$ (wrong ethanol/ water data) score 3 $+1368$ scores 3 1368 scores 2 -1924 scores 3
	(b)	(i)	104 – 110 ;	1	
	(b)	(ii)	four pairs / sets of electrons <i>or</i> 2 lone pairs and two bonding pairs / bonds <i>or</i> four areas of electron density (1) ; around oxygen (atom) / 'central atom' (1) ; repel (1) ; get as far away (AW) as possible / minimise (electronic) energy / minimise repulsion (1) ;	4	no ecf from bond angle 'electrons' can be implied can be implied by discussion of C-O bonds can score all but first mark by describing <i>atoms</i> rather than electron pairs. in the context of atoms, electrons or bonds ignore 'repel as much as possible' for last mark

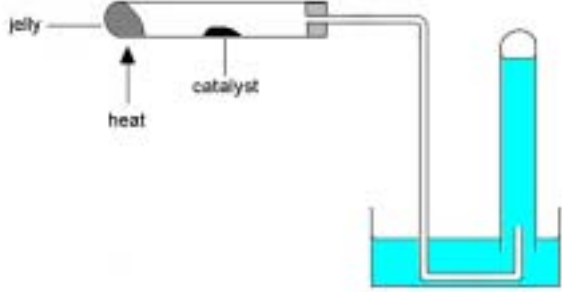
Question		Expected Answers	Marks	Additional Guidance
	(b) (iii)	Ether ;	1	allow alkoxyalkane
	(b) (iv)	$C_5H_{12}O$;	1	allow different order for atoms
	(b) (v)	Reduces / lowers / decreases tendency (1) ; to knock / autoignite / pre-ignite (1) ; (ora)	2	allow stops / prevents ignore references to combustion second mark can be scored separately but first mark depends on second.
		Total	14	

Question			Expected Answers	Marks	Additional Guidance
2	(a)	(i)	${}_{12}^{26}\text{Mg} + {}_{14}^{28}\text{Si} \rightarrow {}_{26}^{54}\text{Fe}$ top line (1) ; bottom line (1) ;	2	do not credit any marks if extra particles added
	(a)	(ii)	protons 26 ; electrons 26 ; neutrons 30 ;	1	all correct for 1 mark
	(a)	(iii)	it is an (weighted) average / mean (1) ; of all / several (naturally occurring) isotopes (1) ;	2	mark separately allow 'both' isotopes
	(b)		 <p><i>labelled diagram</i> showing metal cations (1) ;</p> <p>regular arrangement (1) ;</p> <p><u>delocalised</u> / <u>free</u> electrons <u>labelled</u> (1) ;</p> <p><u>attraction</u> between electrons and (metal cat)ions / plus and minus / opposite charges (1) ;</p>	4	<p><i>only one circle needed for first mark. At least one circle labelled +, 1+, 2+ or 3+ (or 'Fe' with these charges or labelled 'positive' or 'cation'). No other labels needed but 'nuclei' or 'protons' etc are CON ignore 'atoms'. anions shown are 'con'.</i></p> <p>arrays as shown, diagrams show minimum no. for mark</p> <p>ignore labels on circles</p> <p>labelled as shown (must have container or shading if no '-') accept 'e' or 'e⁻' instead of '-'. There must be gaps between the circles to score this mark. Electrons must be <i>between</i> iron ions. allow shading to represent electrons.</p> <p>only last mark can be scored without diagram</p>

Question		Expected Answers	Marks	Additional Guidance
	(c) (i)	$\text{Fe}^{2+}(\text{g}) \rightarrow \text{Fe}^{3+}(\text{g}) + \text{e}^{-}$ idea of Fe(II) to Fe(III) (1); correctly balanced equation with one or more e or e ⁻ as outcome (1); state symbols (1); (provided second mark scored)	3	ignore state symbols / nuclear symbols on e i.e. $\text{Fe}(\text{g}) \rightarrow \text{Fe}^{3+}(\text{g}) + 3\text{e}^{-}$ scores 2 marks
	(c) (ii)	moles Fe = 1.68 / 56 (= 0.03) (1); moles O = 0.64 / 16 (= 0.04) (1); Fe ₃ O ₄ (1) (ecf)	3	ecf for last mark - allow any correctly calculated formula between Fe ₅ O and FeO ₅ Fe ₃ O ₄ scores 3 without working
	(iii)	$\text{Fe}_2\text{O}_3(\text{s}) + 3\text{CO}(\text{g}) \rightarrow 2\text{Fe}(\text{l}) + 3\text{CO}_2(\text{g})$ correct equation (1); ss (1);	2	award ss mark for correct <i>species</i> only (i.e. even if equation incorrectly balanced – allow Fe ₂ here) allow multiples
	(d) (i)	basic / base	1	ignore alkali
	(ii)	X is lime water / calcium hydroxide (solution) (1); <i>plus any three from</i> same masses / moles / amount (of carbonate)(1); <u>heat with</u> same flame / same Bunsen height / same amount of heat (1) (AW); time / speed for lime water to go cloudy (AW); related to thermal stability or time / speed for CO ₂ to be produced related to thermal stability (1); MgCO ₃ less stable than CaCO ₃ (AW) (ora) (1);	4	allow bicarbonate indicator or Universal Indicator ignore CO ₂ allow equal volume allow same temperature ignore references to bubbles produced allow more cloudiness (AW) in given time allow bicarbonate indicator/ Universal Indicator going yellow
	(e) (i)	alpha, beta, gamma ;	1	allow correct symbols allow spelling errors if meaning clear

Question		Expected Answers	Marks	Additional Guidance
	(ii)	Any two from: causes health problems / cancer / could be fatal (AW) ; can damage <u>cells / tissue / organs</u> (AW) / mutate / change / damage DNA ; ionises (cells / tissue) ;	2	ignore harmful not just 'ionising' (in question)
		Total	25	

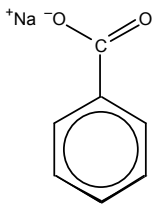

Question		Expected Answers	Marks	Additional Guidance
3	(a)	C ₇ H ₁₆ (1) ; alkane (1) ; heptane (1) ; arene (1) ; alkene (1) ;	5	allow aromatic ignore unsaturated
	(b)	(i) any full structural formula shown (1) ;   (1) ; 2,3-dimethylbutane 2,2-dimethylbutane (1) ;	3	mark separately (i.e. any full structural formula with all hydrogens for first mark) allow any unambiguous representation for second mark (if formula not corrected to C ₆ H ₁₄ , allow one of ) allow correct name of a scoring structure (ignore numbers for above structures) allow 'methly' but not absence of 'di' or double number (e.g. 2,2) ignore presence or absence of dashes, commas, gaps.
		(ii) isomerisation (1) ; cracking (1) ; reforming (1) ;	3	allow reforming or isomerisation for first mark if alkene or cyclic compound given in (i)

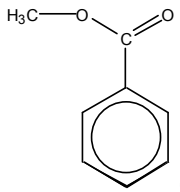
Question	Expected Answers	Marks	Additional Guidance
(c)	 <p>horizontal / sloping (less than 45°) tube with arrow or 'heat' label (2) ; or two separate workable parts for vaporising jelly and passing over catalyst (2) ; connected without leaks to (1) ; correct gas collection apparatus (1) ;</p>	4	<p>'heat' and / or arrow can be shown anywhere on tube (allow tube to be 'blocked' by bung)</p> <p>not tube as single line (mark separately) (allow delivery tube through glass) water level must be shown in beaker but tube can be full or empty</p>
	<p>label of jelly / alkane / reactant(s) in correct position(1) ; label of catalyst / porcelain / pot (AW) in workable position (1) ;</p>		<p>allow at bottom of vertical tube catalyst must be heated for this mark if in separate part of apparatus.</p>
(d)	(i)	1	
	(ii)	1	ignore pressure
(e)	$\text{C}_6\text{H}_{14} + 6\frac{1}{2}\text{O}_2 \rightarrow 6\text{CO} + 7\text{H}_2\text{O}$ <p>formulae correct (1) ; balanced (or double this (1) ;</p>	2	second mark depends on first
	Total	19	

Question			Expected Answers	Marks	Additional Guidance
4	(a)	(i)	$2[\text{K}]^+ \text{ or } 2 \left[\begin{array}{c} \cdot\cdot \\ \cdot\text{K}\cdot \\ \cdot\cdot \end{array} \right]^+ \quad \left[\begin{array}{c} \cdot\cdot \\ \cdot\text{S}\cdot \\ \cdot\cdot \end{array} \right]^{2-}$ <p>charges (+ and 2-) (1); <u>2</u> correct potassium ions (1); sulphide ion (1);</p>	3	<p>ignore inner shells</p> <p>square brackets not essential but ions must be separate to score second mark</p> <p>(ignore charges for second and third marks)</p> <p>Third mark can be scored by covalent structure showing 'shared pairs'</p> <p>allow $[\text{K}^+]_2$ allow all crosses $[\text{K}]_2^+$ scores second mark, not first. on sulphide allow crosses in any of the pairs or six crosses and two dots.</p>
	(a)	(ii)	<p>electrons drop (AW) (1);</p> <p>energy levels (1); <i>depends on first;</i></p> <p>(energy emitted) as light / line in visible (AW) (1);</p> <p>frequency of line depends on gap between levels / $(\Delta)E=h\nu$ (1);</p> <p>several different drops (AW) (1);</p>	5	<p>can score fourth mark for electrons moving up</p>
4	(b)	(i)	<p>moles water = $1.7 \times 10^7 / 2$ or 8.5×10^6(1);</p> <p>multiply by 250 and evaluate (1); (ecf)</p> <p>$(2.1(25) \times 10^9)$</p> <p>2 sf (2.1×10^9) (1);</p>	3	<p>2.1×10^9 scores all three marks</p> <p>4.3×10^9 scores two marks; 4.2×10^9 scores one mark</p> <p>mark sf separately if the result of some shown working.</p>

Question		Expected Answers	Marks	Additional Guidance
	(b) (ii)	<p>any three from:</p> <p>(large volume of) gas / steam produced ; exothermic reaction / high temperature (gas) ; <u>only</u> (AW) steam / water formed or no toxic / corrosive / polluting gases produced ; (Liquid reagents) easy to store / transport (AW) ;</p>	3	<p>'hot gases' scores two marks</p> <p>not just 'water formed'</p> <p>allow 'renewable', 'hydrogen has high energy density'</p> <p>ignore 'abundant' 'low density'</p>
	(b) (iii)	<p>increases (1) ; gas formed (from liquid) (1) ; more ways of arrangement of particles / energy / more disorder (1) ;</p>	3	<p>allow reasoning to back answer to first mpt mark separately</p>
		Total	17	

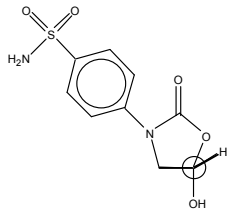
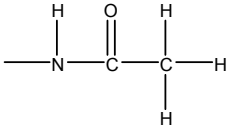

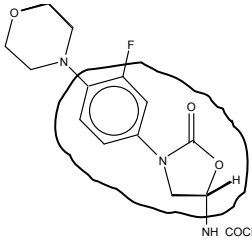
2854 Chemistry by Design

Question		Expected Answers	Marks
1	(a)	 ; no mark if covalent bond shown. allow C ₆ H ₅ COO ⁻ Na ⁺	1
1	(b)	(i) [H ⁺] [A ⁻]/[HA] ;	1
1	(b)	(ii) [H ⁺] = √(6.3 × 10 ⁻⁵ × 0.01) = 7.93 × 10 ⁻⁴ (1) ; pH = -log [H ⁺] = 3.1 (1) ; allow ecf from wrongly calculated value of [H ⁺]	2
1	(b)	(iii) [HA]/[A ⁻] = [H ⁺]/K _a (1) ; [H ⁺] = 2.5 × 10 ⁻⁴ (1) ; ratio = 4.0 (3.99) (1) ;	3
1	(c)	(i) addition of H ⁺ moves equm to left (ora) for OH ⁻ or A ⁻ removes H ⁺ /HA provides H ⁺ (1) ; pH remains (almost) the same (1) ; large amounts of HA and A ⁻ / “reservoir” (AW) (1) ;	3
1	(c)	(ii) enzymes work at specific pHs / substrate can't bind at different pH (1) ; buffering can ensure a different pH / buffers maintain pH (AW) (1) ;	2
1	(d)	(i)  O-H bond (1) ; rest (1) ; “unpaired electron” (1) ; allow non-paired ignore lone, single negative charge CONS this mark	3

Question			Expected Answers	Marks
1	(d)	(ii)	$C_6H_5COOH \rightarrow C_6H_6 + CO_2$ (1) for CO_2 / 'carbon dioxide' ; (1) for rest correct ;	2
1	(d)	(iii)	catalyst / initiator ;	1
1	(d)	(iv)	C_6H_6 (1) ; C_4H_3 (1) ; at least one ion shown as positive (even if incorrect) (1) ;	3
1	(e)		 ester link (1) ; completely correct (1) ;	2
1	(f)	(i)	methanol (1) ; <u>conc</u> sulphuric / hydrochloric acid (1) ;	2
1	(f)	(ii)	flask (labelled at least with a liquid level), connected without leaks. (1) ; to a vertical condenser – unsealed with water connections correctly labelled (1) ;	2
Total:				27

Question			Expected Answers	Marks	
2	(a)	(i)	<p>3C backbone (1) ; rest (1) ;</p>	2	
2	(a)	(ii)	<u>carbon-carbon</u> double bond ; Allow 'alkene groups and C=C	1	
2	(a)	(iii)	bromine (water) / iodine (1) ; decolourised (1) ; <i>second mark depends on first</i> ignore start colour and 'clear'.	2	
2	(a)	(iv)	harden (1) ; by oxidation / cross linking (1) ;	2	
2	(b)		high boiling / involatile liquid (1) ; on solid support / walls of tube (1) ; <u>inert / unreactive</u> gas (1) ; allow named (or formula for) inert gas	3	
2	(c)		peak above 500 (1) ; falls above 650 (1) ;	2	
2	(d)		at least three energy levels (labelled or described) (1) ; smaller gap at top (1) ; electron falls (1) ; $E = hv$ / frequency proportional/ related to energy gap (1) ; different <u>gaps</u> for different elements (1) ; allow last two marks if absorption described	5	
				Total:	17

Question			Expected Answers	Marks
3	(d)	(i)	$\text{PbO} + 2\text{H}^+ / 2\text{HCl} / 2\text{HNO}_3 / \text{H}_2\text{SO}_4 \rightarrow \text{Pb}^{2+} / \text{PbCl}_2 / \text{Pb}(\text{NO}_3)_2 / \text{PbSO}_4 + \text{H}_2\text{O}$ idea of reaction with acid (1) ; completely correct (1) ;	2
3	(d)	(ii)	No oxides or elements on right of Periodic Table (1) ; are usually acidic (1) ; or (ora): oxides on left of Periodic Table (1) ; are usually basic (1) ;	2
			Total:	22

Question		Expected Answers	Marks
4	(a)	 ;	1
4	(b) (i)	 (1) ;  essential. allow R-N	2
4	(b) (ii)	ethanoyl chloride / ethanoic anhydride (1) ; CH_3COCl / $(\text{CH}_3\text{CO})_2\text{O}$ (1) ;	2
4	(b) (iii)	NaBr / conc H_2SO_4 or HBr (1) ; -Br (1) ; or -Cl in which case allow 'conc HCl' above NH_3 (1) ; heat in sealed tube (1) ;	4
4	(c)	 (1) ; allow top N and bottom NH included fits into receptor site on bacterium (1) ; stopping metabolism (AW) (1) ;	3

Question			Expected Answers	Marks
4	(d)		<p><i>two pairs from:</i> C=O; at 1630-1700 ; C=O at 1735-1750; C-H; at 2850-2950 ; C-O; at 1050-1300 ;</p> <p><i>two pairs from:</i> linezolid 4 signals sulphonamide 3 signals; proton environment ; linezolid 5-12; H attached to N ; sulphonamide 0.5 – 4.5; H attached to O ; linezolid 2.2; CH₃ next to CO ; <i>mark correct material and ignore errors, unless CON</i></p> <p>QWC logical and use of three of the following in the correct context (2) ; use of two of the following in the correct context (1) ; peak, absorption, cm⁻¹, wavenumber, chemical shift, (proton) environment, proton (used separately from “proton nmr”)</p>	8
				2
4	(e)	(i)	<p>F₂ (1) ; Fe / FeF₃ / any Lewis acid (1) ; room temp / heat / anhydrous (<i>if one other mark scored</i>) (1) ;</p>	3
4	(e)	(ii)	<p>electron deficient reagent/ positive reagent/attracted to negative charge/ accepts electron pair (1) ; to form bond (1) ; <i>second depends on first</i></p>	2
4	(e)	(iii)	<p>delocalisation (1) ;</p>	1
4	(e)	(iv)	<p>C₆H₆ + 9F₂ → C₆F₁₂ + 6HF (1) ;</p>	1
			Total:	29

Question			Expected Answers	Marks
5	(a)	(i)	$[\text{Ca}^{2+}][\text{CO}_3^{2-}]$;	1
5	(a)	(ii)	$[\text{CaCO}_3] = [\text{Ca}^{2+}] = \sqrt{(5.0 \times 10^{-9})} (1) = 7.07 \times 10^{-5} (1)$; conc in $\text{g dm}^{-3} = 7.07 \times 10^{-5} \times 100 = 7.07 \times 10^{-3} (1)$; <i>ecf from calculated molar concentration</i>	3
5	(b)	(i)	$S_{\text{prods}} = -111.9 (1)$; answer = $-204.8 (1)$;	2
5	(b)	(ii)	more ways of arranging ions/ molecules/ particles (1); than in solid (1);	2
5	(b)	(iii)	high charge (1); small size (1); 'high charge density' <i>scores both these marks</i> many water molecules attracted (1); more organisation of water molecules (1);	4
5	(c)		$-204.8 + 14000 / 298 (47) = -157.8$ (1) for 14000 / 298; (1) for rest <i>with ecf from 1st mpt and (b) (i)</i>	2
5	(d)		solubility greater (1); exothermic reaction (1); equm position moves to right (1); opposes change (1);	4
5	(e)	(i)	$[\text{H}^+] [\text{OH}^-]$;	1
5	(e)	(ii)	$[\text{H}^+] = 7.94 \times 10^{-9} (1)$; $[\text{OH}^-] = 10^{-14} / 7.94 \times 10^{-9} = 1.26 / 1.3 \times 10^{-6} (1)$;	2

Question			Expected Answers	Marks
5	(f)	(i)	much CO ₂ evolved/ greenhouse gas / global warming ;	1
5	(f)	(ii)	Mr values for CaCO ₃ / CO ₂ (100; 44) (1) ; 0.44 tonnes (1) ; 2sf <i>providing some working</i> (1) ;	3
				25

Grade Thresholds

Advanced GCE Chemistry (Salters) (3887/7887)
January 2009 Examination Series

Unit Threshold Marks

Unit		Maximum Mark	A	B	C	D	E	U
2848	Raw	90	73	66	59	52	45	0
	UMS	120	96	84	72	60	48	0
2849	Raw	90	69	62	55	48	42	0
	UMS	90	72	63	54	45	36	0
2850	Raw	75	59	54	49	44	39	0
	UMS	90	72	63	54	45	36	0
2854	Raw	120	85	75	66	57	48	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 (ie 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	11.1	35.8	62.1	84.1	96.0	100.00	608
7887	14.3	41.1	67.0	93.8	99.1	100.00	116

724 candidates aggregated this series

For a description of how UMS marks are calculated see:

http://www.ocr.org.uk/learners/ums_results.html

Statistics are correct at the time of publication.

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