

# **Chemistry (Salters)**

Advanced GCE A2 7887

Advanced Subsidiary GCE AS 3887

## **Mark Schemes for the Units**

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**June 2009**

**3887/7887/MS/R/09**

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## CONTENTS

### Advanced GCE Chemistry (Salters) (7887)

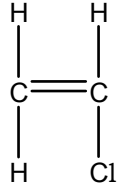
### Advanced Subsidiary GCE Chemistry (Salters) (3887)

#### MARK SCHEME ON THE UNITS

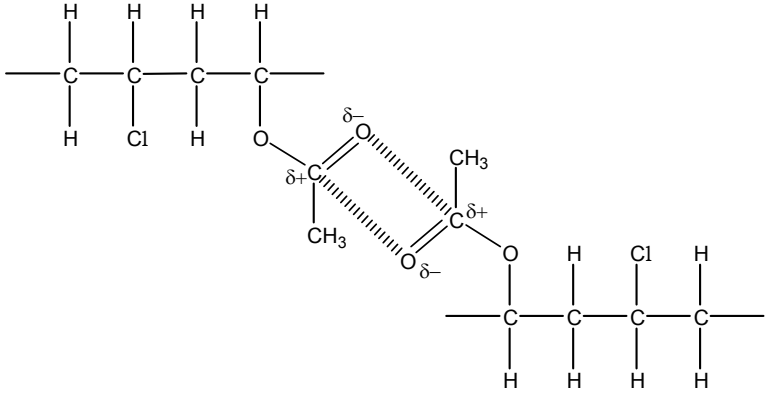
<b>Unit/Content</b>	<b>Page</b>
2848 Chemistry of Natural Resources	1
2849 Chemistry of Materials	13
2850 Chemistry for Life	21
2852/01 Chemistry Salters Open Book	29
2854 Chemistry by Design	35
Grade Thresholds	46

## 2848 Chemistry of Natural Resources

Question		Expected Answers	Marks	Additional Guidance
1	a	PTFE / Teflon / Bakelite / poly(ethyne) / conducting polymers (1) ;	1	<b>accept</b> poly(pyrole)
	b	<i>Any two from:</i> Melting point (1) ; Hardness (1) ; Flexibility/ rigidity/ brittleness (1) ; <u>Tensile</u> strength (1) ;	2	<b>ignore</b> reference to comparison of values. <b>ignore</b> boiling point. <b>not</b> elasticity / plasticity
	c	i	elimination (1) ;	1 <b>allow</b> dehydration

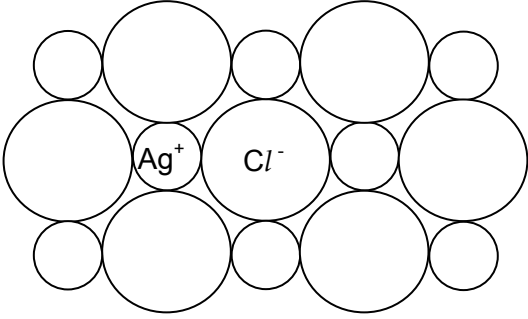
Question	Expected Answers	Marks	Additional Guidance						
ii	<table border="1" data-bbox="353 260 1084 579"> <tr> <td data-bbox="353 260 698 325">reagent</td> <td data-bbox="698 260 1084 325">conditions</td> </tr> <tr> <td data-bbox="353 325 698 443">sulphuric acid(1) ;</td> <td data-bbox="698 325 1084 443">heat (under reflux)(1) ; concentrated (1) ;</td> </tr> <tr> <td data-bbox="353 443 698 579">alumina/ silica/ pumice/ porous pot(1) ;</td> <td data-bbox="698 443 1084 579">heat (1) ; with (ethanol) vapour(1) ;</td> </tr> </table>	reagent	conditions	sulphuric acid(1) ;	heat (under reflux)(1) ; concentrated (1) ;	alumina/ silica/ pumice/ porous pot(1) ;	heat (1) ; with (ethanol) vapour(1) ;	3	<p><b>allow</b> correct formula for reagent.</p> <p>sulphuric acid <b>AND</b> alumina <b>con</b> reagent mark (but can still score subsequent marks).</p> <p>clear alternatives i.e. sulphuric acid <b>OR</b> alumina scores the mark.</p> <p><b>allow</b> c. for concentrated.</p> <p>aqueous / moderately <b>cons</b> concentration mark.</p> <p>heat and concentration marks may only be awarded if the candidate has written an appropriate reagent, or has only made a small mistake e.g.: sulphuric without acid, or wrong formula (like AlO)</p> <p>no marks for sulphuric acid with dichromate and heat.</p> <p>distil <b>cons</b> heat mark for both.</p> <p><b>ignore</b> reference to pressure</p> <p>reflux <b>cons</b> heat mark for alumina route</p> <p><b>accept</b> 200-400°C</p>
reagent	conditions								
sulphuric acid(1) ;	heat (under reflux)(1) ; concentrated (1) ;								
alumina/ silica/ pumice/ porous pot(1) ;	heat (1) ; with (ethanol) vapour(1) ;								
d	<p><math>Cl^- \rightarrow Cl_2</math> (1) ;</p> <p>Adding electrons and balancing (1) ;</p> <p><math>2Cl^- \rightarrow Cl_2 + 2e^-</math> Completely correct equation scores 2</p>	2	<p><b>allow</b> <math>2Cl^- - 2e^- \rightarrow Cl_2</math></p> <p><b>allow</b> multiples in balancing</p> <p>2<sup>nd</sup> mark is for the completely correct equation (i.e. consequential on the first mark)</p>						
e i	 <p>(1) ;</p>	1	<p>the correct shape for the molecule is not required for the mark.</p>						

Question		Expected Answers	Marks	Additional Guidance
	ii	addition (1) ;	1	<b>ignore</b> type. <b>not</b> additional
f	i	(a particle) with an unpaired/lone electron(1) ;	1	<b>ignore</b> 'free' or spare electron. <b>not</b> reference to charge
	ii	homolytic (1) ;	1	<b>accept</b> homolysis <b>ignore</b> small spelling mistakes if the meaning is not ambiguous.
	iii	Propagation (1) ; Termination (1) ;	2	
	iv	1 at lower temperatures particles have less (kinetic) energy / move more slowly (1) ; 2 leading to fewer collisions per unit of time / less frequent collisions (1) ; 3 fewer collisions occur with energy of colliding particles greater than $E_a$ (1) ; 4 activation enthalpy is minimum total energy for colliding particles to react (1) ;  <i><b>QWC:</b> two sentences; spelling, punctuation and grammar correct</i>	4              1	if RA is used then marking point 1 not scored but can get ecf for remaining marks  must be a comment on frequency, not just 'less collisions' or probability  award marking point 3 if description of activation energy i.e. enough energy to react on collision.  in marking point 4 accept 'successful collisions' for 'colliding particles to react'  points 3&4  these must refer to the particles colliding.  both marks can be obtained if the candidate has mentioned on collision at least once and it is clear that the candidate is referring to the collision in the second point. <b>allow</b> one error in spelling.
g	i	alkene (1) ;	1	not just C=C.

Question	Expected Answers	Marks	Additional Guidance
ii	Permanent dipole – (permanent) dipole (1)	1	must be in words.
iii	 <p>1 At least one correct <math>\delta+</math> and <math>\delta-</math> shown (1) ; 2 At least one correct imf shown (1) ;</p>	2	random incorrect labelling of small positive and negative charges negates the first marking point. random incorrect labelling of intermolecular negates the second marking point.
h	<p><u>Branches / side chains</u> push chains apart (1) ; So imf are weaker (1) ; Allowing chains / molecules to slide over each other (more readily) (1) ;</p>	3	<p><b>do not accept</b> side groups <b>do not accept</b> lower or less imf mark must be comparative mark independently / ORA</p>
<b>Total</b>		<b>27</b>	

Question		Expected Answers	Marks	Additional Guidance
2	a	(Position of) <u>equilibrium</u> moves / shifts (1) ; to oppose / counteract t/ reverse change (in reaction conditions) (1) ; adding more alkali increases the OH <sup>-</sup> <u>concentration</u> (1) ; which pushes the (position of) <u>equilibrium</u> to the left (1) ; causing more HCN gas to dissolve / be used up (1) ;	5	<b>accept</b> position of equilibrium changes if candidate does not state Le Chatelier's Principle then <b>allow</b> counteract mark in explanation  <b>accept</b> 'causing more reactants (or named reactants) to form' <b>accept</b> less HCN gas <u>produced</u> <b>do not accept</b> there is less HCN(g)
	b	<i>advantages:</i> does not use a toxic/poisonous chemical like cyanide (1) ; works on low grade ores (1) ; <i>disadvantage:</i> very slow (1) ;	3	answers <b>must</b> come from information given in the question. <b>accept toxic</b> HCN not produced  ORA
	c	i	2	completely correct answer scores 2 ecf for 2 <sup>nd</sup> mark <b>allow</b> 0.45 x 10000 for 2 <sup>nd</sup> mark
		ii	3	<b>accept</b> high temperature but <b>not</b> hot (air) <b>ignore</b> silica/limestone Accept SO <sub>2</sub>
	d	i	2	<b>allow</b> 1 mark if both answers have the sign after the number (i.e: 2- <b>and</b> 2+)
		ii	1	<b>allow</b> oxidation state becomes more negative.

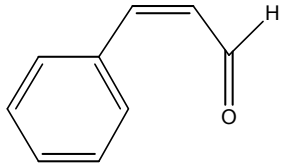
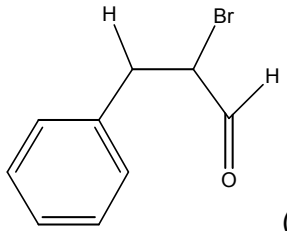


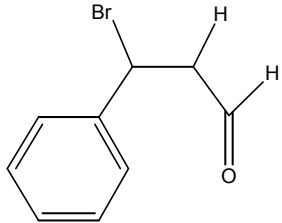
Question		Expected Answers	Marks	Additional Guidance
				<b>accept</b> reduction is gain of electrons <b>do not accept</b> the silver has gained an electron
e	i	$\text{Ag}^+(\text{aq}) + \text{Cl}^-(\text{aq}) \rightarrow \text{AgCl}(\text{s})$ equation (1); state symbols (1);	2	completely correct equation i.e.: without spectator ions scores one mark mark state symbols separately –must have idea of precipitation $(\text{aq}) + (\text{aq}) \rightarrow (\text{s})$
	ii	white (1)	1	<b>ignore</b> changes of colour on standing
	iii	<i>For example:</i>  smaller circle labelled $\text{Ag}^+$ , larger circle labelled $\text{Cl}^-$ (1); four silver species around each chlorine species <b>and</b> vice versa (1);	2	minimum is 4 small circles surrounding large circle and 4 large circles surrounding small circle.
	iv	funnel with filter paper labelled (1); connected without leaks or blockages to side-arm flask with vacuum connection labelled (1); silver chloride shown or labelled in funnel (1);	3	method of sealing flask to funnel should be clearly shown must be a label for vacuum or pump

Question		Expected Answers	Marks	Additional Guidance
	v	The <u>UV / light</u> causes the silver chloride to react or break down (1) ; producing (grey) silver (1) ;	2	ignore photodissociation
<b>Total</b>			<b>26</b>	

Question		Expected Answers	Marks	Additional Guidance
3	a	1,1,1,2-tetrafluoroethane (2) ; tetrafluoroethane (1) ; correct numbering at the beginning(1) ;	2	<b>allow</b> small errors in spelling
	b	i	2	<b>ignore</b> dots <b>ignore</b> initiation/termination reactions
		ii	2	<b>do not allow</b> holds onto electrons more strongly <b>ignore</b> harder to break 2 <sup>nd</sup> mark must refer to UV / radiation. “there is not enough energy” is insufficient to score the mark. <b>not</b> intensity of radiation <b>must</b> be referring to a size effect.
		iii	2	One mark is for converting 346 from kJ to J i.e multiply 346 by 1000. the other mark is for dividing by $6.02 \times 10^{23}$ (the Avogadro constant). A completely correct answer on its own scores all marks.
		iv	3	<b>do not allow</b> second mark for evaluating any other expression e.g.: Answer to (e) (i) $\times 6.63 \times 10^{-34}$ <b>allow</b> s.f. mark for any 3 sig fig answer that follows from any calculation/correctly rearranged equation.  a completely correct answer on its own scores all marks including the s.f. mark.

Question	Expected Answers	Marks	Additional Guidance
c	<p>1 Radiation / UV / visible (from the Sun) <u>absorbed</u> by the Earth (1) ;</p> <p>2 which radiates/emits ir/longer wavelength or lower frequency radiation(1) ;</p> <p>3 this infra red is absorbed by molecules of HFC 134a (1) ;</p> <p>4 which makes <u>bonds</u> vibrate (more) (1) ;</p> <p>5 this increases temperature/ releases heat (1) ;</p> <p><b>QWC</b> for a logical account that includes the use of at least three words from the list, used correctly:</p> <p><i>Absorb, uv, visible, infrared, radiation, KE, vibrate, bonds, molecule.</i></p>	<p>5</p> <p>1</p>	<p><b>do not accept</b> reflects</p> <p><b>allow</b> greenhouse gases for HFC 134a but not other named greenhouses gases</p> <p><b>accept</b> increase the vibrational energy <b>levels</b> of the <b>molecule</b> for marking point 3</p> <p><b>must</b> be referring to infra red for marking points 3 and 4</p> <p><b>must</b> have the idea of transfer of energy for marking point 5. Not just warming.</p>
<b>Total</b>		<b>17</b>	

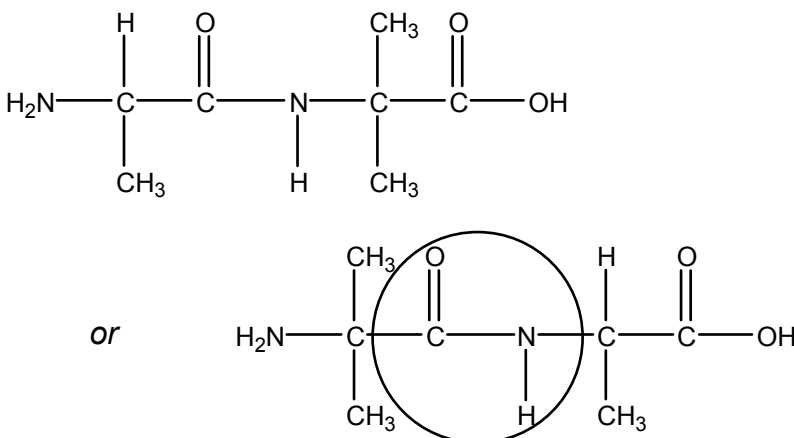
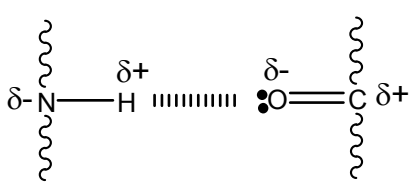
Question			Expected Answers	Marks	Additional Guidance
4	a	i	 <p>Cis formation for C=C (1) ; Rest of structure (1) ;</p>	2	<p><b>allow</b> 1 mark for a correctly drawn cis arrangement for the C=C, even if there is an error in the rest of the structure. aldehyde hydrogen not needed <b>do not allow</b> other hydrogens for second mark</p> <p>rest of the structure is consequential on first mark</p>
		ii	<p>C=C / double bond restricts rotation (1) ; (Substituent groups mean two) different arrangements possible AW (1) ;</p>	2	<p>for 2<sup>nd</sup> mark must have mentioned the double bond somewhere in the answer</p>
	b	i	<p>alkene (1) ;</p>	1	<p><b>do not allow</b> C=C.</p>
		ii	<p>red-brown (1) ; colourless (1) ;</p>	2	<p><b>allow</b> brown / orange / orange-brown / red-orange but not red alone <b>do not allow</b> clear for the second answer</p>
		iii	<p>addition (1) ; electrophilic (1) ;</p>	2	<p>any clear indication of choices scores marks, e.g.: ringed. Three answers indicated scores a maximum of 1, four answers indicated scores zero.</p>
	c		 <p>(1) ;</p>	2	<p>double bonds / circle omitted on both structures that are otherwise correct scores 1.</p>

Question	Expected Answers	Marks	Additional Guidance
	 <p>(1) ;</p>		
d	<p>(Potassium / sodium) dichromate / correct formula (1) ;            Acidified / (sulphuric) acid / H<sub>2</sub>SO<sub>4</sub> / H<sup>+</sup> (1) ;</p> <p>Heat / warm / distil (1) ;</p>	3	<p><b>ignore</b> dichromate oxidation state if dichromate written in words (<b>allow</b> minor spelling error).  <b>allow</b> any inorganic acid.  <b>ignore</b> formula if correct name is given.            Heat mark is only awarded if candidate scores the dichromate mark.  <b>ignore</b> reflux  <b>accept</b> any temperature between 25 and 100°C</p>
e	Acid-base (1) ;	1	

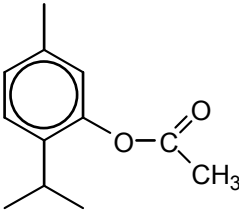
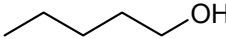
Question		Expected Answers	Marks	Additional Guidance
	f i	26.10 x 0.0100 (1) ; / 1000 and evaluated (= 2.61x 10 <sup>-4</sup> ) (1) ;	2	a correct answer on its own scores all marks
	ii	answer to (i) (1) ;	1	
	iii	Mass cinnamic acid = answer to (ii) x 148 = (0.0386g) (1) ; % cinnamic acid = mass cinnamic acid x 100 / 0.0400 = (96.6/96.57) (1) ;	2	<b>Allow</b> ecf from (i). A correct answer (96.6/96.57) on its own scores all marks.
		<b>Total</b>	<b>20</b>	







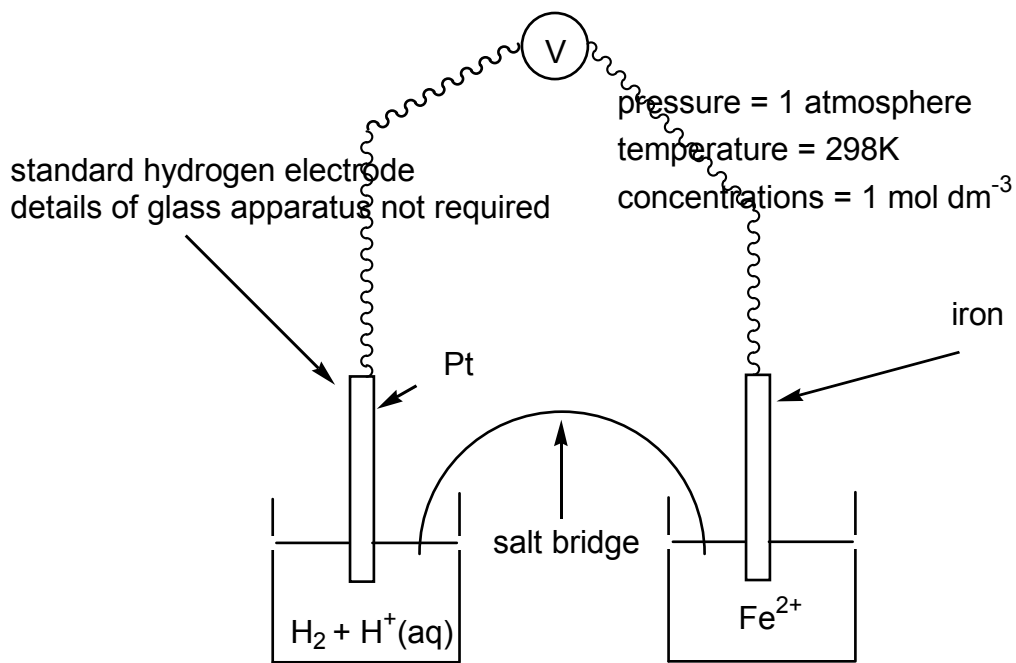
Question	Expected answers	Marks
1 (c)	<p><b>two of the following pairs:</b></p> <p><b>A</b> will have <u>3 peaks</u>, while <b>B</b> will have <u>4</u> (1) ;  because <b>A</b> has 3 <u>different types of H</u>, (while <b>B</b> has 4 types) (1) ;  1 mark only for 'B has more peaks as it has more proton environments'</p> <p><b>B</b> has a peak with a chemical shift of about <u>2.5 (allow 1.5)</u> (1) ;  which <b>A</b> does not; because of the single C-H (1) ;</p> <p>the peak at <u>0.8-1.2</u> is twice as intense / has a greater intensity in <b>A</b> than <b>B</b>  /peak height of 6 (AW) (1) ;  because of the two / more CH<sub>3</sub> groups AW (1) ;</p>	4
1 (d)	 <p>one mark for correct secondary amide structure (1) ;  rest of structure correct (1) ;</p>	2
1 (e) (i)	helix <b>and</b> sheet (1) ;	1
1 (e) (ii)	 <p>correct H-bond shown (1) ;  all 4 partial charges (1) ;  and lone pair (1) ;</p>	3
1 (e) (iii)	<p>any <b>two</b> from:</p> <p>instantaneous (dipole)-induced dipole forces (1) ;  ionic bonds (1) ;  disulphide / sulphur bridges / covalent bonds (1) ;</p>	2
1 (f) (i)	$K_c = [\text{CH}_3\text{C}(\text{CN})(\text{OH})\text{CH}_3] / [\text{HCN}] \times [\text{CH}_3\text{COCH}_3]$ (1) ;	1

Question	Expected answers	Marks
1 (f) (ii)	$\text{dm}^3 \text{ mol}^{-1}$ (1) ; <i>ecf from (i)</i> .	1
1 (f) (iii)	<i>ecf from (i)</i> ; to get moles into concentrations: divide by 5.00 (1) ; $30.18 = [\text{product}] / ((1.00)/5.00) \times (1.00/5.00)$ (1) ; <i>ecf for wrong [ ] values</i> hence $[\text{product}] = 1.21 \text{ mol dm}^{-3}$ to 3 sig figs (1) ;	3
1 (f) (iv)	$\text{CH}_3\text{COCH}_3 = 1$ (1) ; $\text{HCN} = 1$ (1) ;	2
<b>Total mark</b>		<b>29</b>

Question	Expected answers	Marks
2 (a)	pentanoic acid (1) ;	1
2 (b) (i)	CH <sub>3</sub> (CH <sub>2</sub> ) <sub>2</sub> CH <sub>2</sub> <sup>+</sup> (2) ; CH <sub>3</sub> (CH <sub>2</sub> ) <sub>2</sub> CH <sub>2</sub> (1) ; C <sub>4</sub> H <sub>9</sub> <sup>+</sup> only 1 mark;	2
2 (b) (ii)	<b>E</b> / pentanoic acid / C <sub>4</sub> H <sub>9</sub> COOH / <b>allow</b> valerian (1) ;	1
2 (c)	(the hydroxyl group in) <b>C</b> is a phenol / attached to a benzene ring (1) ; so will turn purple (1) ; <i>must be related to a phenol.</i>	2
2 (d) (i)	<b>D C E</b> (1) ;	1
2 (d) (ii)	acidity is due to [H <sup>+</sup> ] / acids are proton donors (1) ; [H <sup>+</sup> ] at equilibrium / equilibrium may be shown with an equation / acidity depends on stability of anion formed in solution) (1) ; stability / [H <sup>+</sup> ] depends on electron delocalisation (in the anion) (1) ; order of delocalisation: R-COO <sup>-</sup> > C <sub>6</sub> H <sub>5</sub> O <sup>-</sup> > RO <sup>-</sup> AW (1) ;	4
2 (e)	 HCl one mark for each compound (2) ;	2
2 (f) (i)	 or      CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> OH (2) ; OH group (1) ; Rest correct (1) ;	2
2 (f) (ii)	remove water / moves equilibrium (position) to the right / speed up the reaction / acts as a catalyst (1) ;	1
<b>Total mark</b>		<b>16</b>

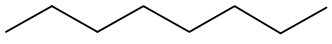
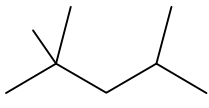
Question	Expected answers	Marks
3 (a) (i)	<p style="text-align: center;">3d                      4s</p> <p>Cr      </p> <p>Cr<sup>3+</sup>   </p> <p>One mark each (2) ;</p>	2
3 (a) (ii)	<p>Cr can form a (stable) <u>ion with a part full d shell</u> of electrons (1) ;</p> <p><b>or</b></p> <p><u>part full d shell</u> of electrons <b>allows</b> <u>variable oxidation states</u> (1) ;</p>	1
3 (b) (i)	Dative (covalent) /coordinate bond (1) ;	1
3 (b) (ii)	<p>the N and an O atom can each (1) ;</p> <p>donate/use a lone pair of electrons to bond (to the Cr<sup>3+</sup> ion) AW (1) ;</p>	2
3 (b) (iii)	<p>6 (1) ;</p> <p>octahedral (1) ;</p>	2
3 (c)	<p>choose a filter having the complementary colour (blue / green) to red (1) ;</p> <p><b>allow</b> 'suitable filter' ;</p> <p>Zero / calibrate / reference colorimeter with a water sample (1) ;</p> <p>make a series of standard samples of the complex (around <math>4.00 \times 10^{-4} \text{ g dm}^{-3}</math>) and measure their absorbance / transmission (<i>absorbance may be anywhere in the answer</i>) AW (1) ;</p> <p>plot a calibration graph of concentration v absorbance (<b>allow</b> readings)(1) ;</p> <p>measure (absorbance of) sample and read concentration off calibration graph (1) ;</p>	5
3 (d) (i)	It is produced in the body / so it should not be toxic / stable (1) ;	1
3 (d) (ii)	Find the maximum dose of picolinate which is safe / check that the complex used is pure / measure its toxicity AW (1).	1
<b>Total mark</b>		<b>15</b>

Question	Expected answers	Marks
4 (a) (i)	<p>Because it has a more positive <math>E^\ominus</math> ORA / <math>E^\ominus</math> cell is positive (1) ; <math>E^\ominus</math> may be inferred in answer</p> <p>plus any <b>two</b> from:</p> <p><math>\text{Fe}^{2+}</math> reacts with / oxidises Al / removes electrons from the Al atoms ORA (1) ; to form <math>\text{Al}^{3+}</math> ions (1) ; breaks down the structure of the metal AW (1) ;</p>	3
4 (a) (ii)	<p><math>2\text{Al} + 3\text{Fe}^{2+} \rightarrow 2\text{Al}^{3+} + 3\text{Fe}</math></p> <p>species correct (1) ; balanced (1) ;</p>	2
4 (b)	<p><math>\text{Al}^{3+}(\text{aq}) + 3\text{OH}^{-}(\text{aq}) \rightarrow \text{Al}(\text{OH})_3(\text{s})</math></p> <p>species correct (1) ; balanced and correct state symbols (1) ; aluminium hydroxide is a <u>white solid / precipitate</u> (1) ;</p>	3
4 (c) (i)	1.22 V (1) ;	1
4 (c) (ii)	<p>The conditions may not be standard (1) ; the <math>E^\ominus</math> of a half-cell varies with temperature and / or concentration / states one condition that is different for the 'lasagne cell' AW (1) ;</p> <p><b>or</b></p> <p>The liquid in lasagne will be different from the electrolyte (AW) used in the standard cell / other metals present in steel (1) ; reactions in the cell may be different AW (1) ;.</p>	2

<p>4 (d)</p>	 <p>standard hydrogen electrode details of glass apparatus not required</p> <p>pressure = 1 atmosphere temperature = 298K concentrations = 1 mol dm<sup>-3</sup></p> <p>Pt</p> <p>iron</p> <p>salt bridge</p> <p>H<sub>2</sub> + H<sup>+</sup>(aq)</p> <p>Fe<sup>2+</sup></p> <p>V</p> <p>Voltmeter and salt bridge correctly linked (1) ; Pt electrode for SHE (1) ; H<sub>2</sub> and H<sup>+</sup> in SHE (1) ; <b>two</b> standard conditions correct (1) ;</p>	<p>4</p>
<p style="text-align: right;"><b>Total mark</b></p>		<p><b>15</b></p>

Question	Expected answers	Marks
5 (a) (i)	ester (1) ;	1
5 (a) (ii)	addition: no molecule is eliminated / no small/water molecule formed / ester linkage already present in monomer / polymer consists of opened monomers added together (1) ;	1
5 (b) (i)	(moderately) concentrated acid (HCl/H <sub>2</sub> SO <sub>4</sub> )(1) ; <b>not</b> Conc. H <sub>2</sub> SO <sub>4</sub> <b>allow</b> aqueous alkali/NaOH/KOH heat under reflux / reflux (1) ;.	2
5 (b) (ii)	carboxyl / carboxylic acid (1); <i>if alkali used in 5(b)(ii) then must be</i> carboxylate (ion) hydroxyl / alcohol (1) ; (one mark for both formulae correct.)	2
5 (b) (iii)	(broad) peak at about 3000 / 3200 cm <sup>-1</sup> indicates <b>OH</b> (1) ; (strong) peak around 1720 cm <sup>-1</sup> indicates <b>C=O</b> <i>may be shown on diagram</i> (1) ; <i>1 mark only for identifying both correct wavenumbers without indicating functional groups</i> carboxylic acid / COOH (1) ;	3
5 (c) (i)	PCL melts / turns into liquid (1) ;	1
5 (c) (ii)	PCL snaps / breaks / shatters (1) ; the polymer chains do not have enough energy (1) ; to be able to slide over one another (1) ;	3
5 (d)	PCL has permanent dipole-permanent dipole forces between chains (1) ; poly(ethene) only has instantaneous dipole-induced dipole forces (1) ; <i>in poly(ethene)</i> <b>allow</b> temporary dipoles/van der Waals forces (1) ;	2
<b>Total mark</b>		<b>15</b>

## 2850 Chemistry for Life

Question		Expected Answers	Marks	Additional Guidance
1	a	octane (number)(1) ;	1	<b>allow</b> octane rating <b>ignore</b> references to pre-ignition/auto-ignition/knocking
	b	i		
		 (1) ;  (1) ;	2	<b>allow</b> any skeletal for 1 mark (no dots) <b>allow</b> variations in angle of lines representing branches in 2,2,4-trimethylpentane <b>not</b> any full structural
		ii	1	<b>allow</b> same number and type of <u>atoms</u> different structure AW <b>not</b> shapes/arrangement <u>on own</u>
		iii	2	<b>full</b> structural(1) ; correct name for example chosen(1) ; <b>all</b> bonds must be shown connecting correct . <b>allow</b> correct name if formula is skeletal or not full structural, not other compounds
	c	i	2	octane C <sub>8</sub> H <sub>18</sub> (1) ; cyclooctane C <sub>8</sub> H <sub>16</sub> (1) ; <b>allow</b> H and C atoms reversed
		ii	1	arene/aromatic (hydrocarbon)(1) ; <b>allow</b> unsaturated
		iii	4	reactants <u>adsorbed</u> on surface(1) ; bonds break(1) ; new bonds form(1) ; products diffuse away/desorb/come off from surface(1) ; <b>allow</b> stick to/bond to/chemisorb on surface bonds break <u>between</u> reactants is a <b>con</b> , but <b>allow</b> new bonds <u>forming</u> between reactants in context
	d	i	1	oxygenates(1) ; Not oxidiser

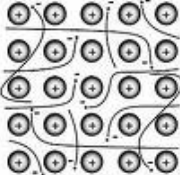


Question		Expected Answers	Marks	Additional Guidance
	ii	$\text{CH}_3\text{OH}(\text{g}) + 1\frac{1}{2}\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{g})$ formulae(1) ; balancing(1) ;	2	<b>do not allow</b> balancing mark if formulae incorrect. <b>ignore</b> state symbols <b>allow</b> any multiple
	iii	sam need less oxygen / $1\frac{1}{2}$ to 2(1) ; for for same amount /no of moles / molecules (of fuel)(1) ; for equivalent alkane	2	<b>allow</b> reverse argument
	iv	carbon monoxide(1) ; toxic/poisonous /photochemical smog(1) ; ( <b>ignore</b> references to greenhouse gas) second mark depends on first	2	<b>allow</b> CO <b>allow</b> <u>description</u> of nature of problem e.g. irreversibly bonds to haemoglobin AW <b>do not allow</b> carbon or unburnt hydrocarbon
	v	ether(1) ;	1	<b>allow</b> alkoxy(alkane)
		<b>Total</b>	<b>21</b>	

Question		Expected Answers	Marks	Additional Guidance	
2	a		one mark each  5	allow words (alpha etc)	
					Type of radiation ( $\alpha$ , $\beta$ or $\gamma$ )
		The particle emitted results in the atomic number increasing by one.			$\beta$
		Radiation of a very short wavelength			$\gamma$
		The particle emitted has a negative charge			$\beta$
		The particle emitted has a mass of four units.			$\alpha$
		The particle emitted is strongly deflected in an electric field.	$\beta$		
	b	i	3	do not allow $e^-$ numbers on right <b>con</b> mark(once) symbol must be correct e.g. not PB (missing electron scores 2 max) wrong type of decay/any additional species scores zero	
		ii	1	cannot penetrate film or layer / does not pass through to detector / stopped by paper - AW (1) ; <b>not</b> ionising/not deflected	
	c	<p><i>any three from:</i></p> <p>have to overcome (nuclear) repulsion (1) ;</p> <p><u>very/extremely</u> high temps needed(1) ;</p> <p><u>very/extremely</u> high pressures needed(1) ;</p> <p>difficult/specialist equipment needed to contain fusion process(1) ;</p> <p>high gravitational forces needed(1) ;</p>	3		

Question	Expected Answers	Marks	Additional Guidance
	Total	12	

Question			Expected Answers	Marks	Additional Guidance																
3	a	i	one each correctly labelled; i.e. going anticlockwise from top right electric field(1) ; magnetic field(1) ; ionisation chamber(1) ; sample inlet(1) ;	4																	
		ii	isotope mass x abundance(1) ; added(=20728)(1) ; divided by 100(1) ; (207.28); four sig figs(1) ; (207.3-scores all four)(1); ecf's on first two marking points (207.2 on own 3)	4	<b>ignore</b> answers with no working unless correct sf mark is a 'stand alone' providing it follows from previous calculation and is correct. Look for 207.2 wrong																
		iii	<table border="1"> <thead> <tr> <th>Isotope</th> <th>Number of protons</th> <th>Number of neutrons</th> <th>Number of electrons</th> </tr> </thead> <tbody> <tr> <td>lead-206</td> <td>82</td> <td>124</td> <td>82</td> </tr> <tr> <td>lead-207</td> <td>82</td> <td>125</td> <td>82</td> </tr> <tr> <td>lead-208</td> <td>82</td> <td>126</td> <td>82</td> </tr> </tbody> </table>	Isotope	Number of protons	Number of neutrons	Number of electrons	lead-206	82	124	82	lead-207	82	125	82	lead-208	82	126	82	one mark for each row  3	
Isotope	Number of protons	Number of neutrons	Number of electrons																		
lead-206	82	124	82																		
lead-207	82	125	82																		
lead-208	82	126	82																		
	b		mass of tin = $0.5 \times 119(59.5)$ (1) ; mass of lead= $100-59.5(40.5)$ scores both marks) (1) ;	2	<b>ecf</b> on second mark																

Question	Expected Answers	Marks	Additional Guidance
c i	<p>delocalised / free electrons (must be within structure) (1);</p> <p>cations / positive metallic residue, <b>NOT</b> atoms or nuclei(1);</p> <p>regular array / AW(1);</p> <p>Looking for two rows of cations minimum for regular array</p> 	3	<p><b>allow</b> (mobile) sea of electrons</p> <p><b>allow</b> '+'/ e<sup>(-)</sup> or just (-) as labels</p> <p><b>allow</b> regular array mark from diagram</p> <p><b>allow</b> mixture of Pb<sup>2+</sup> and Sn<sup>2+</sup></p>
	ii		
d	<p><u>Reactivity</u> depends on <u>outer</u> (shell) electrons / electrons lost from <u>outer</u> shell / outer shell implied(1);</p> <p>2/ Same number of outer electrons / formation of 2<sup>+</sup> ion (result in similar reactivity)(1);</p> <p>on going down group, outer electrons further from nucleus / more electron shells / more screening/shielding(1);</p> <p>electrons held less tightly/attraction to nucleus less /lost more easily (AW)(1);</p> <p>causes an increase in reactivity / get more reactive <u>down group</u> (ORA)(1);</p>	5	
	<b>Total</b>	<b>22</b>	

Question		Expected Answers	Marks	Additional Guidance
4	a	$3\text{C(s)} + \text{H}_2\text{O(g)} + \text{O}_2\text{(g)} \rightarrow 3\text{CO(g)} + \text{H}_2\text{(g)}$ ss(1) ; balancing(1) ; formulae(1) ;	3	ss 'stand alone' for recognisable species <b>neither</b> of last two marking points score if formulae incorrect
	b	dative (covalent bond) (1) ; pair of electrons both come from the oxygen atom(1) ;	2	<b>allow</b> co-ordinate bond
	c	<div style="border: 1px solid black; padding: 5px; width: fit-content;">             elements: <math>7\text{C} + 3\frac{1}{2}\text{O}_2 + 15\text{H}_2</math>              formulae of elements(1) ; balancing(1) ;           </div> sum of products minus sum of reactants(1) ; correct numbers(1) ; correct answer <u>with sign</u> (1) ; ecf's as appropriate	5	<b>allow</b> correct balancing if O and H instead of $\text{O}_2$ and $\text{H}_2$ <b>do not allow</b> multiples/halves for balancing mark  first mark of latter three marks is 'process mark' $\{(7 \times -242) + (-224)\} - (7 \times -111)$ (777-1918) -1141 (-355 scores 1 no multiples)(+1141(2) 1141(1))
		ii decrease in moles/molecules (of gas)(1) ; therefore less disordered(ORA)/fewer ways of arrangement/fewer ways of arranging energy/less random(1) ;	2	<b>not</b> particles or atom on first mark
	d	formula mass of $\text{Ca(OH)}_2 = 74$ (1) ; moles of $\text{Ca(OH)}_2 = 1000/74$ (13.51) (1) ; volume = $13.51 \times 24$ (320/324/324.3/324.32) (1) ;	3	ecf's possible after '74' correct answer scores 3
	e	i bond enthalpy is enthalpy change that occurs when 1 mole of bond broken(1) ; in gaseous state(1) ;	2	

Question			Expected Answers	Marks	Additional Guidance
		ii	NN and OO bonds break(1) ; specify types of bond NN triple OO double(AW)(1) ; ON bonds formed(1) ;	3	<b>con</b> intramolecular
			<b>Total</b>	<b>20</b>	

## 2852/01 Chemistry Salters Open Book

Discuss the chemistry involved in the burning of hydrocarbons to drive a car engine. You should include a discussion of

- why compounds with different chain length and structures release different amounts of energy.
- how the burning fuel produces energy changes that drive the car. [8]

<b>1</b>	<b>RELEASE OF ENERGY</b>	
a	Energy changes depend on bond breaking and bond making	1
b	(in combustion reactions....) More energy is given out when bonds form than taken in when bonds are broken	1
c	Carries out bond enthalpy calculation to show energy release  <b>Note:</b> award 1c if calculation is attempted. <b>Penalise 1 T</b> for any or all of following errors: Bond breaking energy > bond making energy Omission of – sign. Omission of units (kJ mol <sup>-1</sup> )	1
<b>2</b>	<b>DIFFERENT STRUCTURES</b>	
a	Longer chain length hydrocarbons give out more energy when burned	1
b	<u>More</u> bonds are both broken and formed	1
c	<u>bond enthalpies</u> are average values and differ in different molecules	1
d	<u>Bond enthalpy</u> calculations do not take into account state changes	1
e	isomers have <u>slightly</u> different $\Delta H_c$ values	1
f	Discusses chain length in terms of energy density	1

Discuss how chemists improve petrol by using a variety of hydrocarbons. You should include discussion of

- what types of molecules are used as additives to improve fuel performance.
- how the octane number of a fuel is measured and the advantages of using isomers of octane in the fuel. [6]

<b>3</b>	<b>Features of molecules</b>	
a	Types of molecules: any 3 from: short chain, straight chain and branched alkanes; cycloalkanes; alkenes and aromatics	1
b	Molecules <u>containing oxygen</u> enhance fuel performance – e.g. <u>alcohols and ethers</u> / <u>named alcohol and ether</u>	1

Describe the types of intermolecular forces that act between molecules of hydrocarbons used in fuels and lubricants and discuss their effect on volatility and viscosity. Explain how lubricants work and why longer chain hydrocarbons are more likely to have good lubricating properties. [8]

<b>4</b>	<b>IMFs</b>	
a	instantaneous dipole – induced dipole forces occur when uneven electron distribution causes a dipole to form on another atom / molecule.	1
b	In larger <u>molecules</u> , more electrons, greater distortion.	1
c	there are more points of contact between straight chain molecules, less between branched chain molecules, stronger/more id-id forces.	1



<b>5</b>	<b>Volatility and viscosity</b>	
a	stronger imfs give rise to higher boiling points/ lower volatility and higher viscosity ORA	1
b	viscosity of lubricants stays the same at different temperatures because polymer chains unwind	1
c	At low temperatures id-id forces hold coils in shape, as oil warms, id-id forces act <u>between</u> chains	1

<b>6</b>	<b>Extra chemistry (2 max)</b>	
	Definition of enthalpy of combustion / Definition of stoichiometric	
	Gives list of at least 3 values of $\Delta H_c$	
	More detail about id-id e.g. due to attraction of nucleus to the electrons of another atom	
	Use of bond enthalpies to compare $\Delta H_c$ for <b>two</b> different structures	
	Different molecules are produced by isomerism / cracking / reforming	
	Lubricants <u>adsorb</u> onto metal surface.	

**EVALUATION**

Discuss the chemistry involved in the burning of hydrocarbons to drive a car engine. You should include a discussion of

- why compounds with different chain length and structures release different amounts of energy.
- how the burning fuel produces energy transfers that drive the car. [8]

<b>7</b>	<b>Energy changes</b>	
a	Chemical energy changes to heat energy changes to kinetic energy (STATEMENT)	1
b	(During combustion) Increase in number of moles of gas causes small pressure increase.	1
c	Heat/energy released causes huge temperature rise which causes dramatic pressure increase.	1
d	Expansion of gases/pressure increase delivers force on pistons.	1

Discuss how chemists improve petrol by using a variety of hydrocarbons. You should include discussion of

- what types of molecules are used as additives to improve fuel performance.
- The meaning of the term octane number and the advantages of using isomers of octane in the fuel. [6]

<b>8</b>	<b>Octane numbers</b>	
a	tendency for a fuel to auto-ignite is measured by octane number	1
b	Higher octane number allows higher compression ratios in the engine	1
c	Shorter chain alkanes and branched chain alkanes have higher octane numbers / lower tendency to autoignite.	1
d	heptane octane number 0, TMP octane number 100;	1
e	fuels are compared to a mixture of heptane and TMP and given an octane number <b>OR</b> explains example e.g. explains octane rating 97	1

Describe the types of intermolecular forces that act between molecules of hydrocarbons used in fuels and lubricants and discuss their effect on volatility and viscosity. Explain how lubricants work and why longer chain hydrocarbons are more likely to have good lubricating properties. [8]

<b>9</b>	<b>Lubricating properties</b>	
a	Lubricants cling onto metal surface / need to be viscous liquids at operating temperatures of the engine / reduce friction (any <b>two</b> points).	1
<b>10</b>	<b>Lubricants and fuels</b>	
a	Octane and lubricating oil both have instantaneous dipole- induced dipole forces	1
b	molecules used in lubricants have longer carbon chain lengths and so are more viscous and less volatile;	1
c	Molecules used in fuels have short/branched chains and are more volatile	1

Describe the role of chemists in producing materials with improved properties to enhance the performance of F1 cars and the safety of drivers. [4]

<b>11</b>	<b>New materials</b>	
a	Vulcanised rubber introduces S cross links; harder and stronger tyres	1
b	<u>Chemists develop</u> epoxy resin and carbon/glass fibre composites; lighter and stronger car bodies	1
c	Fibre reinforced helmets: light and can withstand severe impact	1
d	Flame retardant THCP contains phosphorus which forms a char with cotton; protects driver's body	1

<b>12</b>	<b>Extra evaluation</b>	
	Too much air engine burns out, too little air car gives out unburnt hydrocarbons	
	Piston moves down, volume expands and gases cool	
	Excess heat used to heat up inlet gases (turbo engine) / KERS	
	Autoignition causes double explosion – this is 'knocking'	
	Detail about testing engines for metal particles to check lubrication performance	
	Antioxidants in tyres stop tyres degrading.	

**Research skill in using and acknowledging sources of information**

- R1 List of sources** used which should include the articles in the question paper and at least two additional and *relevant* references  
 1 for inclusion of Open Book paper articles (minimum: article 1 + article 2)  
 1 for TWO other sources, i.e. either or both Salters books + one other, OR two other sources,  
 1 for specification of the non-Open Book paper sources by page numbers, section titles, site titles, encyclopaedia sections, search engine criteria, **[3 marks]**
- R2 Appropriate material** selected from the question paper and elsewhere to produce a report within the required word limit **[1 mark]**

Examples of reasons why this mark may not be awarded include.

- **exceeding the wordcount** (see below)
- not declaring a **page word-count**
- many sources quoted, with no evidence that they have been used
- excessive **irrelevant material** (use wavy line in left hand margin)
- inclusion of large amounts of material in **appendices**
- mis-use of sources e.g. repeated **errors** in material selected.

<b>Guidance on wordcount</b>	
< 1050 words	OK
> 1050 < 1100	Lose 1 mark ( <b>R2</b> )
>1100	Draw line at about 1000. Do not mark past this point Lose 2 marks ( <b>R2</b> and <b>C1b</b> )
Words on diagrams/in equations do not count but <b>excessive use of lengthy text boxes inserted into diagrams should be penalised.</b>	

- R3 Text annotation**  
 Text annotated where appropriate to acknowledge use of information from the sources listed  
 (1 mark for 2 or more relevant annotations) **[1 mark]**

**Examiner annotation:**

Underline candidate's annotation and write 'A' in the left hand margin for the first two sources seen.

**[Total: 5 marks]**

**Quality of Written Communication**

- S Summary** Four relevant **CHEMICAL** points which summarise the content of the candidate's own response. **[4 marks]**

Ideas to look for...

- **chemical reaction or process**
- **chemical terms**
- **feature of a chemical compound or reaction**

**Main Report****C1 Structure of report**

- a **Well-structured report with** relevant information **organised** clearly and **coherently** without undue repetition. **[1 mark]**

*Examples of reasons why this mark may not be awarded.*

- **jumbled order** or difficult to follow report.
- **undue repetition** (*annotate* 'R' in left hand margin)
- a report where presentation and organisation of the information is weak enough to make the report difficult to follow.

- b **Balanced coverage** of the required points. **[1 mark]**

*Examples of reasons why this mark may not be awarded.*

- exceeding the **word count** (see R2) insufficient balance in the coverage of the **bullet points** on the question paper (use the pattern of marks on the grid as a rough guide).

**C2 Clear and correct use of language**

- a Legible text, appropriate form and style of writing, grammar, punctuation and spelling accurate so that the meaning is clear. **[2 marks]**

**2 spelling or grammatical errors** lose 1 mark, 4 errors lose both marks.

*Examiner annotation:* by underlining error and writing 'S' or 'G' in left hand margin.

*Examples of reasons why marks may not be awarded.*

- Report not written in **continuous prose** e.g. note form or no use of paragraphs.
- Text or language is illegible or **difficult to follow**.

- b Correct use of **scientific and technical** terms. **[2 marks]**

**2 scientific or technical term** errors lose 1 mark, 4 errors lose both marks.

*Examiner annotation:* by underling error and writing 'T' in the left hand margin.

*Examples of errors.*

- Misuse/omission of **subscripts** or **superscripts** from formulae.
- Gaps in word processed text e.g. omission of '→' from equations.
- **Incorrect terms** used e.g. iodine for iodide.

Note: If the report contains no or **very few scientific terms**, diagrams or equations, one or both marks can be deducted due to insufficient evidence being available to award.

- c Correct use of scientific and technical terms where appropriate

**C3 Good use of equations and structural formulae [2 marks]**

**2 marks for 4 relevant and correct equations** or structural formulae;  
**1 mark for 2 relevant and correct equation** or structural formula

**Notes:**

- For **minor errors** e.g. missing subscripts, deduct technical language marks as shown in C2b but allow the equation to count towards marking point C3.
- If **chemistry or evaluation** marks have been scored exclusively from an unexplained equation then the equation cannot also 'count' towards marking point C3.
- **Annotate** script by writing 'E' in the left hand margin.

**List of possible equations and structural formulae**

Combustion of octane  
Hydrocarbons in fuel  
Additives  
Structures of heptane and iso-octane

**C4 Good use of appropriate illustrations (pictures, diagrams, tables, flow charts, graphs, etc.) [2 marks]**

**2 marks for 2 relevant illustrations**, well-positioned and labelled or well-linked into text; these may be from the articles in the question paper; **1 mark for 1 such diagrams**;  
*1 mark only if 2 relevant diagrams from articles simply photocopied and pasted in without further annotation or link from the text.*

- **Annotate** script by writing 'D' ('Diagram') in the left hand margin.

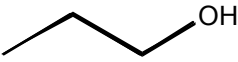
Notes: Illustrations should be **correctly placed** so that they support the flow of the text. One or both marks can be lost if the illustrations are incorrectly placed.

**List of possible illustrations (Ignore photographs)**

diagram of car engine  
diagram of id-id forces  
table of bond enthalpies  
coiled and uncoiled molecules  
sulfur cross links

**[Max 10 marks]**

## 2854 Chemistry by Design

Question	Expected Answers	Marks
1 (a) (i)	green / blue(1) ; <b>ignore</b> start colour	1
1 (a) (ii)	ethanal / ethanoic acid / <i>correct formulae</i> (1) ; <b>ignore</b> aldehyde/carboxylic acid	1
1 (a) (iii)	heat / high / raised temperature / reflux (is used in the lab) / <u>concentrated</u> (allow 'conc') (sulphuric) acid	1
1 (b)	$O_2 + 4H^+ + 4e^{(-)} \rightarrow 2H_2O$ equal $H^+$ and $e$ (1) ; balancing atoms (1) ; <i>mark separately allow</i> multiples/halves	2
1 (c)	It corresponds to C–H (1) ; <i>can be implied (eg in mpt 3)</i> not O–H since present in water ( <b>ignore</b> other breath molecules)/ not C–O since it is in fingerprint region (AW) (1) ; <b>allow</b> C–H not in water NOT just 'C–H not in other substance in breath' ethanoic acid has C–H too <b>allow</b> carboxylic <u>O–H</u> covers/has a peak around 2950 (1) ; it has C=O (1) ; at 1700 – 1725 ( $cm^{-1}$ ) (1) ; <b>ignore</b> single number in this range; <b>ignore</b> 'around 1700'	5
1 (d) (i)	$0.08 \times 4.35 \times 10^{-4}$ (1) ; $= 3.48/3.5 \times 10^{-5}$ (1) ; <b>allow</b> <i>ecf</i> from 1st mpt if working is clear correct answer scores both marks without reference to working.	2
1 (d) (ii)	increase in temperature increases $K_c$ (1) ; because <u>equilibrium*</u> (position) moves to the right / endothermic direction/ towards products(1) ; ( <u>equilibrium*</u> moves to) oppose the change (AW) (1) ; info in brackets needed to score this mark without previous one mark separately *'equilibrium' only needs to be mentioned once	3
1 (e) (i)	 (1) ; <b>ignore</b> O–H but NOT just O	1
1 (e) (ii)	lower Mr / smaller molecule ( <b>allow</b> shorter carbon chain) / lower boiling point / more volatile / different polarities ( <b>ignore</b> 'lighter') / <i>lesser affinity for stationary phase</i> (1) ; <b>ignore</b> references to retention time and affinity to mobile phase (1)	1

Question	Expected Answers	Marks
1 (e) (iii)	ratio of the peak areas/ intensities measured (1) ; for known concentration (of ethanol) (with respect to propan-1-ol) (1) ;	2
	<b>Total</b>	<b>19</b>

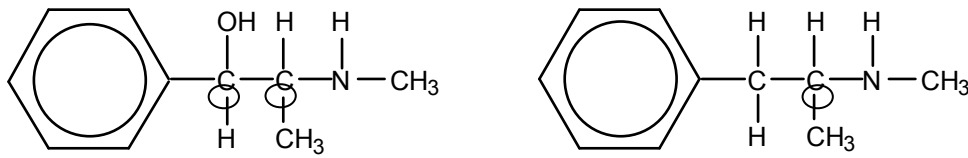




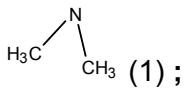
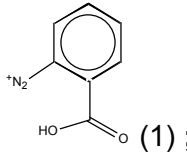
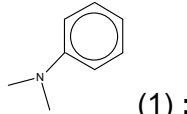
Question	Expected Answers	Marks
2 (d) (i)	more molecules on left than on right <i>ora</i> (1) ; <b>ignore exothermic</b> entropy is a measure of disorder/number of ways of arranging molecules/number of ways of arrangement (1) ; atoms or ions are <b>con</b> <i>mark separately</i>	2
2 (d) (ii)	$(2 \times 256) - (2 \times 249) - 205 = -191$ (2) ; if completely correct <i>correct answer scores 2 without reference to working</i> (1) for one error, eg omitting factors of 2 (-198) or wrong way round (+191, <i>must be "+"</i> ; '191' scores zero)	2
2 (d) (iii)	$\Delta S_{\text{surr}}$ positive (1) ; $\Delta S_{\text{surr}}$ gets smaller as T increases (1) ; $\Delta S_{\text{sys}}$ negative (and stays the same) (1) ; <i>mark separately allow labelled equations</i>	3
2 (d) (iv)	$T = \Delta H / \Delta S_{\text{sys}}$ (1) ; <i>stated or implied (including by 197/-answer to d(ii) )</i> ; $T = 197000 / 191 = 1031.4136$ to 3 or more sf (K) (1) ; <b>allow ecf</b> from value of $\Delta S_{\text{sys}}$ from (d)(ii) <i>correct answer scores 2 without reference to working 1.03(14) scores 1</i> <i>negative answers do not gain any credit</i>	2
2 (e)	$M_r$ values $\text{H}_2\text{SO}_4$ 98, $\text{SO}_2$ 64 evaluated(1) ; $10 \times 98 / 64 = 15.3125^*$ kg <i>ecf</i> for wrong values of $M_r$ of $\text{H}_2\text{SO}_4$ or $\text{SO}_2$ (1) ; <i>correct answer scores 2 without reference to working 7.65625* scores 1</i> <i>without reference to working</i> <b>*allow 2 or more sf</b>	2
	<b>Total</b>	<b>28</b>

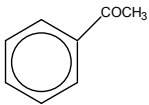
Question	Expected Answers	Marks
3 (a) (i)	$1s^2 2s^2 2p^6$ (1) ; $1s^2 2s^2 2p^6 3s^2 3p^6$ (1) ; one mark for both <b>atoms'</b> correct configurations. <b>allow capital letters but do not award both marks if subscripts are used.</b>	2
3 (a) (ii)	more shells/orbitals <b>ignore</b> 'more electrons' (1) ; <u>outermost shells/outermost</u> electrons further from nucleus/ shells take up more room / more shielding(1) ; same charge / +1 (1) ; <i>mark separately</i>	3
3 (b) (i)	111.4(1) ; <b>allow 3 or more sf</b>	1
3 (b) (ii)	one valid comparison of radius(1) ; one valid comparison of charge density (1) ; to score 2, must give right answer (size/radius) and must include Ba in one comparison.	2
3 (c) (i)	<p>1. enthalpy (change) of hydration/solvation(1) ;  of ions (AW) (1) ;  2. <math>Ba^{2+}(aq) + SO_4^{2-}(aq)</math> (1) allow <math>BaSO_4(aq)</math>  3. enthalpy (change) of solution (1) s  4. (1) ; for one or more levels between printed level (unless labelling is clear)  <i>(mark separately)</i>  <b>allow symbols, eg <math>\Delta H_{sol}</math> (but <math>\Delta H_{solv}</math> at least for solvation) and <math>\Delta H_{hyd}</math> if additional levels are shown, consider marks 2 and 4, also 1. or 3.</b> </p>	5
3 (c) (ii)	Central atom/ion surrounded by three or more V-shaped water molecules or triangles (atoms not essential for this mark) (1) ; 2+ on Ba, at least one water molecule shown as bent with $\delta+$ on H and $\delta-$ on O, with O facing Ba (1) ;	2
3 (d) (i)	$Ba(g) + 2Cl(g)$ (1) ; $Ba^{2+}(g) + 2Cl^{-}(g)$ (1) ;	2
3 (d) (ii)	<p>lattice enthalpy/<math>L_E/\Delta H_{LE}</math>  ignore extra detail         </p>	1

Question	Expected Answers	Marks
3 (d) (iii)	Answer – 1700/1701 scores (3) ; '(+ 1700/1701' scores (2) –677 scores 2 If answer is none of these: 1500 and 512 labelled correctly <i>ignore signs</i> (1) indication of “balancing sides” including signs(1) <i>mark separately</i>	3
	<b>Total</b>	<b>21</b>

Question	Expected Answers	Marks
4 (a) (i)	alcohol / hydroxy(l) (1) ; <b>ignore</b> secondary. primary, tertiary <b>con</b>	1
4 (a) (ii)	reduction/ redox (1) ; <b>allow</b> substitution <b>ignore</b> nucleophilic	1
4 (a) (iii)	 <p style="text-align: center;"> <span style="margin-right: 150px;">ephedrine</span> <span>methamphetamine</span> </p> <p>one mark for each molecule</p>	2
4 (b) (i)	$\text{NH}_2^+$ (+ on N [or whole structure])(1) $\text{Cl}^-$ (NOT bonded) (1) ;	2
4 (b) (ii)	<p>any <b>four</b> from:</p> <p>salt is ionic OR methamphetamine is molecular/non-polar (AW) (1) ;</p> <p>(salt) forms ion-dipole bonds/forces / ions/salt are hydrated / water molecules surround/attracted to ions; (1) ; <b>ignore</b> hydrogen bonds between salt and water</p> <p>hydrogen bonds in water (1) ;</p> <p>idea that imf between salt &amp; water compensates for hydrogen bonds/ionic bonds; (1) ;</p> <p>weaker imf between methamphetamine and water/ fewer hydrogen bonds with water/ permanent dipole-permanent dipole with water/ net breaking of bonds; (AW) (for methamphetamine); (1) ;</p>	4
4 (b) (iii)	sodium hydroxide (or other suitable base) (1) ; <b>allow</b> correct formulae <b>allow</b> hydroxide/ $\text{OH}^-$	1
4 (c)	phenol <b>not</b> hydroxy(l) (1) ;	1
4 (d) (i)	circle all except two methyl groups phenyl group optional(1) ;	1
4 (d) (ii)	<p>Site is three dimensional/ <u>stereospecific</u> / enantiomers are different shapes / one enantiomer has correct shape (AW) (1) ;</p> <p>only one enantiomer will fit/ bind/ is complementary(AW) (1) ;</p>	2
4 (e) (i)	149(1) ;	1
4 (e) (ii)	$\text{CH}(\text{CH}_3)\text{-NH-CH}_3$ / $\text{C}_3\text{H}_8\text{N}$ (1) ; <b>ignore</b> signs. Structure must be correct if drawn	1

Question	Expected Answers	Marks
4 (f)	CH <sub>2</sub> (1); these are protons / hydrogens with the same <u>environment</u> (AW) (1) ;	2
	<b>Total</b>	<b>19</b>

Question	Expected Answers	Marks
5 (a) (i)	 (1); <b>allow</b> unattached bond from N; <b>allow</b> CH <sub>3</sub> displayed	1
5 (a) (ii)	<i>any two from:</i> carboxylic <u>acid</u> / carboxyl; azo ( <b>ignore</b> diazo); (tertiary) amine (primary / secondary <b>con</b> )	2
5 (b) (i)	 (1); <b>allow</b> any bonding between N atoms and charge on either N <b>allow</b> Kekule benzene here and (b)(ii) but not other representations <b>allow</b> more or less displayed -COOH	1
5 (b)(ii)	 (1); <b>allow</b> any correct representation of structure ecf from (a)(i) <b>allow</b> -H in coupling position on ring	1
5 (b) (iii)	coupling (1);	1
5 (b)(iv)	electrophilic (substitution) <b>allow</b> if in (b)(iii) (1);	1
5 (c) (i)	carbon forms three bonds/ overlapping p-orbitals (one on each C implied) (1); one (extra) electron per carbon/ in each p-orbital (1); (electrons) spread over/shared over molecule/ ring/ carbon atoms (1); above and below plane of molecule (1); <b>allow</b> last two from a diagram	4

Question	Expected Answers	Marks
5 (c) (ii)	<p>any <b>six</b> from:</p> <p><u>electrons</u> excited/move up energy levels; mention of d-shell is <b>con</b> (1) ;</p> <p><math>(\Delta)E = hv</math> / frequency proportional to energy <u>gap/difference/absorbed</u>; (1) ;</p> <p><math>(\Delta)E</math>/gap smaller/less energy needed to excite when more delocalisation/larger chromophore <i>ora</i>; (1) ;</p> <p>light not absorbed/complementary colour is transmitted/reflected (<i>not emitted</i>); (1) ;</p> <p>more delocalisation/larger chromophore/ more conjugation in methyl red <i>ora</i>; (1) ;</p> <p>dye absorbs in visible (1) ;</p> <p>benzene absorbs in uv; (1) ;</p> <p><i>max 2 if emission on electrons dropping is described</i></p> <p><b>QWC</b> logical and <b>two</b> words from list used correctly (2) can score when <i>max 2 – ‘emission’ rule has been applied.</i></p> <p><b>one</b> word from list below used correctly (1):</p> <p><i>excites/d, frequency, radiation, delocalisation, chromophore, complementary (colour), transmitted/reflected, uv</i></p>	<p>6</p> <p>2</p>
5 (d) (i)	<p>ethanoyl (<b>allow</b> acyl) <b>ignore</b> chloride <b>allow</b> ketone or methyl ketone(1) ;</p>  <p>(1) ;</p> <p><b>allow</b> more displayed structure if correct</p>	2
5 (d) (ii)	<p>ethanoyl chloride/<math>CH_3COCl</math> (1) ;</p> <p>aluminium chloride/ <math>AlCl_3</math> (1) ;</p> <p>reflux/ anhydrous conditions (1) ;</p> <p><b>allow</b> reflux only if one other mark scored</p>	3
5 (d) (iii)	<p>Friedel Crafts (1) ; <b>allow</b> mis-spellings if it ‘sounds’ correctly / acylation / ethanoylation</p> <p><b>ignore</b> alkylation</p>	1
5 (d) (iv)	<p>Chromophore / delocalised system changed (1) ;</p> <p>C=O delocalised/ <math>\Delta E</math> (AW) changed / different frequencies absorbed / reflected (1) ;</p>	2
5 (e) (i)	<p><math>(In^-)</math> equm moves to right (1) ;</p> <p>alkali removes <math>H^+</math>/ <math>HIn</math> reacts with alkali to form <math>In^-(1)</math> ;</p> <p><i>mark separately</i></p> <p><i>note no mark for <math>In^-</math> alone</i></p>	2

Question	Expected Answers	Marks
5 (e) (ii)	$(-)\text{COOH}$ / correct formula + $\text{OH}^-$ (1) ; $\rightarrow (-)\text{COO}^- + \text{H}_2\text{O}$ (1) ; <b>allow one mark for</b> $(-)\text{OH} + \text{OH}^- \rightarrow (-)\text{O}^- + \text{H}_2\text{O}$ <b>ignore R groups</b>	2
5 (f)	$[\text{H}^+] = K_a$ (1); 5.1 (1) ; <i>correct answer scores 2 with no reference to working</i> <i>ecf - award second mark if pH correctly calculated from a calculated <math>[\text{H}^+]</math> value</i>	2
	<b>Total</b>	<b>33</b>



# Grade Thresholds

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

## Unit Threshold Marks

Unit		Maximum Mark	a	b	c	d	e	u
2848	Raw	90	63	55	48	41	34	0
	UMS	120	96	84	72	60	48	0
2849	Raw	90	72	65	58	51	44	0
	UMS	90	72	63	54	45	36	0
2850	Raw	75	63	56	50	44	38	0
	UMS	90	72	63	54	45	36	0
2852A	Raw	90	73	67	61	55	49	0
	UMS	90	72	63	54	45	36	0
2852B	Raw	90	73	67	61	55	49	0
	UMS	90	72	63	54	45	36	0
2854	Raw	120	88	79	70	61	53	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	21.4	47.7	70.4	85.9	97.2	100.0	1325
7887	30.9	54.7	73.8	88.4	97.1	100.0	7080

## 8405 candidates aggregated this series

For a description of how UMS marks are calculated see:

[http://www.ocr.org.uk/learners/ums\\_results.html](http://www.ocr.org.uk/learners/ums_results.html)

Statistics are correct at the time of publication.

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**1 Hills Road**  
**Cambridge**  
**CB1 2EU**

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