

**GCE**

**Chemistry B (Salters)**

Unit **F334**: Chemistry of Materials

Advanced GCE

**Mark Scheme for June 2014**

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All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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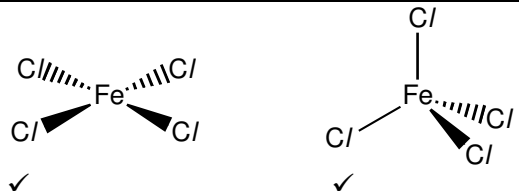
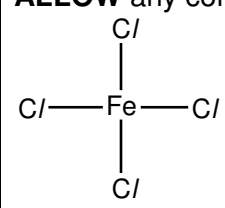
**Annotations** used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

<b>Annotation</b>	<b>Meaning</b>
<b>BP</b>	Blank Page – this annotation must be used on all blank pages within an answer booklet (structured or unstructured) and on each page of an additional object where there is no candidate response.
/	alternative and acceptable answers for the same marking point
✓	separates marking points
<b>not</b>	answers which are not worthy of credit and which will CON a correct answer
<b>ignore</b>	statements which are irrelevant and will NOT 'CON' a correct answer
<b>allow</b>	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 (replaces the old 'or words to that effect')
ora	or reverse argument

**Annotations** used in scoris:

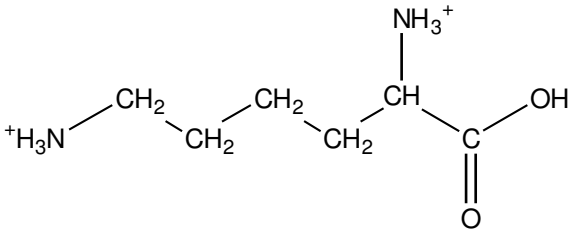
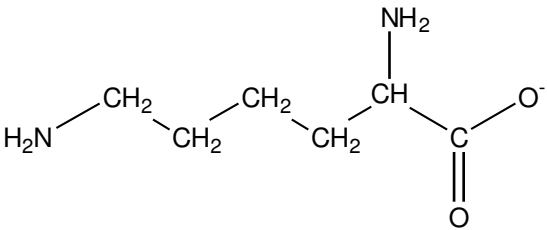
<b>Annotation</b>	<b>Meaning</b>
✓	correct response
✘	incorrect response
bod	benefit of the doubt
nbod	benefit of the doubt <b>not</b> given
ECF	error carried forward
^	information omitted
I	Ignore
R	Reject



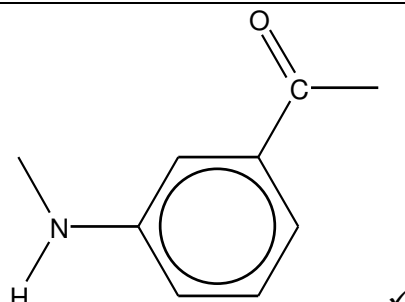
Question		Answer	Mark	Guidance
e	i	<p>iron/Fe/Fe<sup>2+</sup> is oxidised ✓ because O.S. of Fe changes from <u>+2 to +3</u> ✓</p> <p>hydrogen/H is reduced ✓ because O.S. of H changes from <u>+1 to 0</u> ✓</p>	4	<p><b>ALLOW</b> answers in terms of loss of an electron – oxidation <b>BUT</b> must have oxidation states/formulae of ions</p> <p><b>ALLOW</b> Roman numerals and 2+ etc. here</p> <p><b>DO NOT ALLOW</b> H<sup>+</sup> is reduced</p> <p><b>ALLOW</b> gain of an electron – reduction <b>BUT</b> must have oxidation states</p>
e	ii	<p>moles of green rust = <math>100 / (55.8 + 34.0) = 1.11</math> ✓</p> <p>volume of H<sub>2</sub> = <math>1.11 \times 24 / 3 = 8.9</math> dm<sup>3</sup> ✓</p>	2	<p><b>ALLOW</b> <math>M_r = 90</math> for Fe(OH)<sub>2</sub></p> <p>If the only error is <b>incorrect</b> <math>M_r</math> then give 1 mark</p> <p><b>ALLOW</b> 8.91, 8.88, 8.8 or 9 dm<sup>3</sup>, any sfs</p> <p>Dividing by 3 twice gives 2.96/2.97 for 1 mark</p>
f			2	<p><b>IGNORE</b> charges <b>AND</b> brackets around structure</p> <p><b>DO NOT ALLOW</b> for tetrahedral, angles of 90° or all bonds drawn in one plane</p> <p><b>ALLOW</b> any correctly drawn structure for square planar e.g.</p>  <p>for square planar</p> <p><b>NOTE</b> if you are not sure if it is correct shape give it <b>nbod</b></p>
<b>Total</b>			<b>23</b>	

Question		Answer	Mark	Guidance	
2	a	2-hydroxypropanoic acid  2-hydroxy ✓ propanoic acid ✓	2	<b>IGNORE</b> 'dashes & commas' & space between 'hydroxy' and 'propanoic' acid  <b>DO NOT ALLOW</b> propanoic acid, hydroxyl, hydroxo	
	b	moles of NaOH = $1.00 \times 33.6 / 1000$ ✓ = 0.0336 moles of acid in 25.0 cm <sup>3</sup> = <b>0.0336</b> ✓ moles of acid in sample = $4 \times 0.0336$ = 0.134 mass of acid in sample = $90.0 \times 0.134$ = 12.096 g % by mass = $12.096 \times 100 / 25.0$ = <b>48.4</b> % ✓	5	ecf ecf ecf <b>MUST BE</b> 3 sig. figs. for final answer	
	c	mix a constant/fixed/measured volume of <b>B</b> with a constant/fixed/measured volume of each NaOH(aq) AW ✓  zero colorimeter ✓ use suitable/correct filter <b>OR</b> filter of complementary colour ✓  measure absorbance/absorption of sample at known times / over time AW ✓	4	<b>ALLOW</b> calibrate (with water) <b>ALLOW</b> yellow, green or blue filters Complementary must be linked to 'colour' <b>MUST</b> link measurement of absorbance/absorption to time	
	d	i	dilute <b>B</b> by known amounts AW ✓ measure absorbance/absorption ✓ plot graph of absorbance/absorption against [ <b>B</b> ] /concentration (or [ <b>B</b> ] v abs.) (to get linear relationship) ✓	3	<b>IGNORE</b> make up standard solutions / solutions of known concentration of <b>B</b> <b>DO NOT ALLOW</b> 'plot a calibration curve' without reference to what is plotted: i.e. absorbance/absorption v concentration <b>IF NaOH</b> used instead of <b>B</b> and then only the 2 <sup>nd</sup> mark is available
		ii	1 <sup>st</sup> order ✓  (initial) gradient / slope doubles as concentration doubles AW ✓	2	<b>ALLOW</b> gradient/slope halves as concentration halves <b>ALLOW</b> when concentration doubles (reaction) time halves  <b>IGNORE</b> references to rate/half-life ( <i>need to use data from graph</i> )

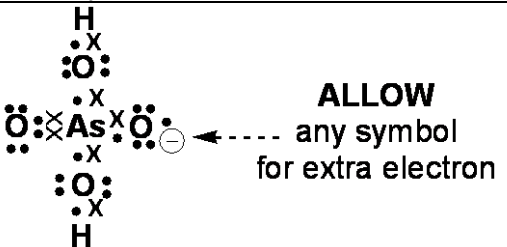
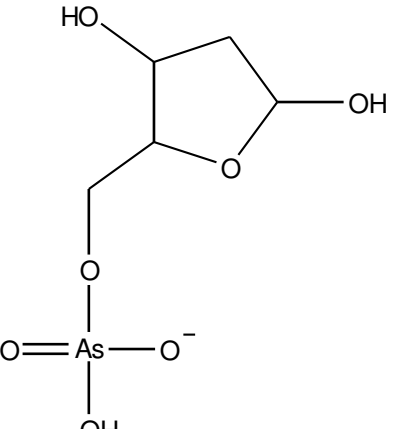
Question		Answer	Mark	Guidance	
	iii	keep $[\text{OH}^-]$ / $[\text{NaOH}]$ constant AW ✓ <u>vary/change/alter/double/halve [B]</u> ✓	2	<b>IGNORE</b> 'have excess NaOH' If <b>B</b> not mentioned, it must be clear they are referring to <b>B</b> (see question)	
e	i	(strong) peak at <u>1742</u> indicates <u>C=O</u> ✓ in ester ✓  (broad) peak between 3200(or 3300)-3600 / at (about) 3400 indicates <u>OH</u> ✓	3	<b>ALLOW</b> carbonyl and hydroxyl for C=O and OH <b>DO NOT ALLOW</b> peak at 1735-1750 or any other range  <b>IGNORE</b> references to arenes, phenols, alcohols	
	ii	purple colour / reaction with Fe(III) indicates phenol ✓	1	<b>ALLOW</b> indicates (OH is) phenol <b>DO NOT ALLOW</b> 'alcohol is a phenol'	
f		<b>A</b> has a chiral / asymmetric C / C with 4 different groups ✓  non- <u>superimposable mirror images</u> <b>OR</b> <u>mirror images</u> cannot be <u>superimposed</u> ✓	2	<b>ALLOW</b> molecule chiral / <b>A</b> has a chiral centre <b>IGNORE</b> C with 4 different functional groups  <b>QWC:</b> superimposable/superimposed must be spelled correctly for second mark	
	g	i	it has two functional groups which can <b>react</b> together / undergo condensation <b>OR</b> -OH (alcohol) and COOH (acid) can <b>react</b> together / in <b>one/same molecule</b> (may be implied) AW ✓  ester ✓	2	
		ii	biodegradable / breaks down in soil AW ✓  renewable/ sustainable source for making <b>A</b> /avoids use of fossil fuels etc. / not made from crude oil AW ✓	2	<b>DO NOT ALLOW</b> 'decomposes faster' alone <b>IGNORE</b> references to physical properties, water, toxicity or atom economy

Question	Answer	Mark	Guidance
h	<p><b>acidic</b></p>  <p>one <math>\text{-NH}_2</math> group protonated on the correct molecule ✓ both protonated and rest of ion correct ✓</p> <p><b>alkaline</b></p>  <p>ion correct ✓</p>	3	<p><b>ALLOW</b> positive charge as shown or on N</p> <p><b>ALLOW</b> delocalised negative charge or <math>\text{COO}^-</math> for carboxylate anion</p>
		31	



Question		Answer	Mark	Guidance
3	a	carbonyl / ketone ✓ ether ✓	2	
	b	i	1	IGNORE H <sub>2</sub> O
	b	ii	1	
		iii	5	NOT at which  IGNORE soften(s)  This may be implied by combining the last two marking points IGNORE reference to intermolecular forces  DO NOT ALLOW more energy to break/separate polymer chains
	c	i	1	IGNORE brackets and any 'n' outside brackets MUST have the two unlinked bonds to the N and C atoms ALLOW -NH , -CO NOT -HN
				
	c	ii	1	acylation ✓
	d	i	1	(secondary) amide ✓ DO NOT ALLOW peptide

Question		Answer	Mark	Guidance
	ii	(chains in Twaron are straighter) so <b>chains/molecules</b> are <b>closer together</b> / more tightly packed ✓  (hydrogen) <b>bonds/intermolecular forces between chains</b> will be <b>stronger</b> ✓	2	<b>IGNORE</b> more intermolecular bonds/forces <b>OR</b> more ordered chains <b>OR</b> more crystalline <b>IGNORE</b> more points of contact <b>IGNORE</b> references to energy  <b>ALLOW</b> 'intermolecular' for 'between chains'
			14	

Question			Answer	Mark	Guidance
4	a	i	(As & P) are in same group (in the periodic table) <b>OR</b> they both have 5/ same number of electrons in the outer shell ✓	1	
	a	ii	 <p>5 electrons for As <b>AND</b> OH groups correct ✓ rest correct i.e. including extra electron and As=O correct ✓</p>	2	<b>ALLOW</b> without negative charge 'dots and crosses' may be interchanged between As & O <b>DO NOT ALLOW</b> ↔xx for double bond
	a	iii	4 areas of electron density ✓ repel and get as far away from each other as possible AW ✓  tetrahedral ✓  any value in range 107 – 110 ✓	4	<b>ALLOW</b>  <b>QWC:</b> third mp can only be scored if first two mp are correct
	a	iv	condensation ✓	1	<b>ALLOW</b> addition-elimination but <b>NOT</b> elimination without addition
	a	v	 <p>primary OH used ✓ (water eliminated to form) As-O-CH<sub>2</sub>-ring <b>OR</b> As-O-ring ✓ rest correct with negative charge on O ✓</p>	3	<b>ALLOW</b> any correct form of structural formula  use of P for As fails to gain 3 <sup>rd</sup> mark if secondary OH used and no other errors then award 2 marks

Question		Answer	Mark	Guidance
	<b>b</b>	<b>i</b>		
		$\text{H}_3\text{AsO}_4$ ✓	<b>1</b>	<b>ALLOW</b> any molecular formula with correct atoms e.g. $\text{H}_2\text{AsO}_3\text{OH}$ , $\text{AsO}(\text{OH})_3$  <b>DO NOT ALLOW</b> use of AS for As in parts <b>b</b> and <b>c</b> Penalise first time use then ECF
	<b>b</b>	<b>ii</b>		
		$\text{H}_2\text{AsO}_4^- + 2\text{OH}^- \rightleftharpoons \text{AsO}_4^{3-} + 2\text{H}_2\text{O}$  $\text{AsO}_4^{3-}$ ✓ rest of equation correct & balanced ✓	<b>2</b>	
	<b>b</b>	<b>iii</b>		
		$\text{H}_2\text{AsO}_4^- + \textcircled{2\text{OH}^-} \longrightarrow \textcircled{\text{AsO}_4^{3-}} + 2\text{H}_2\text{O}$ ✓	<b>1</b>	<b>ALLOW</b> ECF for incorrect formula for arsenate ion in <b>bii</b>
	<b>c</b>	<b>i</b>		
		( $\text{H}_3\text{AsO}_4$ reacts because) $E^\ominus$ / electrode potential for $\text{SO}_4^{2-} / \text{SO}_2$ is <b>more negative</b> than $E^\ominus$ for $\text{H}_3\text{AsO}_4 / \text{H}_3\text{AsO}_3$ ✓  ( $\text{H}_3\text{PO}_4$ does not react because) $E^\ominus$ for $\text{SO}_4^{2-} / \text{SO}_2$ is <b>more positive</b> than $E^\ominus$ for $\text{H}_3\text{PO}_4 / \text{H}_3\text{PO}_3$ ✓  <b>OR</b> (using $E^\ominus_{\text{cell}}$ calculations)  for $\text{H}_3\text{PO}_4$ $E^\ominus_{\text{cell}} < 0$ / (-0.45 V) so is not feasible ✓  for $\text{H}_3\text{AsO}_4$ $E^\ominus_{\text{cell}} > 0$ / (+0.39 V) so is feasible ✓	<b>2</b>	<b>ORA</b>  <b>DO NOT ALLOW</b> higher/lower or similar words <b>DO NOT ALLOW</b> $E^\ominus_{\text{cell}}$ for $E^\ominus$ <b>ALLOW</b> $E^\ominus$ / electrode potential must be used at least once in the answer <b>ALLOW</b> correct identification of half-cell by one of the reactants only e.g. $\text{SO}_2$

Question		Answer	Mark	Guidance
	ii	$\text{H}_3\text{AsO}_4 + \text{H}_2\text{O} + \text{SO}_2 \rightarrow \text{SO}_4^{2-} + 2\text{H}^+ + \text{H}_3\text{AsO}_3$ <p>correct species with no cancelling of <math>\text{H}^+</math> / <math>\text{H}_2\text{O}</math> / <math>\text{e}^-</math> ✓</p> <p>all correct ✓</p>	2	<p><b>ALLOW</b> <math>\text{H}_2\text{SO}_4</math> on RHS of equation</p> <p><b>DO NOT ALLOW</b> an equilibrium arrow</p>
d	i	<p>1<sup>st</sup> order ✓</p> <p>because it has a constant half-life ✓</p>	2	<p>2<sup>nd</sup> mark depends on 1<sup>st</sup></p> <p>so 'zero order because it has a constant half-life' does not score any marks etc.</p>
d	ii	<p>Evidence is for small molecules</p> <p><b>OR</b></p> <p>As-O bonds are not in a small molecule</p> <p><b>OR</b></p> <p>As-O bonds may be stabilised/ strengthened by the DNA structure ✓</p>	1	<p><b>LOOK FOR</b> either</p> <p>comment on relative size of molecules</p> <p>or</p> <p>stability of As-O bonds</p> <p><b>ALLOW</b> DNA is not a small molecule – this may be implied</p>
			22	

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