OCR
Oxford Cambridge and RSA

GCE

Chemistry B (Salters)

Unit **F334:** Chemistry of Materials

Advanced GCE

Mark Scheme for June 2014

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

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

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

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

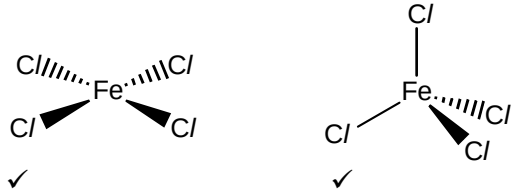
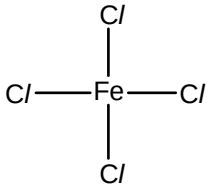
Annotations used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

Annotation	Meaning
BP	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
not	answers which are not worthy of credit and which will CON a correct answer
ignore	statements which are irrelevant and will NOT 'CON' a correct answer
allow	answers that can be accepted
( )	words which are not essential to gain credit
__	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:

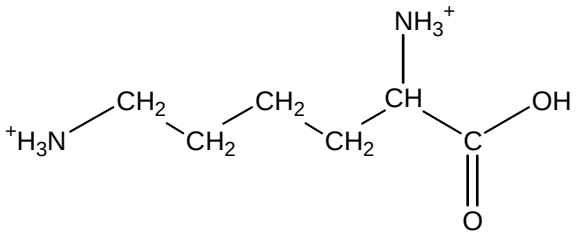
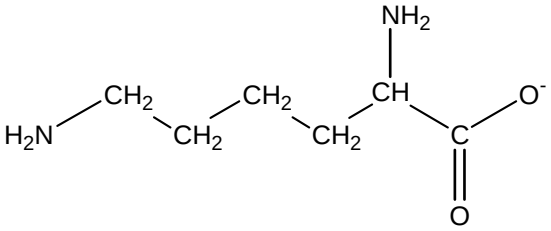
Annotation	Meaning
✓	correct response
×	incorrect response
bod	benefit of the doubt
nbod	benefit of the doubt **not** given
ECF	error carried forward
^	information omitted
I	Ignore
R	Reject

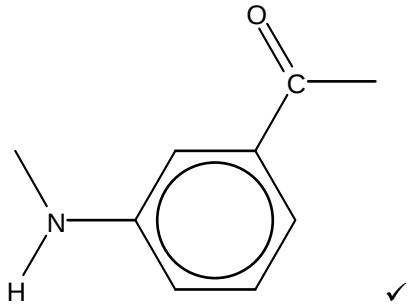
Question			Answer	Mark	Guidance
1	a		**1.** $Fe \rightarrow Fe^{2+} + 2e^-$ ✓ oxidation ✓ **2.** $2H_2O + O_2 + 4e^- \rightarrow 4OH^-$ ✓ reduction ✓ **3.** $Fe^{2+} + 2OH^- \rightarrow Fe(OH)_2$ ✓ (ionic) precipitation ✓	6	**MARK** reaction TYPE independently of EQUATION **IGNORE** state symbols **ALLOW** $H_2O + 1/2O_2 + 2e^- \rightarrow 2OH^-$ ✓ **ALLOW** OXIDISATION, OXIDISE, REDUCE, PRECIPITATE **ECF** for e used than e^- *(i.e. only penalise once)*
	b	i	+3 ✓	1	**DO NOT ALLOW** 3, Fe^{3+} or 3+ **ALLOW +III NOT III**
	b	ii	low oxygen (concentration in ground around pipes) ✓	1	**ALLOW** lack of oxygen, or answers that imply not enough oxygen to oxidise Fe to Fe^{3+} **BUT NOT** answers implying **no** oxygen **IGNORE** water
	c		iron(II) sulfate/ iron(II) sulfate(VI) ✓	1	**ALLOW** sulphate **IGNORE** any formula
	d	i	(central) **metal ion / cation / atom** ✓ bonded to /surrounded by **/**attached to / linked **ligands** / **negative ions / molecules** AW ✓ **molecule / ion:** which has (at least one) lone pair **OR** which forms dative (covalent)/coordinate bond ✓ (polydentate ligand can form) **more than one bond / donate at least two lone pairs** to (central) atom/ion **OR** has **more than one** atom with a lone pair which are used to bond AW ✓	4	**ALLOW** 'species' **DO NOT ALLOW ‘**many/multiple/several lone pairs', 'more than 2 lone pairs etc.' AW **ALLOW** 'has more than 1 attachment site to the central (central) atom/ion'
	d	ii	$[Fe(C_6H_5O_7)]^-$ correct formula ✓ correct charge (**only award if formula is correct**) ✓	2	**ALLOW** without any brackets **ALLOW** -1 or 1- **ALLOW** skeletal formula of citrate **For 1st mark ONLY ALLOW** charges on metal ion **and** ligand if correct **IGNORE** 3 if before the formula for the complex

Question			Answer	Mark	Guidance
	e	i	iron/Fe/Fe^{2+} is oxidised ✓ because O.S. of Fe changes from +2 to +3 ✓ hydrogen/H is reduced ✓ because O.S. of H changes from +1 to 0 ✓	4	**ALLOW** answers in terms of loss of an electron – oxidation **BUT** must have oxidation states/formulae of ions **ALLOW** Roman numerals and 2+ etc. here **DO NOT ALLOW** H^+ is reduced **ALLOW** gain of an electron – reduction **BUT** must have oxidation states
	e	ii	moles of green rust = **100 / (55.8 +34.0)** = 1.11 ✓ volume of H_2 = 1.11 x **24 / 3** = **8.9** dm^3 ✓	2	**ALLOW** M_r = 90 for $Fe(OH)_2$ If the only error **i**s **incorrect M_r** then give 1 mark **ALLOW** 8.91, 8.88, 8.8 or 9 dm^3, any sfs Dividing by 3 twice gives 2.96/2.97 for 1 mark
	f		 ✓ ✓	2	**IGNORE** charges **AND** brackets around structure **DO NOT ALLOW** for tetrahedral, angles of 90^0 or all bonds drawn in one plane **ALLOW** any correctly drawn structure for square planar e.g.  for square planar **NOTE** if you are not sure if it is correct shape give it **nbod**
			Total	**23**	

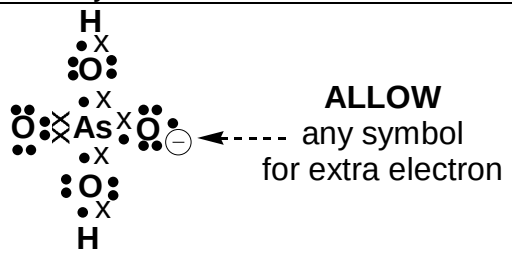
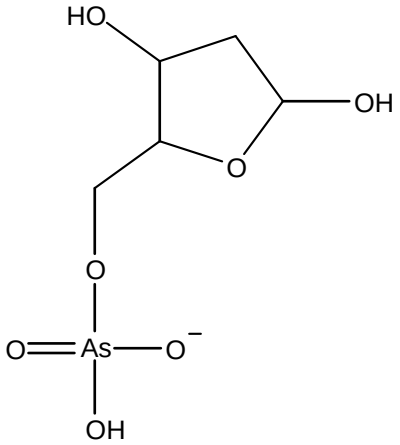
Question			Answer	Mark	Guidance
2	a		2-hydroxypropanoic acid 2-hydroxy ✓ propanoic acid ✓	2	**IGNORE** 'dashes & commas' & space between 'hydroxy' and 'propanoic' acid **DO NOT ALLOW** propan**e**oic acid, hydroxyl, hydroxo
	b		moles of NaOH = **1.00 x 33.6 / 1000** ✓ = 0.0336 moles of acid in 25.0 cm^3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

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

Question			Answer	Mark	Guidance
	h		**acidic**  one $-NH_2$ group protonated on the correct molecule ✓ both protonated and rest of ion correct ✓ **alkaline**  ion correct ✓	**3**	**ALLOW** positive charge as shown or on N **ALLOW** delocalised negative charge or COO^- for carboxylate anion
				31	

Question			Answer	Mark	Guidance
3	a		carbonyl / ketone ✓ ether ✓	2	
	b	i	water ✓	1	**IGNORE** H_2O
	b	ii	condensation ✓	1	
		iii	T_g = temperature **below which** (an amorphous) polymer **becomes brittle/glassy** ✓ **above T_g** : polymer becomes flexible / will bend ✓ because chains can move/ slide over each other ✓ <u>tangled/less ordered</u> chains cannot move/slide easily across each other AW ORA ✓ PPO / tangled chains need more energy to **move/slide over each other** ✓	5	**NOT** at which I**GNORE** 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	acylation ✓	1	
	d	i	(secondary) amide ✓	1	**DO NOT ALLOW** peptide

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

Question			Answer	Mark	Guidance
4	a	i	(As & P) are in same group (in the periodic table) **OR** they both have 5/ same number of electrons in the outer shell ✓	1	
	a	ii	 **ALLOW** any symbol for extra electron 5 electrons for As **AND** OH groups correct ✓ rest correct i.e. including extra electron and As=O correct ✓	2	**ALLOW** without negative charge 'dots and crosses' may be interchanged between As & O **DO NOT ALLOW** **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	**ALLOW** **QWC**: third mp can only be scored if first two mp are correct
	a	iv	condensation ✓	1	**ALLOW** addition-elimination but **NOT** elimination without addition
	a	v	 primary OH used ✓ (water eliminated to form) As-O-CH_2-ring **OR** As-O-ring ✓ rest correct with negative charge on O ✓	3	**ALLOW** any correct form of structural formula use of P for As fails to gain 3rd mark if secondary OH used and no other errors then award 2 marks

Question			Answer	Mark	Guidance
	b	i	H_3AsO_4 ✓	1	**ALLOW** any molecular formula with correct atoms e.g. H_2AsO_3OH, $AsO(OH)_3$ **DO NOT ALLOW** use of AS for As in parts **b** and **c** Penalise first time use then ECF
	b	ii	$H_2AsO_4^- + 2OH^- \rightleftharpoons AsO_4^{3-} + 2H_2O$ AsO_4^{3-} ✓ rest of equation correct & balanced ✓	2	
	b	iii	$H_2AsO_4^- + 2OH^- \rightarrow AsO_4^{3-} + 2H_2O$ ✓	1	**ALLOW** ECF for incorrect formula for arsenate ion in **bii**
	c	i	(H_3AsO_4 reacts because) $E^\ominus$ / electrode potential for SO_4^{2-}/ SO_2 is **more negative** than $E^\ominus$ for H_3AsO_4/ H_3AsO_3 ✓ (H_3PO_4 does not react because) $E^\ominus$ for SO_4^{2-}/ SO_2 is **more positive** than $E^\ominus$ for H_3PO_4/ H_3PO_3 ✓ **OR (**using $E^\ominus_{cell}$ calculations**)** for H_3PO_4 $E^\ominus_{cell} < 0$ / (-0.45 V) so is not feasible ✓ for H_3AsO_4 $E^\ominus_{cell} > 0$ / (+0.39 V) so is feasible ✓	2	**ORA** **DO NOT ALLOW** higher/lower or similar words **DO NOT ALLOW** $E^\ominus_{cell}$ for $E^\ominus$ **ALLOW** $E^\ominus$ / electrode potential must be used at least once in the answer **ALLOW** correct identification of half-cell by one of the reactants only e.g. SO_2

Question			Answer	Mark	Guidance
		ii	$H_3AsO_4 + H_2O + SO_2 \rightarrow SO_4^{2-} + 2H^+ + H_3AsO_3$ correct species with no cancelling of H^+ / H_2O / e^- ✓ all correct ✓	2	**ALLOW** H_2SO_4 on RHS of equation **DO NOT ALLOW** an equilibrium arrow
	d	i	1st order ✓ because it has a constant half-life ✓	2	2nd mark depends on 1st so 'zero order because it has a constant half-life' does not score any marks etc.
	d	ii	Evidence is for small molecules **OR** As-O bonds are not in a small molecule **OR** As-O bonds may be stabilised/ strengthened by the DNA structure ✓	1	**LOOK FOR** either comment on relative size of molecules or stability of As-O bonds **ALLOW** DNA is not a small molecule – this may be implied
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