

Chemistry B (Salters)

Advanced GCE

Unit **F334**: Chemistry of Materials

Mark Scheme for June 2013

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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.

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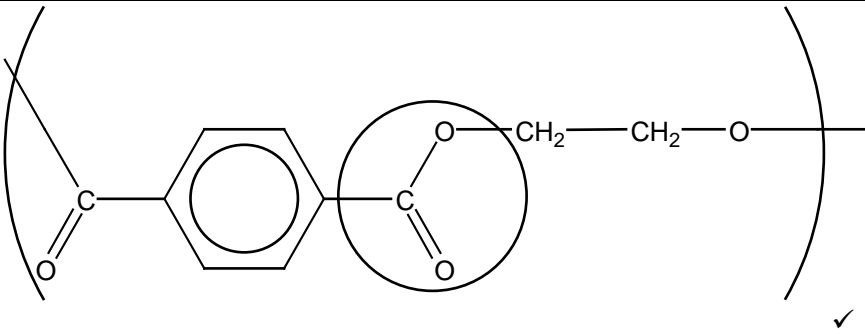
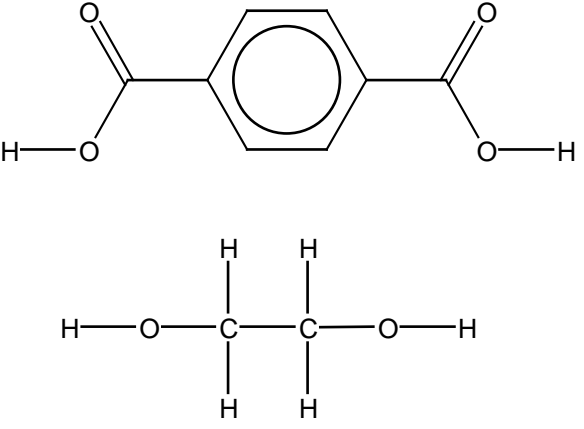
1. Annotations

Annotation	Meaning
	Benefit of doubt
	Contradiction
	Cross
	Error carried forward
	Ignore
	Not answered question
	Benefit of doubt not given
	Not good enough
	Rounding error
	Repeat
	Noted but no credit given
	Error in no. of significant figures
	Tick
	Omission mark

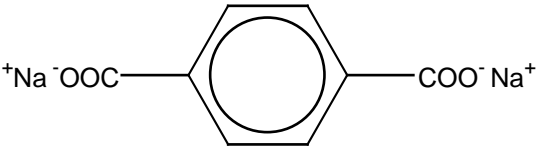
2. Abbreviations, annotations and conventions used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

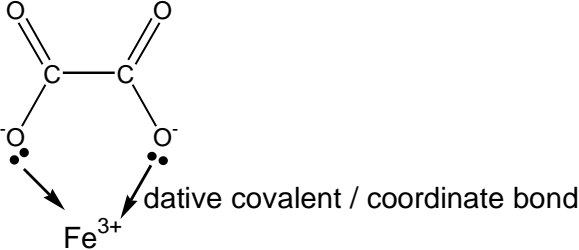
Annotation	Meaning
DO NOT ALLOW	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
()	Words which are not essential to gain credit
—	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

All questions should be annotated with ticks to show where marks have been awarded in the body of the text.
All questions where an ECF has been applied should also be annotated with the ECF annotation.

Question		Answer	Marks	Guidance
1	(a) (i)		1	ALLOW 'circle' to include the two adjacent C atoms
	(ii)	<p>permanent (dipole) – permanent dipole (bond/forces) ✓</p> <p>instantaneous (dipole) – induced dipole (bond/forces) ✓</p>	2	<p>NOT just 'permanent dipole bond/forces'</p> <p>DO NOT ALLOW pd etc</p> <p>ALLOW van der waals</p> <p>IGNORE permanent (dipole) – induced dipole (bond/forces)</p> <p>Each mention of any other type of bond in addition to both of these is a CON</p>
	(iii)	 <p>1 mark for each monomer correct ✓✓</p>	2	<p>ALLOW -COCl for -COOH</p> <p>ALLOW -OH, HOCH₂CH₂OH</p>

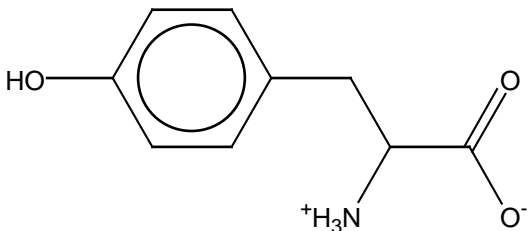
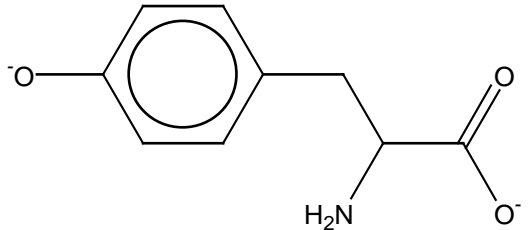
Question		Answer	Marks	Guidance
1	(a) (iv)	condensation / esterification AND water / H ₂ O ✓	1	If –COCl/ in (a) (iii) MUST have HCl/ NOT H ₂ O
	(b) (i)	vapours are condensed / turned into liquid AW ✓ mixture needed to be heated for a long time (to break down polymers / for reaction to occur) OR no reactants or products / vapours are lost OR high temperature required for reaction ✓	2	IGNORE any reference to 'fire' / toxic NOT just 'vapours' fall back down etc. i.e. 'vapours' need state change NOT solution
	(ii)	choice of solvent: dissolves salt well at higher temp but very little / none at room temp AW ✓ method: 1. use hot solvent ✓ 2. dissolve in minimum amount of solvent ✓ 3. leave to crystallise/cool ✓ 4. filter off crystals, (soluble) impurities are left in filtrate / solution AW ✓ 5. wash with (cold) <u>solvent</u> and dry ✓ MP4 is QWC – i.e. for linking removal of impurities to filtration	6	ALLOW boiling point of solvent is lower than the melting point of the salt IGNORE any reference to INSOLUBLE impurities
	(c) (i)	bonds (in a molecule) <u>absorb</u> ✓ specific/different/certain (IR) frequencies/wavelengths ✓ alternative for 1st & 2nd marking points: <u>absorbing different frequencies</u> ✓ causes different bonds to vibrate ✓	2	IGNORE references to energy NOT 'electrons in bonds'

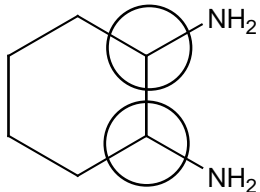
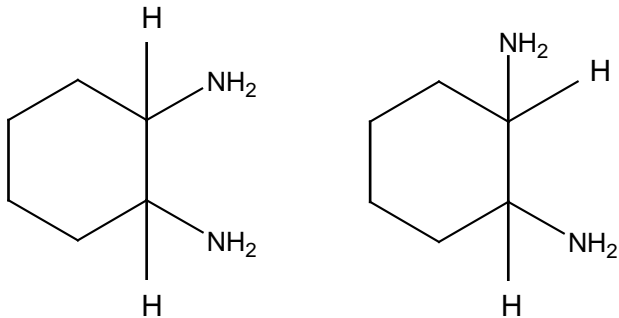
Question		Answer	Marks	Guidance
1	(c) (ii)	<p>structure of A</p>  <p>No OH bond since no <u>broad</u> absorption peak above about (2500-3200) / 3000 (cm⁻¹) ✓</p> <p>C=O absorption peak at about 1720-1740 (cm⁻¹) (so must be carboxylate AW) ✓</p> <p>structure of B</p> <p>HOCH₂CH₂OH ✓</p> <p>OH bond since (broad) absorption peak about 3200-3600 (cm⁻¹) ✓</p>	5	<p>REMEMBER marking points are independent ALLOW any correct structural formulae</p> <p>ALLOW without Na⁺</p> <p>IR data may be drawn on the spectra, please check</p> <p>reference to any functional group other than a carboxylic acid / carboxylate is a CON ALLOW frequency within stated range</p> <p>ALLOW any correct structural formula</p>
	(d) (i)	temperature <u>below</u> which the polymer turns glassy/brittle ✓	1	'below' may be expressed by reducing temperature / cooling / shown in a diagram
	(ii)	it would soften / melt / turn into liquid/fluid ✓	1	
	(e) (i)	chains are further apart / less close together in PBT ✓ so has <u>weaker</u> intermolecular bonding/forces than PET ✓ so chains in PBT can move over one another more easily ✓	3	ORA IGNORE references to ordered chains etc. IGNORE fewer/less imb/fs
	(ii)	butane-1,4-diol butane / butan / but AND diol = ✓ 1,4- = ✓	2	IGNORE commas & dashes '1,4-' must be between 'butane' & 'diol'
Total			28	

Question		Answer	Marks	Guidance
2	(a) (i)	 <p>dative covalent / coordinate bond</p> <p>lone pairs as shown ie must link to bond (any type of drawn line) ✓</p> <p>two bonds shown as arrows from O⁻ pointing to a single Fe³⁺ ✓</p> <p>dative (covalent)/coordinate bond labelled (anywhere on diagram) ✓</p>	3	<p>ECF allow this marking point if the C=O are used instead of the O⁻ (so max mark of 2 if incorrect Os used)</p> <p>CON if any other bond is specifically labelled</p>
	(ii)	<p>$[\text{Fe}(\text{C}_2\text{O}_4)_3]^{3-}$ ✓</p> <p><u>octahedral</u> ✓</p>	2	<p>ALLOW without square brackets</p> <p>IGNORE separate correct charges for both Fe & C₂O₄ as long as overall charge 3- is shown</p> <p>ALLOW structural formula</p>
	(b) (i)	<p>the E^\ominus of CO₂/(COOH)₂ half-cell is more negative/less positive than that of the Fe³⁺/Fe²⁺ half-cell</p> <p>OR</p> <p>$E_{\text{cell}} = +1.26 \text{ V}$, so reaction is feasible ✓</p> <p>(COOH)₂ will release electrons / reduce Fe³⁺</p> <p>OR Fe³⁺ will gain electrons / oxidise (COOH)₂ ✓</p>	2	<p>ALLOW (in this question only) E^\ominus of the Fe³⁺ half-cell etc. (there are only 2 half-cells given)</p>
	(ii)	<p>$2\text{Fe}^{3+}(\text{aq}) + (\text{COOH})_2(\text{aq}) \rightarrow 2\text{Fe}^{2+}(\text{aq}) + 2\text{CO}_2(\text{g}) + 2\text{H}^+(\text{aq})$</p> <p>correct formulae AND balanced ✓</p> <p>state symbols correct ✓</p>	2	<p>ACCEPT CO₂(aq)</p> <p>If balanced with electrons on either side max mark = 1</p> <p>State symbol mark may be awarded if species are correct even if equation is reversed</p>

Question			Answer	Marks	Guidance
2	(c)	(ii)	<p>1. moles of KMnO_4 used in titration = 18.40/1000 x 0.0500 ✓ = 0.0009200</p> <p>2. moles potassium ethanedioate used in titration = 5/2 x answer from 1 ✓ = 0.002300</p> <p>3. moles potassium ethanedioate in 100 cm^3 = 4 x answer from 2 ✓ = 0.009200</p> <p>4. M_r of $\text{K}_2\text{C}_2\text{O}_4 \cdot \text{H}_2\text{O}$ = 184 / 184.2 ✓</p> <p>5. mass potassium ethanedioate in 100 cm^3 = 184.2 x (answer from 3) ✓ = 1.6946</p> <p>6. Answer = 1.695 or 1.69 g ✓ to 4 or 3 sig figs</p>	6	<p>The marks are awarded for the working out given in bold</p> <p>ALLOW ecf between each step</p> <p>3. may be done in 2 steps via moles dm^{-3} and still scores only 1 mark</p> <p>Note: 1 error means only 1 mark is lost eg incorrect M_r eg these are probably 5 marks but place ticks appropriately: 0.200 (/ M_r instead of x M_r) 3.39 (/2 missing) 5010 (in step 1: x(1000/18.40) rather than /)</p> <p>the following is probably 4 marks 0.42 (missing x4 and incorrect sf)</p>

Question		Answer	Marks	Guidance
2	(d) (i)	<p>X to Y: increases ✓ rate speeds up as (catalyst) Mn^{2+} is formed ✓</p> <p>Y to Z: decreases ✓ rate slows as reactants / $\text{C}_2\text{O}_4^{2-}$ / MnO_4^- are/is used up / as concentrations of reactants fall ✓</p>	4	
	(ii)	colorimetry / use a colorimeter / visible spectroscopy / visible spectrophotometry ✓	1	ALLOW conductivity / gas volume IGNORE pH
	(iii)	<p>EITHER (colourless) effervescence/fizzing/bubbling AW ✓</p> <p>OR (purple/pink) colour fades AW ✓</p>	1	<p>IF MORE THAN ONE ANSWER MARK FIRST IN LIST ONLY</p> <p>NOT gas forms NOT colour change IGNORE references to absorbance incorrect colour is a CON</p>
Total			30	

Question		Answer	Marks	Guidance
3	(a) (i)	phenol / hydroxyl ✓ carboxyl / carboxylic acid ✓ amino / amine ✓	3	NOT hydroxide, alcohol IGNORE 'primary' but 'secondary' is a CON
	(ii)	(neutral) FeCl ₃ / iron(III) chloride ✓ turns purple / violet (phenol present) ✓	2	NOT blue or pink If initial colour is given, it must be yellow, orange or colourless otherwise CON
	(b) (i)	contains a positive charge and a negative charge ✓  structure ALL correct ✓	2	IGNORE dipolar MUST indicate that there are only 1+ and 1- charge present this may be indicated by the structure drawn
	(ii)	acidic ✓ (because it has a) phenol group ✓	2	ALLOW structural formula for phenol IGNORE references to -COOH & -NH ₂ groups
	(iii)	 1 mark for phenol group reacted correctly ✓ 1 mark for rest of the molecule correct ✓	2	IGNORE any Na ⁺ ions

Question		Answer	Marks	Guidance
3	(c)	(i)	2	IGNORE complementary IGNORE enzyme NOT 'react with'
		(ii)	1	ALLOW 'benefits outweigh side effects' IGNORE reference to 'disease'
	(d)	<p>optical isomers:</p>  <p>chiral Cs shown on the diagram ✓</p> <p>4 different groups around (each) C OR not superimposable on their mirror image ✓</p> <p>cis-trans isomers: C-C between the chiral (AW) atoms is prevented from rotating by the ring structure ✓</p>  <p>2 correct diagrams for isomers ✓</p>	4	<p>NOT 'functional groups'</p> <p>IGNORE references to 'ring rotation'</p> <p>H's may not necessarily be shown as in MS ACCEPT if NH₂ groups only are shown with lines/wedges/dotted lines etc. MUST CONVINCe that we have cis & trans isomers</p>
Total			18	

Question		Answer	Marks	Guidance
4	(a) (i)	order for $[\text{CH}_3\text{Cl}] = 1 \checkmark$ order for $[\text{H}_2\text{O}] = 2 \checkmark$	2	
	(ii)	rate = $k [\text{CH}_3\text{Cl}] [\text{H}_2\text{O}]^2 \checkmark$ overall order = 3 \checkmark	2	ALLOW with 'x's in rate equation ECF from (i) ECF from rate equation
	(iii)	slow step/rate determining step involves one CH_3Cl (molecule) so it is 1 st order AW \checkmark one OH^- formed from the two H_2O (molecules) so 2 nd order with respect to H_2O AW \checkmark	2	IGNORE 'rds'
	(b)	hydrochloric acid \checkmark methanoic acid \checkmark	2	ALLOW hydrogen chloride, formic acid IGNORE formulae
	(c)	acidified \checkmark (potassium) dichromate / (sodium) dichromate / $\text{Cr}_2\text{O}_7^{2-}$ \checkmark (add reagent to alcohol and) distil off aldehyde as it is formed \checkmark	3	any concentration of sulfuric acid / H_2SO_4 DO NOT ALLOW hydrochloric OR nitric acids use of 'reflux' is a CON
	(d)	$1.56 \times 10^{-4} = k \times 1.82 \times 10^{-3} \checkmark$ $k = 0.0857 / 0.086 \checkmark$ $\text{s}^{-1} \checkmark$	3	ALLOW any correct rearrangement of equation CORRECT ANSWER gets both marks ALLOW two or more sig figs
Total			14	

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