OCR
RECOGNISING ACHIEVEMENT

GCE

Chemistry B (Salters)

Advanced GCE

Unit **F334:** Chemistry of Materials

Mark Scheme for June 2013

Oxford Cambridge and RSA Examinations

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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.

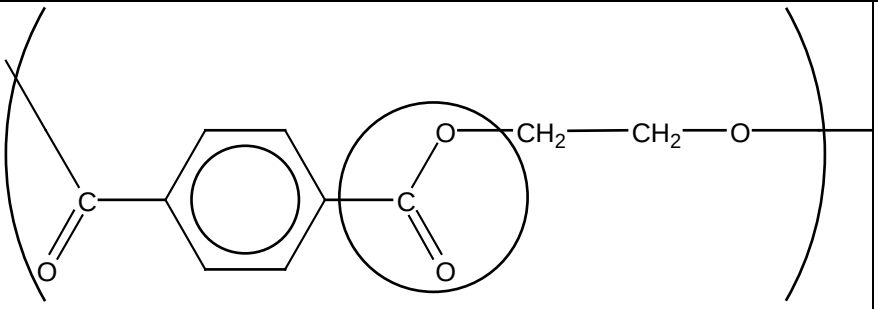
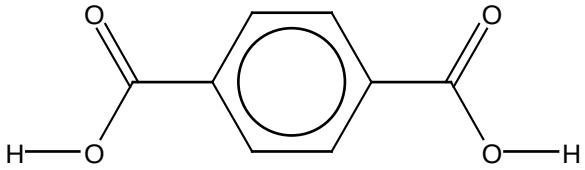
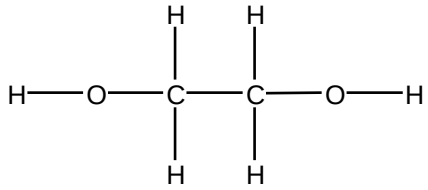
1. **Annotations**

Annotation	Meaning
BOD	Benefit of doubt
CON	Contradiction
	Cross
ECF	Error carried forward
I	Ignore
NAQ	Not answered question
NBOD	Benefit of doubt not given
NGE	Not good enough
RE	Rounding error
REP	Repeat
SEEN	Noted but no credit given
SF	Error in no. of significant figures
	Tick
^	Omission mark

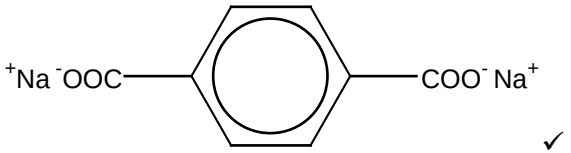
2. Abbreviations, annotations and conventions used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

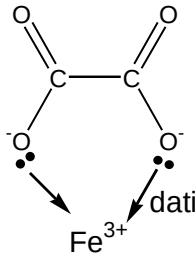
Annotation	Meaning
DO NOT ALLOW	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
( )	Words which are not essential to gain credit
__	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording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

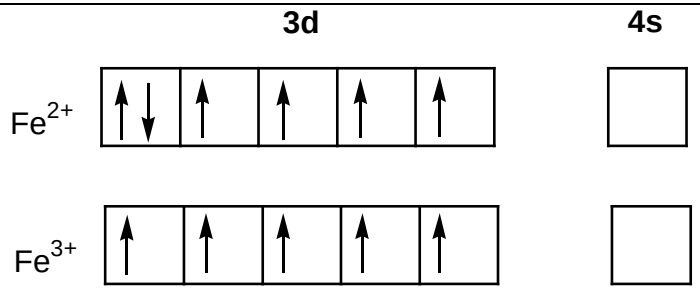
All questions should be annotated with ticks to show where marks have been awarded in the body of the text.
All questions where an ECF has been applied should also be annotated with the ECF annotation.

Question			Answer	Marks	Guidance
1	(a)	(i)	 ✓	1	**ALLOW** 'circle' to include the two adjacent C atoms
		(ii)	permanent (dipole) – permanent dipole (bond/forces) ✓ instantaneous (dipole) – induced dipole (bond/forces) ✓	2	**NOT** just 'permanent dipole bond/forces' **DO NOT ALLOW** pd etc **ALLOW** van der waals **IGNORE** permanent (dipole) – induced dipole (bond/forces) **Each mention of any other type of bond in addition to both of these is a CON**
		(iii)	  1 mark for each monomer correct ✓✓	2	**ALLOW** –COC*l* for –COOH **ALLOW** –OH, $HOCH_2CH_2OH$

Question			Answer	Marks	Guidance
1	(a)	(iv)	condensation / esterification **AND** water / H_2O ✓	1	If –COC*l* in (a) (iii) **MUST** have HC*l* **NOT** H_2O
	(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</u> *different frequencies* ✓ causes different bonds to vibrate ✓	2	**IGNORE** references to energy **NOT** 'electrons in bonds'

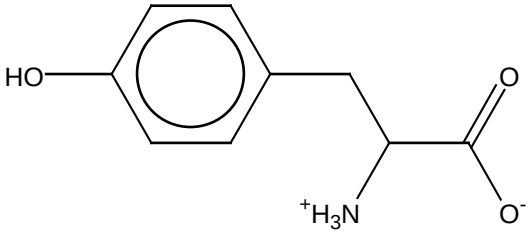
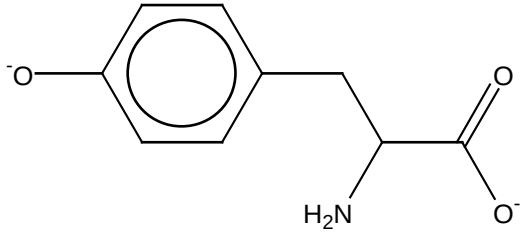
Question			Answer	Marks	Guidance
1	(c)	(ii)	**structure of A**  ✓ No OH bond since no broad absorption peak above about (2500-3200) / 3000 (cm^{-1}) ✓ C=O absorption peak at about 1720-1740 (cm^{-1}) (so must be carboxylate **AW**) ✓ **structure of B** $HOCH_2CH_2OH$ ✓ OH bond since (broad) absorption peak about 3200-3600 (cm^{-1}) ✓	5	**REMEMBER marking points are independent** **ALLOW** any correct structural formulae **ALLOW** without Na^+ **IR data may be drawn on the spectra, please check** reference to any functional group other than a carboxylic acid / carboxylate is a **CON** **ALLOW** frequency within stated range **ALLOW** any correct structural formula
	(d)	(i)	temperature below 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 weaker 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**	

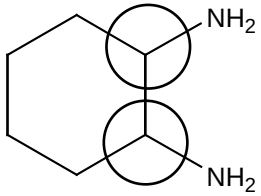
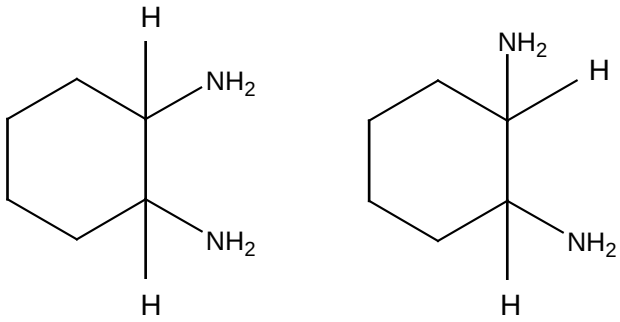
Question			Answer	Marks	Guidance
2	(a)	(i)	 dative covalent / coordinate bond lone pairs as shown ie must link to bond (any type of drawn line) ✓ **two** bonds shown as arrows from O^- pointing to a single **Fe^{3+}** ✓ dative (covalent)/coordinate bond labelled (anywhere on diagram) ✓	3	**ECF** allow this marking point if the C=O are used instead of the O^- (so max mark of 2 if incorrect Os used) **CON** if any other bond is specifically labelled
		(ii)	$[Fe(C_2O_4)_3]^{3-}$ ✓ octahedral ✓	2	**ALLOW** without square brackets **IGNORE** separate correct charges for **both** Fe & C_2O_4 as long as overall charge 3- is shown **ALLOW** structural formula
	(b)	(i)	the $E^{\ominus}$ of **CO_2/$(COOH)_2$** half-cell is **more negative/less positive** than that of the **Fe^{3+}/Fe^{2+}** half-cell **OR** E_{cell} = +1.26 V, so reaction is feasible ✓ **$(COOH)_2$** will release electrons / reduce Fe^{3+} **OR** Fe^{3+} will gain electrons / oxidise **$(COOH)_2$** ✓	2	**ALLOW** (in this question only) $E^{\ominus}$ of the **Fe^{3+}** half-cell etc. (there are only 2 half-cells given)
		(ii)	$2Fe^{3+}(aq) + (COOH)_2(aq) \rightarrow 2Fe^{2+}(aq) + 2CO_2(g) + 2H^+(aq)$ correct formulae **AND** balanced ✓ state symbols correct ✓	2	**ACCEPT** $CO_2(aq)$ If **balanced with electrons** on either side max mark = 1 State symbol mark may be awarded if species are correct even if equation is reversed

Question			Answer	Marks	Guidance
2	(b)	(iii)	 any 6 electrons for Fe^{2+} and 5 for Fe^{3+}= 1st mark ✓ correct arrangements for both = 2nd mark ✓	2	
		(iv)	half-filled d shell (is more stable) AW ✓	1	**AW** eg only 1 electron in **each** of the d orbitals
	(c)	(i)	1. manganate(VII) solution in burette ✓ 2. pipette known/stated volume of ethanedioate solution **OR** graduated/volumetric pipette for ethanedioate solution ✓ 3. add acid ✓ 4. warm / heat solution / 60°C ✓ 5. titrate (AW) until pink colour persists/remains AW ✓ 6. *no indicator needed because* only MnO_4^-(aq) is coloured **OR** a colour change takes place during the reaction AW ✓ **QWC** to gain the 1st mark the spelling of **burette** has to be correct at least **once in the answer**	6	If pipette & burette **used wrong way round** then 1 mark only for points 1 and 2 **AND** mark 5 is only available if purple changes to colourless **IGNORE** 'bulb' **ALLOW** acid / 'acidified' in either solution **NOT** purple alone here **MUST HAVE** pink **ALLOW** purple–colourless **NOT** colourless–purple **INCORRECT** colour change is a **CON** eg orange–green, purple–pink etc.

Question			Answer	Marks	Guidance
2	(c)	(ii)	1. moles of $KMnO_4$ used in titration = **18.40/1000 x 0.0500** ✓ = 0.0009200 2. moles potassium ethanedioate used in titration = **5/2** x answer from **1** ✓ = 0.002300 3. moles potassium ethanedioate in 100 cm^3 = **4** x answer from **2** ✓ = 0.009200 4. M_r of $K_2C_2O_4 \bullet H_2O$ = **184** / **184.2** ✓ 5. mass potassium ethanedioate in 100 cm^3 = **184.2** x (answer from **3**) ✓ = 1.6946 6. Answer = **1.695** or **1.69 g** ✓ to 4 or 3 sig figs	6	**The marks are awarded for the working out given in bold** **ALLOW** ecf between each step 3. may be done in **2 steps** via moles dm^{-3} and still scores only 1 mark **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 /*) the following is probably 4 marks **0.42** (*missing x4 and incorrect sf*)

Question			Answer	Marks	Guidance
2	(d)	(i)	**X to Y**: increases ✓ rate speeds up as (catalyst) Mn^{2+} is formed ✓ **Y to Z**: decreases ✓ rate slows as reactants / $C_2O_4^{2-}$ / MnO_4^- are/is used up / as concentrations of reactants fall ✓	4	
		(ii)	colorimetry / use a colorimeter / visible spectroscopy / visible spectrophotometry ✓	1	**ALLOW** conductivity / gas volume **IGNORE** pH
		(iii)	**EITHER** (colourless) effervescence/fizzing/bubbling AW ✓ **OR** (purple/pink) colour fades AW ✓	1	**IF MORE THAN ONE ANSWER MARK FIRST IN LIST ONLY** **NOT** gas forms **NOT** colour change **IGNORE** references to absorbance incorrect colour is a **CON**
			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)	they have different <u>shapes</u> / only one with correct <u>shape</u> AW ✓ only one will fit/bind in active site /binding site / receptor ✓	2	**IGNORE** complementary **IGNORE** enzyme **NOT** 'react with'
		(ii)	it is better / less adverse effects / more effective than other drugs ✓	1	**ALLOW** 'benefits outweigh side effects' **IGNORE** reference to 'disease'
	(d)		**optical isomers:**  chiral Cs shown on the diagram ✓ 4 different groups around (each) C **OR** not superimposable on their mirror image ✓ **cis-trans isomers:** C-C between the chiral (AW) atoms is prevented from rotating by the ring structure ✓  2 correct diagrams for isomers ✓	4	**NOT** 'functional groups' **IGNORE** references to 'ring rotation' H's may not necessarily be shown as in MS **ACCEPT** if NH_2 groups only are shown with lines/wedges/dotted lines etc. **MUST CONVINCE** that we have cis & trans isomers
			Total	**18**	

Question			Answer	Marks	Guidance
4	(a)	(i)	order for $[CH_3Cl]$ = 1 ✓ order for $[H_2O]$ = 2 ✓	2	
		(ii)	rate = k $[CH_3Cl]$ $[H_2O]^2$ ✓ overall order = 3 ✓	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 1st order AW ✓ one OH^- formed from the **two** H_2O (molecules) so 2nd order with respect to H_2O AW ✓	2	**IGNORE** 'rds'
	(b)		hydrochloric acid ✓ methanoic acid ✓	2	**ALLOW** hydrogen chloride, formic acid **IGNORE** formulae
	(c)		**acidified** ✓ (potassium) **dichromate** / (sodium) dichromate / $Cr_2O_7^{2-}$ ✓ (add reagent to alcohol and) **distil** off aldehyde as it is formed ✓	3	any concentration of sulfuric acid / H_2SO_4 **DO NOT ALLOW** hydrochloric **OR** nitric acids use of 'reflux' is a **CON**
	(d)		$1.56 \times 10^{-4} = k \times 1.82 \times 10^{-3}$ ✓ k = 0.0857 / 0.086 ✓ s^{-1} ✓	3	**ALLOW** any correct rearrangement of equation **CORRECT ANSWER** gets both marks **ALLOW** two or more sig figs
			Total	**14**	

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