OCR
RECOGNISING ACHIEVEMENT

GCE

Chemistry B (Salters)

Advanced GCE

Unit **F334:** Chemistry of Materials

Mark Scheme for June 2012

Oxford Cambridge and RSA Examinations

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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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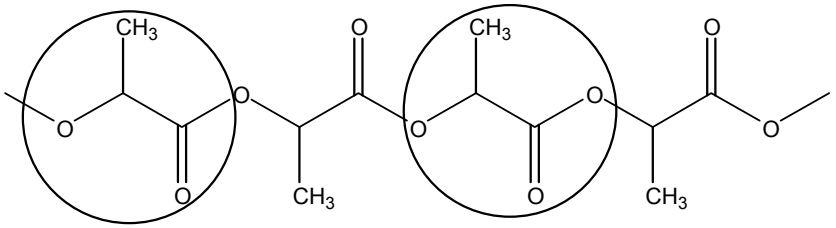
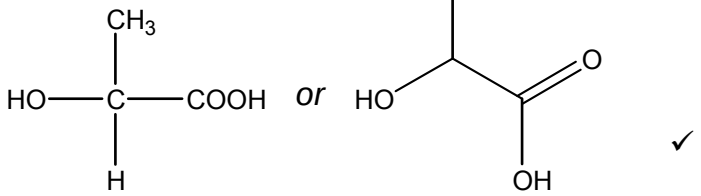
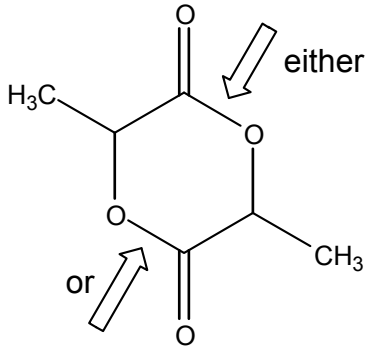
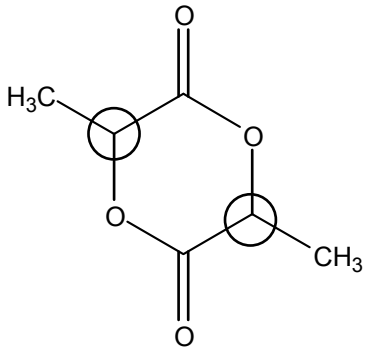
Annotations

Annotation	Meaning
/	alternative and acceptable answers for the same marking point
(1)	separates marking points
not	answers which are not worthy of credit
reject	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
	Correct point
	Incorrect point
	Benefit of the doubt
	No benefit of doubt given
	Error carried forward
	Omission mark
	Ignore
	Reject

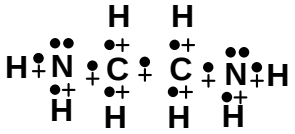
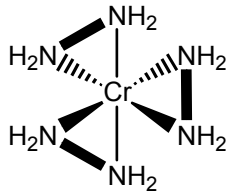
Question			Answer	Marks	Guidance
1	(a)	(i)	 ALLOW AT ANY POSITION ✓ DO NOT ALLOW	1	**DO NOT ALLOW** if -COO one side and no -O on the other
		(ii)	ester ✓	1	**ALLOW** polyester
	(b)		 ✓	1	**ALLOW** skeletal or partial skeletal formula as long as structure is correct
	(c)	(i)	 either or ✓	1	**ALLOW** if both arrows are shown

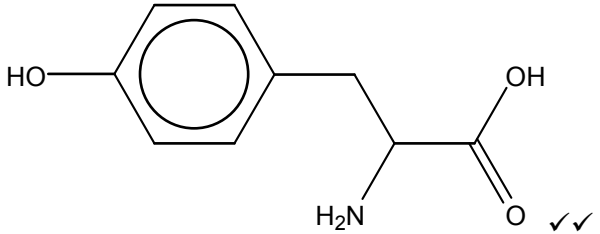
Question			Answer	Marks	Guidance
		(ii)	**no water** is produced in the reaction ✓ no polymer broken down/lost **OR** no polymer bonds broken ✓	2	**DO NOT ALLOW** 'no reaction with water' alone must refer to polymer being broken down etc.
		(iii)	polymerisation of **B** has a higher atom economy / 100% atom economy **OR** polymerisation of **A** has a lower atom economy ✓ (for polymerisation of **B**) all atoms are used / no waste is formed **OR** (for polymerisation of **A**) waste is formed ✓	2	**ALLOW** less waste is formed **for** no waste is formed **DO NOT ALLOW** no molecule lost from **B**
	(d)	(i)	not superimposable on its mirror image ✓	1	**ALLOW** has an asymmetric carbon atom **OR** carbon atom attached to four different groups **DO NOT ALLOW** carbon atom attached to four different **functional** groups / atoms / molecules **DO NOT ALLOW** 'chiral atom' for 'carbon atom'
		(ii)	 ✓	1	

Question			Answer	Marks	Guidance
	(e)	(i)	how polymer chains/molecules/sections are packed together in an orderly/regular way **OR** how polymer chains/molecules/sections are aligned/lined up ✓	1	**ALLOW** chains are highly ordered some sort of particles have to be ordered' etc. 'ordered structure' is not sufficient **DO NOT ALLOW** 'chains are packed closely' alone
	(e)	(ii)	above T_m: polymer **melts**/becomes **liquid**/fluid ✓ below T_g: polymer becomes **brittle** ✓ because chains cannot **move over each other** ✓ so **break** when a **force is applied** ✓ (blended polymer is more crystalline) so **intermolecular bonds**/**forces** / imbs / imfs are **stronger** **AND more energy** is needed to separate chains/melt polymer (QWC) ✓	5	**please annotate marks given with ticks** **ALLOW** glass transition temperature and melting temperature for T_g and T_m **IGNORE** references to rigid, flexible, amorphous, crystalline **ALLOW** more crystalline means more points of contact for imbs/imfs **OR** more iimbs/imfs **INSTEAD** of stronger imbs/imfs
	(f)		manufactured from a renewable source / starch / plants **OR** not manufactured from oil/natural gas ✓	1	
			Total	17	

Question			Answer	Marks	Guidance
2	(a)	(i)	carbon dioxide / CO_2 ✓	1	
		(ii)	oxidation states: Fe(+2) to Fe(+3) ✓ Cr(+3) to Cr(+6) ✓ an increase in oxidation state / loss of electrons ✓	3	**DO NOT ALLOW** + sign after / absent ; for first oxidation state ecf for rest **ALLOW** correct Roman numerals for 1 mark only
		(iii)	sodium/disodium chromate(VI) ✓	1	oxidation state must be correct **AND** after 'chromate' **ALLOW** without brackets around oxidation state **ALLOW** gaps **IGNORE** (I) after sodium
	(b)		$2Na_2CrO_4 + H_2SO_4 \rightarrow Na_2Cr_2O_7 + Na_2SO_4 + H_2O$ H_2O ✓ rest correct and balanced ✓	2	**IGNORE** state symbols *or* Fe_2O_3 as reactant AND product in equation
	(c)		filtration / centrifuge ✓	1	**IGNORE** vacuum
	(d)		(Cr(III) cannot be reduced by carbon but Fe(III) can so) **Fe_2O_3 has greater** oxidising strength than Cr_2O_3 **OR** **Cr_2O_3 has lower** oxidising strength than Fe_2O_3 ✓	1	
	(e)	(i)	**Cr^{3+}(aq)/Cr(s) half-cell**: Cr^{3+}(aq) in beaker and Cr electrode labelled ✓ voltmeter **AND** salt bridge correctly connected ✓ standard conditions: concentration is 1 mol dm^{-3} **AND** temperature is 298K / 25ºC ✓	3	**ALLOW** Cr(III) or soluble salt *e.g.* sulfate or nitrate **ALLOW** electrode if totally immersed if not labelled as salt bridge **ALLOW** correct formula/name for chemical in salt bridge *i.e any soluble sodium, potassium or ammonium salt* **IGNORE** pressure **ALLOW** 1M / 1 mol $litre^{-1}$

Question			Answer	Marks	Guidance
		(ii)	$2Cr(s) + 6H^+(aq) \rightarrow 2Cr^{3+}(aq) + 3H_2(g)$ reactants and products correct ✓ state symbols correct **AND** balanced ✓	**2**	**ALLOW** 1 mark if equation is the other way round but balanced with correct state symbols **ALLOW** 1st mark only if electrons are included but reactants and products are correct **ALLOW** if balanced using $1.5H_2$
		(iii)	*electronegativity*: ...ability of atom to attract electrons ✓ in a (covalent) bond ✓ *conclusion*: **Fe^{2+}** is a **stronger** oxidising agent than **Cr^{3+}** ✓ because the ***$E^{\ominus}$* of Fe^{2+}/Fe** half-cell is **more positive/less negative** than that of the **Cr^{3+}/Cr** half-cell ✓	**4**	**ALLOW** …atom to pull electrons … **ORA** this means: **Cr** is a **stronger** reducing agent than **Fe** ✓ because the ***$E^{\ominus}$* of Cr^{3+}/Cr** half-cell is **less positive/more negative** than that of the **Fe^{2+}/Fe** half-cell ✓ **ALLOW *$E^{\ominus}$* of Fe/iron** half-cell / ***$E^{\ominus}$* of Cr/chromium** half-cell **BUT NOT FOR** oxidising agents formulae reasoning in last marking point is only for correct conclusion **ECF** use of ions for reducing agents
	(f)		transfer/exchange of proton **OR** a proton is lost/donated **AND** gained/accepted ✓ $[Cr(H_2O)_6]^{3+}$ **AND** H_3O^+ ✓	**2**	**ALLOW** H^+ for proton **DO NOT ALLOW** 'Cr complex ion' without formula
	(g)	**(i)**	1,2-diaminoethane ✓	**1**	**IGNORE** commas and dashes **ALLOW** ethylenediamine **BUT NOT** ethan(e)-1,2-diamine

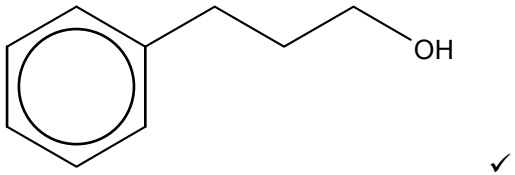
Question			Answer	Marks	Guidance
		(ii)	 **ALL** bond pairs correct ✓ **BOTH** lone pairs correct ✓	**2**	**ALLOW** two crosses for lone pair
		(iii)	it can use/donate **two**/**both** lone pairs (of electrons) ✓ to form dative covalent/coordinate bonds (with metal cation) ✓	**2**	**ACCEPT** 'free' pair of electrons
	(h)	(i)	6 ✓	**1**	
		(ii)	 where ▬ represents $-CH_2CH_2-$ 3D octahedral diagram showing 6 bonds from central atom ✓ 3 bidentate ligands linking pairs of adjacent bonds ✓	**2**	**IGNORE** charge on Cr or complex ion **DO NOT ALLOW** 2D diagrams **ALLOW** any representation for the carbon chains
		(iii)	90 (°/degrees) ✓	**1**	
		(iv)	it has an asymmetric structure / it is chiral **OR** its **mirror image** / the **two isomers** is/are non-superimposable ✓	**1**	
			Total	**30**	

Question			Answer	Marks	Guidance
3	(a)		condensation ✓	1	
	(b)	(i)	(moderately) concentrated hydrochloric acid/HCl ✓ boiling/heating (under reflux) ✓	2	**ALLOW** mod. conc. sulfuric acid **BUT NOT** conc. H_2SO_4 **ALLOW** reflux **DO NOT ALLOW** other named acids / mod. conc. acid alone
		(ii)	 ✓✓	2	1st mark for having a $–NH_2$ and a –COOH group 2nd mark for rest of structure correct **ALLOW** –COOH, structural formula for carbon chain
	(c)	(i)	colorimetry ✓	1	
		(ii)	forms a **purple** colour ✓ with *Tyr* because of the **phenol** group ✓	2	
	(d)	(i)	the <u>three dimensional shape/structure</u> of the protein **OR** folding of the secondary structure / α-helix / β-pleated sheet **OR** overall folding of the protein/polypeptide ✓	1	**DO NOT ALLOW** 'overall shape of the protein'
		(ii)	changing pH affects the ionic/electrostatic attractions / charges on groups ✓ so by lowering pH $–COO^-$/carboxylate can be protonated/can form –COOH **OR** lowering pH NH_2 protonated to NH_3^+ ✓	2	**ALLOW** hydrogen bonding **DO NOT ALLOW** 'intermolecular bonds/forces' alone

Question			Answer	Marks	Guidance
	(e)	(i)	to help judge the disappearance of the suspension / milkiness AW **OR** makes milky suspension easier to see AW **OR** makes the change from milky/white to clear/colourless easier to see ✓	1	**IGNORE** any reference to colour change other than white-colourless
		(ii)	to act as a control / to compare with the suspension (and so judge/determine the end of the reaction) ✓	1	**DO NOT ALLOW** 'to compare test-tubes' alone
		(iii)	read off **rate** / 1/t on y-axis for (a particular) **temperature** on x-axis ✓	1	**ALLOW** correct construction shown on diagram
		(iv)	**1st mark:** as the temperature rises particles have more energy ✓ **2nd mark:** more collisions have energy greater than the activation enthalpy/energy ✓ **3rd mark:** graph falls because at high temperatures intermolecular bonds break ✓ **4th mark:** loss of active site **OR** shape of active site changes **OR** tertiary structure of enzyme changes / is altered / unable to form enzyme-substrate complex ✓ **QWC** to gain the **2nd mark** the spelling of activation enthalpy/energy has to be correct	4	**IGNORE** references to enzyme–substrate complexes for marks 1-3 **ALLOW** system/molecules/enzymes and substrates have more energy **ALLOW** hydrogen bonds / bonds holding the tertiary structure together **BUT NOT** 'intramolecular bonds' or 'bonds' alone **IGNORE** the use of 'denature' etc.

Question			Answer	Marks	Guidance
	(f)		$3.08 \times 10^{-3} = k \times 0.010 =$ **0.308** ✓ $k = 3.1 \times 10^{-1} / 0.31$ ✓ units: s^{-1} ✓	**3**	**ALLOW** any correct rearrangement of equation **2 sf** only ecf for units for using incorrect rate equation
	(g)		Zero order ✓ all the active sites are full **OR** maximum number of enzyme-complexes have formed **OR** all enzymes have combined with substrate molecules ✓	**2**	
			Total	**23**	

Question			Answer	Marks	Guidance
4	(a)		how to dissolve/administer/form a suspension of the oil **OR** find out dilution which is a non-irritant AW **OR** dose which is safe AW ✓	1	**DO NOT ALLOW** to find if it is more effective, cost **ALLOW** dose which does not irritate the skin
	(b)		draw **pencil-line** near bottom of plate and place 1 **drop** (or similar word) **of mixture** (and a drop of each of the 3 compounds) on the line ✓ place plate in solvent, **line above solvent** level **AND** add **lid/cover** ✓ when solvent nears **top of plate**, **remove/dry** plate ✓ locate spots with **UV light/iodine** ✓ **compare** heights/position of spots from mixture with the 3 standard compounds **OR** **calculate R_f** values of spots and compare with those of the standards (may be named) ✓	5	**please annotate marks given with ticks** **ALL** marking points may be gained from labelled diagram(s) **DO NOT ALLOW** paper for plate **BUT** ecf for further use **DO NOT ALLOW** 'locating agent' alone
	(c)		alkene / C = C ether phenol/hydroxy(l) **ALL** correct 2 marks ✓✓ **ANY 2** correct 1 mark ✓	2	**DO NOT ALLOW** double bond, formulae **DO NOT ALLOW** alcohol

Question			Answer	Marks	Guidance
	(d)		Eugenol/phenol reacts with NaOH to form salt/soluble product ✓ alcohols do not react with NaOH **OR** no phenol group in linalool so no reaction ✓	**2**	**ALLOW** for 1st mark formula of ions forming salt eg -0^{-} Na^{+} **DO NOT ALLOW** 'linalool does not react' without reference to a phenol or alcohol functional group
	(e)		(peak at) 3200–3640 (cm^{-1}) indicates –OH (in alcohol) ✓ no (strong) peak at (about) 1720–1740 (cm^{-1}) so no C=O group (in aldehyde) ✓  ✓	**3**	may be shown on the diagram of the spectrum **ALLOW** any value or range of values for peak within the range may show $-CH_2-$ groups
	(f)		acidified dichromate ✓ heat / reflux ✓	**2**	**ALLOW** any concentration of acid **ALLOW** formulae, sulfuric acid for acid, potassium or sodium salt

Question			Answer	Marks	Guidance
	(g)		1. concentration of standard Na_2CO_3 solution = **0.6625**/**106.0** ✓ = 0.00625 mol dm^{-3} 2. moles of carbonate (CO_3^{2-}) used = **10.80/1000** x answer from **1** ✓ = 0.0000675 3. moles (of $H^+(aq)$) in 50 cm^3 cinnamic acid = **2** x answer from **2** ✓ = 0.000135 4. moles (of $H^+(aq)$) in 1000 cm^3 cinnamic acid = **1000**/**50** x answer from **3** ✓ = 0.0027 5. solubility of cinnamic acid = 148.2 x (answer from **4**) = **0.400** ✓	**5**	0.4 with no / incomplete working scores 5 marks. **The marks are awarded for the working out given in bold** **ALLOW** ecf between each step **If final answer is incorrect please annotate marks given with ticks** **ALLOW** any sig figs
			Total	**20**	

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