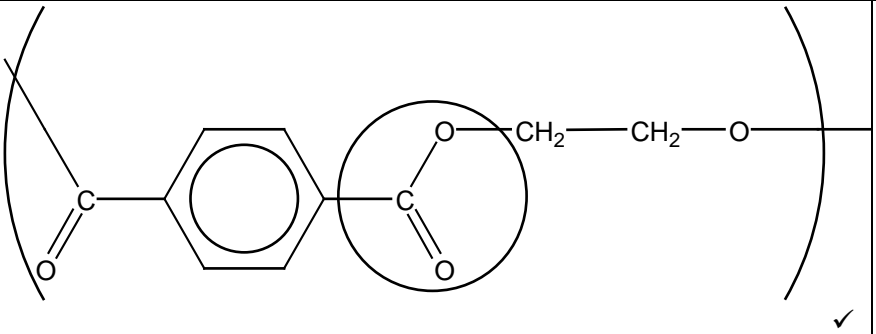
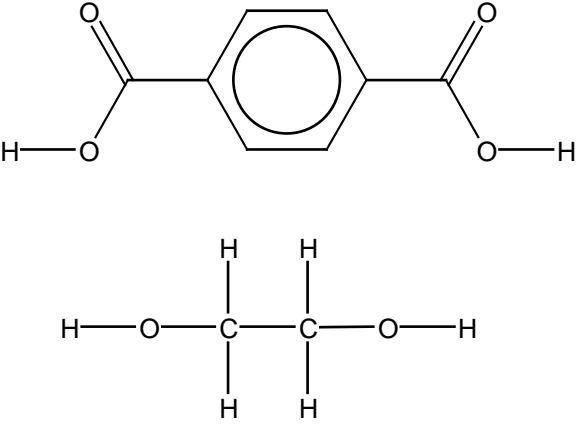
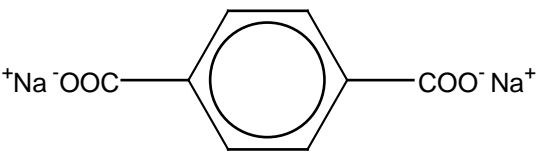
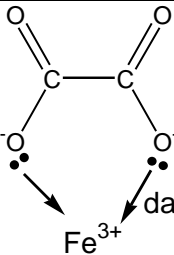


Question			Answer	Marks	Guidance
1	(a)	(i)		1	ALLOW 'circle' to include the two adjacent C atoms
		(ii)	<p>permanent (dipole) – permanent dipole (bond/forces) ✓</p> <p>instantaneous (dipole) – induced dipole (bond/forces) ✓</p>	2	<p>NOT just 'permanent dipole bond/forces'</p> <p>DO NOT ALLOW pd etc</p> <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 -COC/ for -COOH</p> <p>ALLOW -OH, HOCH₂CH₂OH</p>

Question			Answer	Marks	Guidance
1	(a)	(iv)	condensation / esterification AND water / H ₂ O ✓	1	If –COC/ in (a) (iii) MUST have HC/ 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'

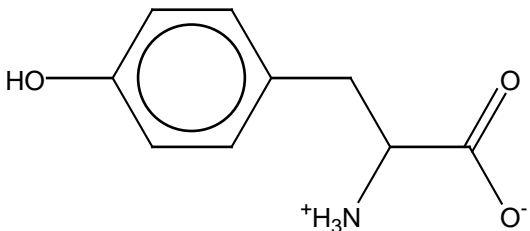
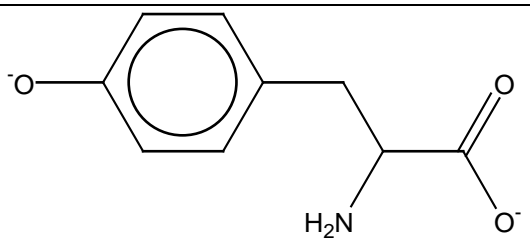
Question			Answer	Marks	Guidance
1	(c)	(ii)	<p>structure of A</p>  <p>✓</p> <p>No OH bond since no <u>broad</u> absorption peak above about (2500-3200) / 3000 (cm⁻¹) ✓</p> <p>C=O absorption peak at about 1720-1740 (cm⁻¹) (so must be carboxylate AW) ✓</p> <p>structure of B</p> <p>HOCH₂CH₂OH ✓</p> <p>OH 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)	<p>chains are further apart / less close together in PBT ✓</p> <p>so has <u>weaker</u> intermolecular bonding/forces than PET ✓</p> <p>so chains in PBT can move over one another more easily ✓</p>	3	<p>ORA</p> <p>IGNORE references to ordered chains etc.</p> <p>IGNORE fewer/less imb/fs</p>
		(ii)	<p>butane-1,4-diol</p> <p>butane / butan / but AND diol = ✓</p> <p>1,4- = ✓</p>	2	<p>IGNORE commas & dashes</p> <p>'1,4-' must be between 'butane' & 'diol'</p>
			Total	28	

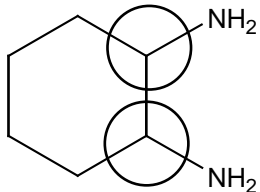
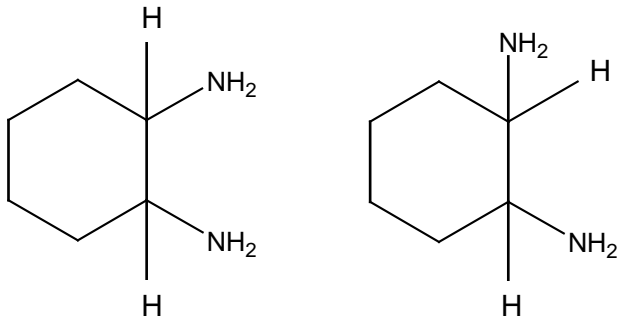
Question			Answer	Marks	Guidance
2	(a)	(i)	 <p>dative covalent / coordinate bond</p> <p>lone pairs as shown ie must link to bond (any type of drawn line) ✓</p> <p>two bonds shown as arrows from O⁻ pointing to a single Fe³⁺ ✓</p> <p>dative (covalent)/coordinate bond labelled (anywhere on diagram) ✓</p>	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° 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° 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	(b)	(iii)	<div><div><div>3d</div><div>4s</div></div><div><div><div>Fe²⁺</div><div><div><div>↑↓</div><div>↑</div><div>↑</div><div>↑</div><div>↑</div></div><div><div></div><div></div></div></div><div><div>Fe³⁺</div><div><div>↑</div><div>↑</div><div>↑</div><div>↑</div><div>↑</div></div><div><div></div><div></div></div></div></div><div>any 6 electrons for Fe²⁺ and 5 for Fe³⁺ = 1st mark ✓ correct arrangements for both = 2nd mark ✓</div></div></div>	2	
		(iv)	half-filled <u>d</u> shell (is more stable) AW ✓	1	AW eg only 1 electron in each of the d orbitals
	(c)	(i)	<div><div>1. manganate(VII) solution in <u>burette</u> ✓</div><div>2. <u>pipette</u> known/stated volume of ethanedioate solution OR graduated/volumetric <u>pipette</u> for ethanedioate solution ✓</div><div>3. add acid ✓</div><div>4. warm / heat solution / 60°C ✓</div><div>5. titrate (AW) until <u>pink</u> colour persists/remains AW ✓</div><div>6. <i>no indicator needed because</i> only MnO₄⁻(aq) is coloured OR a colour change takes place during the reaction AW ✓</div><div>QWC to gain the 1st mark the spelling of burette has to be correct at least once in the answer</div></div>	6	<div><div>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’</div><div>ALLOW acid / ‘acidified’ in either solution NOT purple alone here MUST HAVE pink</div><div>ALLOW purple–colourless NOT colourless–purple INCORRECT colour change is a CON eg orange–green, purple–pink etc.</div></div>

Question			Answer	Marks	Guidance
2	(c)	(ii)	<p>1. moles of KMnO_4 used in titration $= \mathbf{18.40/1000} \times \mathbf{0.0500} \checkmark = 0.0009200$</p> <p>2. moles potassium ethanedioate used in titration $= \mathbf{5/2} \times \text{answer from 1} \checkmark = 0.002300$</p> <p>3. moles potassium ethanedioate in 100 cm^3 $= \mathbf{4} \times \text{answer from 2} \checkmark = 0.009200$</p> <p>4. M_r of $\text{K}_2\text{C}_2\text{O}_4 \cdot \text{H}_2\text{O} = \mathbf{184} / \mathbf{184.2} \checkmark$</p> <p>5. mass potassium ethanedioate in $100 \text{ cm}^3 =$ $\mathbf{184.2} \times (\text{answer from 3}) \checkmark = 1.6946$</p> <p>6. Answer = $\mathbf{1.695}$ or $\mathbf{1.69 \text{ g}}$ \checkmark 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 $\times M_r$) 3.39 (/2 missing) 5010 (in step 1: $\times(1000/18.40)$ rather than /)</p> <p>the following is probably 4 marks 0.42 (missing $\times 4$ 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 ✓ 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)	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)		<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	