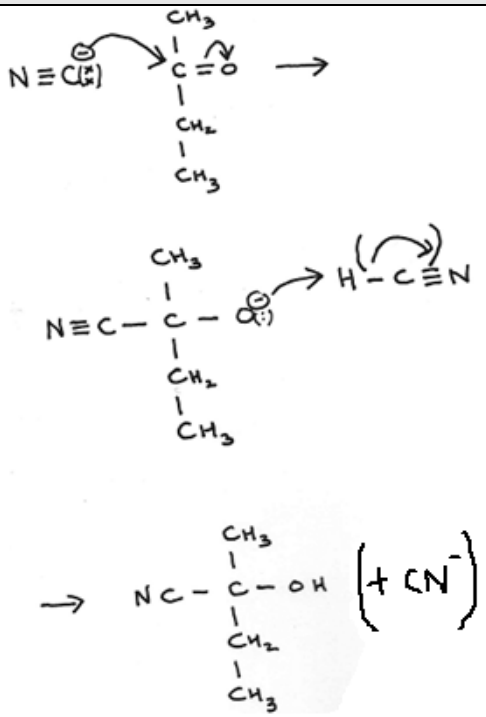
Question Number	Correct Answer	Reject	Mark
1(a)(i)	Sodium/potassium dichromate ((VI)) **and** (Dilute/concentrated) sulfuric acid OR correct formulae / H^+ **and** $Cr_2O_7^{2-}$ ALLOW H^+ **and** $Cr_2O_7^{2-}$/acidified dichromate((VI)) **(1)** Reflux/distil Ignore 'heat', 'warm', and 'boil' alone. ALLOW Just 'under reflux' Just 'under distillation' **(1)** Second mark depends on mention of dichromate/$Cr_2O_7^{2-}$ in first part OR $KMnO_4$ and acid with heat **(1)**	Hydrochloric acid	**2**

Question Number	Correct Answer	Reject	Mark
1 (a)(ii)	Carbonyl group – addition of 2,4-dinitrophenylhydrazine / 2,4-DNP(H) / Brady's reagent **(1)** to give yellow/orange/red precipitate/ppt/ppte/solid/crystals ALLOW recognisable spelling e.g., percepitate **(1)** $CH_3C{=}O$ reaction with iodine in alkali/NaOH/KOH/OH^- ALLOW Iodoform/tri-iodomethane/haloform AND reaction/test **(1)** to form (pale) yellow / cloudy precipitate/solid/crystals **(1)** Ignore references to smell Ignore heat in either part **Note** • In both cases result mark depends on test being recognisably correct even if it did not score a mark Examples: DNP gives yellow ppt Iodine test gives yellow ppt • Tests for aldehydes with correct results, no marks	2-DNP/4DNP Just DNP Brick red ppt	**4**

Question Number	Correct Answer	Reject	Mark
1 (b)(i)	 Arrow (from carbon) of CN^- to carbon of C=O AND Arrow from part of C=O double bond to oxygen ALLOW Two steps via a charged canonical form **(1)** Intermediate anion with C-CN bond. **(1)** Arrow from resulting O^- to hydrogen of $HCN/H^+/H_2O$ **(1)** **Note** Arrow directions must be correct to score each mark Penalise half-headed arrows each time in both parts ALLOW skeletal formulae.	CN without negative charge ...C-NC bond	**3**

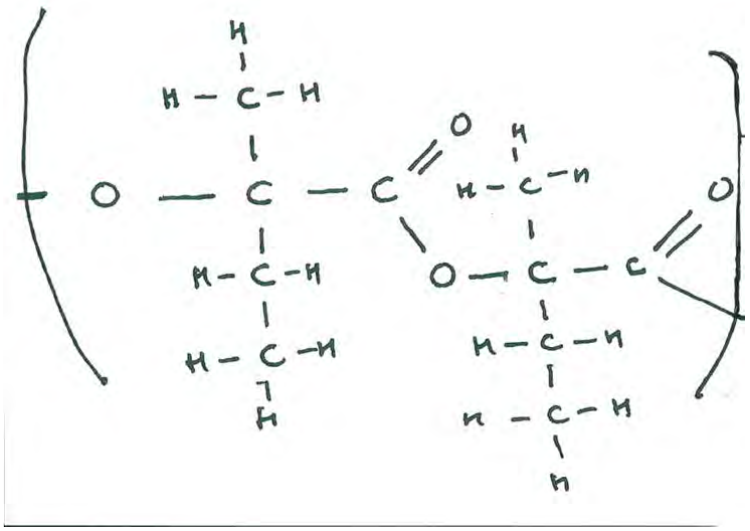
Question Number	Correct Answer	Reject	Mark
1 **(b)(ii)**	Forms a racemic mixture **(1)** Because bonds around C=O are planar OR Carbonyl group/reaction site is (trigonal) planar OR Bonds around carbonyl carbon are planar **(1)** Cyanide can attack from either side / above or below **(1)**	Butanone/molecule/it is planar C=O is planar Carbonyl bond is planar Intermediate is planar	**3**

Question Number	Correct Answer	Reject	Mark
1 (c)(i)	(Acid) hydrolysis OR Alkaline hydrolysis followed by acidification	Hydration	**1**

Question Number	Correct Answer	Reject	Mark
10 **(c)(ii)**	The O-H absorptions for alcohol and carboxylic acid overlap. OR OH absorption for an acid is very broad OR Quote data booklet values which must show some overlap, to include 3300 to 3200. ALLOW OH absorptions similar/the same.	Just 'both have OH groups' Just 'two OH groups present'	**1**

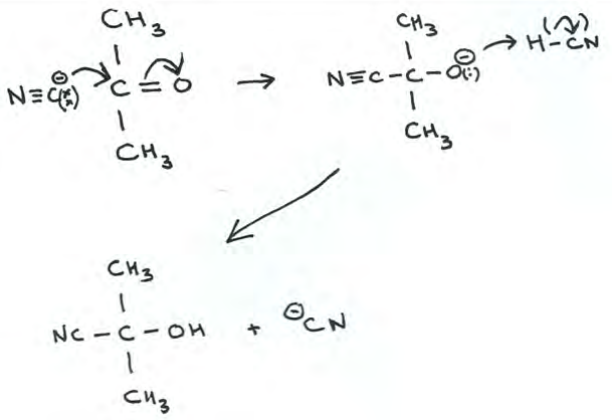
Question Number	Correct Answer	Reject	Mark
10 **(c)(iii)**	(Chemical shift δ) 2.0 - 4.0 (ppm) / any value within this range ALLOW Correct number followed by δ, eg 3δ		**1**

Question Number	Correct Answer	Reject	Mark
10 **(c)(iv)**	There is no hydrogen atom/proton on the adjacent/neighbouring carbon atom ALLOW No adjacent/neighbouring hydrogens/protons		**1**

Question Number	Correct Answer	Reject	Mark
1 (d)	 Ester linkage **(1)** Rest of molecule **(1)** ALLOW Attached chains as structural formulae Ignore n or other numbers outside bracket		**2**

Question Number	Correct Answer	Reject	Mark
2 (a)(i)	Sodium/potassium dichromate ((VI)) **and** (Dilute/concentrated) sulfuric acid OR correct formulae / H^+ **and** $Cr_2O_7^{2-}$ ALLOW H^+ **and** $Cr_2O_7^{2-}$/acidified dichromate((VI)) **(1)** Reflux/distil Ignore 'heat', 'warm', and 'boil' alone. ALLOW Just 'under reflux' Just 'under distillation' **(1)** Second mark depends on mention of dichromate/$Cr_2O_7^{2-}$ in first part OR $KMnO_4$ and acid with heat **(1)**	Hydrochloric acid	2

Question Number	Correct Answer	Reject	Mark
2 (a)(ii)	Carbonyl group – addition of 2,4-dinitrophenylhydrazine / 2,4-DNP(H) / Brady's reagent **(1)** to give yellow/orange/red precipitate/ppt/ppte/solid/crystals ALLOW recognisable spelling e.g., percepitate **(1)** $CH_3C{=}O$ reaction with iodine in alkali/NaOH/KOH/OH^- ALLOW Iodoform/tri-iodomethane/haloform AND reaction/test **(1)** to form (pale) yellow / cloudy precipitate/solid/crystals **(1)** Ignore references to smell Ignore heat in either part **Note** • In both cases result mark depends on test being recognisably correct even if it did not score a mark Examples: DNP gives yellow ppt Iodine test gives yellow ppt Tests for aldehydes with correct results, no marks	2-DNP/4DNP Just DNP Brick red ppt	4

Question Number	Correct Answer	Reject	Mark
2 (b)(i)			3
	Arrow (from carbon) of CN^- to carbon of C=O	CN without negative charge	
	AND		
	Arrow from part of C=O double bond to oxygen		
	ALLOW		
	Two steps via a charged canonical form **(1)**		
	Intermediate anion with C-CN bond. **(1)**		
	Arrow from resulting O^- to hydrogen of $HCN/H^+/H_2O$ **(1)**		
	Note	...C-NC bond	
	Arrow directions must be correct to score each mark		
	Penalise half-headed arrows each time in both parts		
	ALLOW skeletal formulae.		

Question Number	Correct Answer	Reject	Mark
2 (c)(i)	(Acid) hydrolysis OR Alkaline hydrolysis followed by acidification	Hydration	1

Question Number	Correct Answer	Reject	Mark
2 (b)(ii)	At low pH very few CN^- ions ALLOW No CN^- ions OR No KCN/ only HCN present **(1)** At high pH very few H^+ / HCN ALLOW No H^+ / HCN OR Hydroxide reacts with H^+ / HCN/ acid **(1)**		1

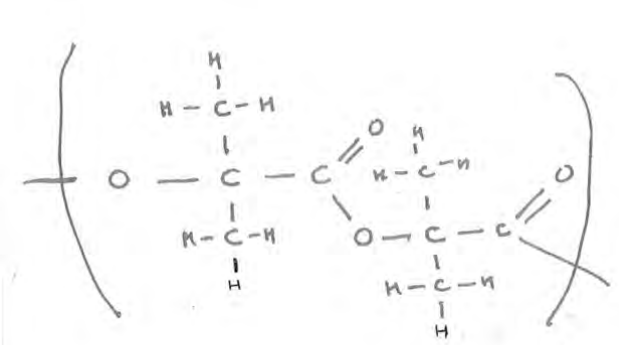
Question Number	Correct Answer	Reject	Mark
2 (c)(ii)	The O-H absorptions for alcohol and carboxylic acid overlap. OR OH absorption for an acid is very broad OR Quote data booklet values which must show some overlap, to include 3300 to 3200. ALLOW OH absorptions similar/the same.	Just 'both have OH groups' Just 'two OH groups present'	1

Question Number	Correct Answer	Reject	Mark
2 (c)(iii)	(Chemical shift) 2.0 - 4.0 (ppm) / any value within this range e.g 3.1/ 3.12/3 ALLOW Correct number followed by , eg 3δ		1

Question Number	Correct Answer	Reject	Mark
2(c)(iv)	3 (peaks) / three		1

Question Number	Correct Answer	Reject	Mark
2 (c)(v)	There is no hydrogen atom/proton on the adjacent/neighbouring carbon atom ALLOW No adjacent/neighbouring hydrogens/protons		1

Question Number	Correct Answer	Reject	Mark
2 **(c)(vi)**	(No) 2-hydroxy-2-methylpropanoic acid does not have a chiral centre OR It is not chiral OR It does not have a mirror image which is non-superimposable OR Does not have a carbon atom attached to four different groups	Yes...	1

Question Number	Correct Answer	Reject	Mark
2 (d)(i)	 Ester linkage **(1)** Rest of molecule **(1)** ALLOW Attached chains as structural formulae Ignore n or other numbers outside bracket **COMMENT** Check formulae carefully – different carbon frameworks appear.		1

Question Number	Correct Answer	Reject	Mark
2(d)(ii)	Ester		1

Question Number	Acceptable Answers	Reject	Mark
3(a)	Orange/yellow **and** precipitate/ppt or solid or crystals ALLOW orange-red or red-orange for colour	Any other colour alone or in combination, e.g.red	**1**

Question Number	Acceptable Answers	Reject	Mark
3(b)	(Heat with) Benedict's/Fehling's (solution) **(1)** Ketone/X would remain blue/no change/no reaction **(1)** Aldehyde/Y would form red/brown **and** ppt/Cu_2O **(1)** ALLOW combinations of red or brown with orange OR (Heat with) Tollens' Reagent/ammoniacal silver nitrate **(1)** Ketone/X remains colourless/no change/no reaction **(1)** Aldehyde/Y forms a silver mirror or black/grey precipitate/Ag/silver **(1)** OR (Heat with) acidified dichromate((VI)) (ions) **(1)** Ketone/X remains orange/no change/no reaction **(1)** Aldehyde/Y goes green/blue **(1)** ALLOW *answer with acidified or alkaline* $KMnO_4$ Ketone/X remains purple/pink/no change/no reaction **(1)** Aldehyde/Y goes colourless (with acid)/goes green (with alkali) **(1)** Near miss on reagent (e.g. silver nitrate not ammoniacal silver nitrate) observations can score 2 ALLOW iodoform test with ketone identified (since X can only be butanone) (Aqueous) sodium hydroxide and iodine **(1)** Ketone/X forms yellow precipitate/solid/crystals **(1)** Aldehyde/Y no change/no reaction **(1)**	Just orange Ppt Just clear	**3**

Question Number	Acceptable Answers	Reject	Mark
3(c)(i)	**Both** $CH_3CH_2CH_2CHO$ And $(CH_3)_2CHCHO$ ACCEPT displayed or skeletal formulae if structural formulae not given	COH unless shown correctly in a displayed or skeletal formula	**1**

Question Number	Acceptable Answers	Reject	Mark
3(c)(ii)	Recrystallization IGNORE solvent	Just crystallization	**1**

Question Number	Acceptable Answers	Reject	Mark
3(c)(iii)	Measure melting temperature / point **(1)** Compare with literature/database / known value **(1)** Second mark can only be awarded if first mark scored	Just boiling temperature	**2**