

Question Number	Acceptable Answers	Reject	Mark
1 (a)	Alcohol; (2)-methylpropan-2-ol (1) Catalyst: sulfuric acid OR any named strong acid Ignore concentration of acid (1) Accept formula for acid	Formula of alcohol Just acid/H ⁺ for catalyst	2

Question Number	Acceptable Answers	Reject	Mark
1 (b) (i)	Tap funnel / separating funnel	Buchner funnel Filter funnel	1

Question Number	Acceptable Answers	Reject	Mark
1 (b) (ii)	To neutralize / remove/ react with (excess) acid Allow To neutralize / remove / react with (excess) H ⁺ To remove acidic impurities To remove ethanoic acid To remove the acid (used as a) catalyst Ignore additional comments on quenching or reaction stopping	To purify it To remove excess acid and alcohol Just "to quench acid catalyst/stop reaction"	1

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1 (b) (iii)	Add (anhydrous) calcium chloride/ sodium sulfate/ magnesium sulfate/ Allow silica gel Allow formulae of drying agents	Conc. sulfuric acid Anhydrous copper sulphate Just "silica"	1

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1 (b)(iv)	<p>Round bottomed or pear-shaped flask + still head with stopper or thermometer + heat source (1)</p> <p>This mark cannot be given if apparatus is completely sealed /large gaps between components</p> <p>Downwards sloping condenser (with correct water flow) + collection vessel (1)</p> <p>Thermometer in correct position with bulb opposite condenser opening (1)</p> <p>Ignore fractionating column if included between flask and condenser</p>	<p>Conical flask</p> <p>Flat bottomed flask</p>	3

Question Number	Acceptable Answers	Reject	Mark
*1 (c)	<p>First mark (Two signals so) two hydrogen environments (1) This mark may be gained by a description of the only two environments, but reference to hydrogen must be made.</p> <p>Second mark (Numbers of hydrogen in each environment are/ are predicted to be) in ratio 3:9 or 1:3</p> <p>OR</p> <p>Peak due to $(\text{CH}_3)_3$ is 3x higher than peak due to CH_3 (1)</p> <p>Third mark Environments are CH_3COO and $(\text{CH}_3)_3$ (H may have been specified in first marking point) These may be shown on a diagram of the formula of the molecule</p> <p>OR</p> <p>H-C-C=O (peak at 2.1) and H-C-C (peak at 1.3) (1)</p> <p>Fourth mark Singlets/ no splitting as no H on adjacent C</p> <p>OR</p> <p>Singlets as the hydrogen environments are not adjacent to other H environments Allow "only one peak" for no splitting (1)</p>	Just "the peaks are due to $(\text{CH}_3)_3$ and CH_3	4

Question Number	Acceptable Answers	Reject	Mark
1 (d) (i)	$\text{CH}_3\text{COOCH}_2\text{CH}(\text{CH}_3)_2$ Or correctly displayed Allow $\text{CH}_3\text{COOCH}_2\text{CH}(\text{CH}_3) \text{CH}_3$		1

Question Number	Acceptable Answers	Reject	Mark
1 (e)(ii)	No because the isomers (which are carboxylic acids) contain same bonds / groups (C=O, C-O, C-H etc) (1) OR Yes because could be distinguished by infrared fingerprint (1)	 Yes because spectrum is unique	1

Question Number	Acceptable Answers	Reject	Mark
2 (a)(i)	(Acid) hydrolysis	substitution	1

Question Number	Acceptable Answers	Reject	Mark
2 (a)(ii)	$K_2Cr_2O_7$ / $Na_2Cr_2O_7$ / $Cr_2O_7^{2-}$ Potassium dichromate(VI) / sodium dichromate(VI) / dichromate(VI) ions <i>ALLOW</i> manganate(VII) ions, etc	Just "dichromate" chromates Correct formula with wrong name and vice versa Incorrect oxidation number	1

Question Number	Acceptable Answers	Reject	Mark
2 (a)(iii)	Lithium tetrahydridoaluminate/ lithium aluminium hydride/ $LiAlH_4$ (in dry ether)	Just $[H^-]$	1

Question Number	Acceptable Answers	Reject	Mark
2 (a)(iv)	Methyl butanoate (1) $CH_3CH_2CH_2COOH + CH_3OH \rightarrow CH_3CH_2CH_2COOCH_3 + H_2O$ (1) <i>ALLOW</i> \rightleftharpoons <i>IGNORE</i> state symbols even if wrong	Methyl butoate	2

Question Number	Acceptable Answers	Reject	Mark
2 (a)(v)	$\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-C}\begin{matrix} \text{=O} \\ \text{Cl} \end{matrix}$ <p>Don't penalise undisplayed methyl groups as here. COCl must be displayed as above.</p>	C ₃ H ₇ for CH ₃ CH ₂ CH ₂	1

Question Number	Acceptable Answers	Reject	Mark
2 (b)(i)	<p>Nitrogen inert / unreactive / less reactive (than oxygen)</p> <p>OR</p> <p>Oxygen might react with chemicals going through column / sample might oxidise</p>		1

Question Number	Acceptable Answers	Reject	Mark
2 (b)(ii)	<p>Solubility (in liquid / stationary phase)</p> <p>OR</p> <p>Interaction with liquid / stationary phase</p> <p>OR</p> <p>Interaction between mobile and stationary phase</p> <p>OR</p> <p>Attraction for liquid / stationary phase</p> <p>OR</p> <p>Strength of (named) intermolecular forces</p> <p>OR</p> <p>Adsorption on liquid / stationary phase</p> <p>OR</p> <p>Absorption on liquid / stationary phase</p>	<p>Size of molecule / molar mass</p> <p>Polarity, unless with explanation</p> <p>Boiling point / volatility</p> <p>Viscosity</p> <p>Attraction for carrier gas</p> <p>Just a named intermolecular force</p> <p>Just 'retention time'</p> <p>Density</p>	1

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2 (c)(i)	$\left(\begin{array}{c} \text{H} & & \text{O} & & \text{H} & & \text{O} \\ & & & & & & \\ \text{O}-\text{C}-\text{CH}_2-\text{C}-\text{O}-\text{C}-\text{CH}_2-\text{C} \\ & & & & & & \\ \text{CH}_3 & & & & \text{CH}_3 & & \end{array} \right)$ <p>OR</p> $\left(\begin{array}{c} \text{H} & & \text{O} & & \text{H} & & \text{O} \\ & & & & & & \\ \text{C}-\text{CH}_2-\text{C}-\text{O}-\text{C}-\text{CH}_2-\text{C}-\text{O} \\ & & & & & & \\ \text{CH}_3 & & & & \text{CH}_3 & & \end{array} \right)$ <p>Ester link including C=O (1) Rest of polymer with oxygens at end correct (1)</p> <p>All H atoms must be shown.</p> <p><i>PENALISE</i> lack of displayed C=O once only <i>ACCEPT</i> Without brackets around formula but bonds at end should be shown More than two correct units <i>IGNORE</i> n after brackets</p>		2

Question Number	Acceptable Answers	Reject	Mark
2 (c)(ii)	<p>Hydrolysis</p> <p>OR</p> <p>Splits / breaks ester link</p> <p>OR</p> <p>polymer breaks down to monomers</p> <p>OR</p> <p>equation showing hydrolysis</p>	Just 'breaks polymer down'	1

Question Number	Acceptable Answers	Reject	Mark
3(a)(i)	Sodium/potassium dichromate((VI))/potassium manganate ((VII))/Na ₂ Cr ₂ O ₇ /K ₂ Cr ₂ O ₇ /KMnO ₄ IGNORE references to acid	Just Cr ₂ O ₇ ²⁻ / MnO ₄ ⁻	1

Question Number	Acceptable Answers	Reject	Mark
3(a)(ii)	(Heat under) reflux (1) Use excess/sufficient oxidizing agent/reagent named in (a)(i), even if incorrect (1) IGNORE references to (excess) acid Stand alone marks		2

Question Number	Acceptable Answers	Reject	Mark
3(a)(iii)	<p>$\text{CH}_3\text{CH}_2\text{CN}/\text{C}_2\text{H}_5\text{CN}$ (1)</p> <p>ACCEPT displayed or skeletal formulae</p> <p>$\text{CH}_3\text{CH}_2\text{CN} + \text{H}^+ + 2\text{H}_2\text{O} \rightarrow \text{CH}_3\text{CH}_2\text{COOH} + \text{NH}_4^+$</p> <p>OR</p> <p>$\text{CH}_3\text{CH}_2\text{CN} + \text{HCl} + 2\text{H}_2\text{O} \rightarrow \text{CH}_3\text{CH}_2\text{COOH} + \text{NH}_4\text{Cl}$ (2)</p> <p>If equation is incorrect then presence of H^+ or acid in equation/or above arrow and water on LHS scores (1) Mark cq on formula of nitrile</p> <p>ALLOW one mark for the following equation without H^+. $\text{CH}_3\text{CH}_2\text{CN} + 2\text{H}_2\text{O} \rightarrow \text{CH}_3\text{CH}_2\text{COOH} + \text{NH}_3$</p> <p>ALLOW two marks for either of the following with H^+ above the arrow $\text{CH}_3\text{CH}_2\text{CN} + 2\text{H}_2\text{O} \rightarrow \text{CH}_3\text{CH}_2\text{COOH} + \text{NH}_3$ $\text{CH}_3\text{CH}_2\text{CN} + 2\text{H}_2\text{O} \rightarrow \text{CH}_3\text{CH}_2\text{COOH} + \text{NH}_4^+$</p> <p>ALLOW answers for alkaline hydrolysis followed by acidification $\text{CH}_3\text{CH}_2\text{CN} + \text{OH}^- + \text{H}_2\text{O} \rightarrow \text{CH}_3\text{CH}_2\text{COO}^- + \text{NH}_3$ (1)</p> <p>Then $\text{CH}_3\text{CH}_2\text{COO}^- + \text{H}^+ \rightarrow \text{CH}_3\text{CH}_2\text{COOH}$ (1)</p> <p>If propanamide, $\text{CH}_3\text{CH}_2\text{CONH}_2$ is given initially then ALLOW the two equation marks for the hydrolysis $\text{CH}_3\text{CH}_2\text{CONH}_2 + \text{H}^+ + \text{H}_2\text{O} \rightarrow \text{CH}_3\text{CH}_2\text{COOH} + \text{NH}_4^+$</p> <p>If no acid is used then only one mark $\text{CH}_3\text{CH}_2\text{CONH}_2 + \text{H}_2\text{O} \rightarrow \text{CH}_3\text{CH}_2\text{COOH} + \text{NH}_3$</p>	Hydroxynitriles	3

Question Number	Acceptable Answers	Reject	Mark
3(b)	<p>Reagent - Propanoyl chloride/$\text{CH}_3\text{CH}_2\text{COCl}$ (1)</p> <p>Any two from:</p> <p>C-Cl bond is weaker (than C- O) (1)</p> <p>Cl^-/chloride (ion) is a better leaving group (1)</p> <p>Carbonyl carbon is more positive/more δ^+/more attractive to nucleophiles (1)</p> <p>OR</p> <p>Reagent - Propanoic anhydride/$(\text{CH}_3\text{CH}_2\text{CO})_2\text{O}$ (1)</p> <p>CH_3COO^-/propanoate (ion) is a better leaving group (1)</p> <p>Carbonyl carbon is more positive/more δ^+/more attractive to nucleophiles (1)</p> <p>IGNORE references to eversible/equilibrium/ catalysts IGNORE bond polarity</p>	<p>Propyl chloride</p> <p>Just Cl is more electronegative</p>	3

Question Number	Acceptable Answers	Reject	Mark
3(c)(i)	Radio waves/radio frequency	Just radio	1

Question Number	Acceptable Answers	Reject	Mark
3(c)(ii)	<p>Any two from:</p> <p>Protons/nuclei/they have a property called spin/ have a magnetic moment/ have a magnetic field/ are aligned with the external magnetic field (1)</p> <p>which flips/changes (1)</p> <p>align against the external magnetic field (when radiation is absorbed) (1)</p>	<p>starts to spin</p> <p>just dipole moment</p> <p>polarity flips</p> <p>any reference to electrons or molecules scores zero</p>	2

Question Number	Acceptable Answers	Reject	Mark
3(c)(iii)	<p>Quartet (1)</p> <p>ALLOW quadruplet/indication of four (peaks)</p> <p>Value from 0.1 to 1.9 (ppm) inclusive (1)</p> <p>ACCEPT any range within the above range</p>		2