Question Number	Acceptable Answers	Additional Guidance	Mark
3(a)	• calculation of mass of ethanol **and** calculation of mass of butanoic acid (1) • calculation of moles of ethanol **and** calculation of moles of butanoic acid **and** statement that moles of butanoic acid > moles of ethanol / butanoic acid is in excess (because the ratio is 1:1) (1)	<u>Example of calculation</u> $5 \times 0.79 = 3.95$ (g) $10 \times 0.96 = 9.6$ (g) $3.95 \div 46 = 0.085870$ (mol) $9.6 \div 88 = 0.1091$ (mol) $0.1091 > 0.085870$ (mol) Allow statement that moles of ethanol < moles of butanoic acid Allow TE from M1 to M2 Ignore SF Allow (2) for n(ethanol) = 0.085870 and n(butanoic acid) = 0.1091 so butanoic acid in excess because the masses must have been determined Calculation dividing molar mass by density scores (0)	**2**

Question Number	Acceptable Answers	Additional Guidance	Mark
3(b)	An explanation that makes reference to the following points: • CO_2 is produced which increases **pressure** / to prevent build up of **pressure** from the CO_2 produced (inside funnel if tap not opened / stopper not removed) (1) • $H_2SO_4 + 2NaHCO_3 \rightarrow Na_2SO_4 + 2H_2O + 2CO_2$ / $C_3H_7COOH + NaHCO_3 \rightarrow C_3H_7COO^{(-)}Na^{(+)} + H_2O + CO_2$ / $H^+ + HCO_3^- \rightarrow CO_2 + H_2O$ $H^+ + NaHCO_3 \rightarrow Na^+ + CO_2 + H_2O$ (1)	Allow just '**pressure** increases/to relieve **pressure'** provided CO_2 given as a product in an equation even if the equation is incorrect Allow 'gas is produced which increases **pressure**' Do not allow if incorrect gas stated Do not award reference to explosion Ignore state symbols even if incorrect Accept other formulae except molecular Allow $H_2SO_4 + NaHCO_3 \rightarrow NaHSO_4 + H_2O + CO_2$ Use of RCOOH in equation	**2**

Question Number	Acceptable Answers	Additional Guidance	Mark
3(c)	An explanation that makes reference to the following points: Any two from three **Either** • aqueous layer will not flow (from the funnel when tap is open) (1) • as stopper prevents air from entering top of funnel (to keep pressure constant) (1) • due to creation of lower pressure / vacuum (inside) (1) **Or** • some of the (aqueous) liquid flows out (of the funnel) (1) • bubbles of air (enter through tap) / flow is stopped (1) • (which) mixes/disturbs the two layers (1)	Do not award for liquid flow due to 'normal' functioning of separating funnel	**2**

Question Number	Acceptable Answers	Additional Guidance	Mark
3(d)(i)	An answer that makes reference to the following point: • name or formula of a suitable drying agent	(anhydrous) sodium sulfate / Na_2SO_4 /calcium chloride / $CaCl_2$ (anhydrous) calcium sulfate / $CaSO_4$ / magnesium sulfate / $MgSO_4$ Allow silica gel/silica crystals Ignore any other conditions except aqueous Do not award copper sulfate / $CuSO_4$ / cobalt chloride / $CoCl_2$ /silicone gel If name and formula given then both must be correct	**1**

Question Number	Acceptable Answers	Additional Guidance	Mark
3(d)(ii)	An explanation that makes reference to the following points: • (no more drying agent is needed) when liquid is no longer cloudy / drying agent stops clumping together	Allow when liquid clears/ goes transparent/ liquid goes translucent Allow drying agent remains as a powder Allow use cobalt chloride paper which turns pink (from blue) if water is still present Allow drying agent stops sticking to the glass Ignore drying agent is no longer crystalline Do not award reference to colour change Do not award reference to water/aqueous layer The use of $CuSO_4$ has already been penalised in (i) so the mark can be awarded here if reference is made either to the presence of a blue colour due to copper(II) sulfate and requiring more drying agent or the absence of blue colour meaning that no more copper(II) sulfate is needed	**1**

Question Number	Acceptable Answers	Additional Guidance	Mark
3(d)(iii)	An answer that makes reference to the following point: • distillation	 Allow redistillation Ignore ‘fractional’ Ignore ‘simple’ Do not award ‘steam distillation’	**1**

Question Number	Acceptable Answers	Additional Guidance	Mark
3(e)(i)	An explanation that makes reference to the following points: • (peak between 2.2 and 2.4 ppm is due to) hydrogens attached to carbon attached to carbonyl carbon / **H**-C-C=O **(1)** • and is a triplet as adjacent carbon atom has 2 hydrogen atoms attached (so n+1 = 3) **(1)**	Allow protons attached to C adjacent to carbonyl C highlighted or labelled on drawing of structure Do not award if described as aldehyde or ketone or amide Allow is a triplet as group is attached to a CH_2 group Allow 3-splits/3-splitting peak / 3 peaks for triplet Allow use of hydrogens and of protons interchangeably but penalise once only the use of the symbol H^+ Penalise once only in either M1 or M2 if reference is made to mass spectrum fragments e.g. $CH_3CH_2CH_2CO^+$	**2**

Question Number	Acceptable Answers		Additional Guidance	Mark
3(e)(ii)	An answer that makes reference to the following points: the proton NMR spectrum of ethyl propanoate will			**3**
	• have 1 fewer peak (than the 5 of ethyl butanoate / have 4 peaks	**(1)**	Allow proton environment for peaks Ignore just 'it has less peaks' Do not award carbon environments	
	• there will be no sextet (at 1.7 ppm)	**(1)**	Allow hextet/6-splitting peak for sextet Allow peak due to $CH_3C\mathbf{H}_2CH_2$ not evident Ignore just no peak between 1.6 and 1.9 ppm	
	• the triplet (at 2.2 - 2.4) will become a quartet	**(1)**	Allow have (an extra) quartet instead of multiplet Allow spectrum has two not three triplets Allow spectrum has two not one quartet Allow spectrum has two triplets and two quartets Allow 3-splits/3-splitting peak(let) / 3 peaks for triplet Allow 4-splits etc for quartet Ignore reference to peak integrations/area ratios even if incorrect A list of the peaks of each compound scores (2) only unless there is a comparison such as the use of 'but'/ 'only'/ 'whereas' etc	

(Total for Question 3 = 14 marks)