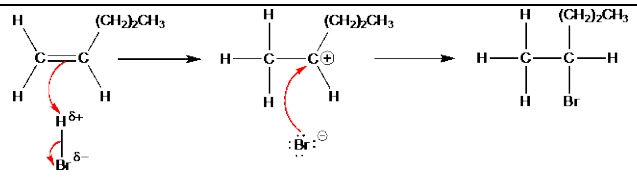
Question number	Answer	Marks	Guidance
1 (a)	The upper layer as the density of the organic products is lower than water	B1	
1 (b)	carbon dioxide	B1	
1 (c)	hydrochloric acid	B1	
1 (d) (i)	51 ºC	B1	
1 (d) (ii)	*n*(2-methylpropan-2-ol) = 3.7/74 = 0.050 mol	B1	
1 (d) (iii)	*n*(2-chloro-2-methylpropane) = 2.22/92.5 = 0.024 mol	B1	
1 (d) (iv)	% yield = 0.024/0.050 × 100 = 48%	B1	
2 (a)	concentrated sulfuric acid: corrosive butan-1-ol: flammable	B1 B1	
2 (b)	Sulfuric acid, water and unreacted butan-1ol	B1 B1 B1	
2 (c)	Carbon dioxide formed by reaction of acid with sodium hydrogencarbonate	B1 B1	
2 (d)	Add layers to a separating funnel Run off each layer through the tap	B1 B1	
2 (e)	Add an anhydrous salt (e.g. $MgSO_4$, $CaCl_2$)	B1	
3 (a)	**A**: condenser; **B**: receiver	B1 B1	
3 (b)	At position **C** so that the condenser fills with water OR promotes more efficient cooling	B1	
3 (c)	Add layers to a separating funnel Run off each layer through the tap AND collect top layer Add an anhydrous salt to dry organic layer (e.g. $MgSO_4$, $CaCl_2$) Redistill AND collect fraction distilling at 116 ºC	B1 B1 B1 B1	
4 (a)	but-1-ene	B1	

Question number	Answer	Marks	Guidance
	$CH_3CH_2CH_2CH_2OH \rightarrow CH_3CH_2CH=CH_2 + H_2O$ Concentrated acid (e.g. H_2SO_4 or H_3PO_4) + heat	 B1	
4 (b)	butanoic acid $CH_3CH_2CH_2CH_2OH + [O] \rightarrow CH_3CH_2CH_2COOH + H_2O$ H_2SO_4 and $K_2Cr_2O_7$ + reflux	B1 B1	
4 (c)	1-bromobutane $CH_3CH_2CH_2CH_2OH + HBr \rightarrow CH_3CH_2CH_2CH_2Br + H_2O$ H_2SO_4 and NaBr	B1 B1	
5	**A**: alcohol, haloalkane **B**: aldehyde, alkene and alcohol	B2 B3	
6 (a)	Steam and an acid catalyst (e.g. H_2SO_4 or H_3PO_4) $CH_3CH=CH_2 + H_2O \rightarrow CH_3CH(OH)CH_3$	B1 B1 B1	
6 (b)	Intermediate haloalkane HBr; then NaOH(aq)	B1 B1 B1	
7 (a)	1-bromobutane to butyl propanoate **Step 1**: Aqueous sodium hydroxide, NaOH(aq) $CH_3CH_2CH_2CH_2Br + NaOH \rightarrow CH_3CH_2CH_2CH_2OH + NaBr$ **Step 2**: propanoic acid and acid catalyst (e.g. H_2SO_4) $CH_3CH_2COOH + CH_3(CH_2)_3OH + [O] \rightarrow CH_3CH_2COO(CH_2)_3CH_3 + H_2O$	B1 B1 B1 B1	
7 (b)	propene to propanone **Step 1:** Steam and an acid catalyst (e.g. H_2SO_4 or H_3PO_4) $CH_3CH=CH_2 + H_2O \rightarrow CH_3CH(OH)CH_3$ **Step 2**: H_2SO_4 and $K_2Cr_2O_7$ + reflux $CH_3CH(OH)CH_3 + [O] \rightarrow CH_3COCH_3 + H_2O$	B1 B1 B1 B1	
8 (a)	**Step 1:** Concentrated acid (e.g. H_2SO_4 or H_3PO_4) +	B1	

Question number	Answer	Marks	Guidance
	heat **Step 2**: Hydrogen bromide, HBr **Step 3**: Aqueous sodium hydroxide, NaOH(aq) **Step 4**: H_2SO_4 and $K_2Cr_2O_7$ + reflux	 B1 B1 B1	
8 (b)	Elimination	B1	
8 (c)	 1 mark for curly arrow from C=C to $H^{\delta+}$ of HBr 1 mark for curly arrow from H–Br and correct dipole 1 mark for correct carbocation AND curly arrow from Br^- to C^+	B1 x 3	
8 (d)	Colour change from orange to green/blue	B1	
8 (e)	React with hydrogen and nickel catalyst	B1 B1	