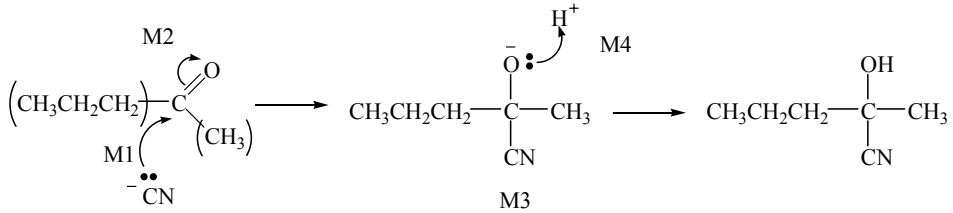
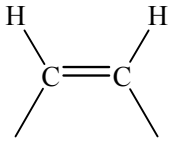
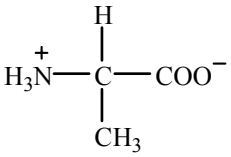
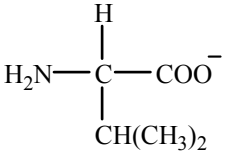
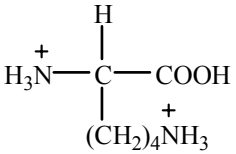
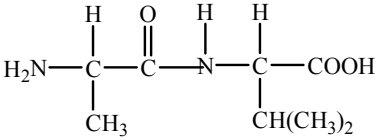
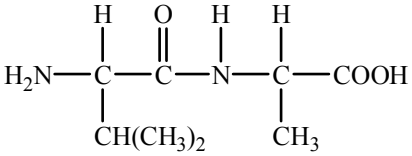
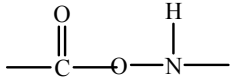
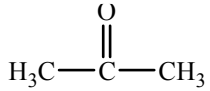
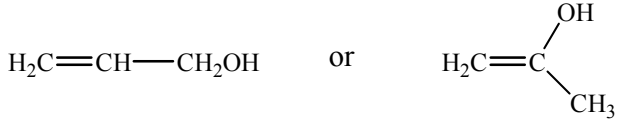
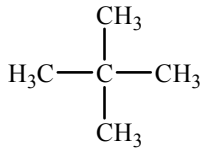
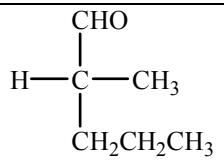
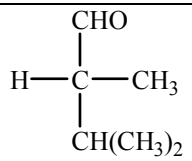
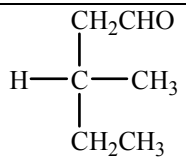
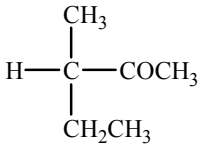
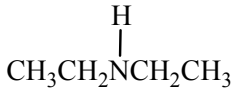
Question	Part	Sub Part		Mark	Comments
4	(a)		nucleophilic addition  M3 for completely correct structure not including lp M4 for lp and arrow 2-hydroxy-2-methylpentan(e)nitrile	1 4 1	Attack by HCN loses M1 and M2 M2 not allowed independent of M1, but allow M1 for correct attack on C+ +C=O loses M2 M2 only allowed if correct carbon attacked allow minus charge on N i.e. :CN^- allow C_3H_7 in M3 allow without – allow 2-hydroxy-2-methylpentanonitrile
4	(b)		Product from **Q** is a racemic mixture/ equal amounts of enantiomers racemic mixture is inactive or inactive explained Product from **R** is inactive (molecule) or has no chiral centre	1 1 1	if no reference to products then no marks; not **Q** is optically active or has a chiral centre etc
4	(c)	(i)	**mark the three sections of Qu 4(c) separately** **R** or $CH_3CH_2COCH_2CH_3$	1	
4	(c)	(ii)	$[CH_3CH_2COCH_2CH_3]^{+\cdot}$ ***OR*** $[C_5H_{10}O]^{+\cdot}$ $\rightarrow$ $[CH_3CH_2CO]^+ + {}^{\cdot}CH_2CH_3$ ***OR*** $\rightarrow$ $[C_3H_5O]^+ + {}^{\cdot}C_2H_5$	1 1	allow molecular formulae allow without brackets if brackets not shown, allow dot anywhere on radical or + anywhere on ion
4	(c)	(iii)	m/z = 43 or 71	1	

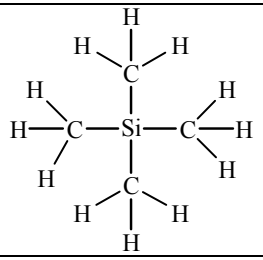
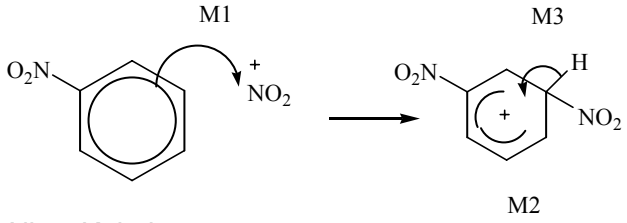
Question	Part	Sub Part		Mark	Question
5	(a)	(i)	propan(e)-1,2,3-triol or 1,2,3- propan(e)triol	1	not propyl ignore hyphen, commas
5	(a)	(ii)	soaps	1	allow anionic surfactant not cationic surfactant not detergents, not shampoos
5	(b)	(i)	(bio)<u>diesel</u>	1	Allow fuel for <u>diesel</u> engines not biofuel, not oils
5	(b)	(ii)		1	ignore anything else attached except any more H atoms.
5	(b)	(iii)	$CH_3(CH_2)_{12}COOCH_3 + 21½\ O_2 \rightarrow 15CO_2 + 15\ H_2O$ ***OR*** $C_{15}H_{30}O_2$ or 43/2	1	**not** allow equation doubled

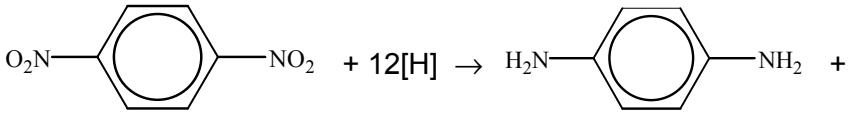
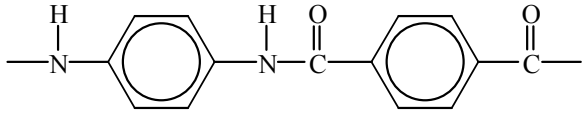
Question	Part	Sub Part		Mark	Comments
					allow $^{+}NH_3–$ don't penalize position of + on NH_3
6	(a)	(ii)		1	allow $–CO_2^-$ allow $NH_2–$ allow C_3H_7
6	(a)	(iii)		1	allow $–CO_2H$ allow $^{+}NH_3–$ don't penalize position of + on NH_3
6	(b)		 	1 1	allow $–CO_2H$ allow $NH_2–$ allow C_3H_7 allow as zwitterions if error in peptide link e.g.  if twice, penalise both times not polymers if wrong amino acid in both can score Max 1

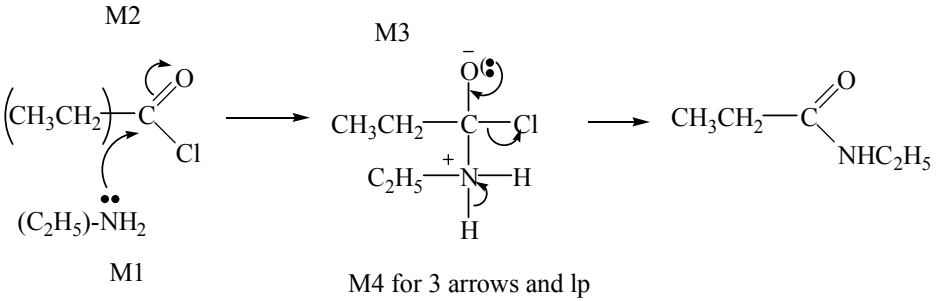
6	(c)		chromatography or electrophoresis	1	ignore qualification to chromatography

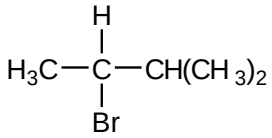
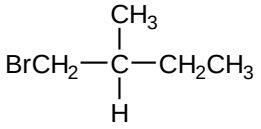
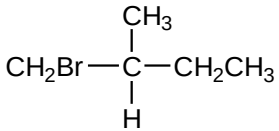
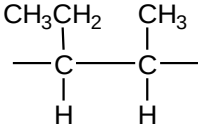
Question	Part	Sub Part		Mark	Comments
7	(a)		A 	1	allow CH_3COCH_3
			B 	1	must show C=C Penalise sticks once per pair
7	(b)		C $CH_3CH_2CH_2CH_2CH_3$	1	
			D 	1	NOT cyclopentane which is only C_5H_{10} Penalise sticks once per pair
7	(c)		E $CH_3CH_2COOCH_3$	1	Allow $C_2H_5CO_2CH_3$
			F $CH_3COOCH_2CH_3$	1	Allow $CH_3CO_2CH_2CH_3$ or $CH_3CO_2C_2H_5$ Penalise sticks once per pair
7	(d)		G  ***OR***  ***OR***  allow C_3H_7 allow C_3H_7 allow C_2H_5	1	not C_5H_{11} nor C_4H_9 Penalise sticks once per pair
			H  allow C_2H_5	1	

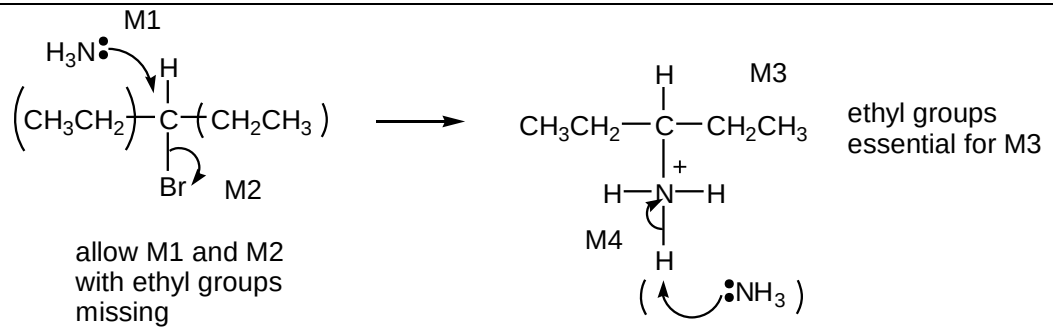
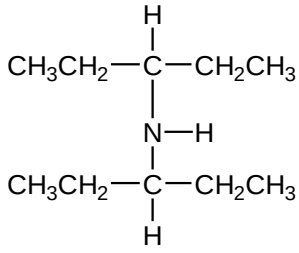
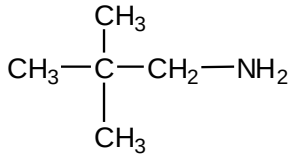
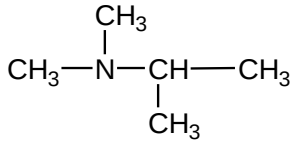
7	(e)		I 	1	allow C_2H_5
			J 	1	NOT C_3H_7 Penalise sticks once per pair

Question	Part	Sub Part		Mark	Comments
(8)	(a)	(i)	**W** 3 **X** 4 **Y** 2	1 1 1	
(8)	(a)	(ii)		1	displayed formula shows ALL bonds
(8)	(b)	(i)	NO_2^+ $HNO_3 + 2H_2SO_4 \rightarrow NO_2^+ + 2HSO_4^- + H_3O^+$ ***OR*** $HNO_3 + H_2SO_4 \rightarrow NO_2^+ + HSO_4^- + H_2O$	1 1	allow + anywhere can score in equation or use two equations via $H_2NO_3^+$
(8)	(b)	(ii)	electrophilic substitution  Allow Kekule structures + must be on N of $^+NO_2$ (which must be correct) both NO_2 must be correctly positioned and bonded to gain M2	1 3	Not Friedel Crafts M1 arrow from circle or within it to N or to + on N horseshoe must not extend beyond C2 to C6 but can be smaller + not too close to C1 M3 arrow into hexagon unless Kekule allow M3 arrow independent of M2 structure ignore base removing H in M3

8	(c)	(i)	H_2/Ni or H_2/Pt or Sn/HCl or Fe/HCl (conc or dil or neither) allow dil H_2SO_4 ignore mention of NaOH  $4H_2O$ Or $6H_2$	1 1	Not $NaBH_4$ Not $LiAlH_4$ Not Na/C_2H_5OH not conc H_2SO_4 or any HNO_3 allow $C_6H_4(NO_2)_2$ etc , allow NO_2- NH_2- i.e. be lenient on structures, the mark is for balancing equ
8	(c)	(ii)	 1st mark for correct peptide link 2nd mark for the rest correct including trailing bonds	 2	allow –CONH- ignore [ ]n as in polymer
8	(c)	(iii)	**M1** Kevlar is <u>biodegradeable</u> but polyalkenes not **M2** Kevlar has <u>polar</u> bonds / is a (poly) amide / has peptide link **M3** can be hydrolysed/attacked by nucleophiles/acids/bases/enzymes **M4** polyalkenes <u>non polar</u> /has <u>non-polar</u> bonds	1 1 1 1	allow Kevlar is <u>more</u> biodegradeable comment on structure of Kevlar comment on structure of polyalkenes but not just strong bonds

Question	Part	Sub Part		Mark	Comments
9	(a)		(nucleophilic) addition-elimination	1	
			 M4 for 3 arrows and lp	4	minus on NH_2 loses M1 M2 not allowed independent of M1, but allow M1 for correct attack on C+ +C=O loses M2 only allow M4 after correct or very close M3 lose M4 for Cl^- removing H^+ in mechanism, but ignore HCl as a product
			<u>N-ethylpropanamide</u>	1	Not N-ethylpropaneamide
9	(b)		CH_3CN or ethan(e)nitrile or ethanonitrile	1	not ethanitrile but allow correct formula with ethanitrile
			for each step wrong or no reagent loses condition mark	1	contradiction loses mark
			Step 1 Cl_2		
			uv or above 300 ^oC	1	wrong or no reagent loses condition mark
			Step 2 KCN	1	
			aq and alcoholic (both needed)	1	allow uv light / (sun)light / uv radiation
			Step 3 H_2/Ni or $LiAlH_4$ or Na/C_2H_5OH	1	not CN^- but mark on NOT HCN or KCN + acid, and this loses condition mark NOT $NaBH_4$ Sn/HCl (forms aldehyde!) ignore conditions

Q	Part	Sub Part	Marking Guidance	Mark	Comments
10	(a)	(i)	 must be **branched** and chiral or  or 	1	not allow C_3H_7 allow C_2H_5 bonded to C either way round
10		(a)	(ii) elimination allow base – elimination	1	but penalise any other qualification
10	(a)	(iii)	Z-pent-2-ene or cis-pent-2-ene either Z or cis is necessary (allow Z-2-pentene or cis-2-pentene)	1	with or without brackets around Z with or without hyphens
10	(b)	(i)	C	1	
10	(b)	(ii)	A	1	
10	(b)	(iii)	B	1	
10	(b)	(iv)	D	1	
10	(c)		 allow C_2H_5 bonded via C or H addition or radical or step or chain growth	1 1	must have both trailing bonds ignore brackets or n QOL not additional

10	(d)	(i)	 allow M1 and M2 with ethyl groups missing ethyl groups essential for M3	4	Allow SN1, i.e M2 first then attack of NH_3 on carbocation. Allow C_2H_5 in M3 bonded either way Allow with or without NH_3 to remove H^+ in M4, but lose mark if Br^- used. ignore δ+ or δ– unless wrong + on central C instead of δ+ loses M2
10	(d)	(ii)	<u>excess</u> NH_3 ignore reflux	1	allow conc ammonia in sealed tube
10	(d)	(iii)	 NOT $-C_5H_{11}$	1	Allow C_2H_5 bonded either way
10	(e)	(i)		1	
10	(e)	(ii)		1	NOT $(C_2H_5)_2NCH_3$ which is tertiary with 3 peaks but its spectrum has no doublet.

Q	Part	Sub Part	Marking Guidance	Mark	Comments
11	(a)		chromatography (allow GLC TLC GC HPLC)	1	allow any qualification
11	(b)		5 Allow 320(.0) or 322(.0)	1 1	
11	(c)		Use of excess air/oxygen or high temperature (over 800 ^{o}C) or remove chlorine-containing compounds before incineration	1	
11	(d)	(i)	$Si(CH_3)_4$ allow SiC_4H_{12} allow displayed formula and do not penalise sticks	1	Not TMS
11	(d)	(ii)	3	1	