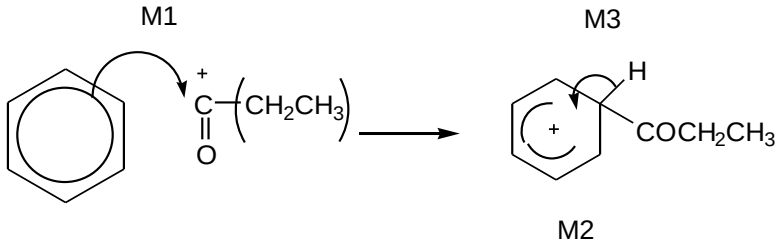
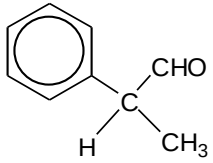
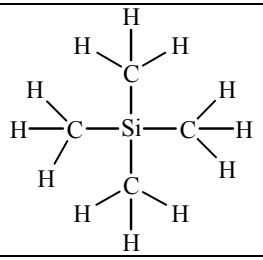
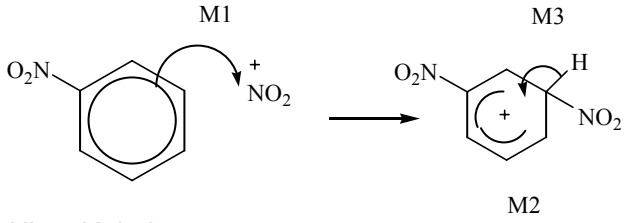
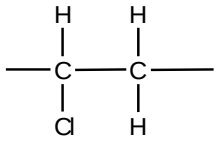
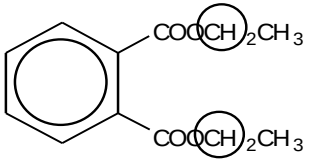
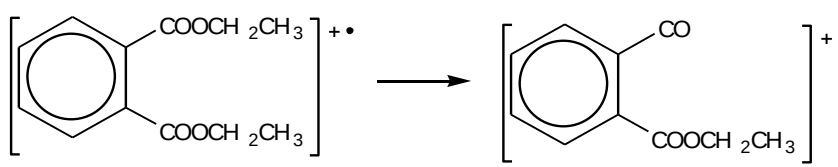
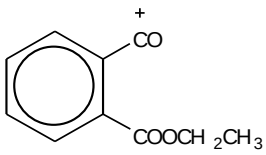
Aromatic Compounds and Amines Answers

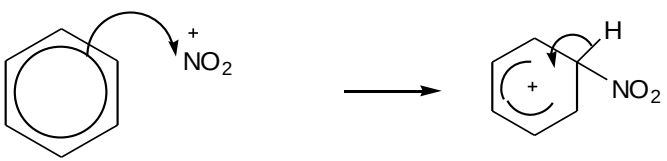
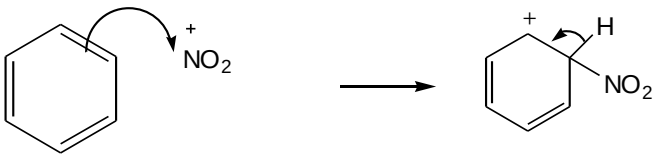
Q	Part	Sub Part	Marking Guidance	Mark	Comments
8	a		CH_3CH_2COCl OR CH_3CH_2CClO OR propanoyl chloride OR $(CH_3CH_2CO)_2O$ OR propanoic anhydride penalize contradiction in formula and name e.g. propyl chloride	1	could score in equation
			$AlCl_3$ or $FeCl_3$ or names	1	could score in equation
			$CH_3CH_2COCl + AlCl_3 \rightarrow CH_3CH_2CO^+ + AlCl_4^-$ Allow RCOCl in equation but penalise above	1	allow + on C or O in equation
8	b			3	M1 arrow from circle or within it to C or to + on C 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		Tollens or ammoniacal silver nitrate	1	penalise wrong formula
				1	

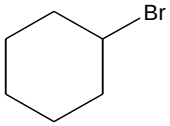
Question	Part	Sub Part		Mark	Comments
(8)	(a)	(i)	**W** 3 **X** 4 **Y** 2	1 1 1	
(8)	(a)	(ii)		1	displayed formula shows ALL bonds
(8)	(b)	(i)	NO_2^+ $HNO_3 + 2H_2SO_4 \rightarrow NO_2^+ + 2HSO_4^- + H_3O^+$ ***OR*** $HNO_3 + H_2SO_4 \rightarrow NO_2^+ + HSO_4^- + H_2O$	1 1	allow + anywhere can score 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

Question	Marking Guidance	Mark	Comments
5(a)	Benzene-1,2-dicarboxylic acid	1	Allow 1,2-benzenedicarboxylic acid
5(b)		1	Must show all bonds including trailing bonds Ignore *n*
5(c)(i)	2 C_2H_5OH H_2O	1 1	*NB Two ethanols* *but only one water*
5(c)(ii)	6 or six	1	
5(c)(iii)		1	Ignore overlap with O to the left or H to the right, but must only include this one carbon. either or allow both (as they are identical)

5(d)	 $\bullet OCH_2CH_3$ $[DEP]^{+\bullet}$ OR $[C_{12}H_{14}O_4]^{+\bullet} \rightarrow [C_{10}H_9O_3]^{+} + [C_2H_5O]^{\bullet}$	1 LHS 1 RHS	Allow + on C or O in  Dot must be on O in radical
5(e)(i)	Rate = k[DEP]	1	Must have brackets but can be ( )
5(e)(ii)	Any **two** of • experiment repeated/continued <u>over a long period</u> • repeated by independent body/other scientists/avoiding bias • investigate breakdown products • results made public	2 Max	Not just repetition Ignore animal testing

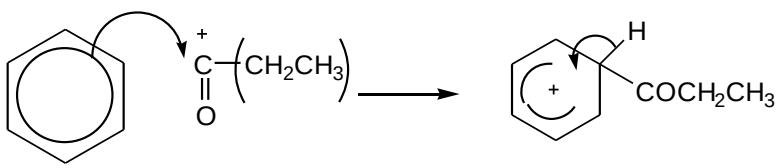
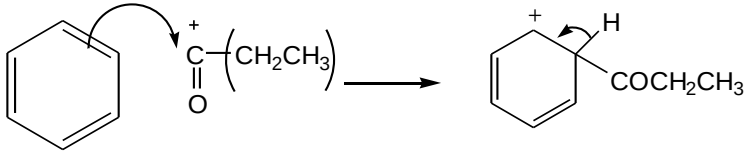
Question	Marking Guidance	Mark	Comments
8(a)	**M1** Benzene is <u>more stable than cyclohexatriene</u>	1	more stable than cyclohexatriene must be stated or implied If benzene more stable than cyclohexene, then penalise M1 but mark on If benzene less stable: can score M2 only
	M2 Expected $\Delta H^{\ominus}$ hydrogenation of C_6H_6 is 3(–120) = –360 kJ mol^{-1}	1	Allow in words e.g. expected $\Delta H^{\ominus}$ hydrog is three times the $\Delta H^{\ominus}$ hydrog of cyclohexene
	M3 Actual $\Delta H^{\ominus}$ hydrogenation of benzene is 152 kJ mol^{-1} (less exothermic) or 152 kJ mol^{-1} different from expected	1	Ignore energy needed
	M4 Because of delocalisation or electrons spread out or resonance	1	

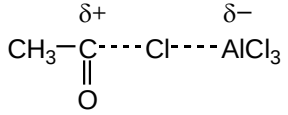
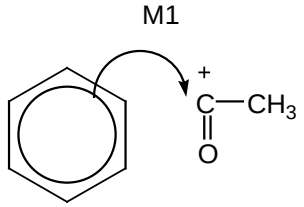
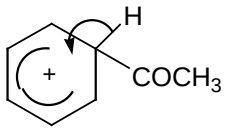
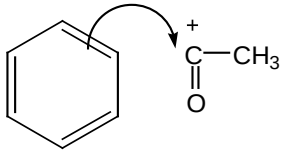
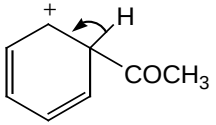
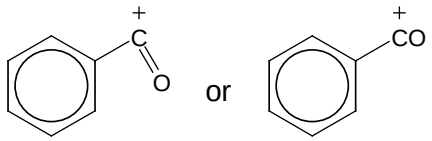
8(b)	**No mark for name of mechanism**		
	Conc HNO_3 Conc H_2SO_4	1 1	If either or both conc missing, allow one; this one mark can be gained in equation
	$2\ H_2SO_4 + HNO_3 \rightarrow 2\ HSO_4^- + NO_2^+ + H_3O^+$ **OR** $H_2SO_4 + HNO_3 \rightarrow\ HSO_4^- + NO_2^+ + H_2O$ **OR via two equations** $H_2SO_4 + HNO_3 \rightarrow\ HSO_4^- + H_2NO_3^+$ $H_2NO_3^+ \rightarrow\ NO_2^+ + H_2O$	1	Allow + anywhere on NO_2^+
	M1 M3  M2 **OR** M1 M3  M2	3	M1 arrow from within hexagon to N or + on N Allow NO_2^+ in mechanism 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 + on H in intermediate loses M2 not M3

8(c)	**If intermediate compound V is wrong or not shown, max 4 for 8(c)**		
	M1  or Cl or chlorocyclohexane or bromocyclohexane	1	
	Reaction 3 **M2** HBr **M3** Electrophilic addition	1 1	Allow M2 and M3 independent of each other
	Reaction 4 **M4** Ammonia if wrong do not gain M5 **M5** Excess ammonia or sealed in a tube or under pressure **M6** Nucleophilic substitution	1 1 1	Allow M4 and M6 independent of each other If CE e.g. acid conditions, lose M4 and M5
8(d)	Lone or electron pair on N Delocalised or spread into ring in U Less available (to accept protons) or less able to donate (to H^+)	1 1 1	No marks if reference to “lone pair on N” missing,

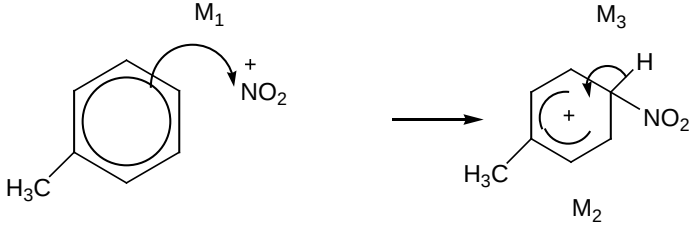
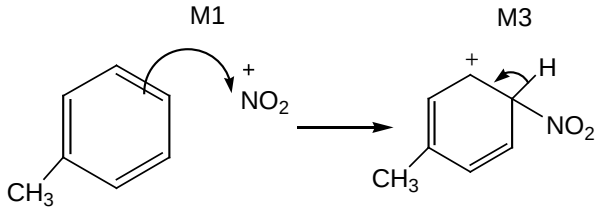
UMS conversion calculator www.aqa.org.uk/umsconversion

Question	Marking Guidance	Mark	Comments
6(a)(i)	$C_6H_6 + CH_3CH_2COCl \rightarrow C_6H_5COCH_2CH_3 + HCl$ **OR** $C_6H_6 + CH_3CH_2CO^+ \rightarrow C_6H_5COCH_2CH_3 + H^+$	1	allow C_2H_5 penalise $C_6H_5–CH_3CH_2CO$ allow + on C or O in equation
	phenylpropanone **OR** ethylphenylketone **OR** phenylethylketone	1	Ignore 1 in formula, but penalise other numbers
	$AlCl_3$	1	can score in equation
	$CH_3CH_2COCl + AlCl_3 \rightarrow CH_3CH_2CO^+ + AlCl_4^-$	1	allow C_2H_5 allow + on C or O in equation
	$AlCl_4^- + H^+ \rightarrow AlCl_3 + HCl$	1	

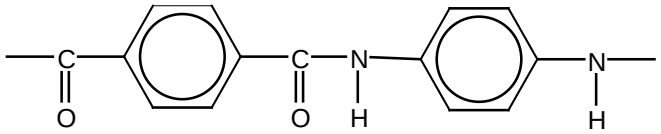
6(a)(ii)	electrophilic substitution M1 M3  M2 for structure **OR** M1 M3  M2	1 3	can allow in (a)(i) if no contradiction M1 arrow from circle or within it to C or to + on C horseshoe must not extend beyond C2 to C6 but can be smaller + not too close to C1 M2 penalise C_6H_5–CH_3CH_2CO (even if already penalized in (a)(i)) M3 arrow into hexagon unless Kekule allow M3 arrow independent of M2 structure ignore base removing H in M3
6(b)(i)	$CH_3CH_2\underline{CHO}$ + HCN → $CH_3CH_2CH(OH)CN$ **OR** $C_2H_5CH(OH)CN$ 2-hydroxybutan<u>e</u>nitrile **OR** 2-hydroxybutan<u>o</u>nitrile	1 1	aldehyde must be -CHO brackets optional no others

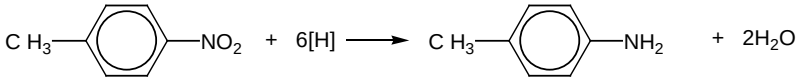
Question	Marking Guidance	Mark	Additional Guidance
6(a)	$CH_3COCl + AlCl_3 \longrightarrow CH_3CO^+ + AlCl_4^-$	1	Allow RHS as  Allow + on C or O in equation but + must be on C in mechanism below Ignore curly arrows in equation even if wrong.
	$AlCl_4^- + H^+ \rightarrow AlCl_3 + HCl$	1	
	M1  M3  M2 OR M1  M3  M2	3	• M1 arrow from within hexagon to C or to + on C • + must be on C of RCO in mechanism • + in intermediate not too close to C1 • gap in horseshoe must be centred approximately around C1 • M3 arrow into hexagon unless Kekule • allow M3 arrow independent of M2 structure • ignore base removing H for M3 • **NO** mark for name of mechanism
	Phenylethanone ignore 1 in name, penalise other numbers	1	Note: this is the sixth marking point in 6a
6(b)		1	+ must be on C But allow $[C_6H_5CO]^+$

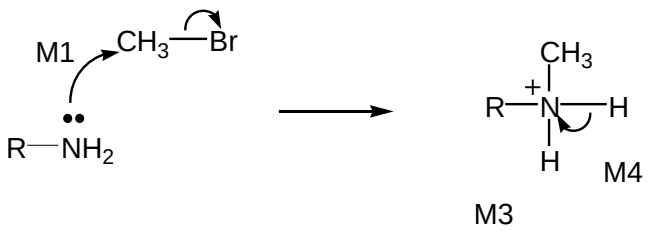
6(c)	M1 about electrons	methyl group has (positive) inductive effect OR increases electron density on benzene ring OR pushes electrons OR is electron releasing	1	Ignore reference to delocalisation
	M2 about attraction	electrophile attracted more or benzene ring better nucleophile	1	Allow intermediate ion stabilised **M2 only awarded after correct or close M1**

Question	Marking Guidance	Mark	Comments
9(a)(i)	Conc HNO_3 Conc H_2SO_4 $2\ H_2SO_4 + HNO_3 \rightarrow 2\ HSO_4^- + NO_2^+ + H_3O^+$ **OR** $H_2SO_4 + HNO_3 \rightarrow\ HSO_4^- + NO_2^+ + H_2O$ **OR** via two equations $H_2SO_4 + HNO_3 \rightarrow\ HSO_4^- + H_2NO_3^+$ $H_2NO_3^+ \rightarrow\ NO_2^+ + H_2O$	1 1 1	If either or both conc missing, allow one; this one mark can be gained in equation` Allow + anywhere on NO_2^+
9(a)(ii)	M_1 M_3  M_2 **OR** M1 M3  M2	3	• ignore position or absence of methyl group in M1 but must be in correct position for M2 • M1 arrow from within hexagon to N or <u>+ on N</u> • Allow NO_2^+ in mechanism • Bond to NO_2 must be to 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 • + on H in intermediate loses M2 not M3
9(b)	5	1	

9(c)	2	1	
9(d)	$2C_7H_5N_3O_6 \rightarrow 5H_2O + 3N_2 + 7C + 7CO$	1	Or halved

Question	Marking Guidance	Mark	Comments
7(a)	Sn / HCl ***OR*** Fe / HCl not conc H_2SO_4 nor any HNO_3 Ignore subsequent use of NaOH	1	Ignore reference to Sn as a catalyst with the acid Allow H_2 (Ni / Pt) but penalise wrong metal But NOT $NaBH_4$ $LiAlH_4$ Na / C_2H_5OH
	Equation must use molecular formulae $C_6H_4N_2O_4 + 12\,[H]$	1	12[H] and $4H_2O$ without correct molecular formula scores 1 out of 2
	$\rightarrow C_6H_8N_2 + 4H_2O$	1	Allow ….. + $6H_2$ if H_2 / Ni used
		2	Allow –CONH— or —COHN— or —C_6H_4—
			Mark two halves separately : lose 1 each for • error in diamine part • error in diacid part • error in peptide link • missing trailing bonds at one or both ends • either or both of H or OH on ends
			Ignore *n*
7(b)	H_2 (Ni / Pt) but penalise wrong metal	1	NOT Sn / HCl, $NaBH_4$ etc.
	CH_2	1	
	In benzene 120^o	1	
	In cyclohexane $109^o\,28'$ or $109½^o$	1	Allow 108^o - 110^o
	If only one angle stated without correct qualification, no mark awarded		

Question	Marking Guidance	Mark	Comments
5(a) **G**	Electrophilic substitution	1	Both words needed Ignore minor misspellings
5(b)(i)	Sn/HCl **OR** H_2/Ni OR H_2/Pt **OR** Fe/HCl **OR** Zn/HCl **OR** $SnCl_2$/HCl	1	Ignore conc or dil with HCl, Allow (dil) H_2SO_4 but not conc H_2SO_4 Not allow HNO_3 or H^+ Ignore NaOH after Sn/HCl Ignore catalyst
5(b)(ii)	$CH_3C_6H_4NO_2 + 6[H] \rightarrow CH_3C_6H_4NH_2 + 2H_2O$ **OR** 	1	Allow molecular formulae as structures given $C_7H_7NO_2 + 6[H] \rightarrow C_7H_9N + 2H_2O$ Qu states use [H], so penalised $3H_2$
5(b)(iii)	making dyes ***OR*** making quaternary ammonium salts ***OR*** making (cationic) surfactants ***OR*** making hair conditioner ***OR*** making fabric softener ***OR*** making detergents	1	

5(c)	M2  NO Mark for name of mechanism	4	Allow SN1 M1 for lone pair on N and arrow to C or mid point of space between N and C M2 for arrow from bond to Br M3 for structure of protonated secondary amine M4 for arrow from bond to N or + on N For M4: ignore RNH_2 or NH_3 removing H^+ but penalise Br-

5(d)	M1	<u>lone or electron pair on N</u>	1	If no mention of lone pair CE=0 If lone pair mentioned but not on N then lose M1 and mark on
	M2	in **J** spread/delocalised into ring (or not delocalised in K)	1	Ignore negative inductive effect of benzene
	M3	less available (for protonation or donation in **J**)	1	Allow interacts with ***π*** cloud for M2
		OR		
	M2	in **K** there is a positive inductive effect / electron releasing)		
	M3	more available (for protonation or donation in **K**)		

Question	Marking Guidance	Mark	Comments
8(a)(i)	3(-120) – (-208) = -152 OR 3(120) – 208 = 152 (kJ mol^{-1})	1	Must show <u>working</u> and answer and maths must be correct, but ignore sign
8(a)(ii)	Electrons <u>delocalised</u> OR <u>delocalisation</u> (QOL) Or allow reference to <u>resonance</u> (QOL)	1	
8(b) **G**	x, y, w	1	Must be in this order
8(c)(i) **G**	-240 (kJ mol^{-1})	1	Must have minus sign
8(c)(ii)	between -239 and -121 (kJ mol^{-1})	1	Must have minus sign
8(c)(iii)	Must specify which diene:		
	M1 Proximity – for 1,3 C=C bonds are close together	1	allow converse for 1,4 diene
	M2 Delocalisation – for 1,3 some delocalisation OR some overlap of electrons, π clouds or p orbitals	1	allow converse for 1,4 diene
	M3 some extra stability for the 1,3- isomer	1	