EXAM PAPERS PRACTICE

Boost your performance and confidence with these topic-based exam questions

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Detailed mark scheme

Suitable for all boards

Designed to test your ability and thoroughly prepare you

Time allowed
70 Minutes

Score /58

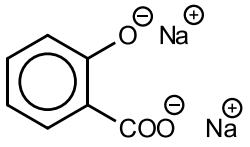
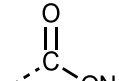
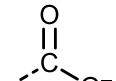
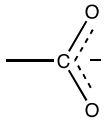
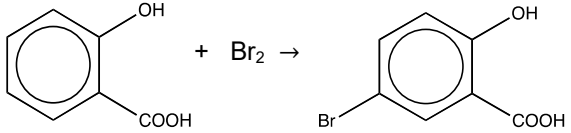
Percentage %

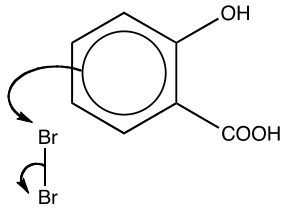
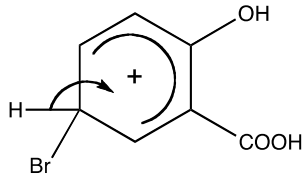
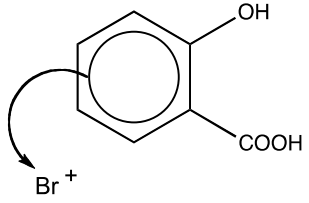
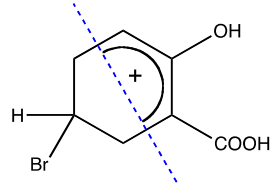
CHEMISTRY

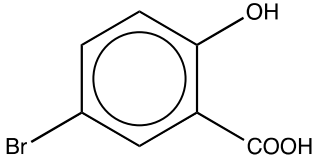
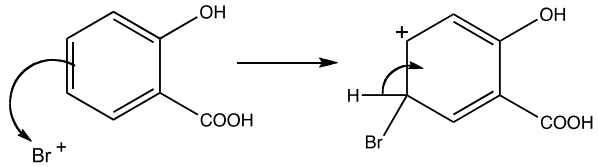
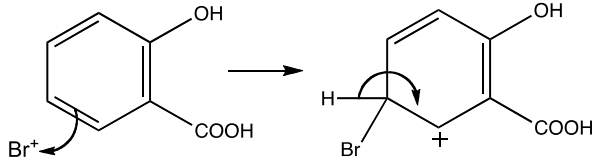
Mark Scheme

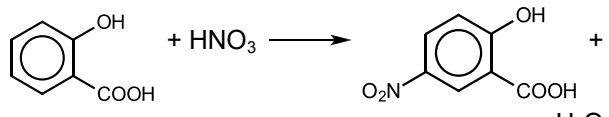
OCR
AS & A LEVEL

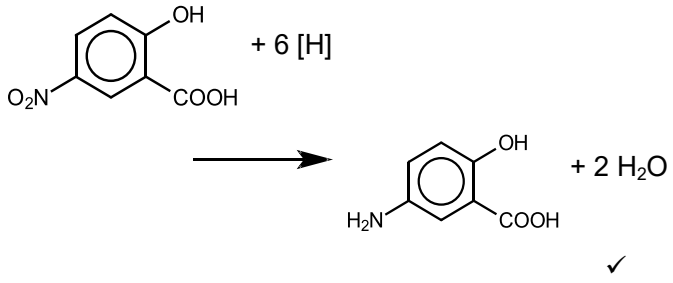
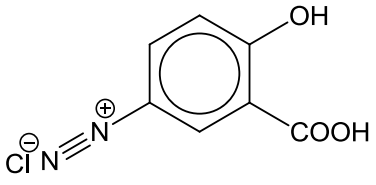
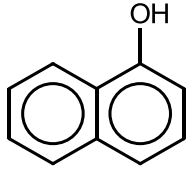
Module 6: Organic chemistry and analysis

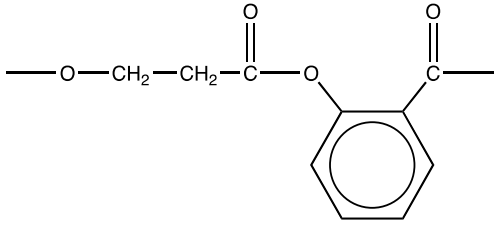
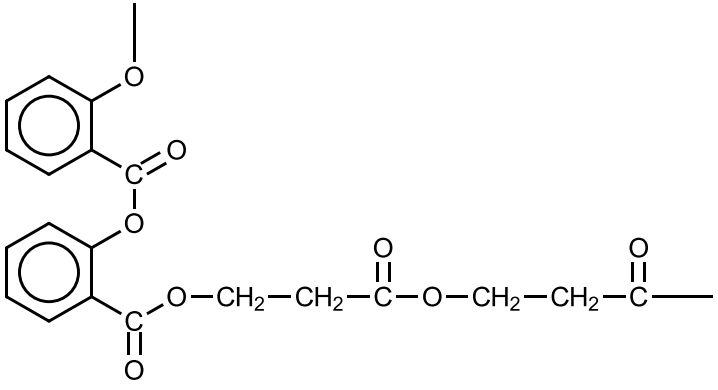
Question			Answer	Mark	Guidance
Where circles have been placed round charges, this is for clarity only and does not indicate a requirement					
1	(a)	(i)	 ✓	1	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous **DO NOT ALLOW** —O—Na **OR** -COO-Na (covalent bond) **ALLOW** $-O^-$ **ALLOW** —ONa **ALLOW** —COONa **OR**  **OR**  **ALLOW** delocalised carboxylate  (Na^+)
1	(a)	(ii)	(Bromine) would be decolourised/turn (from orange/red/yellow/brown) to colourless **OR** white precipitate/solid/emulsion (formed) ✓	1	**IGNORE** goes clear **DO NOT ALLOW** other colours for bromine **IGNORE** cream precipitate **DO NOT ALLOW** salicylic acid turns colourless/decolourised **IGNORE** temperature/fumes
1	(a)	(iii)	 + HBr ✓	1	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous **MUST** be all correct to score mark **ALLOW** molecular formulae, i.e. $C_7H_6O_3 + Br_2 \rightarrow C_7H_5O_3Br + HBr$

Question			Answer	Mark	Guidance
1	(a)	(iv)	$(CH_3)_2CHOH/CH_3CH(OH)CH_3$/propan(-)2(-)ol **AND** acid/H^+/H_2SO_4 (catalyst) ✓	1	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous **ALLOW** 2-propanol **DO NOT ACCEPT** incorrect name or incorrect formula of alcohol **IGNORE** reflux/concentrated (acid)
1	(b)	(i)	 No Br_2 dipole needed Curly arrow to Br from ring **OR** from within the ring **AND** curly arrow Br-Br bond to Br ✓  ✓ correct intermediate (with charge) ✓ curly arrow from C—H to reform ring	4	**ALLOW** mechanism with Br^+ electrophile (Maximum 3 marks)  **IGNORE** any equations involving a halogen carrier **BUT DO NOT ALLOW** intermediate with π-system covering less than half of ring:  **ALLOW** + charge anywhere inside the 'horseshoe' Horseshoe must have open end towards Br Apply ecf to error in structure of intermediate (M2)

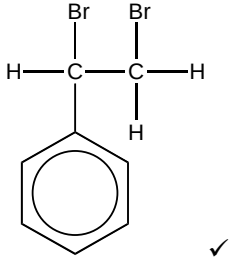
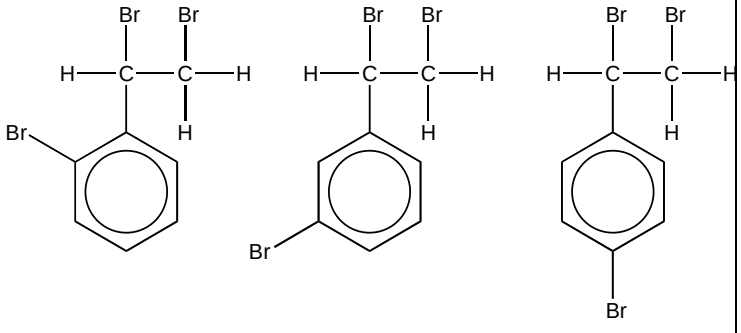
Question	Answer	Mark	Guidance
	 + HBr /H^++ Br^- ✓ Correct products (Br^- may be shown in the first step)		**ALLOW** Kekulé mechanism as shown (Maximum 3 marks if Br^+ is the electrophile)  **ALLOW** double bonds in alternate arrangement 

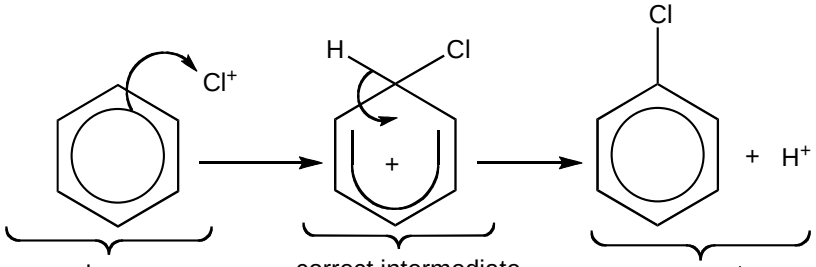
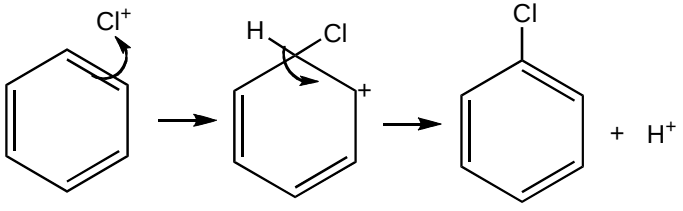
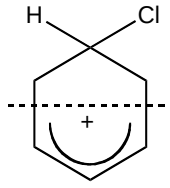
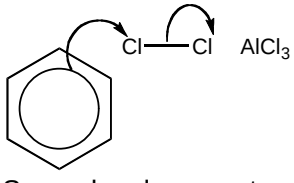
Question			Answer	Mark	Guidance
1	(b)	(ii)	(In salicylic acid) lone pair/pair of electrons on O(H)/phenol is ~ (partially) **delocalised** into the ring ✓ electron density increases/is high **ORA** ✓ Br_2/electrophile is (more) polarised **ORA** ✓ ✎ **QWC**: delocalised/delocalized/delocalise *etc.* must be spelled correctly in the correct context at least once	3	**ALLOW** diagram to show movement of lone pair into ring but delocalised ring must be mentioned **ALLOW** lone pair/pair of electrons on O(H)/phenol is (partially) drawn/attracted/pulled into **delocalised** ring **IGNORE** 'activates the ring' **ALLOW** more electron rich **DO NOT ALLOW** charge density or electronegativity **ALLOW** (salicylic acid) attracts electrophiles more/more susceptible to electrophilic attack **ALLOW** Br_2 is (more) attracted **OR** Br_2 is not polarised by benzene **OR** induces dipoles (in bromine/electrophile) Delocalise(d) needed to score the first marking point
1	(c)	(i)	**Step 1** Add HNO_3 ✓  ✓	4	**ALLOW** reagent mark if HNO_3 in equation **IGNORE** H_2SO_4 (**NOTE**: H_2SO_4 not required with phenols) **IGNORE** concentrations of acids/temperature **ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous Equations **MUST** be completely correct for **one** mark each

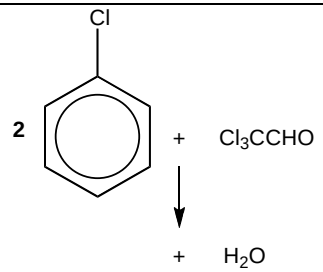
Question			Answer	Mark	Guidance
			Step 2 Tin **AND concentrated** HCl ✓  ✓		**DO NOT ALLOW** $3H_2$
1	**(c)**	**(ii)**	Nitrogen electron pair **OR** nitrogen lone pair accepts a proton/H^+ ✓	**1**	**DO NOT ALLOW** nitrogen/N lone pair accepts hydrogen (proton/H^+ required) **ALLOW** nitrogen donates an electron pair/lone pair to H^+ **IGNORE** NH_2 group donates electron pair
1	**(c)**	**(iii)**	compound **A** ✓  compound **B**  ✓	**2**	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous **ALLOW** —N_2Cl **OR** —$N_2^+Cl^-$ **DO NOT ALLOW** —N≡N^+ **OR** —N≡N^+ Cl^- **DO NOT ALLOW** –N_2-Cl (covalent bond)

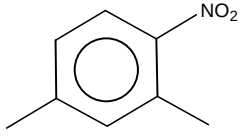
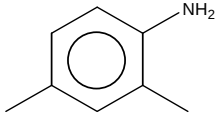
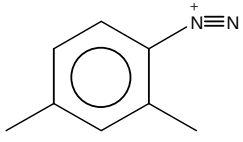
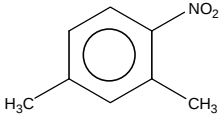
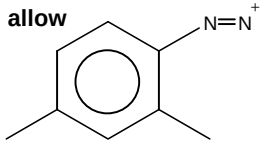
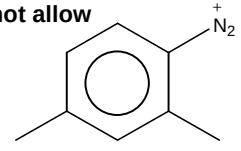
Question	Answer	Mark	Guidance
			**ALLOW**  **IGNORE** bond angles **DO NOT ALLOW** more than one repeat unit unless correct repeat unit is indicated **IGNORE** brackets with *n* **ALLOW** any correct repeat unit **ALLOW** end bonds shown as - - - - - **DO NOT ALLOW** if structure has no end bonds
	Total	**22**	

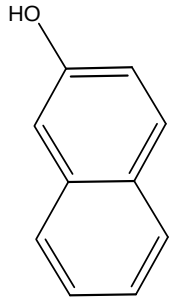
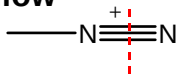
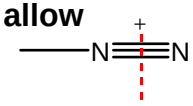
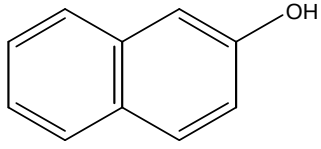
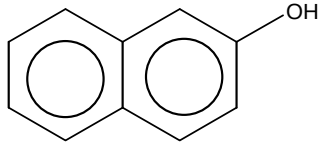
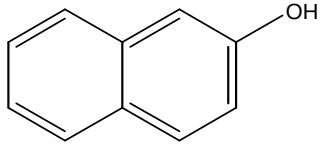
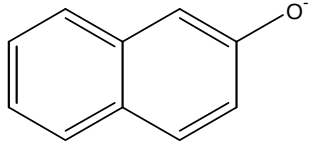
Question			er	Marks	Guidance
2	(a)		In benzene, electrons **OR** π-bond(s) are **delocalised** ✓ **QWC** requires delocalised/delocalized **spelled correctly** and used in correct context In alkenes, ΠΠ-electrons are **OR** ΠΠ-bond is **AND** localised **OR** between two carbons ✓ benzene has a lower electron density **OR** alkene/C=C has a higher electron density ✓ *Comparison* ***essential*** benzene polarises bromine / Br_2 **LESS** **OR** benzene attracts bromine / Br_2 **LESS** **OR** benzene induces a **weaker** dipole in bromine / Br_2 ✓	4	***ANNOTATIONS MUST BE USED*** **ALLOW** diagram with (π-bond) electrons **AND** delocalised **labelled** **IGNORE** benzene has delocalised structure or ring **ALLOW** diagram with π-bond labelled **ALLOW** pi bond for π-bond **π**-bond **OR π-**electrons ***essential*** *for this mark* **IGNORE** charge density **DO NOT ALLOW** electronegativity **ALLOW** Br–Br for Br_2 **ALLOW** electrophile for Br_2 **ALLOW** benzene does **NOT** polarise bromine / Br_2 **OR** alkene/C=C polarises Br_2 **ALLOW** benzene does **NOT** attract bromine / Br_2 **OR** alkene/C=C attracts Br_2 **ALLOW** benzene does **NOT** induce dipole in bromine / Br_2 **OR** alkene/C=C induces dipole in Br_2

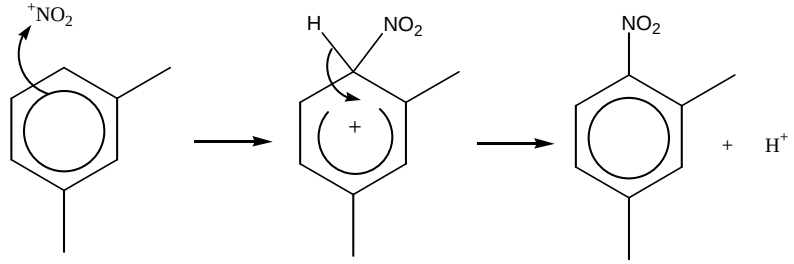
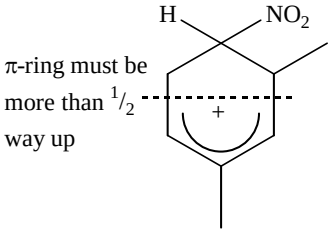
Question			er	Marks	Guidance
	(b)	(	 ✓	1	**ALLOW** correct structural **OR** displayed **OR** skeletal formula **ALLOW** combination of formulae as long as unambiguous
		(ii)	6 ✓	1	**NO ECF from (i)**
		(iii)	Two of the three structures below with 1 mark for each correct structure ✓✓ 	2	**ALLOW** correct structural **OR** displayed **OR** skeletal formula **ALLOW** combination of formulae as long as unambiguous Structures must clearly show position of Br on benzene ring in relation to side chain **ALLOW ECF** from **(i)** if **BOTH** Br atoms on same carbon on side chain **DO NOT ALLOW ECF** from **(i)** if **EITHER** bromine has been substituted onto the benzene ring
		(iv)	**reaction 1**: electrophilic addition ✓ **reaction 2**: electrophilic substitution ✓	2	**ALLOW** electrophile addition **ALLOW** electrophile substitution **ALLOW** other phonetic spellings for electrophilic, e.g. electrophylic, etc.
			Total	**10**	

Question			Answer	Mark	Guidance
3	(a)		$AlCl_3 + Cl_2 \longrightarrow AlCl_4^- + Cl^+$ ✓  curly arrow from π-bond to Cl^+ ✓ correct intermediate ✓ curly arrow from C–H bond back to reform π-ring ✓ correct products ✓ $H^+ + AlCl_4^- \longrightarrow AlCl_3 + HCl$ ✓ **Note**: 1st curly arrow should start within the ring or on the ring --- **Note: ALLOW** mechanism using Kekulé structures:  	6	***ANNOTATIONS MUST BE USED*** **DO NOT ALLOW** the following intermediate:  π-ring must be more than 1/2 way up **AND** 'horseshoe' the right way up, *ie* gap towards C with Cl **ALLOW** + sign anywhere inside the 'hexagon' of intermediate **ALLOW** 1st curly arrow starting within the hexagon **ALLOW** mechanism with Cl–Cl----$AlCl_3$ for 1st 2 marks, ie  Second curly arrow to either –Cl or $AlCl_3$ **Note**: If Br^+ is used, **DO NOT ALLOW** 1st mechanism mark but all other marks available by **ECF**

Question			Answer	Mark	Guidance
	(b)	(i)	 **1st mark**: reactants, correctly balanced, ✓ *ie* **2** C_6H_5Cl + Cl_3CCHO **2nd mark**: product, (correctly balanced) ✓ *ie* H_2O	**2**	**Each mark is independent of the other** **ALLOW** C_6H_5Cl for chlorobenzene **ALLOW** any unambiguous structure for Cl_3CCHO, e.g. CCl_3CHO **BUT** ….. **DO NOT ALLOW** CCl_3COH **Standalone mark** **Standalone mark**
		(ii)	6 ✓	**1**	
	(c)		substitution/nitration/NO_2 at different positions (on the ring) **OR** forms different isomers **OR** multiple substitution/nitration ✓	**1**	**ALLOW** examples, e.g. 1-chloro-2-nitrobenzene and 1-chloro-2-nitrobenzene **ALLOW** 'it' for nitro group **ALLOW** examples, e.g. 1-chloro-2,3-dinitrobenzene **IGNORE** nitrate/NO_3
	(d)		In phenol, (lone) pair of electrons on O is (partially) **delocalised** into the ring ✓ **QWC**: delocalised/delocalized/delocalise, etc must be spelt correctly in the correct context for benzene **OR** phenol at least once electron density increases/is high ✓ **ORA** Cl_2/electrophile is (more) polarised ✓ **ORA**	**3**	***ANNOTATIONS MUST BE USED*** **ALLOW** diagram to show movement of lone pair into ring but **delocalised** ring must be mentioned **ALLOW** lone pair of electrons on O is (partially) drawn/ attracted/pulled into **delocalised** ring **IGNORE** 'activates the ring' **DO NOT ALLOW** charge density or electronegativity **ALLOW** Cl_2 is (more) attracted **OR** Cl_2 is not polarised by benzene **OR** induces dipoles (in chlorine/electrophile)
			Total	**13**	

Question			Expected Answers	Marks	Additional Guidance
4	a		Bond length intermediate between/different from (short) C=C and (long) C–C ✓ ΔH hydrogenation less exothermic than expected (when compared to ΔH hydrogenation for cyclohexene) ✓ Only reacts with Br_2 at high temp or in presence of a halogen carrier / resistant to electrophilic attack ✓ **Please annotate, use ticks to show where marks are awarded**	3	**ALLOW** all carbon–carbon bonds the same length **ALLOW** ΔH hydrogenation less (negative) than expected **ALLOW** ΔH hydrogenation different from that expected **DO NOT ALLOW** ΔH halogenation/hydration **ALLOW** doesn't decolourise/react with/polarise Br_2 **ALLOW** doesn't undergo addition reactions (with Br_2)
	b	i	compound **A**  if NO_2 in wrong position penalise here and ECF for rest of **b(i)** and **b(ii)** ✓ compound **B**  ✓ compound **C**  ✓	4	**ALLOW** any 4-nitro-1,3-dimethylbenzene drawn in any orientation **ALLOW**  drawn in any orientation **ALLOW** any 4-amino-1,3-dimethylbenzene drawn in any orientation **ECF** amine of incorrect compound **A** (e.g. position of NO_2 or lack of methyl sticks/groups) **ALLOW** diazonium chloride salt of 1,3-dimethylbenzene **ECF** diazonium salt/compound of incorrect compound **B** **IGNORE** Cl^- ion **allow**  **not allow** 

Question	Expected Answers	Marks	Additional Guidance
	compound **D**  ✓		**ALLOW** if + charge is floating between the two Ns only if it is closer to the correct N **allow**  **not allow**  **ALLOW** any of     **ALLOW** O^- in place of OH

Question	Expected Answers	Marks	Additional Guidance
ii	***mark 1*** $HNO_3 + 2H_2SO_4 \rightarrow H_3O^+ + 2HSO_4^- + NO_2^+$ ✓ ***mark 4*** – curly arrow from C–H bond back to reform π ring **AND** correct products ✓  ***mark 2*** – curly arrow from π ring to $^+NO_2$ ✓ ***mark 3*** – intermediate with π ring broken in the correct place ✓ ***mark 5*** - $H^+ + HSO_4^- \rightarrow H_2SO_4$ ✓ Link to compound **A** in part **(i)** – cannot score full marks [in **b(i)** & **b(ii)**] if NO_2 is not adjacent to a methyl	5	Equation to show formation of NO_2^+ ion ✓ **ALLOW** $HNO_3 + H_2SO_4 \rightarrow H_2O + HSO_4^- + NO_2^+$ $HNO_3 + H_2SO_4 \rightarrow HSO_4^- + H_2NO_3^+ \rightarrow H_2O + NO_2^+$ **ALLOW** mark 2 curly arrow must be from 1,3-dimethylbenzene to NO_2^+ and **ECF** for marks 3 and 4 **DO NOT ALLOW** intermediate  π-ring must be more than $^1/_2$ way up **ALLOW** CH_3s shown **ALLOW** $H_3O^+ + HSO_4^- \rightarrow H_2O + H_2SO_4$
iii	2 ✓	1	No other correct response
	Total	**13**	

If NO_2 is in correct position do not penalise even if compound **A** in **b(i)** is not in correct position