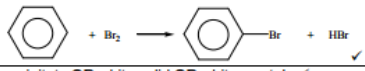
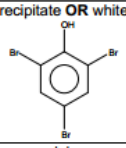
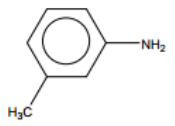
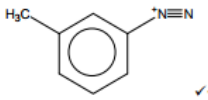
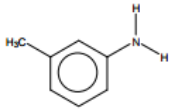
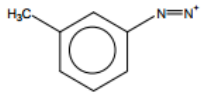
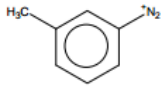
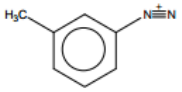
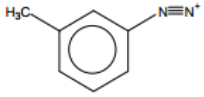
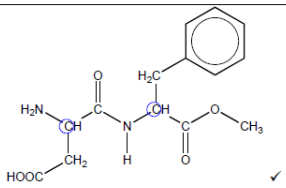
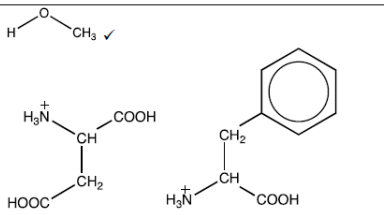
Test Name: Benzene Lesson 1

Marking Guides

Question: 1 (299199)

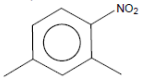
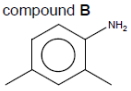
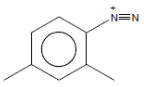
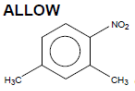
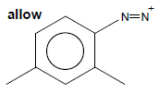
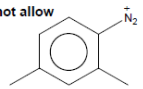
Question			Expected Answers	Marks	Additional Guidance
	(a)		 ✓	1	**ALLOW** $C_6H_6 + Br_2 \longrightarrow C_6H_5Br + HBr$ **DO NOT ALLOW** multiple substitution **DO NOT ALLOW** Br^+
	(b)	(i)	White precipitate **OR** white solid **OR** white crystals ✓  ✓	2	**DO NOT ALLOW** colourless **DO NOT ALLOW** white ppt and bubbles **DO NOT ALLOW** $Br_3C_6H_2OH$ **OR** 2,4,6-tribromophenol **OR** tribromophenol
		(ii)	1,2-Dibromocyclohexane ✓	1	**ALLOW** 1,2dibromocyclohexane **OR** 1-2dibromocyclohexane **OR** 12dibromocyclohexane **OR** cyclo-1,2-dibromohexane **DO NOT ALLOW** dibromocyclohexane **OR** $C_6H_{10}Br_2$ **OR** structures
		(iii)	**MUST** spell delocalised/delocalized or localised/localized correctly once in the answer to obtain all 5 marks **benzene** electrons or π-bonds are delocalised ✓ **phenol** a lone or non-bonded pair of electrons on the oxygen or the OH group is (partially) delocalised into the ring ✓ **cyclohexene** electrons are localised **OR** delocalised between two carbons ✓ benzene has a lower **electron density OR** phenol has a higher electron density **OR** cyclohexene has a higher electron density ✓ benzene cannot **polarise** or induce a dipole in Br_2 **OR** phenol can polarise the Br_2 **OR** cyclohexene can polarise Br_2 or the Br–Br bond ✓	5	**ALLOW** diagram to show overlap of all 6 p-orbitals for delocalisation **DO NOT ALLOW** benzene has delocalised structure or ring **ALLOW** diagram to show movement of lone pair into ring for phenol **ALLOW** diagram or description of overlap of 2 adjacent p-orbitals for bonding in cyclohexene **DO NOT ALLOW** cyclohexene has a C=C double bond **IGNORE** slip if cyclohexene is written as cyclohexane but π - bonding correctly described **DO NOT ALLOW** charge density **OR** electronegativity instead of electron density **ALLOW** $Br^{\delta+}$ **OR** electrophile Br^+ as alternate to polarise
	(c)		 ✓  ✓✓ **ALLOW** ECF ✓✓ on incorrect amine HNO_2 + HCl and temp < 10 °C **OR** $NaNO_2$ + HCl and temp < 10 °C ✓ alkaline **AND** phenol (if temperature stated must be below 10 °C) ✓	5	**ALLOW**  **IGNORE** Cl^- ion **DO NOT ALLOW** if ring is connected to the N triple bond in the diazonium or if diazonium has a negative charge **ALLOW** one mark for correct displayed diazonium if alkyl group is not shown **ALLOW**  for both marks **ALLOW**  for one mark **ALLOW**  for one mark **ALLOW**  for one mark **ALLOW** NaOH **OR** KOH & C_6H_5OH **OR** phenoxide ion **OR** $C_6H_5O^-$ **ALLOW** reagents and conditions from the equations
			Total	14	

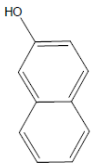
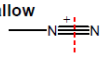
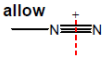
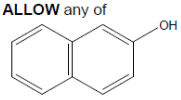
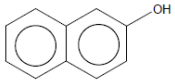
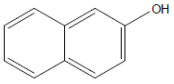
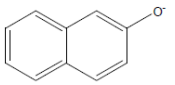
Question: 2 (308157)

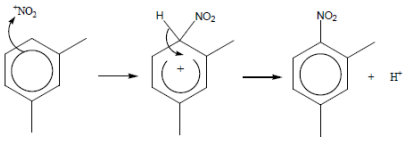
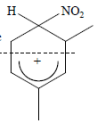
Question			Answer	Mark	Guidance
	(a)	(i)	 ✓	1	Circles can be around C **OR** CH atoms but must **not** include other atoms **ALLOW** any suitable way of highlighting chiral carbons, e.g. asterisk, * **Note**: Mark the circles and ignore other working on diagram
		(ii)	carboxyl **OR** carboxylic acid, amine, amide, ester must be **names** 2 marks for 4 correct functional groups ✓✓ 1 mark for 3 correct functional groups ✓	2	**ALLOW** peptide for amide
	(b)		 ✓ 1 mark for left-hand amino acid with NH_3^+ **OR** NH_2 ✓ 1 mark for right-hand amino acid with NH_3^+ **OR** NH_2 ✓ 1 mark for **both** amino acids shown with NH_3^+ ✓	4	**ALLOW** correct structural **OR** displayed **OR** skeletal formula **OR** mixture of the above (as long as unambiguous) **ALLOW** + charge on H of NH_3 groups, ie NH_3^+ **Note**: If there are more than three structures shown, credit any correct structures and ignore incorrect structures

Question			Answer	Mark	Guidance
	(c)		(adverse) side effects **OR** toxicity **OR** irritation ✓	1	**ALLOW** a stated adverse side effect, *eg* allergy, carcinogenic, hyperactivity etc **IGNORE** references to optical isomers, chirality, etc **IGNORE** vague statements such as harmful to body, dangerous to body **DO NOT ALLOW** obesity, corrosive to body **ALLOW** company liable to litigation/damages **Note**: Scroll down to bottom of page to check for any further writing
			Total	8	

Question: 3 (309216)

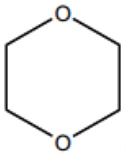
Question			Expected Answers	Marks	Additional Guidance
	a		Bond length intermediate between/different from (short) C=C and (long) C–C ✓ ΔH hydrogenation less exothermic than expected (when compared to ΔH hydrogenation for cyclohexene) ✓ Only reacts with Br_2 at high temp or in presence of a halogen carrier / 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 ½ 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

Question: 4 (6803701)

(a)	**G**: CO ✓ $HCOOH/H_2CO_2 \longrightarrow CO + H_2O$ ✓	
(b)	**H**: C ✓ $C_{12}H_{22}O_{11} \longrightarrow 12C + 11H_2O$ ✓	
(c)	**I**: $C_4H_8O_2$ ✓ $2C_2H_6O_2 \longrightarrow C_4H_8O_2 + 2H_2O$ ✓ Structure:  ✓ accept any sensible structure of $C_4H_8O_2$	**[7]**

Test Name: Benzene Lesson 1

Examiner notes
Question: 1 (299199)

(a) This part was generally well answered but a substantial number of candidates failed to score the mark by either writing out the mechanism in full or in part or by writing an equation for a reaction between benzene and chlorine.

(b)(i) It was disappointing that few candidates scored both marks. Most correctly identify the organic product for one mark but only a minority recorded the correct observation.

(b)(ii) Many candidates displayed a lack of precision in naming 1,2-dibromocyclohexane with well over half scoring no marks. It was common to see errors such as either omitting the numbers or the 'di' or the 'cyclo' as well as seeing hexene instead of hexane. A surprising number named the product as 2,4,6-tribromophenol which related back to the product in **1b(i)**.

(b)(iii) This was generally well answered. A substantial number failed to score full marks by confusing electronegativity with electron density or by not referring to one of the three chemicals in the question.

(c) The preparation of an azo dye was well answered with over 30% scoring 5/5. It was apparent that this reaction sequence was well known but many failed to score maximum marks by carelessly forgetting the methyl group or by moving the methyl group from the '3' position. A substantial number of responses started with phenylamine and produced the azo dye formed when phenol couples with benzenediazonium chloride. The initial error prohibited full marks but the rest was marked consequentially.

Question: 2 (308157)

The final question this series represented a fairly gentle end to the paper with the possible exception of part **(b)**.

(a) The large majority of candidates could ring the two chiral carbons. Most could also identify at least three of the functional groups; a ketone group was a very common incorrect answer, with the amide/peptide group the group omitted.

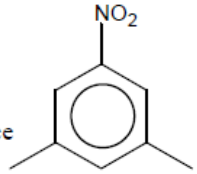
(b) The identification of the hydrolysis products was the most challenging part of the last question. Most identified methanol and many identified one or both of the amino acids. Only a very small minority realised that the amine groups would be protonated under the acidic conditions.

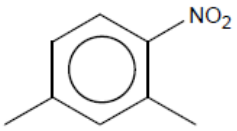
(c) The last part of the last question was meant to be a gentle end to the paper. However, there were a large number of vague answers, such as the ubiquitous 'harmful'.

Question: 3 (309216)

(a) The Mark Scheme allocated marks for separately explaining benzene's reluctance to undergo addition reactions, the uniformity of the C–C bond lengths and the stability of benzene. There were some very clear concise answers that scored full marks but there was also evidence to suggest that some candidates were not familiar with this part of the specification. A substantial number lost marks whilst trying to explain the stability of benzene which required a comparison of the ΔH hydrogenation values of benzene with those of cyclohexene. Very many candidates incorrectly compared bond enthalpy or boiling points or, most commonly, ΔH hydration.

(b)(i) Compound **A** was often incorrectly drawn with a large majority ignoring the position of the nitration.

It was common to see 

rather than 

Compounds **B** and **C** scored well and were marked consequentially from compound **A**. Compound **D** was well answered but a surprising number either showed two hydroxyl groups or a diazonium compound.

(b)(ii) The electrophilic substitution mechanism was well known and many scored full marks. A substantial number ignored the first line in the stem and simply nitrated benzene.

(b)(iii) This was surprisingly difficult with the most common response being 3. Most candidates seem to have worked out the number of isomers in their head as there was little, or no, evidence of candidates drawing out the different isomers in the space below the question.

Question: 4 (6803701)

As this is a specimen Question Paper, no Examiner's Report is available.