OCR A-Level Chemistry A

Aromatic compounds and phenols mark scheme · goes with “Aromatic compounds and phenols” · whiteboardchemistry.com/revision/exam-questions/ocr-a-level-chemistry/

Mark schemes

Aromatic compounds and phenols · 8 questions

Q1 · June 2022 · Paper 2 (Synthesis and analytical techniques) · Q3 · [1 mark]

Answer: **D**

OCR MARK SCHEME

15

EXAMINER GUIDANCE

ALLOW *15 (correct number of sigma bonds)*

Q2 · June 2023 · Paper 2 (Synthesis and analytical techniques) · Q4 · [1 mark]

Answer: **C**

phenol, amide

Q3 · June 2023 · Paper 2 (Synthesis and analytical techniques) · Q6 · [1 mark]

Answer: **B**

The carbon-carbon bond lengths are all the same.

Q4 · June 2024 · Paper 2 (Synthesis and analytical techniques) · Q21 · [14 marks]

OCR MARK SCHEME

21(a)(i)

ALLOW *correct Kekulé representation of benzene throughout question 21*

An electron pair acceptor ✓

[1 mark]

EXAMINER GUIDANCE

ALLOW *gains an electron pair / lone pair*

21(a)(ii)

Generation of electrophile

$AlCl_3 + CH_3CH_2Cl \longrightarrow CH_3CH_2^+ + AlCl_4^-$ ✓

Electrophilic substitution

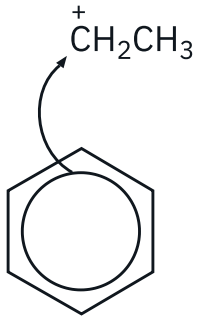
ALLOW *any combination of skeletal OR structural OR displayed formula as long as unambiguous*

ALLOW C_2H_5Cl *AND* $C_2H_5^+$

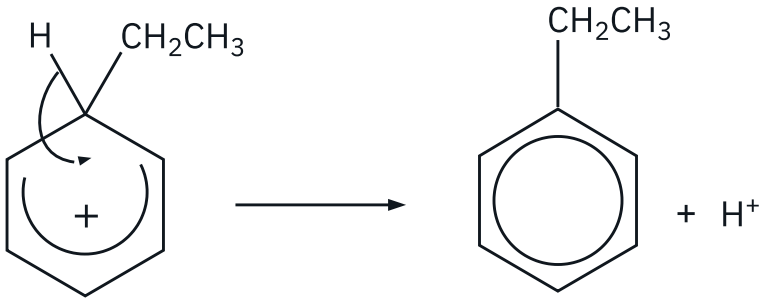
ALLOW *positive charge anywhere on* CH_2CH_3 *e.g.* $CH_2CH_3^+$

NOTE*: curly arrows can be straight, snake-like, etc. but* ***NOT*** *double headed or half headed arrows*

1st curly arrow must



Curly arrow from π-bond to $^{+}CH_2CH_3$ ✓



Correct intermediate ✓

Curly arrow from C–H bond to reform π-ring

AND H^+ as product ✓

Regeneration of catalyst

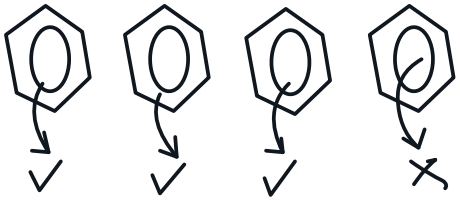
$H^+ + AlCl_4^- \longrightarrow AlCl_3 + HCl$ ✓

[5 marks]

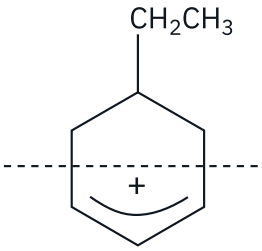
- start from, OR close to circle of benzene ring

AND

- go to anywhere on $^{+}CH_2CH_3$



DO NOT ALLOW *the following intermediate:*



π-ring should cover approximately 4 of the 6 sides of the benzene ring structure

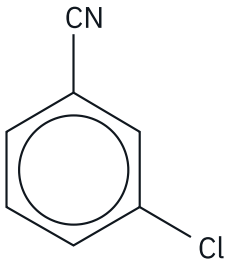
AND

'horseshoe' the right way,

i.e. gap towards C with CH_2CH_3

ALLOW *+ sign anywhere inside the 'hexagon' of intermediate*

21(b)(i)



✓

IGNORE *additional copies of the same structures*

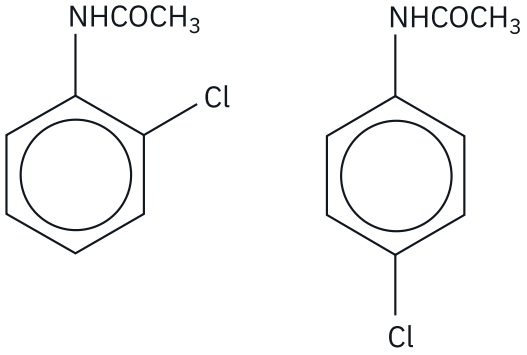
IGNORE *connectivity to CN and* $NHCOCH_3$ *in products.*

IGNORE *HCl /* H^+

IGNORE *multisubstituted products*

ALLOW *protonation of* $NHCOCH_3$ *group i.e.* $NH_2^+COCH_3$

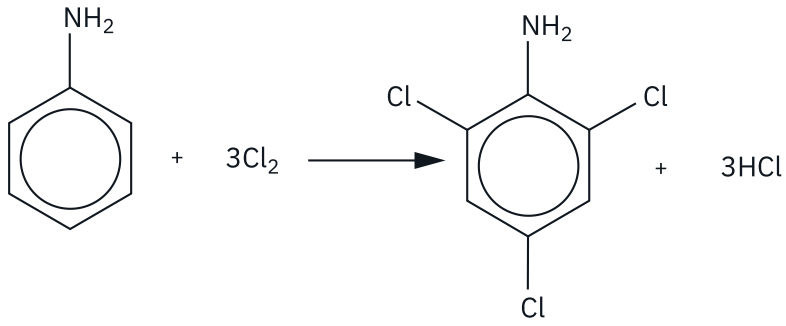
ALLOW ECF *small slips on* $NHCOCH_3$ *e.g. extra O or missing 3 on* CH_3



✓ ✓

[3 marks]

21(b)(ii)



Correct organic product ✓

Correct balanced equation ✓

[2 marks]

ALLOW *any trichlorophenyl amine structure*

ALLOW *$C_6H_2Cl_3NH_2$ OR $C_6H_4Cl_3N$ (allow elements in any order) for correct organic product*

IGNORE *incorrect structural or molecular formula* ***IF*** *correct structure is drawn*

ALLOW *ammonium salt of trichloro product $C_6H_2NH_3Cl_4$*

ALLOW *multiples for balanced equation*

ALLOW *1 mark for use of Br_2 with a correctly balanced equation*

21(b)(iii)

(In phenylamine) a (lone) pair of electrons on N is (partially) delocalised / donated into the π-system / ring ✓

Electron density increases/is higher (than benzene) ✓

ORA

(phenylamine is) more susceptible to electrophilic attack

OR

(phenylamine) attracts/accepts electrophile/Cl_2 more

OR

(phenylamine) polarises electrophile/Cl_2 more ✓

ORA

[3 marks]

Must be clear that electrons come from N not just NH_2

ALLOW *the electron pair (in the p-orbitals) on N atom becomes part of the π-system / ring*

ALLOW *diagram to show movement of lone pair into ring from N*

ALLOW *lone pair of electrons on N is (partially) drawn / attracted / pulled into π-system / ring*

ALLOW *lone pair on N (i.e. no reference to electrons)*

ALLOW *π-bond instead of π-system / ring*

DO NOT ALLOW *(two) lone pairs are delocalised/donated into the π-system / ring*

Responses must be comparative for 2nd and 3rd marking point.

IGNORE *activating*

IGNORE *charge density*

IGNORE *electronegativity*

IGNORE *phenylamines react more readily with electrophiles/Cl_2 (given in question)*

ALLOW *Cl^+ for electrophile*

IGNORE *Cl for electrophile*

ALLOW *Benzene can't polarise electrophile/Cl_2 but phenylamine can (polarise electrophile/Cl_2)*

Q5 · June 2025 · Paper 2 (Synthesis and analytical techniques) · Q20 · [17 marks]

OCR MARK SCHEME

20(a)

(In the delocalised model):

(C–C) bond length is between single (C–C) and double bond (C=C)

OR all (C–C) bond lengths are the same ✓

(Enthalpy change of) hydrogenation is less exothermic (than expected) ✓

[2 marks]

EXAMINER GUIDANCE

IGNORE *less susceptible to electrophilic attack (given in question)*

DO NOT ALLOW *enthalpy of hydration* ***OR*** *$\Delta_{hyd}H$*

ALLOW *'less negative'* ***OR*** *'more positive'* ***OR*** *'less (heat) energy released' for 'less exothermic'*
IGNORE *higher/lower*

ALLOW *comparison of values that show delocalised is less exothermic e.g. Kekulé is -360 delocalised is -208*

20(b)(i)

(In phenol) a (lone) pair of electrons on O is (partially) delocalised/donated into the ring / π-system ✓

Electron density increases/is higher (than benzene) ✓

ORA

(phenol is) more susceptible to electrophilic attack

OR

ALLOW *the electron pair in a p-orbital on O atom becomes part of the ring / π-system*

ALLOW *diagram to show movement of lone pair into ring*

ALLOW *lone pair of electrons on O is (partially) drawn/attracted/pulled/ into ring / π-system*

(phenol can) attract/accept electrophile/Br_2 more

OR

(phenol can) polarise electrophile/Br_2 more ✓

ORA

[3 marks]

ALLOW *lone pair on O*

DO NOT ALLOW *(two) lone pairs are (partially) delocalised into ring / π-system*

Responses must be comparative for 2nd and 3rd marking point

IGNORE *activating*

IGNORE *charge density*

IGNORE *electronegativity*

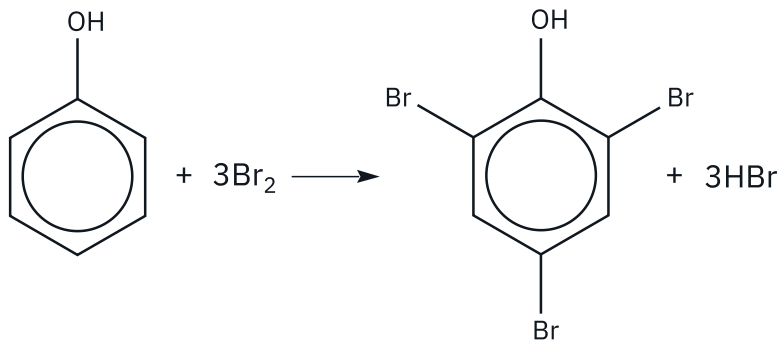
ALLOW *Br^+ for electrophile*

IGNORE *Br for electrophile*

ALLOW *Benzene can't polarise electrophile/Br_2 but phenol can (polarise electrophile/Br_2)* ***ORA***

IGNORE *phenol reacts more readily/easily with electrophiles*

20(b)(ii)



2,4,6-tribromophenol product ✓

Rest of equation and balancing ✓

[2 marks]

ALLOW *Kekulé structure*

DO NOT ALLOW *substitution at any three positions on ring, must be 2, 4, 6.*

IGNORE *molecular formula even if incorrect*

DO NOT ALLOW ECF *for organic product with incorrect number of substituted Br*

(Second mark is dependent on getting first mark)

20(c)(i)

CH_3Cl **AND** $AlCl_3$ ✓

[1 mark]

ALLOW *names if no formulae given*

ALLOW *CH_3Br for reagent*

ALLOW *$AlBr_3$* ***OR*** *$FeCl_3$* ***OR*** *$FeBr_3$ for the Lewis acid*

ALLOW *suitable non-specification alternative Lewis acids e.g. zeolite, BF_3*

20(c)(ii)

Role of H_2SO_4 catalyst 2 marks

ALLOW *for forming an electrophile*

Forming electrophile

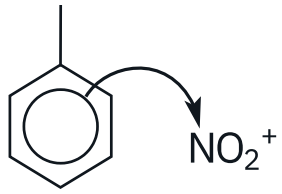
$HNO_3 + H_2SO_4 \rightarrow NO_2^+ + HSO_4^- + H_2O$ ✓

Reforming catalyst

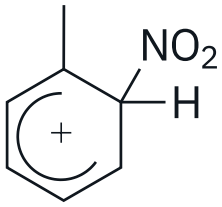
$H^+ + HSO_4^- \rightarrow H_2SO_4$ ✓

Electrophilic attack 1 mark

Curly arrow from π-bond to NO_2^+ ✓



Correct intermediate 1 mark

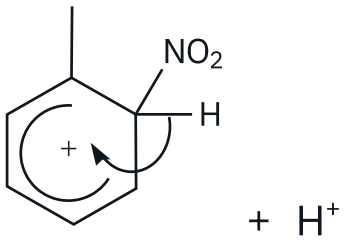


✓

Reforming benzene ring 1 mark

Curly arrow from C–H bond to reform π-ring

AND H^+ as product ✓



[5 marks]

$HNO_3 + 2H_2SO_4 \rightarrow NO_2^+ + 2HSO_4^- + H_3O^+$

ALLOW *for forming an electrophile*

$HNO_3 + H_2SO_4 \rightarrow H_2NO_3^+ + HSO_4^-$

AND then $H_2NO_3^+ \rightarrow NO_2^+ + H_2O$

NOTE*: curly arrows can be straight, snake-like etc. but* ***NOT*** *double headed or half headed arrows*

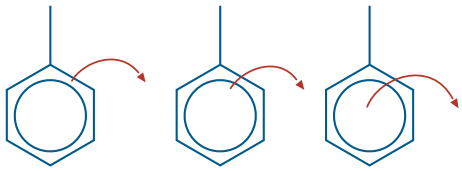
ALLOW *use of* $^+NO_2$ ***OR*** NO_2^+

1st curly arrow must:

- start from, **OR** close to circle or benzene ring

AND

- go to anywhere on NO_2^+

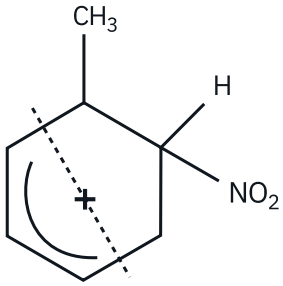


✓ ✓ ✗

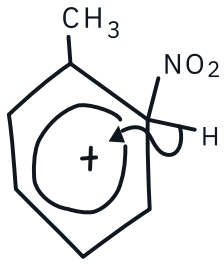
DO NOT ALLOW *mark for intermediate if methyl group is missing, or substitution is in wrong position*

IGNORE *connectivity (mark is for correct substitution position and position of π-ring)*

DO NOT ALLOW *following intermediates:*



OR



✗

π -ring should cover approximately 4 of the 6 sides of the benzene ring structure

AND

the correct orientation, i.e. gap towards C with NO_2 and H

ALLOW *+ sign anywhere inside the 'hexagon' of intermediate*

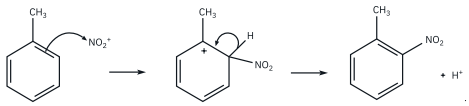
2nd curly arrow must:

- start from, **OR** be traced back to any part of the C – H bond

AND

- go inside the 'hexagon' of the intermediate

ALLOW *mechanism using Kekulé structures with wheland intermediate*

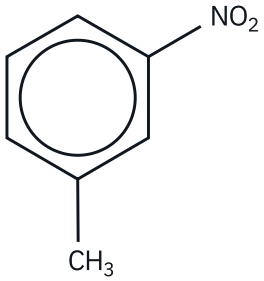


20(c)(iii)

(Synthesis 1 shows that the) $-CH_3$ is 2, (4)-directing

AND

(Synthesis 2 is not successful because) $-NO_2$ / nitro group is 3-directing ✓



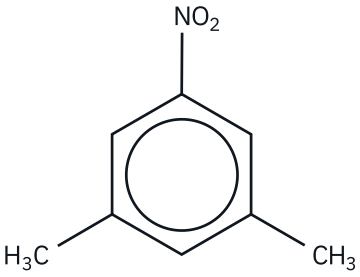
ALLOW *CH_3 is 2, (4)-directing* ***AND*** *$-NO_2$ / nitro group is not (2, 4-directing)*

ALLOW *$-NO_2$ / nitro group is 3-directing AND $-CH_3$ is not*

IGNORE *CH_3 and NO_2 have different directing effects (the directing effect of at least one of the groups must be specified)*

ALLOW *alternatives for 'directing' e.g. substitutes at*

OR



✓

[2 marks]

ALLOW *–NO_2 / nitro group is meta directing*

ALLOW *-CH_3 is ortho, (para) directing*

IGNORE *5-directing for -NO_2*

IGNORE *6-directing for -CH_3*

ALLOW *Kekulé structure*

20(c)(iv)

Reagents

Sn **AND** HCl ✓

Equation



H_2O product **AND** balancing ✓

[2 marks]

ALLOW *names if no formulae given*

IGNORE *dilute for HCl*

IGNORE *H_2 (with Sn and HCl)*

IGNORE *NaOH if seen as a reagent to convert nitro group into amine*

e.g 'Sn/(concentrated) HCl then NaOH' scores the mark

ALLOW *suitable non-specification alternatives:*

e.g. Zn **AND** HCl

OR H_2 **AND** Ni

Q6 · November 2020 · Paper 2 (Synthesis and analytical techniques) · Q7 · [1 mark]

Answer: **A**

Aqueous potassium hydroxide

Q7 · November 2021 · Paper 2 (Synthesis and analytical techniques) · Q14 · [1 mark]

Answer: **C**

Only 2 and 3

Q8 · November 2021 · Paper 2 (Synthesis and analytical techniques) · Q15 · [1 mark]

Answer: **A**

1, 2 and 3

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