A level Chemistry exam questions :Aromatic compounds

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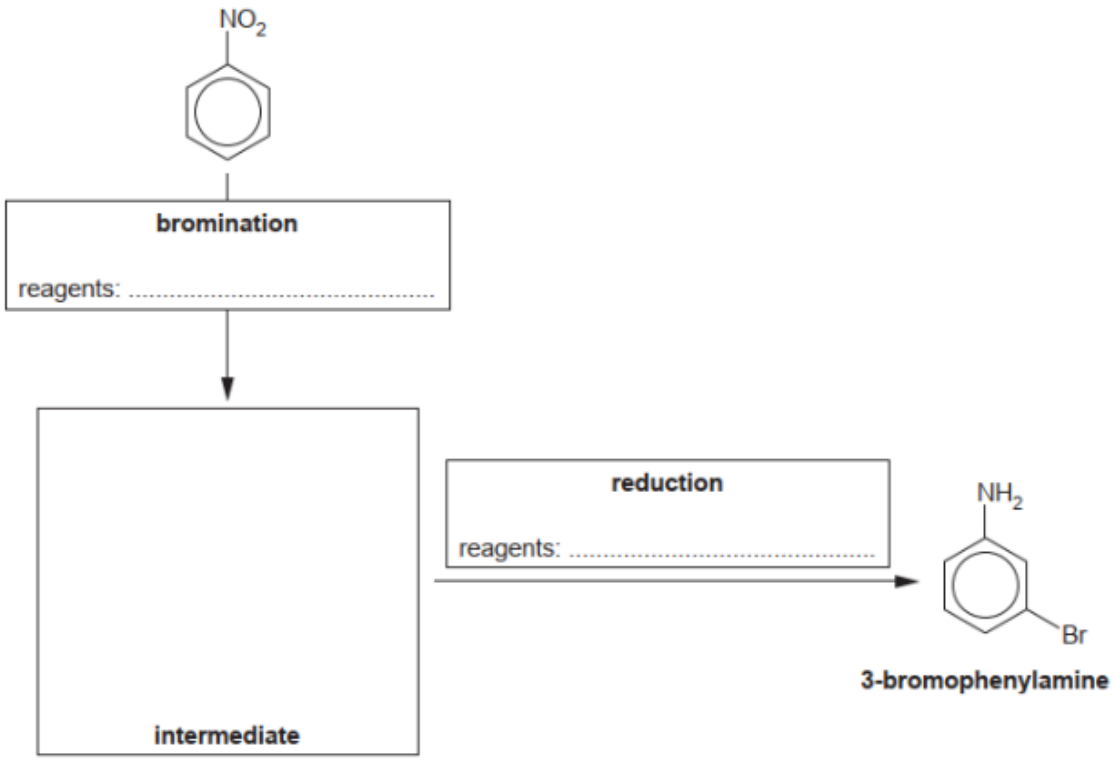
Question 1.

A student synthesises 3-bromophenylamine, shown below, starting from nitrobenzene.

(i) Complete the flowchart showing the structure of the intermediate and the formulae of the reagents for each stage.



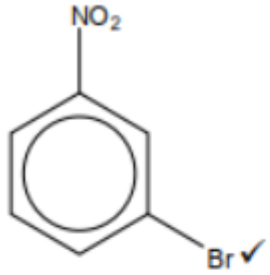
(ii) Another student attempts the same synthesis but carries out reduction before bromination.

The student was surprised to find that two structural isomers of 3-bromophenylamine had been formed instead of the desired organic product.

Explain this result and suggest the structures of the two isomers that formed.

Answer 1. (i)

Bromination : Br_2 AND $AlBr_3$ /$FeBr_3$ /Fe



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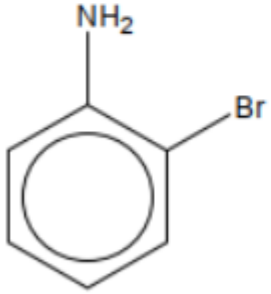
Reduction: Sn **AND** (concentrated) HC*l* ✓

(ii)

NH_2 is 2,4 directing ✓

Products (1 mark for each):



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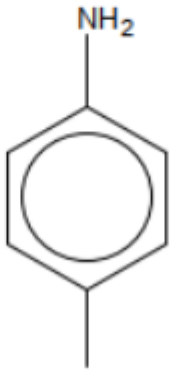

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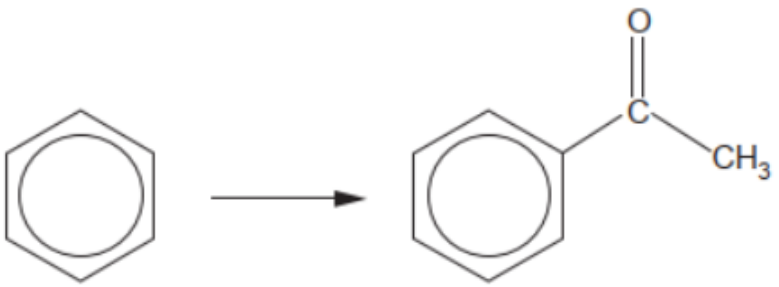
Question 2.

Benzene reacts with an organic reagent in the presence of a halogen carrier to form phenylethanone.



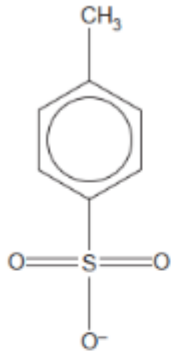
phenylethanone

Which organic reagent is required?

A. CH_3CH_2OH B. CH_3CHO C. CH_3COCl D. CH_3COOH

Question 3.

Methylbenzene reacts with sulfur trioxide, SO_3, to form D, shown below.

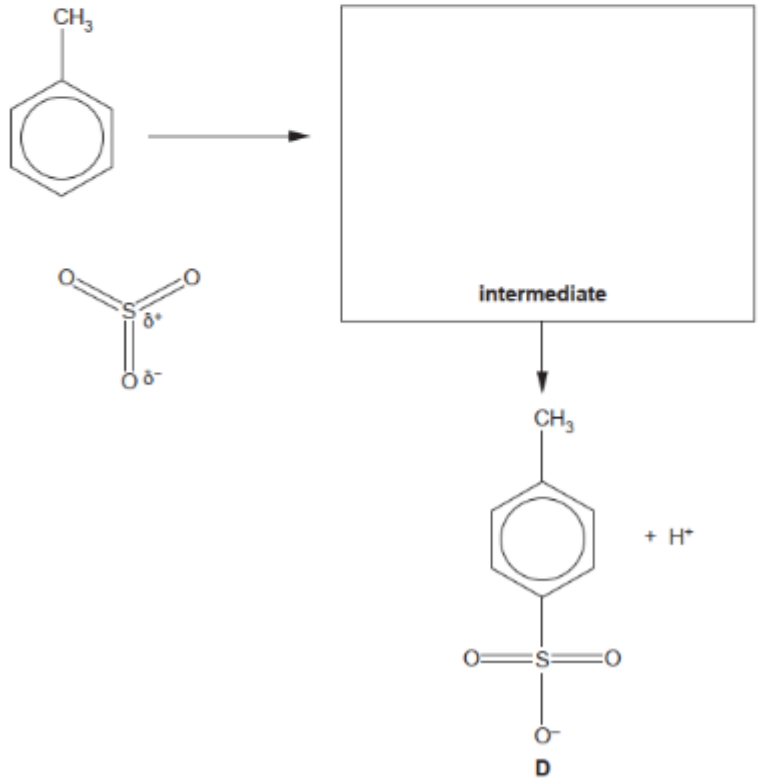


D

The electrophile in this reaction is SO_3.

Complete the mechanism for the formation of D .

Show curly arrows and the structure of the intermediate.

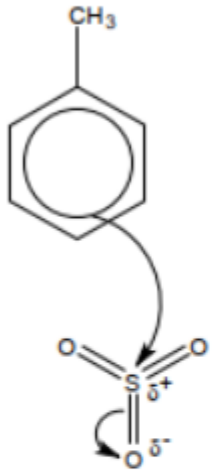


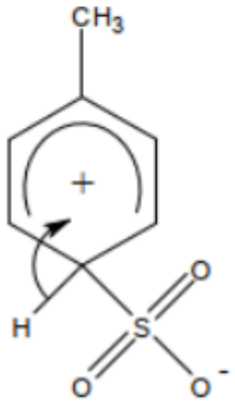
Answer 3.

Curly arrow from π -bond to S in SO_3

AND

curly arrow from the S=O bond to O atom





Question 4.

This question is about benzene.

(a) Over time, the Kekulé and delocalised models have been used to describe the bonding and structure of a benzene molecule.

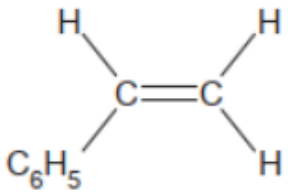
(i) Describe, in terms of orbital overlap, the similarities and differences between the bonding in the Kekulé model and the delocalised model of benzene.

(ii) Experimental evidence led to the general acceptance of the delocalised model over the Kekulé model.

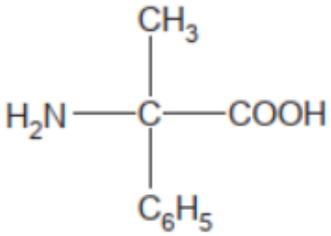
Describe two pieces of evidence to support the delocalised model of benzene.

(b) Benzene can be used as the starting material for the synthesis of compounds D and E , shown below.

In the diagrams C_6H_5 is a phenyl group.



compound D



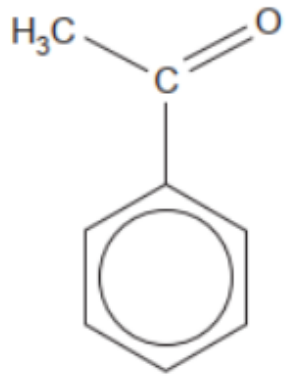
compound E

Compounds D and E can be converted into polymers.

(i) Draw two repeat units of these polymers.

(ii) State the type of polymer formed from compounds D and E.

(iii) In the synthesis of compounds D and E , benzene is first reacted with ethanoyl chloride, CH_3COCl , to form phenylethanone, shown below.



phenylethanone

The reaction takes place in the presence of aluminium chloride, $AlCl_3$, which acts as a catalyst.

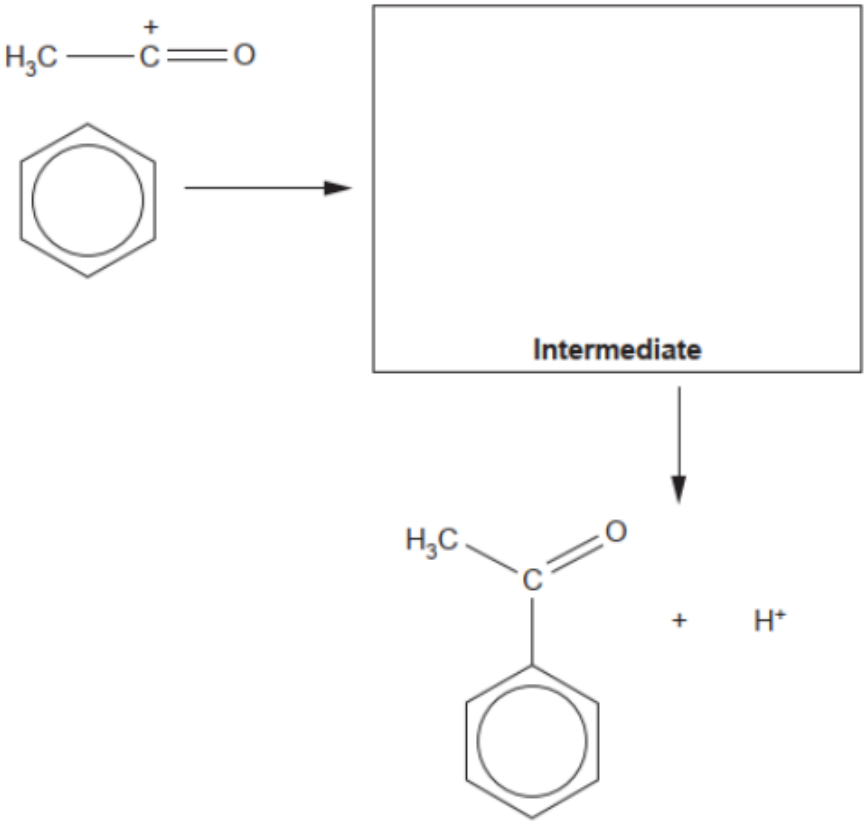
In the mechanism for this reaction,

- ethanoyl chloride first reacts with aluminium chloride to form the $CH_3-C^+=O$ cation
- the $CH_3-C^+=O$ cation then behaves as an electrophile.

Complete the mechanism for the reaction.

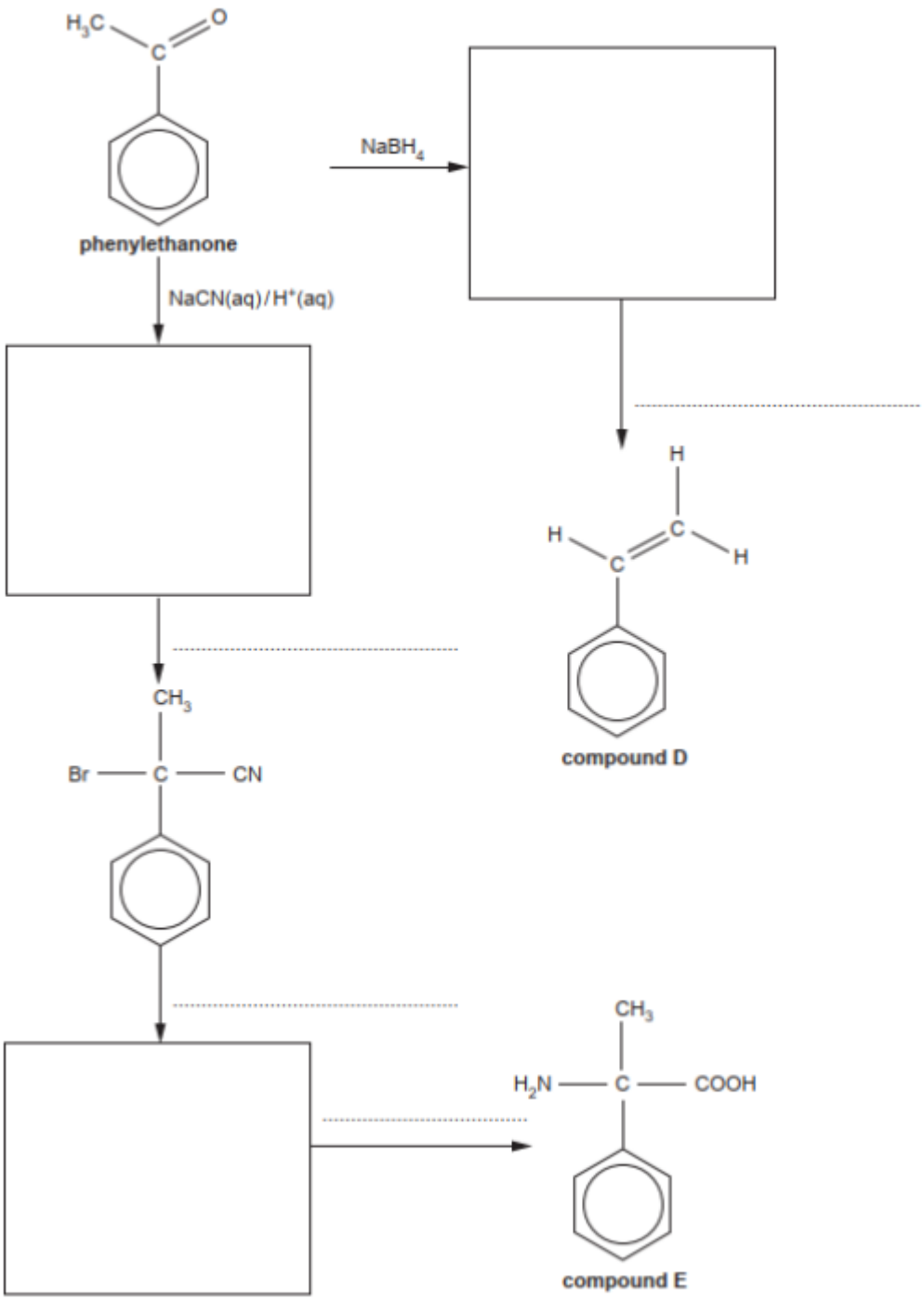
Include equations to show the role of the $AlCl_3$ catalyst, relevant curly arrows and the structure of the intermediate.

Formation of electrophile .....



Regeneration of catalyst .....

(iv) Complete the flowchart for the synthesis of compounds D and E from phenylethanone.



Answer 4.

Similarities

Orbital overlap

Difference

Kekule has: alternating π-bond

AND

Delocalised has: π ring (system)

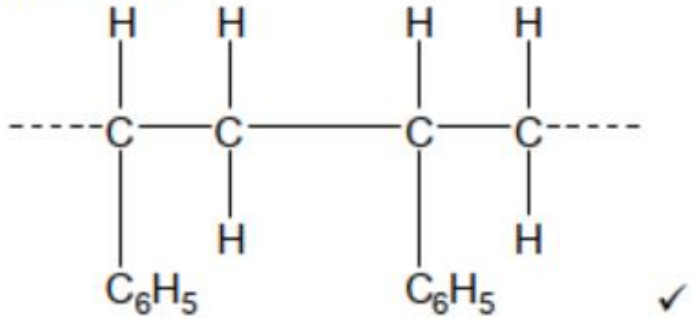
Bond length

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

Resistance to reaction

Benzene is less reactive than alkenes

Polymer from D



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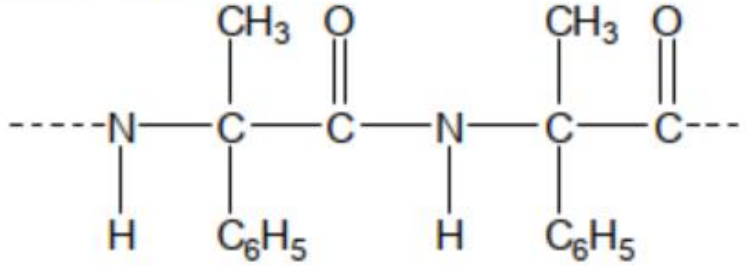
Polymer from E



(ii) D Addition / polyalkene

AND

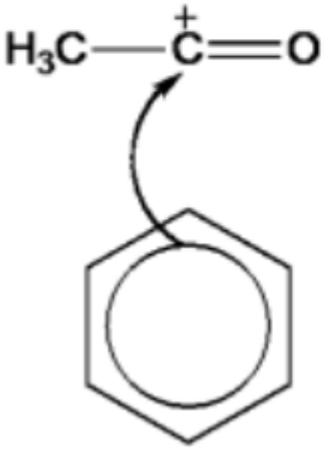
E : Condensation / polyamide

(iii) Formation of electrophile

$$CH_3COCl + AlCl_3 \rightarrow CH_3 - C^+ = O + AlCl_4^-$$

Mechanism

Curly arrow from -bond to $CH_3C=O$



Regeneration of catalyst

$H^+ + AlCl_4^- \rightarrow AlCl_3 + HCl$

(iv) one mark for each correct structure/reagent