

Question

Benzene Properties

Subject & topics: Chemistry | Organic | Aromaticity **Stage & difficulty:** A Level P1

Part A

Benzene

Which property of benzene may be directly attributed to the stability associated with its delocalised electrons?

- It tends to undergo substitution rather than addition reactions.
- It does not conduct electricity.
- It has a low boiling point.
- It is susceptible to attack by nucleophilic reagents.
- Its enthalpy change of formation is negative.

Part B
Reactions

The most characteristic type of reaction undergone by benzene and its derivatives is:

- Free radical substitution
- Electrophilic addition
- Nucleophilic addition
- Nucleophilic substitution
- Electrophilic substitution

Part A adapted with permission from UCLES, A-Level Chemistry, June 1992, Paper 4, Question 23;

Part B adapted with permission from OCSEB, A-Level Chemistry, June 1995, Paper 1, Question 24.

Question

Nitration of Methylbenzene

Subject & topics: Chemistry | Organic | Reactions (aromatics) **Stage & difficulty:** A Level P2

When methylbenzene reacts with a mixture of concentrated nitric and sulfuric acids the product consists largely of two isomers of formula $C_7H_7NO_2$.

Part A

Reaction type

What type of reaction is this?

Part B

Major products

While the nitro group could replace any of the hydrogens on the ring, giving [] potential isomers, not all of them are equally likely. Due to the directing effect of the methyl group, the main products will be 1-methyl-[]-nitrobenzene and 1-methyl-[]-nitrobenzene.

Items:

- 1
- 2
- 3
- 4
- 5

Adapted with permission from UCLES, A-Level Science, November 1996, Chains and Rings, Question 2

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Question

Nitration of Benzene Mechanism

Subject & topics: Chemistry | Organic | Reactions (aromatics) **Stage & difficulty:** A Level P3

The mechanism of the nitration of benzene by concentrated nitric and sulfuric acids is thought to proceed via the following pathway.

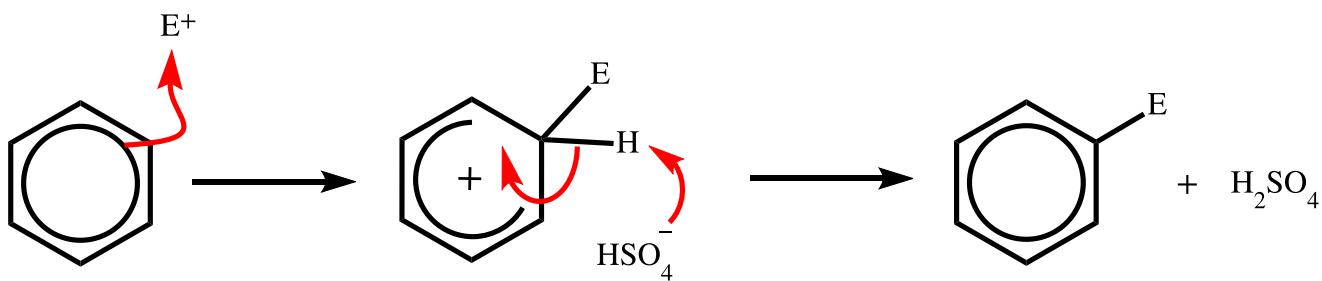


Figure 1: Benzene nitration mechanism

Part A
Electrophile

What is the formula and charge of the electrophile in this reaction?

Part B
Formation of electrophile

Write a balanced equation for the formation of this electrophile (state symbols are not required).

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Question

Aromatic Chemistry with Side Chains

Subject & topics: Chemistry | Organic | Aromaticity **Stage & difficulty:** A Level P1

Part A

Reaction with cyanide ion

A compound **Q** has the following structure:

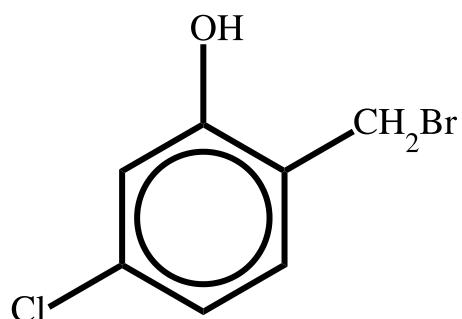
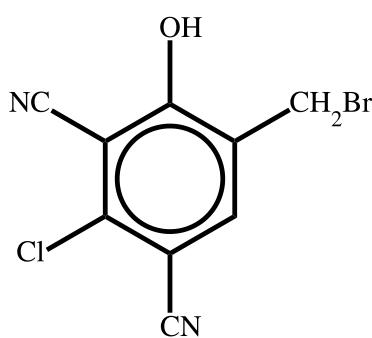
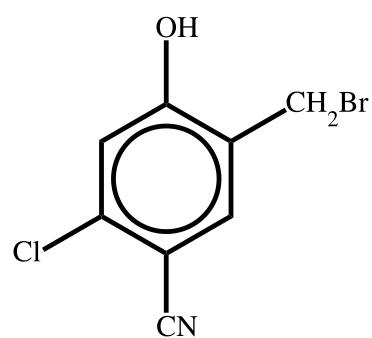


Figure 1: Structure of compound **Q**

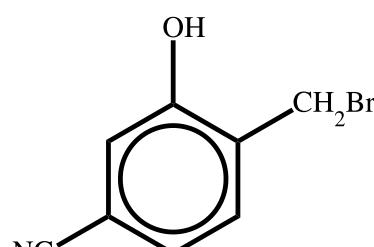
Which compound is obtained by nucleophilic substitution when a cyanide ion reacts with compound **Q**?



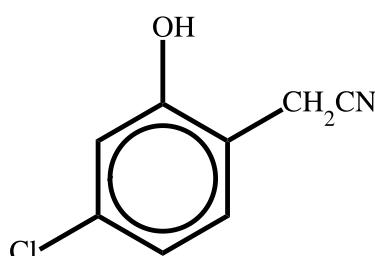
A



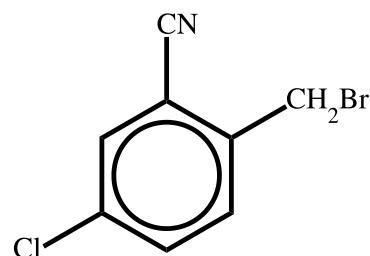
B



C



D



E

Figure 2: Possible reaction products of **Q** with cyanide ion.

- A**
- B**
- C**

D

E

Part B

Methylbenzene with chlorine

The reaction between boiling methylbenzene and chlorine takes place in a number of steps to give several products.

Which of the following could be one of the steps?

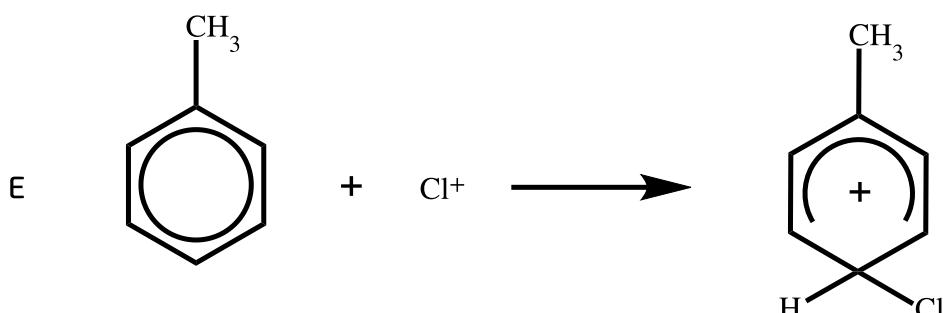
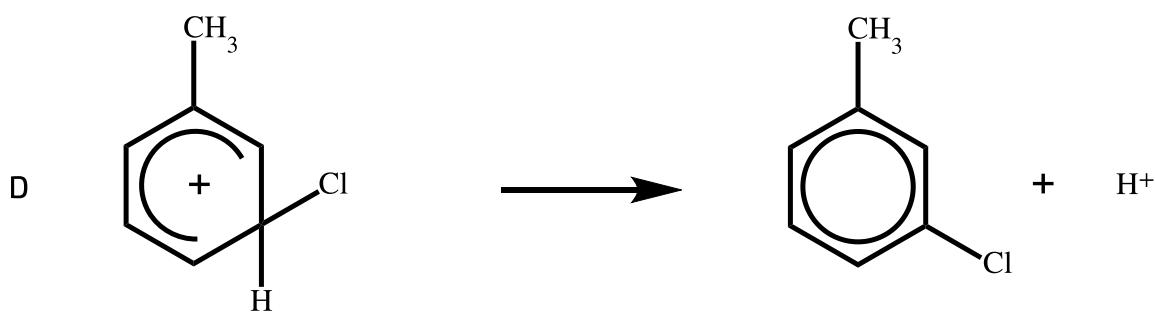
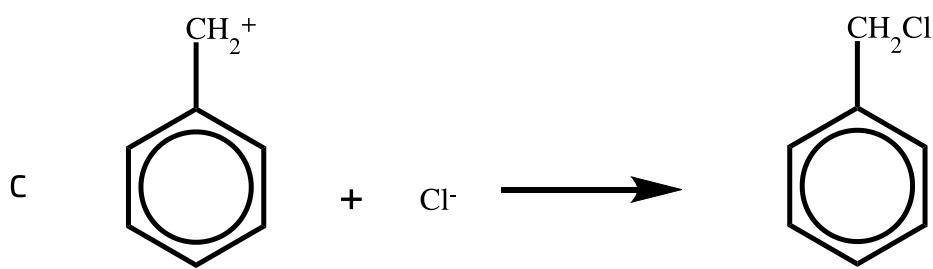
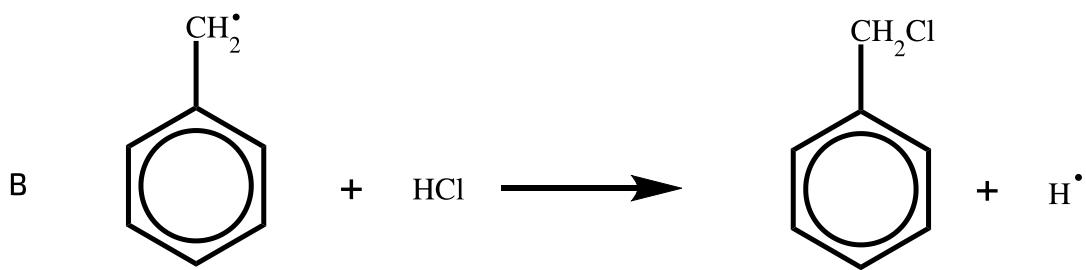
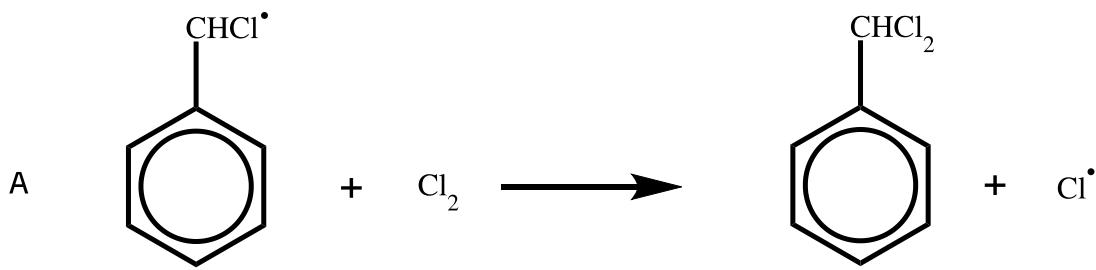


Figure 3: Possible reaction steps of methylbenzene with chlorine.

- A
- B
- C

D

E

Part A adapted with permission from UCLES, A-Level Chemistry, June 1991, Paper 1, Question 26;

Part B adapted with permission from UCLES, A-Level Chemistry, November 1992, Paper 4, Question 22

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Question

Phenols

Subject & topics: Chemistry | Organic | Aromaticity **Stage & difficulty:** A Level P1

Part A

Phenol with aqueous bromine

An account in a student's notebook read:

"An excess of aqueous bromine was added to aqueous phenol in a test-tube. 2,4,6-Tribromophenol was produced as a creamy-white precipitate suspended in a yellow alkaline solution."

Which statement in this account must have been incorrect?

- The resultant solution is not alkaline, but acidic.
- The precipitate is not 2,4,6-tribromophenol, but a mixture of 2- and 4-bromophenol
- The resultant solution is not yellow, but purple.
- The precipitate obtained is not creamy-white but yellow

Part B
Germicide

Phenol was one of earliest antiseptics used; however, it causes painful blisters on the skin. A safer and more effective germicide can be produced by reacting phenol with aqueous chlorine.

What is the formula of this safer germicide?

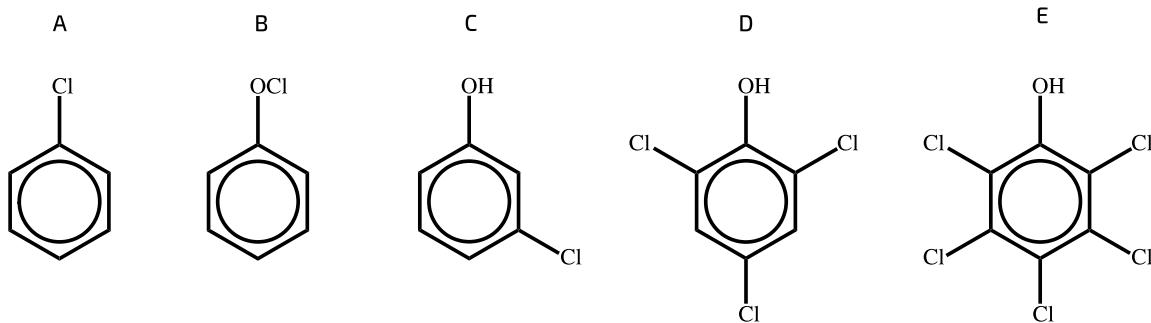


Figure 1: Possible products of reaction between phenol and chlorine

- A
- B
- C
- D
- E

Part A adapted with permission from UCLES, A-Level Chemistry, June 1995, Paper 4, Question 25;

Part B adapted with permission from UCLES, A-Level Chemistry, November 1992, Paper 4, Question 25.

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Question

Aromatics with Nitrogen Groups

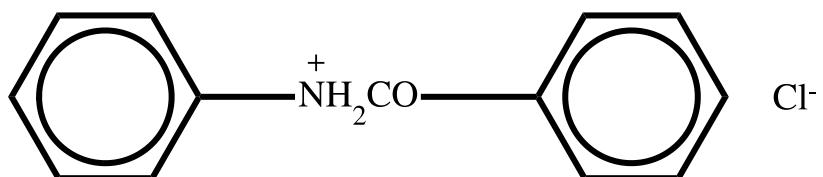
Subject & topics: Chemistry | Organic | Aromaticity **Stage & difficulty:** A Level P1

Part A

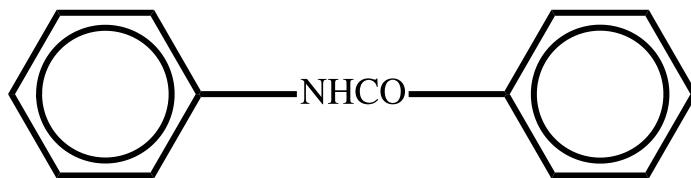
Phenylamine and benzoyl chloride

What is the most likely product of the reaction between phenylamine and benzoyl chloride (C_6H_5COCl)?

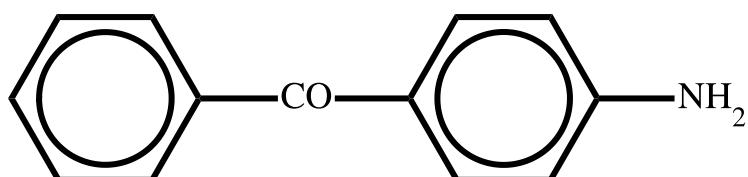
A



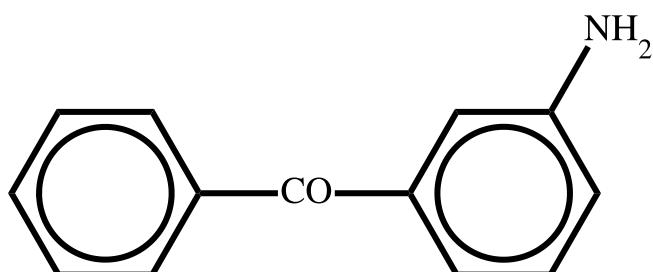
B



C



D



E

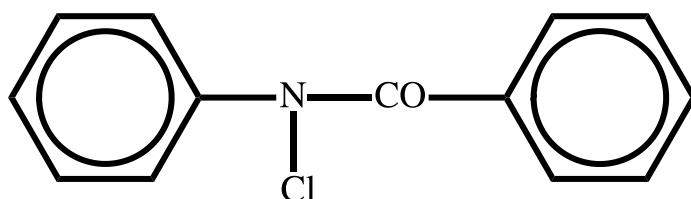


Figure 1: Possible products of reaction between phenylamine and benzoyl chloride.

A

- B**
- C**
- D**
- E**

Part B
Hydrolysis

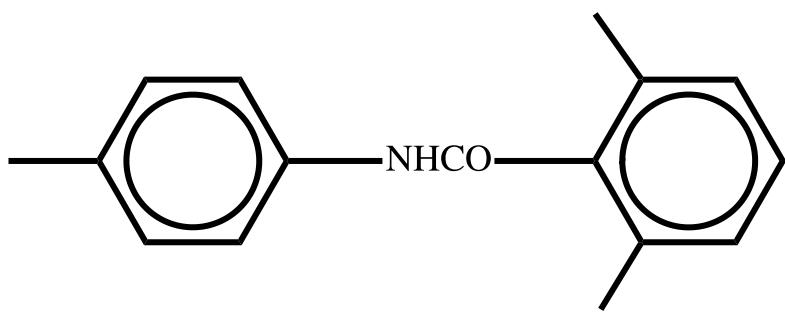
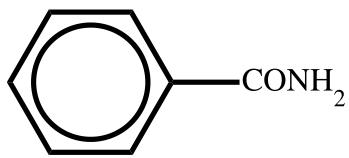


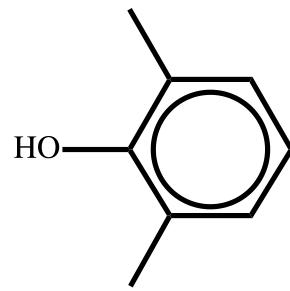
Figure 2: Compound Y

Which of the following are formed by the hydrolysis of compound Y?

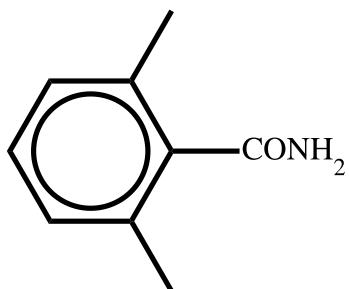
A



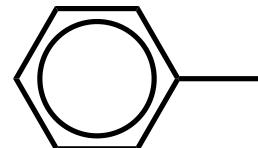
and



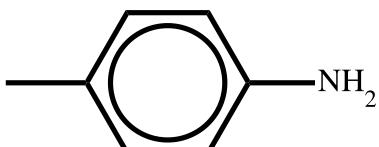
B



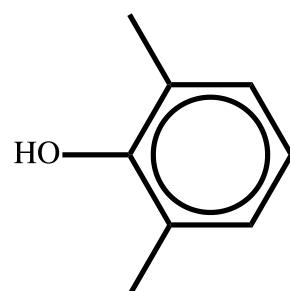
and



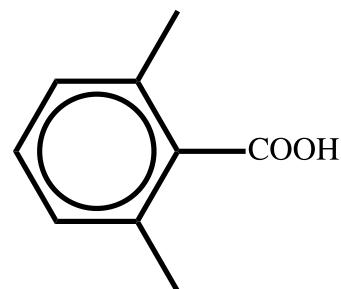
C



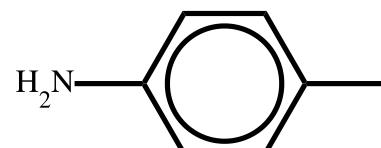
and



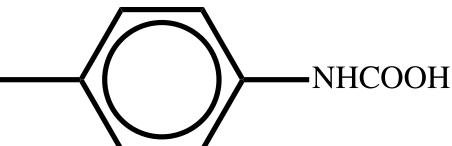
D



and



E



and

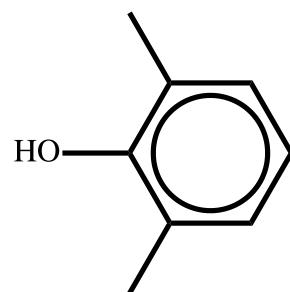


Figure 3: Possible products of hydrolysis of compound Y

A

B

C

D

E

Part A adapted with permission from UCLES, A-Level Chemistry, June 1991, Paper 1, Question 30;

Part B adapted with permission from UCLES, A-Level Chemistry, June 1988, Paper 3, Question 29.

Question deck:

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Question

Electrophilic Attack

Subject & topics: Chemistry | Organic | Aromaticity Stage & difficulty: A Level C1

Part A

Site of attack

At which of the carbon atoms in the molecule below is electrophilic attack most likely?

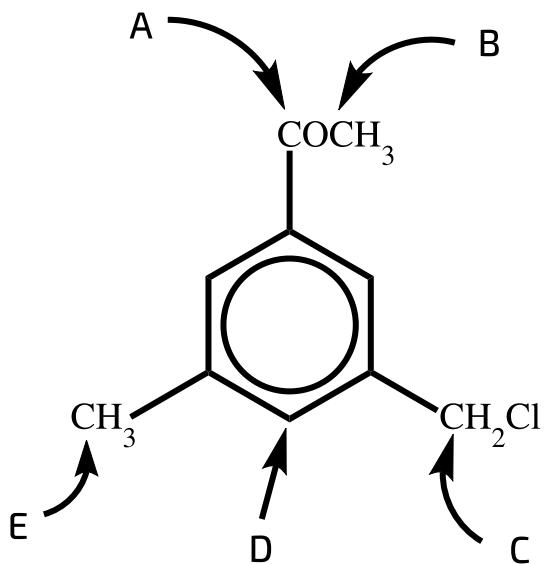


Figure 1: Potential sites of electrophilic attack

- A
- B
- C
- D
- E

Part B

Cumene process

The first stage of the cumene process for the industrial production of phenol is as follows.

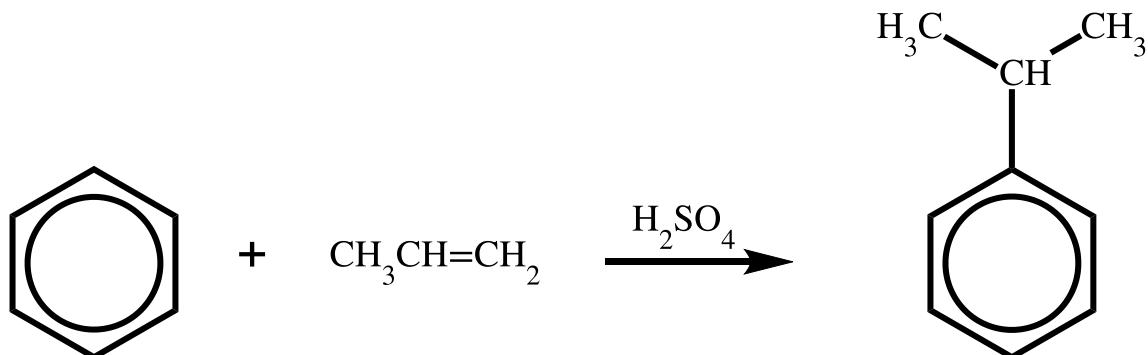
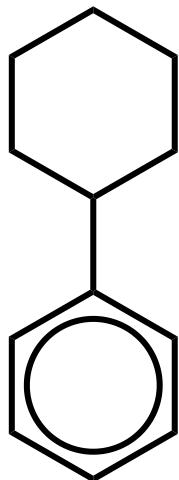
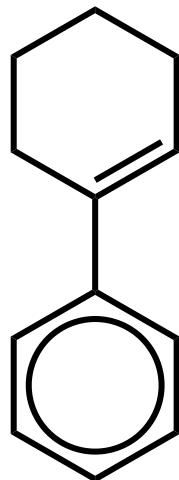


Figure 2: First stage of the cumene process

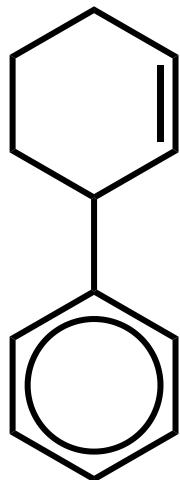
Which of the following would be the product of the reaction, under similar conditions, between benzene and cyclohexene?



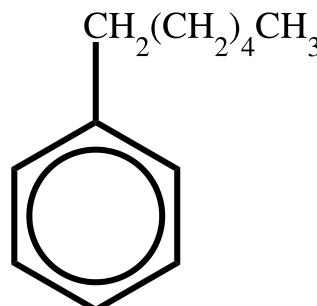
A



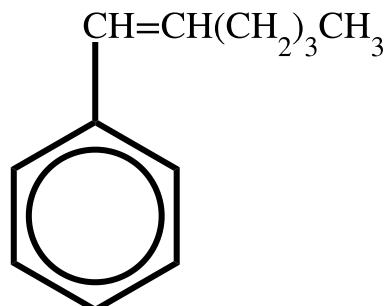
B



C



D



E

Figure 3: Possible products of the reaction between benzene and cyclohexene

- A
- B
- C
- D
- E

Part A adapted with permission from UCLES, A-Level Chemistry, 1988, Paper 3, Question 24;

Part B adapted with permission from UCLES, A-Level Chemistry, 1988, Paper 3, Question 27.

Question deck:

STEM SMART Chemistry Week 41

Question

Reactions of Aromatics

Subject & topics: Chemistry | Organic | Reactions (aromatics) **Stage & difficulty:** A Level P2

Draw the structures of the products of the following reactions. If there is no reaction, give the structure of the starting material.

Use the [structure editor](#) to generate SMILES strings.

In the editor, after drawing your structure, click on the round, yellow smiley face to generate a SMILES string. Copy the SMILES string and paste it in the answer box.

[Using the structure editor](#)

Part A

Benzene + Br₂

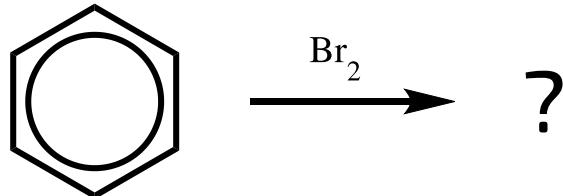


Figure 1: Benzene + Br₂

Part B

Benzene + Br₂ / FeBr₃

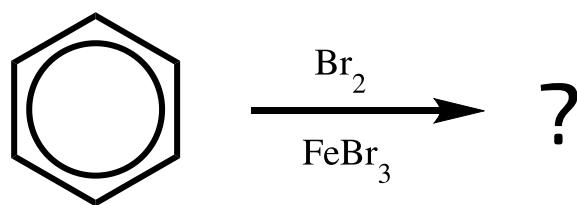


Figure 2: Benzene + Br₂ / FeBr₃

Part C

Phenol + Br₂

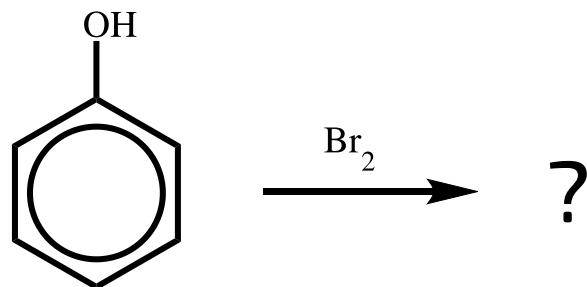


Figure 3: Phenol + Br₂

Part D

Benzene + CH_3COCl / AlCl_3

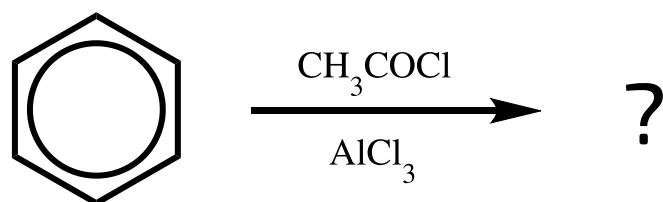


Figure 4: Benzene + CH_3COCl / AlCl_3

Part E

Phenol + CH_3COCl

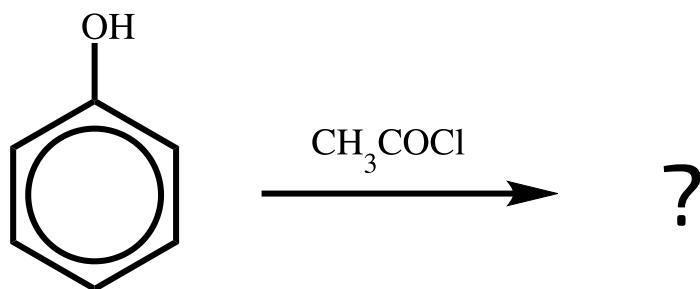


Figure 5: Phenol + CH_3COCl

Part F

Nitrobenzene + Sn / HCl

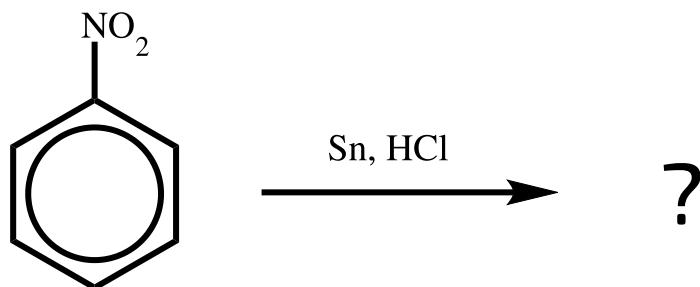


Figure 6: Nitrobenzene + Sn / HCl

Part G

Benzene + $\text{C}_2\text{H}_5\text{Cl}$ / AlCl_3

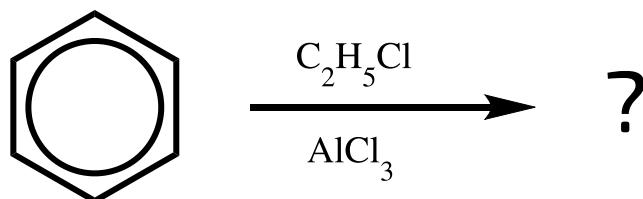


Figure 7: Benzene + $\text{C}_2\text{H}_5\text{Cl}$ / AlCl_3

Question

Ethylbenzene

Subject & topics: Chemistry | Organic | Aromaticity **Stage & difficulty:** A Level C1

Ethylbenzene, is an important intermediate in the manufacture of poly(phenylethene), commonly known as polystyrene.

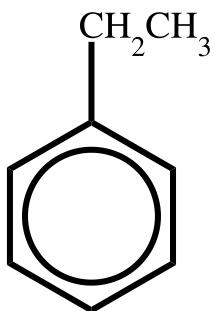


Figure 1: Structure of ethylbenzene.

When ethylbenzene is treated with chlorine under certain conditions, a mixture of two isomeric chlorides, **A** and **B**, are formed.

A and **B** both react with hot concentrated alcoholic potassium hydroxide to give phenylethene, but with aqueous sodium hydroxide, form two isomeric compounds **C** and **D**, respectively, of formula C₈H₁₀O.

C reacts with acidified potassium dichromate(VI) to give **E** which does not give a silver mirror in the presence of Tollens' reagent.

D also reacts with acidified potassium dichromate(VI) to give **F** as a final product. **F** gives effervescence of CO₂ on addition of aqueous sodium carbonate solution.

Give the structures of compounds **A** - **F**. Use the [structure editor](#) to generate a SMILES string as your answer.

Part A

Compound A

Give the structure of compound **A**. Use the [structure editor](#) to generate a SMILES string as your answer.

Part B

Compound B

Give the structure of compound **B**. Use the [structure editor](#) to generate a SMILES string as your answer.

Part C

Compound C

Give the structure of compound **C**. Use the [structure editor](#) to generate a SMILES string as your answer.

Part D

Compound D

Give the structure of compound **D**. Use the [structure editor](#) to generate a SMILES string as your answer.

Part E

Compound E

Give the structure of compound **E**. Use the [structure editor](#) to generate a SMILES string as your answer.

Part F

Compound F

Give the structure of compound F. Use the [structure editor](#) to generate a SMILES string as your answer.

Adapted with permission from UCLES, A-Level Chemistry, November 1995, Paper 1, Question 10.

Question deck:

[STEM SMART Chemistry Week 41](#)

Question

Aromatic Acids and Bases

Subject & topics: Chemistry | Organic | Aromaticity **Stage & difficulty:** A Level C2

The benzene ring has a strong effect on the acidity and basicity of groups directly bonded to the ring. **Negative charges** and **lone pairs** of electrons are **delocalised** into the aromatic ring.

OH groups become more acidic and N lone pairs become less basic as a result of this delocalisation.

Part A

Aromatic acids

Match the aromatic compound with its correct pK_a value.

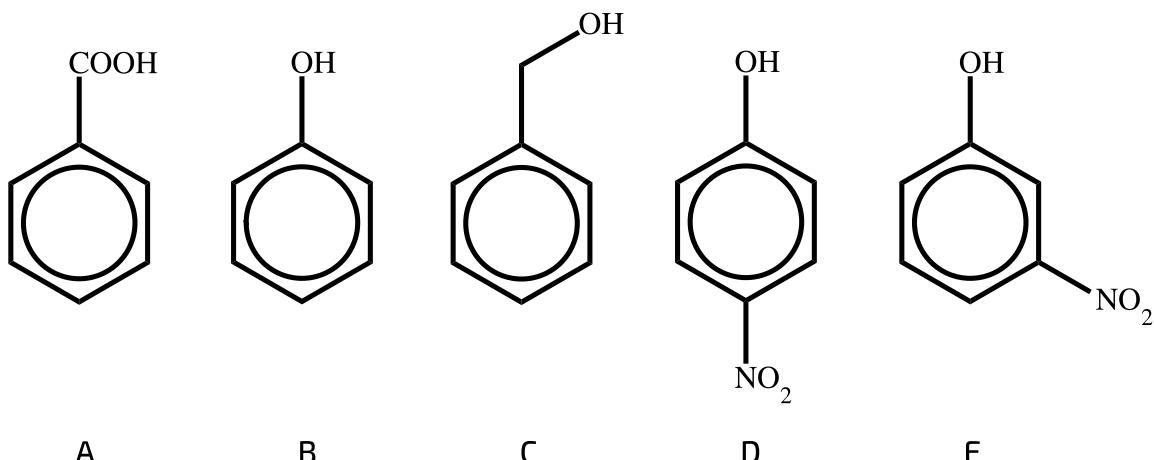


Figure 1: Aromatic compounds A - E with acidic hydrogen atoms.

Compound	pK_a
A	<input type="text"/>
B	<input type="text"/>
C	<input type="text"/>
D	<input type="text"/>
E	<input type="text"/>

Items:

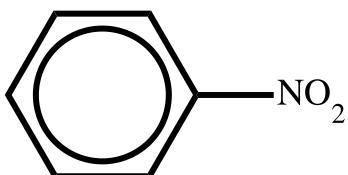
- 4.2 7.2 8.4 10.0 15.4

Part B

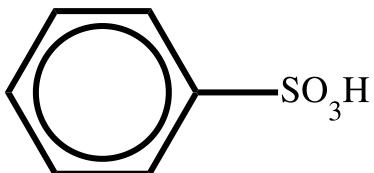
Phenylamine with aqueous sulfuric acid

Which of the following products is formed when phenylamine (aniline) dissolves in dilute aqueous sulfuric acid?

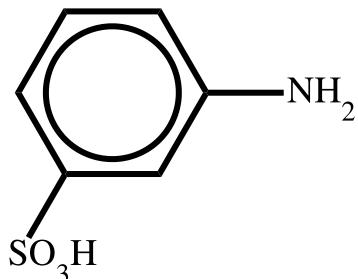
A



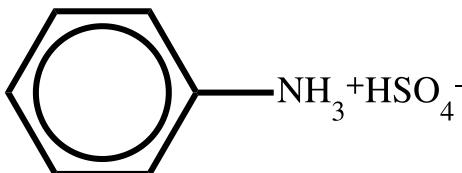
B



C



D



E

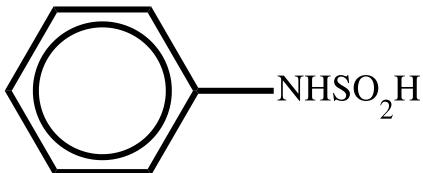


Figure 2: Possible products of phenylamine with dilute aqueous sulfuric acid.

- A
- B
- C
- D
- E

Part C

Basicity of amines

Rank the following compounds in order of increasing basicity:

Most basic

Least basic

Items:

Phenylamine

Diphenylamine

Ammonia

Ethylamine

Diethylamine

Parts A and C created for isaacphysics.org by R. Less;

Part B adapted with permission from OCSEB, A-Level Chemistry, June 1994, Paper 1, Question 28