



A LEVEL CHEMISTRY

TOPIC 18 – AROMATIC CHEMISTRY

ASSESSED HOMEWORK

Answer all questions

Max 80 marks

Name		
Mark/80%	Grade

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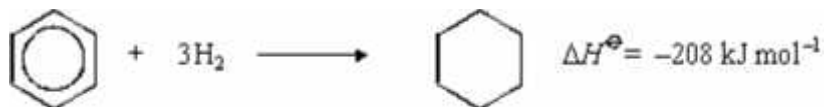
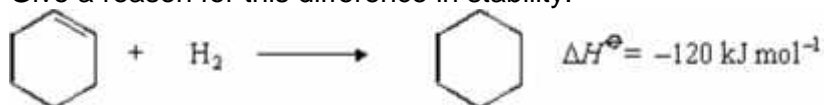


1. (a) Use the following data to show the stability of benzene relative to the hypothetical

cyclohexa-1,3,5-triene.



Give a reason for this difference in stability.



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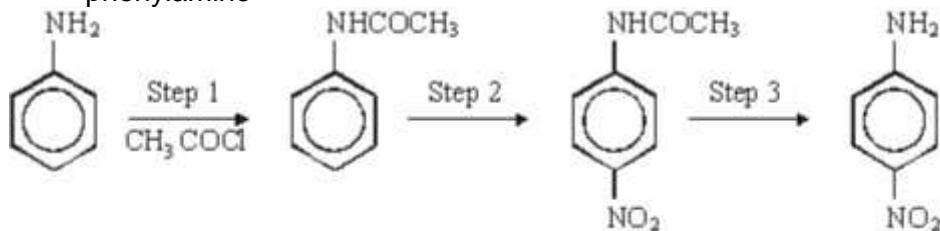
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(b) Consider the following reaction sequence which starts from phenylamine



(i) State and explain the difference in base strength between phenylamine and ammonia.

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(ii) Name and outline a mechanism for the reaction in Step 1 and name the organic product of Step 1.

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(iii) The mechanism of Step 2 involves attack by an electrophile. Give the reagents used in this step and write an equation showing the formation of the electrophile. Outline a mechanism for the reaction of this electrophile with benzene.

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- (iv) Name the type of linkage which is broken in Step 3 and suggest a suitable reagent for this reaction.

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(17)
(Total 21 marks)

2. Many synthetic routes need chemists to increase the number of carbon atoms in a molecule by forming new carbon-carbon bonds. This can be achieved in several ways including reaction of an aromatic compound with an acyl chloride

Consider the reaction of benzene with $\text{CH}_3\text{CH}_2\text{COCl}$

- (i) Write an equation for this reaction and name the organic product.
Identify the catalyst required in this reaction.
Write equations to show how the catalyst is used to form a reactive intermediate and how the catalyst is reformed at the end of the reaction.

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(5)

- (ii) Name and outline a mechanism for the reaction of benzene with this reactive intermediate.

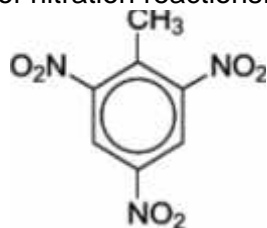
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(4)
(Total 9 marks)

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3. Many aromatic nitro compounds are used as explosives. One of the most famous is 2-methyl-1,3,5-trinitrobenzene, originally called trinitrotoluene or TNT. This compound, shown below, can be prepared from methylbenzene by a sequence of nitration reactions.



- (a) The mechanism of the nitration of methylbenzene is an electrophilic substitution.

- (i) Give the reagents used to produce the electrophile for this reaction.
Write an equation or equations to show the formation of this electrophile.

Reagents

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Equation

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(3)

- (ii) Outline a mechanism for the reaction of this electrophile with methylbenzene to produce 4-methylnitrobenzene.

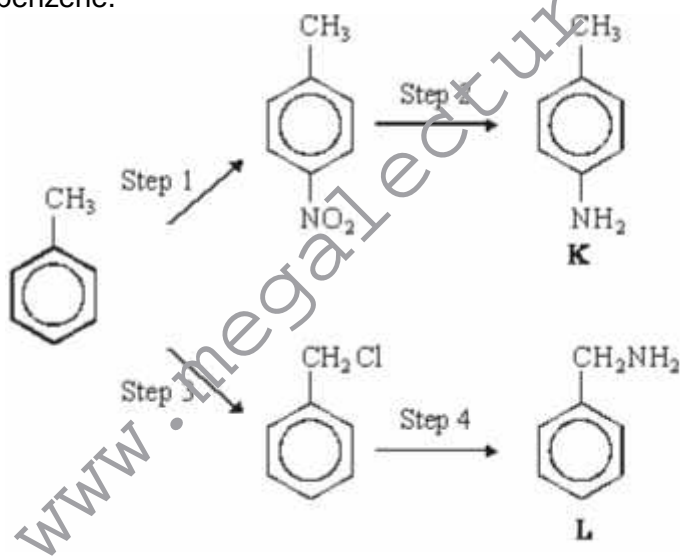
(3)

- (b) Using the molecular formula ($C_7H_5N_3O_6$), write an equation for the decomposition reaction that occurs on the detonation of TNT. In this reaction equal numbers of moles of carbon and carbon monoxide are formed together with water and nitrogen.

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(1)
(Total 7 marks)

4. The following reaction scheme shows the formation of two amines, **K** and **L**, from methylbenzene.



- (a) (i) Give the reagents needed to carry out Step 1. Write an equation for the formation from these reagents of the inorganic species which reacts with methylbenzene.

Reagents

Equation

- (ii) Name and outline a mechanism for the reaction between this



inorganic species and methylbenzene.

Name of
mechanism

Mechanism

(7)

(b) Give a suitable reagent or combination of reagents for Step 2.

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(1)



- (c) (i) Give the reagent for Step 4 and state a condition to ensure that the primary amine is the major product.

Reagent

Condition

- (ii) Name and outline a mechanism for Step 4.

Name of mechanism

Mechanism

(7)

- (d) Explain why amine **K** is a weaker base than ammonia.

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(2)

- (e) Draw the structure of the organic compound formed when a large excess of bromomethane reacts with amine **L**.

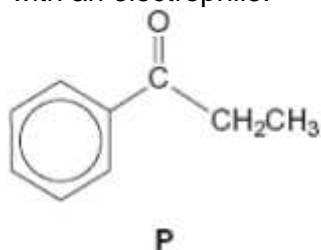
(1)

- (f) Draw the structure of the organic compound formed when ethanoyl chloride reacts with amine **L** in an addition–elimination reaction.

(1)

(Total 19 marks)

5. Consider compound **P** shown below that is formed by the reaction of benzene with an electrophile.



- (a) Give the **two** substances that react together to form the electrophile and write an equation to show the formation of this electrophile.

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(3)

- (b) Outline a mechanism for the reaction of this electrophile with benzene to form **P**.

(3)

- (c) Compound **Q** is an isomer of **P** that shows optical isomerism. **Q** forms a silver mirror when added to a suitable reagent.

Identify this reagent and suggest a structure for **Q**.

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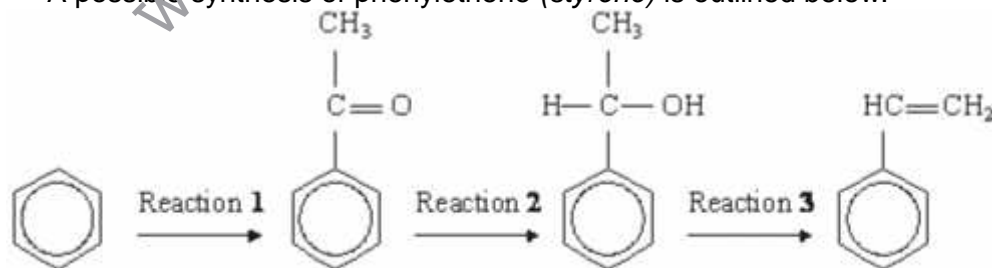
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(2)
(Total 8 marks)

6. A possible synthesis of phenylethene (*styrene*) is outlined below.



- (a) In Reaction 1, ethanoyl chloride and aluminium chloride are used to form a reactive species which then reacts with benzene. Write an equation to show the formation of the reactive species.



Name and outline the mechanism by which this reactive species reacts with benzene.

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(6)

- (b) NaBH_4 is a possible reagent for Reaction 2.
Name and outline the mechanism for the reaction with NaBH_4 in Reaction 2.
Name the product of Reaction 2.

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(6)

- (c) Name the type of reaction involved in Reaction 3 and give a reagent for the reaction.

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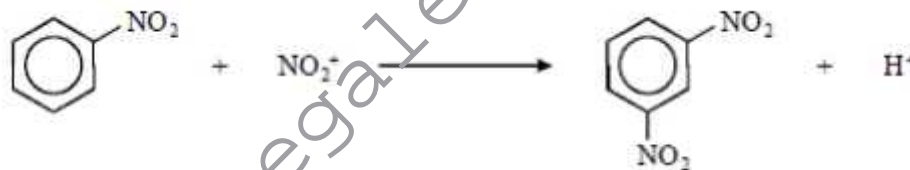
(2)

(Total 14 marks)

7. In a reaction which gave a 27.0% yield, 5.00 g of methylbenzene were converted into the explosive 2,4,6-trinitromethylbenzene (TNT) ($M_r = 227.0$). The mass of TNT formed was
- A** 1.35 g
B 3.33 g
C 3.65 g
D 12.34 g

(Total 1 mark)

8. 1,3-dinitrobenzene can be prepared by heating nitrobenzene with a mixture of fuming nitric acid and concentrated sulphuric acid. The reaction can be represented by the following equation.



If the yield of the reaction is 55%, the mass of 1,3-dinitrobenzene produced from 12.30 g of nitrobenzene is

- A** 16.90 g
B 16.80 g
C 9.30 g
D 9.24 g

(Total 1 mark)