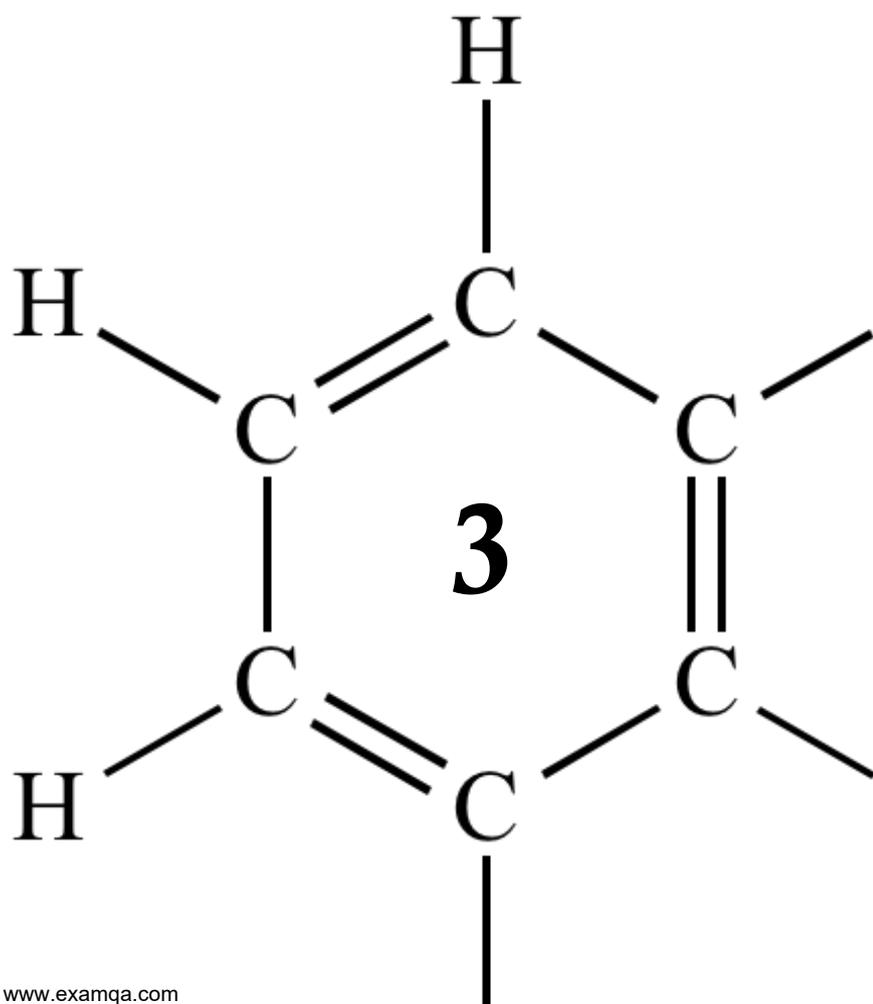


OCR A2 CHEMISTRY

MODULE 6.2

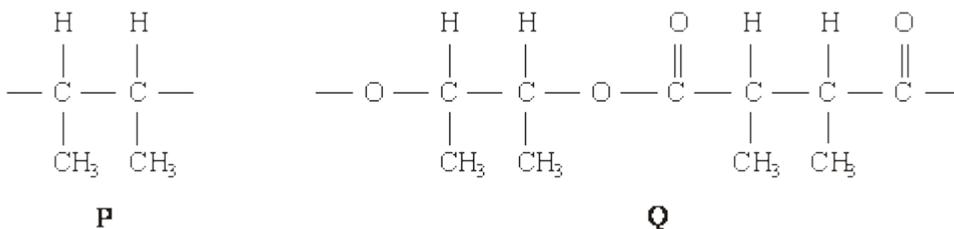
NITROGEN COMPOUNDS

POLYMERS



1

(a) The repeating units of two polymers, **P** and **Q**, are shown below.



- (i) Draw the structure of the monomer used to form polymer **P**. Name the type of polymerisation involved.

Structure of monomer

Type of polymerisation

- (ii) Draw the structures of **two** compounds which react together to form polymer **Q**. Name these **two** compounds and name the type of polymerisation involved.

Structure of compound 1

Name of compound 1

Structure of compound 2

Name of compound 2

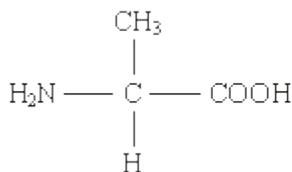
Type of polymerisation

- (iii) Identify a compound which, in aqueous solution, will break down polymer **Q** but not polymer **P**.

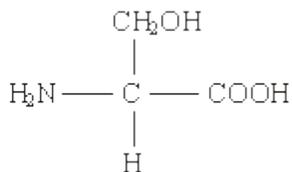
.....

(8)

- (b) Draw the structures of the **two** dipeptides which can form when one of the amino acids shown below reacts with the other.



Structure 1



Structure 2

(2)

- (c) Propylamine, $\text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2$, can be formed either by nucleophilic substitution or by reduction.

- (i) Draw the structure of a compound which can undergo nucleophilic substitution to form propylamine.

- (ii) Draw the structure of the nitrile which can be reduced to form propylamine.

- (iii) State and explain which of the two routes to propylamine, by nucleophilic substitution or by reduction, gives the less pure product. Draw the structure of a compound formed as an impurity.

Route giving the less pure product

Explanation

.....

Structure of an impurity

(5)
(Total 15 marks)

2

(a) Name the compound $(\text{CH}_3)_2\text{NH}$

.....

(1)

(b) $(\text{CH}_3)_2\text{NH}$ can be formed by the reaction of an excess of CH_3NH_2 with CH_3Br . Name and outline a mechanism for this reaction.

Name of mechanism

Mechanism

(5)

(c) Name the type of compound produced when a large excess of CH_3Br reacts with CH_3NH_2 . Give a use for this type of compound.

Type of compound

Use

(2)

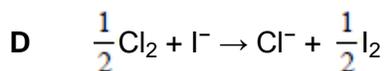
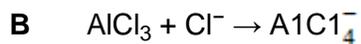
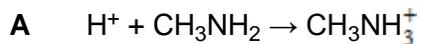
(d) Draw the structures of the two compounds formed in the reaction of CH_3NH_2 with ethanoic anhydride.

(2)

(Total 10 marks)

3

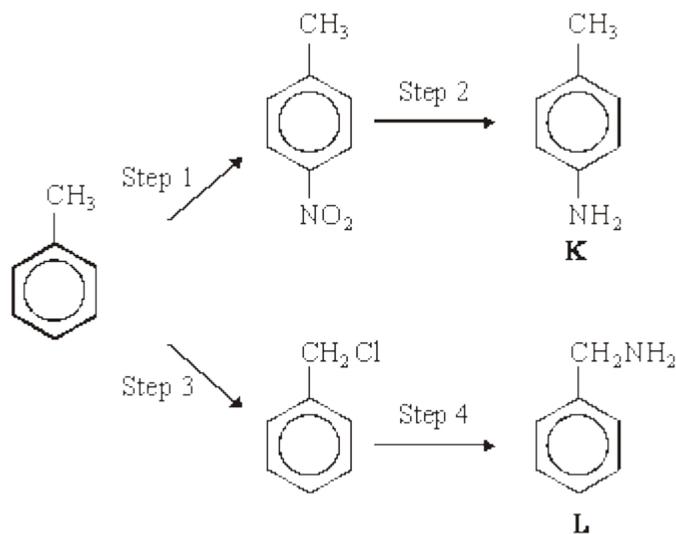
Which one of the following reactions does **not** involve donation of an electron pair?



(Total 1 mark)

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.

.....

(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.

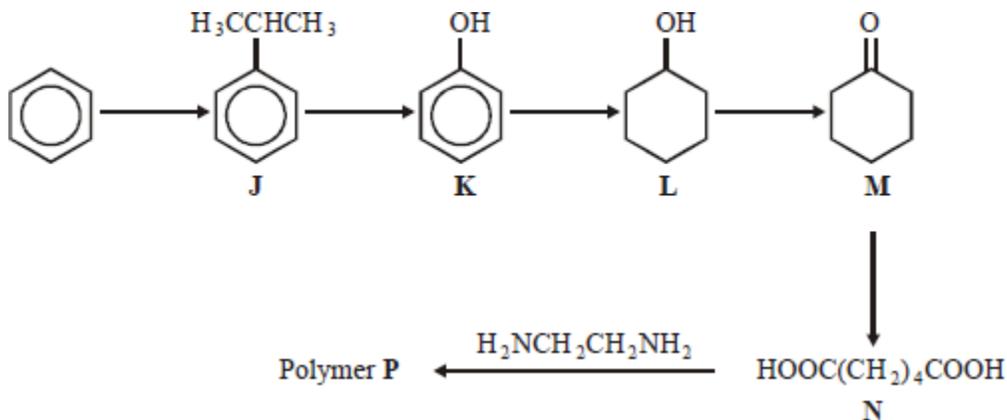
Name of mechanism

Mechanism

(7)
(Total 15 marks)

5

This question is about the following reaction scheme which shows the preparation of polymer **P**.



Polymer **P** is formed in a two-step reaction from **N**. The first stage is a neutralisation reaction. The volume, in cm^3 , of a 0.20 mol dm^{-3} solution of $\text{H}_2\text{NCH}_2\text{CH}_2\text{NH}_2$ required to neutralise $6.8 \times 10^{-3} \text{ mol}$ of the acid **N** is

- A 17
- B 34
- C 68
- D 136

(Total 1 mark)

6

(a) Name and outline a mechanism for the formation of butylamine, $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{NH}_2$, by the reaction of ammonia with 1-bromobutane, $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Br}$.

Name of mechanism

Mechanism

(5)

- (b) Butylamine can also be prepared in a two-step synthesis starting from 1-bromopropane, $\text{CH}_3\text{CH}_2\text{CH}_2\text{Br}$. Write an equation for each of the two steps in this synthesis.

Step 1

.....

Step 2

.....

(3)

- (c) (i) Explain why butylamine is a stronger base than ammonia.

.....

.....

.....

- (ii) Identify a substance that could be added to aqueous butylamine to produce a basic buffer solution.

.....

(3)

- (d) Draw the structure of a tertiary amine which is an isomer of butylamine.

(1)

(Total 12 marks)

7

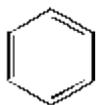
Which one of the following is **not** a correct general formula for the non-cyclic compounds listed?

- A alcohols $\text{C}_n\text{H}_{2n+2}\text{O}$
- B aldehydes $\text{C}_n\text{H}_{2n+1}\text{O}$
- C esters $\text{C}_n\text{H}_{2n}\text{O}_2$
- C primary amines $\text{C}_n\text{H}_{2n+3}\text{N}$

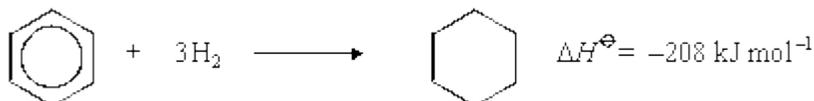
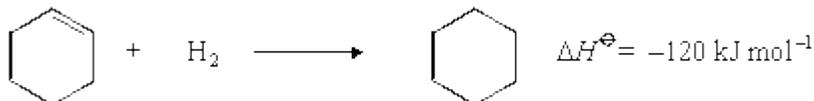
(Total 1 mark)

8

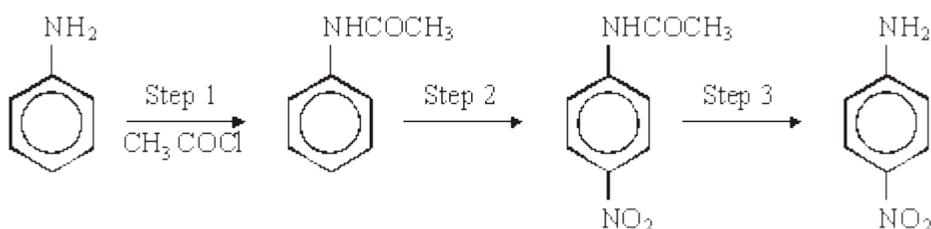
- (a) Use the following data to show the stability of benzene relative to the hypothetical cyclohexa-1,3,5-triene.



Give a reason for this difference in stability.

**(4)**

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

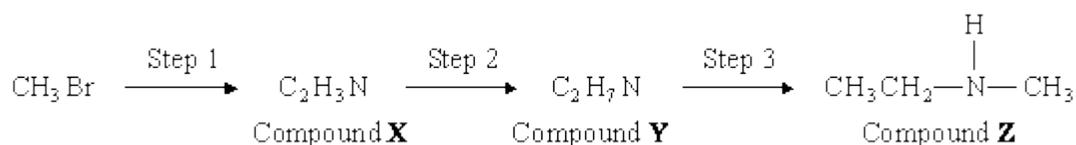


- State and explain the difference in base strength between phenylamine and ammonia.
- Name and outline a mechanism for the reaction in Step 1 and name the organic product of Step 1.
- The mechanism of Step 2 involves attack by an electrophile. Give the reagents used in this step and write an equation showing the formation of the electrophile. Outline a mechanism for the reaction of this electrophile with benzene.
- Name the type of linkage which is broken in Step 3 and suggest a suitable reagent for this reaction.

(17)
(Total 21 marks)

9

Compound **Z** can be formed via compounds **X** and **Y** in the three step synthesis shown below.



Identify compounds **X** and **Y** and give reagents and conditions for Steps 1 and 2.

State the **type** of compound of which **Z** is an example.

Compound **Z** reacts with a large excess of bromomethane to form a solid product. Draw the structure of this product and name the type of mechanism for this reaction.

(Total 9 marks)

10

(a) Outline a mechanism for the formation of ethylamine from bromoethane. State why the ethylamine formed is contaminated with other amines. Suggest how the reaction conditions could be modified to minimise this contamination.

(6)

(b) Suggest one reason why phenylamine cannot be prepared from bromobenzene in a similar way. Outline a synthesis of phenylamine from benzene. In your answer you should give reagents and conditions for each step, but equations and mechanisms are not required.

(5)

(Total 11 marks)

11

(a) Methylamine is a weak Brønsted-Lowry base and can be used in aqueous solution with one other substance to prepare a basic buffer.

(i) Explain the term *Brønsted-Lowry base* and write an equation for the reaction of methylamine with water to produce an alkaline solution.

Brønsted-Lowry base

Equation

(ii) Suggest a substance that could be added to aqueous methylamine to produce a basic buffer.

.....

- (iii) Explain how the buffer solution in part (a)(ii) is able to resist a change in pH when a small amount of sodium hydroxide is added.

.....
.....
.....

(5)

- (b) Explain why methylamine is a stronger base than ammonia.

.....
.....
.....

(2)

- (c) A cation is formed when methylamine reacts with a large excess of bromoethane. Name the mechanism involved in the reaction and draw the structure of the cation formed.

Name of mechanism

Structure

(2)

(Total 9 marks)

12

- (a) Synthetic polyamides are produced by the reaction of dicarboxylic acids with compounds such as $\text{H}_2\text{N}(\text{CH}_2)_6\text{NH}_2$

- (i) Name the compound $\text{H}_2\text{N}(\text{CH}_2)_6\text{NH}_2$

.....

- (ii) Give the repeating unit in the polyamide nylon 6,6.

.....

(2)

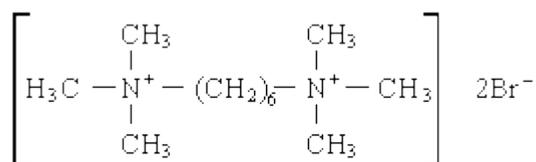
(b) Synthetic polyamides have structures similar to those found in proteins.

(i) Draw the structure of 2-aminopropanoic acid.

(ii) Draw the organic product formed by the condensation of two molecules of 2-aminopropanoic acid.

(2)

(c) Compounds like $\text{H}_2\text{N}(\text{CH}_2)_6\text{NH}_2$ are also used to make ionic compounds such as **X**, shown below.



Compound **X**

(i) **X** belongs to the same type of compound as $(\text{CH}_3)_4\text{N}^+\text{Br}^-$.
Name this **type** of compound.

.....

(ii) State a reagent which could produce **X** from $\text{H}_2\text{N}(\text{CH}_2)_6\text{NH}_2$ and give a necessary condition to ensure that **X** is the major product.

Reagent

Condition

(iii) Name the mechanism involved in this reaction to form **X**.

.....

(4)
(Total 8 marks)