

- Q1.** (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

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Step 2

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(3)

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

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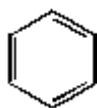
- (ii) Identify a substance that could be added to aqueous butylamine to produce a basic buffer solution.

(3)

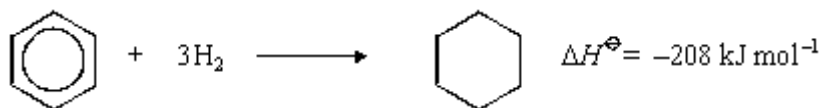
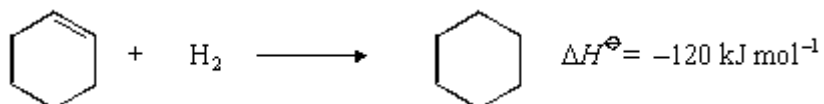
(d) Draw the structure of a tertiary amine which is an isomer of butylamine.

(1)
(Total 12 marks)

Q2. (a) Use the following data to show the stability of benzene relative to the hypothetical cyclohexa-1,3,5-triene.

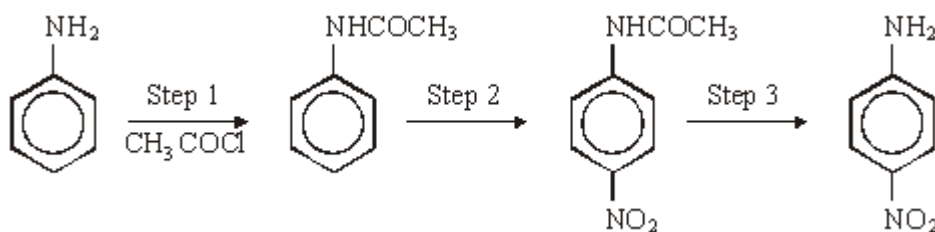


Give a reason for this difference in stability.



(4)

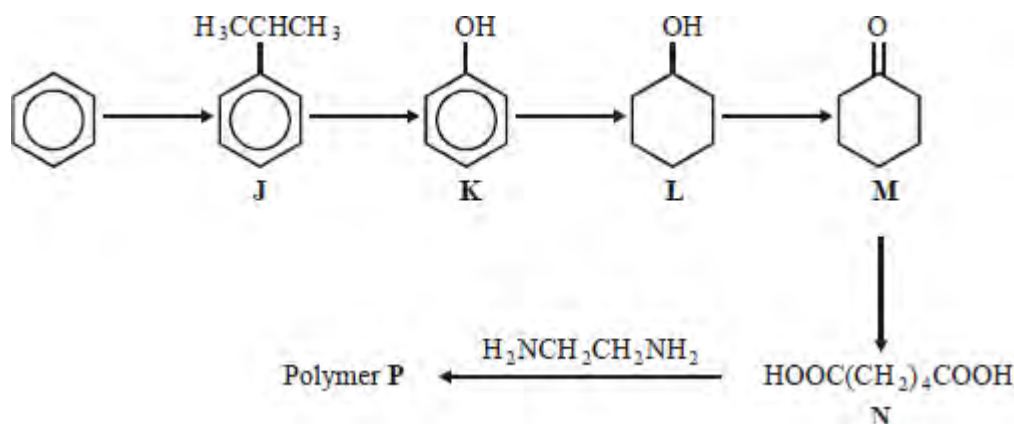
(b) Consider the following reaction sequence which starts from phenylamine.



- (i) State and explain the difference in base strength between phenylamine and ammonia.
- (ii) Name and outline a mechanism for the reaction in Step 1 and name the organic product of Step 1.
- (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.
- (iv) Name the type of linkage which is broken in Step 3 and suggest a suitable reagent for this reaction.

(17)
(Total 21 marks)

Q3. 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 cm³, of a 0.20 mol dm⁻³ solution of H₂NCH₂CH₂NH₂ required to neutralise 6.8 × 10⁻³ mol of the acid **N** is

- A** 17
B 34
C 68
D 136

Q4. (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.

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(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.

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(5)

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

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(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)