

- 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*

.....

*Step 2*

.....

(3)

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

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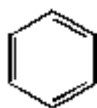
- (ii) Identify a substance that could be added to aqueous butylamine to produce a basic buffer solution.

(3)

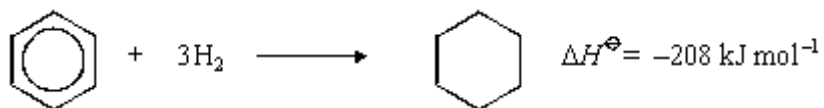
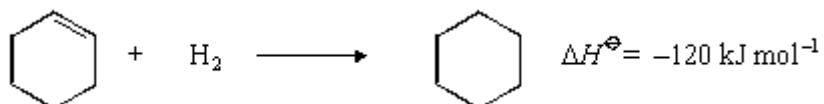
(d) Draw the structure of a tertiary amine which is an isomer of butylamine.

(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.

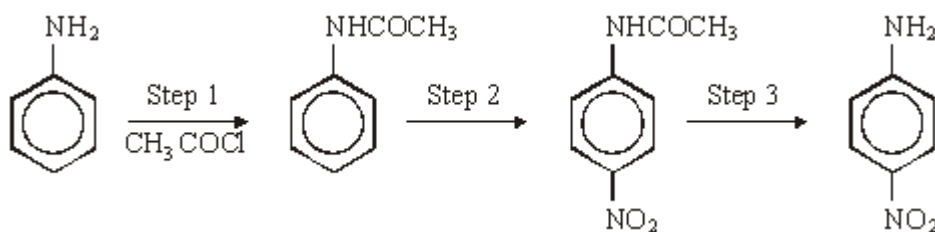


Give a reason for this difference in stability.



(4)

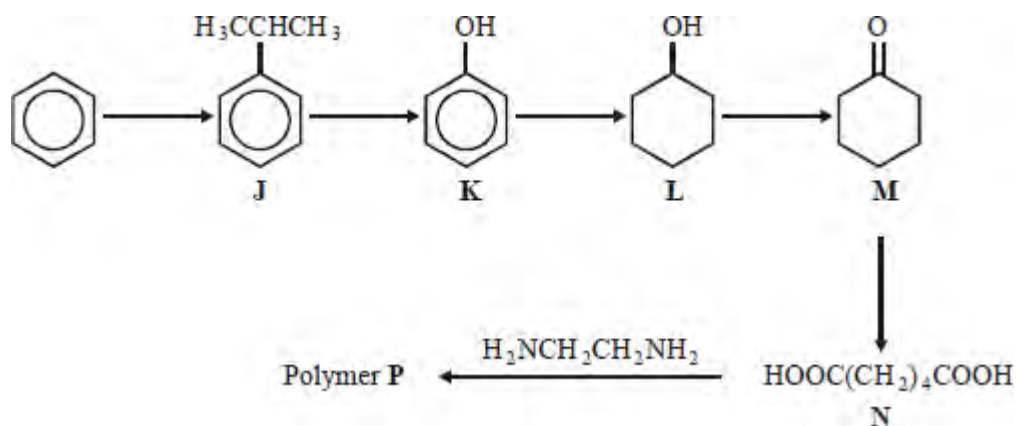
(b) Consider the following reaction sequence which starts from phenylamine.



- (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  $\text{cm}^3$ , of a  $0.20 \text{ mol dm}^{-3}$  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

**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)