AQA A-LEVEL CHEMISTRY · 7405

CHEMISTRY



EXAM QUESTION PACK

3.3.11 AMINES

SCORE	PERCENTAGE
/121	%

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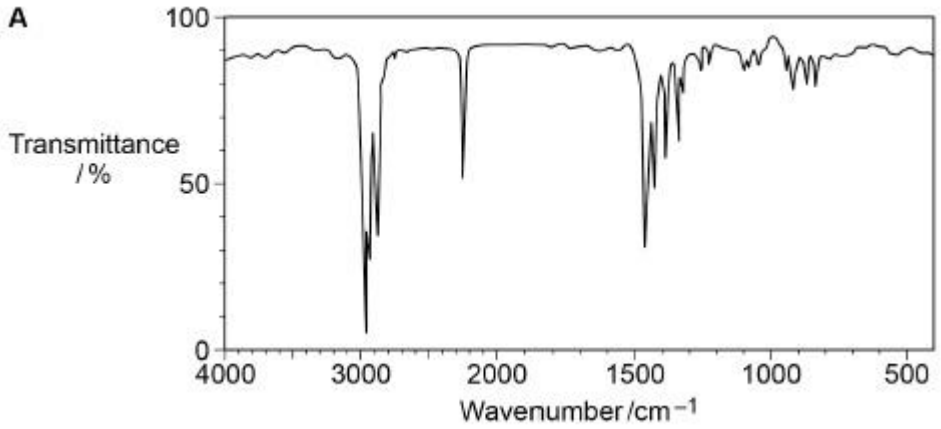
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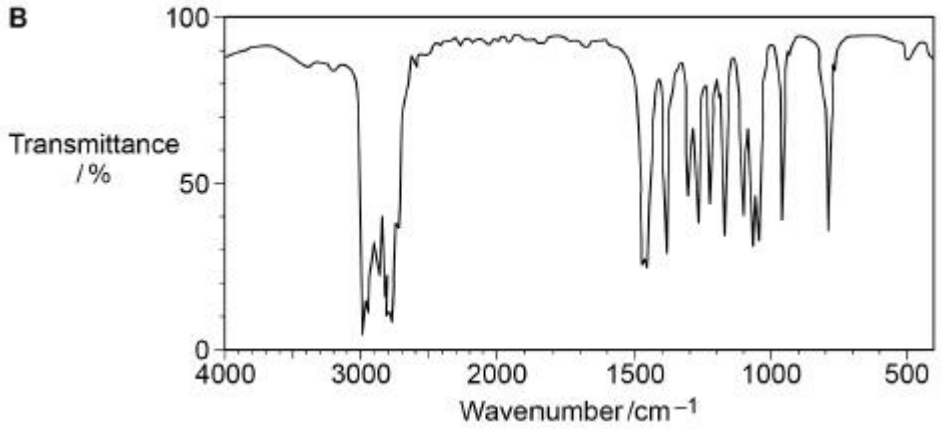
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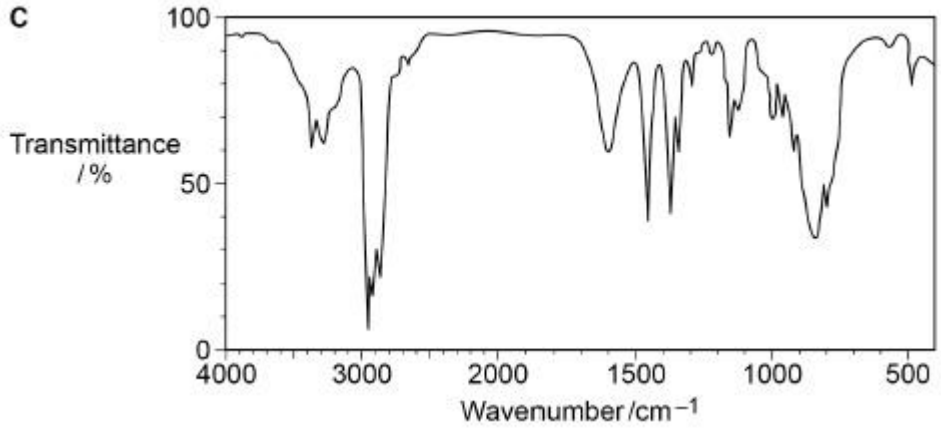
Q1.

This question is about amines.

(a) The infrared spectra **A**, **B** and **C** are those of a primary amine, a tertiary amine and a nitrile, but not necessarily in that order.







Give the letter of each compound in the correct box.

primary amine	tertiary amine	nitrile

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(1)

(b) There are **three** secondary amines that contain four carbon atoms per molecule.

Draw the skeletal formulas of these **three** secondary amines.

(2)

(c) Primary amines can be prepared by the reaction of halogenoalkanes with ammonia or by the reduction of nitriles.

Justify the statement that it is better to prepare primary amines from nitriles rather than from halogenoalkanes.

_____

_____

_____

_____

_____

_____

(2)

(d) Draw the structure of a primary amine with four carbon atoms that **cannot** be formed from a nitrile.

(1)

(e) A student dissolves a few drops of propylamine in 1 cm^3 of water in a test tube.

Give an equation for the reaction that occurs.

Describe what is observed when Universal Indicator is added to this solution.

Equation _____

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Observation _____

_____

_____

(2)

(f) Phenylamine can be prepared by a process involving the reduction of nitrobenzene using tin and an excess of hydrochloric acid.

Give an equation for the reduction of nitrobenzene to form phenylamine. Use [H] to represent the reducing agent.

Explain why an aqueous solution is obtained in this reduction even though phenylamine is insoluble in water.

Equation _____

Explanation _____

_____

_____

_____

(2)

(Total 10 marks)

Q2.

Aqueous solutions of ammonia, ethylamine and phenylamine are prepared.
Each solution has the same concentration.

Which is the correct order for the pH values of these solutions?

A ammonia > ethylamine > phenylamine ⬭

B ammonia > phenylamine > ethylamine ⬭

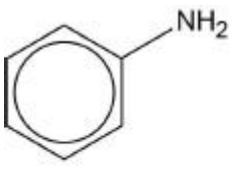
C ethylamine > ammonia > phenylamine ⬭

D ethylamine > phenylamine > ammonia ⬭

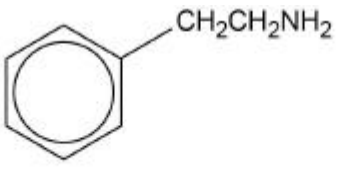
(Total 1 mark)

Q3.

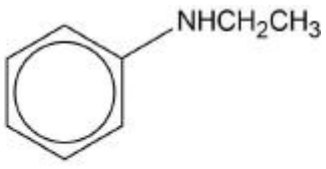
This question is about the three amines, **E**, **F** and **G**.



E



F



G

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(a) Amines **E**, **F** and **G** are weak bases.

Explain the difference in base strength of the three amines and give the order of increasing base strength.

(6)

(b) Amine **F** can be prepared in a three-step synthesis starting from methylbenzene.

Suggest the structures of the two intermediate compounds.

For each step, give reagents and conditions only. Equations and mechanisms are **not** required.

(5)

(Total 11 marks)

Q4.

Which compound is the strongest base?

A Ammonia ⬭

B Ammonium chloride ⬭

C Methylamine ⬭

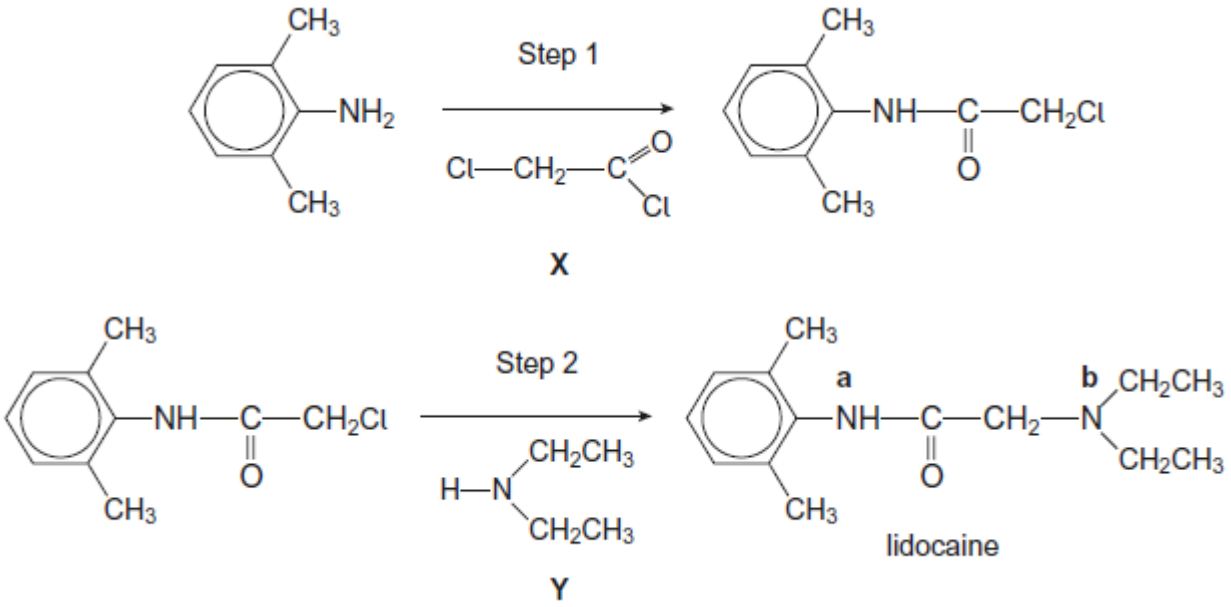
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D Phenylamine ⬭

(Total 1 mark)

Q5.

Lidocaine is a local anaesthetic used in dentistry and in minor surgical operations.
The synthesis of lidocaine in 2 steps from 2,6-dimethylphenylamine is shown.



(a) (i) Give the IUPAC name of reagent **X** in Step 1.

_____

(1)

(ii) Outline a mechanism for Step 1.
In your answer, use RNH_2 to represent 2,6-dimethylphenylamine.

(4)

(b) Name the mechanism for Step 2.

_____

(1)

(c) Which of these is the total number of peaks in the ^{13}C n.m.r spectrum of lidocaine?

Tick (✓) one box.

8 ☐ 9 ☐ 11 ☐ 12 ☐

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(1)

(d) Calculate the percentage by mass of hydrogen in a molecule of lidocaine.

_____

_____

_____

(2)

(e) Give the name, including the classification, of the functional group that contains the nitrogen atom labelled **b**.

_____

(1)

(f) Lidocaine is used medically as the salt lidocaine hydrochloride.

(i) Suggest which one of the nitrogen atoms labelled **a** or **b** is protonated in lidocaine hydrochloride. Explain your answer.

Nitrogen atom protonated _____

Explanation _____

_____

_____

_____

(3)

(ii) Suggest why lidocaine hydrochloride is used medically in preference to lidocaine.
Explain your answer.

_____

_____

_____

_____

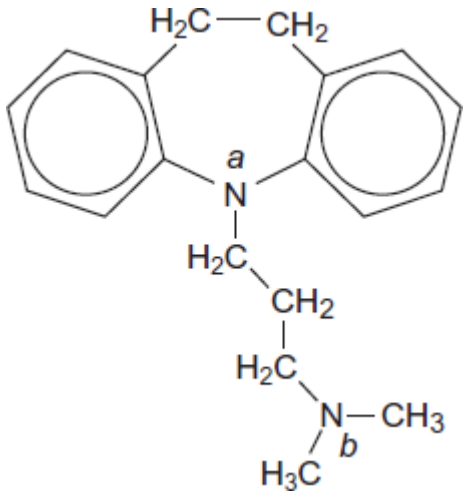
(2)

(Total 15 marks)

Q6.

Imipramine has been prescribed as an antidepressant. The structure of imipramine is shown below.

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(a) The medicine is usually supplied as a salt. The salt is formed when one mole of imipramine reacts with one mole of hydrochloric acid.

Suggest why the nitrogen atom labelled *b* is more likely to be protonated than the nitrogen atom labelled *a* when the salt is formed.

_____

_____

_____

_____

_____

_____

_____

(3)

(b) Deduce the molecular formula of imipramine and give the number of peaks in its ^{13}C n.m.r. spectrum.

_____

_____

_____

_____

_____

(2)

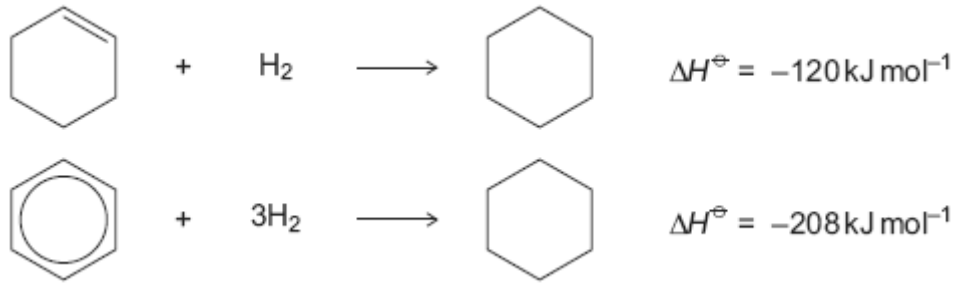
(Total 5 marks)

Q7.

The hydrocarbons benzene and cyclohexene are both unsaturated compounds.
Benzene normally undergoes substitution reactions, but cyclohexene normally undergoes addition reactions.

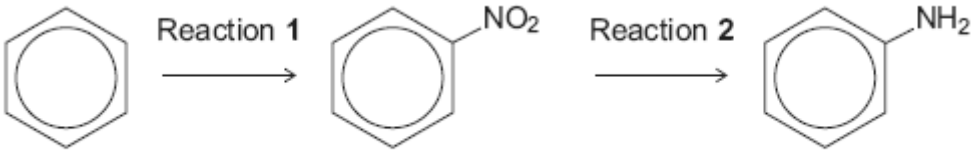
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(a) The molecule cyclohexatriene does not exist and is described as hypothetical. Use the following data to state and explain the stability of benzene compared with the hypothetical cyclohexatriene.



(4)

(b) Benzene can be converted into amine **U** by the two-step synthesis shown below.



U

The mechanism of Reaction **1** involves attack by an electrophile.

Give the reagents used to produce the electrophile needed in Reaction **1**.

Write an equation showing the formation of this electrophile.

Outline a mechanism for the reaction of this electrophile with benzene.

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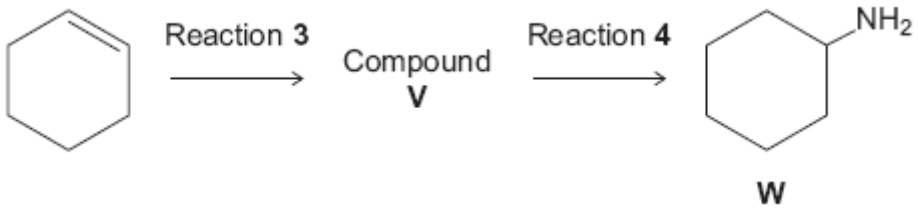
_____

_____

_____

(6)

(c) Cyclohexene can be converted into amine **W** by the two-step synthesis shown below.



Suggest an identity for compound **V**.

For Reaction **3**, give the reagent used and name the mechanism.

For Reaction **4**, give the reagent and condition used and name the mechanism.

Equations and mechanisms with curly arrows are **not** required.

_____

_____

_____

_____

_____

_____

_____

(6)

(d) Explain why amine **U** is a weaker base than amine **W**.

_____

_____

_____

_____

_____

(3)

(Total 19 marks)

Q8.

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

A $H^+ + CH_3NH_2 \rightarrow CH_3NH_3^+$

B $AlCl_3 + Cl^- \rightarrow AlCl_4^-$

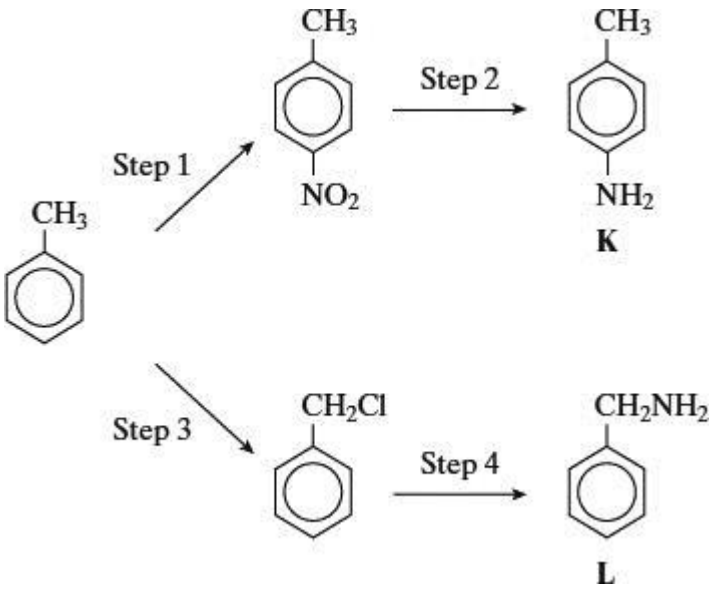
C $CH_3Cl + CN^- \rightarrow CH_3CN + Cl^-$

D $\frac{1}{2}Cl_2 + I^- \rightarrow Cl^- + \frac{1}{2}I_2$

(Total 1 mark)

Q9.

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

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(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.

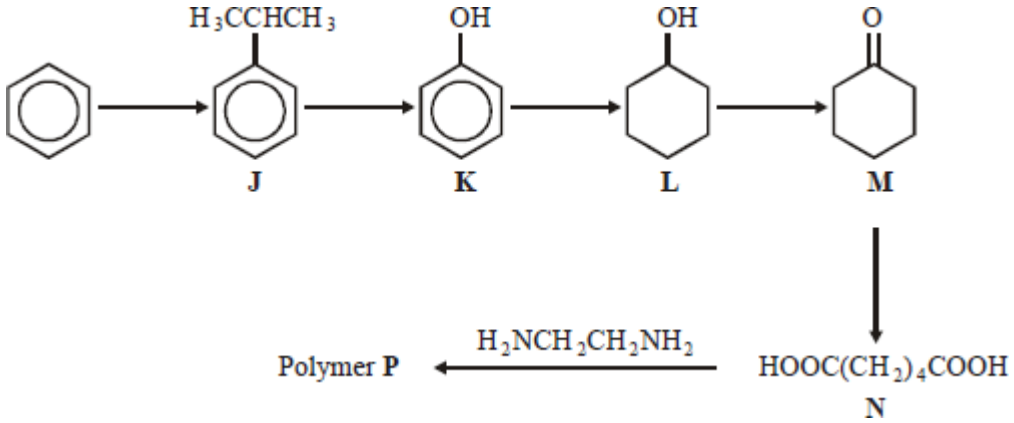
Name of mechanism _____

Mechanism

(7)
(Total 15 marks)

Q10.

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 $H_2NCH_2CH_2NH_2$ required to neutralise 6.8×10^{-3} mol of the acid **N** is

A 17

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B 34

C 68

D 136

(Total 1 mark)

Q11.

(a) Name and outline a mechanism for the formation of butylamine, $CH_3CH_2CH_2CH_2NH_2$, by the reaction of ammonia with 1-bromobutane, $CH_3CH_2CH_2CH_2Br$.

Name of mechanism _____

Mechanism

(5)

(b) Butylamine can also be prepared in a two-step synthesis starting from 1-bromopropane, $CH_3CH_2CH_2Br$. 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)

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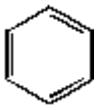
(d) Draw the structure of a tertiary amine which is an isomer of butylamine.

(1)

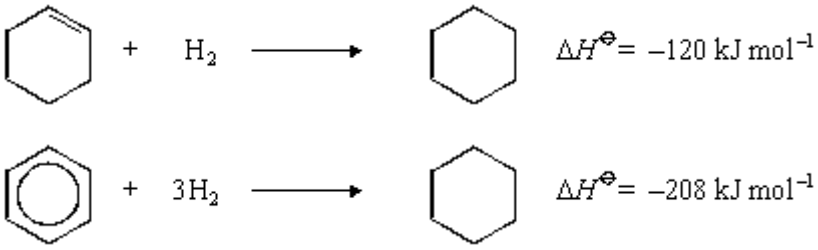
(Total 12 marks)

Q12.

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



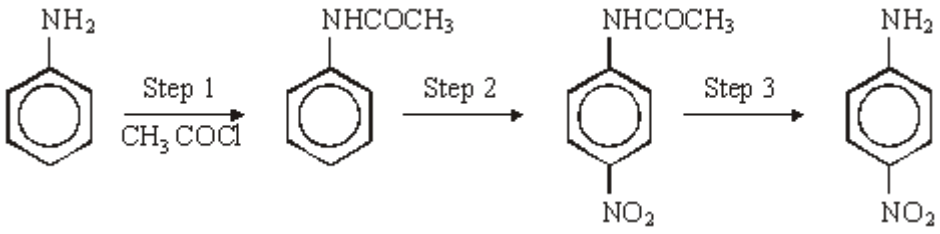
Give a reason for this difference in stability.



(4)

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

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

(3)

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

(6)

(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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(6)

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

_____

_____

_____

_____

(2)

(Total 21 marks)

Q13.

(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.

_____

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_____

_____

(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)

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