

**Q1.**

Methylamine reacts with bromoethane by nucleophilic substitution to produce a mixture of products.

Which is **not** a possible product of this reaction?

- A  $\text{C}_2\text{H}_5\text{NHCH}_3$
- B  $(\text{C}_2\text{H}_5)_2\text{NCH}_3$
- C  $[(\text{C}_2\text{H}_5)_2\text{N}(\text{CH}_3)_2]^+ \text{Br}^-$
- D  $[(\text{C}_2\text{H}_5)_3\text{NCH}_3]^+ \text{Br}^-$

(Total 1 mark)

**Q2.**

This question is about amines.

- (a) Give an equation for the preparation of 1,6-diaminohexane by the reaction of 1,6-dibromohexane with an excess of ammonia.

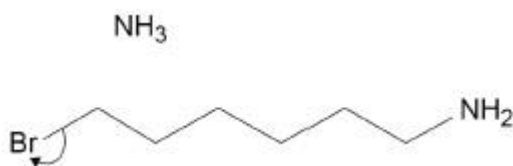
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(2)

- (b) Complete the mechanism for the reaction of ammonia with 6-bromohexylamine to form 1,6-diaminohexane.

Suggest the structure of a cyclic secondary amine that can be formed as a by-product in this reaction.

Mechanism



Cyclic secondary amine

(4)

- (c) 1,6-Diaminohexane can also be formed in a two-stage synthesis starting from 1,4-dibromobutane.  
Suggest the reagent and a condition for each stage in this alternative synthesis.

Stage 1 reagent and condition

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Stage 2 reagent and condition

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(3)

- (d) Explain why 3-aminopentane is a stronger base than ammonia.

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(2)

- (e) Justify the statement that there are no chiral centres in 3-aminopentane.

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(1)

(Total 12 marks)

### Q3.

Methylamine reacts with bromoethane by substitution to produce a mixture of products.

Which compound is not a possible product of this reaction?

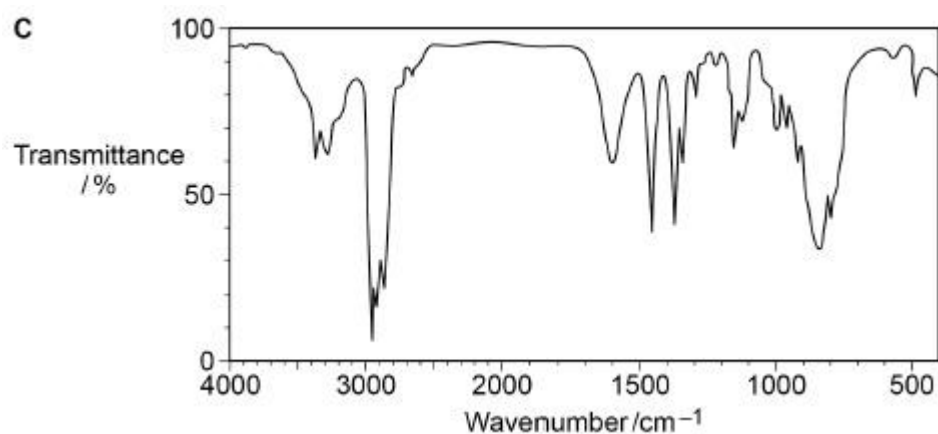
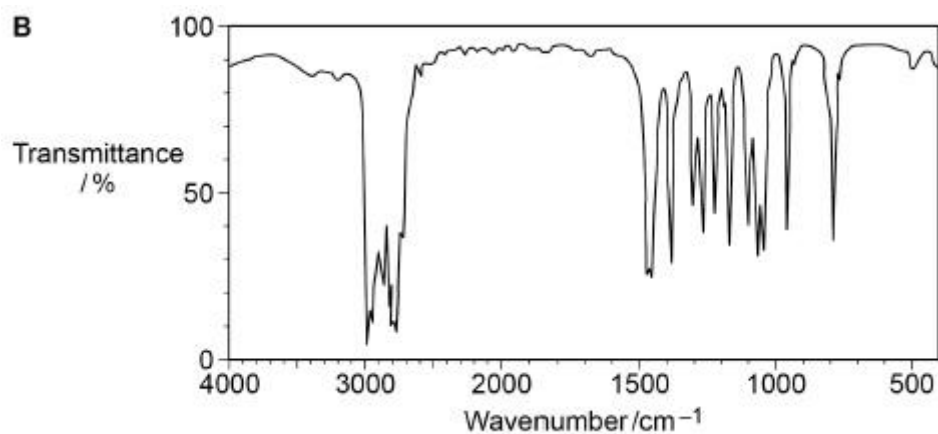
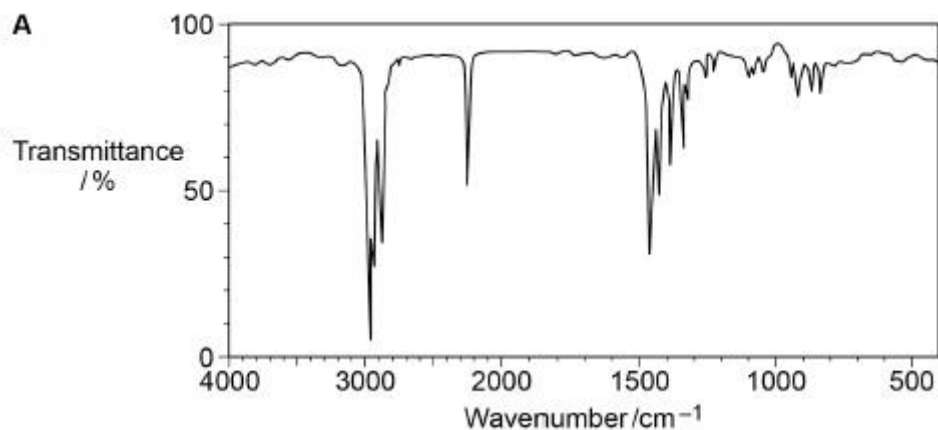
- A  $\text{C}_2\text{H}_5\text{NHCH}_3$
- B  $(\text{C}_2\text{H}_5)_2\text{NCH}_3$
- C  $[(\text{C}_2\text{H}_5)_3\text{NCH}_3]^+ \text{Br}^-$
- D  $[(\text{C}_2\text{H}_5)_2\text{N}(\text{CH}_3)_2]^+ \text{Br}^-$

(Total 1 mark)

**Q4.**

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

(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.

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(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<sup>3</sup> 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

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(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

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Explanation

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(2)

(Total 10 marks)

**Q5.**

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

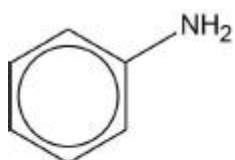
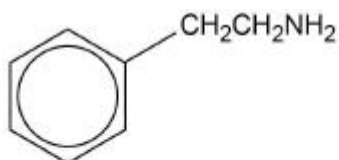
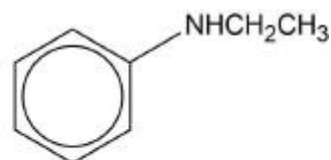
**C** ethylamine > ammonia > phenylamine

**D** ethylamine > phenylamine > ammonia

(Total 1 mark)

**Q6.**

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

**E****F****G**

(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.

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(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.

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(5)

(Total 11 marks)

**Q7.**

Which compound is the strongest base?

- A** Ammonia
- B** Ammonium chloride
- C** Methylamine
- D** Phenylamine

(Total 1 mark)

**Q8.**

What type of reaction is used to convert  $(\text{CH}_3)_3\text{N}$  into the cationic surfactant  $[(\text{CH}_3)_3\text{N}(\text{CH}_2)_{15}\text{CH}_3]\text{Cl}$ ?

- A** Bronsted–Lowry acid-base reaction
- B** Nucleophilic addition
- C** Nucleophilic addition-elimination
- D** Nucleophilic substitution