

- 1 (a) The following data were obtained from experiments on solutions of aqueous amines of the same concentration.

Amine	Formula	pH of solution
Butylamine	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{NH}_2$	11.9
Dibutylamine	$(\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2)_2\text{NH}$	12.1
Phenylamine (aniline)	$\text{C}_6\text{H}_5\text{NH}_2$	8.8

- (i) Identify the feature of the amine molecules that causes the solutions to be alkaline.

(1)

- (ii) Write the equation for the reaction that occurs when butylamine is dissolved in water. State symbols are not required.

(1)

- *(iii) Suggest why the dibutylamine solution is more alkaline than the butylamine solution.

(2)

*(iv) Suggest why the phenylamine solution is much less alkaline than the butylamine solution.

(2)

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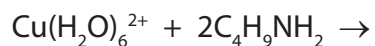
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(b) When butylamine is added to an aqueous solution of copper(II) sulfate, initially a pale blue precipitate is formed. When excess butylamine is added, the precipitate dissolves to form a deep blue solution.

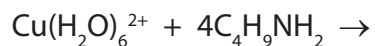
Complete the equations below. State symbols are not required.

(4)

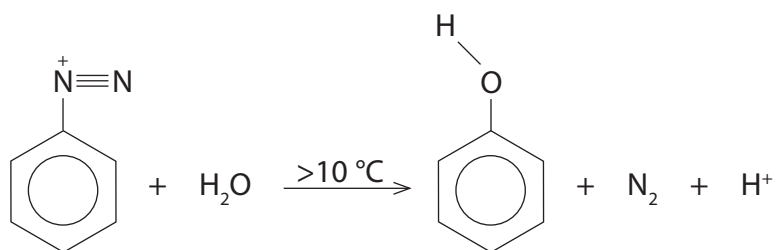
I Formation of the pale blue precipitate



II The overall equation for the formation of the deep blue solution



*(c) When phenylamine is treated with a mixture of sodium nitrite, NaNO_2 , and hydrochloric acid at about 5°C , the resulting solution contains the benzenediazonium ion. If the temperature of this solution is allowed to rise above 10°C , the benzenediazonium ion reacts to form phenol:



By considering the role of the water molecule in this reaction, state the type and mechanism occurring and explain why it is unusual in benzene chemistry.

(2)

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(Total for Question = 12 marks)

2 This question is about 1,2-diaminoethane, $\text{H}_2\text{NCH}_2\text{CH}_2\text{NH}_2$.

(a) Write an equation for the reaction between 1,2-diaminoethane and **excess** dilute hydrochloric acid.

(2)

(b) When an aqueous solution of nickel(II) ions is added to 1,2-diaminoethane, a complex ion forms.



(i) Suggest the colour of this complex.

(1)

(ii) Without using the data booklet, suggest why the complex formed is more stable than $\text{Ni}(\text{H}_2\text{O})_6^{2+}$ by considering the appropriate entropy change.

(2)

(iii) This complex can exist as two structures, which are non-superimposable mirror images.

Suggest the physical property that would enable you to distinguish between these two structures.

(1)

(c) 1,2-diaminoethane reacts with butane-1,2-dioyl dichloride, $\text{ClOCCH}_2\text{CH}_2\text{COCl}$, to form a polymer.

(i) Draw a displayed formula for this polymer showing one repeat unit.

(2)

(ii) Give, and explain, the name for this type of polymerization reaction.

(2)

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*(iii) State and explain the intermolecular forces between two of these polymer chains.

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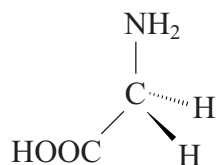
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(Total for Question 15 marks)

3 Proteins are polymers of α -amino acids, the simplest of which is glycine.



(a) (i) Draw the **structural** formula for the zwitterion of glycine in the solid state.

(1)

(ii) Explain, on the basis of your answer to (a)(i), why glycine has a relatively high melting temperature for such a small molecule.

(2)

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(iii) Draw the structure of the protein chain that would be formed if glycine alone were to be polymerized. Show part of the chain containing two glycine residues.

(2)

