

- 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)

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- (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)

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

(2)

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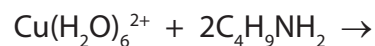
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(b) When butylamine is added to an aqueous solution of copper(II) sulfate, initially a pale blue precipitate is formed. When excess butylamine is added, the precipitate dissolves to form a deep blue solution.

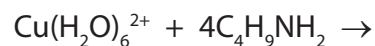
Complete the equations below. State symbols are not required.

(4)

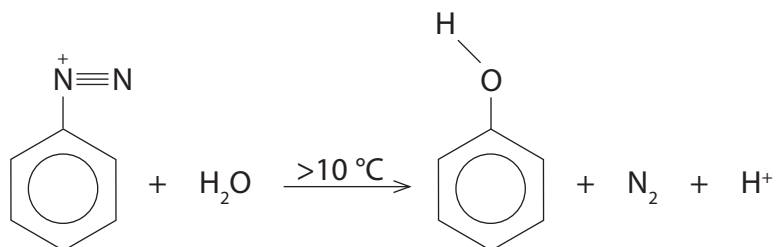
I Formation of the pale blue precipitate



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.

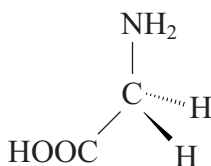
(2)

(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)

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)

***(b)** A solution of hydrolysed protein contains the individual amino acids that make up the protein. Briefly state how you would use chromatography, together with known samples of amino acids, to show which amino acids the protein contained. Do **not** give detailed experimental instructions.

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(Total for Question 10 marks)