

# Amines, Amides, Amino Acids & Proteins

## Question Paper

Level	International A Level
Subject	Chemistry
Exam Board	Edexcel
Topic	Transition Metals & Organic Nitrogen Chemistry
Sub Topic	Amines, Amides, Amino Acids & Proteins
Booklet	Question Paper

Time Allowed: **53 minutes**

Score: **/44**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	77.5%	70%	62.5%	57.5%	45%	<45%

- 1 This question is about water, and equimolar aqueous solutions of ammonia, butylamine and phenylamine.

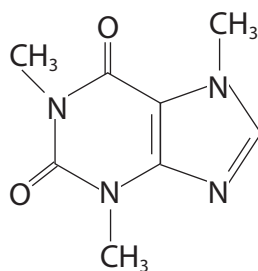
The order of **increasing** pH is

- A phenylamine, butylamine, ammonia, water.
- B water, ammonia, butylamine, phenylamine.
- C water, phenylamine, ammonia, butylamine.
- D ammonia, phenylamine, butylamine, water.

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(Total for Question 1 = 1 mark)

- 2 The structure of caffeine,  $C_8H_{10}O_2N_4$ , is



Which functional group is **not** present?

- A ketone
- B alkene
- C amide
- D amine

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(Total for Question 2 = 1 mark)

3 Four isomers with the formula  $C_4H_9NH_2$  are

- A 1-aminobutane,  $CH_3CH_2CH_2CH_2NH_2$
- B 2-aminobutane,  $CH_3CH_2CH(NH_2)CH_3$
- C 1-amino-2-methylpropane,  $(CH_3)_2CHCH_2NH_2$
- D 2-amino-2-methylpropane,  $(CH_3)_3CNH_2$

(a) Which isomer is chiral?

(1)

- A
- B
- C
- D

(b) Which isomer gives a **low** resolution proton nmr spectrum with the fewest peaks?

(1)

- A
- B
- C
- D

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(Total for Question 3 = 2 marks)

4 All naturally occurring amino acids exist as crystalline solids.

The **best** explanation for this is that amino acids

- A have large numbers of electrons.
- B form hydrogen bonds.
- C form ionic bonds.
- D are symmetrical so the molecules can pack closely in the lattice.

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(Total for Question 4 = 1 mark)

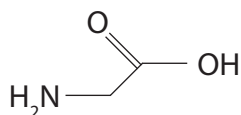
5 Dilute sulfuric acid was added to a sample of phenylamine until the reaction was just complete. The resulting mixture was poured onto a watch-glass and allowed to stand in a warm place for about 24 hours. At the end of this time, the watch-glass contained

- A no residue.
- B a liquid inorganic residue.
- C a liquid organic residue.
- D a white solid.

(Total for Question 5 = 1 mark)

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6 Glycine (2-aminoethanoic acid) is the simplest amino acid. The structure of glycine is



Which of the following is **not** true about glycine?

- A Glycine is a white crystalline solid at room temperature.
- B A glycine molecule is non-superimposable on its mirror image.
- C Glycine reacts with ninhydrin to form a purple compound.
- D Glycine molecules form condensation polymers with other amino acids.

(Total for Question 6 = 1 mark)

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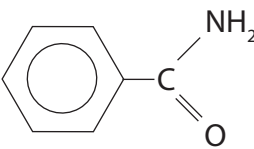
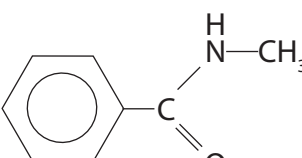
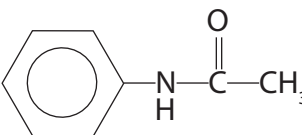
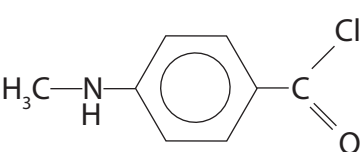
7 When a gas jar containing methylamine is opened near an open bottle of concentrated hydrochloric acid, white smoke is seen. The chemical formula of the white smoke is

- A  $\text{CH}_3\text{NH}_4\text{Cl}$
- B  $\text{CH}_3\text{NH}_3\text{Cl}$
- C  $\text{CH}_3\text{NH}_2\text{Cl}$
- D  $\text{NH}_4\text{Cl}$

(Total for Question 7 = 1 mark)

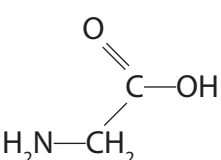
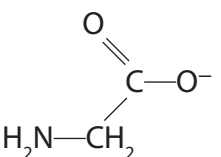
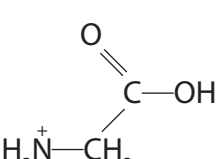
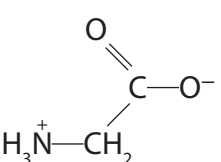
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8 When benzoyl chloride,  $C_6H_5COCl$ , is added to methylamine at room temperature, the main organic product of the reaction is

- A 
- B 
- C 
- D 

(Total for Question 8 = 1 mark)

9 In an aqueous solution with a pH of 3, the amino acid glycine exists mainly as

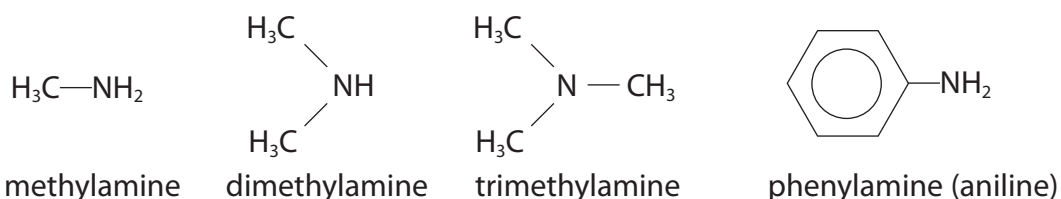
- A 
- B 
- C 
- D 

(Total for Question 9 = 1 mark)

### Organic Nitrogen Chemistry

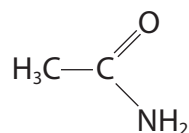
Organic compounds that contain nitrogen are vital to life, but are also important in everyday applications of chemistry.

The simplest organic nitrogen compounds are amines, which may be regarded as derivatives of ammonia in which one or more of the hydrogen atoms of ammonia have been replaced by an alkyl group or an aryl group. Some simple amines are shown below.



Amines with one alkyl group are called primary, with two alkyl groups secondary and with three alkyl groups tertiary. Because of the presence of nitrogen, the physical and chemical properties of alkyl amines are similar to those of ammonia but the similarities are less marked with phenylamine.

Amides are carboxylic acid derivatives which have a carbonyl group adjacent to an amine group. The simplest amide is ethanamide:



ethanamide

Because the two groups are adjacent, the chemical properties of amides are different from those of amines.

Amino acids are compounds with an amine group and a carboxylic acid group. The presence of these two functional groups gives amino acids properties that are also different from those of amines. The great significance of the amino acids is their ability to form polymers called polypeptides, leading to the formation of proteins, the building blocks of life. To form polypeptides, amino acids are joined by the amide group, sometimes called the peptide link.

(a) Methylamine boils at 267 K and dissolves in water to form an alkaline solution.

- (i) Explain why methylamine has a higher boiling temperature than ammonia. A detailed description of the forces involved is **not** required.

(2)

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- \*(ii) Explain why primary amines are soluble in water but their solubility decreases as molar mass increases.

(3)

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- (iii) Write an equation for the reaction of methylamine with water to produce an alkaline solution. State symbols are not required.

(1)

(iv) Suggest why dimethylamine is more basic than methylamine and why both are **much** more basic than phenylamine.

(3)

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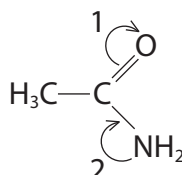
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(b) The interaction of the carbonyl group and the amine group in ethanamide may be shown by the following diagram.



(i) Explain what each of the two arrows represents.

(2)

Arrow 1 .....

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Arrow 2 .....

.....

(ii) Draw a diagram showing the ethanamide molecule if the changes indicated by the arrows go to completion.

(1)



- (iii) Suggest why the carbonyl group in an amide does not react with 2,4-dinitrophenylhydrazine.

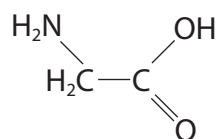
(1)

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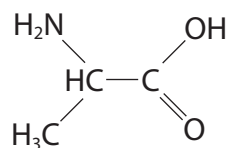
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- (c) The structures of the two simplest amino acids are shown below.



glycine



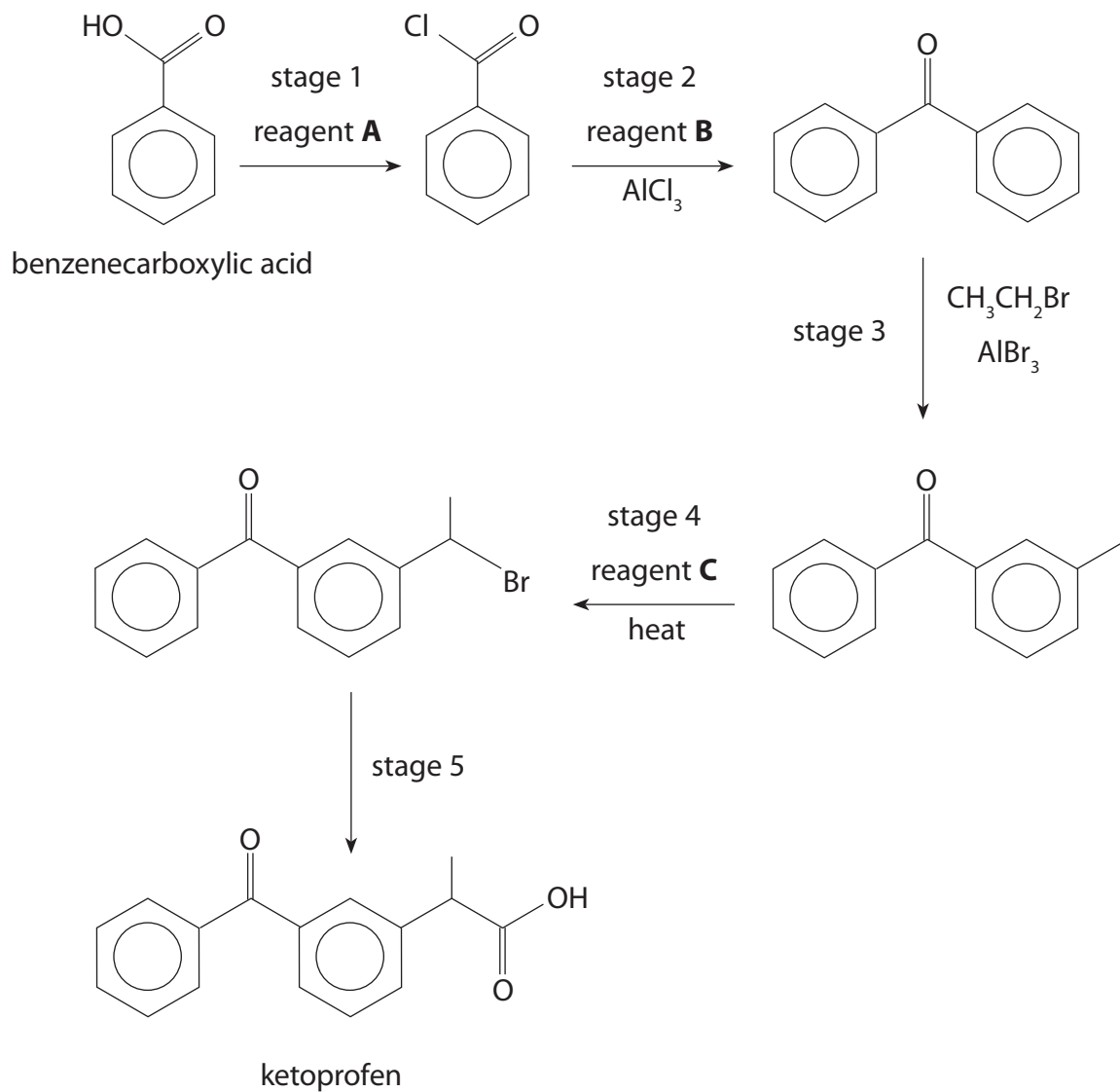
alanine

- (i) Draw the structures of the **two** compounds, called dipeptides, that can be formed when glycine and alanine combine. Any double bonds **must** be displayed.

(2)



11 Ketoprofen is an analgesic used in the treatment of arthritis-related inflammatory pains. A synthesis of ketoprofen from benzenecarboxylic acid is shown below.



(a) Identify reagents **A**, **B** and **C** by name or formula.

(3)

**A** .....

**B** .....

**C** .....

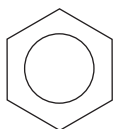
(b) Stage 3 is an electrophilic substitution.

- (i) Write an equation for the formation of the electrophile and explain the role of the  $\text{AlBr}_3$  in this process.

(2)

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- (ii) Complete the mechanism for the electrophilic substitution in stage 3. You need only show the benzene ring on the right of the structure. This is given below.

(3)



(c) The first step of stage 5 of the synthesis is the addition of a carbon atom to the chain. One way of achieving this is to replace the bromine atom with a nitrile group in a nucleophilic substitution.

(i) Suggest the name or formula of a reagent that could be used in this nucleophilic substitution. Suggest a suitable solvent in which to carry out the reaction.

(2)

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(ii) The second step of stage 5 is the conversion of the nitrile into ketoprofen. State the reagent or reagents required.

(1)

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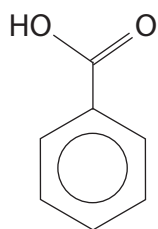
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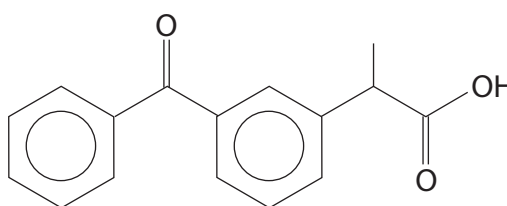
(d) Benzenecarboxylic acid and ketoprofen have different infrared spectra.

- (i) In the diagram below, insert in the boxes the wavenumber **ranges** for the infrared absorptions due to C=O groups in benzenecarboxylic acid and ketoprofen.

(3)



benzenecarboxylic  
acid



ketoprofen

- (ii) Explain how these absorptions can be used to distinguish between the two compounds.

(1)

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**(Total for Question 11 = 15 marks)**