

# Nitrogen Compounds

## Question Paper 6

Level	International A Level
Subject	Chemistry
Exam Board	CIE
Topic	Nitrogen Compounds
Sub-Topic	
Paper Type	Theory
Booklet	Question Paper 6

Time Allowed: **74 minutes**

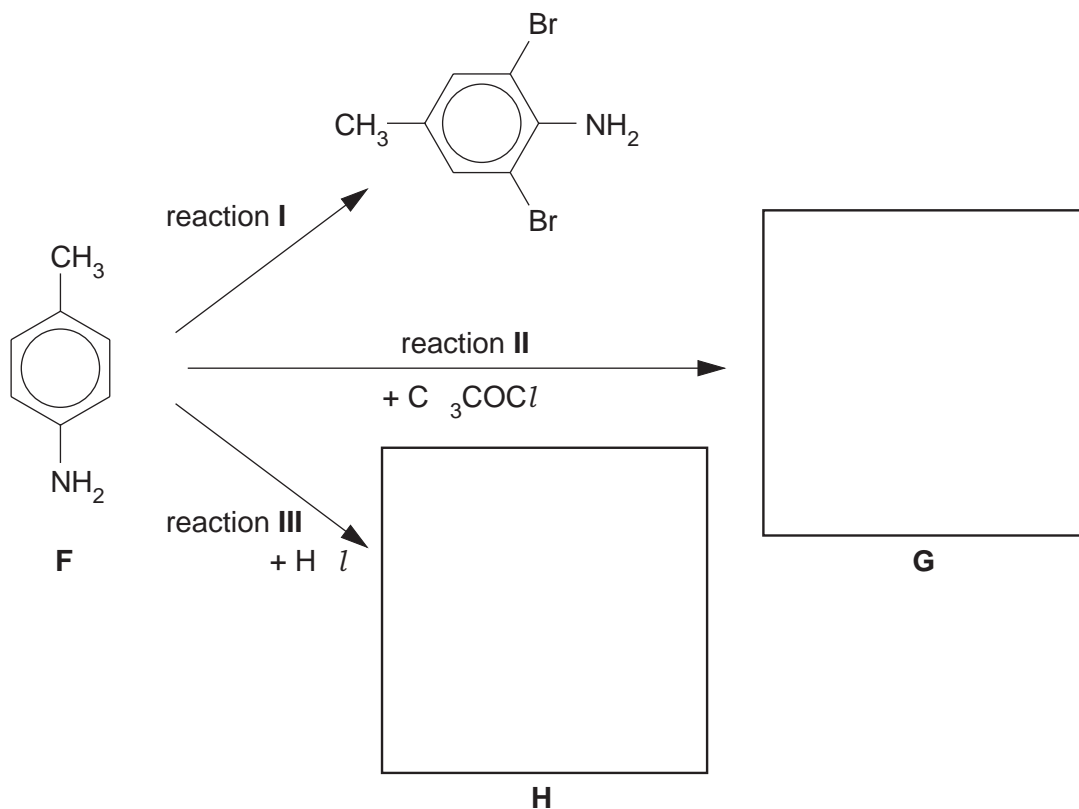
Score: **/61**

Percentage: **/100**

Grade Boundaries:

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

- 1 4-Amino-1-methylbenzene, **F**, is a useful starting material for making several dyes. The following chart shows some of its reactions.



- (a) (i) Suggest reagents and conditions for reaction I.

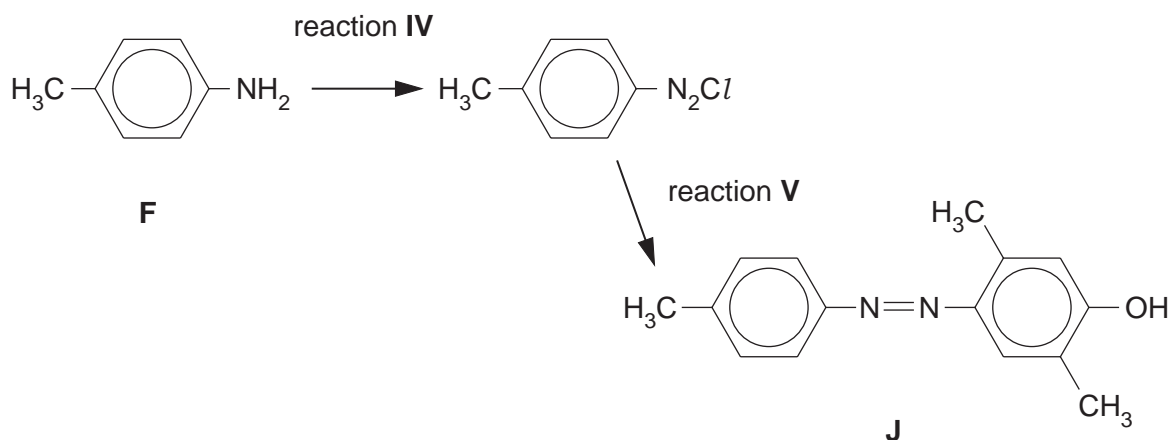
.....

- (ii) Draw the structural formulae of compounds **G** and **H** in the boxes above.

- (iii) Name the functional group you have drawn in compound **G**.

.....

(b) The dye **J** can be made from **F** by the following series of reactions.



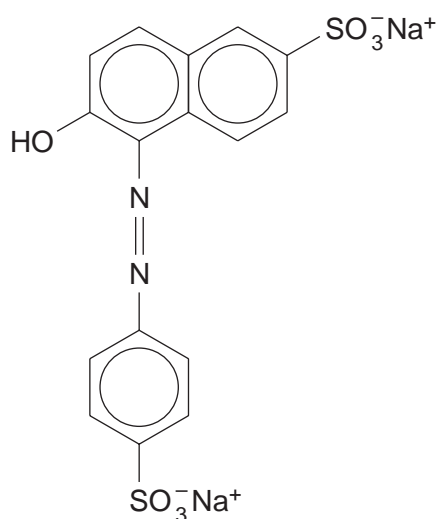
Suggest reagents and conditions for

(i) reaction IV, .....

(ii) reaction V.

..... [4]

(c) Many dyestuffs used as food colourings, such as Sunset Yellow, contain sodium sulphonate ( $-\text{SO}_3^-\text{Na}^+$ ) groups attached to the rings. Suggest, with an explanation, a reason for this.



Sunset Yellow

..... [2]

[Total: 10]

2 Nitrogen, which makes up about 80% of the Earth’s atmosphere, is very unreactive.

(a) (i) Explain the lack of reactivity of nitrogen.

.....  
.....  
.....

(ii) Nitrogen does, however, undergo some reactions. Write an equation for **one** reaction of nitrogen, stating the conditions under which it occurs.

equation .....

conditions .....

.....  
.....

(iii) Suggest why nitrogen does react in the example you have chosen.

.....  
.....

[6]

Ammonium nitrate,  $\text{NH}_4\text{NO}_3$ , is a commercially important compound of nitrogen.

(b) (i) State **one** large-scale use of ammonium nitrate.

.....

(ii) What are the environmental consequences of the uncontrolled use of ammonium nitrate?

.....  
.....  
.....  
.....

[4]

When solid ammonium nitrate is heated with solid sodium hydroxide in a test-tube, three products are formed. A colourless alkaline gas, **Y**, is given off, and a colourless liquid can be seen on the cooler parts of the test-tube. A white solid remains in the tube.

**(c) (i)** Identify gas **Y**.

.....

**(ii)** Write an equation, with state symbols, for the reaction of ammonium nitrate with sodium hydroxide.

.....

[3]

**(d)** In order to produce gas **Y** in a pure state in the laboratory, it must be passed through a drying agent.

Why is concentrated sulphuric acid not suitable for drying gas **Y**?

.....

..... [1]

[Total: 14]

3 This question is about the reactions of some functional groups.

(a) (i) Draw the structural formula of an amide of your choice containing **four** carbon atoms.

(ii) What reagents and conditions are needed to hydrolyse this amide?

.....

(iii) Write a balanced equation showing the hydrolysis of the amide whose structural formula you drew in part (i).

.....[4]

(b) (i) Draw the structural formula of an acyl chloride containing three carbon atoms.

(ii) What starting material and reagent are needed to form this acyl chloride?

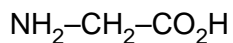
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(iii) Write a balanced equation showing the formation of an ester containing five carbon atoms from the acyl chloride you drew in part (i).

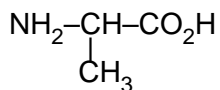
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[Total: 7]

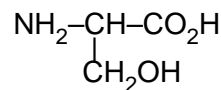
- 4 Much research has been carried out in recent years investigating the exact structure of silk. The silk of a spider’s web is at least five times as strong as steel, and twice as elastic as nylon. A silk fibre is composed of many identical protein chains, which are mainly made from the amino acids glycine, alanine and serine, with smaller amounts of four other amino acids.



glycine



alanine



serine

- (a) Amino acids can exist as zwitterions. Draw the zwitterionic structure for glycine.

[1]

- (b) Amino acids can act as acids or bases. Write equations to show:

- (i) the reaction between alanine and  $\text{HCl}(\text{aq})$ ,

.....

- (ii) the reaction between serine and  $\text{NaOH}(\text{aq})$ .

.....

[2]

- (c) Draw the structural formula of a portion of the silk protein, showing three amino acid residues. Label a peptide bond on your structure.

[3]

- (d) What *type* of polymer is silk protein?

.....[1]

- (e) The  $M_r$  of a silk protein molecule is about 600,000. Assuming it is made from equal amounts of the above three amino acids, calculate the average number of amino acid residues in the protein chain. [ $M_r$  (glycine) = 75;  $M_r$  (alanine) = 89;  $M_r$  (serine) = 105]

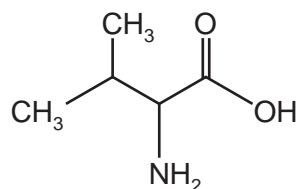
number of residues = ..... [3]

[Total: 10]

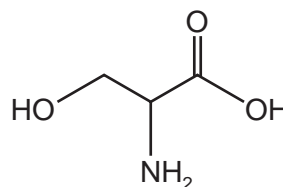


5 This question looks at the formation and breakdown of protein chains in the body.

(a) Proteins are formed from chains of amino acid monomers joined together. The structures of two amino acids, valine and serine are shown.



valine (val)



serine (ser)

(i) Draw the structure of the dipeptide val-ser, showing the peptide bond in displayed form.

(ii) What *type of reaction* has taken place in order to form this dipeptide?

.....

(iii) Identify the other molecule produced in this reaction.

.....

[4]

(b) Both DNA and RNA are involved in protein synthesis.

Complete the table to show **three** differences between the structures of DNA and RNA.

	DNA	RNA
1		
2		
3		

[3]

- (c) In protein synthesis, sections of the DNA are copied by mRNA and this, in turn, is read by the ribosome in order to assemble the amino acids for the new protein chain. Each group of three bases codes for one amino acid, with some amino acids having several codes. The codes are summarised in the table.

UUU	phe	UCU	ser	UAU	tyr	UGU	cys
UUC	phe	UCC	ser	UAC	tyr	UGC	cys
UUA	leu	UCA	ser	UAA	stop	UGA	stop
UUG	leu	UCG	ser	UAG	stop	UGG	trp
CUU	leu	CCU	pro	CAU	his	CGU	arg
CUC	leu	CCC	pro	CAC	his	CGC	arg
CUA	leu	CCA	pro	CAA	gln	CGA	arg
CUG	leu	CCG	pro	CAG	gln	CGG	arg
AUU	ile	ACU	thr	AAU	asn	AGU	ser
AUC	ile	ACC	thr	AAC	asn	AGC	ser
AUA	ile	ACA	thr	AAA	lys	AGA	arg
AUG	met/ start	ACG	thr	AAG	lys	AGG	arg
GUU	val	GCU	ala	GAU	asp	GGU	gly
GUC	val	GCC	ala	GAC	asp	GGC	gly
GUA	val	GCA	ala	GAA	glu	GGA	gly
GUG	val	GCG	ala	GAG	glu	GGG	gly

In general the amino acid chains start with the code AUG, and end with one of the three ‘stop’ codes shown in the table.

- (i) Use the abbreviations to show the sequence of amino acids in the peptide for the base sequence shown.

– AUGCUAACACCGGAGUAA –

.....

- (ii) Sometimes an error can occur in the base sequence.

What are these errors called?

.....

- (iii) This type of error can lead to the formation of a protein with a different structure from the original, as in *sickle cell anaemia*. In this case the amino acid glutamic acid (glu) is replaced by valine (val) in the protein as a result of one base being changed in a three base code.

Use the table to suggest the change of base that causes this.

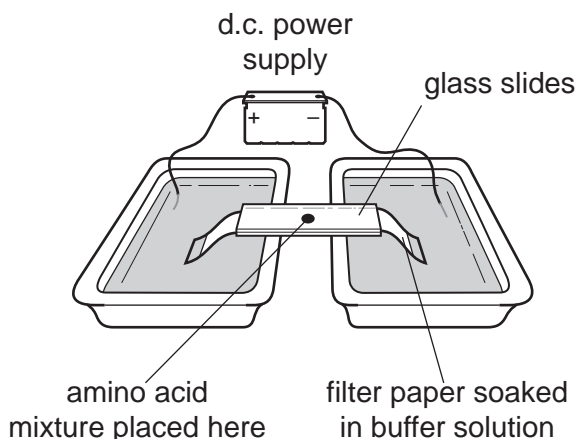
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[3]

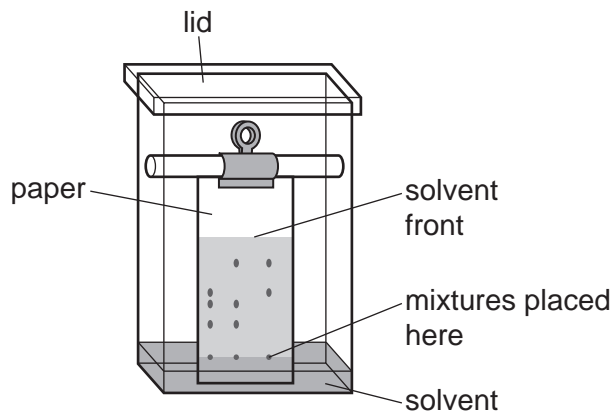
[Total: 10]

6 Modern methods of chemical analysis often rely on the interpretation of data gathered from instrumental techniques.

(a) Electrophoresis and paper chromatography can both be used to separate amino acids from a mixture obtained from polypeptides.



electrophoresis



paper chromatography

In each case, give **one** property of the amino acids that causes their separation.

electrophoresis .....

.....

paper chromatography .....

.....

[2]

(b) Amino acids are colourless.

How are the positions of the different amino acids made visible so that measurements can be made?

.....

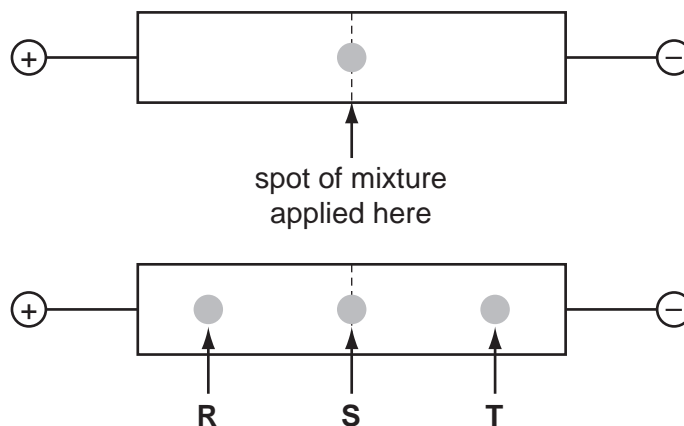
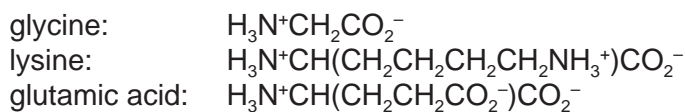
..... [1]

(c) Which **measurements** need to be made in order to identify individual amino acids in paper chromatography?

.....

..... [1]

- (d) The diagram shows the results of electrophoresis on a mixture of the amino acids glycine, lysine and glutamic acid at pH 7.0. The structures of the amino acids at pH 7.0 are shown.



Identify the amino acids responsible for the spots labelled **R**, **S** and **T**.

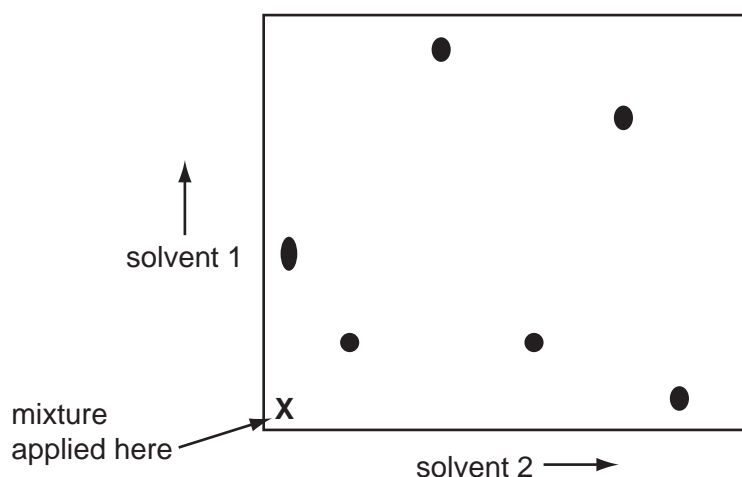
**R** .....

**S** .....

**T** .....

[3]

- (e) This diagram shows the results of two-way paper chromatography of a mixture of amino acids.



To answer these questions you need to indicate clearly on the diagram above as directed in the questions.

- (i) Put a **U** next to the amino acid that travelled furthest in solvent 2.
- (ii) Put a ring around the **two** amino acids that were **not** separated in solvent 1.
- (iii) Put a **W** next to the amino acid that was very soluble in **both** solvents.

[3]

[Total: 10]