Nitrogen Compounds

Question Paper 3

Level	International A Level
Subject	Chemistry
Exam Board	CIE
Topic	Nitrogen Compounds
Sub-Topic	
Paper Type	Theory
Booklet	Question Paper 3

Time Allowed: **72 minutes**

Score: **/60**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	777.5%	70%	62.5%	57.5%	45%	<45%

1 Concentrated sulfuric acid may be used in a school or college laboratory to produce hydrogen chloride by reaction with solid chlorides such as sodium chloride.

(a) What will be seen when concentrated sulfuric acid is carefully added to solid sodium chloride?

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(ii) Write a balanced equation for this reaction.

.....

(iii) Solutions of both H_2SO_4 and HC*l* are strong acids.
What is meant by the term *strong acid*?

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.....
[3]

(b) If the same reaction is carried out with solid sodium iodide and concentrated sulfuric acid, hydrogen iodide is **not** produced.

(i) State **one** observation you would make when carrying out this reaction with solid sodium iodide.

.....

(ii) Explain why hydrogen iodide is **not** a product of this reaction.

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[3]

(c) Aqueous silver nitrate and aqueous ammonia are used to test for the presence of halide ions.

(i) Aqueous silver nitrate is slowly added to aqueous sodium chloride and the resulting mixture is then shaken with an excess of aqueous ammonia.

Describe what you would observe at **each** stage of this process.

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(ii) Write balanced equations, with state symbols, for **all** reactions that occur in this process.

(iii) The same process of adding aqueous silver nitrate followed by an excess of aqueous ammonia is repeated using aqueous sodium iodide instead of aqueous sodium chloride.

State **two** differences that would be observed with aqueous sodium iodide.

.....

.....

[8]

[Total: 14]

2 Proteins are complex molecules made up from long chains that are folded to give a three-dimensional structure.

(a) Study the table which describes aspects of bonding in proteins. For each description of a bonding type, indicate whether it contributes to the primary, secondary or tertiary structure of a protein.

bonding type	structure involved
disulfide bonds between parts of the chain	
hydrogen bonds in a β-pleated sheet	
ionic bonds between parts of the chain	
peptide links between amino acids	

[3]

(b) Explain, with the use of diagrams as appropriate, the difference between competitive and non-competitive inhibition of enzymes.

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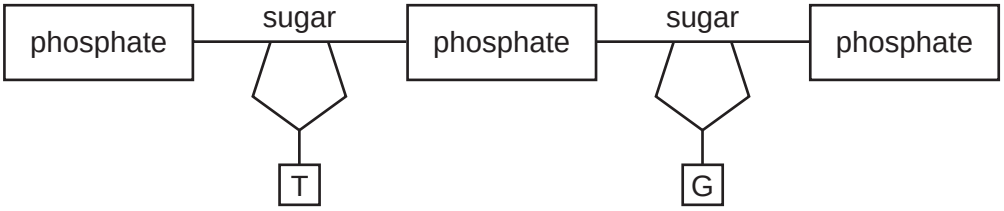
..... [4]

(c) The diagram shows one strand of DNA. Draw a matching strand showing clearly, with labels, the bonds holding the two strands together.
Name the bases in **your** strand, indicating clearly which base bonds to each base in the strand shown.



names of bases .....
[3]

[Total: 10]

3 **(a)** **(i)** Explain why ethylamine is basic.

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(ii) Write an equation showing ethylamine acting as

a base, ...

a nucleophile. .....

(iii) Why is phenylamine less basic than ethylamine?

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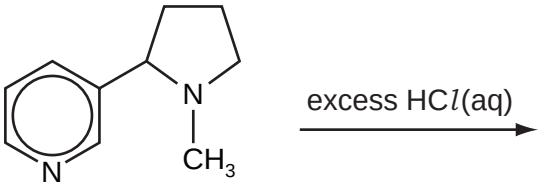
Alkaloids are naturally-occurring compounds that act as bases.

(iv) Suggest the structure of the product, **E**, of the reaction between the alkaloid nicotine and an excess of HC*l*(aq).



nicotine

excess HC*l*(aq) →

E

[6]

(b) Phenylamine, and substituted phenylamines, are used to make cloth dyes and food colourants.
The first step in this process is the production of a diazonium salt.

(i) State the reagents and conditions necessary for this reaction.

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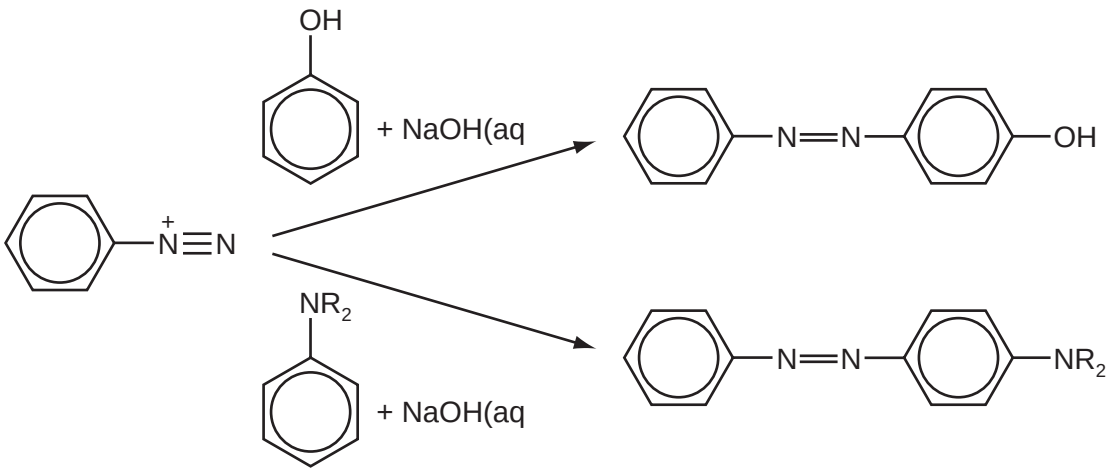
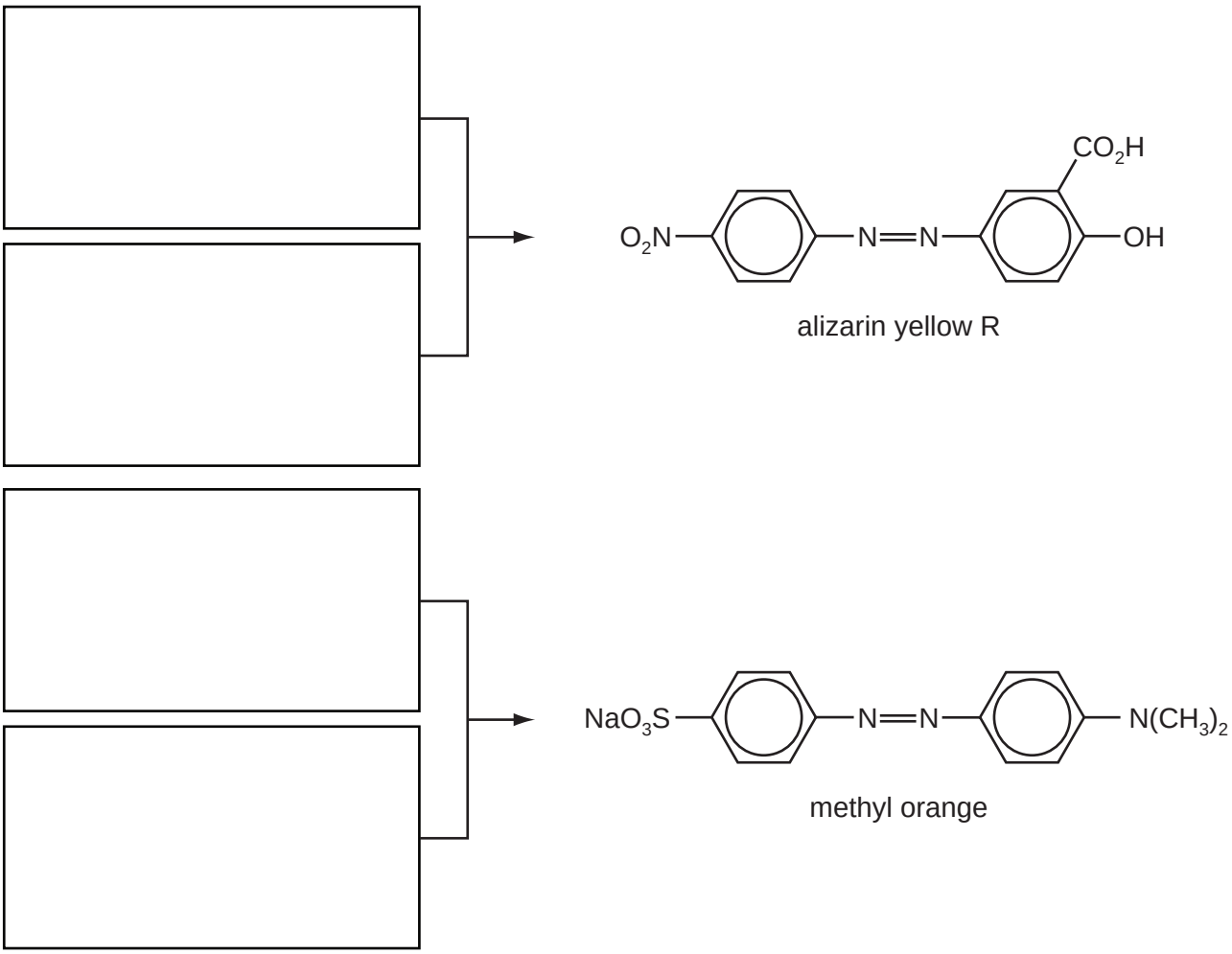
The diazonium salt is then reacted with a phenol or an aryl amine in alkaline solution.



(ii) Suggest the starting materials needed to synthesise the following dyes.
Draw their structures in the boxes provided.



(iii) Suggest what effect the NaO_3S- group in methyl orange has on its properties. This group has no effect on the colour of the compound.

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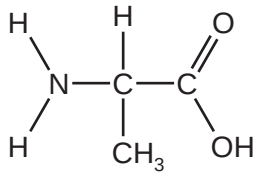
[7]

[Total: 13]

4 The proteins in the human body are complex polymers made up of around 20 different amino acids. Alanine is a typical amino acid.



alanine

(a) Glycine, $H_2NCH_2CO_2H$, is the simplest amino acid and differs from each of the other 2-amino acids in a significant way. What is this difference?

..... [1]

(b) Protein molecules coil and fold, producing molecules with complex three-dimensional shapes. This is referred to as the secondary and tertiary structures of a protein.

(i) State **one** form of **secondary** structure and give the type of bonding responsible.

structure .....

bonding .....

(ii) Give **two** examples of bonding causing the **tertiary** structure, and give the amino acid responsible in each case.

bonding ..... amino acid .....

bonding ..... amino acid .....

[6]

(c) Suggest why globular proteins, such as enzymes, contain relatively small amounts of glycine and alanine when compared to the amounts of some other amino acids. You may wish to refer to their structures given above.

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..... [1]

(d) DNA consists of a double helix with each strand having a sugar-phosphate 'backbone' with one of four bases – adenine (A), cytosine (C), guanine (G) and thymine (T) – attached to the sugar.

(i) The two strands of the double helix are held together by hydrogen bonds between pairs of bases. What are the pairs of bases?

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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 below.

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

(ii) The coding for all protein chains starts with the AUG, and ends with one of three 'stop' codes shown in the table. What amino acid sequence would the following series of bases produce?

-AUGGGUAGCCUCGCAUCGUAA-

.....

(iii) What would be the effect on the amino acid sequence, of a mutation that changed the base at position 10 in the series of bases above from C to G?

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[5]

[Total: 13]

5 The technique of DNA fingerprinting has been one of the most important developments in biochemical analysis in recent times. It has enabled enormous advances to be made in forensic science, medicine and archaeology.

(a) The table shows different stages in the production of a genetic fingerprint. Use the numbers 1 to 6 to put the stages in the correct sequence in the blank column.

stages	process	correct sequence (numbers)
A	place samples on agarose gel	
B	use polymerase chain reaction	
C	label with radioactive isotope	
D	extract DNA	
E	use restriction enzyme	
F	carry out electrophoresis	

[3]

(b) One of the stages above uses a radioactive isotope.

(i) What isotope is used? .....

(ii) Why is this isotope chosen?

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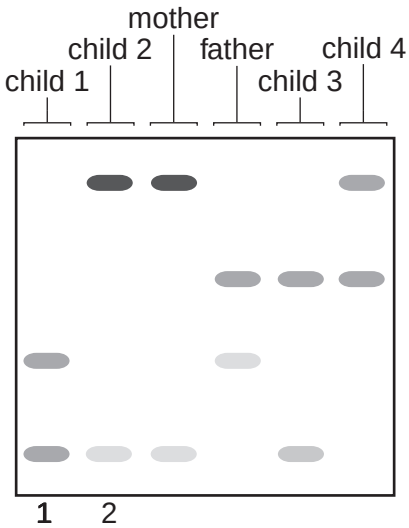
.....

[2]

(c) The following DNA fingerprints were taken from a family of mother, father and four children.



(i) Are all of the children related to the mother? State the evidence for your answer.

.....

.....

(ii) Which child is unlikely to be related to the father? State the evidence for your answer.

.....

.....

[2]

(d) DNA fingerprinting has been successfully used in archaeological investigations.

(i) Ancient writings were often made on goatskins. Over the centuries these have often become broken into fragments, making reconstruction of the writings almost impossible.

Suggest how the use of DNA fingerprinting might be able to identify which fragments came from a particular skin.

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(ii) Apart from the examples of human remains and goatskins, state one other material that could be investigated using this technique.

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[3]

[Total: 10]