

# Stereochemistry

## Question Paper

Level	Pre U
Subject	Chemistry
Exam Board	Cambridge International Examinations
Topic	Stereochemistry- Organic Chemistry
Booklet	Question Paper

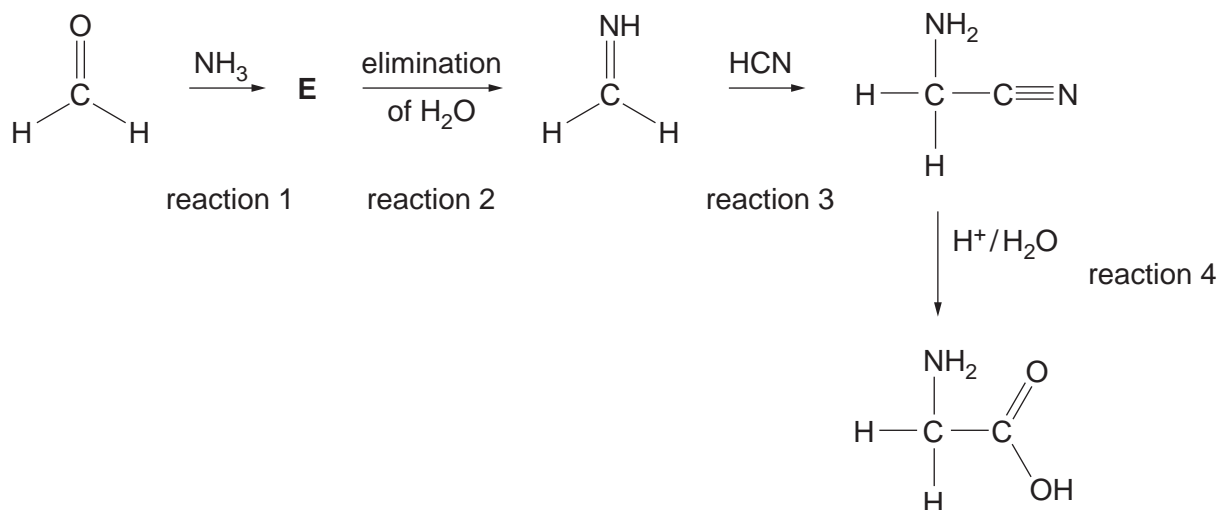
**Time Allowed:** 59 minutes

**Score:** /49

**Percentage:** /100

**Grade Boundaries:**

1. The Strecker synthesis is a route to preparing amino acids. Glycine, 2-aminoethanoic acid, can be prepared from methanal in this way. This is shown in the four-reaction scheme below.



(a) Circle the atom in methanal that is attacked by the ammonia molecule. [1]

(b) What kind of reagent is ammonia, in the context of this synthesis?

..... [1]

(c) Suggest a structure for compound E.

(d) What type of reaction is reaction 3? [1]

..... [1]

(e) The product of reaction 2 is an imine. Name a compound, which does not contain nitrogen, that undergoes a similar reaction with HCN.

..... [1]

(f) What type of reaction is reaction 4?

..... [1]

(g) State the functional group level of the carbon atom in methanal and the functional group level of this carbon atom in the product of reaction 2 and the product of reaction 3.

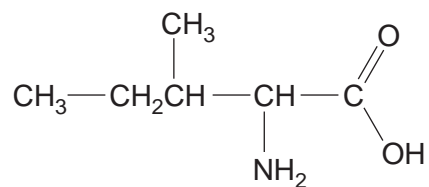
methanal .....

product of reaction 2 .....

product of reaction 3 .....

[3]

(h) The amino acid shown is isoleucine, 2-amino-3-methylpentanoic acid.



Molecule **Z** can be used as the starting material to prepare this amino acid using a Strecker synthesis.

(i) Draw the structure of **Z**.

[1]

(ii) Name molecule **Z**.

..... [1]

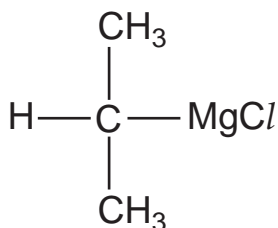
(i) Alanine, 2-aminopropanoic acid, can be made in a similar way, but the synthesis produces a mixture of two optical isomers.

Draw the optical isomers of alanine.

[2]

[Total: 13]

2. (a) Grignard reagents are commonly used in synthesis to create carbon-carbon bonds. The structure is shown of the Grignard reagent formed from the reaction of 2-chloropropane and magnesium. Show the dipole on the relevant bond to carbon.



[1]

- (b) Which three of the following terms describe a Grignard reagent? Circle the three correct answers.

reducing agent

acid

oxidising agent

base

electrophile

nucleophile

[3]

- (c) The Grignard reagent from part (a) reacts with ethanal.

- (i) Draw the structure of the organic product of this reaction.

[1]

- (ii) Identify any chiral carbon atoms in the product with an asterisk (\*). [1]

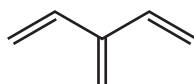
- (iii) Name this organic product.

..... [1]

- (d) Solvents that are employed for Grignard chemistry need to be rigorously dried. By considering the dipole on the O–H bonds in water, suggest what organic product results from getting the Grignard compound in part (a) wet.

[1]

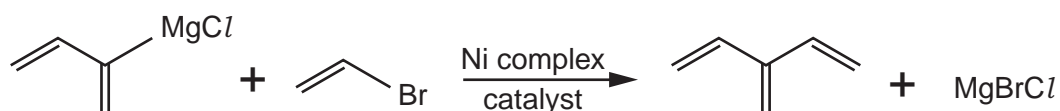
- (e) Recent research (*Angewandte Chemie International Edition*, 2009) has produced the first practical synthesis of dendralenes. Dendralenes are acyclic conjugated polyalkenes. An example is shown.



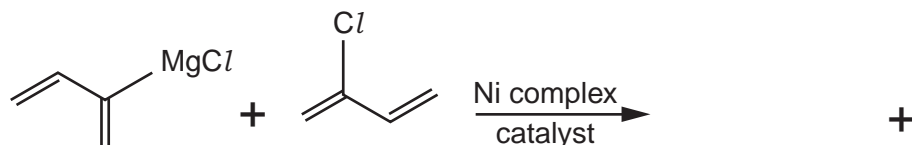
- (i) What is the molecular formula of this compound?

.....[1]

- (ii) The breakthrough was the discovery of the nickel complex that catalysed the process. An example of their dendralene synthesis is shown.



Complete the equation below by inserting the skeletal formula of the organic product and the formula of the inorganic product.



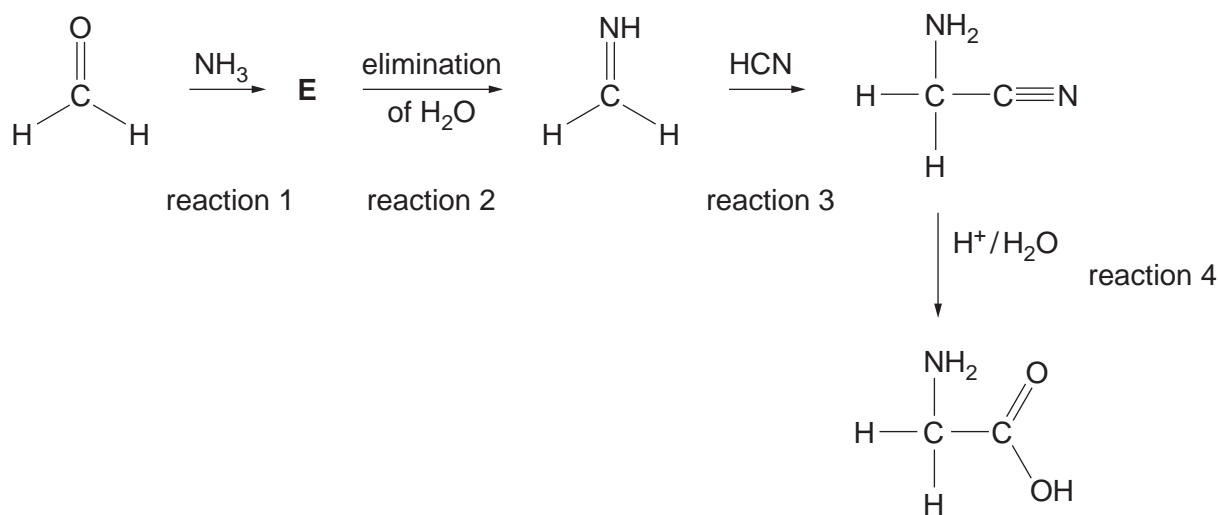
[2]

- (iii) The Grignard reagent from part (e)(ii) can also react with 1,1-dichloroethene in the presence of the nickel complex catalyst. Draw the skeletal formula of the dendralene product.

[2]

[Total: 13]

3. The Strecker synthesis is a route to preparing amino acids. Glycine, 2-aminoethanoic acid, can be prepared from methanal in this way. This is shown in the four-reaction scheme below.



(a) Circle the atom in methanal that is attacked by the ammonia molecule. [1]

(b) What kind of reagent is ammonia, in the context of this synthesis?

.....[1]

(c) Suggest a structure for compound E.

(d) What type of reaction is reaction 3? [1]

.....[1]

(e) The product of reaction 2 is an imine. Name a compound, which does not contain nitrogen, that undergoes a similar reaction with HCN.

.....[1]

(f) What type of reaction is reaction 4?

.....[1]

- (g) State the functional group level of the carbon atom in methanal and the functional group level of this carbon atom in the product of reaction 2 and the product of reaction 3.

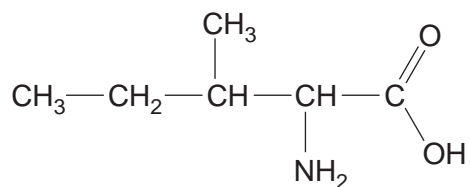
methanal .....

product of reaction 2 .....

product of reaction 3 .....

[3]

- (h) The amino acid shown is isoleucine, 2-amino-3-methylpentanoic acid.



Molecule **Z** can be used as the starting material to prepare this amino acid using a Strecker synthesis.

- (i) Draw the structure of **Z**.

[1]

- (ii) Name molecule **Z**.

.....[1]

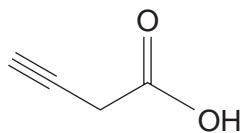
- (i) Alanine, 2-aminopropanoic acid, can be made in a similar way, but the synthesis produces a mixture of two optical isomers.

Draw the optical isomers of alanine.

[2]

[Total: 13]

4. The molecule shown is but-3-ynoic acid.



- (a) Give the molecular formula for but-3-ynoic acid.

molecular formula ..... [1]

- (b) Draw the structure and name an isomer of but-3-ynoic acid that contains the same functional groups.

structure

name..... [2]

- (c) Work out the percentage composition (by mass) of the constituent elements in but-3-ynoic acid.

C ..... %    H ..... %    O ..... %    [2]

- (d) Give the  $m/z$  value of the molecular ion peak in the mass spectrum of but-3-ynoic acid.

..... [1]



- (e) (i) Describe the **two** most significant features that you would expect to see in the infra-red spectrum of but-3-ynoic acid.

.....  
.....  
..... [2]

- (ii) Liquid samples for infra-red analysis are commonly prepared by placing them between two sodium chloride discs. Why could this approach not be considered for recording the IR spectrum of an aqueous solution of but-3-ynoic acid?

.....  
..... [1]

- (f) Scientists recently isolated a novel, highly toxic and unstable molecule, **T**, from the poisonous Asian mushroom *Russula subnigricans* (reported in *Nature Chemical Biology*, 2009).

**T** is an isomer of but-3-ynoic acid. Its infrared spectrum indicates that **T** also contains a carboxylic acid group. Its carbon-13 NMR spectrum, however, only contains 3 signals.

Suggest a structure for **T**.

[1]

[Total: 10]