

Name of the Student: _____

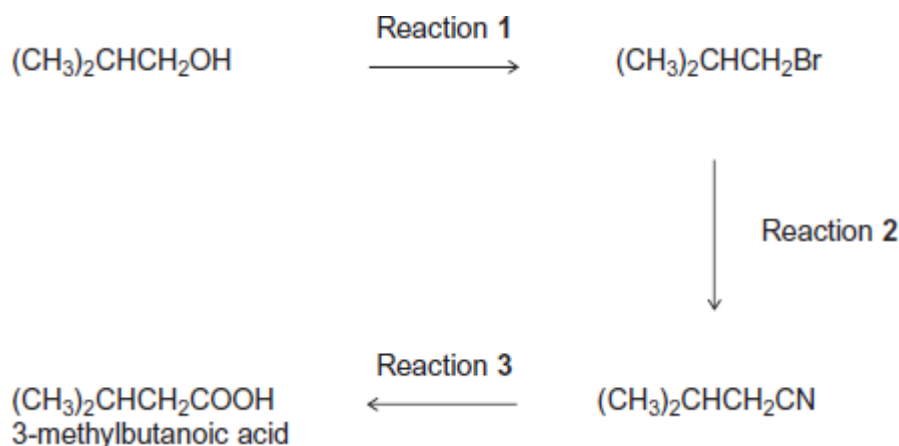
Max. Marks : 21 Marks

Time : 21 Minutes

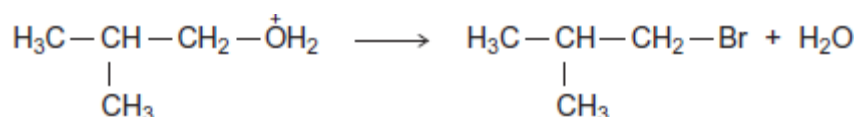
Q1.

The carboxylic acid 3-methylbutanoic acid is used to make esters for perfumes.

The following scheme shows some of the reactions in the manufacture of this carboxylic acid.



- (a) One of the steps in the mechanism for Reaction 1 involves the replacement of the functional group by bromine.
- (i) Use your knowledge of organic reaction mechanisms to complete the mechanism for this step by drawing **two** curly arrows on the following equation.

 BF_3 :

(2)

- (ii) Deduce the name of the mechanism in part (i).

Give the IUPAC name of $(\text{CH}_3)_2\text{CHCH}_2\text{Br}$

(2)

- (b) Reaction 3 is an acid-catalysed reaction in which water is used to break chemical bonds when the CN functional group is converted into the COOH functional group. Infrared spectroscopy can be used to distinguish between the compounds in this reaction.

Deduce the name of the type of reaction that occurs in Reaction 3.

Identify **one** bond in $(\text{CH}_3)_2\text{CHCH}_2\text{CN}$ and a **different** bond in $(\text{CH}_3)_2\text{CHCH}_2\text{COOH}$ that can be used with infrared spectroscopy to distinguish between each compound.

For each of these bonds, give the range of wavenumbers at which the bond absorbs. Use **Table A** on the Data Sheet when answering this question.

(3)

- (c) When 3-methylbutanoic acid reacts with ethanol in the presence of an acid catalyst, an equilibrium is established. The organic product is a pleasant-smelling ester.



The carboxylic acid is very expensive and ethanol is inexpensive. In the manufacture of this ester, the mole ratio of carboxylic acid to ethanol used is 1 to 10 rather than 1 to 1.

- (i) Use Le Chatelier's principle to explain why a 1 to 10 mole ratio is used. In your explanation, you should **not** refer to cost.

(3)

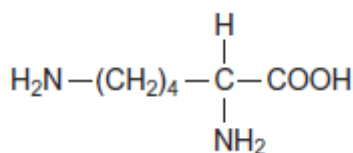
- (ii) Explain how a catalyst increases the rate of a reaction.

(2)

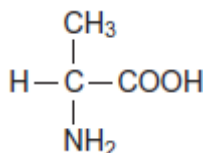
(Total 12 marks)

Q2.

Lysine and alanine are two amino acids.



lysine



alanine

- (a) Give the IUPAC name of lysine.

(1)

- (b) Draw structures to show the product formed in each case when lysine reacts with

- (i) an excess of aqueous HCl

(1)

- (ii) an excess of aqueous NaOH

(1)

- (iii) methanol in the presence of a small amount of concentrated H_2SO_4

(1)

- (c) The mass spectrum of alanine gives a major peak at $m/z = 44$

Write an equation for the fragmentation of the molecular ion of alanine to give an ion that produces this peak.

In your answer, draw the displayed formula for this fragment ion.

(2)

- (d) Draw a dipeptide formed from one molecule of lysine and one molecule of alanine.

(1)

- (e) The dipeptide in part (d) is hydrolysed in acid conditions and the mixture produced is analysed by column chromatography. The column is packed with a resin which acts as a polar stationary phase.

Suggest why lysine leaves the column after alanine.

(2)

(Total 9 marks)