

# Chirality

## Question Paper 1

Level	International A Level
Subject	Chemistry
Exam Board	Edexcel
Topic	Rates, Equilibria & Further Organic Chemistry
Sub Topic	Chirality
Booklet	Question Paper 1

**Time Allowed:** 71 minutes

**Score:** /59

**Percentage:** /100

**Grade Boundaries:**

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

1 Some chemical tests are described below.

A Warm with Fehling's (or Benedict's) solution

B Warm with iodine dissolved in alkali

C Add sodium carbonate solution

D Add 2,4-dinitrophenylhydrazine solution

(a) Which test would result in effervescence with the compound  $\text{CH}_3\text{CH}=\text{CCl}(\text{COOH})$ ?

(1)

A

B

C

D

(b) Which test can be used to distinguish between aldehydes and ketones?

(1)

A

B

C

D

(c) Which test results in an orange-yellow precipitate with  $\text{CH}_3\text{COCH}_3$ ?

(1)

A

B

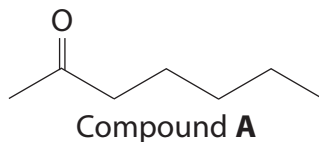
C

D

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(Total for Question 1 = 3 marks)

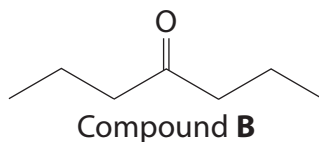
- 2 A naturally occurring ketone, compound **A**, contributes to the smell and flavour of some blue cheeses.



- (a) Give the systematic name of **A**.

(1)

- (b) Compound **B** is an isomer of **A** with the same functional group.



Describe a simple **chemical** test which would distinguish **A** from **B**.  
State the result of the test for each of the compounds.

(2)

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- (c) Give **two** chemical tests for **B** which, when used together, would confirm that **B** contains a carbonyl group and is not an aldehyde. For each test, state the result and what is deduced.

(4)

Test 1

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Test 2

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- (d) Give the **displayed** or **structural** formula of the compound which forms when **A** is reduced. State the name or formula of a suitable reducing agent.

(2)

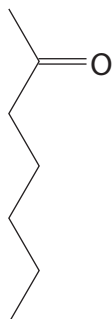
Formula

Reducing agent .....

(e) (i) Hydrogen cyanide reacts with **A** in the presence of  $\text{CN}^-$  ions.

Write a mechanism for this reaction, using the skeletal formula of **A** below.

(3)



\*(ii) By considering the reaction mechanism, explain why the solution produced in this reaction does **not** rotate the plane of plane-polarized light.

(3)

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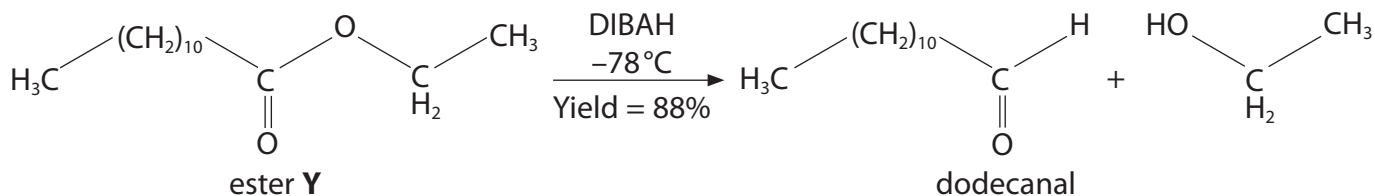
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- 3 Aldehydes can be synthesised in the laboratory by the reaction of esters with the reagent diisobutylaluminiumhydride (DIBAH), which acts as a source of hydride ions. An example is shown below.



- (a) Give the systematic name of ester Y.

(1)

- (b) DIBAH acts as a source of hydride ions. What type of reagent is DIBAH?

(1)

- (c) Suggest why the reaction is kept at  $-78^\circ\text{C}$ .

(1)

- (d) The overall yield for this process is 88%.

Calculate the mass, in g, of dodecanal that would be formed from 5.26 g of the ester Y.

[Molar masses /  $\text{g mol}^{-1}$ : ester Y = 228; dodecanal = 184]

(3)

(Total for Question 3 = 6 marks)

4 Butanone,  $\text{CH}_3\text{CH}_2\text{COCH}_3$ , is used as an industrial solvent.

- (a) State each stage in the procedure in which 2,4-dinitrophenylhydrazine is used to confirm the identity of a carbonyl compound thought to be butanone.

Detailed practical descriptions are not required.

(3)

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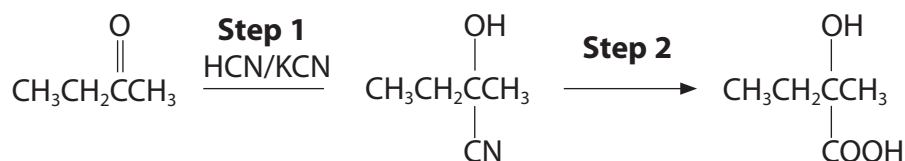
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- (b) Butanone can be converted into 2-hydroxy-2-methylbutanoic acid,  $\text{CH}_3\text{CH}_2\text{C}(\text{OH})(\text{CH}_3)\text{COOH}$ , in two steps:



- (i) Classify the type and mechanism of the reaction taking place in **Step 1**.

(2)

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(ii) Identify the reagent(s) and conditions for the reaction taking place in **Step 2**.

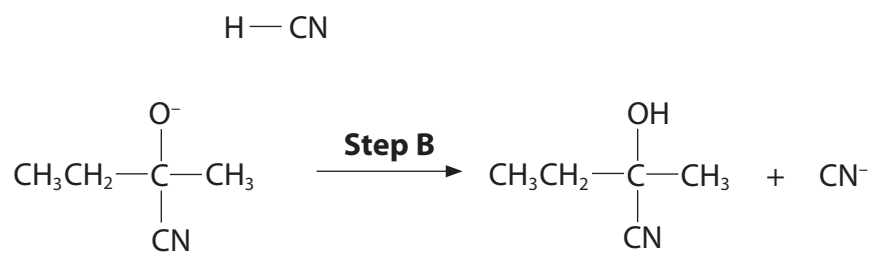
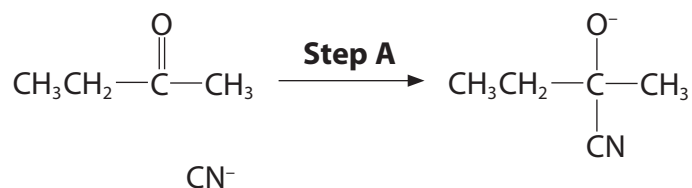
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(2)

(iii) The incomplete mechanism for **Step 1** is shown below.



On the incomplete mechanism above, draw the curly arrows **and** the relevant lone pairs of electrons to complete the mechanism.

(3)

(iv) Explain why the 2-hydroxy-2-methylbutanoic acid produced in this reaction is **not** optically active.

(3)

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- (c) Draw **two** repeat units of the polymer that could be formed from 2-hydroxy-2-methylbutanoic acid.

(2)

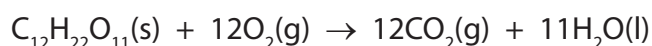
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**(Total for Question 4 = 15 marks)**

- 5 This question is about sucrose, the chemical commonly known as sugar. Some thermochemical data for sucrose and oxygen are given in the table below.

Standard entropy of sucrose, $S^\ominus$ [ $C_{12}H_{22}O_{11}(s)$ ]	+392.4 J mol <sup>-1</sup> K <sup>-1</sup>
Standard enthalpy change of combustion of sucrose, $\Delta H_c^\ominus$	-5639.7 kJ mol <sup>-1</sup>
Standard entropy of oxygen, $S^\ominus$ [ $\frac{1}{2}O_2(g)$ ]	+102.5 J mol <sup>-1</sup> K <sup>-1</sup>

The equation for the complete combustion of sucrose,  $C_{12}H_{22}O_{11}$ , is



- (a) (i) Calculate the standard entropy change of the system,  $\Delta S_{\text{system}}^\ominus$ , for this combustion, using the data given in the table and your Data Booklet. Include a sign and units in your answer.

(3)

- (ii) Calculate the standard entropy change of the surroundings,  $\Delta S_{\text{surroundings}}^\ominus$ , for this combustion at 298 K. Include a sign and units in your answer.

(2)

(iii) Calculate the total standard entropy change for the combustion,  $\Delta S_{\text{total}}^{\ominus}$ , at 298 K.

State the significance of your answer.

(2)

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(iv) State and explain the effect, if any, of increasing the temperature on  $\Delta S_{\text{surroundings}}^{\ominus}$ ,  $\Delta S_{\text{total}}^{\ominus}$  and the extent of the reaction.

(3)

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(v) Icing sugar can be hazardous when it is being finely powdered in a factory.

Explain why sucrose is stable at room temperature, in spite of your answer to part (iii), but its manufacture is hazardous.

(2)

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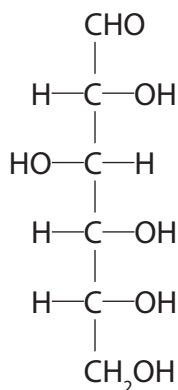
(vi) Suggest **two** risks associated with high levels of sucrose in the diet.

(2)

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- (b) Sucrose can be hydrolysed by warming with dilute hydrochloric acid to form glucose and fructose.

In aqueous solution, a structure of glucose is



- (i) Circle or mark with an asterisk (\*) all the chiral centres on the structure of glucose.

(2)

- (ii) State the physical property associated with molecules which have chiral centres.

(1)

- (iii) State what change you would expect to see when glucose is boiled with Benedict's or Fehling's solutions.

Explain the chemistry involved in this reaction.

(3)

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**(Total for Question 5 = 20 marks)**