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 $CH_3CH{=}CCl(COOH)$?

(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 CH_3COCH_3?

(1)

☒ **A**

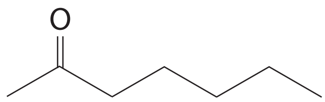
☒ **B**

☒ **C**

☒ **D**

(Total for Question 1 = 3 marks)

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



Compound **A**

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

(1)

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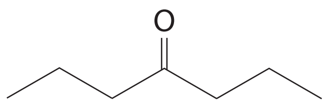
(b) Compound **B** is an isomer of **A** with the same functional group.



Compound **B**

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)

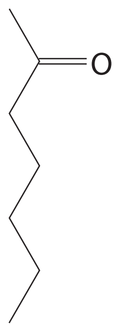
Formula

Reducing agent ....

(e) (i) Hydrogen cyanide reacts with **A** in the presence of 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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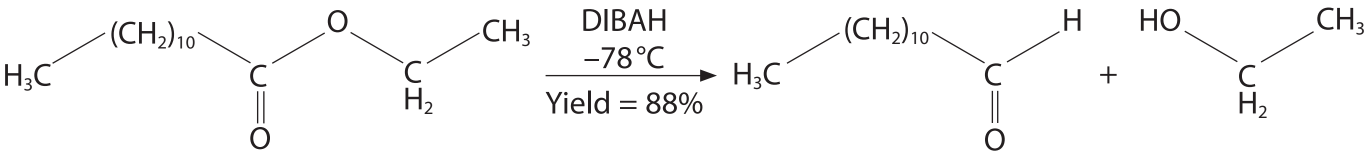
(Total for Question 2 = 15 marks)

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.



ester **Y** dodecanal

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

(1)

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

(1)

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(c) Suggest why the reaction is kept at −78 °C.

(1)

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(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 / g mol^{-1}: ester **Y** = 228; dodecanal = 184]

(3)

(Total for Question 3 = 6 marks)

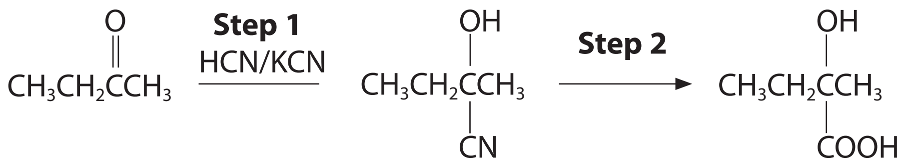
4 Butanone, $CH_3CH_2COCH_3$, is used as an industrial solvent.

(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)

(b) Butanone can be converted into 2-hydroxy-2-methylbutanoic acid, $CH_3CH_2C(OH)(CH_3)COOH$, in two steps:



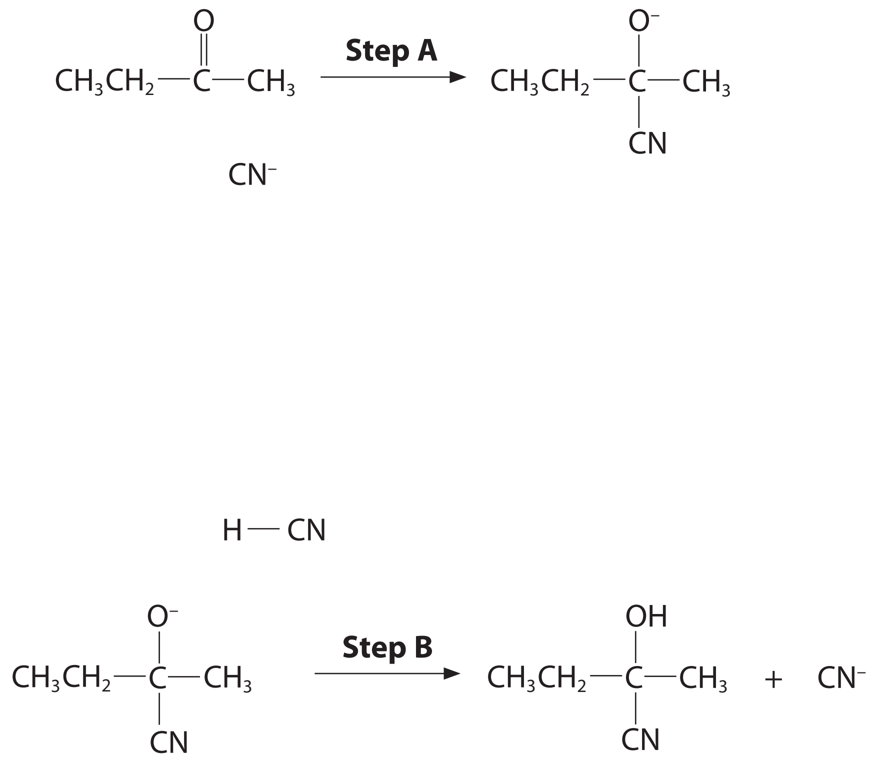
(i) Classify the type and mechanism of the reaction taking place in **Step 1**.

(2)

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

(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)

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

(2)

(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^{-1} K^{-1}
Standard enthalpy change of combustion of sucrose, $\Delta H_c^{\ominus}$	–5639.7 kJ mol^{-1}
Standard entropy of oxygen, $S^{\ominus}$ [½O_2(g)]	+102.5 J mol^{-1} K^{-1}

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

$$C_{12}H_{22}O_{11}(s) + 12O_2(g) \rightarrow 12CO_2(g) + 11H_2O(l)$$

(a) (i) Calculate the standard entropy change of the system, $\Delta S^{\ominus}_{system}$, 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, $\Delta S^{\ominus}_{surroundings}$, 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, $\Delta S^{\ominus}_{total}$, 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 $\Delta S^{\ominus}_{surroundings}$, $\Delta S^{\ominus}_{total}$ 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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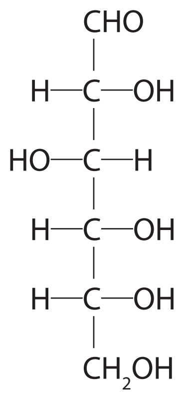
(b) Sucrose can be hydrolysed by warming with dilute hydrochloric acid to form glucose and fructose.

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)

(Total for Question 5 = 20 marks)