

## Monday 18 October 2021 – Morning

### A Level Chemistry B (Salters)

#### H433/03 Practical skills in chemistry

Time allowed: 1 hour 30 minutes



**You must have:**

- the Practical Insert (inside this document)
- the Data Sheet for Chemistry B

**You can use:**

- a scientific or graphical calculator
- an HB pencil



Please write clearly in black ink. **Do not write in the barcodes.**

Centre number

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Candidate number

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First name(s)

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Last name

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### INSTRUCTIONS

- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

### INFORMATION

- The total mark for this paper is **60**.
- The marks for each question are shown in brackets [ ].
- Quality of extended response will be assessed in questions marked with an asterisk (\*).
- This document has **16** pages.

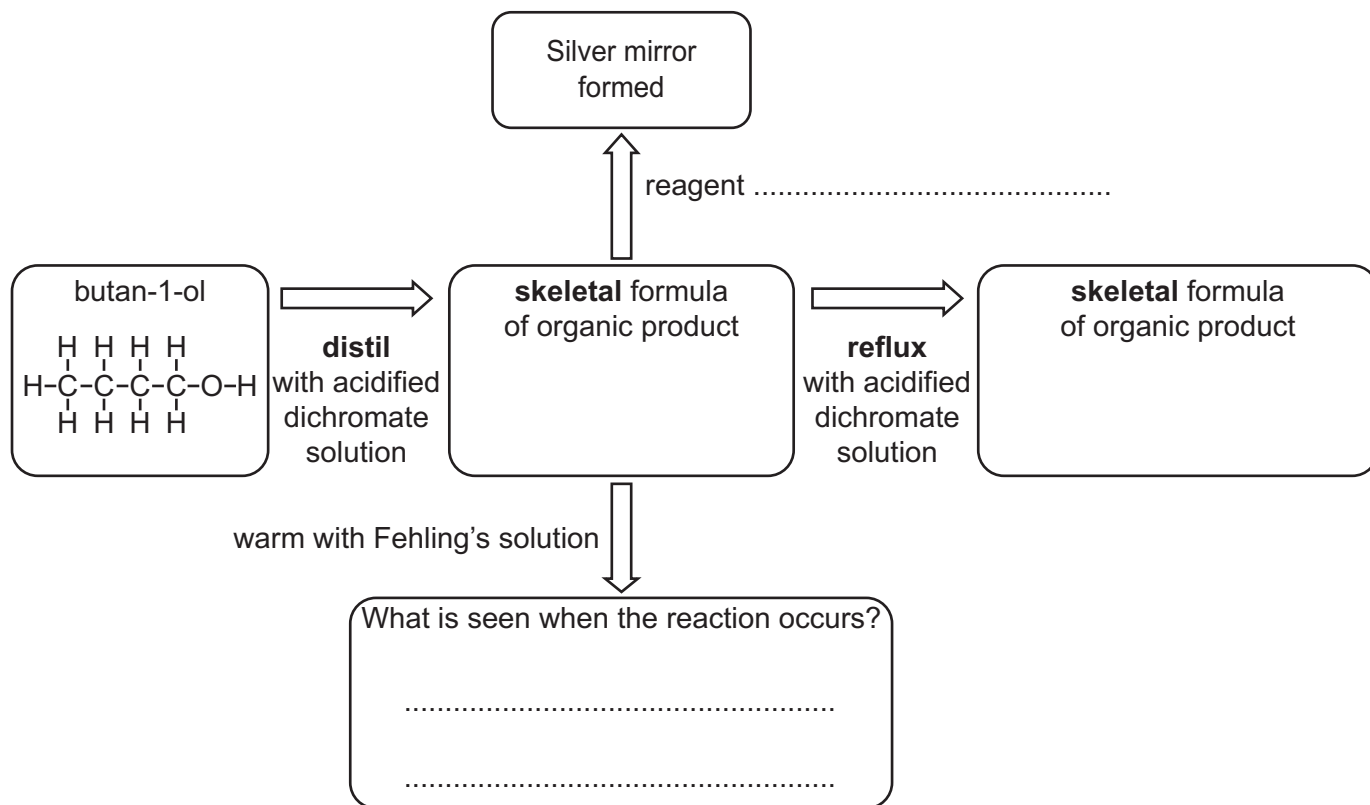
### ADVICE

- Read each question carefully before you start your answer.

Answer **all** the questions.

- 1 Alcohols are useful intermediates and react to give a variety of products. For example, butan-1-ol can be oxidised to other useful products as shown below.

- (a) Complete the flow diagram by writing on the dotted lines and drawing skeletal formulae in the empty boxes.



[4]

- (b) Butan-2-ol is an isomer of butan-1-ol.

Alcohols can be categorised as primary, secondary or tertiary. Which is the correct category for butan-2-ol?

Explain your answer.

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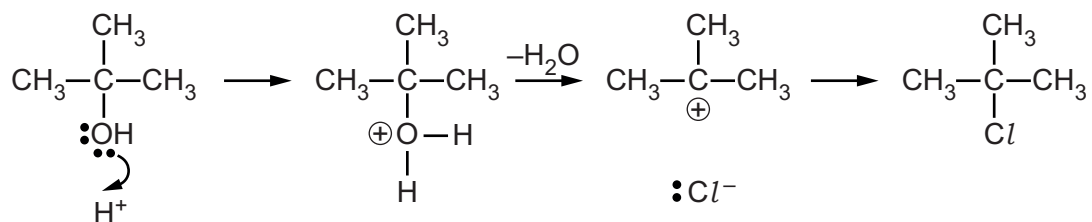
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..... [2]

(c) Alcohols can also undergo substitution reactions.

The following sequence shows an incomplete mechanism for the reaction between  $(\text{CH}_3)_3\text{COH}$  and concentrated hydrochloric acid.

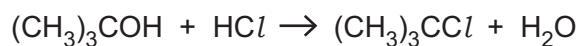


The 'curly arrow' shows the movement of a pair of electrons.

Complete this mechanism by drawing **two** more curly arrows in appropriate places.

[2]

(d)\* A student prepares a pure sample of  $(\text{CH}_3)_3\text{CCl}$  by the reaction from (c):



The preparation involves two parts.

**Part A** The student shakes about  $10\text{ cm}^3$  of the alcohol with  $20\text{ cm}^3$  of concentrated hydrochloric acid in a stoppered conical flask. The reaction occurs quickly at room temperature.

**Part B** The student then separates the layers formed, removes the acid and dries and purifies the organic product.

The student uses data as shown in the table below.

Compound	Does it mix with water?	Density / $\text{g cm}^{-3}$
$(\text{CH}_3)_3\text{COH}$	yes	0.78
$(\text{CH}_3)_3\text{CCl}$	no	0.85

Describe and explain the student's procedure in **part B**.

[6]

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Additional answer space if required.

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- 2 Our bodies contain many proteins, including enzymes.  
These proteins have individual molecular shapes.

- (a) A protein can be described in terms of its primary, secondary and tertiary structure.  
Explain the terms primary, secondary and tertiary in this context.

Primary .....

.....

Secondary .....

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Tertiary .....

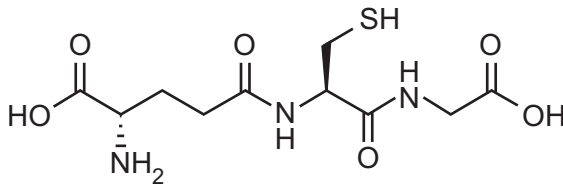
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[3]

- (b) Peptides and proteins are condensation polymers formed from amino acid monomers.

The tripeptide glutathione is an antioxidant found in the body.

The skeletal structure of glutathione is:



- (i) Explain the significance of the dashed line and the wedge shown on the structure.

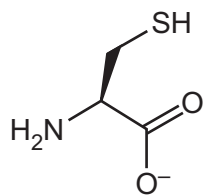
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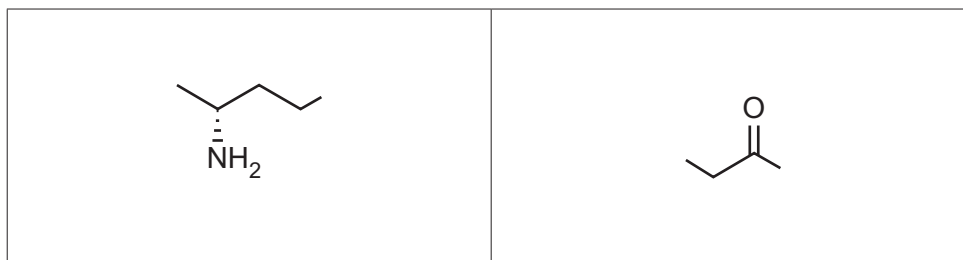
..... [1]

(ii) There are **three** organic products from the **alkaline** hydrolysis of glutathione.

The skeletal structure of one of the organic products is shown below.



Complete the skeletal structures of the other two organic products in the boxes below.



[2]

(c) Many medicinal molecules, including glutathione, show stereoisomerism and interact with active sites on protein molecules in the body.

(i) Salbutamol and salmeterol are medicines used in the treatment of asthma.

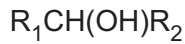
They contain the same **pharmacophore**.

Explain the term **pharmacophore**.

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 ..... [1]

(ii) Salbutamol and salmeterol are both chiral molecules and have enantiomers.

The structure of salbutamol can be represented as shown below.



Use this representation to draw appropriate structural diagrams of salbutamol to explain the terms **chiral** and **enantiomer**.

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 .....  
 ..... [3]

(iii) One of the enantiomers of salbutamol is nearly seventy times more effective at treating asthma than the other.

Suggest why this is the case.

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





- 3 Brine is a solution of mainly sodium chloride in water. There is also some iodine present as the iodide ion,  $I^-$ .

$I^-$  ions are oxidised to  $I_2$  commercially using chlorine.

- (a) Some students investigate this process.

They react aqueous chlorine with aqueous potassium iodide.

They then shake the resulting solution with an equal volume of cyclohexane.

They see a brown layer and a purple layer.

- (i) Write an ionic equation for the reaction.

[1]

- (ii) Identify the coloured layers.

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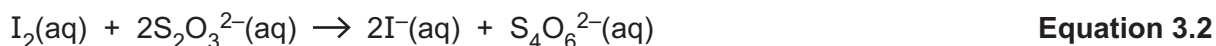
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- (b) One way to determine the amount of iodine in brine is to react the brine with an excess of aqueous  $Cu^{2+}$  ions.

This produces molecular iodine along with a precipitate of copper(I) iodide.



The iodine,  $I_2$ , produced can then be quantitatively measured using titration with aqueous thiosulfate ions,  $S_2O_3^{2-}$ .



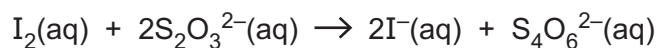
- (i) Analysis of  $25.0\text{cm}^3$  of a sample of brine by this method gave an average titre of  $14.20\text{cm}^3$  of  $1.00 \times 10^{-3}\text{mol dm}^{-3}$  aqueous  $S_2O_3^{2-}$ .

Calculate the concentration of iodine in the brine in  $\text{mg dm}^{-3}$ .

Give your answer to an **appropriate** number of significant figures.

concentration of iodine = .....  $\text{mg dm}^{-3}$  [4]

- (ii) The reaction in **Equation 3.2** is a redox reaction.



**Equation 3.2**

The thiosulfate ion,  $\text{S}_2\text{O}_3^{2-}$ , is oxidised by the iodine.  
Use oxidation numbers to explain why this is an oxidation.

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..... [2]

- (c) The element iodine is much less soluble in water than potassium iodide, KI.

State the structures of iodine and potassium iodide.

Suggest why potassium iodide is more water-soluble than iodine.

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4 This question refers to the **Practical Insert** that is provided as an insert to this paper.

For propanoic acid,  $\text{C}_2\text{H}_5\text{COOH}$ ,  $K_a = 1.3 \times 10^{-5} \text{ mol dm}^{-3}$ .

(a) (i) Investigate, by **calculation**, whether the starting pH of 2.5 recorded for the propanoic acid solution is the expected value.

[2]

(ii) A student says that the pH of propanoic acid with the added  $\text{HCl(aq)}$  is the same as if the  $20 \text{ cm}^3$  of  $0.05 \text{ mol dm}^{-3} \text{ HCl(aq)}$  had been diluted with  $30 \text{ cm}^3$  water.

Carry out a calculation to see whether this is so.

[2]

(b) Explain, using an appropriate equation, why the sodium propanoate solution is alkaline.

In your explanation you should identify the species behaving as a base and identify its conjugate acid.

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- (e) Buffer solutions can also be prepared using weak bases in solution such as amines,  $\text{RNH}_2$ .

Explain, in terms of their electronic structure, why amines behave as bases in aqueous solution. You should draw a labelled diagram of the amine structure to help explain your answer.

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..... [2]

**END OF QUESTION PAPER**

**ADDITIONAL ANSWER SPACE**

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

This section of the page is a large, empty area of lined paper. It features a vertical solid line on the left side, creating a margin. The rest of the page is filled with horizontal dotted lines, providing space for writing answers. The lines are evenly spaced and extend across the width of the page.

A large rectangular area with a solid vertical line on the left and horizontal dotted lines across the rest of the page, intended for writing answers.



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