



Oxford Cambridge and RSA

**Friday 23 June 2023 – 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.

2

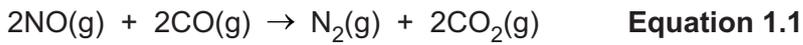
1 Ozone, O<sub>3</sub>, is a serious pollutant when present in the troposphere.

(a) Give **one** polluting effect of ozone in the troposphere.

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

(b) Tropospheric ozone is produced by the reactions of nitrogen oxides, NO<sub>x</sub>, and hydrocarbons. These, together with carbon monoxide, CO, are pollutants produced by motor vehicles.

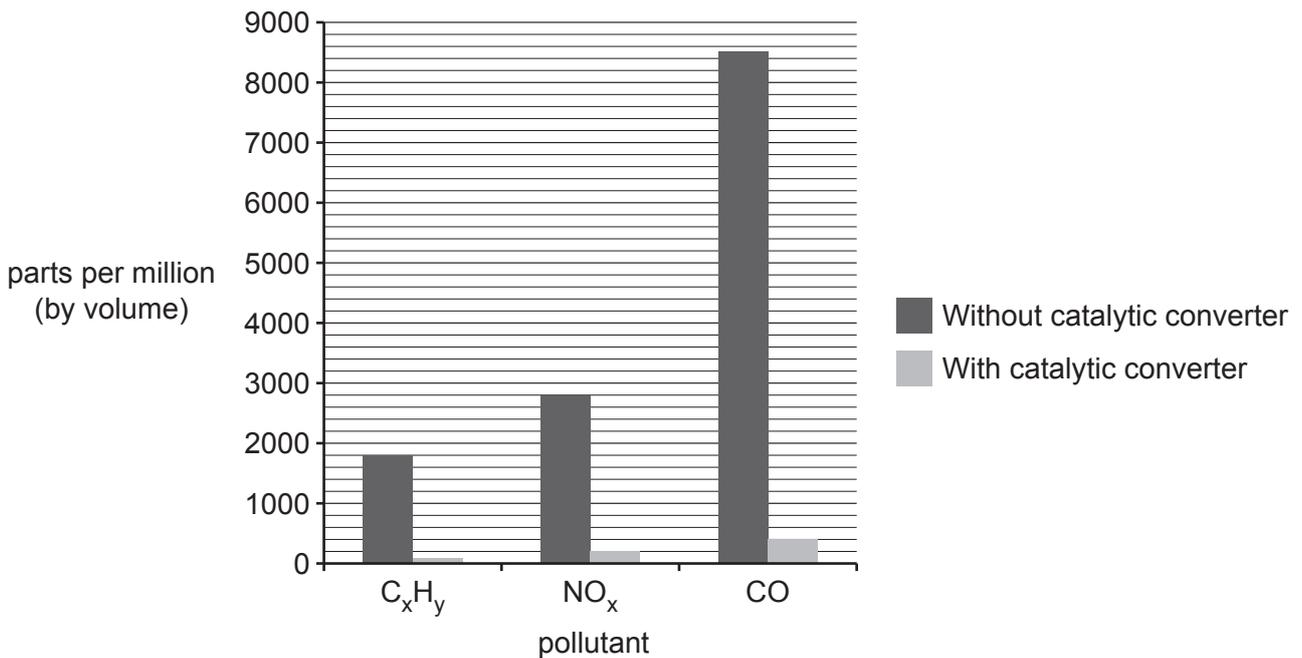
Catalytic converters in vehicle exhausts catalyse the reaction in **Equation 1.1** and also the oxidation of hydrocarbons to carbon dioxide and water.



(i) The bar chart below shows the reduction in the various pollutant levels when a suitable catalytic converter is fitted.

Calculate the percentage reduction in **NO<sub>x</sub>** levels when a catalytic converter is fitted.

Give your answer to **2** significant figures.



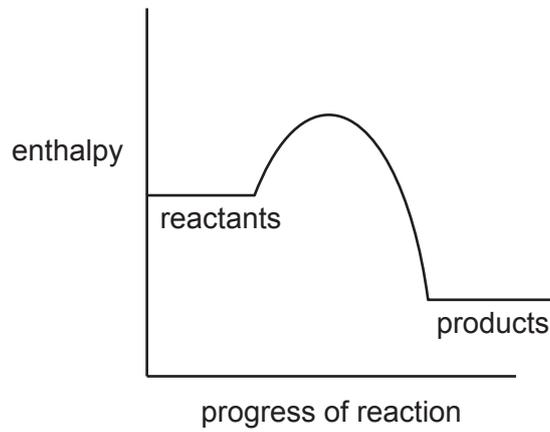
percentage reduction ..... % [2]

3

- (ii) A student says that the reactions in a catalytic converter decrease car pollution to zero.  
Comment on this statement.

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

- (iii) The diagram below represents an energy profile for the catalysed reaction in **Equation 1.1**.

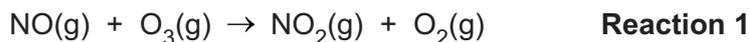


On the diagram:

- Indicate the activation enthalpy of the catalysed reaction.
- Draw a progress curve for the uncatalysed reaction.

[1]

- (c) In the stratosphere, nitrogen monoxide removes ozone molecules by the sequence of reactions below.



A student suggests that the NO molecule is behaving as a heterogeneous catalyst.

Use your chemical knowledge to comment on the student's suggestion.

.....

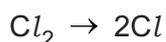
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..... [2]

- (d) Chlorine atoms also act as catalysts to remove ozone.

The atoms can be formed by the reaction shown below.



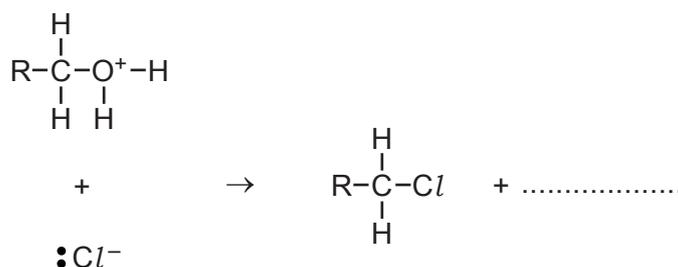
What conditions are needed for this reaction to occur and what **type** of bond fission occurs?

Conditions .....

Type of bond fission ..... [2]

- (e) By contrast, chloride **ions** react in a different way, for example in the reaction below.

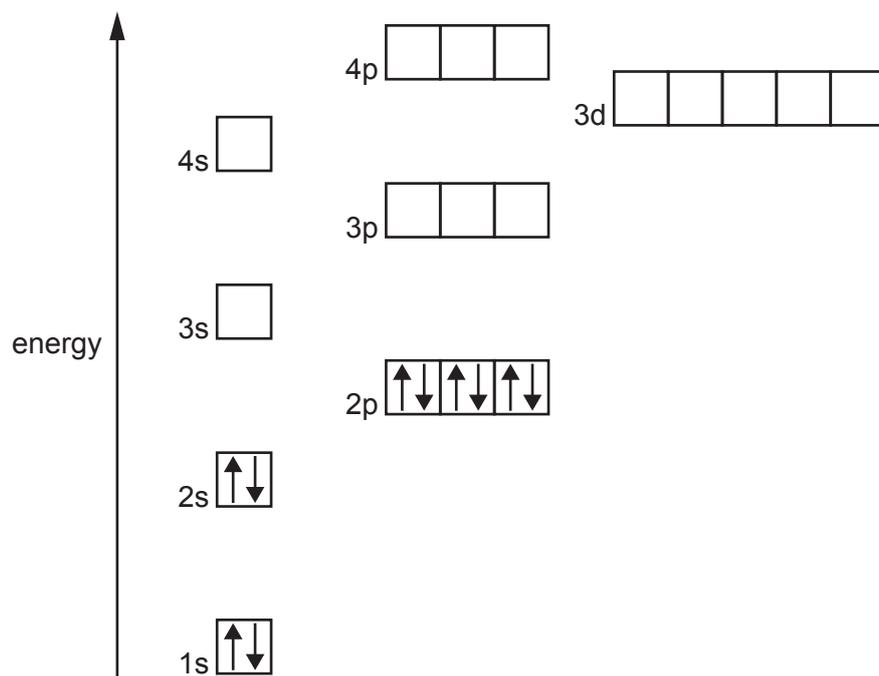
Mark 'curly arrows' on the diagram and give the other product.



[2]

2 Copper is a d-block metal and forms many complexes.

(a) (i) Complete the diagram below to show the electronic configuration of a  $\text{Cu}^{2+}$  ion.



[2]

(ii) Explain why copper is classed as a transition metal.

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..... [1]



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Additional answer space if required.

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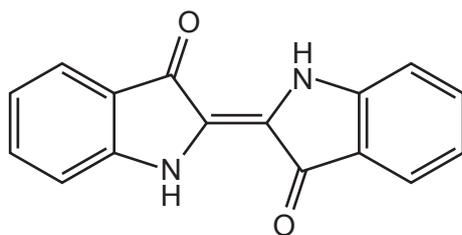
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- 3 Indigo is a natural blue dye that can be extracted from various plants.



**Indigo**

- (a) (i) The IR spectrum of indigo has a significant absorption around  $3300\text{ cm}^{-1}$ .  
Suggest the most likely bond in indigo responsible for this absorption.  
..... [1]
- (ii) Indigo is used to dye cotton. The cotton structure has many  $\text{-OH}$  groups.  
Suggest the strongest type of intermolecular bond that binds indigo to cotton.  
..... [1]
- (b) A frequency of yellow light has a wavelength of  $5.90 \times 10^{-7}\text{ m}$ .
- (i) Calculate the energy (in kJ) associated with one mole of photons of this wavelength.

energy = ..... kJ [3]

- (ii) Explain why indigo has a blue colour.

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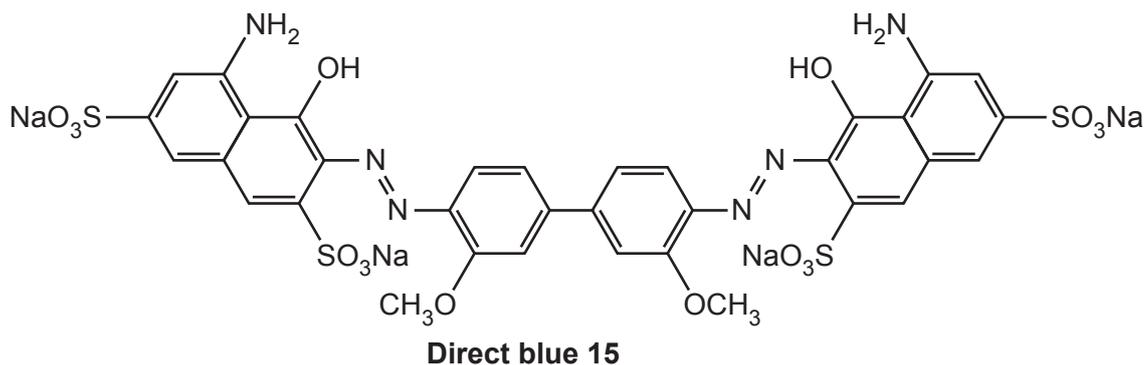
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..... [3]



- (d) (i) The dye **direct blue 15** does not fade, whereas indigo does.



This dye is made by sulfonation.

Give the reagents and conditions used in the sulfonation of **benzene**, the name of the mechanism of the reaction and a property of **direct blue 15** that is caused by the sulfonation.

Reagents and conditions .....

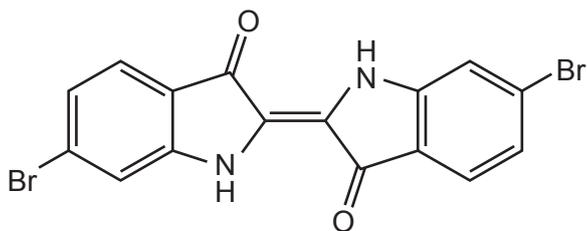
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Name of mechanism .....

Property of **direct blue 15** .....

..... [4]

- (ii) Dibromoindigo can be prepared synthetically by reacting indigo with bromine, using an iron catalyst.



**Dibromoindigo**

The reaction has the same type of mechanism as sulfonation.

Explain the role of the iron in forming  $\text{Br}^+$ .

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.....

..... [2]

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

(a) (i) Explain why the results of **Experiment 1** show that the rate of reaction does **not** vary with the iodine concentration.

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

(ii) During **Experiment 1**, the students ensured the concentration of propanone remained virtually constant.

How did they do this?

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

(b) Suggest why the total volume is kept constant in **Experiment 2**.

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

- (c) (i) An extended version of **Table 4.1** from the Insert is given below.

Use the data in this table to calculate the rates of reaction (in  $\text{cm}^3$  of iodine solution decolorised per second) in **Run B** and **Run C**.

Give your answers to **2** significant figures and write your values in the appropriate blank boxes in the table.

**Table 4.1**

	Run A	Run B	Run C
Volume of $2.0 \text{ mol dm}^{-3} \text{ HCl} / \text{cm}^3$	20.0	10.0	20.0
Volume of $2.0 \text{ mol dm}^{-3} \text{ propanone} / \text{cm}^3$	8.0	8.0	4.0
Volume of water / $\text{cm}^3$	0	10.0	4.0
Volume of $0.010 \text{ mol dm}^{-3} \text{ iodine} / \text{cm}^3$	4.0	4.0	4.0
Total volume in flask / $\text{cm}^3$	32.0	32.0	32.0
Time for colour to disappear	115	234	240
Rate of reaction of iodine / $\text{cm}^3 \text{ s}^{-1}$	0.035		
Rate of reaction of iodine / $\text{mol dm}^{-3} \text{ s}^{-1}$	$1.1 \times 10^{-5}$		

[1]

- (ii) The students do a text book search and find that the rate equation for the reaction is:

$$\text{Rate} = k [\text{propanone}][\text{H}^+]$$

Explain whether the results of **Experiment 1** and **Experiment 2** support this rate equation.

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..... [3]

(d) (i) Show why the rate of reaction of iodine in **Run A** is  $1.1 \times 10^{-5} \text{ mol dm}^{-3} \text{ s}^{-1}$ .

[1]

(ii) Using the data in **Table 4.1** for **Experiment 2 Run A**, calculate the initial concentrations of hydrochloric acid and propanone in the flask.

Use these values, along with the rate from (d)(i), to calculate the value of the rate constant,  $k$ , with its units.

$[\text{HCl}] = \dots\dots\dots \text{ mol dm}^{-3}$

$[\text{propanone}] = \dots\dots\dots \text{ mol dm}^{-3}$

$k = \dots\dots\dots \text{ units } \dots\dots\dots$  [4]



15

- (f) The students wear safety goggles and protective gloves when carrying out the experiments.

Using the information from the insert, suggest **one other** necessary health and safety measure.

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

**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).

A large rectangular area with horizontal dotted lines for writing, intended for providing additional answers. A solid vertical line is positioned on the left side of this area, creating a margin for writing the question number(s).

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