

Please check the examination details below before entering your candidate information

Candidate surname

Other names

Centre Number

Candidate Number

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Pearson Edexcel International Advanced Level**Thursday 26 October 2023**

Morning (Time: 1 hour 20 minutes)

Paper
reference**WCH16/01****Chemistry****International Advanced Level****UNIT 6: Practical Skills in Chemistry II****You must have:**

Scientific calculator, ruler

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
– *there may be more space than you need.*

Information

- The total mark for this paper is 50.
- The marks for **each** question are shown in brackets
– *use this as a guide as to how much time to spend on each question.*
- You will be assessed on your ability to organise and present information, ideas, descriptions and arguments clearly and logically, including your use of grammar, punctuation and spelling.
- A Periodic Table is printed on the back cover of this paper.

Advice

- Read each question carefully before you start to answer it.
- Show all your working in calculations and include units where appropriate.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ►

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Answer ALL the questions. Write your answers in the spaces provided.

- 1** A series of tests is carried out on a violet-coloured solid **A**, which contains two cations and one anion.

- (a) Some solid calcium oxide is added to a spatula measure of **A** in a test tube and the mixture heated gently.

A pungent gas is given off which turns damp red litmus paper blue.

- (i) Give the name or formula of the gas produced in this test.

(1)

- (ii) Give the **formula** of the cation in **A** shown by this test.

(1)

- (b) Alkaline solutions are added drop by drop to separate samples of an aqueous solution of **A** until there is no further reaction.

With dilute sodium hydroxide, a green precipitate forms which dissolves in excess sodium hydroxide giving a green solution.

With dilute aqueous ammonia, a green precipitate forms which dissolves in excess ammonia giving a violet solution.

- (i) State the **types** of reaction that occur when the precipitates dissolve.

(2)

with excess sodium hydroxide.....

with excess ammonia.....

- (ii) Give the **formula** of the cation in **A**, shown by the tests in (b).

(1)

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- (c) An aqueous solution of **A** is acidified with dilute hydrochloric acid, and a few drops of barium chloride solution are added.
A white precipitate forms.

(i) Give the **formula** of the anion in **A** shown by this test.

(1)

(ii) State the reason for adding the dilute hydrochloric acid.

(1)

(d) Suggest a formula for compound **A**, using your answers to (a), (b) and (c).

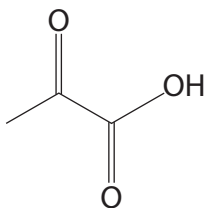
(1)

(Total for Question 1 = 8 marks)



2 Compounds **B** and **C** are isomers with the molecular formula $C_3H_4O_3$.

Compound **B** is a colourless liquid with the structure shown.



(a) Name the functional groups present in **B**.

(2)

(b) A series of tests is carried out on **B**.

Complete the observation boxes.

(i) 2 cm^3 of aqueous sodium hydrogencarbonate, $\text{NaHCO}_3(\text{aq})$, is added to a test tube containing a small quantity of **B**.

(1)

Observation

(ii) A few drops of **B** are added to 2 cm^3 of acidified potassium dichromate(VI) solution. The mixture is placed in a warm water bath.

(1)

Observations	
Initial colour	Final colour



- (iii) A few drops of **B** are added to 2 cm³ of a solution of 2,4-dinitrophenylhydrazine (Brady's reagent).

(1)

Observation

- (iv) A few drops of **B** are added to 2 cm³ of Fehling's solution. The mixture is placed in a warm water bath.

(1)

Observations	
Initial appearance of mixture	Final appearance of mixture

- (v) A few drops of **B** are added to 2 cm³ of a solution of iodine dissolved in aqueous sodium hydroxide solution. The mixture is placed in a warm water bath.

(1)

Observation

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- C** reacts with Tollens' reagent to produce a silver mirror.

(2)

Possible structure of $\mathbf{C}$

(Total for Question 2 = 9 marks)



- 3 This question is about ethanedioic acid, $(\text{COOH})_2$, also known as oxalic acid. Traces of ethanedioic acid are found in many foods including spinach, fruits, nuts and seeds.

A group of students carried out an experiment to determine the percentage by mass of ethanedioic acid in rhubarb leaves.

- (a) The first stage of the experiment was the extraction of ethanedioic acid.

319 g of rhubarb leaves was chopped up and placed into a large beaker of distilled water. The mixture was boiled gently for about 15 minutes and then filtered. The solution was transferred to a volumetric flask and the volume made up to exactly 1000.0 cm^3 with distilled water and mixed thoroughly. This solution was labelled **R**.

One student suggested that hexane should be used as the solvent rather than water.

Explain why water is used as a solvent and not hexane.

(2)

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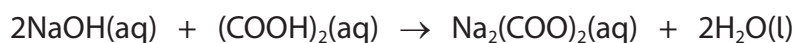
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- (b) The second stage of the experiment was the titration of the ethanedioic acid solution **R**.

25.0 cm³ portions of **R** were placed in conical flasks and titrated with **either** aqueous sodium hydroxide, NaOH, **or** aqueous cerium(IV) sulfate, Ce(SO₄)₂.

The equations for these reactions are



Ce⁴⁺(aq) ions have a yellow colour and Ce³⁺(aq) ions are colourless.

- (i) For each of these titrations, describe how the end-point can be detected, stating the colour changes in each case.

(3)

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- (ii) Some of the students decided to titrate 25.0 cm^3 portions of solution **R** with $0.0400\text{ mol dm}^{-3}$ aqueous sodium hydroxide.

The mean titre was 20.60 cm^3 .

Calculate the percentage, by mass, of ethanedioic acid in this sample of rhubarb leaves.

Give your answer to an appropriate number of significant figures.

[Molar mass $(\text{COOH})_2 = 90.0\text{ g mol}^{-1}$]

(5)

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- (c) Ethanedioic acid is used in many laboratories. It is usually supplied as hydrated crystals, $(\text{COOH})_2 \cdot x\text{H}_2\text{O}$, and dissolved in distilled water to make a solution.

A technician makes 500 cm^3 of a 0.500 mol dm^{-3} ethanedioic acid solution by dissolving 31.5 g of hydrated ethanedioic acid and making the volume up to 500 cm^3 with distilled water.

Calculate the value of x in the formula of hydrated ethanedioic acid, $(\text{COOH})_2 \cdot x\text{H}_2\text{O}$.

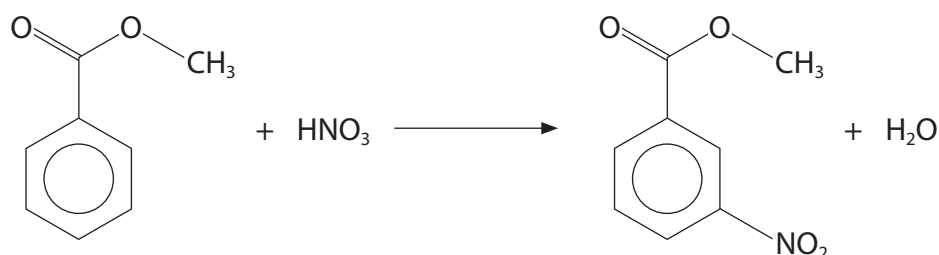
(3)

(Total for Question 3 = 13 marks)



4 This question is about the nitration of methyl benzoate.

The equation for the reaction is shown.



Procedure

- Step 1** Weigh between 1.9 g and 2.1 g of methyl benzoate in a 50 cm³ conical flask.
- Step 2** Slowly add 5 cm³ of concentrated sulfuric acid to the methyl benzoate with swirling and place the flask in an ice-water bath to cool.
- Step 3** Place 2.0 cm³ of concentrated nitric acid into a test tube.
Cool the nitric acid by immersing the test tube in an ice-water bath before slowly adding 2.0 cm³ of concentrated sulfuric acid.
Allow this nitrating mixture to cool.
- Step 4** Using a teat pipette, add the nitrating mixture very slowly to the conical flask, ensuring the temperature does not exceed 7°C.
- Step 5** Allow the flask to stand at room temperature for about 15 minutes and then pour the contents into a beaker containing some crushed ice.
Impure methyl 3-nitrobenzoate will form.
- Step 6** Recrystallise the methyl 3-nitrobenzoate using methanol as the solvent.
- Step 7** Weigh the dry crystals and determine their melting temperature.
- (a) A bottle of concentrated nitric acid has two hazard warning signs.



(i) State the two hazards.

(1)

- (ii) Give a precaution to reduce the risk when using concentrated nitric acid.
Assume that safety goggles and a laboratory coat are used.

(1)

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- (b) Explain why the nitrating mixture is added slowly in Step 4.

(2)

- (c) During recrystallisation in Step 6, the methyl 3-nitrobenzoate is dissolved in a minimum volume of hot methanol and the hot mixture filtered.
The filtrate is cooled, and the resulting crystals filtered and rinsed with ice-cold methanol.

- (i) State why methanol is a suitable solvent for use in the recrystallisation of methyl 3-nitrobenzoate.

(1)

- (ii) State the purpose of each of the filtrations during the recrystallisation of methyl 3-nitrobenzoate.

(2)



(iii) Give the purpose of rinsing the crystals, stating why the methanol is ice-cold.

(2)

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(d) 1.95 g of methyl benzoate reacted with an excess of nitric acid to form 1.51 g of methyl 3-nitrobenzoate.

[Molar mass values: methyl benzoate, $\text{C}_6\text{H}_5\text{CO}_2\text{CH}_3 = 136 \text{ g mol}^{-1}$
methyl 3-nitrobenzoate, $\text{C}_6\text{H}_4\text{CO}_2\text{CH}_3\text{NO}_2 = 181 \text{ g mol}^{-1}$]

(i) Calculate the percentage yield.

(2)

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(ii) Give **one** possible reason why the yield in (d)(i) is less than 100%.

(1)

(Total for Question 4 = 12 marks)

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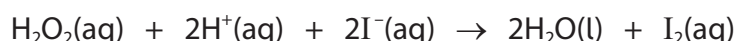
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- 5 A group of students carried out a series of experiments to investigate the kinetics of the reaction between hydrogen peroxide and iodide ions in acidic conditions.

The equation for the reaction is shown.



Procedure

- Step 1** Measure 10 cm^3 of aqueous sodium thiosulfate solution into a conical flask. Add 5 cm^3 of aqueous starch solution and 25 cm^3 of distilled water.
- Step 2** Measure 5 cm^3 of aqueous potassium iodide solution and 5 cm^3 of dilute sulfuric acid and add these to the mixture in the conical flask from Step 1.
- Step 3** Measure 5 cm^3 of aqueous hydrogen peroxide solution into a test tube.
- Step 4** Add the hydrogen peroxide solution to the conical flask, mix thoroughly and start the timer.
- Step 5** Record the time when the solution turns blue-black.
- Step 6** Repeat the experiment varying the volumes of aqueous potassium iodide solution and distilled water, keeping the total volume of the mixture constant.

- (a) Explain the purpose of adding the sodium thiosulfate solution in Step 1.

(2)

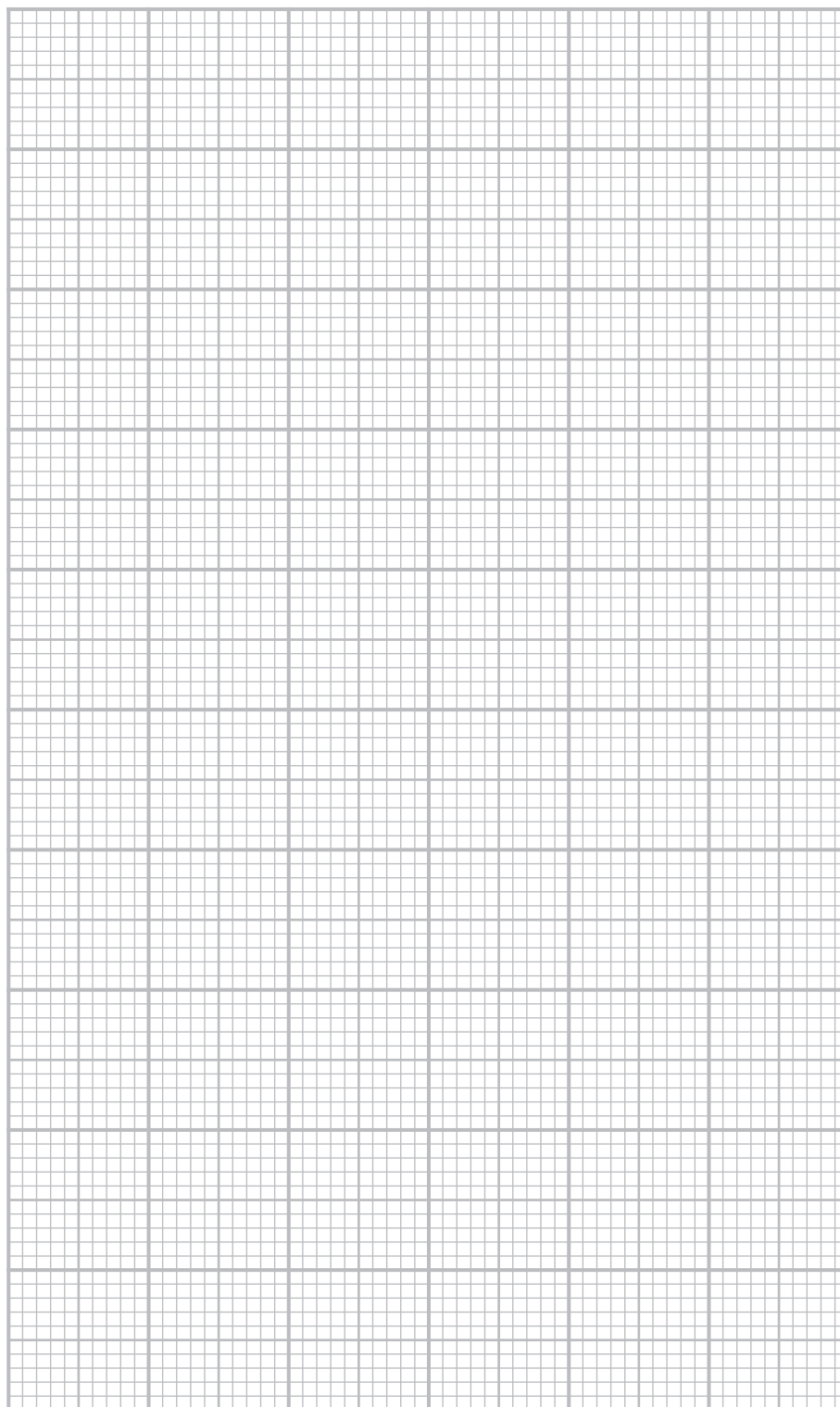
- (b) A set of results is shown.

Run	Volume of solutions / cm^3						Time (t) / s	$1/t$ / s^{-1}
	$\text{Na}_2\text{S}_2\text{O}_3$	Starch	H_2O	KI	H_2SO_4	H_2O_2		
1	10	5	25	5	5	5	270	0.0037
2	10	5	20	10	5	5	138	0.0072
3	10	5	15	15	5	5	93	0.011
4	10	5	10	20	5	5	71	0.014
5	10	5	5	25	5	5	55	0.018



- (i) Plot a graph of $1/t$ against the volume of potassium iodide.

(3)



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- (ii) Deduce the order of the reaction with respect to iodide ions, using your graph. Justify your answer.

(2)

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- (c) Give a reason why the concentration of the potassium iodide solution is significantly lower than that of the hydrogen peroxide solution and the sulfuric acid.

(1)

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(Total for Question 5 = 8 marks)

TOTAL FOR PAPER = 50 MARKS

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The Periodic Table of Elements

[illegible]

* Lanthanide series

* Actinide series

Elements with atomic numbers 112-116 have been reported but not fully authenticated

