

Please check the examination details below before entering your candidate information

Candidate surname

Other names

Pearson Edexcel
International
Advanced Level

Centre Number

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Candidate Number

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Wednesday 17 June 2020

Morning (Time: 1 hour 15 minutes)

Paper Reference **WCH06/01**

Chemistry

Advanced

Unit 6: Chemistry Laboratory Skills II

Candidates must have: Scientific calculator
Ruler

Total Marks

Instructions

- Use **black** ink or **black** ball-point pen.
- **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 give units where appropriate.
- 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 transition metal **M** has two oxides.

One oxide is a black solid. This solid reacts with dilute nitric acid to form a blue solution **X**.

(a) Tests are carried out on the solution **X**. Complete the table.

Test	Observation	Inference
(i) To 1 cm ³ of X in a test tube, add a few drops of sodium hydroxide solution followed by an excess	A pale blue precipitate forms which does not dissolve in excess sodium hydroxide solution	The formula of the transition metal cation in X is
(ii) To 1 cm ³ of X in a test tube, add a few drops of dilute ammonia solution followed by an excess	After adding a few drops of dilute ammonia solution: After adding excess ammonia solution:	This confirms the inference made in (i)
(iii) A few drops of X are added to 3 cm ³ of concentrated hydrochloric acid and the colour of the mixture observed	The colour seen is caused by a species with the formula
(iv) To 1 cm ³ of X in a test tube, add a few drops of potassium iodide solution Then add a few drops of starch solution	A brown solution and a white solid form The brown solution turns blue black	Identify by name or formula: the substance causing the brown colour the white solid

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(b) A reagent containing a compound of **M** produces the second oxide of **M** when it is warmed with ethanal.

(i) Name a reagent which reacts with ethanal to produce this second oxide of **M**. (1)

(ii) Give the **formula** of this second oxide of **M**. (1)

(iii) Describe what you would **see** when carrying out this reaction. (1)

(Total for Question 1 = 10 marks)



2 This question is about butanoic acid, $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$, and one of its isomers.

- (a) State what test you could use, other than adding an indicator or using a pH meter, to confirm that butanoic acid contains an acid group.

Give the result of the test.

(2)

Test

Result

- (b) Compound **A** is an organic liquid which is an isomer of butanoic acid.

There are two functional groups in **A**. Neither functional group is a carboxylic acid.

Tests were carried out on **A**.

- (i) Dry phosphorus(V) chloride was added to **A**. Steamy fumes were produced which turned damp blue litmus paper red.

State what you can deduce about **A** from this test.

(1)

- (ii) **A** was tested with 2,4-dinitrophenylhydrazine solution (Brady's reagent). The result was **positive**.

State what you would see when a positive result is obtained in this test and what you would deduce from this result.

(2)

Observation

Deduction

- (iii) Another portion of **A** was then warmed with Tollens' reagent. No change was seen.

State what you can deduce about **A** from this test.

(1)



- (iv) **A** was warmed with iodine in the presence of sodium hydroxide.
Pale yellow crystals formed.

State what you can deduce about **A** from this test.

(1)

- (v) **A** is optically active. The carbon chain in **A** is not branched.

Draw the displayed formula for **A** which is consistent with this information and the deductions from (b)(i) to (b)(iv).

Circle the chiral centre.

(2)

- (vi) State why the **low** resolution proton nmr spectrum of **A** has four peaks.

(1)

- (vii) State the number of singlets, doublets, triplets and quartets in the **high** resolution proton nmr spectrum of **A**.
Some of these numbers may be zero.

(3)

Number of singlets	Number of doublets	Number of triplets	Number of quartets

(Total for Question 2 = 13 marks)

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3 Ethyl ethanoate, $\text{CH}_3\text{COOC}_2\text{H}_5$, was hydrolysed by reacting it with hydrochloric acid.

10.0 cm^3 of the ester and 100 cm^3 of 1.00 mol dm^{-3} hydrochloric acid were placed in separate containers in a water bath at 40°C .

The contents were allowed to reach the temperature of the water bath.

The ester was mixed with the hydrochloric acid and a timer was started.

At intervals, over a period of 60 minutes, 5.00 cm^3 samples of the mixture were withdrawn by pipette and added to a mixture of ice and water in a conical flask.

These samples were then titrated with 0.200 mol dm^{-3} sodium hydroxide solution added from a burette.

After 60 minutes the remaining mixture was heated under reflux for 15 minutes. Another 5.00 cm^3 sample was then withdrawn and the titration repeated.

(a) Write the equation for the hydrolysis of ethyl ethanoate.

State symbols are not required.

(1)

(b) Explain why the number of moles of hydrochloric acid in each 5 cm^3 sample remains constant.

(1)

(c) Give a reason why the samples were added to a mixture of ice and water.

(1)

(d) Phenolphthalein indicator was used in the titration.

State the colour change which was seen at the end-point.

(1)

From to



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(e) The mixture remaining after 60 minutes was heated under reflux and another 5 cm³ sample was titrated.

(i) By considering the products of the reaction, suggest what information this titre provides.

(1)

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(ii) Draw a labelled diagram of the apparatus used to heat the reaction mixture under reflux.

(3)



(f) The results of the experiment are shown.

Results

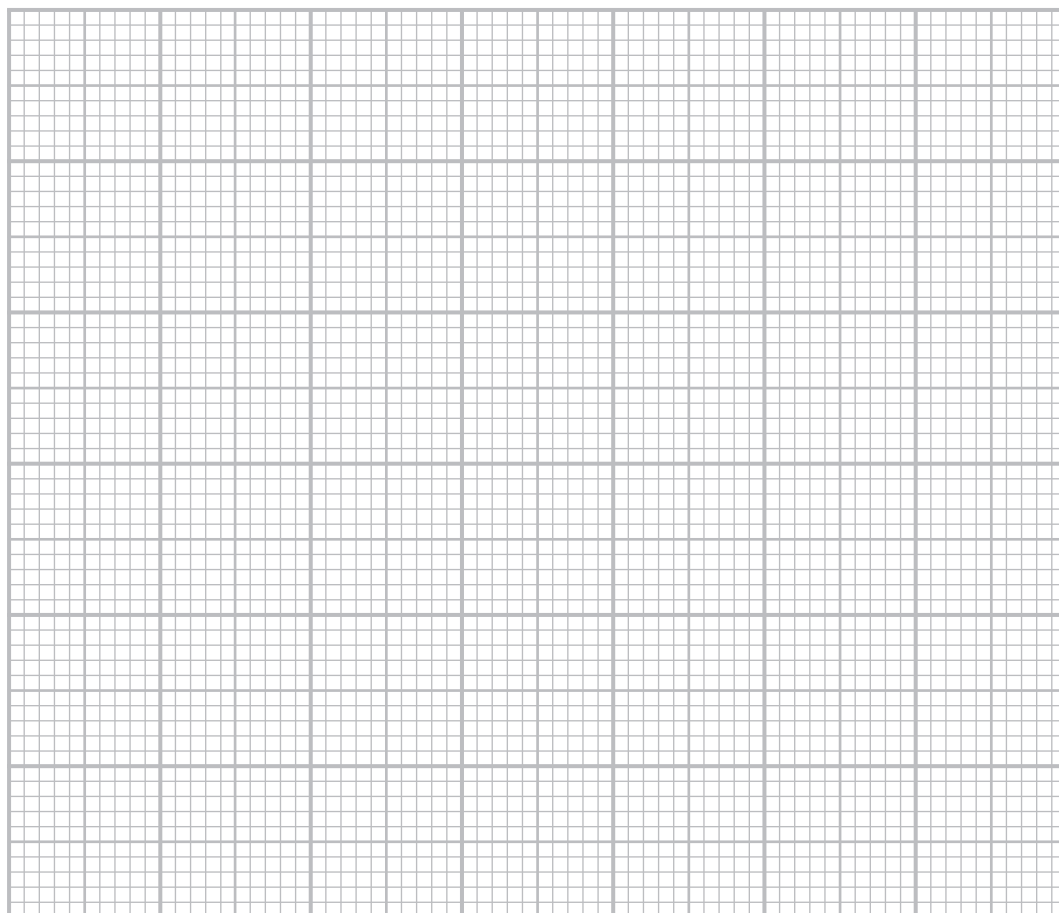
Time / min	Titre / cm ³	$V = (45.00 - \text{titre}) / \text{cm}^3$
0	22.70	22.30
10	28.50	16.50
20	32.50	12.50
30	35.95	9.05
40	37.90	7.10
50	39.75	5.25
60	41.20	3.80
After refluxing	45.00	

The quantity V is directly proportional to the concentration of the ester in the sample.



(i) Plot a graph of **V** on the vertical axis against time on the horizontal axis.

(2)



(ii) Use your graph to determine the order of reaction by measuring two successive half-lives.

(2)

First half-life

Second half-life

Order of reaction

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- (g) (i) Calculate the number of moles of ethyl ethanoate in the 10.0 cm^3 used in the reaction mixture.

Data for ethyl ethanoate:

Density	0.900 g cm^{-3}
Molar mass	88.1 g mol^{-1}

(1)

- (ii) Give a reason why the number of moles of water present for hydrolysis does not have to be known when finding the order of the reaction.

(1)

.....
.....

- (h) A student suggested that the order of the reaction could be found by plotting a graph of the pH of the mixture against time, and measuring half-lives.

Give **two** reasons why this method cannot be used.

(2)

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(Total for Question 3 = 16 marks)



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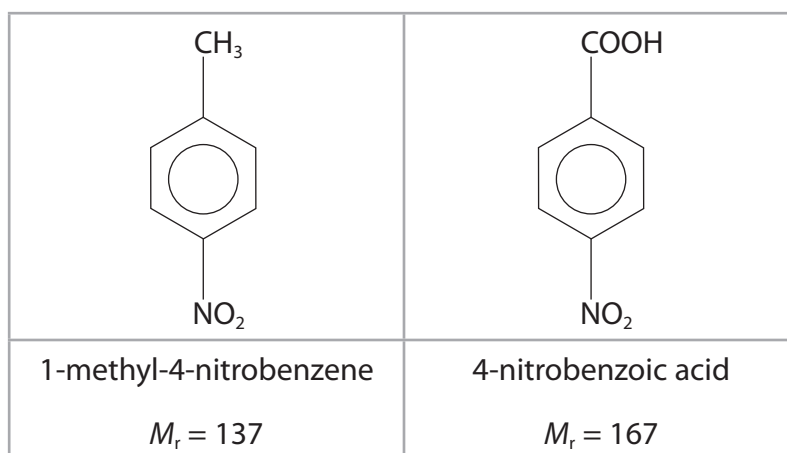
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- 4 This question is about the preparation of 4-nitrobenzoic acid from 1-methyl-4-nitrobenzene.

This reaction is one stage in the production of benzocaine, a local anaesthetic.



Outline procedure

- Step 1** Add 10.0 g of 1-methyl-4-nitrobenzene to a cold acidic solution of sodium dichromate(VI). Heat the mixture under reflux for an hour and allow it to cool.
- Step 2** Pour the mixture onto ice in a large beaker. Filter off the solid under reduced pressure and wash it with distilled water.
- Step 3** Transfer the solid to a beaker and add enough sodium hydroxide solution to dissolve the 4-nitrobenzoic acid. Filter under reduced pressure to remove the chromium(III) compound which precipitates. Collect the filtrate.
- Step 4** Add the filtrate to a mixture of concentrated hydrochloric acid and ice in a beaker and stir. Test the resulting mixture to ensure the solution is strongly acidic. (4-nitrobenzoic acid is not soluble in acidic solutions.) Filter the resulting precipitate under reduced pressure and wash it with distilled water. Allow the precipitate to dry in a desiccator.

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- (a) The solid sodium dichromate(VI), used to make the solution in Step 1, is stored in a container labelled with the following symbols.

State the meaning of each symbol.

(2)

- (b) Draw a labelled diagram showing the apparatus used to filter under reduced pressure in Steps 2, 3 and 4.

(3)

- (c) Identify, by name or formula, the solid chromium(III) compound formed in Step 3 and state its colour.

(2)

Name or formula

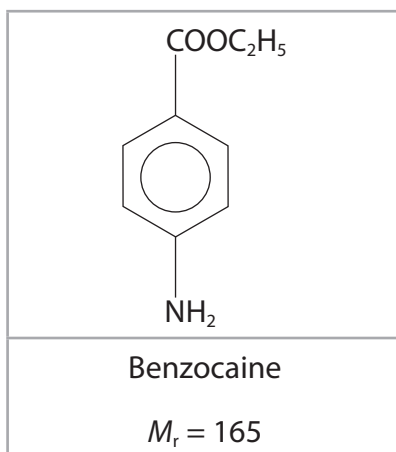
Colour



- (d) Give a test and its positive result that would show the solution of 4-nitrobenzoic acid in Step 4 is **strongly** acidic.

(1)

- (e) Benzocaine can be prepared from 4-nitrobenzoic acid by carrying out two further reactions.



Calculate the mass of 4-nitrobenzoic acid that is required to prepare 10.0 g of benzocaine. The yield in each of the two further reactions is 70%.

(3)

(Total for Question 4 = 11 marks)

TOTAL FOR PAPER = 50 MARKS



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The Periodic Table of Elements

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