



# Cambridge O Level

CANDIDATE  
NAME

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NUMBER

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## CHEMISTRY

5070/31

Paper 3 Practical Test

October/November 2020

1 hour 30 minutes

You must answer on the question paper.

You will need: The materials and apparatus listed in the confidential instructions

## INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

## INFORMATION

- The total mark for this paper is 40.
- The number of marks for each question or part question is shown in brackets [ ].
- Notes for use in qualitative analysis are provided in the question paper.

### For Examiner's Use

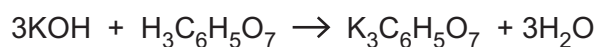
|       |  |
|-------|--|
| 1     |  |
| 2     |  |
| Total |  |

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- 1 Citric acid is a carboxylic acid found in lemon juice.

The equation for the reaction between citric acid,  $\text{H}_3\text{C}_6\text{H}_5\text{O}_7$ , and potassium hydroxide,  $\text{KOH}$ , is shown.



The mass of citric acid dissolved in  $500\text{ cm}^3$  of an aqueous solution can be determined by titration with  $\text{KOH(aq)}$ .

Thymolphthalein is used to determine the end-point of the titration.

**P** is  $0.100\text{ mol/dm}^3\text{ KOH(aq)}$ .

**Q** is aqueous citric acid.

- (a) Put **P** into the burette.

Pipette  $25.0\text{ cm}^3$  of **Q** into a flask and titrate with **P** using three drops of thymolphthalein as the indicator.

The end-point is the first appearance of a blue colour that remains for 30 seconds.

Record your results in the table.

Repeat the titration as many times as necessary to achieve consistent results.

### Results

#### *Burette readings*

| titration number                        | 1 | 2 |  |  |  |
|-----------------------------------------|---|---|--|--|--|
| final reading / $\text{cm}^3$           |   |   |  |  |  |
| initial reading / $\text{cm}^3$         |   |   |  |  |  |
| volume of <b>P</b> used / $\text{cm}^3$ |   |   |  |  |  |
| best titration results (✓)              |   |   |  |  |  |

### Summary

Tick (✓) the best titration results in the table.

Using the best titration results the average volume of **P** required is .....  $\text{cm}^3$ .  
[12]

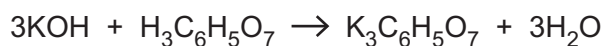
(b) **P** is  $0.100 \text{ mol/dm}^3 \text{ KOH(aq)}$ .

Use your results from (a) to calculate the number of moles of KOH in the average volume of **P** used.

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

number of moles of KOH ..... [1]

(c) Use your answer from (b) to calculate the number of moles of citric acid in  $25.0 \text{ cm}^3$  of **Q**.



number of moles of citric acid in  $25 \text{ cm}^3$  of **Q** ..... [1]

(d) Use your answer from (c) to calculate:

(i) the concentration of citric acid in **Q**.

concentration of citric acid in **Q** .....  $\text{mol/dm}^3$  [1]

(ii) the number of moles of citric acid in  $500 \text{ cm}^3$  of **Q**.

number of moles of citric acid in  $500 \text{ cm}^3$  of **Q** ..... [1]

- (e) Citric acid is available in hydrated form.

The formula of hydrated citric acid is  $\text{H}_3\text{C}_6\text{H}_5\text{O}_7 \cdot \text{H}_2\text{O}$

Use your answer from (d)(ii) to calculate the mass of hydrated citric acid crystals needed to make  $500 \text{ cm}^3$  of **Q**.

[ $A_r$ : H, 1; C, 12; O, 16]

mass of hydrated citric acid in  $500 \text{ cm}^3$  of **Q** ..... g [2]

[Total: 18]

2 You are provided with solution **R** and solid **S**.

(a) (i) Do the tests on **R** shown in the table.

Record your observations in the table.

You should test and name any gases evolved.

| test no. | test                                                                                                                                                                         | observations |
|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>1</b> | To 1 cm depth of <b>R</b> in a test-tube, add a few drops of universal indicator solution.<br><br>Keep the solution for use in test <b>2</b> .                               |              |
| <b>2</b> | To the solution from test <b>1</b> , add dilute nitric acid drop by drop until a change is seen.                                                                             |              |
| <b>3</b> | To 1 cm depth of <b>R</b> in a boiling tube, add 1 cm depth of aqueous sodium hydroxide.<br><br>Gently warm the mixture.<br><br>Keep the solution for use in test <b>4</b> . |              |
| <b>4</b> | To the solution from test <b>3</b> , add 3 cm depth of dilute nitric acid and then add 1 cm depth of aqueous silver nitrate.                                                 |              |

[6]

(ii) Identify the cation responsible for the colour seen in test **1**.

cation .....

[1]

(iii) Identify the cation responsible for the observations in test **3**.

cation .....

[1]

(iv) Identify the anion responsible for the observation in test **4**.

anion .....

[1]

(b) (i) Do the tests on **S** shown in the table.

Record your observations in the table.

You should test and name any gases evolved.

| test no. | test                                                                                                                                                                           | observations |
|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>1</b> | To the sample of <b>S</b> in a boiling tube, add 2 cm depth of dilute nitric acid.<br><br>Keep the solution for use in tests <b>2</b> , <b>3</b> and <b>4</b> .                |              |
| <b>2</b> | To 1 cm depth of the solution from test <b>1</b> in a test-tube, add aqueous sodium hydroxide drop by drop until a change is seen.<br><br>Add excess aqueous sodium hydroxide. |              |
| <b>3</b> | To 1 cm depth of the solution from test <b>1</b> in a test-tube, add aqueous ammonia drop by drop until a change is seen.<br><br>Add excess aqueous ammonia.                   |              |
| <b>4</b> | To 1 cm depth of the solution from test <b>1</b> in a test-tube, add a few drops of dilute nitric acid and then add 1 cm depth of aqueous barium nitrate.                      |              |

[11]

(ii) Identify solid **S**.

solid **S** .....

[2]

[Total: 22]

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## QUALITATIVE ANALYSIS NOTES

## Tests for anions

| <i>anion</i>                                    | <i>test</i>                                                           | <i>test result</i>                                 |
|-------------------------------------------------|-----------------------------------------------------------------------|----------------------------------------------------|
| carbonate ( $\text{CO}_3^{2-}$ )                | add dilute acid                                                       | effervescence, carbon dioxide produced             |
| chloride ( $\text{Cl}^-$ )<br>[in solution]     | acidify with dilute nitric acid, then add aqueous silver nitrate      | white ppt.                                         |
| iodide ( $\text{I}^-$ )<br>[in solution]        | acidify with dilute nitric acid, then add aqueous silver nitrate      | yellow ppt.                                        |
| nitrate ( $\text{NO}_3^-$ )<br>[in solution]    | add aqueous sodium hydroxide, then add aluminium foil; warm carefully | ammonia produced                                   |
| sulfate ( $\text{SO}_4^{2-}$ )<br>[in solution] | acidify with dilute nitric acid, then add aqueous barium nitrate      | white ppt., insoluble in excess dilute nitric acid |

## Tests for aqueous cations

| <i>cation</i>                      | <i>effect of aqueous sodium hydroxide</i>                  | <i>effect of aqueous ammonia</i>                               |
|------------------------------------|------------------------------------------------------------|----------------------------------------------------------------|
| aluminium ( $\text{Al}^{3+}$ )     | white ppt., soluble in excess giving a colourless solution | white ppt., insoluble in excess                                |
| ammonium ( $\text{NH}_4^+$ )       | ammonia produced on warming                                | —                                                              |
| calcium ( $\text{Ca}^{2+}$ )       | white ppt., insoluble in excess                            | no ppt.                                                        |
| chromium(III) ( $\text{Cr}^{3+}$ ) | green ppt., soluble in excess giving a green solution      | green ppt., insoluble in excess                                |
| copper(II) ( $\text{Cu}^{2+}$ )    | light blue ppt., insoluble in excess                       | light blue ppt., soluble in excess giving a dark blue solution |
| iron(II) ( $\text{Fe}^{2+}$ )      | green ppt., insoluble in excess                            | green ppt., insoluble in excess                                |
| iron(III) ( $\text{Fe}^{3+}$ )     | red-brown ppt., insoluble in excess                        | red-brown ppt., insoluble in excess                            |
| zinc ( $\text{Zn}^{2+}$ )          | white ppt., soluble in excess giving a colourless solution | white ppt., soluble in excess giving a colourless solution     |

## Tests for gases

| <i>gas</i>                       | <i>test and test result</i>      |
|----------------------------------|----------------------------------|
| ammonia ( $\text{NH}_3$ )        | turns damp red litmus paper blue |
| carbon dioxide ( $\text{CO}_2$ ) | turns limewater milky            |
| chlorine ( $\text{Cl}_2$ )       | bleaches damp litmus paper       |
| hydrogen ( $\text{H}_2$ )        | 'pops' with a lighted splint     |
| oxygen ( $\text{O}_2$ )          | relights a glowing splint        |

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