Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

8610145108

CHEMISTRY **5070/41**

Paper 4 Alternative to Practical **May/June 2022**

1 hour

You must answer on the question paper.

No additional materials are needed.

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 60.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **16** pages. Any blank pages are indicated.

DC (PQ/CT) 321853/4

[Turn over

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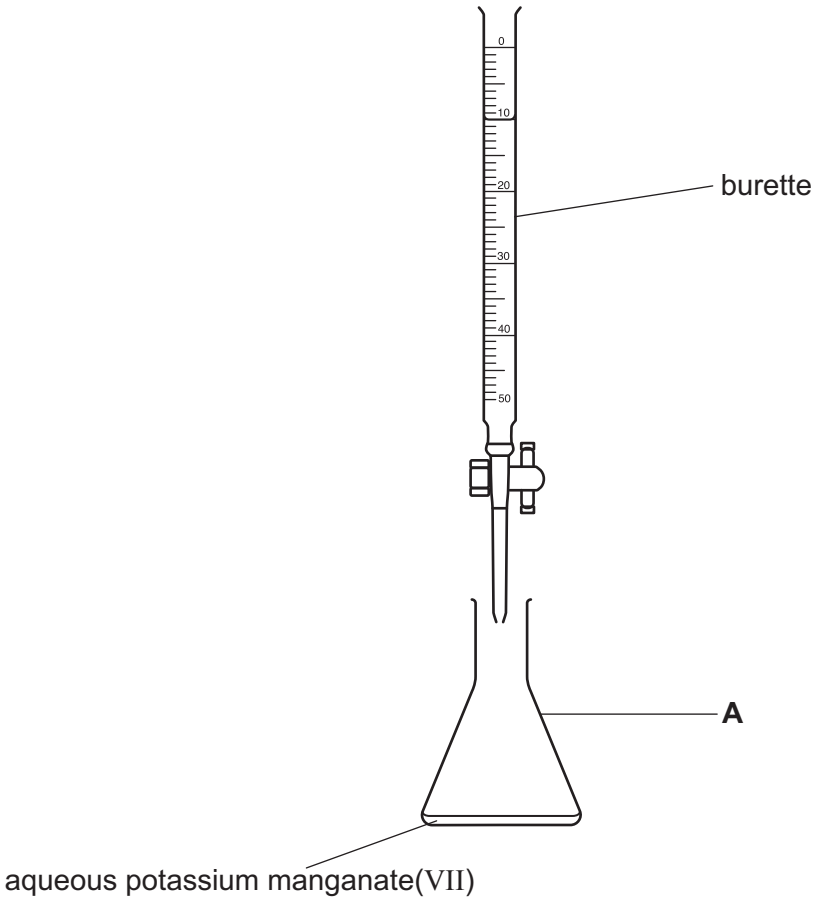
1 A student transfers 4.0 cm^3 of aqueous potassium manganate(VII) from the burette into apparatus **A**.



(a) Name apparatus **A**.

..... [1]

(b) The student adds 25 cm^3 of dilute sulfuric acid to apparatus **A**.

Name a suitable piece of apparatus to measure the 25 cm^3 of acid.

..... [1]

(c) The student heats the mixture in apparatus **A** until it reaches 60 °C.

Name a suitable piece of apparatus to measure the temperature.

..... [1]

(d) The student:

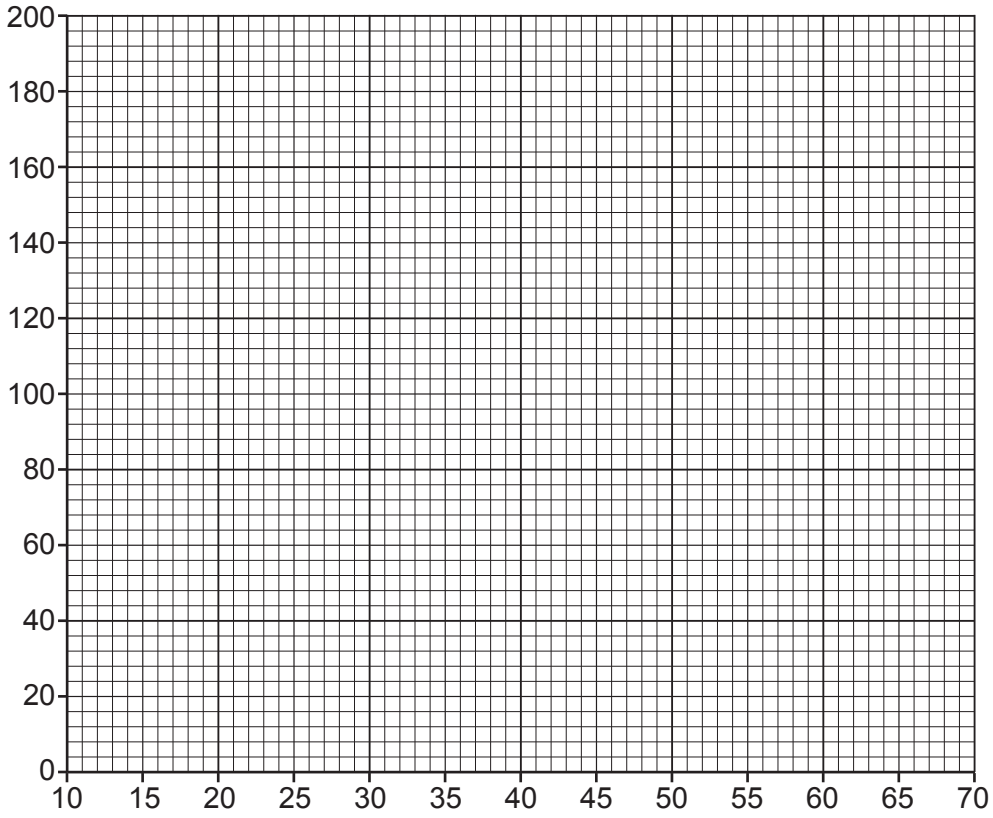
- places apparatus **A**, containing the hot mixture, on a white tile
- adds 10 cm^3 of aqueous glucose to apparatus **A**
- starts a stop-watch
- stirs the contents of apparatus **A** and records the temperature
- stops the stop-watch when the colour changes
- records the time taken.

The student does this experiment at five different temperatures.

The results are shown in the table.

temperature / °C	time taken / s
55	5
40	25
32	48
23	90
20	150

A grid to plot the results is shown.



(i) Label the axes on the grid. Include the appropriate units. [1]

(ii) Plot the results on the grid. [2]

(iii) Draw a curve of best fit. [1]

(iv) Use the graph to:

- determine the time taken at 25 °C
- extend your curve of best fit to determine the temperature at which the reaction takes 180 s
- suggest why an experiment at 70 °C is **not** done.

time ..... s

temperature ..... °C

suggestion .....
[4]

[Total: 11]

2 A student has a mixture of solid ionic compounds.

The student adds the mixture to a beaker with water and stirs the contents of the beaker.

The beaker contains a colourless solution and an insoluble black solid.

(a) Draw a diagram to show how the student separates the colourless solution from the black solid.

Label the apparatus, the black solid and the colourless solution in your diagram.

[3]

(b) The student tests the colourless solution as shown in the table.

(i) Complete the table.

Name any gas formed and describe the tests used to identify the gas.

	test	observations	conclusions
1	Add dilute hydrochloric acid followed by aqueous barium chloride.	....	.... The mixture contains sulfate ions and carbonate ions.
2	Add aqueous sodium hydroxide and warm the mixture.	....	.... The mixture contains ammonium ions.
3	Add dilute nitric acid followed by aqueous silver nitrate.	.... A pale yellow precipitate is formed.	....

[8]

(ii) Use the conclusions from tests 2 and 3 **only** to name an ionic compound in the mixture.

..... [1]

(c) The student tests the insoluble black solid as shown in the table.

Complete the table.

	test	observations	conclusions
1	Put the black solid into dilute sulfuric acid and warm the mixture.	The black solid dissolves and a blue solution is formed.	....
2	To some of the blue solution from test 1, add aqueous sodium hydroxide drop by drop until it is in excess.	A light blue precipitate is formed which is insoluble in excess.	....
3	To some of the blue solution from test 1, add aqueous ammonia drop by drop until it is in excess.	....	

[4]

[Total: 16]

3 A student has three colourless organic liquids, **W**, **X** and **Y**.

One is an alkene, one is an alcohol and one is a carboxylic acid but the student does not know which liquid is which.

Describe a series of tests to determine which liquid, **W**, **X** or **Y**, is the alkene, which is the alcohol and which is the carboxylic acid.

Each liquid must be identified by a positive test.

You are provided with:

- separate samples of liquids **W**, **X** and **Y**
- acidified aqueous potassium manganate(VII)
- aqueous bromine
- solid calcium carbonate
- the apparatus normally found in a school laboratory.

In your answer include:

- a description of the tests
- the apparatus needed for the tests
- how the results of the tests are used to identify **W**, **X** and **Y**
- a safety risk that is involved in doing one of the tests and a precaution to avoid the risk.

.....

.....

.....

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.....

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.....

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.....

.....

..... [8]

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4 A student determines the concentration of aqueous sodium hydroxide, NaOH(aq), by titration with aqueous citric acid, $C_6H_8O_7$(aq).

The student:

step **1** records the mass of an empty beaker and then adds solid citric acid

step **2** records the mass of the beaker and the citric acid

step **3** adds distilled water to the beaker and stirs the mixture until all the citric acid dissolves

step **4** transfers all of the aqueous citric acid from the beaker into a 250 cm^3 volumetric flask

step **5** fills the volumetric flask up to the mark with distilled water and shakes the flask to make solution **P**

step **6** uses a measuring cylinder to add 25.0 cm^3 of **P** into a conical flask

step **7** adds a few drops of indicator to the flask

step **8** fills a burette with aqueous sodium hydroxide and records the initial volume in the burette

step **9** adds the NaOH(aq) to the flask until the indicator changes colour and records the final volume in the burette.

The student repeats steps **6** to **9** three more times.

(a) The student uses an incorrect piece of apparatus to measure a volume.

Identify the incorrect piece of apparatus and suggest a more accurate piece of apparatus.

incorrect piece of apparatus .....

more accurate piece of apparatus ..... [2]

(b) Explain why the contents of the volumetric flask are shaken in step **5**.

.....

..... [1]

(c) Explain why the indicator is needed in step **9**.

.....

..... [1]

(d) The diagrams show the masses on an electronic balance.

Calculate the mass of citric acid added to the beaker.

mass = ... g [1]

(e) Calculate the number of moles of citric acid added to the beaker.

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

[M_r: citric acid, 192]

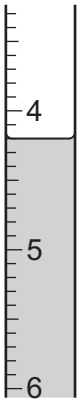
..... mol [1]

(f) Calculate the concentration, in mol / dm^3, of citric acid in the volumetric flask.

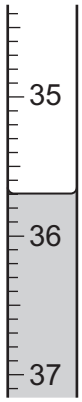
..... mol / dm^3 [1]

(g) The diagrams show parts of the burette with the liquid levels at the beginning and end of titration 1.

initial burette reading



final burette reading



Use the diagrams to enter the values for titration 1 in the results table shown.

titration	1	2	3	4
final burette reading / cm^3		30.9	30.7	30.8
initial burette reading / cm^3		0.0	0.0	0.0
volume of NaOH(aq) added / cm^3		30.9	30.7	30.8
best titration result (✓)				

[2]

(h) The table also shows the results of three other titrations.

Complete the table by ticking the best titration results.

Explain why you have ticked these values.

explanation .....

.....

.....

[2]

(i) Use the best titration results to calculate the average volume of NaOH(aq) used.

..... cm^3 [1]

(j) Use your answer to **(f)** to calculate the number of moles of citric acid in 25.0 cm^3 of solution **P**.

..... mol [1]

(k) The equation for the reaction between citric acid, $C_6H_8O_7$, and NaOH is shown.

$$C_6H_8O_7 + 3NaOH \longrightarrow Na_3C_6H_5O_7 + 3H_2O$$

Calculate the number of moles of NaOH that react with the citric acid in 25.0 cm^3 of solution **P**.

..... mol [1]

(l) Calculate the concentration, in mol / dm^3, of the NaOH(aq).

..... mol / dm^3 [1]

(m) 25 cm^3 of the NaOH(aq) is added to an excess of iron(II) sulfate, $FeSO_4$(aq).

The equation for the reaction is shown.

$$2NaOH(aq) + FeSO_4(aq) \longrightarrow Na_2SO_4(aq) + Fe(OH)_2(s)$$

A precipitate is formed.

(i) Use the equation and your answer from **(l)** to calculate the number of moles of $Fe(OH)_2$(s) that is made.

If you do not have a value for the concentration of NaOH(aq) assume it is 0.255 mol / dm^3 (this is not the correct value).

..... mol [2]

(ii) State the colour of the precipitate.

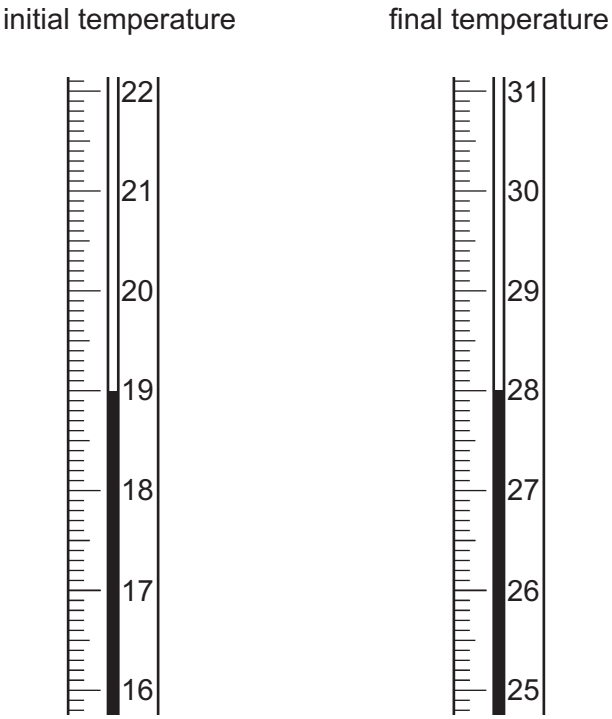
..... [1]

[Total: 18]

5 A student:

- measures 25 cm^3 of 1.0 mol/dm^3 hydrochloric acid into a glass beaker
- measures the temperature of the hydrochloric acid
- adds 30 cm^3, an excess, of aqueous potassium hydroxide
- records the maximum temperature the mixture reaches.

(a) The diagram shows the initial and final temperatures.



Use the diagram to complete the table.

initial temperature / °C	
final temperature / °C	
temperature change / °C	

[2]

(b) Use the information in the table in **(a)** to suggest what type of reaction is taking place.

..... [1]

(c) The student repeats the experiment using 2.0 mol / dm^3 instead of 1.0 mol / dm^3 hydrochloric acid.

All volumes are kept constant. The aqueous potassium hydroxide is still in excess.

Predict the temperature change in this new experiment.

Explain your answer.

prediction ..... °C

explanation .....

.....

[2]

(d) The temperature change measured is lower than expected.

(i) Suggest a reason for the temperature change being lower than expected.

..... [1]

(ii) Suggest an improvement to the experiment which will make the measured temperature closer to the expected value.

..... [1]

[Total: 7]

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