Cambridge Assessment International Education

# Cambridge O Level

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| CANDIDATE NAME | |
| CENTRE NUMBER | |
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*9020441524*

**CHEMISTRY** **5070/42**

Paper 4 Alternative to Practical **October/November 2021**

**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.

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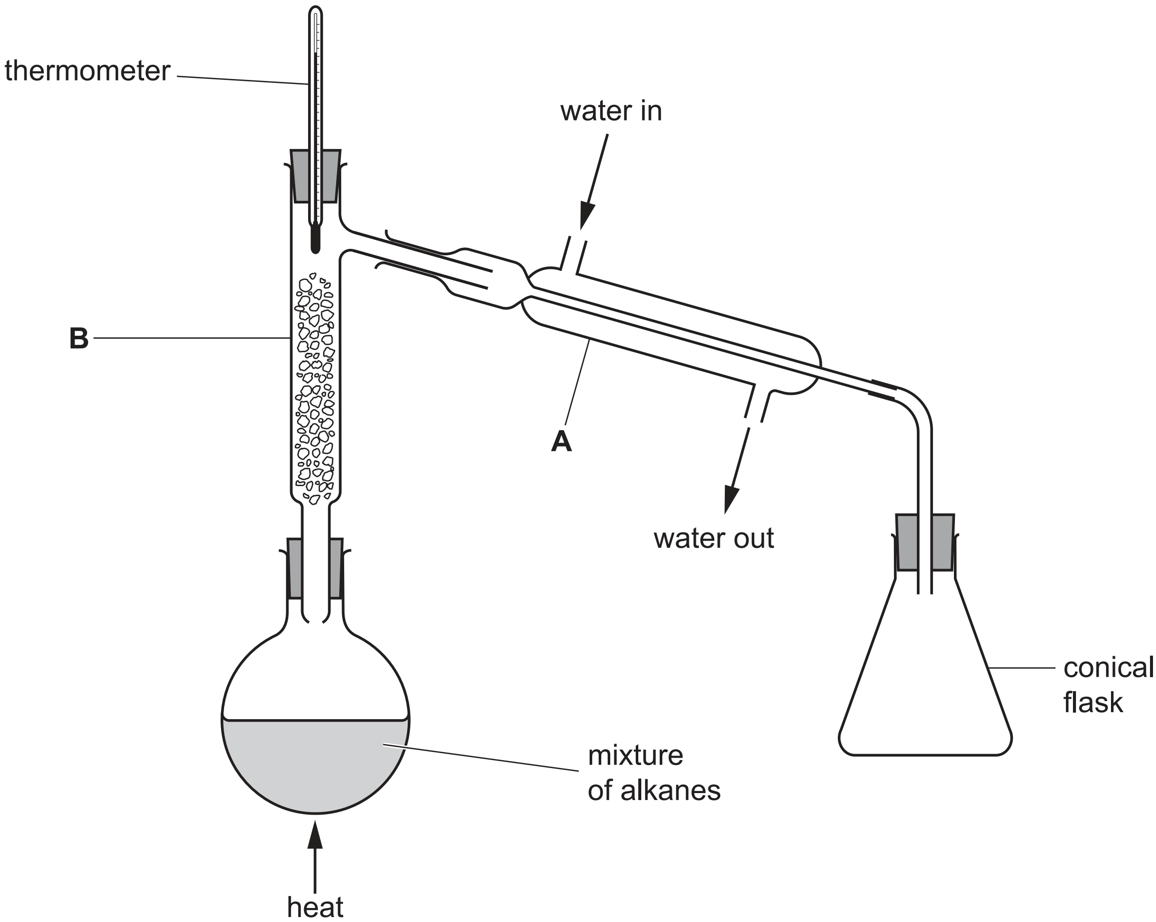
1 A student uses the apparatus to separate a mixture of three alkanes.




**(a)** Name apparatus **A** and **B**.

**A** ..................................................................................................................................

**B** ..................................................................................................................................
[2]

**(b)** Identify **two** errors in the assembled apparatus shown in the diagram.

1 ..................................................................................................................................

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

The errors are corrected.

The mixture of alkanes is heated in the flask to start the separation.

The boiling points of the alkanes are shown.

| alkane | boiling point / °C |
|---|---|
| octane | 126 |
| nonane | 151 |
| decane | 174 |

**(c)** **(i)** State why the flask is **not** heated directly with the flame of a Bunsen burner.

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

**(ii)** State why the flask is **not** heated with a beaker of boiling water.

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

**(iii)** Name a piece of apparatus that is suitable to heat the flask.

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

**(d)** Name the first alkane collected in the conical flask.

Explain your answer.

alkane ................................

explanation ..........................................................................................................................

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

**(e)** State the purpose of apparatus **B**.

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

[Total: 9]

2 A student investigates the reaction between zinc and dilute sulfuric acid.

The equation for the reaction is shown.

$$Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$$

**(a)** The student observes bubbles of a gas being produced when zinc is added to dilute sulfuric acid. The student does a test to show that the gas is hydrogen.

**(i)** Give a test and observation to identify hydrogen gas.

test ..............................................................................................................................

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

**(ii)** State one **other** observation the student makes when zinc is added to dilute sulfuric acid.

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

A student does an experiment to find out how the rate of this reaction changes as the temperature of the dilute sulfuric acid changes.

**Method**

The student:

- measures 100 $cm^3$ of 1.0 mol/$dm^3$ dilute sulfuric acid (an excess) and pours this into a beaker
- places a thermometer in the acid
- heats the acid to the required temperature
- removes the heat
- adds a known mass of zinc to the acid
- immediately starts a clock
- stops the clock when **all** the zinc has reacted
- records this reaction time.

The student repeats the experiment several times at different temperatures.

All other variables likely to affect the rate of reaction are kept constant in each experiment.

The results are shown in the table.

| experiment | temperature / °C | reaction time / s |
|---|---|---|
| 1 | 30 | 150 |
| 2 | 40 | 80 |
| 3 | 50 | 45 |
| 4 | 60 | 90 |
| 5 | 70 | 2 |

**(b)** **(i)** State which experiment has an anomalous reaction time.

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

**(ii)** Suggest what the student should do to check if the reaction time in **(b)(i)** is anomalous.

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

**(iii)** State which experiment has the greatest rate of reaction.

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

**(iv)** Describe how the rate of this reaction changes as the temperature of the dilute sulfuric acid increases.

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

**(c)** Another student does the reaction at 90 °C.

State why it is difficult to measure an accurate reaction time at 90 °C.

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

**(d)** Suggest two variables, other than the temperature of the dilute sulfuric acid or the mass of zinc, that affect the rate of this reaction.

1 ..........................................................................................................................

2 ..........................................................................................................................

[2]

[Total: 9]

**3** A student is provided with three unlabelled bottles which each contain a solution.

The student knows the bottles contain:

- dilute hydrochloric acid
- aqueous aluminium sulfate
- aqueous zinc sulfate.

The student is provided with:

- dilute nitric acid
- aqueous silver nitrate
- aqueous ammonia

but **no other chemicals or indicators**.

For each of the three unlabelled bottles, describe a **test** and give the **observations** to identify the contents of the bottle.

You must describe tests that give positive results to identify the contents of **each** bottle.

It must be clear in your answer which solution is identified by each positive result.

Chemical equations are **not** required.

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.................................................................................................................................... [7]

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**4** A solid mixture contains iron(II) sulfate and sand.

A student determines the percentage by mass of iron(II) sulfate in this mixture.

**(a)** The student measures the mass of an empty beaker.

The student adds a sample of the mixture to the beaker and then measures the mass of the beaker and the mixture.

| | |
|---|---|
| mass of beaker | = 36.02 g |
| mass of beaker + mixture | = 55.96 g |

Calculate the mass of the mixture used in the experiment.

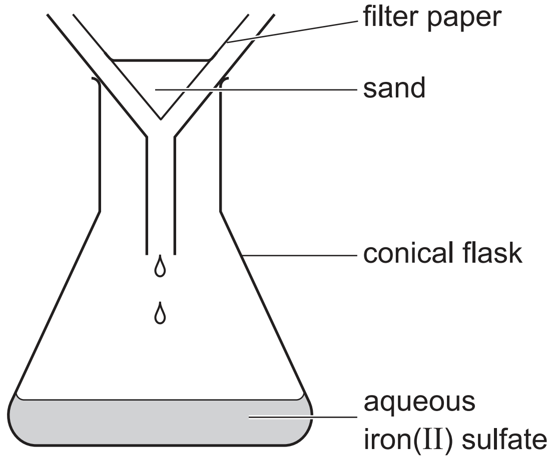
....................................................... g [1]

The student adds water to the mixture in the beaker.

Iron(II) sulfate dissolves in the water.

The sand does not react with or dissolve in the water.

The sand is separated from the aqueous iron(II) sulfate by filtration.




**(b)** Suggest how the student makes sure that no iron(II) sulfate remains on the filter paper.

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

**(c)** The aqueous iron(II) sulfate is transferred from the conical flask into a volumetric flask.

Suggest how the student should make sure that **all** the aqueous iron(II) sulfate is transferred from the conical flask to the volumetric flask.

..........................................................................................................................................

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

The solution in the volumetric flask is made up to 500 $cm^3$ with water. This is solution **R**.

**(d)** The student uses a pipette together with another piece of apparatus to place 20.0 $cm^3$ of **R** into a conical flask.

Name the other piece of apparatus that is used with the pipette.

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

The student adds excess dilute sulfuric acid to the conical flask.

Solution **T** is 0.0200 mol / $dm^3$ potassium manganate(VII).

The student:

- fills a burette with **T**
- runs **T** into the conical flask until the end-point is reached.

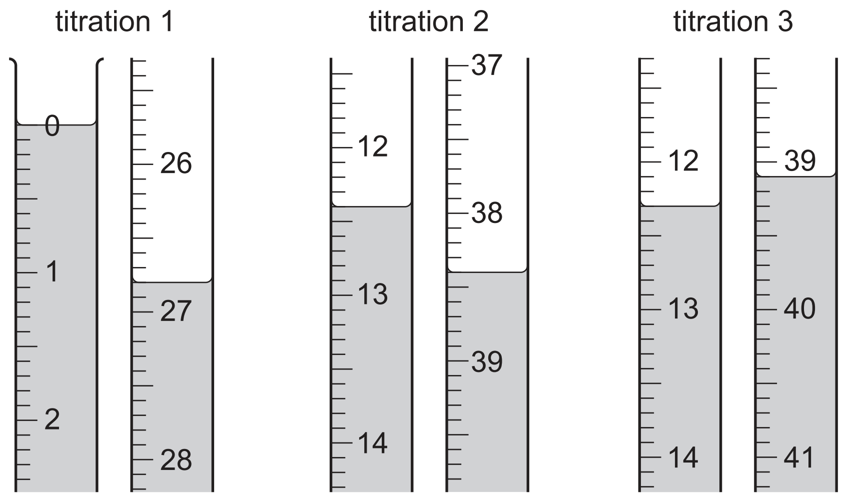
**(e)** Solution **T** reacts with the iron(II) sulfate in the conical flask.

Iron(II) sulfate is a reducing agent.

State the colour change in the conical flask at the end-point of the titration.

from ................................................. to ................................................................ [1]

**(f)** The student does three titrations. The diagrams show parts of the burette with the liquid levels at the beginning and at the end of each titration.




Use the diagrams to complete the table.

| titration number | 1 | 2 | 3 |
|---|---|---|---|
| final burette reading / $cm^3$ | | | |
| initial burette reading / $cm^3$ | | | |
| volume of **T** / $cm^3$ | | | |
| best titration results (✓) | | | |

**Summary**

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

Use the ticked values to calculate the average volume of **T**.

.................................................... $cm^3$ [4]

**(g)** Solution **T** is 0.0200 mol / $dm^3$ potassium manganate(VII).

Calculate the number of moles of potassium manganate(VII) in the average volume of **T** used in the titration.

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

**(h)** **One** mole of potassium manganate(VII) reacts with **five** moles of iron(II) sulfate, $FeSO_4$.

Calculate the number of moles of $FeSO_4$ in 20.0 $cm^3$ of **R**.

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

**(i)** Calculate the number of moles of $FeSO_4$ in 500 $cm^3$ of **R**.

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

**(j)** Calculate the mass of $FeSO_4$ in 500 $cm^3$ of **R**.

[$M_r$: $FeSO_4$, 152]

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

**(k)** Use your answers to **(a)** and **(j)** to calculate the percentage by mass of $FeSO_4$ in the mixture.

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

[Total: 15]

**5** A solid **S** contains two cations and one anion.

Complete the table.

Name any gases that are formed in the tests.

| test | observation | conclusion | |
|---|---|---|---|
| **(a)** **S** is dissolved in water. The solution is divided into three portions for tests **(b)**, **(c)** and **(d)**. | A coloured solution forms. | ............................................<br>............................................ | [1] |
| **(b)** **(i)** To a portion of the solution from **(a)**, aqueous ammonia is added until a change is seen. | ............................................<br>............................................ | **S** contains $Cu^{2+}$ ions. | [1] |
| **(ii)** An excess of aqueous ammonia is added to the mixture from **(b)(i)**. | ............................................<br>............................................ | **S** contains $Cu^{2+}$ ions. | [1] |
| **(c)** **(i)** To a portion of the solution from **(a)** aqueous sodium hydroxide is added until a change is seen. | ............................................<br>............................................ | **S** contains $Cu^{2+}$ ions. | [1] |
| **(ii)** An excess of aqueous sodium hydroxide is added to the mixture from **(c)(i)**. | ............................................<br>............................................<br>............................................ | **S** contains $Cu^{2+}$ ions. | [1] |
| **(iii)** The mixture from **(c)(ii)** is warmed and the gas formed is tested with damp red litmus paper. | ............................................<br>............................................<br>............................................ | **S** contains $NH_4^+$. | [2] |
| **(d)** ............................................<br>............................................<br>............................................ | A white precipitate forms. | **S** contains $SO_4^{2-}$. | [2] |

[Total: 9]

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**6** When aqueous sodium hydroxide is added to dilute sulfuric acid a reaction occurs.

$$2NaOH(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$$

A student has two solutions.

**W** is 2.0 mol / $dm^3$ NaOH(aq).

**X** is $H_2SO_4$(aq) of unknown concentration.

The student determines the concentration of **X**.

The student:

- transfers 20.0 $cm^3$ of **W** into a glass beaker
- measures the temperature of **W**
- adds 5.0 $cm^3$ of **X** to **W** in the beaker
- stirs the mixture
- measures the highest temperature reached
- calculates the increase in temperature
- repeats with different volumes of **X**.

The table shows the results.

| experiment | volume of **W** / $cm^3$ | volume of **X** / $cm^3$ | temperature increase / °C |
|---|---|---|---|
| 1 | 20.0 | 5.0 | 2.7 |
| 2 | 20.0 | 10.0 | 5.4 |
| 3 | 20.0 | 15.0 | 8.0 |
| 4 | 20.0 | 20.0 | 9.1 |
| 5 | 20.0 | 25.0 | 7.8 |
| 6 | 20.0 | 30.0 | 6.5 |

**(a)** The student uses a burette to measure the volumes of **W** and **X**.

State why the student uses a burette instead of a measuring cylinder.

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

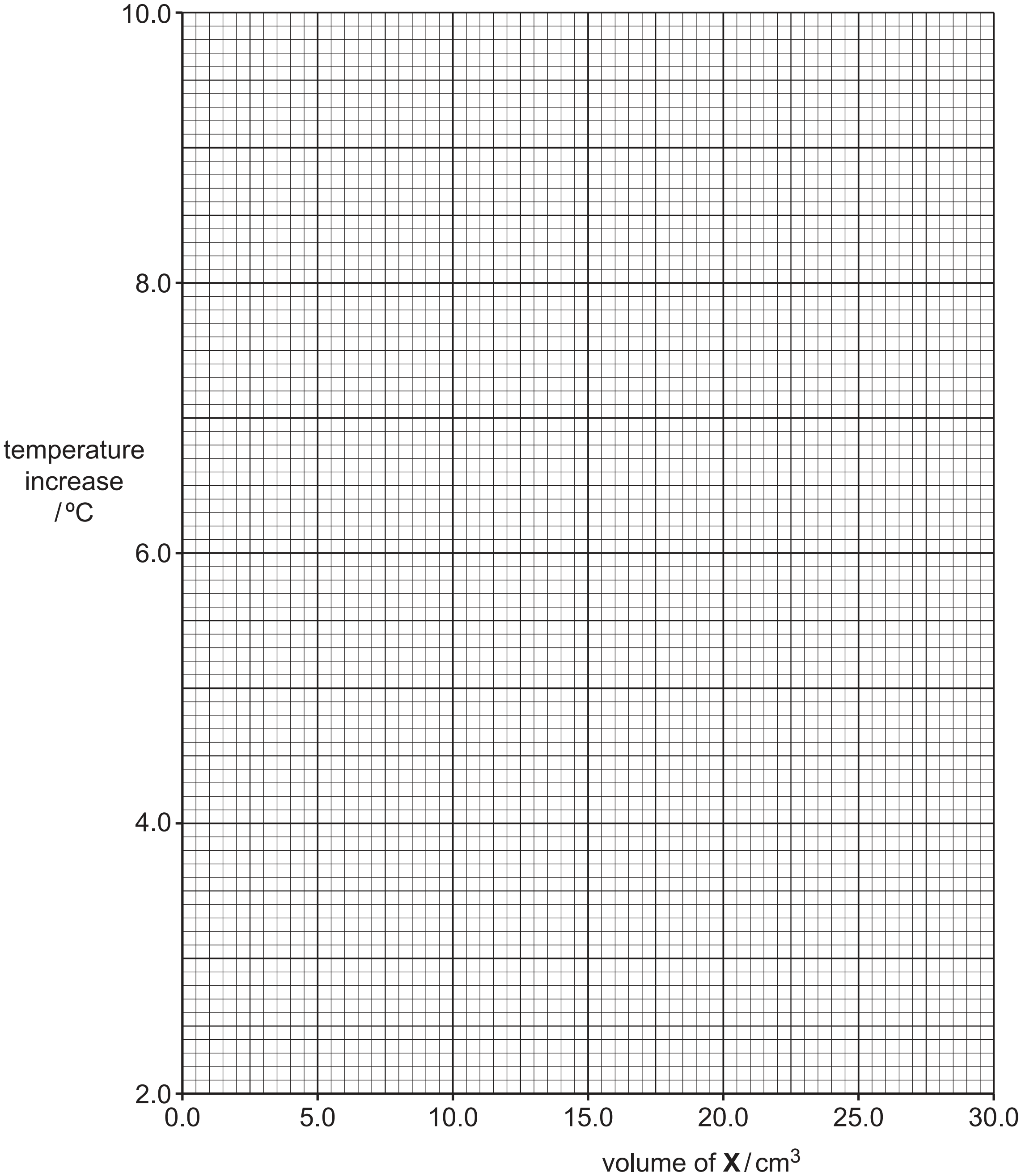
**(b)** State the evidence in the table that shows that the reaction is exothermic.

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

**(c)** Plot the results from the table on the grid.

Draw one straight line through the first three points and a second straight line through the other three points.

Extend both straight lines until they intersect.




[3]

**(d)** Use your graph to answer these questions.

**(i)** Determine the volume of **X** that produces a temperature increase of 5.6 °C when added to 20.0 $cm^3$ of **W**.

.................................................. $cm^3$ [1]

**(ii)** Determine the temperature increase if 12.5 $cm^3$ of **X** is added to 20.0 $cm^3$ of **W**.

.................................................. °C [1]

**(e)** **(i)** Use your graph to determine the minimum volume of **X** that reacts with all of the NaOH in 20.0 $cm^3$ of **W**.

.................................................. $cm^3$ [1]

**(ii)** **W** is 2.0 mol / $dm^3$ NaOH.

The equation for the reaction between NaOH and $H_2SO_4$ is shown.

$$2NaOH(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$$

Use your answer to **(e)(i)** and the equation to calculate the concentration of $H_2SO_4$ in **X**.

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

[Total: 11]