Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER					

0023860837

CHEMISTRY **9701/52**

Paper 5 Planning, Analysis and Evaluation **May/June 2020**

1 hour 15 minutes

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, use appropriate units and use an appropriate number of significant figures.

INFORMATION

- The total mark for this paper is 30.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **12** pages. Blank pages are indicated.

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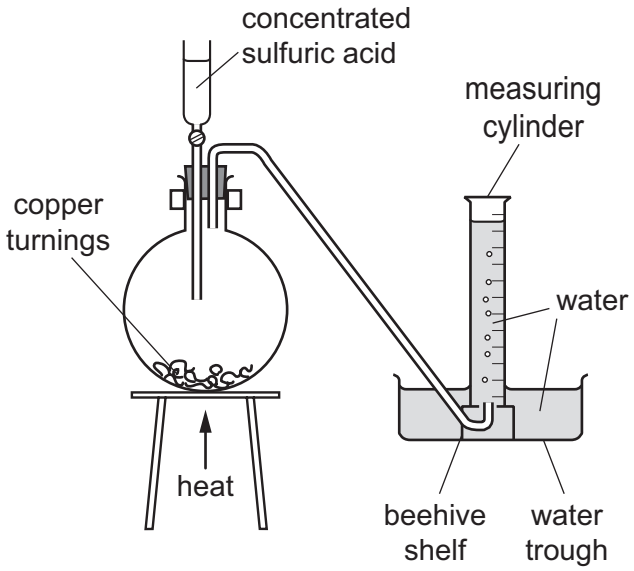
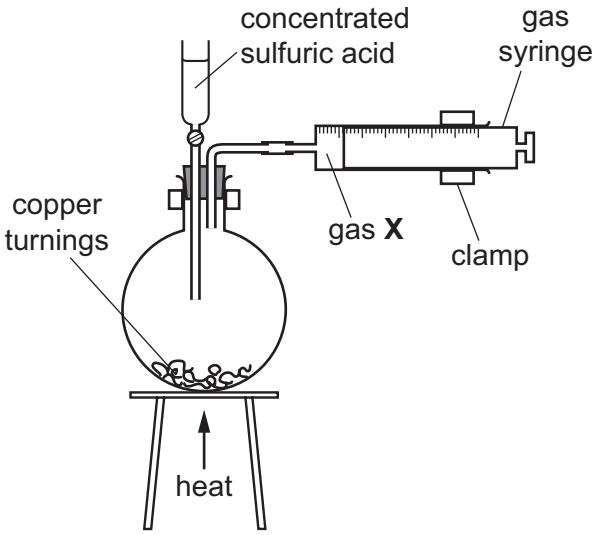
1 A student plans to carry out an experiment to find the relative molecular mass, M_r, of a soluble acidic gas, **X**, by finding the mass of a measured volume of gas **X**. Gas **X** can be prepared by the reaction between concentrated sulfuric acid and copper.

Two methods of gas collection are available to the student, as shown.



method **A**



method **B**

(a) (i) Explain why the first sample of gas collected from either apparatus should not be used for the M_r determination of gas **X**.

.....

..... [1]

(ii) Give **two** reasons, other than your answer to **(a)(i)**, why, for this experiment, the apparatus in method **A** is less suitable than the apparatus in method **B** for collecting a sample of gas **X**.

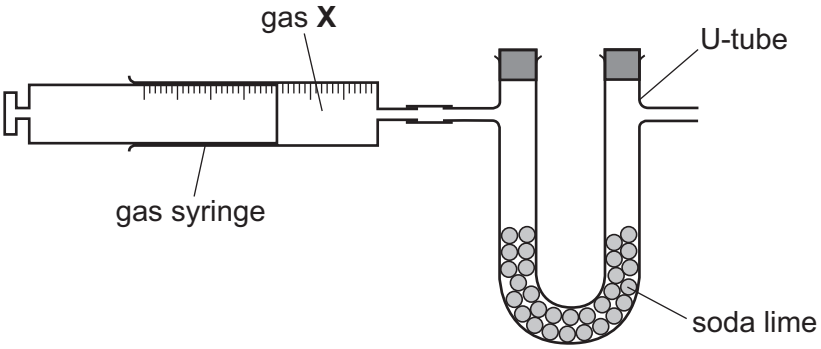
reason 1 .....

.....

reason 2 .....

.....
[2]

(b) The student is told to use the U-tube shown to find the mass of a sample of gas **X**.



A 100.0 cm^3 sample of pure gas **X** is placed in a gas syringe. The gas syringe is attached to a U-tube containing small lumps of solid soda lime, a mixture of sodium hydroxide and calcium hydroxide. All of gas **X** is slowly passed into the U-tube and the mass of gas **X** absorbed determined.
The temperature and the pressure of the room are recorded.

(i) State the measurements that are needed to determine the mass of gas **X** absorbed.

.....

..... [1]

(ii) Suggest why soda lime is used to absorb gas **X**.

.....

..... [1]

(c) Gas **X** can cause respiratory distress.

State an appropriate precaution that should be taken when doing this experiment.

.....

..... [1]

(d) Experiment 1 is carried out at a temperature of 21 °C, a pressure of 9.8×10^4 Pa, and uses 100 cm^3 of pure gas **X**.

(i) Calculate the number of moles of gas **X** present in Experiment 1.

You should assume that gas **X** behaves like an ideal gas and so use $PV = nRT$.

$R = 8.31\ J\,K^{-1}\,mol^{-1}$

moles of gas **X** = ... mol [2]

(ii) The sample of gas **X** is found to have a mass of 0.251 g.

Explain how the student should use this information and their results to determine the M_r of **X**.

.....

.....

..... [1]

(iii) Not all of gas **X** is absorbed by the soda lime.

State what effect, if any, this has on the student's calculated value of the M_r of gas **X**.

.....

..... [1]

(iv) In Experiment 2, the same mass of gas **X** is used, but the student did not record the temperature and pressure.

The calculated M_r of **X** for Experiment 2 is higher than the value calculated by the student for Experiment 1.

State and explain how the value of $\frac{P}{T}$ changes from Experiment 1 to Experiment 2.

.....

.....

..... [1]

(e) State how the reliability of the results in Experiment 1 could be improved.

.....

..... [1]

(f) A different gas, methylamine, is alkaline.

State a change that would have to be made to the apparatus so that the M_r of methylamine could be determined.

.....

..... [1]

[Total: 13]

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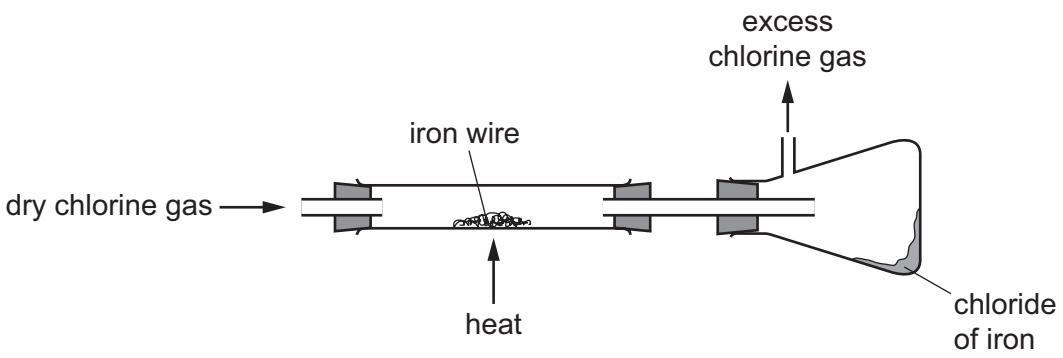
2 Each student in a class of nine students performs an experiment to find the formula of a chloride of iron. Each student prepares the chloride of iron by passing a stream of chlorine gas over a sample of iron wire as shown in the diagram.



(a) Each student carries out the following steps in the order shown in the list. Some of the measurement steps are missing from the list.

- Weigh the reaction tube containing a quantity of iron wire.
- Set up the apparatus as shown in the diagram.
- Start the flow of dry chlorine gas.
- Heat the iron wire until it has completely reacted.
- Allow the apparatus to cool, with chlorine gas still flowing.
- Weigh the side-arm conical flask containing the chloride of iron.

(i) State the **two** additional measurement steps that each student must perform in order to find the formula of the chloride of iron.

1 .....

2 .....
[1]

(ii) The flow of dry chlorine gas must start before the iron wire is heated.

Explain why.

.....

..... [1]

(iii) State an assumption that has to be made for the measurements made in this experiment to be valid.

.....

..... [1]

(b) **(i)** The class results are shown in the table.

student	mass of iron wire / g	mass of iron chloride / g	mass of chlorine / g	amount of iron / mol	amount of chlorine atoms / mol
1	0.57	1.64			
2	1.10	3.16			
3	1.40	4.03			
4	1.95	5.61			
5	2.18	5.89			
6	2.75	7.90			
7	3.05	8.77			
8	3.45	9.80			
9	3.90	11.18			

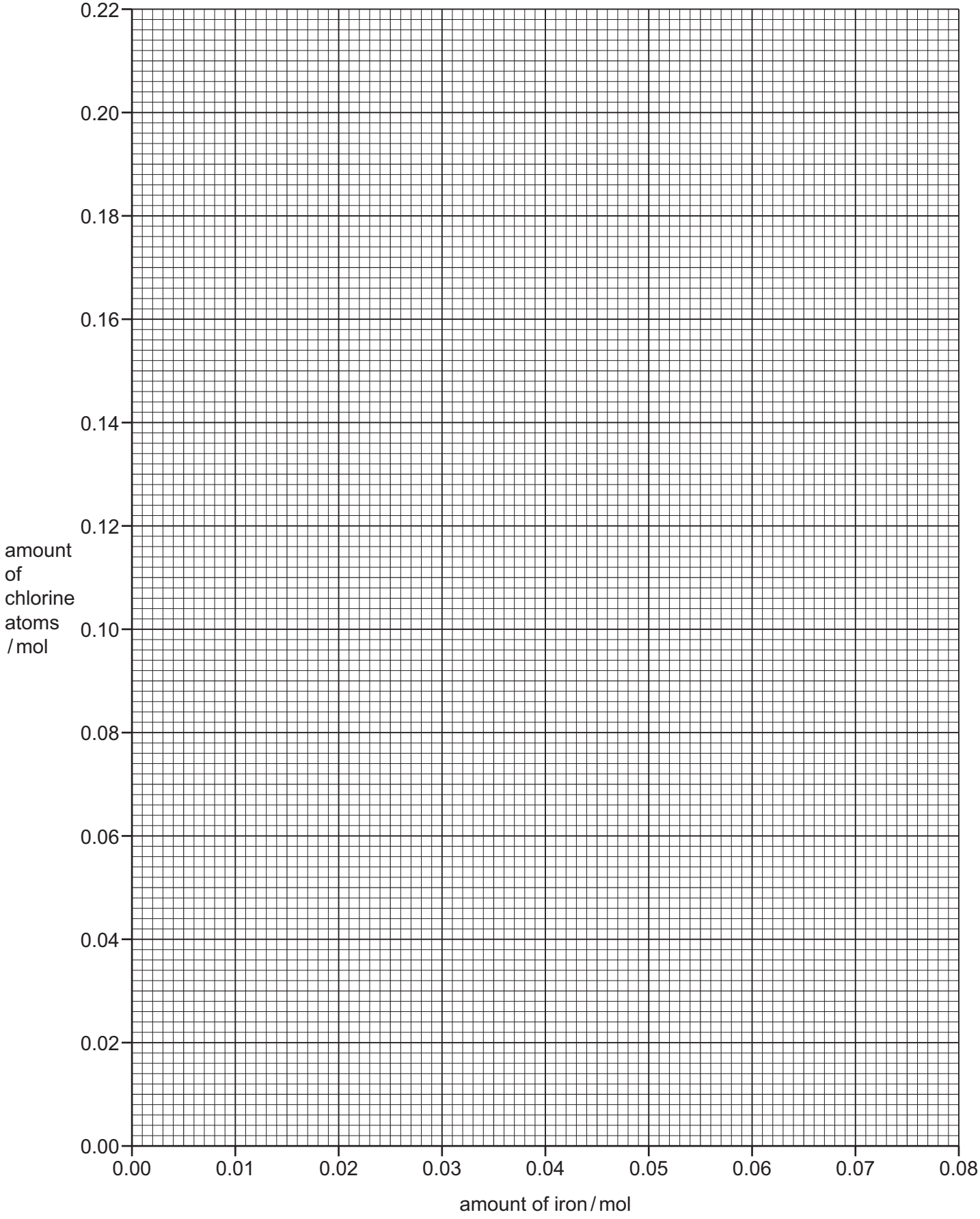
Calculate the mass of chlorine that reacts with the iron wire in each experiment. Record each mass to **two decimal places**.

Calculate the amount of iron, in mol, and amount of chlorine atoms, in mol, that reacts in each experiment. Record the number of moles to **three significant figures**.

[A_r: Fe, 55.8; C*l*, 35.5]

[3]

(ii) Plot a graph on the grid of the amount of chlorine atoms against the amount of iron.
Use a cross (×) to plot each data point.
Draw a line of best fit through the plotted points. You should consider whether (0,0) should be on the line of best fit. [2]


0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
amount of chlorine atoms / mol
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
amount of iron / mol

(iii) Circle the point on the graph you consider to be most anomalous.
Suggest **one** reason why this anomaly may have occurred during this experimental procedure.

.....

..... [2]

(c) Use the graph to determine the gradient of the line of best fit.

State the coordinates of both points you used in your calculation. These must be on your line of best fit.

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

coordinates 1 ..... coordinates 2 .....

gradient = ...
[2]

(d) The formula of the chloride of iron produced in this experiment is $FeCl_3$.

State how the results student 4 obtains could be used to determine this formula.

.....

.....

..... [1]

(e) **(i)** Student 3 weighs the conical flask using a balance accurate to two decimal places and records its mass. After the chloride of iron is produced the mass increases by 4.03 g.

Calculate the percentage error in measuring the mass of this chloride of iron.

percentage error = ... % [1]

(ii) Student 8 follows the same procedure as student 3.

State whether the results from student 8 will have more or less percentage error than those from student 3.
Explain your answer.

.....

..... [1]

(f) Another student suggested that the chloride of iron could also be prepared by the reaction between iron wire and hydrochloric acid.

(i) A sample of a chloride of iron prepared in this way contains 44% iron by mass.

Show that the formula of this chloride of iron is $FeCl_2$.
[A_r: Fe, 55.8; C*l*, 35.5]

[1]

(ii) Explain, using the electrode potential values in the table, why the methods in **(a)** and **(f)** do not produce the same chlorides of iron.

reaction	electrode potential, $E^{\ominus}$/V
$Fe^{2+}(aq) + 2e^- \rightleftharpoons Fe(s)$	–0.44
$2H^+(aq) + 2e^- \rightleftharpoons H_2(g)$	0.00
$Fe^{3+}(aq) + e^- \rightleftharpoons Fe^{2+}(aq)$	+0.77

.....

.....

.....

..... [1]

[Total: 17]

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