Cambridge Assessment International Education

Example Responses – Paper 4

Cambridge O Level
Chemistry 5070

For examination from 2023

Cambridge Pathway

Contents

Introduction

The main aim of this booklet is to exemplify standards for those teaching Cambridge O Level Chemistry 5070.

This booklet contains responses to all questions from June 2023 Paper 42, which have been written by a Cambridge examiner. Responses are accompanied by a brief commentary highlighting common errors and misconceptions where they are relevant.

The question papers and mark schemes are available to download from the School Support Hub

5070 June 2023 Question Paper 42

5070 June 2023 Mark Scheme 42

Past exam resources and other teaching and learning resources are available from the School Support Hub

Question 1

1 A student investigates the rusting of iron.

Fig. 1.1 shows the apparatus the student uses.

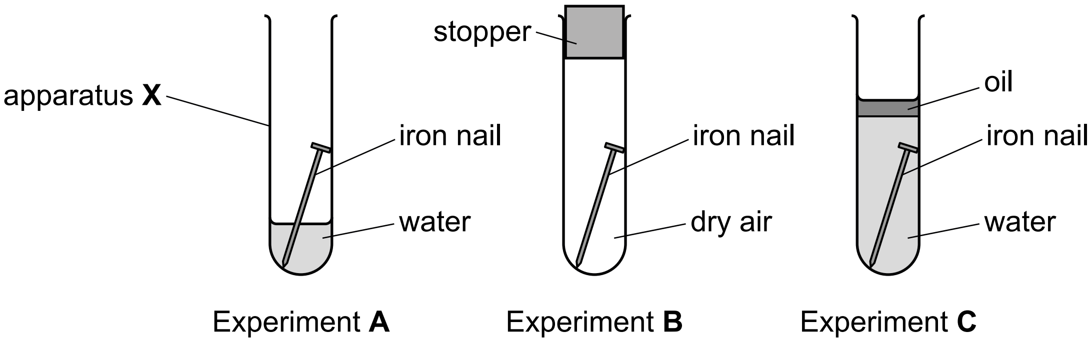

Fig. 1.1

(a) Name apparatus **X**.

boiling tube .... [1]

(b) State why a stopper is used in Experiment **B**.

the stopper prevents water in the air from entering the test tube ....

.... [1]

Examiner comment

Candidates needed to look carefully at the context of the question. There were a number of true statements that could be made, but they did not answer the question of why the stopper was used in this experiment. For example, the fact that the stopper prevents air escaping was true, but not relevant.

(c) State why the water in Experiment **C** is boiled before use.

boiling removes oxygen which is dissolved in the water ....

.... [1]

Examiner comment

As in **(b)**, there were a number of true, but irrelevant, answers. For example, stating that hot water would speed up the rate of rusting.

(d) State why a layer of oil is used in Experiment **C**.

the oil prevents oxygen from entering the water

[1]

(e) The experiments are left for one week.

Predict in which of the experiments the nail will have rusted.

the nail will only rust in Experiment A

Explain your prediction.

Experiment A is the only one which contains both oxygen and water.
Both of these are essential for iron to rust.

[2]

[Total: 6]

Question 2

2 Aqueous ammonia is a solution of ammonia gas.

A student titrates two samples of aqueous ammonia, **A** and **B**, with 0.500 mol / dm^3 hydrochloric acid.

The student does four titrations, two with **A** and two with **B**.

The student:

Step 1. rinses and fills a burette with 0.500 mol / dm^3 hydrochloric acid
Step 2. uses a volumetric pipette to add 25.0 cm^3 of **A** to a conical flask
Step 3. adds five drops of methyl orange indicator to the conical flask
Step 4. places the conical flask on a white tile
Step 5. adds 0.500 mol / dm^3 hydrochloric acid from the burette while swirling the contents of the flask, adding drop by drop near the end-point, until the solution just changes colour
Step 6. empties the conical flask and rinses it with distilled water
Step 7. repeats steps 2 to 6
Step 8. repeats steps 2 to 7 using aqueous ammonia **B** instead of aqueous ammonia **A**.

(a) Fig. 2.1 shows the burette readings for the two titrations with **A**.

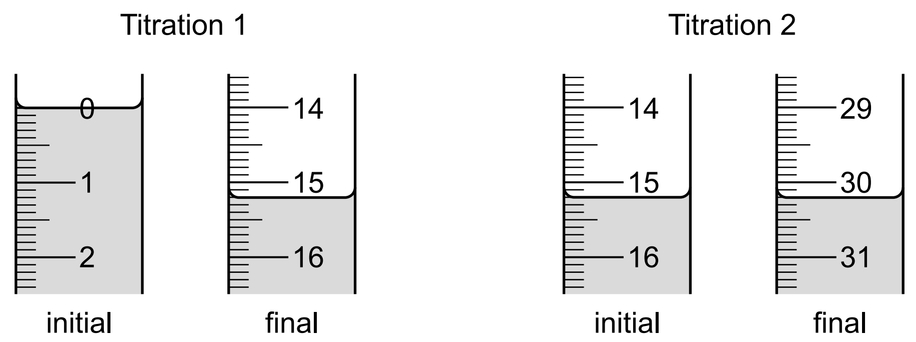

Fig. 2.1

Record the burette readings in Table 2.1.

Complete Table 2.1 with the volume used in each titration.

Table 2.1

	Titration 1	Titration 2
final burette reading / cm^3	15.2	30.2
initial burette reading / cm^3	0.0	15.2
volume used / cm^3	15.2	15.0

[3]

Examiner comment

- The question tested the candidates' ability to read a burette scale. Many candidates read the burette in the wrong direction, for example, the final result in titration one was read as 16.8 instead of 15.2.
- The results in the question were deliberately chosen to test candidates' understanding of the use of decimal places to indicate the precision of the experiment. It was essential for candidates to give values of 0.0 and 15.0 not 0 and 15.

(b) Fig. 2.2 shows the burette readings for one of the titrations with **B**.

Titration 4

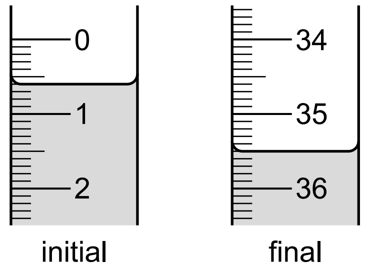

Fig. 2.2

Record the burette readings for Titration 4 in Table 2.2.

Complete Table 2.2 with the volume used in each titration.

Table 2.2

	Titration 3	Titration 4
final burette reading / cm^3	34.9	35.5
initial burette reading / cm^3	0.2	0.6
volume used / cm^3	34.7	34.9

[1]

(c) Explain why the student uses a white tile in these titrations.

the white tile makes it easier to see the colour change which gives a [1]
more accurate value for the end point of the titration

Examiner comment

Although the tile may have made it easier to see the colour of the solution, the reason for using it in the context of a titration was to facilitate an accurate end point. Candidates therefore needed to refer to the colour change, not just the colour.

(d) Calculate the mean volume of 0.500 mol / dm^3 hydrochloric acid needed to neutralise 25.0 cm^3 of **A** and of **B**.

mean volume of acid needed for solution **A** ......15.1...... cm^3

mean volume of acid needed for solution **B** ......34.8...... cm^3

[1]

Examiner comment

The variety of answers given and some of the working shown by candidates indicated that there was a lack of understanding of the term 'mean volume'. Candidates needed to be aware of both of the words 'mean' and 'average'.

(e) The equation for the reaction between hydrochloric acid and aqueous ammonia is shown.

$$HCl + NH_3 \rightarrow NH_4Cl$$

Use the mean volume of acid needed to neutralise 25.0 cm^3 of **A** in **(d)** to calculate the concentration of ammonia in **A**.

Give your answer to an appropriate number of significant figures.

number of moles of acid used =

concentration x volume in dm^3 = $0.5 \times \frac{15.1}{1000}$ = 0.00755

the equation shows a ratio of 1:1 therefore the moles of ammonia = 0.00755

concentration of ammonia = number of moles x volume in dm^3 =

$0.00755 \times \frac{1000}{25}$

concentration ......0.302...... mol / dm^3 [2]

Examiner comment

- Showing working was not essential in calculations unless specifically requested in the question. However, candidates were encouraged to show working especially where there was more than 1 mark for the question, as this gave them the opportunity for some marks to be given for their answer.
- Candidates were expected to be able to work out the appropriate number of significant figures and / or decimal places from the experimental and mathematical context of a question. In this case it was three significant figures.

(f) Calculate the volume of ammonia gas measured at room temperature and pressure, r.t.p., dissolved in 25.0 cm^3 of **A**.

The volume of one mole of any gas at r.t.p. is 24 dm^3.

number of moles of ammonia = $\frac{0.302}{40}$ = 0.00755

volume of gas = number of moles x the volume of one mole of any gas at r.t.p. = 0.00755 x 24

volume ....0.181.......... dm^3 [2]

(g) Use your answers to **(d)** and **(f)** to calculate the volume of ammonia gas measured at r.t.p. dissolved in 25.0 cm^3 of **B**.

volume of ammonia in B = volume of ammonia in A x (mean volume of acid for B / mean volume of acid for A)

volume ....0.418.......... dm^3 [1]

Examiner comment

- The question mentioned the use of **(d)** and **(f)** to guide the candidates to the method of calculation shown in the example response and they were expected to follow these guidelines.
- Other methods of calculation were awarded marks, as long as they gave the correct answer.

(h) The student rinses the burette with 0.500 mol / dm^3 hydrochloric acid immediately before it is filled.

Explain why the student should **not** rinse the burette with distilled water immediately before it is filled with 0.500 mol / dm^3 hydrochloric acid.

If the burette is rinsed with distilled water then some water will remain in the burette. This will dilute the hydrochloric acid when it is added to the burette and will give a titration volume which is greater than the correct value. [2]

Examiner comment

Candidates were expected to be specific in their answers. For example, 'distilled water will **change** the concentration of the acid' was not specific enough. They needed to state that water **decreases** the concentration or dilutes the acid. Similarly, a statement which says that the water would **affect** the volume of acid used was not specific enough. They needed to say that the volume of acid used in the titration was **greater**.

(i) Suggest why universal indicator is **not** suitable for use in these titrations.

universal indicator does not provide a clear end point because it shows a number of colour changes during the titration [1]

[Total: 14]

Examiner comment

- Candidates often found it difficult to apply their knowledge of universal indicator to a context they had not previously considered.
- Some candidates did not seem to be aware that universal indicator is available as a solution, not just as universal indicator paper.
- Some candidates thought that universal indicator only gave a pH value, not a colour change as well.

Question 3

3 A student investigates solution **W** and solid **X**.

(a) Solution **W** is green in colour and contains Fe^{2+} ions.

(i) Describe how **W** can be shown to contain Fe^{2+} ions.

A few drops of aqueous sodium hydroxide are added to solution W followed by an excess of aqueous sodium hydroxide. [2]

A green precipitate is formed which is insoluble in excess aqueous sodium hydroxide.

Examiner comment

Throughout Question 3, candidates should make use of the notes in qualitative analysis. As these notes are now provided in the alternative to practical paper, then a higher level of detail is expected in answers.

(ii) Excess **W** is added to acidified aqueous potassium manganate(VII).

Describe the colour change seen.

from ....purple........ to ....green........ [2]

Examiner comment

Candidates were familiar with the colour change of potassium manganate (VII). However, they found it difficult to apply this knowledge to the context in which the excess **W** remaining at the end of the experiment was green. This colour was given in **(a)**.

(iii) Describe the observations made when a few drops of aqueous ammonia and then an excess of aqueous ammonia are added to the mixture from **(ii)**.

a few drops a brown precipitate is formed

an excess the brown precipitate remains insoluble

[2]

Examiner comment

This question illustrated the importance of carefully reading the question. The ammonia was added to the mixture from **(a)(ii),** not to solution **W**. The observations were therefore a brown precipitate, because iron(III) is present, not a green precipitate which forms with iron(II).

(b) Solid **X** is a shiny grey metal.

The tests the student does on **X** are shown in Table 3.1.

Some of the observations for these tests are also shown.

Table 3.1

	tests on solid **X**	observations
1	Add excess dilute acid to **X** in a test-tube. The gas produced is tested.	solid disappears solution remains colourless and becomes warmer
2	Add dilute nitric acid, then add aqueous silver nitrate to some of the solution from test 1.	solution remains colourless
3	Add dilute nitric acid, then add aqueous barium nitrate to some of the solution from test 1.	white precipitate

(i) Predict the identity of the gas produced in test 1.

Describe how the student tests the gas to confirm its identity.

gas *hydrogen*

test *place a lighted splint in the gas*

observation to confirm gas *a pop sound is heard*

[3]

Examiner comment

- **(b)** required the candidates to read the question carefully to recognise that **X** was a metal and so would produce hydrogen with a dilute acid.
- A wide range of different gases were suggested, with oxygen and carbon dioxide being the most common.

(ii) The observations for test 1 are incomplete.

State one **other** observation that the student makes for test 1.

bubbles form in the solution [1]

(iii) State the conclusion you can make from test 2.

chloride, bromide or iodide ions are not present in the solution [1]
from test one

Examiner comment

- Careful reading of the question was required. The example above used the solution from test 1, not solid **X**.
- Writing 'Solid **X** does not contain chloride, bromide or iodide ions', was not a valid conclusion from the results.

(iv) State the conclusion you can make from test 3.

sulfate ions are present in the solution from test 1 [1]

Examiner comment

As in **(b)(iii)**, the test relates to the solution not to solid **X**.

(v) Identify the acid used in test 1.

sulfuric acid [1]

Examiner comment

Candidates needed to recognise that the anions came from the acid in the tests, not from solid **X**.

(vi) Suggest the identity of metal **X**.

magnesium [1]

Examiner comment

- Any metal above hydrogen in the reactivity series that would produce an observable amount of effervescence would be suitable.
- Candidates should suggest a metal they are familiar with instead of choosing more obscure metals from the periodic table which they are not expected to know. It is reasonable to expect that candidates would have seen this experiment using magnesium and / or zinc and these would be the sensible metals to suggest.

Question 4

4 Baking soda is used to make bread rise. When baking soda is heated, it decomposes and carbon dioxide gas is released.

Baking soda also decomposes gradually when it is stored. The longer the baking soda is stored, the less carbon dioxide it releases when it is heated.

Plan an investigation to show which of two different samples of baking soda has been stored for longer.

Your plan should include the use of common laboratory apparatus and the two samples of baking soda. No other chemicals should be used.

Your plan should include:

- the apparatus needed
- the method to use
- the measurements to take
- the variables to control
- how to use the results to determine which sample has been stored for longer.

You may draw a diagram to help you answer the question.

- use a balance to measure 2g of each sample
- measure the mass of two beakers and place the 2g sample of each baking soda into the beakers
- heat each sample for the same amount of time. Use a Bunsen burner with the air hole fully open
- reweigh the beakers and samples
- repeat the heating and weighing until no further change in mass takes place
- calculate the loss in mass for each sample
- the sample which has the greater loss in mass is the one which has been stored for less time

[6]

Examiner comment

- There were a variety of methods which could be used. Marks could be awarded for any suitable method which met the criteria in the question.
- The question clearly stated that the baking soda samples were provided, but **no other chemical could be used**.
- Since candidates were not expected to know the temperature at which baking soda decomposes, marks could be awarded for the use of any heating method.
- Although some marks were awarded for methods that required other chemicals, these were not awarded full marks.
- Diagrams were not essential, but could be used alongside written explanations.
- To be awarded marks for a diagram alongside a written explanation, the diagram needed to be correctly labelled.

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