Cambridge Assessment International Education

Example Responses – Paper 3

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 32, 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 32

5070 June 2023 Mark Scheme 32

5070 June 2023 Instructions 32

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

Question 1

1 Aqueous ammonia is a solution of ammonia gas.

You are provided with two samples of aqueous ammonia labelled **A** and **B**.

You are going to investigate the reaction between these samples and 0.500 mol / dm^3 hydrochloric acid.

Read all the instructions carefully before starting the experiments.

Instructions

You are going to do **four** titration experiments.

Rinse and fill a burette with 0.500 mol / dm^3 hydrochloric acid.

(a) Experiment 1

- Use a volumetric pipette to add 25.0 cm^3 of **A** to a conical flask.
- Add five drops of methyl orange indicator to the conical flask.
- Record the initial burette reading in Table 1.1.
- Add 0.500 mol / dm^3 hydrochloric acid from the burette while swirling the flask, adding drop by drop near the end-point, until the solution just changes colour.
- Record the final burette reading in Table 1.1.

Experiment 2

- Empty the conical flask and rinse it with distilled water.
- Refill the burette if necessary.
- Repeat experiment 1.

Complete Table 1.1 with the volume used in each experiment.

Table 1.1

	Experiment 1	Experiment 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

[4]

Examiner comment

- Candidates were expected to do two titrations only and record their results in the table provided.
- They needed to know that titration readings and volumes should be expressed to one decimal place to reflect the scale on the burette.
- They were not expected to know that a burette could be read to half a division, giving a reading to $\pm$ 0.05, although this was acceptable if given.

- Candidates should not be recording readings to any other values in the second decimal place. For example, 15.20 or 15.25 were acceptable values in Experiment 1, but 15.21 was not. It was not possible to read a standard burette to + / - 0.01.
- If candidates did the practical in different groups or rooms, then supervisors needed to provide results for each session and clearly indicate which results applied to which candidates. The accuracy of the candidates' results was determined by how close they were to the supervisor's result.

(b) Experiments 3 and 4

- Empty the conical flask and rinse it with distilled water.
- Refill the burette if necessary.
- Repeat Experiments 1 and 2 using **B** instead of **A**.
- Record the initial and final burette readings for experiments 3 and 4 in Table 1.2.
- Complete Table 1.2 with the volumes used in experiments 3 and 4.

Table 1.2

	Experiment 3	Experiment 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

[2]

Examiner comment

All of the points mentioned in **(a)** also apply to **(b)**.

(c) State the colour change observed in the flask in each experiment.

from ....yellow.......... to ....red.......... [1]

(d) Suggest why you are provided with a white tile for use in these titrations.

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

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.

(e) 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'.

(f) 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** from **(e)** 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

- The answer to the calculations in parts **(f)** to **(h)** depended on the values shown in candidates' results tables, not expected or supervisor values.
- Showing working is not essential in calculations unless specifically requested in the question. However, candidates should show working especially where there was more than 1 mark for the question as this gives 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.

(g) 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]

(h) Use your answers to **(e)** and **(g)** 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 **(e)** and **(g)** 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.

(i) The burette is rinsed with 0.500 mol / dm^3 hydrochloric acid immediately before it is filled.

Explain why the burette should **not** be rinsed 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 need to state that water **decreases** the concentration or dilutes the acid. Similarly, a statement which says that the water will **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**.

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

universal indicator does not provide a clear end point because it .... [1]

shows a number of colour changes during the titration

[Total: 17]

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 2

2 You are provided with solution **W** and solid **X**.

Do the following tests, recording all of your observations at each stage.

Tests on solution W

(a) Put 1 cm depth of **W** into a test-tube. Add aqueous sodium hydroxide drop by drop until a change is seen.

Then add a further 2 cm depth of aqueous sodium hydroxide.

Record your observations.

A green precipitate is formed. When a 2 cm depth of aqueous sodium hydroxide is added, the precipitate remains insoluble.

[2]

Examiner comment

Throughout Question 2, candidates should make use of the notes for qualitative analysis which were provided to help them as they completed the practical.

(b) Put 1 cm depth of **W** into a test-tube. Add 2 cm depth of dilute nitric acid and then add 1 cm depth of aqueous barium nitrate.

Record your observations.

a white precipitate is formed

[1]

Examiner comment

- The use of the word ‘precipitate’ should be encouraged as a description of an insoluble solid forming in a liquid. This is the term used in the qualitative analysis notes provided.
- Descriptions such as ‘cloudy’ or ‘milky’, etc. were not an appropriate description for the formation of a white precipitate, except in the test for carbon dioxide.

(c) Identify the cation and the anion in **W**.

cation iron(II) / Fe^{2+} anion sulfate / SO_4^{2-} [2]

Examiner comment

- In this practical paper, conclusions were dependent on the candidate's results.
- Marks could be awarded for some alternative conclusions which matched incorrect observations in earlier parts. For example, if a candidate thought that the green precipitate in **(a)** dissolves in excess aqueous sodium hydroxide, then marks were awarded for suggesting Cr^{3+} instead of Fe^{2+}.

(d) Put 1 cm depth of **W** into a boiling tube. Add 1 cm depth of aqueous hydrogen peroxide.

Record your observations.

Test the gas given off.

Describe the test and its result.

Identify the gas.

Keep the mixture for use in **(e)**.

observations effervescence is seen as the gas bubbles through the solution.

the solution turns brown

test for gas and result the gas relights a glowing splint

identity of gas oxygen

[4]

(e) Add aqueous sodium hydroxide drop by drop to the mixture from **(d)** until a change is seen.

Then add a further 2 cm depth of aqueous sodium hydroxide.

Record your observations.

A brown precipitate is formed. When a 2 cm depth of aqueous sodium hydroxide is added the precipitate remains insoluble.

[2]

(f) Identify the cation produced by the reaction in **(d)**.

Iron(III) / Fe^{3+} [1]

Examiner comment

As in **(c)**, marks were awarded for some alternative conclusions which matched incorrect observations in **(e)**.

(g) Put a piece of **X** into a test-tube and add 2 cm depth of dilute sulfuric acid.

Record your observations.

Test the gas given off.

Describe the test and its result.

Identify the gas.

observations *effervescence is seen as the gas bubbles through the solution, solid X becomes smaller and dissolves*

test for gas and result *a lighted splint is placed in the gas, a pop sound is heard*

identity of gas *hydrogen*

[4]

(h) Suggest the identity of **X**.

magnesium [1]

[Total: 17]

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 were not expected to know. It is reasonable to expect that candidates have seen this experiment using magnesium and / or zinc and these would be the sensible metals to suggest.
- Stating that **X** was a metal without naming it was insufficient.

Question 3

3 You are not expected to do any experimental work for this question.

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 2 g of each sample
- measure the mass of two beakers and place the 2 g 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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