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Examiners' report

GCSE

GATEWAY SCIENCE CHEMISTRY A

OCR Level 1/Level 2 GCSE (9-1) in Chemistry A (Gateway Science)

J248

For first teaching in 2016

J248/04 Summer 2025 series

Version 1

Contents

Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates.

The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. A selection of candidate responses is also provided. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report.

A full copy of the question paper and the mark scheme can be downloaded from Teach Cambridge.

Paper 4 series overview

J248/04 is the second of two examination components for candidates entered for the Higher Tier of the GCSE examination for Gateway Science Chemistry A. This unit is designed to assess content from Topics C4, C5 and C6, with assumed knowledge of topics C1, C2 and C3, and is 50% of the total GCSE. The practical skills specified in Section C7 of the specification are also assessed so candidates therefore need to be familiar with a range of experimental procedures and be able to think about how an experimental method could be improved. The first two questions in Section B overlap with the Foundation Tier paper.

There was no evidence to suggest that candidates were short of time in answering the paper. All candidates answered all the multiple choice questions. In Section B, the majority of candidates attempted all of the questions.

Several questions (for example Questions 16 (b) (i), 18 (b), 20 (b) and 22 (b) (ii)) required candidates to analyse information and ideas, including data in graphical form. Candidates coped very well with the mathematical analysis of the data in Question 16 (b) (i). However, in Question 18 (b) candidates often simply restated the data in the question rather than using the numerical data to explain why one material was more suitable than the others.

There were several questions where candidates needed to carry out a numerical calculation, for example Questions 16 (b) (i), 17 (c) (ii), 20 (d), 22 (c) (ii) and 23 (c). As for paper J248/03, examiners noted that many candidates showed their working clearly and logically in a format which was easy to interpret. This meant that if candidates made an error examiners were able to follow the candidate's working out and award marks for an error carried forward.

Question 21 (a) is the 6-mark Level of Response question where candidates had the opportunity to demonstrate their knowledge and understanding of chemistry by constructing their own answer. The question required candidates to plan a series of experiments, including the reactants and apparatus used and the results of each experiment. Many candidates structured clear and logical answers, using the guidance in the stem of the question, and were able to access Levels 2 and 3.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• explained why a reaction is faster in terms of more particles per unit volume and increased collision frequency (**Question 16 (c)**) • explained how a catalyst speeds up a reaction (**Question 17(b)(ii)**) • were able to identify the ester functional group in a condensation polymer (**Question 19 (b)**) • described the experiment to make the condensation polymer nylon in the laboratory (**Question 19 (c)**) • read the volume on a burette correctly and to 2 decimal places (**Question 20 (b)**) • calculated the concentration of dilute sulfuric acid from the results of a titration (**Question 20 (d)**) • described the tests, and their results, to identify metal cations, halide ions and carbonate ions (**Question 21 (a)**) • evaluated phytoextraction as a method rather than just describing the processes (**Question 22 (b) (ii)**) • explained the relationship between increased world population and increased CO_2 concentration in terms of increasing energy (**Question 23 (a)**).	• were unable to state an advantage of a continuous process (**Question 17 (c) (iii)**) • could not state two stages in a life-cycle assessment (**Question 18 (a)**) • simply quoted data from the question, rather than interpreting it (**Question 18(b)**) • were unable to draw the structure of the polymer from the monomer, usually including a C=C in their structure (**Question 18(c)**) • could not state the apparatus that should be used to accurately measure 25.0 cm^3 of solution (**Question 20 (a) (i)**) • could not write the balanced symbol equation for the displacement reaction of Cl_2 with LiBr (**Question 21(c) (i)**) • explained the relationship between increased world population and increased CO_2 concentration in terms of increased respiration (**Question 23 (a)**) • were able to calculate moles from the mass of CO_2 gas but could not then use the number of moles to calculate the volume of gas (**Question 23 (c)**).

Section A overview

Section A is comprised of 15 Multiple Choice Questions (MCQs) which assess AO1 (recall of knowledge and understanding) and AO2 (application of knowledge and understanding). Mistakes most commonly occurred on Questions 1, 2 and 3, with Questions 9, 13, 14 and 15 being the most challenging in this section. Questions 5, 6, 8, 10, 11 and 12 were answered correctly by most candidates so there were no common errors for examiners to comment on. All of the MCQs in Section A were attempted by all candidates.

As on Paper J248/03, many candidates continue to demonstrate good practice and use the 'white' space around the question to write down working and/or equations. They did this effectively to assist with answering the question, to help them to check their answer at the end and eliminate incorrect options as they read the question. Other good practices seen included underlining key words and working through distractors, crossing out those perceived to be most obviously incorrect.

Question 1

1 Which row in the table shows the change in the percentage of each gas in the **Earth's atmosphere today** compared to the Earth's early atmosphere?

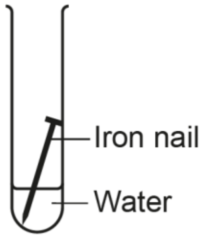
	Carbon dioxide	Oxygen
A	decreased	decreased
B	decreased	increased
C	increased	decreased
D	increased	increased

Your answer ☐ **[1]**

C was a common incorrect answer with candidates selecting the reverse of the correct answer B.

Question 2

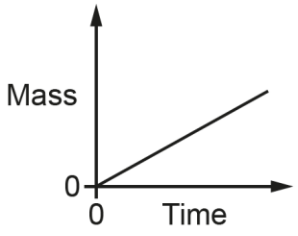
2 An iron nail is left in a test tube containing water.



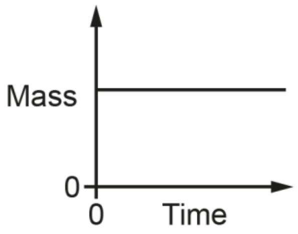
The iron nail rusts.

Which graph shows how the mass of the iron nail changes?

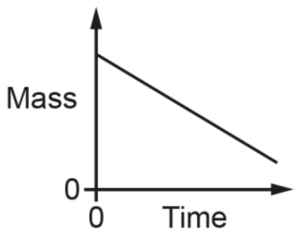
A



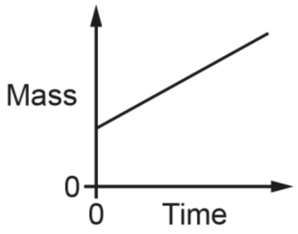
B



C



D



Your answer ☐ **[1]**

C was a very common incorrect answer with candidates thinking that the mass of the nail decreases when it rusts. The equation for rusting (iron + oxygen + water → hydrated iron oxide) is helpful to reinforce to students that the mass of iron increases on rusting.

Question 3

3 The alkanes are a homologous series of molecules.

Which statement about different alkane molecules is **correct**?

A The molecular formula of the molecules differs by CH_3.

B The molecules all contain a double bond.

C The molecules all have the same general formula.

D The molecules all have the same physical properties.

Your answer ☐ **[1]**

B was a common incorrect answer as candidates often confused the structures of alkanes and alkenes.

Question 4

4 Which row in the table shows a property of a Group 1 metal and of a transition metal?

	Group 1 metal	**Transition metal**
A	forms white compounds	low density
B	high melting point	conducts electricity
C	low density	forms coloured compounds
D	very reactive	low density

Your answer ☐ **[1]**

All possible answers were seen by examiners as the properties of Group 1 metals compared to transition metals remains a common area for errors for candidates. This is a topic within the specification that teachers are encouraged to review with candidates as a key revision topic.

Question 9

9 Nitrogen reacts with hydrogen to make ammonia.

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

What is the volume of ammonia made from 366 cm^3 of hydrogen?

A 183 cm^3

B 244 cm^3

C 549 cm^3

D 732 cm^3

Your answer ☐ **[1]**

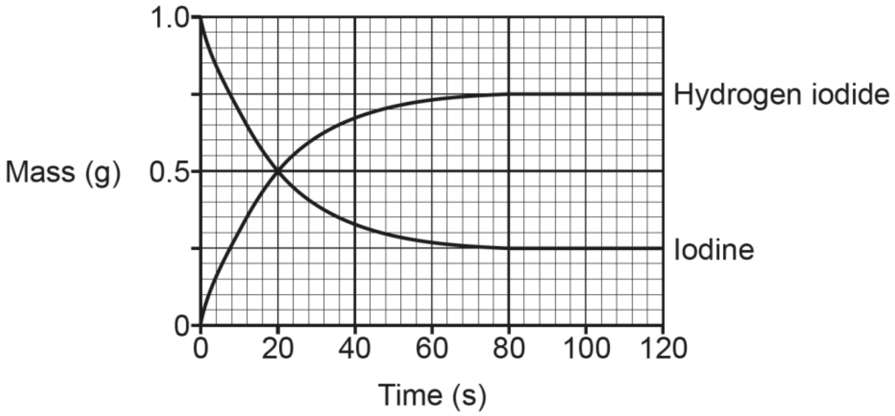
This question required candidates to use the mole ratio of H_2 to NH_3 to calculate the volume of NH_3. The most common incorrect answers were C ((366 ÷ 2) × 3) and D (366 × 2).

Question 13

13 The reaction between iodine gas and hydrogen gas reaches equilibrium in a sealed container.

Hydrogen iodide is made.

The graph shows how the mass of iodine and the mass of hydrogen iodide change over time.



At what time is equilibrium reached?

A 0 s

B 20 s

C 80 s

D 120 s

Your answer ☐ **[1]**

B was a common incorrect answer, the time at which mass of iodine and the mass of hydrogen iodide are equal, rather than C, the time at which the mass of the reactants and products are no longer changing.

Misconception

A common misconception when interpreting graphs showing how the mass of the reactants and products change during a reversible reaction is that equilibrium is reached at the point when the lines cross. Candidates should recall that at dynamic equilibrium the forward and backward reactions are still occurring but the mass of the reactants and products are no longer changing, so the time at which equilibrium is reached is when both lines become horizontal.

Question 14

14 The equation shows one stage in the extraction of the metal titanium, Ti.

$TiCl_2 + Mg \rightarrow MgCl_2 + Ti$

Which row in the table shows what is oxidised and what is reduced?

	Oxidised	Reduced
A	Mg	Ti^{2+}
B	Mg^{2+}	Ti^{2+}
C	Ti	Mg
D	Ti^{2+}	Mg

Your answer ☐ **[1]**

Examiners noted a range of incorrect answers to this question. Only higher attaining candidates understood that the titanium ion, Ti^{2+}, in $TiCl_2$ gains electrons and is reduced to form Ti metal and Mg metal loses electrons to form the magnesium ion, Mg^{2+}, in $MgCl_2$.

Question 15

15 The reaction between sulfur dioxide gas and oxygen gas reaches equilibrium in a sealed container.

$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$

The reaction is exothermic.

Which conditions will move the position of equilibrium to the **left**?

A	high pressure	catalyst
B	high pressure	low temperature
C	low pressure	high temperature
D	low temperature	catalyst

Your answer ☐ **[1]**

Again, only higher attaining candidates understood that a low pressure and high temperature will move the position of equilibrium to the left as the equilibrium position shifts to reduce the effect of the changes to the system. B was a common incorrect response.

Section B overview

This section includes short response questions as well as questions requiring longer answers. There is also one Level of Response question: Question 21 (a). Questions 16 and 17 overlap with the Foundation Tier paper. This section covers all the assessment objectives, AO1, AO2 and AO3 (analysing information and ideas). Very few questions were omitted in Section B which was very pleasing to see.

As candidates read a question they should be encouraged to '**BUG**' the question:

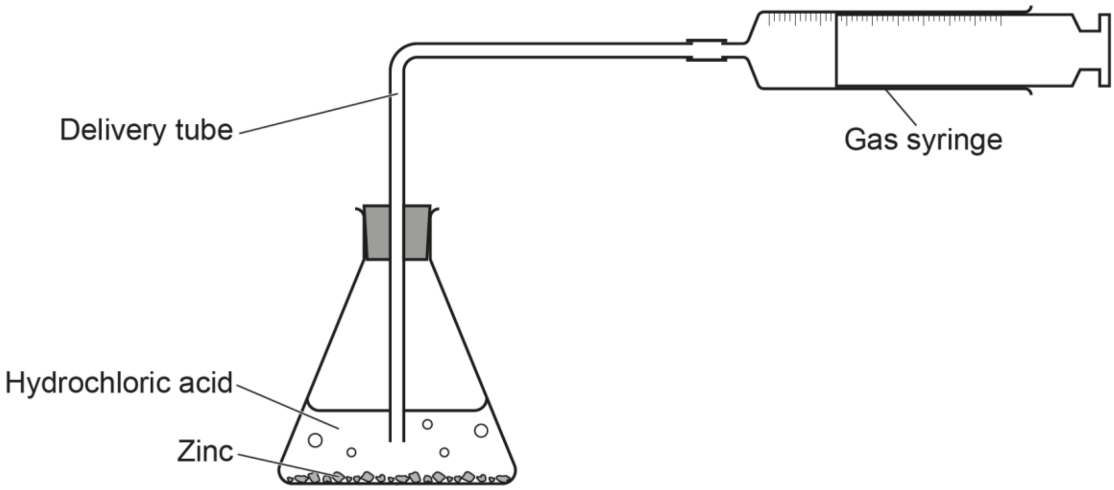
- draw a **B**ox around the command word
- **U**nderline the key words in the question
- **G**lance over the question again to gain any more information

This allows them to analyse the question thoroughly and understand what the question is looking for.

Question 16 (a)

16 A student investigates the rate of the reaction between zinc and an excess of hydrochloric acid.

The diagram shows the equipment the student uses.



(a) The student has made a mistake setting up the delivery tube in their experiment.

Describe the mistake and the problem this will cause.

Mistake ....

....

Problem ....

....

[2]

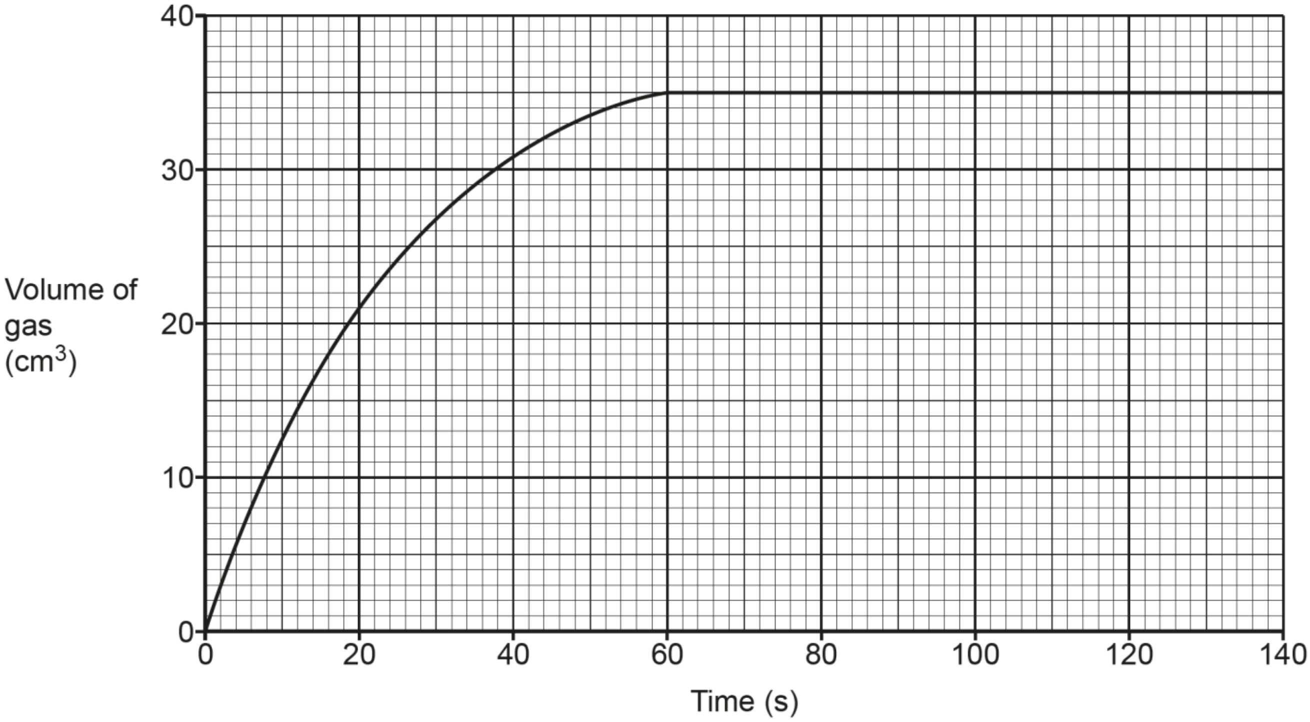
Most candidates correctly identified that the delivery tube is in the acid and so acid will travel up the tube and/or no gas will be collected. Many candidates described that the gas syringe was not set at zero and focused on that as the mistake. Candidates should be encouraged to underline key phrases in the stem of a question; in this case 'a mistake in <u>setting up the delivery tube</u>'.

Question 16 (b) (i)

(b) The student sets up the experiment correctly.

They measure the volume of gas every 20 seconds.

The graph shows their results.



(i) Calculate the mean rate of reaction between 0 seconds and 60 seconds.

Use the graph and the equation:

$$\text{mean rate of reaction} = \frac{\text{volume of gas}}{\text{time}}$$

Give the units for your answer.

Mean rate of reaction = ... Units .... **[4]**

The majority of candidates gained 4 marks for this question. The most common error was calculating the rate at intervals, usually 20 s, in the first 60 s and then calculating the mean of these. Less successful candidates gave the units as s/cm^3.

Question 16 (b) (ii)

(ii) The student repeats the experiment.

They use the same mass of zinc, but in **smaller** pieces.

Draw a line on the graph to show the student's results. **[2]**

Most candidates scored 2 marks although a significant number of candidates drew a steeper curve levelling off at more than 35 cm^3.

Question 16 (c)

(c) The reaction is faster when **more concentrated** hydrochloric acid is used.

Explain why.

....

....

.... **[2]**

Many candidates explained why the reaction is faster, using collision theory, in terms of more particles leading to more collisions. At Higher Tier candidates need to give an explanation in terms of more particles <u>per unit volume</u> leading to increased collision <u>frequency</u>.

Question 17 (a)

17 Ammonia is made from nitrogen and hydrogen in the Haber process.

The word equation for the reaction is:

nitrogen + hydrogen $\rightleftharpoons$ ammonia

(a) What does the symbol $\rightleftharpoons$ tell you about the reaction?

.... **[1]**

Most candidates knew that the $\rightleftharpoons$ in the equation indicated that the reaction was reversible. Fewer candidates stated that the reaction can reach equilibrium.

Question 17 (b) (i)

(b) A catalyst is used in the Haber process.

(i) What is the catalyst used?

Tick (✓) **one** box.

Iron ☐

Manganese(IV) oxide ☐

Nickel ☐

Platinum ☐

[1]

Most candidates knew that iron is the catalyst in the Haber process. The most common error was manganese(IV) oxide.

Question 17 (b) (ii)

(ii) Explain how the catalyst speeds up the reaction.

....

....

.... **[2]**

Successful candidates were able to correctly explain the action of a catalyst in terms of providing an alternative reaction pathway with a lower activation energy.

Misconception

Examiners noted a variety of misconceptions in this question, including:

- the catalyst increases the frequency and/or energy of the collisions
- the catalyst provides the activation energy for the reaction
- the catalyst impacts on the temperature of the reaction
- the catalyst alters the position of equilibrium.

Question 17 (c) (i)

(c) Ammonia is used in the manufacture of fertilisers.

NPK fertilisers contain the essential elements nitrogen, phosphorus, and potassium.

The table shows the percentages of nitrogen, phosphorus, and potassium in four different fertilisers.

Fertiliser	**Percentage (%) of essential element**		
	Nitrogen	**Phosphorus**	**Potassium**
A	12	6	36
B	8	8	30
C	12	12	17
D	15	5	12

Plants do **not** grow well if they get too little of these essential elements because:

- too little nitrogen can cause yellow leaves
- too little phosphorus can cause poor root growth
- too little potassium can cause poor fruit growth.

(i) Which fertiliser is best at preventing yellow leaves **and** poor fruit growth?

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

[1]

Most candidates correctly identified A.

Question 17 (c) (ii)

(ii) A farmer buys a 25 kg bag of fertiliser **C**.

Calculate the mass of **potassium** in the bag of fertiliser.

Mass of potassium = ... kg **[2]**

Most candidates were able to correctly calculate the mass of potassium. Less successful candidates calculated the mass as 9 kg (using 36% from A) or 3 kg (using 12% from D) and gained one error carried forward mark. Again, encouraging candidates to underline key phrases in the stem of a question ('fertiliser C') will help to eliminate such errors. A small proportion of candidates added up the percentages for C (12 + 12 + 17 = 41) and then divided 17 by 41.

Question 17 (c) (iii)

(iii) Fertilisers are made in industry using a continuous process.

Fertilisers can be made in a school laboratory using a batch process.

State **one advantage** of using a continuous process.

....

.... **[1]**

Most candidates stated that a continuous process operates all of the time. Lower attaining candidates answered in terms of the process being faster or giving a higher yield (rather than a higher rate of production).

Question 18 (a)

18 A life-cycle assessment is an analysis of the overall environmental impact that a product may have throughout its lifetime.

(a) The life-cycle assessment is broken down into four main stages.

The first stage is looking at obtaining the **raw materials**.

State **two** other stages in a life-cycle assessment.

1 ....

2 ....

[2]

Most candidates scored 2 marks. A common error was describing recycling instead of disposal.

Question 18 (b)

(b) A company does a life-cycle assessment to investigate three possible materials for making a single-use takeaway food container.

The table gives some of the information the company uses.

	Aluminium	**Poly(propene)**	**Polystyrene**
Mass of raw materials (g)	8	31.5	8
Energy used (MJ / kg)	61	73	40
Percentage recycled (%)	54	11	12
Cost per kg (£)	1.40	0.98	0.62

Suggest which material the company should use to make the food container.

Explain your answer using information from the table.

Material ....

Explanation ....

....

....

....

....

.... **[4]**

Most candidates suggested using polystyrene, with fewer suggesting aluminium. The explanation required candidates to interpret the quantitative data to give a comparative explanation. Common errors were not giving a comparative answer (e.g. polystyrene uses a low amount of energy) or simply quoting data from the table. A significant proportion of candidates misunderstood the mass of raw materials and described the mass of the finished food container.

Exemplar 1

Material ....polystyrene....

Explanation ....

uses the least amount of energy

Has lowest cost per kg

~~Has~~ 12% can be recycled (more recyclable than

poly(propene)

disposable

[4]

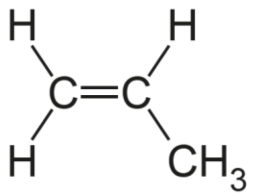
This 4-mark response is comparative, clear and concise; very much a case of 'less is more'. The candidate has used the data to state the polystyrene uses the least amount of energy and has the lowest cost per kg. '12% recycled' on its own would not have scored a mark, but the candidate had qualified this by stating that this is 'more recyclable than poly(propene)). Candidates should be encouraged to look at the number of marks for the question as a guide to the number of points they need to make in their answer.

Less is More

This candidate's response is a good example of acceptable response styles for GCSE science papers. Candidates may respond in full sentences, but bullet points, numbered lists, comparative tables, labelled diagrams and chemical word or formula equations should also be encouraged.

Question 18 (c)

(c) Poly(propene) is a polymer made from the monomer propene.



Propene

Draw the structure of the **polymer** poly(propene).

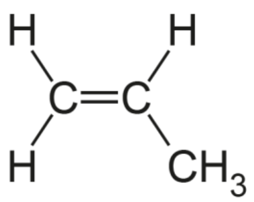
[2]

Most candidates correctly drew the structure of poly(propene). The most common errors were retaining the C=C, not including the brackets, omitting the methyl group or not showing the end bonds passing through the brackets.

Question 18 (d)

(d) Propene reacts with hydrogen.

Complete the equation for this reaction.

 + H_2 →

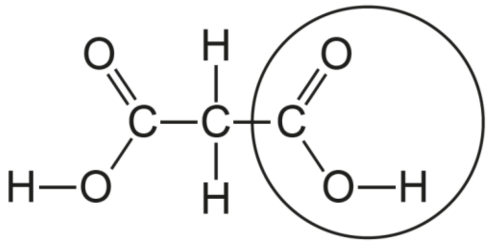
[2]

Most candidates were able to draw the correct structure for propane. A common error was replacing the CH_3 group with C_2H_5.

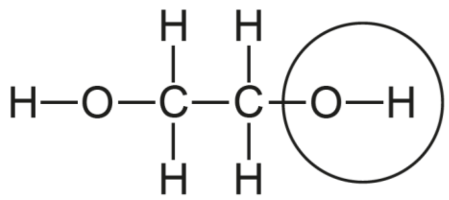
Question 19 (a)

19 The displayed formulae of molecules **X** and **Y** are shown in **Fig. 19.1**.

Fig. 19.1



Molecule **X**



Molecule **Y**

The functional group of each molecule is shown in a ring.

(a) State the name of the functional group in molecule **X** and molecule **Y**.

Molecule **X** ....

Molecule **Y** ....
[2]

Most candidates were able to correctly name both functional groups. Candidates who gave COOH and OH did not score marks as these groups were shown in the displayed formulae of molecules X and Y, and not their names. A common error was hydroxide instead of alcohol/hydroxyl.

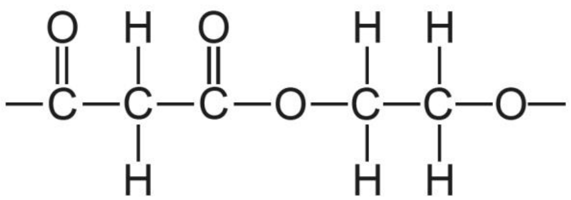
Question 19 (b)

(b) Molecule **X** reacts with molecule **Y** to form polymer **Z**.

Polymer **Z** is a polyester because it contains an **ester functional group**.

Polymer **Z** is shown in **Fig. 19.2**.

Fig. 19.2



Draw a ring around the ester functional group in **Fig. 19.2**. **[1]**

Higher attaining candidates correctly identified the ester functional group.

Question 19 (c)

(c) Polyester is a condensation polymer.

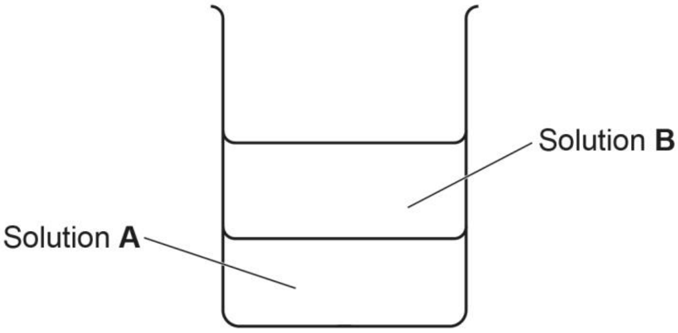
Nylon is also a condensation polymer.

Nylon can be made in the laboratory using two solutions, **A** and **B**, as shown in **Fig. 19.3**.

Solution **A** is poured into a beaker.

Solution **B** is carefully poured on top of solution **A** to minimise mixing.

Fig. 19.3



State where the nylon forms and describe how the nylon is removed from the beaker.

The nylon forms ....

The nylon is removed from the beaker by ....

....

....

[3]

Many candidates correctly identified that the nylon forms at the boundary of solutions A and B. Only the highest attaining candidates correctly described picking up the nylon with tweezers and then wrapping the strand around a glass rod. Filtration, evaporation, distillation and fractional distillation were methods often suggested.

Question 19 (d)

(d) The monomer in solution **A** contains two NH_2 groups.

The monomer in solution **B** contains two $COCl$ groups.

State the formula of the small molecule made as well as the nylon.

.... **[1]**

Only the highest attaining candidates stated HCl. H_2O was the most common answer, being the small molecule produced in the condensation polymerisation reaction between a dicarboxylic acid and a dialcohol. Section C6.2e of the specification states that at Higher Tier candidates should explain the basic principles of condensation polymerisation, to include '…e.g. a polyamide'.

Question 19 (e)

(e) A naturally occurring polymer is made by combining monomers called nucleotides.

State the name of this natural polymer.

.... **[1]**

Most candidates correctly named DNA.

Question 20 (a) (i)

20 A student plans a titration experiment to find the concentration of a solution of sulfuric acid.

This is their method:

- Fill the burette with dilute sulfuric acid.
- Add $25.0\,cm^3$ of $0.50\,mol/dm^3$ sodium hydroxide solution to a conical flask.
- Add 5 drops of indicator to the sodium hydroxide solution.
- Add the dilute sulfuric acid to the sodium hydroxide solution until the indicator changes colour.
- Repeat the titration.

(a)
(i) State the piece of apparatus the student should use to accurately measure the $25.0\,cm^3$ of sodium hydroxide solution.

.... **[1]**

Most candidates suggested a piece of apparatus other than a (volumetric) pipette; measuring cylinder and beaker were the most common answers.

OCR support

A number of the GCSE Examiner Reports this year have raised the concern that candidates' practical skills and knowledge is in decline. OCR has produced a wealth of practical resources to support teachers as part of our Purposeful Practicals materials, including integrated instructions and disciplinary and procedural knowledge assessment opportunities. Find them on Teach Cambridge now.

Question 20 (a) (ii)

(ii) State a suitable indicator for the student to use in the titration.

.... **[1]**

Most candidates correctly stated methyl orange or phenolphthalein. Examiners gave credit for phonetic spelling of phenolphthalein. The most common error was universal indicator or iodine.

Question 20 (a) (iii)

(iii) Suggest an improvement to the student's method.

....

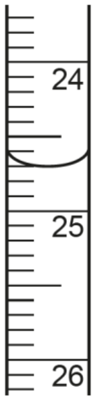
.... **[1]**

Most candidates suggested swirling the conical flask, adding the acid drop by drop or placing a white tile under the conical flask. It was rare for examiners to see a candidate suggest rinsing the burette with acid before filling. The question asked for an improvement to the student's method and answers in terms of doing a rough titration were therefore ignored.

Question 20 (b)

(b) The reading at the start of the rough titration is 0.0 cm^3.

At the end of the rough titration the student reads the volume of dilute sulfuric acid added from the burette.



What is the volume of dilute sulfuric acid added?

Give your answer to **2** decimal places.

Volume = ... cm^3 **[1]**

A common error was not giving an answer to 2 decimal places, i.e. 24.7. Frequent incorrect answers were also 24.60, 24.65 and 25.30.

Question 20 (c)

(c) After the rough titration the student repeats the experiment five more times.

The table shows their results.

Titration number	1	2	3	4	5
Volume of dilute sulfuric acid added (cm^3)	24.80	24.45	24.50	24.55	24.50

The student calculated that the mean of these results was 24.50 cm^3.

Explain why.

Use data from the table.

....

....

.... **[2]**

Most candidates correctly identified that titration 1 was not included in the calculation of the mean and were able to explain why using appropriate terminology, i.e. stating it was not concordant, an anomalous result, or an outlier.

Question 20 (d)

(d) The equation for the reaction in the student's titration is

$$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$$

They used 25.0 cm^3 of 0.40 mol / dm^3 sodium hydroxide solution and 24.50 cm^3 of dilute sulfuric acid.

Calculate the concentration of the dilute sulfuric acid in mol / dm^3.

Give your answer to **2** significant figures.

Concentration of dilute sulfuric acid = ... mol / dm^3 **[4]**

Many candidates gained 4 marks for this question. If candidates did not calculate the correct answer, the most frequently gained marks were for the moles of NaOH, and for the calculation of the concentration of H_2SO_4, often with error carried forward from the incorrect mole ratio (either 1:1 or 2 H_2SO_4 : 1 NaOH). Some candidates used the concentration in mol/dm^3 with the volume in cm^3 to calculate the moles of NaOH. Candidates should be encouraged to make sure units are consistent. Many candidates set out their working clearly so that if they made an error the examiner could follow their working out and award marks for an error carried forward. However, examiners noted that there were still responses consisting of a jumble of numbers making it difficult to assign marks when the final answer is incorrect. Candidates should also be encouraged to note when a question asks for an answer to a specific number of significant figures or decimal places; a significant number of candidates lost a mark by giving an answer of 0.2 mol/dm^3.

Exemplar 2

Calculate the concentration of the dilute sulfuric acid in mol/dm^3.

Give your answer to **2** significant figures.

$conc = \frac{mol}{Volume}$

NaOH

$conc. = \frac{moles}{Volume}$

$0{\cdot}40 = \frac{moles}{0.025}$

$moles = 0{\cdot}4 \times 0{\cdot}025$

$\boxed{moles = 0.01}$

molar ratio $= 2:1$

moles of $H_2SO_4 = 0.005$

$conc. = \frac{moles}{Volume}$

$= \frac{0.005}{0.02450}$

$= 0.204081632$ mol/dm^3

$\boxed{= 0{\cdot}20}$

Concentration of dilute sulfuric acid = 0.20 mol/dm^3 **[4]**

This response gained 4 marks for this titration calculation. The candidate has clearly set out their working, making it easy for the examiner to follow. If the candidate had made an error, it would have been straightforward for the examiner to give marks for an error carried forward. The candidate has calculated the moles of sodium hydroxide. They have appreciated the mole ratio and correctly calculated the moles of sulfuric acid, going on to use this to calculate the concentration of the acid. They have correctly given their answer to 2 significant figures.

Question 21 (a)*

21
(a)* A teacher finds an unlabelled beaker containing a white solid.

They know that the solid is one of the following:

- lithium bromide
- lithium iodide
- sodium bromide
- sodium carbonate.

Plan a series of experiments the teacher can do to identify the white solid.

Include the reactants and apparatus used and the results of each experiment.

....

....

....

....

....

.... **[6]**

This 6-mark Level of Response question assessed AO1 and AO3. At Level 3 (5 – 6 marks) candidates needed to demonstrate their knowledge and understanding of the practical tests for metal and non-metal ions and analyse the information given in the question to plan a series of experiments to identify the white solid. The question differentiated well. Most candidates were able to correctly describe a flame test and give the correct flame colours for lithium and sodium. Many were able to describe the test for halide ions, although the use of nitric acid was often omitted. More candidates knew the colours of the bromide and iodide precipitates than knew how to perform the test. The most common error was the use of barium chloride to test for carbonate ions, although sometimes in addition to hydrochloric acid.

Exemplar 3

Include the reactants and apparatus used and the results of each experiment. a few drops of

in order to find out the white solid, the ~~wha~~ teacher needs to first add HCl (hydrochloric acid) and if it is sodium carbonate, there would be effervescence and this can be confirmed using lime water. If the lime water turns cloudy, carbon dioxide is present, meaning ~~th~~ it is sodium carbonate. The teacher can use a pipette to put in a few drops of HCl. If this is not observed, teacher then can carry out the test for halide ions, whereby a few drops of HNO_3 (nitric acid) and $AgNO_3$ (silver nitrate) are added using a pipette. If bromine is present, there would be a cream precipitate, whereas there would be iodine present if the precipitate is yellow. If the precipitate is cream, it is either lithium bromide or sodium bromide. The student can identify which one it is by carrying out a flame test. First take a nichrome wire and dip it in HCl and hold it over a blue flame to sterilise it from impurities. After this, dip the wire in the sample and hold it over the flame again. If the flame is red, it is lithium bromide, if it is yellow it is sodium **[6]** bromide.

This is a Level 3, (6 mark) response.

The candidate begins by clearly describing the test and result for carbonate ions, appreciating that this test alone identifies the white solid as sodium carbonate. They then describe the test for halide ions, giving the correct colours for the precipitates formed with bromide or iodide ions. The candidate then describes how they would distinguish between lithium bromide and sodium bromide using a flame test.

The answer is clear, detailed, and succinct indicating that the Level of Response question is designed to be answered within the answer lines given.

Question 21 (b)

(b) Instrumental methods of analysis can be used to analyse chemical substances.

State **two advantages** of instrumental methods of analysis.

1 ....

2 ....
[2]

Most candidates scored both marks. Common answers which did not score marks were reducing human error, reliability and precision.

Question 21 (c) (i)

(c) Chlorine, Cl_2, reacts with lithium bromide, LiBr.

(i) Write the **balanced symbol equation** for the reaction.

.... **[2]**

Most candidates were able to write and balance the equation. It was rare for examiners to award just one mark, with candidates often writing $LiCl_2$ and 2Br as the products and therefore scoring no marks as the balancing mark is dependent on the correct formulae.

Question 21 (c) (ii)

(ii) Iodine, I_2, does **not** react with lithium bromide.

Explain why.

....

.... **[2]**

Most candidates knew that iodine is less reactive than bromine and hence would not displace bromine from lithium bromide.

Assessment for learning

Candidates should be encouraged to use correct terminology; many candidates did not gain the first mark as they stated that iodine is less reactive than <u>bromide</u>. Candidates should also be encouraged to avoid the use of the word 'it' as examiners were often unclear as to which element the candidate was referring to.

Question 22 (a)

22 Copper ore can be obtained by quarrying.

Copper metal is then extracted by heating the copper ore in a furnace.

(a) One type of copper ore contains copper oxide.

The copper oxide is heated with carbon.

Write the **balanced symbol equation** for this reaction.

.... **[2]**

Most candidates were able to write the correct balanced symbol equation. The most common errors were giving the formulae of the reactants as CuO_2 and/or C_2, with Cu_2 sometimes given as a product.

Question 22 (b) (i)

(b) Scientists have developed methods of extracting copper from ores that contain a **low percentage** of copper compounds.

(i) Suggest **two** reasons why scientists have developed these methods.

1 ....

2 ....

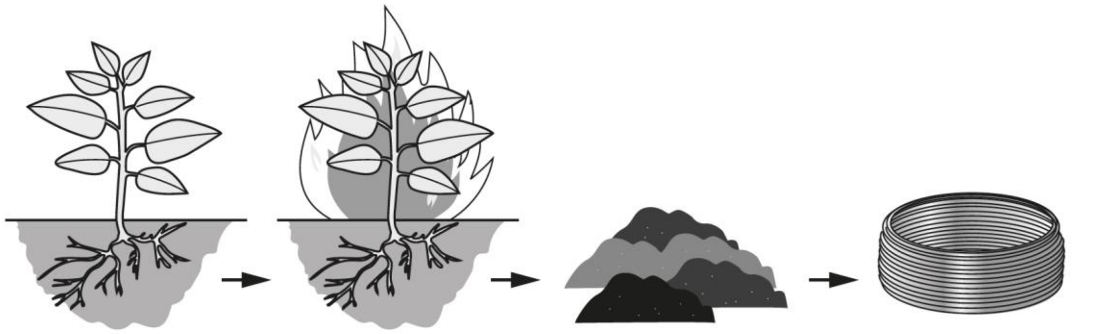
[2]

Only higher attaining candidates scored both marks for this question. Examiners noted many vague answers, e.g. better for the environment or cheaper.

Question 22 (b) (ii)

(ii) Phytoextraction is a method used to obtain copper from ores that contain a low percentage of copper compounds.

The diagram shows the stages in phytoextraction.



Evaluate phytoextraction as a method of obtaining copper compared to quarrying and heating the copper ore in a furnace.

Use the information in the diagram and your own knowledge of how metals are extracted.

[4]

Examiners saw a range in quality of answers and gave a range of marks for this question. Many candidates described extracting copper by phytoextraction and quarrying/heating with carbon rather than evaluating the two methods.

Assessment for learning

Candidates should be encouraged to underline and focus on the command word in a question; in this case evaluate. Centres are encouraged to make sure that candidates have a clear understanding of command words. 'Evaluate' requires candidates to describe the advantages and disadvantages of something and then to make a qualitative judgement, considering different factors and using their own knowledge. They should be encouraged to use comparative words like 'better than', 'more than', 'less than', etc.

Question 22 (c) (i)

(c) Metals can also be extracted from their metal oxide by reduction with hydrogen.

Element **X** is a metal.

$\mathbf{X}O_3 + 3H_2 \rightarrow \mathbf{X} + 3H_2O$

(i) Explain how the equation shows that the metal oxide is **reduced**.

....

.... **[1]**

Good responses to this question explained that the metal oxide loses oxygen. Examiners also saw responses in terms of loss and gain of electrons. A frequent error was stating that the metal loses oxygen.

Question 22 (c) (ii)

(ii) The sum of the relative formula masses (M_r) of the reactants is 149.9.

Identify element **X**.

Use the Periodic Table.

Relative atomic mass (A_r): H = 1.0 O = 16.0

X = ... **[3]**

Most candidates correctly used the equation in part (i) to calculate the relative atomic mass of element **X** and hence to identify it a molybdenum.

Question 23 (a)

23 In the last 75 years there has been an increase in both:

- the world population
- the concentration of carbon dioxide in the atmosphere.

(a) Why may the increase in the world population have caused the increase in the concentration of carbon dioxide in the atmosphere?

....

....

.... **[2]**

Many candidates described an increase in world population leading to an increase in respiration and scored no marks.

Question 23 (b)

(b) State **one** possible problem associated with an increase in the concentration of carbon dioxide in the atmosphere.

....

.... **[1]**

Global warming and/or the enhanced/increased greenhouse effect was usually correctly stated. Lower attaining candidates simply stated 'the greenhouse effect' and did not gain the mark.

Question 23 (c)

(c) A household gas central heating boiler produces 42 460 g of carbon dioxide in a week.

Calculate the **volume** of carbon dioxide, in dm^3, produced at room temperature and pressure in a week.

Relative atomic mass (A_r): C = 12.0 O = 16.0

Volume of carbon dioxide = ... dm^3 **[2]**

Most candidates correctly calculated the moles of carbon dioxide. Many however could not then use the number of moles to calculate the volume of gas as they did not recall the equation
$moles\ of\ gas = \frac{volume\ of\ gas}{molar\ volume}$.

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