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GCSE (9–1)

Examiners' report

GATEWAY SCIENCE CHEMISTRY A

J248

For first teaching in 2016

J248/04 Summer 2024 series

Version 1

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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 answers 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 OCR.

Paper 4 series overview

J248/04 is the second of two examination components for candidates entered for the Higher Tier of the new revised 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 16 (a) (i), 18 (c) (iii), 20 (b) and 20 (c) (i), required candidates to analyse information and ideas, including data in graphical form. Just as for J248/03, candidates should be encouraged to practise interpreting data both qualitatively and quantitatively from different sources. In particular, candidates need to use numerical data to identify trends and patterns rather than just restating the data given in a question.

There were several questions where candidates needed to carry out a numerical calculation, for example 17 (c), percentage yield; 18 (c) (ii), reacting masses; 21 (b) (ii), titration calculation and 22 (b). Candidates performed well on the first three. Question 22 (b) required candidates to draw and use the slope of a tangent to calculate the rate of a reaction and many candidates seemed unfamiliar with this skill.

Question 22 (d) 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. It is important that candidates answer the question set in a logical way with clear explanations and many candidates were able to do this.

There are a number of questions where an explanation is required. Candidates should be encouraged to use the number of answer lines and the marks for the sub-part as a guide to the length of their answers. Candidates should also make sure that they use appropriate chemistry terminology correctly in their answers. Use of incorrect terminology was a common reason for candidates not gaining marks e.g. in Question 18 (b) where candidates referred to zinc rusting and in Question 19 (d) where candidates referred to breaking covalent bonds rather than intermolecular forces.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• recalled how the properties of Group 1 elements depend on the outer shell of electrons (**Question 16 (b) (i)**) • recalled the definition of dynamic equilibrium and the conditions that affect a dynamic equilibrium (**Questions 17 (a) (iii) & (b)**) • were able to calculate percentage yield (**Question 17 (c)**) • were able to apply their knowledge of the reactions of organic compounds (**Question 19 (f)**) • analysed data in graphical form to draw a conclusion (**Question 20 (b) (i)**) • calculated the volume of alkali used from the results of a titration (**Question 20 (b) (ii)**) • drew and used the slope of a tangent to calculate the rate of a reaction (**Question 22 (b)**) • knew that a catalyst does not affect the volume of gas produced in a reaction, nor is its own mass changed (**Questions 22 (c) (i) & (ii)**) • produced a clear, concise, and well-structured answer for the Level of Response question analysing the results to conclude which experiment was faster, explaining their answer in terms of collision theory, and suggesting how the experiment could be improved (**Question 21 (a)**).	• did not appreciate why hydrochloric acid should not be used when testing for chloride ions (**Question 16 (c)**) • were unable to explain why a painted nail will rust if the paint is scratched, but a nail coated in zinc will not rust if the zinc is scratched (**Question 18 (b)**) • were unable to apply knowledge of redox reactions (**Question 18 (c) (i)**) • could not write the balanced symbol equation for the combustion of methane, often stating H_2 as a product (**Question 19 (b)**) • did not recall that carbon/soot is another product of incomplete combustion in addition to CO and H_2O, often giving an answer of hydrogen (**Question 19 (c)**) • did not recall the crude oil is a feedstock for the petrochemical industry (**Question 19 (e)**) • could not describe how the amounts of carbon dioxide and water vapour in the Earth's atmosphere have changed over time (**Question 20 (a)**) • were unable to state what is meant by concordant results (**Question 21 (b) (i)**).

Section A overview

Section A is 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 10, 11 and 15, with Questions 10 and 11 being the most challenging in this section. All of the MCQs in Section A were attempted by all candidates.

Many candidates had taken on board advice from last year's examiners' report to use the "white" space around the question to write down working and/or equations (to assist with answering the question and to help them to check their answer at the end of the examination) and eliminate incorrect options as they read through the question. Other good practice seen included underlining key words and working through distractors, crossing out those perceived to be most obviously incorrect.

Centres should encourage candidates to take care to write their answer letter clearly as B and D can be confused if writing is unclear. If a candidate changes their mind about an answer, they should cross out their original answer and write their new answer clearly to the right of the answer box, rather than overwriting their original answer. Marks cannot be awarded if the answer is not clear.

Question 10

10 Which equation shows the reaction at the **anode** in a hydrogen/oxygen fuel cell?

A $H_2(g) \rightarrow 2H^+(aq) + 2e^-$

B $4H^+(aq) + O_2(g) + 4e^- \rightarrow 2H_2O(g)$

C $2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$

D $O_2(g) + 4e^- \rightarrow 2O^{2-}(g)$

Your answer ☐ **[1]**

Selecting B or C were common misconceptions in this question, probably because candidates recalled that water is made in a hydrogen/oxygen fuel cell. Candidates should be encouraged to take note of key words written in **bold** in a question, as **anode** was in this question.

Question 11

11 The polymer nylon can be made from hexanedioyl dichloride, $ClOC(CH_2)_4COCl$, and hexane-1,6-diamine, $NH_2(CH_2)_6NH_2$.

Which small molecule is made as well as nylon?

A HCl

B H_2

C H_2O

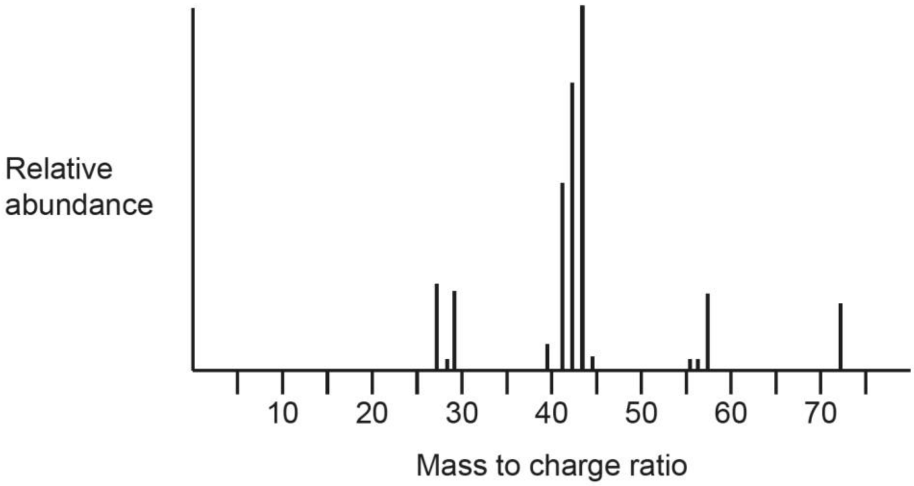
D NH_3

Your answer ☐ **[1]**

Only the higher attaining candidates correctly answered A, with C being a very common incorrect answer as water is the product in many condensation polymerisation reactions.

Question 15

15 Which carbon compound produces this mass spectrum?



Relative atomic mass (A_r): C = 12.0 H = 1.0

A C_2H_4

B C_3H_8

C C_4H_8

D C_5H_{12}

Your answer **[1]**

Selecting B, C_3H_8 with a mass to charge ratio of 44, was a very common misconception in this question. Candidates should recall that the peak on the far right represents the molecular ion, and not the peak with the highest relative abundance.

Section B overview

This section includes short (1 mark) questions as well as questions requiring longer answers. There is also one Level of Response question, Question 22 (d). 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, too, which was very pleasing to see. In some of the longer answer questions, a large proportion of the candidates re-stated the same point in several different ways. This gained no extra marks but often resulted in candidates writing below the answer lines and trying to squash an answer in which then became very difficult to read. Candidates should be encouraged to use the number of lines within a question as a guide to the length of answer required.

Question 16 (a) (i)

16
(a) The table shows some properties of four Group 1 elements.

Element	Density (g/cm^3)	Melting Point (°C)	Boiling Point (°C)
Lithium	0.53	180	1342
Sodium	0.97	98	883
Potassium	0.86	63	759
Rubidium	1.53	39	688

(i) State **one** trend in the properties of the Group 1 elements shown in the table.

....

.... **[1]**

Most candidates were able to correctly identify that melting point and/or boiling point decrease down Group 1. A common incorrect response was that density increases down Group 1.

Question 16 (a) (ii)

(ii) Caesium is below rubidium in Group 1.

Predict the melting point of caesium using the information in the table.

Melting point of caesium = ... °C **[1]**

Candidates who did not gain this mark usually gave a temperature above 180°C, possibly thinking that caesium is above lithium in Group 1 or, when a very high temperature was quoted, predicting the boiling point instead.

Question 16 (b) (i)

(b) The Group 1 elements all react with Group 7 elements to form ionic compounds.

(i) Explain why the Group 1 elements all react in the same way.

....

.... **[1]**

Good responses to this question stated that Group 1 elements all have 1 electron in their outer shell. Candidates also answered in terms of losing one electron to get a full or complete outer shell. However, some candidates who chose to answer in terms of losing one electron either did not give an explanation or gave an explanation not in terms of Group 1 electron configurations, e.g. 'to become neutral' or 'to complete the outer shell of a Group 7 element'.

Question 16 (b) (ii)

(ii) The Group 1 elements become **more** reactive down the group.

Explain why.

....

....

....

....

.... **[3]**

This question differentiated between candidates well. When marks were not gained it tended to be because there was a misconception that the attraction between the nucleus and the outer shell electron was 'intermolecular' or 'magnetic'. Candidates who wrote about losing an electron, without specific reference to the outer shell electron, gained a maximum of 2 marks.

Question 16 (b) (iii)

(iii) Sodium reacts with bromine, Br_2, to make sodium bromide, NaBr.

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

.... **[2]**

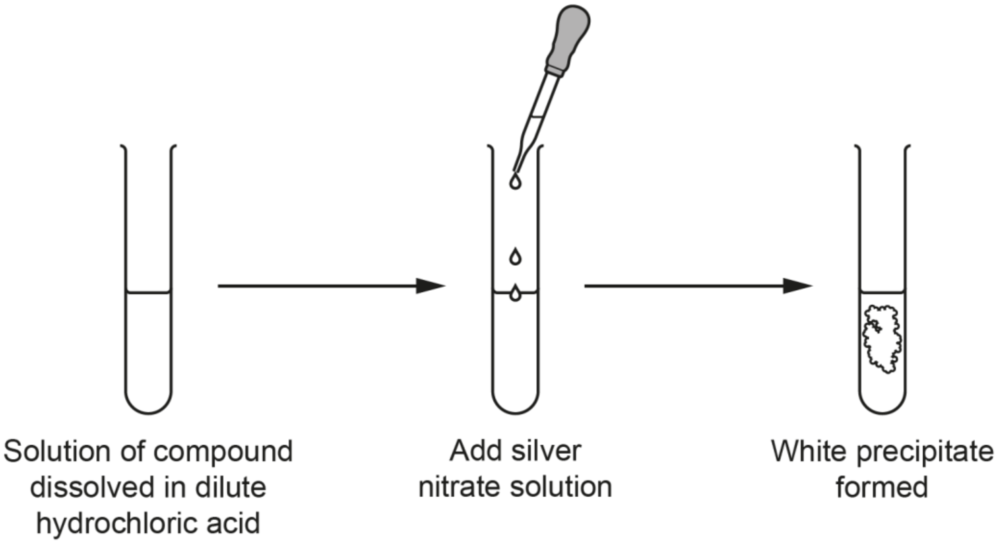
Most candidates gained 2 marks. The most common errors in formulae were Na_2 and $NaBr_2$.

Question 16 (c)

(c) Group 7 ions can be identified using silver nitrate solution.

A student tests a compound for chloride ions.

The diagram shows the student's experiment.



The student's experiment does **not** work to identify chloride ions.

Explain why.

....

....

.... **[2]**

Higher attaining candidates recognised that the hydrochloric acid was adding chloride ions and gained 2 marks. Candidates who didn't spot this often knew that the test should use nitric acid and gained 2 marks for suggesting that hydrochloric acid was used but it should have been nitric acid. Lower attaining candidates suggested that this was not a test for chloride ions but for some other anion or cation (sulfate and zinc were often mentioned), or that chloride ions should give a cream precipitate and it is bromide ions that give a white precipitate.

Question 17 (a) (i)

17 Ammonia is made in the Haber process. This is the balanced symbol equation for this process.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

(a) The reversible reaction is carried out in a closed system.

(i) State how you can tell that this reaction is **reversible**.

.... **[1]**

Most candidates knew that the ⇌ in the equation indicated that the reaction was reversible. Answers in terms of 'the reversible symbol' were not sufficient to gain the mark.

Question 17 (a) (ii)

(ii) What is a **closed system**?

....

.... **[1]**

Good responses to this question described that to maintain an equilibrium nothing should enter or leave the system. Lower attaining candidates tended to focus solely on preventing anything leaving the system, and this was often specified as gases.

Question 17 (a) (iii)

(iii) If **dynamic equilibrium** is reached, which of these statements are correct?

Tick (✓) **two** boxes.

Only ammonia, NH_3, is being made.	☐
The amounts of reactants and products are constant.	☐
The forward and backward reactions are happening at the same rate.	☐
The forward reaction is faster than the backward reaction.	☐
The reaction has finished.	☐

[2]

Most candidates correctly ticked the second and third boxes.

Question 17 (b)

(b) The reaction in the Haber process can be reversed by altering the reaction conditions.

The reaction can be reversed by altering the pressure.

Suggest **one other** change that could be made to the reaction conditions.

.... **[1]**

Most candidates correctly identified that the temperature could be changed.

Question 17 (c)

(c) A factory predicts they will make 800 tonnes of ammonia.

They actually make 620 tonnes of ammonia.

Calculate the percentage yield.

Percentage yield of ammonia = ... % **[2]**

Most candidates correctly calculated the percentage yield as 77.5 or 78%, with many candidates setting out their working clearly.

Question 17 (d)

(d) State why the reaction in the Haber process has an atom economy of 100%.

Use the balanced symbol equation.

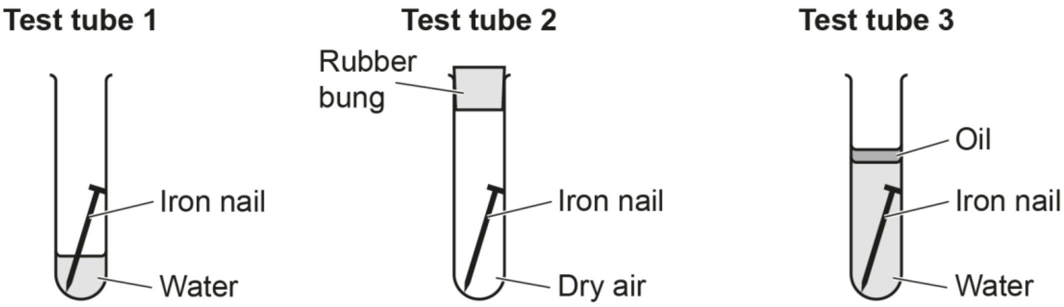
.... **[1]**

Good responses to this question used the balanced symbol equation to identify that there was only one product or no waste products. Incorrect responses were usually based on the idea of conservation of mass. The guidance in the question to 'use the equation' led lower attaining candidates to merely re-write the equation that was given to them in the stem of the question.

Question 18 (a)

18 A student sets up three test tubes to investigate the rusting of iron as shown in **Fig. 18.1**.

Fig. 18.1



- The student measures the mass of each nail at the start of the experiment.
- They measure the mass of each nail again after a week.

(a) The table shows the results.

Test tube	Mass of nail at start (g)	Mass of nail after a week (g)
1	4.42	....
2	4.46	....
3	4.51	4.51

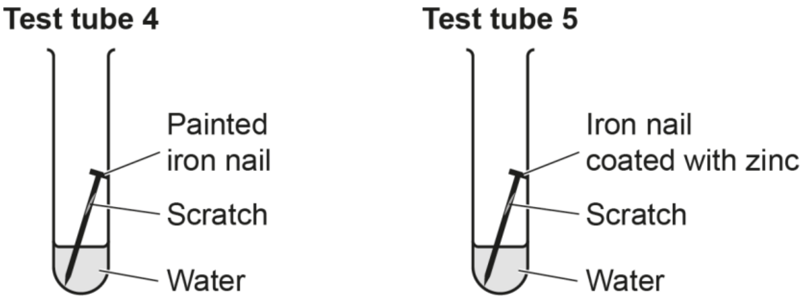
Complete the table to estimate the mass of the nails in test tubes 1 and 2 after a week. **[2]**

More candidates scored a mark for Test tube 2 than did for Test tube 1. Lower attaining candidates thought that the nail in Test tube 1 would lose mass, rather than recalling that during rusting iron reacts with oxygen and water to form hydrated iron oxide.

Question 18 (b)

(b) The student sets up another two test tubes as shown in **Fig. 18.2**.

Fig. 18.2



The iron nail in test tube 4 rusted. The iron nail in test tube 5 did **not** rust.

Explain why.

Test tube 4 ....

....

Test tube 5 ....

....

.... **[3]**

Good responses to this question identified that in Test tube 4 the scratch in the paint exposed the iron to oxygen/air and/or water. They then went on to describe that in Test tube 5 the zinc will corrode first because zinc is more reactive than iron. Lower attaining candidates usually knew the conditions needed for rusting but thought the role of the zinc coating was limited to that of being a barrier. The idea that paint was permeable to oxygen/air and water was also common.

Misconception

A significant number of candidates appreciated that zinc is more reactive than iron but then incorrectly stated that the zinc would <u>rust</u> in preference to iron.

Question 18 (c) (i)

(c) Copper is extracted by heating copper oxide with carbon.

$2CuO + C \rightarrow 2Cu + CO_2$

(i) Explain why this is an example of a **redox** reaction.

....

....

.... **[2]**

Good responses to this question explained the redox reaction in terms of copper oxide losing oxygen and carbon gaining oxygen. Examiners also saw responses in terms of loss and gain of electrons. A frequent error was stating that <u>copper</u> loses oxygen.

Question 18 (c) (ii)

(ii) Calculate the mass of copper that can be made from 15 tonnes of copper oxide.

$2CuO + C \rightarrow 2Cu + CO_2$

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

Relative atomic mass (A_r): Cu = 63.5
Relative molecular mass (M_r): CuO = 79.5

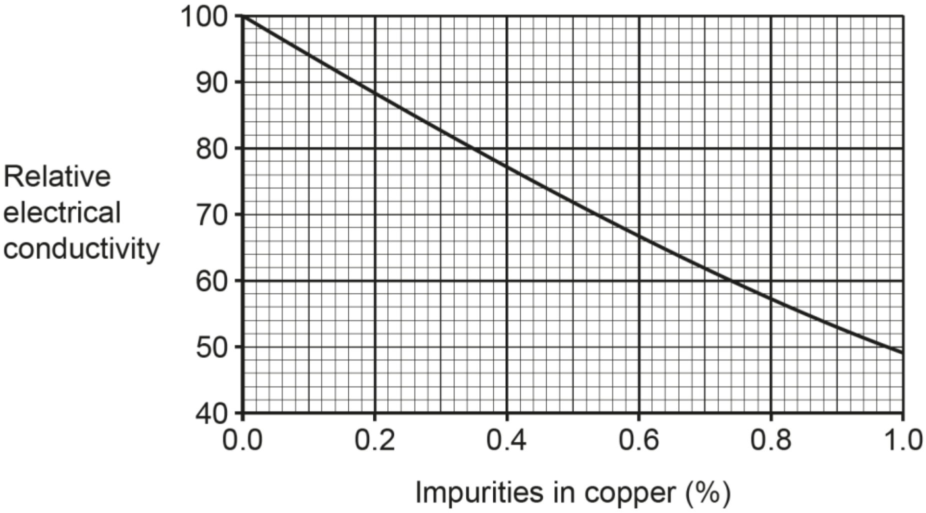
Mass of copper = ... tonnes **[3]**

Candidates had been well prepared for reacting mass calculations, with most candidates gaining 3 marks. Some candidates did not express their answers to 2 significant figures. Errors that were made often arose from doubling only one of the A_r of Cu (from 63.5 to 127) or the M_r of CuO (from 79.5 to 159).

Question 18 (c) (iii)

(iii) Copper is used in electrical wires.

The graph shows how impurities in copper affect the relative electrical conductivity of copper.



Copper extracted from copper oxide is about 99% pure.

Explain why copper extracted from copper oxide is purified to almost 100% pure using electrolysis.

Use data from the graph in your answer.

....

....

.... **[2]**

Lower attaining candidates misinterpreted the question and gave answers relating to the electrolysis reaction. Many candidates identified that the graph showed that impurities in copper brought about a decrease in its electrical conductivity. Higher attaining candidates were able to give a quantitative answer in terms of pure copper being twice as conductive as 99% pure copper or quoting two values from the graph to illustrate this relationship.

Question 19 (a)

19 The first member of the alkane homologous series is methane, CH_4.

(a) State the formula of the alkane with 10 carbon atoms.

.... **[1]**

Most candidates correctly stated $C_{10}H_{22}$. Some candidates followed the example of methane and gave an incorrect response of $C_{10}H_{40}$ and lower attaining candidates tended to give the name, decane, rather than the formula.

Question 19 (b)

(b) Write the **balanced symbol** equation for the **complete** combustion of methane.

.... **[2]**

Most candidates were able to write the correct balanced symbol equation. The most common error was giving H_2, usually instead of H_2O, as a product.

Question 19 (c)

(c) Methane can also undergo **incomplete** combustion.

Carbon monoxide and water are made in incomplete combustion.

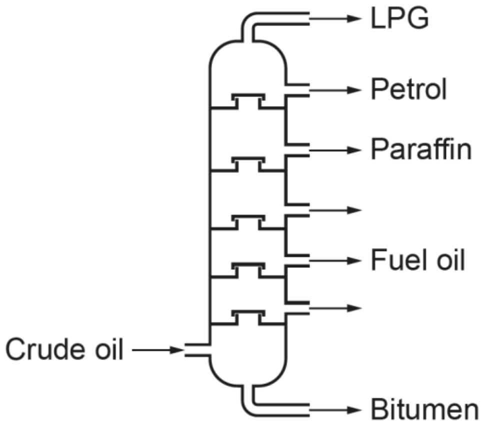
State **one** other possible product of the incomplete combustion of methane.

.... **[1]**

Most candidates stated hydrogen instead of carbon/soot.

Question 19 (d)

(d) Alkanes are obtained from the fractional distillation of crude oil.



The LPG fraction contains propane and butane.

Explain why the LPG fraction leaves at the **top** of the fractionating column.
Use ideas about intermolecular forces.

....

....

....

....

....

.... **[4]**

This question differentiated between candidates well. A common misconception was that because the LPG fraction leaves at the top of the column there are strong intermolecular forces between molecules and hence the fraction has a high boiling point. Many candidates gained 3 marks often missing that the LPG fraction contains small molecules or the idea that the fractionating column has a temperature gradient.

Exemplar 1

The LPG fraction leaves at the top where the temperature is the coolest. It has the lowest boiling point because it has the weakest intermolecular forces, as it is the shortest chain hydrocarbon found in crude oil. Therefore it requires less energy to break the intermolecular forces so condenses at the lowest temp. **[4]**

> This response states that the fractionating column is coolest at the top. The idea that the LPG fraction contains small molecules, so has weaker intermolecular forces which need less energy to break is clearly stated. This response was given 4 marks. Lower attaining candidates often referred to breaking bonds, rather than intermolecular forces.

Question 19 (e)

(e) Which industry is crude oil a feedstock for?

.... **[1]**

> Very few candidates could recall that crude oil is a feedstock for the petrochemical industry, as stated in topic C6.2 of the specification.

Question 19 (f)

(f) Draw lines to connect each **description** with its correct **structural formula**.

Description

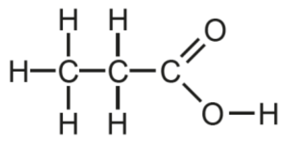
Made by an addition reaction between an alkene and hydrogen, H_2

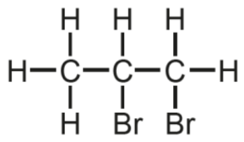
Made when propanol is oxidised

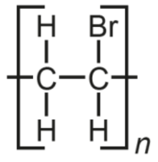
Made when propene reacts with bromine water

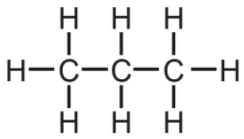
Made in a condensation polymerisation reaction

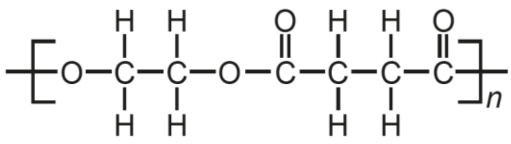
Structural Formula











[4]

Most candidates gained 4 marks for this question. The most common error was linking 'Made when propene reacts with bromine water' to the polymer poly(bromoethane), the third option in the list on the right.

Question 20 (a)

20 The Earth's early atmosphere is thought to have been mainly carbon dioxide, with smaller amounts of water vapour.

(a) Describe how the amounts of these gases changed over time to develop an oxygen-rich atmosphere.

....

....

....

....

....

.... **[3]**

Only the highest attaining candidates gained 3 marks for this question. Although many candidates recalled that water vapour condensed to form oceans, they did not explain that this resulted from the Earth cooling. The mark for plants/algae evolving and using photosynthesis to take in carbon dioxide and make oxygen was most often gained. Lower attaining candidates described this process as respiration whilst others did not mention both plants and photosynthesis.

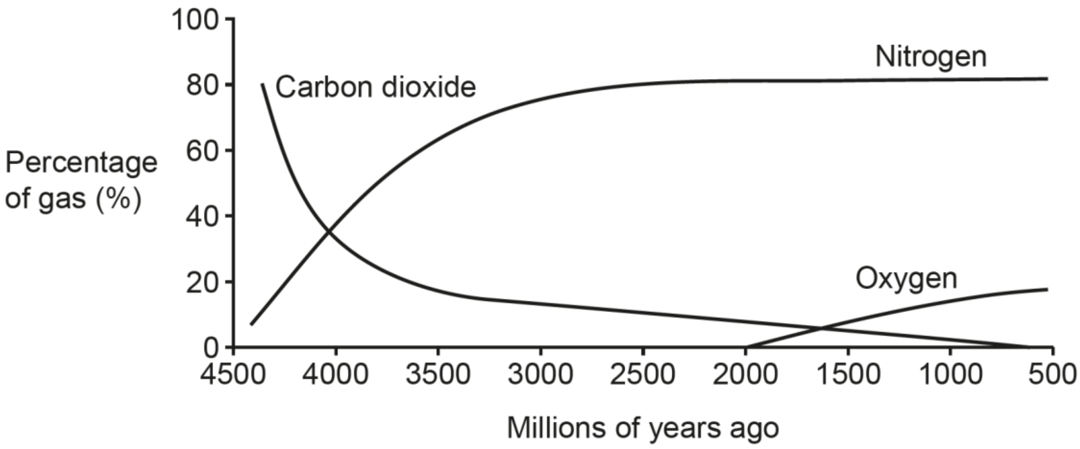
Exemplar 2

Carbon dioxide and water vapour were the products from hot volcanic eruptions. As temperatures cooled, the water vapour condensed to form the oceans and seas. Then, microorganisms and plants were developed. Plants used the CO_2 and water to photosynthesise and produce oxygen. The increasing number of plants therefore led to an oxygen rich atmosphere. **[3]**

This response clearly describes how the amounts of carbon dioxide and oxygen changed in the correct chronological order (which was required to gain 3 marks, as this response received). The response describes temperatures cooling so that water vapour condensed to form oceans and seas. The idea that plants evolved and used carbon dioxide to photosynthesis and produce oxygen is then described.

Question 20 (b) (i)

(b) The graph shows how the percentages of different gases in the atmosphere have changed over time.



(i) Describe the relationship between the percentage of carbon dioxide and the percentage of nitrogen in the atmosphere.

....

.... **[1]**

Most candidates described the relationship that as the percentage of carbon dioxide decreases the percentage of nitrogen increases or vice versa.

Question 20 (b) (ii)

(ii) Estimate when the percentage of carbon dioxide and the percentage of oxygen were equal.

Answer = ... millions of years ago **[1]**

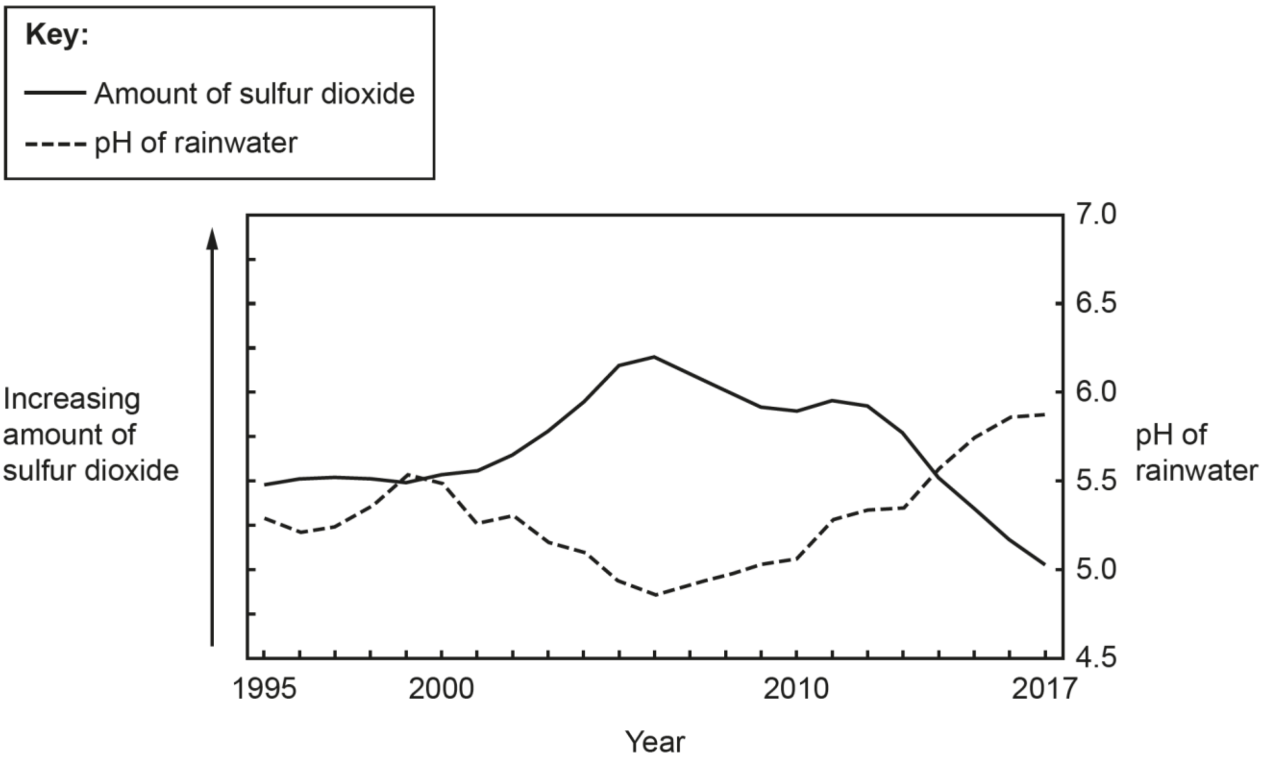
Most candidates correctly gave an answer in the range 1600 – 1700. The most common incorrect response was an answer of around 4000 millions of years ago, being when the percentages of carbon dioxide and nitrogen were equal.

Question 20 (c) (i)

(c) Sulfur dioxide can be a pollutant in the atmosphere.

This graph shows

- how the amount of sulfur dioxide changed from 1995 to 2017
- how the pH of rainwater changed from 1995 to 2017.



(i) Describe the link between the amount of sulfur dioxide in the atmosphere and the concentration of the hydrogen ion, H^+, in the rainwater between the years 2000 and 2005.

Use the graph.

....

....

....

.... **[3]**

Lower attaining candidates often correctly described a decrease in pH but then stated that this would lead to a similar decrease in the concentration of H^+ ions. Some candidates did not confine themselves to the years specified in the stem of the question and discussed the years after 2005 when the amount of sulfur dioxide is decreasing.

Question 20 (c) (ii)

(ii) Since 2014 the amount of acid rain in the atmosphere has decreased.

Suggest why.

....

.... **[1]**

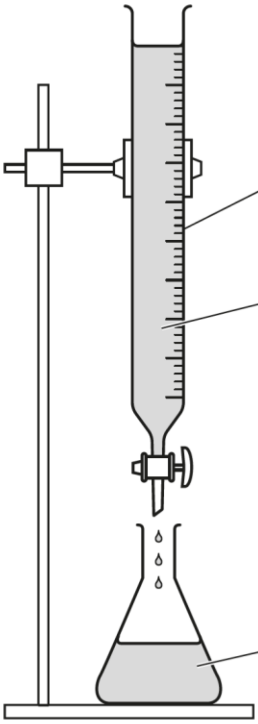
A wide range of candidates addressed this question by referring back to the graph in part **(c) (i)** and correctly and reasonably suggested that the amount of acid rain had decreased because the amount of sulfur dioxide was decreasing. Only a minority of candidates offered an explanation for this trend as an answer.

Question 21 (a)

21 A student investigates the neutralisation reaction between sodium hydroxide solution and dilute hydrochloric acid.

They do a titration experiment.

The diagram shows the apparatus they use.



(a) Describe how the student uses the apparatus to do the titration.

Include the name of a suitable indicator and state the colour change that would be seen.

....

....

....

....

....

.... **[5]**

It was clear that most candidates had obviously seen or done a titration and almost all candidates gained marks. Marks from marking points 2,3 and 4 were gained across a broad range of candidates. Many candidates were able to offer a named indicator, although it was quite common for this to be universal indicator. Only the higher attaining candidates gained a mark for a correct indicator colour change. Examiners felt that most candidates had clearly performed or seen an acid/base titration with the acid in the burette and were then giving the reverse colour change.

Question 21 (b) (i)

(b) The student repeats the titration four times.

They work out the average volume of sodium hydroxide from their concordant results.

(i) What is meant by **concordant** results?

.... **[1]**

Only higher attaining candidates appreciated what is meant by concordant results. 'Results that are similar' was a common incorrect response. Some candidates gave the correct numerical tolerance but then negated their answer by stating the units as dm^3.

Question 21 (b) (ii)

(ii) In the titration the student:

- uses 25 cm^3 of 0.12 mol / dm^3 dilute hydrochloric acid in the conical flask
- adds 0.4 mol / dm^3 sodium hydroxide solution from the burette.

The equation for the reaction is shown.

$HCl + NaOH \rightarrow NaCl + H_2O$

Calculate the average volume of sodium hydroxide used **in cm^3**.

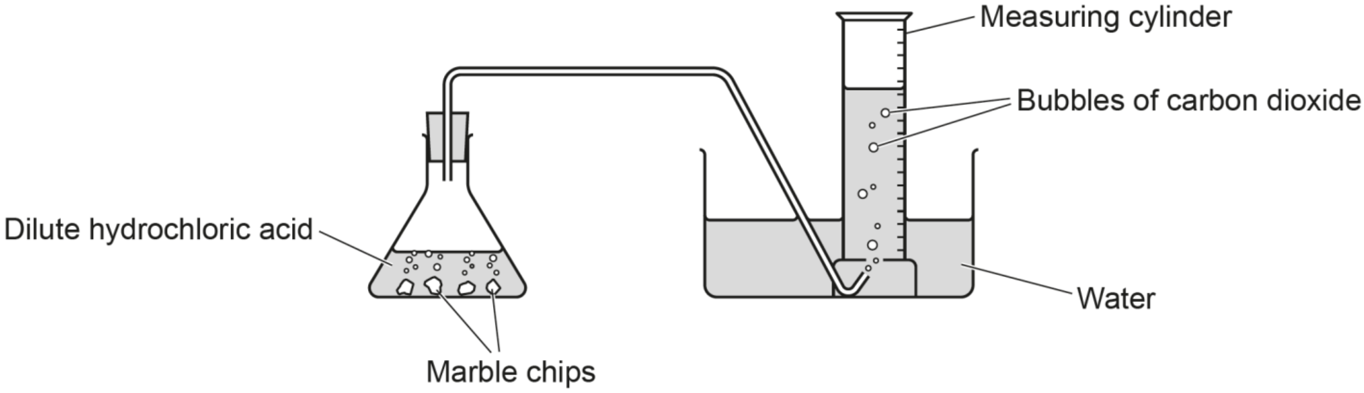
Average volume of sodium hydroxide = ... cm^3 **[4]**

Most candidates gained 4 marks for this question. If candidates did not calculate the correct answer, the most frequently gained marks were for the 1:1 mole ratio of alkali to acid, and for the conversion of an answer in dm^3 to an answer in cm^3. Some candidates used the concentration in mol/dm^3 with the volume in cm^3 to calculate the moles of acid. Candidates should be encouraged to ensure units are consistent.

Question 22 (a) (i)

22 A student investigates the reaction between marble chips and dilute hydrochloric acid.

The diagram shows their experiment.



The student measures the volume of carbon dioxide gas collected in the measuring cylinder every 30 seconds.

(a)
(i) Suggest another piece of equipment that could be used to measure the volume of carbon dioxide gas.

.... **[1]**

Most candidates correctly suggested using a gas syringe.

Question 22 (a) (ii)

(ii) Explain how the student could tell that the dilute hydrochloric acid is the limiting reactant in this reaction.

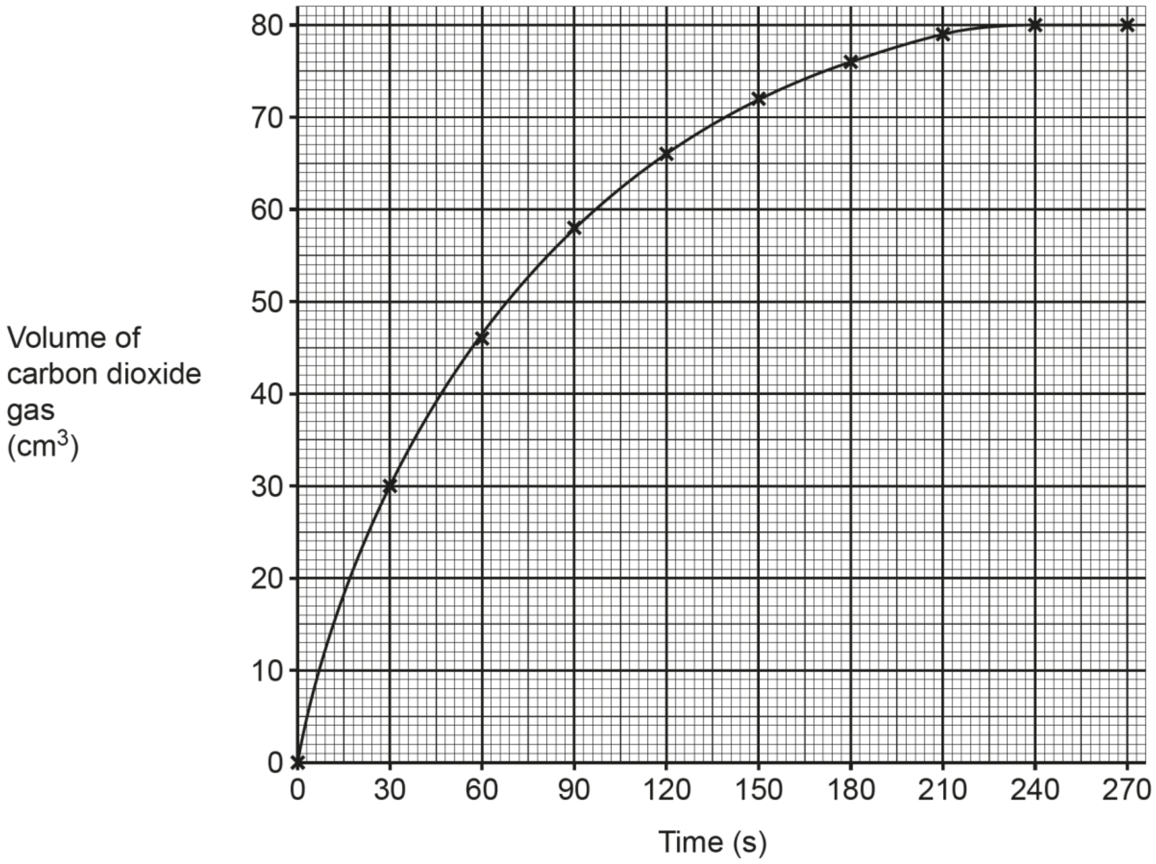
....

.... **[1]**

Many candidates stated that the acid would be all used up. Whilst this statement is correct it does not address the question and explain <u>how the student could tell</u> that the acid is the limiting reactant.

Question 22 (b)

(b) The student plots their results on a graph.



Use the graph and a tangent line to calculate the rate of the reaction at 60 seconds.

Rate of reaction at 60 seconds = ... cm^3/s **[3]**

Most candidates were able to construct a tangent at 60 seconds and were then able to use it to determine a rate within the acceptable range. Common errors included using x-step ÷ y-step for the rate or using a single point (usually 46,60) to calculate the rate.

Question 22 (c) (i)

(c) The rate of the reaction can be changed by adding a catalyst.

(i) What happens to the final volume of carbon dioxide when a catalyst is added?

.... **[1]**

Most candidates stated that the final volume would stay the same, but 'increase' was a common incorrect answer.

Question 22 (c) (ii)

(ii) How does the mass of the catalyst change during the experiment?

.... **[1]**

Most candidates stated that the mass of the catalyst would stay the same, but 'decrease' was a common incorrect answer.

Question 22 (d)*

(d)* Another student reacts dilute hydrochloric acid with magnesium.

The student does two experiments.

In each experiment they use the **same**

- concentration of dilute hydrochloric acid
- mass of magnesium.

The table shows their results.

	Experiment 1	**Experiment 2**
Magnesium	large pieces	small pieces
Temperature of dilute hydrochloric acid (°C)	20	42
Rate of reaction (/s)	0.0044	0.04

Evaluate the student's results, explaining the difference in the rate of reaction.

Use the reacting particle model.

State how the student's experiment could be improved.

....

....

....

....

....

.... **[6]**

This 6 mark Level of Response question assessed AO2 and AO3. At Level 3 (5 – 6 marks) candidates needed to analyse the results to conclude that experiment 2 has the faster rate of reaction and to apply knowledge and understanding to give a detailed explanation, involving both surface area and temperature, why Experiment 2 is faster. Candidates also needed to suggest how the experiment could be improved. Virtually all candidates attempted the question which generated a wide range of responses and differentiated well. Some candidates thought that Experiment 1 had the faster rate of reaction, either thinking that 0.0044 was larger than 0.04 or misreading rate for time. Candidates who did not gain Level 3 usually correctly explained that smaller pieces have a larger surface area and a higher temperature would mean the particles had more energy and/or moved faster but did not then go on to explain their ideas in terms of particle collision frequency. Whilst many candidates suggested only having one independent variable as an improvement, many also wrote about repeats, measuring the size of the magnesium more accurately, using a larger range of temperatures or changing the concentration of the acid.

Exemplar 3

please see below

In experiment one the magnesium where large pieces so it has a higher volume than surface area whereas in experiment 2, the smaller pieces meant there is a higher surface area to volume ratio. This means as ~~on~~ only the surface of magnesium can react, there was more surface for the HCl to react to in experiment 2 than experiment one. More surface meant there are more successful, more frequent reactions. ~~Also~~ Higher temperature in experiment 2 meant that particles got more kinetic energy and so ~~move~~ moved faster and there were more successful, more frequent reactions than in experiment one. This is why rate of reaction for experiment **[6]**
2 is much higher than experiment one.

This is a Level 2, 4 mark response.

The candidate clearly identifies that Experiment 2 is faster than Experiment 1. They have clearly explained the difference in the rate of reaction, but this is not detailed and does not describe increased particle collision frequency. 'More frequent reactions' is insufficient. The candidate has also not suggested an improvement to the experiment.

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