Qualification Accredited

Oxford Cambridge and RSA

GCSE (9-1)

Examiners' report

GATEWAY SCIENCE CHEMISTRY A

J248

For first teaching in 2016

J248/04 Summer 2019 series

Version 1

www.ocr.org.uk/science

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. 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 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 component assesses teaching topics C4-C6, with assumed knowledge of topics C1-C3, and is 50% of the total GCSE. To do well on this paper, candidates need to demonstrate knowledge and understanding of scientific ideas, techniques and procedures across all three topics. They need to be able to apply their knowledge and understanding to unfamiliar contexts as well as displaying the ability to analyse information. Candidates also need to be familiar with a range of experimental procedures and be able to think about how an experimental method could be improved.

J248/04 has an equal emphasis on knowledge and understanding of the assessment outcomes from the specification and application of this knowledge. There are fewer questions which assess analysis of information and ideas.

Candidates who did well on this paper generally did the following:

- Constructed and balanced symbol equations for familiar and unfamiliar reactions: 18(a) & 19(a).
- Performed standard calculations following the required rubric (e.g. clear working, components and, where needed, significant figures) relating to rate of reaction: 19(d), moles and gas volumes: 22(a), determination of a reactant in excess: 22(b)(i), and titrations: 22(b)(ii) & (c).
- Produced a clear, concise and well-structured answer for the Level of Response question, while showing an appreciation of fair testing: 19(b).
- Clearly explained the chemical and physical properties of elements, using appropriate terminology: 20(b), 20(d) & 20(e).
- Applied knowledge and understanding to questions set in a novel context.

Candidates who found this paper difficult generally did the following:

- Found it difficult to apply what they had learnt to unfamiliar situations.
- Found it difficult to analyse data and then make a judgement, or draw a conclusion, in relation to the data, e.g. 16(a) & 17(a).
- Found it difficult to analyse information to describe improvements to a specific experimental procedure, e.g. 21(a).
- Showed imprecise use of scientific terminology, e.g. 18(b)(ii), 18(d)(ii), 19(c).

When answering multiple choice questions, centres should encourage candidates who wish to change an answer to cross through their answer and write their new response to the right of the answer box, rather than trying to overwrite their original answer. The latter can result in examiners being unable to decipher their answer.

Centres should also encourage candidates to set out their working to calculations clearly. 'Signposting' of calculations was often poor, with numbers written at random in the answer space. This makes it difficult for the examiner to seek out credit-worthy points and/or award marks for errors carried forward. Equally, for candidates, it often leads to them getting 'lost' going through the calculation.

The clarity of handwriting is an issue for some candidates, as is poor use of English and/or scientific terminology when explaining their answers.

There was no evidence that time constraints had led to underperforming. Very few questions were left blank by candidates.

Section A overview

Questions 1, 3, 4, 5, 10 and 13 in this section proved to be good discriminators with many higher ability candidates answering correctly. Questions 2, 7, 8, 11, 12 and 15 were answered well by candidates with many correct answers.

Question 3

3 Which of these pairs of gases are **both** greenhouse gases?

A Nitrogen and methane

B Nitrogen and oxygen

C Water vapour and methane

D Water vapour and oxygen

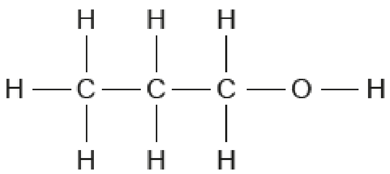
Your answer ☐ **[1]**

?	**Misconception**	Some candidates do not recognise water vapour as a greenhouse gas. Candidates also confuse nitrogen with nitrous oxides so think nitrogen itself is a greenhouse gas.

Question 5

5 Which displayed formula shows butanol?

A



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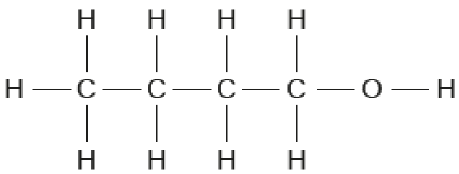

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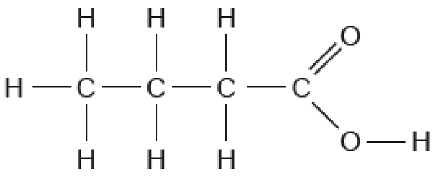

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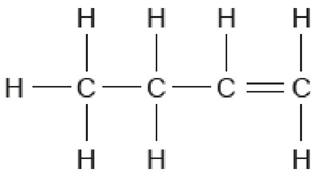


Your answer ☐ **[1]**

?	**Misconception**	A and B were both common misconceptions in this question.

Question 6

6 A student tests a solution for **chloride ions**.

She adds dilute nitric acid to the solution. She then adds a few drops of silver nitrate solution.

Why does she need to add dilute nitric acid in this test?

A To increase the pH of the solution.

B Nitrate ions are needed for the test to work.

C To make sure that no carbonate ions are present.

D The test only works in alkaline conditions.

Your answer ☐ **[1]**

?	**Misconception**	A was a common misconception in this question.

Question 7

7 Which statement describes what happens when a reaction **reaches** equilibrium?

A The forward reaction happens at a faster rate than the backwards reaction.

B The forward and backward reactions happen at the same rate.

C The forward and backward reactions stop happening.

D The backward reaction happens at a faster rate than the forward reaction.

Your answer ☐ **[1]**

?	**Misconception**	A and C were both common misconceptions in this question.

Question 9

9 A hydrogen-oxygen fuel cell produces electricity.

Hydrogen reacts with oxygen to produce water.

What is the equation for the reaction that happens at the **anode**?

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

B $4H^+(aq) + 4e^- \rightarrow 2H_2(g)$

C $2H_2(g) \rightarrow 4H^+(aq) + 4e^-$

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

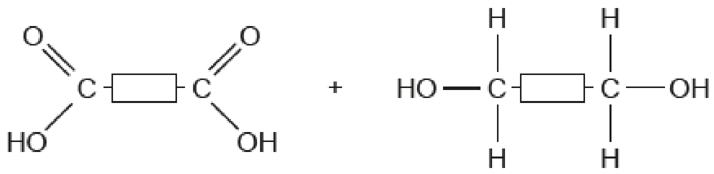
Your answer [ ] **[1]**

Candidates found this question challenging but there was no pattern of incorrect responses.

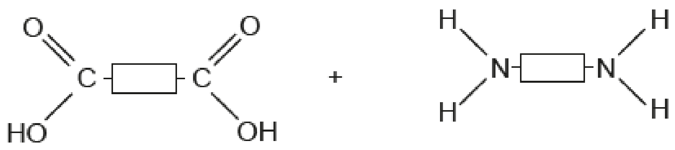
Question 10

10 Which pairs of molecules would react to form a **polyester**?

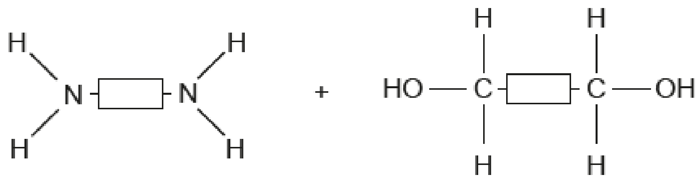
A



B



C



D

Your answer ☐ **[1]**

?	**Misconception**	B and D were both common misconceptions in this question.

Question 14

14 Which statement about a **mass spectrum** of a molecule is correct?

A Each peak represents an atom in the molecule.

B The charge to mass ratio of the molecular ion peak is equal to the relative formula mass of the molecule.

C The peak with the highest relative abundance represents the molecular ion.

D The peak on the far right of the spectrum represents the molecular ion.

Your answer **[1]**

Candidates found this question challenging but there was no pattern of incorrect responses.

Section B overview

Question 16 (a)

16 This question is about properties of materials.

Police bullet-resistant vests could be made from steel or Kevlar®.

The table shows some information about steel and Kevlar®.

	Steel	Kevlar®
Density (g/cm^3)	7.85	1.44
Relative strength	1	5
Flexibility	low	high
Resistance to corrosion	low	high

(a) Describe and explain **two** reasons why bullet-resistant vests are made from Kevlar® instead of steel.

1 ....

....

....

2 ....

....

....

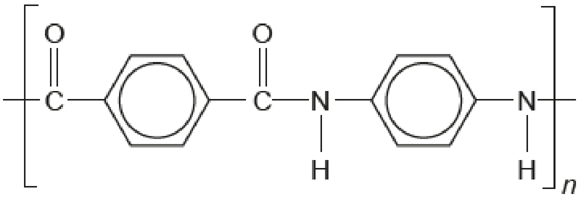
[4]

This question required candidates to use the data to compare steel and Kevlar®. Candidates who did not gain full credit often simply repeated the stem of the question, ie Kevlar® is stronger than steel so is better at resisting bullets. Vague explanations, such as 'Kevlar® gives better protection', did not gain credit.

?	**Misconception**	Lower ability candidates still tend to confuse 'low density' with 'light'.

Question 16 (b)

(b) Look at the structure of Kevlar®.



What type of molecule is Kevlar®?

.... **[1]**

Many candidates correctly stated that Kevlar® is a polymer or polyamide. Polyester, alcohol and alkene were common incorrect responses.

?	**Misconception**	**Addition** polymer was a common misconception

Question 16 (c) (i)

(c) Nanoparticles are being used to make a material that is better than Kevlar® at resisting bullets.

Nanoparticles are often made of silicon dioxide.

A silicon dioxide nanoparticle has a diameter of 18 nm.

The diameter of a silicon atom is 0.22 nm.

(i) Estimate how many times larger the silicon dioxide nanoparticle is, compared to a silicon atom.

Give your answer to **1** significant figure.

Number of times larger = ... **[3]**

Good responses to this question required candidates to use estimating skills and round the data in the question to 1 significant figure in order to work out the answer. Most candidates simply divided 18 by 0.22 and then rounded their answer to 1 significant figure to obtain an answer of 80, only gaining 1 mark.

	AfL	Appendix 5e of the specification lists the mathematical skills that will be assessed within the context of relevant chemistry. Skill M1d requires candidates to make estimates of the results of simple calculations.

Question 16 (c) (ii)

(ii) Silicon dioxide is used as a **catalyst**.

Suggest why 1 g of silicon dioxide is **more effective** as a catalyst when used as nanoparticles rather than as a powder.

....

....

....

.... **[3]**

High ability candidates were able to describe that nanoparticles have a greater surface area to volume ratio. They appreciated that chemical reactions take place on the surface of the catalyst and so the larger surface area would help more collisions between reactant particles. Lower ability candidates did not appreciate that this was heterogeneous catalyst activity.

?	**Misconception**	A common misconception is that the catalyst takes part in the reaction and reacts with the reactants.

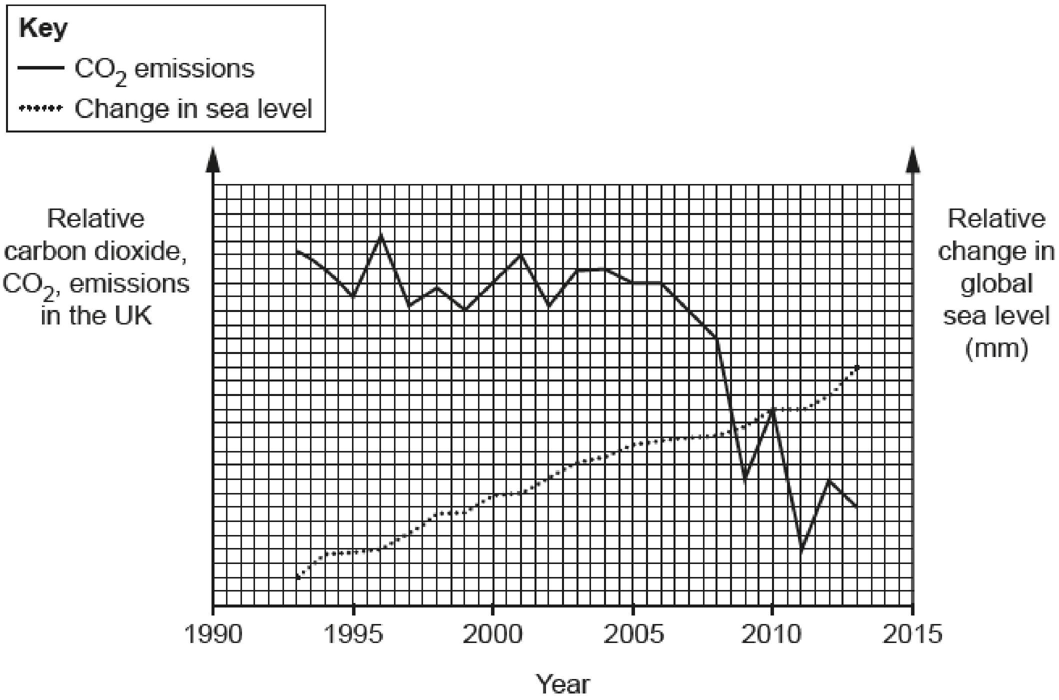
Question 17 (a)

17 Some scientists believe that the increased burning of fossil fuels has contributed to global warming.

The scientists say that global warming is causing ice to melt, which results in sea levels rising.

Other scientists believe that rises in global temperatures are just natural variations.

The graph shows the carbon dioxide, CO_2, emissions by fossil fuels in the UK and the changes in global sea levels between 1993 and 2013.



(a) Evaluate the information shown in the graph.

To what extent does the graph support a link between human activity and global warming?

....

....

....

....

.... **[3]**

Good responses to this question evaluated the information in the graph to describe that despite carbon dioxide emissions declining from (approximately) 2006, global sea levels have continued to rise; therefore, the data does not support a link between human activity and climate change. Many candidates also appreciated the mismatch between the data, ie one is UK but one is global. Lower ability candidates thought that they should be finding a link and contrived one from the period 1995 – 2005.

	AfL	Candidates should be encouraged to write their answers clearly and concisely. Many candidates wrote more than was necessary in their answer to this question and often contradicted themselves as a result.

Exemplar 1

The graph does not show a link between human activity and global warming. Firstly, the graph shows that the sea levels increase as the relative CO_2 emissions decreases. Therefore, the use of fossil fuels has not had an impact on the rise of global sea levels. **[3]**

This response illustrates a clear, concise answer to this question, which was given all 3 marks.

Question 17 (b)

(b) There are problems with using information about **CO_2 emissions by fossil fuels** to draw conclusions about the effect of carbon dioxide emissions on **global** sea levels.

Suggest what these problems are.

....

....

.... **[2]**

Many candidates correctly stated that CO_2 emissions can come from sources other than the burning of fossil fuels or that the CO_2 emissions (in the data) are only from the UK and are not a global figure.

	AfL	Examiners use **bold type** to draw the candidates' attention to key aspects of a question. Despite the emboldening of '**CO_2 emissions by fossil fuels**' in this question, many candidates described other factors, or other greenhouse gases, which may affect global sea levels and did not gain marks.

Question 17 (c) (i)

(c) (i) Describe **one** effect on the Earth's climate of increased carbon dioxide levels, other than rising sea levels.

....

.... **[1]**

Good responses to this question described melting ice caps or altered weather patterns. A significant number of candidates did not relate their answer to climate, but to the effect on animals or ecosystems, and therefore did not gain the mark. The most common response was 'increased temperatures; this also did not gain the mark as 'rise in global temperatures' and 'global warming' were both mentioned in the stem of the question.

Question 17 (c) (ii)

(ii) Suggest how we can lower carbon dioxide levels.

....

.... **[1]**

Most candidates were able to suggest a method to lower carbon dioxide levels.

Question 18 (a)

18 In the Haber process nitrogen gas, N_2, reacts with hydrogen gas.

Ammonia, NH_3, is made. The reaction is a reversible reaction.

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

.... **[2]**

Most candidates were able to write the correct balanced symbol equation for the reaction of nitrogen with hydrogen. One mark was given for the correct reactants and products and one mark for the correct balancing. The balancing mark was dependent on the correct formulae, but one mark was allowed for a balanced equation with minor errors in subscripts or formulae. For example, $N_2 + 3H2 \rightleftharpoons 2Nh_3$, would gain one mark. When candidates did not gain marks, it was often because they wrote 6H as a reactant, rather than $3H_2$.

	AfL	Although it was not penalised in this question, candidates should be taught to use the $\rightleftharpoons$ symbol for a reversible reaction, rather than an $\rightarrow$.

Question 18 (b) (i)

(b) The conditions used to make ammonia in the Haber process are:

- a pressure of 200 atmospheres
- a temperature of 450 °C.

The reaction is an exothermic reaction.

A company making ammonia increases the temperature used to 550 °C.

(i) What happens to the **rate of the reaction** when the temperature is increased?

.... **[1]**

Candidates usually appreciated that the rate of a reaction increases when the temperature is increased.

Question 18 (b) (ii)

(ii) The company thinks that the increase in temperature will increase the **yield** of ammonia.

Is the company correct? Explain your answer.

....

....

.... **[2]**

This question required candidates to apply their knowledge of Le Chatelier's principle and assessed AO2. Good responses described that an increase in temperature will favour the endothermic (or backward) reaction and so the yield of ammonia will be reduced. Lower ability candidates tended to gain just one mark for the idea that the equilibrium will shift to the left-hand side and/or the yield of ammonia is reduced, without being able to explain the shift in terms of a higher temperature favouring the endothermic reaction.

?	**Misconception**	A common misconception was to treat this as a kinetics question and to give an answer in terms of increased rate making ammonia quicker and therefore increasing the yield.

Exemplar 2

The company is incorrect as when the temperature increases the equilibrium position will shift to the endothermic side so the backward reaction will be favoured and the yield will decrease. **[2]**

This response shows clear understanding of Le Chatelier's principle and describes that an increase in temperature would favour the endothermic / backward reaction and so the yield of ammonia will be reduced.

Question 18 (c)

(c) The company wants to reduce the cost of making the ammonia.

They decide to reduce the pressure used to 150 atmospheres.

Write about **two** disadvantages of using a lower pressure to make ammonia.

1 ....

....

2 ....

.... **[2]**

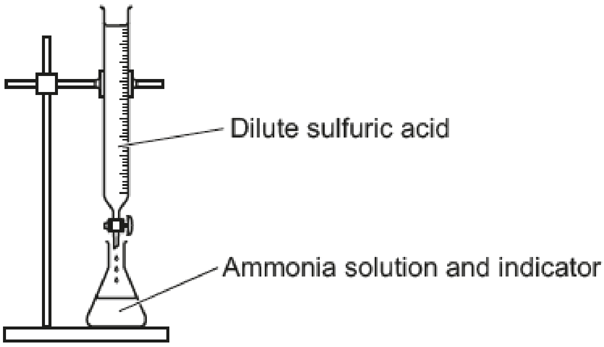
Two marks were usually gained in this question for reduced yield and lower rate of reaction.

Question 18 (d) (i)

(d) Ammonia is used to make fertilisers such as ammonium sulfate.

A student makes some ammonium sulfate crystals in a laboratory.

She uses a titration method, as shown in the diagram.



She adds an indicator to ammonia solution in a conical flask. She then adds dilute sulfuric acid from a burette until the indicator changes colour.

The student then crystallises the solution. She is left with **impure** ammonium sulfate crystals.

(i) What should the student have done to obtain **pure** ammonium sulfate crystals?

....

....

.... **[2]**

Good responses to this question described repeating the titration until concordant results are obtained and then repeating the experiment without the indicator. Lower ability candidates described using concentrated acid to give purer crystals, filtering the impure crystals or using distillation to remove the indicator.

	AfL	The idea of repeating the experiment to obtain **concordant titres** was only seen from higher ability candidates.

Question 18 (d) (ii)

(ii) In industry the same reaction is used to make ammonium sulfate.

The method used is different.

Give **one** reason why the laboratory method to make ammonium sulfate is **not** used in industry.

....

....

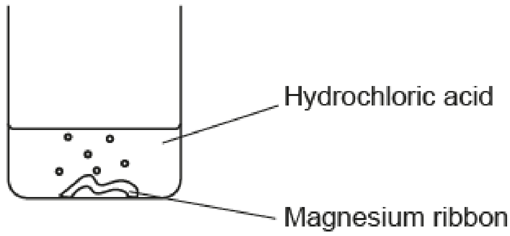
.... **[1]**

?	**Misconception**	A common misconception that the process would be too slow in a laboratory.

Question 19 (a)

19 A student investigates the reaction between magnesium and dilute hydrochloric acid, HCl.

The student adds magnesium ribbon to hydrochloric acid in a beaker, as shown in the diagram.



(a) Write the **balanced symbol** equation for this reaction.

.... **[2]**

As in Question 18(a), one mark was given for the correct reactants and products and one mark for the correct balancing. The balancing mark was dependent on the correct formulae, but one mark was allowed for a balanced equation with minor errors in subscripts or formulae. When candidates did not gain marks, it was usually because they wrote $MgCl$ as the formula of magnesium chloride. 2H, rather than H_2, as the other product was also a common error.

Question 19 (b)

(b)* The student measures the time it takes for all the magnesium to react. This is the reaction time.

The student does five experiments.

This is the student's prediction:

"The smaller the volume of acid and the greater the concentration of acid, the faster the reaction rate."

Look at the student's results.

Experiment	Mass of magnesium used (g)	Volume of acid used (cm^3)	Concentration of acid (mol/dm^3)	Reaction time (s)
1	0.05	25	1.0	30
2	0.05	50	1.0	30
3	0.05	50	2.0	15
4	0.10	25	1.0	30
5	0.10	50	2.0	15

Describe and explain whether the student's results support his prediction.

Include ideas about the reacting particle model in your answer.

....

....

.... **[6]**

This 6-mark, Level of Response, question assessed AO2 and AO3. At Level 3 (5 - 6 marks) candidates needed to analyse the student's results to describe if the results supported the prediction with reference to experimental data **that includes fair testing**. At this level candidates also needed to explain the results using the idea of the reacting particle model and **collision frequency**.

Some of the responses were excellent, showing a clear understanding of fair testing and rates of reaction.

The answers of lower ability candidates often

- did not treat the predictions for volume and concentration independently of one another; they looked for experiments where the volume was low and the concentration was high and/or vice versa
- chose experiments where the mass of magnesium was also varied
- looked for experiments where the reaction time was lowest (experiments 3 & 5) and drew the conclusion that the volume had to be high (as well as the concentration) to get a faster reaction rate
- criticised that data for not having an experiment where the smaller volume ($25cm^3$) and higher concentration ($2.0\ mol/dm^3$) were used together.

Exemplar 3

Include ideas about the reacting particle model in your answer.

His results do not support the first part of his ~~conclusions~~ prediction. Volume does not change the rate of reaction as this does not change how often the particles collide. This can be seen in experiments 1 and 2, where only the volume was changed ~~and~~ but the reaction time stayed at 30 seconds. However, he is correct about a greater concentration of acid speeding up the reaction. This can be seen in experiments ~~3 and 4,~~ ~~where~~ 2 and 3, where increasing the concentration from $1 mol/dm^3$ to $2 mol/dm^3$ caused the reaction time to decrease from 30s to 15s, meaning it was faster. This is because increasing the concentration of the acid means that there are more acid particles, which **[6]**

causes them to be more crowded. This leads to ~~a great~~ more frequent collisions between the acid particles and the magnesium particles, which speeds up the rate of reaction.

This is a Level 3 (6 mark) response, which has correctly identified that in experiments 1 & 2 only the volume of acid is changed and in experiments 2 & 3 only the concentration of the acid is changed. The candidate has correctly described that the results in relation to the volume of acid do not support the prediction but that the prediction is supported in relation to concentration. The candidate explains the results clearly using the idea of collision frequency.

Exemplar 4

The students results don't support "The smaller the volume of acid" part because Expeiment 1 and 4 used a smaller volume of acid (25cm³) than all the others which used 50cm³. The reason these two expeiments don't back up his prediction is because they both have 30 second reaction times. Other experiments like 3 have higher volume of acid [50cm³] but a lower reaction time (15 seconds). "The greater the concentration of acid" is backed up because experiments 3 and 5 have the highest concentration of acid (2.0 mol/dm³) and the fastest reaction time at 15 seconds. **[6]**

His predictions are perfect to support the particle collision theory but his results do not back up his prediction. You would expect a higher concentration of acid in a smaller volume to have a higher rate of reaction. This is because more successful collision are expected. However, his results do not back this up. Would recommend him repeating each experiment 3 times to get more accurate results incase some on his results table are anomolys.

This is a Level 2 (4 mark) response. While the candidate appreciates that the results in relation to the volume of acid do not support the prediction but that the prediction is supported in relation to concentration, they have not shown an appreciation of fair testing. The candidate explains the results clearly using the idea of more collisions, rather than collision frequency.

Question 19 (c)

(c) The student repeats experiment **1**. This time he uses acid at a **higher** temperature.

Explain, using the reacting particle model, **what happens to the rate of reaction** and **predict the reaction time** for this reaction.

....

....

....

....

....

.... **[3]**

Good responses to this question described that heating the acid would give the particles more energy and/or make the particles move faster, resulting in more frequent collisions. Credit was given for any reaction time less than 30 seconds.

Question 19 (d)

(d) Another student investigates the reaction between marble chips and hydrochloric acid.

She times how long it takes for all the marble chips to react.

Look at her results.

Experiment	Size of marble chips	Reaction time (s)	Mean rate of reaction (g/s)
1	large	240	8.33×10^{-4}
2	large	120	
3	large	100	2.00×10^{-3}
4	small	50	4.00×10^{-3}

Look at the student's results for experiment **2**.

Calculate the **mean rate of reaction** in experiment **2**.

Give your answer to **3** significant figures and in **standard form**.

Mean rate of reaction = ... g/s **[3]**

Many candidates gained 3 marks for a correct answer of 1.67×10^{-3}.

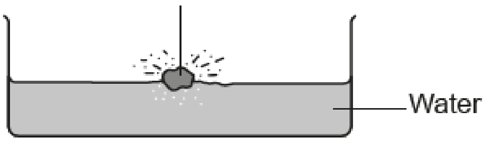
	AfL	Appendix 5e of the specification lists the mathematical skills that will be assessed within the context of relevant chemistry. Skill M2a requires candidates to use an appropriate number of significant figures. Incorrect rounding to 3 significant figures, giving 1.66×10^{-3}, was a common error.

Question 20 (a)

20 This question is about the properties of elements in Groups 1, 7 and 0.

(a) Lithium, sodium and potassium are all Group 1 elements.

A teacher adds a small piece of potassium to a trough of water, as shown in the diagram.



The potassium fizzes and a gas is produced.

Describe what else you would observe.

....

.... **[2]**

Most candidates were able to give two correct observations.

When candidates did not gain credit, it was usually because they stated the type of observations you would make (eg **if** the potassium caught fire, **if** the potassium floated etc) rather than the actual observations made.

Question 20 (b)

(b) Reactivity **increases** going down Group 1 from lithium to potassium.

Explain this trend in reactivity.

Use ideas about the electronic configurations of the atoms in your answer.

....

....

....

.... **[2]**

Good responses to this question described the idea that down Group 1 there are more electron shells, so there is less attraction between the nucleus and the **outer** shell electron, which is lost more easily. When candidates did not gain both marks it was usually because they did not state that it was the **outermost** or **outer** shell electron that is lost.

Question 20 (c)

(c) Look at the table. It shows information about the Group 7 elements.

Complete the table.

Element	Formula	Colour	State at room temperature
Fluorine	F_2	pale yellow	gas
Chlorine	Cl_2	....	....
Bromine	Br_2	brown	liquid
Iodine	I_2	grey	....

[3]

?	**Misconception**	The colour of chlorine as yellow and iodine being a liquid at room temperature were common misconceptions.

Question 20 (d)

(d) The Group 7 elements exist as simple molecules.

Fluorine boils at −188 °C.

Explain why fluorine has a low boiling point.

....

....

.... **[2]**

Higher ability candidates described that fluorine has weak intermolecular forces, which are easily broken.

?	**Misconception**	A common misconception is still that simple covalent molecules have low melting & boiling points due to weak covalent bonds between molecules or weak forces between atoms.

Question 20 (e)

(e) The elements in Group 0 (the noble gases) are unreactive.

Explain why, in terms of their electronic configurations.

....

....

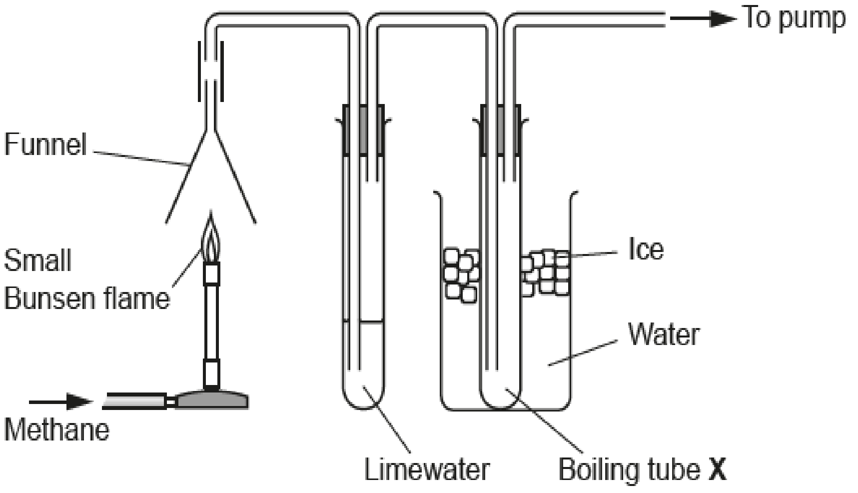
.... **[2]**

Good responses to this question described that the elements in Group 0 have a full outer shell, so have no tendency to lose or gain electrons.

Question 21 (a)

21 A student did an experiment to prove that methane gas, CH_4, produces carbon dioxide and water when it burns.

Look at the diagram of her experiment.



(a) The limewater turned milky showing that carbon dioxide had been formed.

A small amount of a colourless liquid condensed in boiling tube **X**. The student said that this proved that burning methane produced water.

The teacher said that the experiment had been set up incorrectly.

The teacher said that the student's conclusion about water was not valid.

Describe and explain how the student could change how the experiment is set up to prove that water is produced **by burning methane**.

....

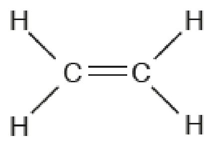
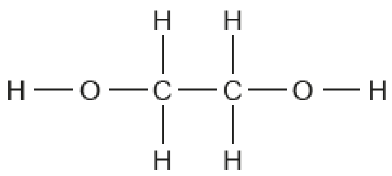
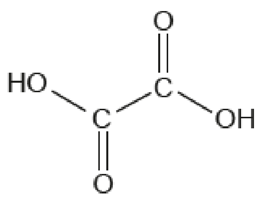
....

.... **[2]**

Higher ability candidates suggested swapping the position of boiling tube X and the boiling tube of limewater to make sure that any liquid that condenses in boiling tube X must have come from the burning methane and not from the limewater. Lower ability candidates misunderstood the question and focused on testing the condensed liquid to prove that it was water. Another common misconception was to suggest that the experiment needed to be a closed system to prevent water vapour/oxygen/carbon dioxide from the air affecting the results.

Question 21 (b)

(b) Look at the monomers shown in the table.

Monomer	Structure
Ethene	
Ethane-1,2-diol	
Ethanedioic acid	

Two of the monomers from the table react to form a polymer which is a **polyester**.

Explain, using the appropriate monomers from the table, how the polyester is formed.

Include the **type of polymerisation** and an **equation for the reaction** in your answer.

....

....

....

....

....

....

.... **[4]**

Good responses to this question described the reaction of ethanedioic acid with ethane-1,2-diol in a condensation polymerisation reaction to form an ester and water. Many candidates gained 3 marks, but the fourth mark for drawing the correct ester link was less frequently given.

Choosing ethene as one of the monomers was a common error.

Question 21 (c) (i)

(c) DNA and proteins are biological polymers.

(i) How many **different** monomers are found in a DNA polymer?

.... **[1]**

Two and three were common errors in this question.

Question 21 (c) (ii)

(ii) What are the monomers in **proteins** called?

.... **[1]**

Most candidates knew that the monomers in proteins are amino acids.

Question 21 (d) (i)

(d) An alcohol, **X**, has the formula C_3H_7OH.

Alcohol **X** can be oxidised to a compound, **Y**, with the molecular formula $C_3H_6O_2$.

(i) Compound **Y** is **not** an alcohol but is a member of another homologous series.

Write down the name of this homologous series.

.... **[1]**

Alkanes, amines and esters were common errors in this question.

Question 21 (d) (ii)

(ii) Draw the **displayed formula** of a molecule of alcohol **X** and of a molecule of compound **Y**.

Show all the covalent bonds.

Alcohol **X**

Compound **Y**

[2]

More candidates were able to correctly draw the structure of alcohol X than compound Y. Many candidates did not gain the mark for the displayed formula of the alcohol because they lacked the O-H bond. The question stated '**show all the covalent bonds'**. Lower ability candidates did not recall the carboxylic acid functional group, -COOH. Often the diagrams had two C-O bonds drawn (the oxygens had no other bonds). Other diagrams included C=OH or more than one C=O within the structure.

Question 22 (a)

22 (a) In an experiment, a mixture of ammonium chloride and calcium hydroxide is heated.

Ammonia gas, NH_3, is made.

$$2NH_4Cl + Ca(OH)_2 \rightarrow CaCl_2 + 2NH_3 + 2H_2O$$

A student adds 5.00 g of ammonium chloride to an excess of calcium hydroxide.

Calculate the maximum **volume of ammonia gas** that could be made at room temperature and pressure.

One mole of a gas occupies 24 dm^3 at room temperature and pressure.

Volume of ammonia gas = ... dm^3 **[2]**

Higher ability candidates correctly calculated the volume of ammonia gas as 2.24dm^3. Examiners gave error carried forward for correctly converting an incorrectly calculated number of moles to a volume.

Common errors in this calculation included

- using 107 (2 x 53.5) as the formula mass before calculating the number of moles of NH_4Cl to give an answer of 1.12
- just multiplying 5(g) x 24
- dividing the number of moles by 24
- converting 24dm^3 to cm^3 before multiplying by the number of moles.

Question 22 (b) (i)

(b) In another experiment a student reacts sodium hydroxide solution with dilute hydrochloric acid.

$$NaOH + HCl \rightarrow NaCl + H_2O$$

(i) 35.0 cm^3 of 0.075 mol/dm^3 hydrochloric acid, HCl, are added to 25.0 cm^3 of 0.100 mol/dm^3 sodium hydroxide solution, NaOH.

Use the information to determine which reactant is **in excess**.

....

....

....

....

.... **[3]**

Many candidates correctly calculated the moles of HCl and NaOH and deduced that the HCl is in excess.

	AfL	Many candidates still forget to convert cm^3 to dm^3 before calculating moles or concentrations – see also Question 22(c).

Question 22 (b) (ii)

(ii) To find the exact amount of dilute hydrochloric acid that reacts with 25.0 cm^3 of the sodium hydroxide solution, the student does a titration.

Look at the student's results. The rough titration is **not** shown.

	Titration 1	Titration 2	Titration 3	Titration 4
Final burette reading (cm^3)	36.30	38.60	39.25	38.30
Initial burette reading (cm^3)	0.00	2.80	4.05	2.10
Volume of acid used (cm^3)	36.30	35.80	35.20	36.20

Use the student's **concordant** results to calculate the mean volume of hydrochloric acid required.

Mean volume = ... cm^3 **[2]**

Many candidates correctly selected the concordant results from titrations 1 & 4 to calculate the mean volume as 36.25 cm^3.

Lower ability candidates tended to calculate the mean from all four titres; 1 mark was given.

Question 22 (c)

(c) In another titration 25.0 cm^3 of potassium hydroxide solution, KOH, are titrated with 0.200 mol / dm^3 sulfuric acid, H_2SO_4.

$$2KOH + H_2SO_4 \rightarrow K_2SO_4 + 2H_2O$$

24.80 cm^3 of sulfuric acid are needed to neutralise 25.0 cm^3 of the potassium hydroxide solution.

Calculate the concentration of the potassium hydroxide solution in mol / dm^3.

Concentration = ... mol / dm^3 **[4]**

Some of the responses were excellent, with clearly shown working out that was easy for the examiner to follow. If candidates did not obtain an answer of 0.3968 mol/dm^3 examiners looked to award marks for working out and/or ECF. It is worth centres stressing to candidates that this is only possible when an answer is clearly set out.

The most common error was ignoring the stoichiometry of the reaction.

	AfL	Many candidates still forget to convert cm^3 to dm^3 before calculating moles or concentrations.

Exemplar 5

$2KOH + H_2SO_4 \rightarrow K_2SO_4 + 2H_2O$

$25cm^3$ $\quad$ $24.8cm^3$ $\quad$ $0.2mol/dm^3$

$c = n/V \quad n = C \times V$

conc of $H_2SO_4 = 0.0248 dm^3 \times 0.2 mol/dm^3$
$= 4.96 \times 10^{-3}$ mol

molar ratio $= 2:1$, so mols in KOH $= 9.92 \times 10^{-3}$

$$C = \frac{n}{V} = \frac{(9.92 \times 10^{-3})}{0.025 dm^3} = 0.3968 mol/dm^3$$

Concentration = 0.3968 mol/dm^3 **[4]**

This response illustrates a clearly set out calculation answer, which is easy for the examiner to follow. When candidates write numbers at random in the answer space it is difficult for the examiner to seek out credit-worthy points and/or award marks for errors carried forward.

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