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Examiners' report

GATEWAY SCIENCE CHEMISTRY A

J248
For first teaching in 2016

J248/02 Summer 2018 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. 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 J248/02 series overview

J248/02 is the second of two foundation tier papers for the revised specification for Chemistry A (Gateway Science). It assesses Topics C4-C7, and assumes some knowledge of Topics C1-C3.

Candidate performance

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

- Identified the key words in each question part. The examination is a time of considerable stress, and it is easy to misunderstand precisely what the question is asking. It is always a good strategy to identify the command line(s) of the question and to underline key words.
- Realised that information which they recalled might not always quite fit the demands of the question, and so were prepared to modify their answer in the light of this.
- Could decide which information might be significant and which not, especially in tables.
- In calculation questions, showed their working. The majority of candidates got the answers to calculations wrong, and their working is their only way of gaining credit. Candidates are not penalised for incorrect working.

Candidates who did less well on this paper displayed the following tendencies:

- Identified familiar words from the question line, and then assumed that they knew what the question was asking rather than reading the question in detail.
- Gave explanations which, while relevant to the question, lacked sufficient detail, e.g. "bad for the environment".
- Had difficulty in basic mathematical manipulations.
- Left questions blank, guaranteeing a mark of zero. Examiners look for ways in which to give candidates credit, not for reasons to deduct marks. It is ***always*** better to write something than nothing.

There was no evidence that any time constraints had led to a candidate underperforming.

Section A overview

Examiners are very happy for candidates to change their answers, but any changes MUST be unambiguous. Candidates should cross out their original clearly, then write the new answer immediately to one side of the answer box. Examiners could not give any credit for answers which were ambiguous.

Question 1

1 Lithium, sodium and potassium are Group 1 elements.

What happens when these elements are added to water?

A Some float and carbon dioxide gas and an alkaline solution are made.

B Some float and hydrogen gas and an alkaline solution are made.

C They all float and hydrogen gas and an acidic solution are made.

D They all float and hydrogen gas and an alkaline solution are made.

Your answer ☐ **[1]**

Candidates had clearly seen the reaction between alkali metals and water, and almost all chose an option involving hydrogen gas. There was a lot more uncertainty over whether *all* the elements floated, and whether the solution was acidic or alkaline.

Question 2

2 Damp litmus paper is used to test for chlorine gas.

Which statement describes the correct result of the test for chlorine gas?

A Damp blue litmus paper turns red then white.

B Damp blue litmus paper turns white then red.

C Damp red litmus paper turns blue then white.

D Damp red litmus paper turns white then blue.

Your answer ☐ **[1]**

Many of the higher ability candidates knew the test for chlorine. However, almost half the candidates suggested that the litmus paper went white and *then* changed to red or blue, suggesting that they hadn't linked the white colour to the bleaching effect of chlorine.

Question 3

3 What is the name of the process that converts large alkane molecules into smaller alkane molecules?

A Cracking

B Fractional distillation

C Hydrogenation

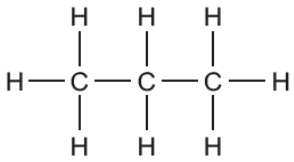
D Polymerisation

Your answer ☐ **[1]**

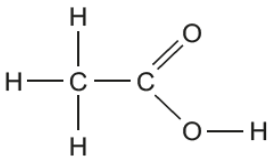
This question discriminated very effectively, with higher ability candidates choosing option A. Option B, fractional distillation, was the most frequently chosen alternative.

Question 4

4 Which displayed formula shows an alkene?



A



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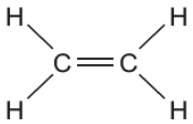

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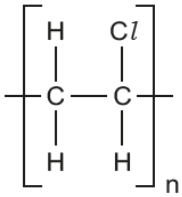


D

Your answer ☐ **[1]**

This question was well answered.

Question 5

5 The list shows part of the reactivity series of metals including carbon.

Sodium
Lithium
Calcium
Magnesium
Aluminium
Carbon
Zinc
Iron
Tin
Lead

Which row of the table correctly describes how the metals are extracted from their ores?

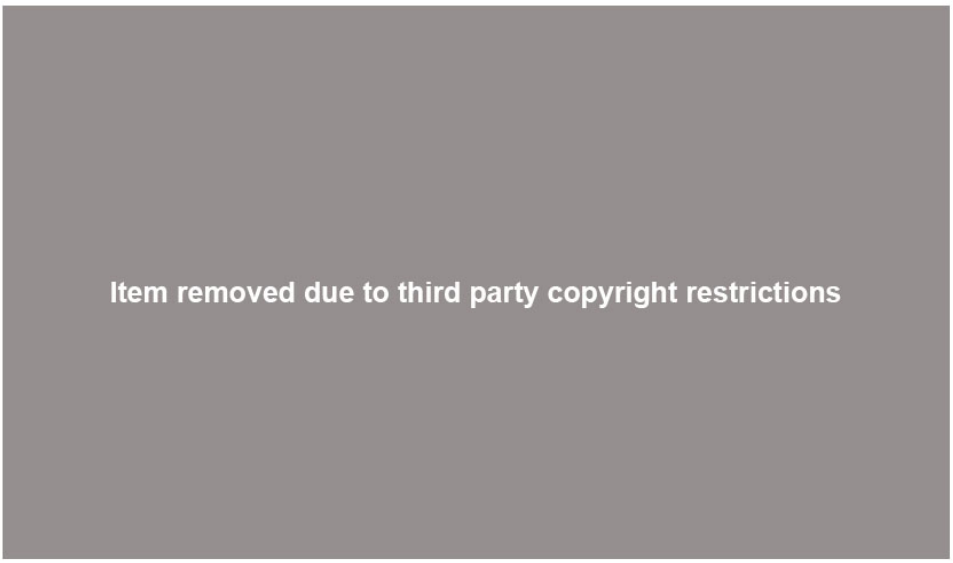
	Metals extracted by electrolysis	Metals extracted by heating with carbon
A	Sodium, Magnesium, Zinc	Aluminium, Iron, Tin
B	Aluminium, Zinc, Iron	Lead, Tin
C	Calcium, Magnesium, Aluminium	Sodium, Iron, Tin
D	Sodium, Calcium, Magnesium	Lead, Tin, Zinc

Your answer ☐ **[1]**

This question was reasonably well answered. Option D was by far the most frequent answer, with incorrect responses spread fairly evenly between the other three alternatives.

Question 6

6 Look at the mass spectrum of a carbon compound.



Which carbon compound is the mass spectrum from?

A C_2H_2

B $C_2H_5^+$

C $C_3H_7^+$

D C_4H_{10}

Your answer ☐ **[1]**

Interpretation of mass spectra caused considerable uncertainty across the whole ability spectrum, with no one group performing any better than the others.

Question 7

7 Which statement about catalysts is correct?

A A catalyst decreases the activation energy of a reaction.

B A catalyst increases the activation energy of a reaction.

C A catalyst increases the time for a reaction to go to completion.

D A catalyst slows down a reaction.

Your answer ☐ **[1]**

While almost no candidates chose option D, the most popular responses were B and C, suggesting widespread uncertainty both about the nature of activation energy and, to a lesser degree, the relationship between rate and time.

Question 8

8 Hydrogen gas can be made by reacting methane and steam (H_2O).

$CH_4 + H_2O \rightarrow 3H_2 + CO$

6 g of hydrogen gas can be made from 18 g of steam, H_2O.

How much hydrogen gas can be made from 3.6 g of steam, H_2O?

A 0.4 g

B 0.6 g

C 1.2 g

D 6.8 g

Your answer ☐ **[1]**

This question was well answered, with all but the lowest ability candidates scoring the mark.

Question 9

9 Which statement is true for a reversible reaction when it is at dynamic equilibrium?

A The concentration of the products is increasing.

B The rate of the backward reaction is greater than the rate of the forward reaction.

C The rate of the forward reaction is equal to the rate of the backward reaction.

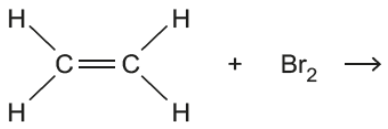
D The rate of the forward reaction is greater than the rate of the backward reaction.

Your answer ☐ **[1]**

Dynamic equilibrium was well understood by most candidates.

Question 10

10 What is the formula of the product in this equation?



A C_2H_2Br

B C_3Br_4

C C_2H_3Br

D $C_3H_4Br_2$

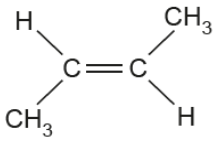
Your answer ☐ **[1]**

Please note an erratum notice was issued for this question. You can view this at the end of the report.

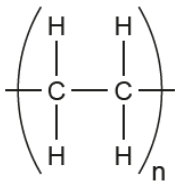
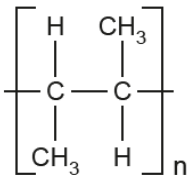
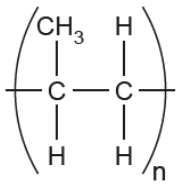
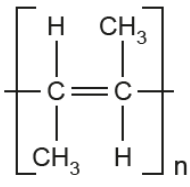
All candidates were credited with the mark for this question.

Question 11

11 Look at the displayed formula of the monomer butene.



What is the formula of the **polymer** formed from butene?

			
A	**B**	**C**	**D**

Your answer ☐ **[1]**

The two most common choices were B and D, showing that candidates had looked carefully at the structures in the diagrams. Of these, D was the more common choice.

Question 12

12 DNA molecules are polymers.

What are the monomers that make up DNA called?

A Carbohydrates

B Nucleotides

C Phosphates

D Proteins

Your answer ☐ **[1]**

This question was well answered.

Question 13

13 What is the major source of carbon monoxide in the Earth's atmosphere?

A Incomplete combustion of fossil fuels and wood.

B Production in a nuclear power station.

C The combustion of impurities in coal.

D The combustion of impurities in natural gas.

Your answer ☐ **[1]**

This question was well answered

Question 14

14 Look at the following sentences.

They describe one possible theory for how the Earth's atmosphere evolved.

The sentences are not in the correct order.

1	Carbon cycle now keeps the composition of the atmosphere almost constant
2	Initial atmosphere of ammonia and carbon dioxide
3	Increase in oxygen and nitrogen levels
4	Photosynthetic organisms began to make oxygen
5	Degassing from the Earth's crust and formation of water

What is the correct order for the sentences?

A 2, 4, 3, 5, 1

B 2, 5, 4, 3, 1

C 5, 2, 3, 4, 1

D 5, 2, 4, 3, 1

Your answer ☐ **[1]**

Candidates found this question very difficult, and option B was most often chosen. Candidates did not appreciate that degassing from the Earth's crust preceded the formation of an initial atmosphere.

Question 15

15 Look at the information about four different polymers.

Polymer	Cost (£ per kg)	Tensile strength (MPa)	Melting point (°C)	Maximum useable temperature (°C)
A	0.74	15	120	85
B	1.20	78	254	70
C	0.92	35	176	160
D	1.42	42	156	160

Which polymer would be best for making a plastic cup to hold hot drinks?

Your answer ☐ **[1]**

This question was well answered, with most candidates able to make a suitable choice. The most common incorrect choice was for option B, which both ignores the price factor and also suggests that candidates may have stopped reading before they got to the final column.

Section B overview

A significant number of candidates left questions unanswered in this part. As always, when examiners read through an answer they look for anything that might deserve credit, as opposed to looking for reasons to take marks away. Candidates who do not know an answer but are willing to attempt the question often gain partial credit for some aspect of their answer. The same applies to working in calculations. Incorrect working is not penalised, but used to award partial credit when the final answer is incorrect. The majority of candidates gain credit for their calculations by this route.

Questions 24 and 25 were common with the Higher Tier paper.

Question 16(a)

16 The Group 7 elements are called the halogens.

The table shows information about some of the halogens.

Name	Atomic number	Boiling point (°C)	State at room temperature	Molecular formula
Fluorine	9	−188	Gas	F_2
Chlorine	17	−34	Gas	Cl_2
Bromine	35	59	Liquid	Br_2
Iodine	53	184	Solid	I_2

(a) Which is the **most reactive** halogen in the table?

..... **[1]**

Many candidates recognised that fluorine is the most reactive halogen, and there was the usual crop of misspellings of the name. Iodine was the most common incorrect response and showed that, even when candidates did not know the answer, they still had some understanding of the existence of trends within the Periodic Table.

Question 16(b)(i)

(b) Astatine is also a halogen. It has the atomic symbol At and an atomic number of 85.

Look at the table.

(i) Predict the **state** of astatine at room temperature.

..... **[1]**

This question discriminated well, with all but the lowest ability candidates stating that astatine is a solid. Almost all candidates understood the concept of 'state' in this context.

Question 16(b)(ii)

(ii) Predict the **boiling point** of astatine.

..... **[1]**

Most candidates realised that the boiling point of astatine would be greater than that of iodine. However, this year the question was addressed at the higher ability section of the cohort, and examiners looked for answers which used the size of the increases shown in the table to make a more exact prediction.

Question 16(c)(i)

(c) Sodium, Na, reacts with chlorine. A white solid is made.

(i) What is the **name** of this white solid?

..... **[1]**

All but the lowest ability candidates correctly stated that the product was sodium chloride. On this occasion examiners were prepared to accept 'salt' as a possible response. The most common alternative was 'precipitate'.

Question 16(c)(ii)

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

..... **[2]**

Candidates struggled with basic formulae, including that of chlorine despite the fact that it was given in the table. The most common responses were
$Na + Cl \rightarrow NaCl$ and $Na + Cl_2 \rightarrow NaCl_2$

Question 17(a)

17 A student added 2.4 g of magnesium to hydrochloric acid. She observed that no magnesium was left when the reaction was complete.

The student transferred the solution to an evaporating basin. She heated the solution using a Bunsen burner and evaporated all the water.

(a) Explain how you can tell from the student's observation that the hydrochloric acid was in excess.

.....

..... **[1]**

Many candidates realised that it was the disappearance of the magnesium that indicated that the acid was in excess.

Question 17(b)

(b) Look at the equation for the reaction.

$Mg + 2HCl \rightarrow MgCl_2 + H_2$

The student knows the reaction is complete when there is no magnesium left.

Use the equation to explain one **other** way the student could tell that the reaction was complete.

.....

..... **[1]**

While most candidates related their answer to hydrogen, many did not articulate that production of hydrogen would have stopped once the reaction was complete. The exemplar response below illustrates this.

Exemplar 1

When ~~magnesium~~ hydogen gas was being produad thats when sh would know reaction is complete [1]

Question 17(c)

(c) The student predicts she should make 9.5 g of magnesium chloride, $MgCl_2$.

She actually makes 7.9 g.

Calculate the **percentage yield**.

Give your answer to **3** significant figures.

Answer = ... **[3]**

This question discriminated well, with the higher ability candidates not only carrying out the calculation, but also correctly rounding their answer to three significant figures. A large percentage of candidates, while not getting the correct answer, were still able to gain marks for their working.

Question 17(d)

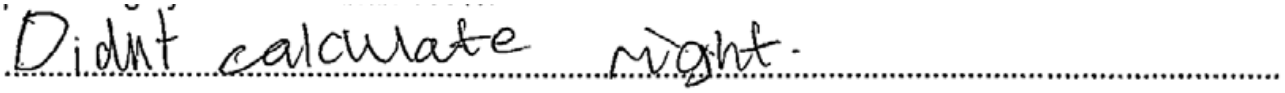
(d) Write down one reason, other than a mistake, why the student may have obtained a percentage yield of less than 100%.

.....

..... **[1]**

Few candidates appreciated why yields are less than 100%. Many candidates ignored the question stem and discussed mistakes, as illustrated in the exemplar response below.

Exemplar 2



Question 18(a)

18 Antacid tablets are used to treat indigestion.

A student investigates two different antacid tablets, **X** and **Y**. Both tablets, **X** and **Y**, contain calcium carbonate, $CaCO_3$.

Calcium carbonate reacts with hydrochloric acid. Calcium chloride, $CaCl_2$, water and carbon dioxide are made.

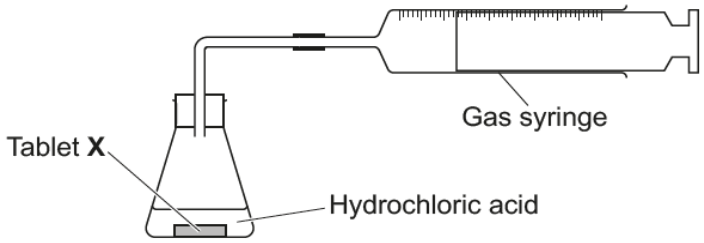
(a) Write a **balanced symbol** equation for this reaction.

..... **[2]**

Unlike in Question 16cii, in this question most of the formulae were given and the highest ability candidates were able to demonstrate their ability to write symbol equations. Other candidates struggled with basic formulae, failing even to correctly transcribe the formula of $CaCl_2$ from the line above. CaC_2 was frequently seen. The formulae of water and carbon dioxide were generally well known, but the formula for hydrochloric acid was often given as HCl_2.

Question 18(b)(i)

(b) The diagram shows the apparatus the student uses.



The student reacts tablet **X** with 100 cm^3 of hydrochloric acid. The hydrochloric acid is in excess.

He measures the volume of gas made every minute during the first five minutes.

He does a second experiment using tablet **Y** and a fresh 100 cm^3 sample of the same hydrochloric acid.

The table shows his results.

Time (minutes)	Volume of gas (cm^3)	
	Tablet X	Tablet Y
0	0	0
1	38	32
2	48	54
3	48	67
4	48	72
5	48	72

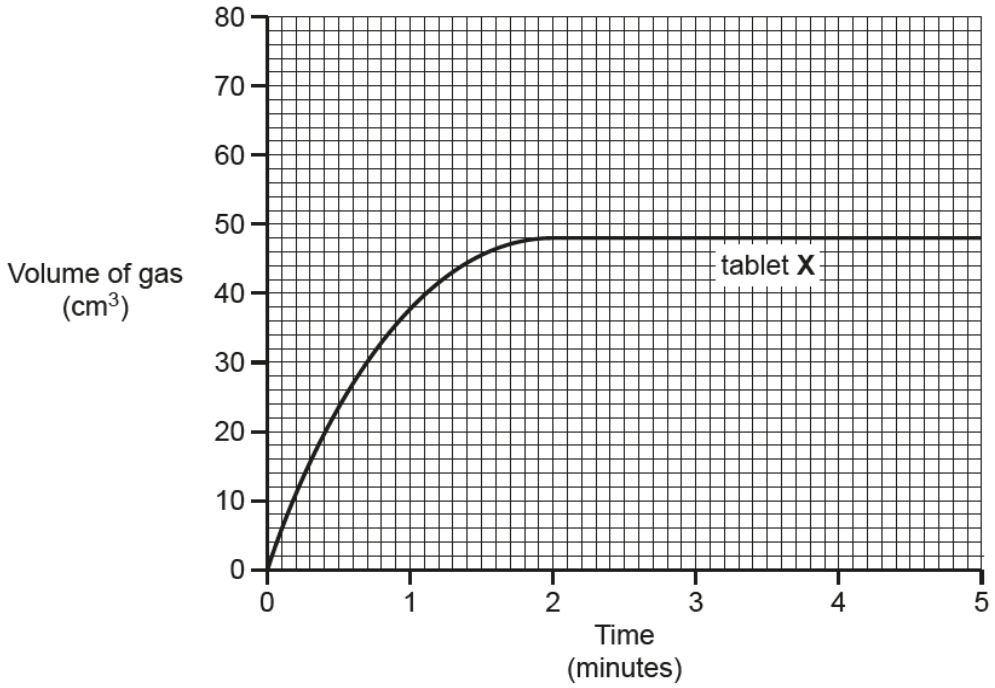
(i) The graph shows the results for tablet **X**.

What is the volume of gas made by the end of the experiment?

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

Candidates of all abilities could read the final volume off the graph, though also refer to Question 25bi.

Question 18(b)(ii)



(ii) Plot the results for tablet **Y** on the grid. Draw a line of best fit. **[2]**

The graph points were plotted accurately by most candidates. Not all realised that the most appropriate line to draw here would be a curve, so there were many straight lines.

Question 18(b)(iii)

(iii) Tablet **X** contains less calcium carbonate than tablet **Y**.

How do the results show this?

.....

..... **[1]**

The higher ability candidates realised that what was important was the total volume of gas produced, whereas others went for the time taken for the reaction.

Question 18(c)

(c) The rate of reaction between calcium carbonate and hydrochloric acid can be increased by:

- Using a more concentrated solution of hydrochloric acid
- Increasing the temperature of the acid.

Explain how each of these methods increase the rate of the reaction.

Use ideas about collisions between particles.

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.....

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.....

..... **[4]**

Many candidates gained some credit for stating that increasing the temperature increased the energy or the speed of the particles. Higher ability candidates also discussed the distance between particles when concentration was increased.

For this sort of question, the quality of a candidates' expression makes a lot of difference. Answers couched in terms of 'more particles to react' and 'more collisions' do not show an understanding of rate. Examiners were looking for statements such as 'more frequent collisions'.

As usual, many candidates thought that an increase in concentration makes particles move faster, that energy increases when particles collide and that an increase in concentration acts as a catalyst.

Question 19(a)

19 Ammonia is made from nitrogen and hydrogen.

(a) The reaction between nitrogen and hydrogen is **reversible**.

Explain what this means.

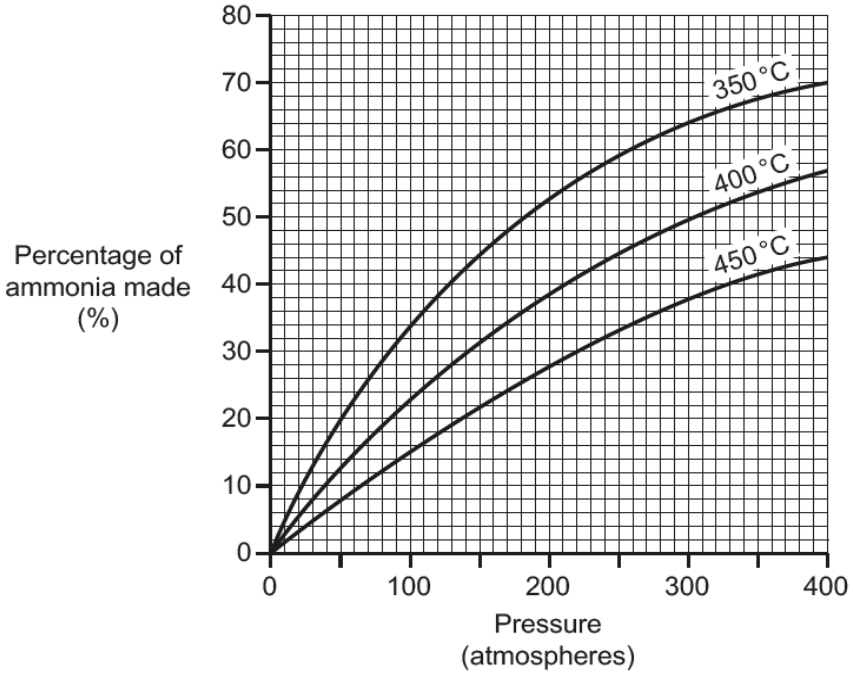
.....

..... **[1]**

Most candidates showed a clear understanding of the nature of a reversible reaction.

Question 19(b)(i)

(b) The graph shows the percentage of ammonia made at different temperatures and pressures.



(i) Describe how the percentage of ammonia changes as the **pressure** increases at 450 °C.

..... **[1]**

In the stress of the examination, many candidates answered a different question. They described the relationship between percentage of ammonia and temperature, not percentage and pressure.

Question 19(b)(ii)

(ii) Write down a temperature and pressure which make 20% of ammonia.

Temperature = ... °C Pressure = ... atmospheres **[1]**

Able candidates had no difficulty in reading a suitable value off one of the three curves. Many others suggested a temperature of 550, despite there being no line for that temperature on the graph.

Question 20(a)

20 A student wants to identify the ions contained in a solid, **X**.

She dissolves the solid in some water and then does some tests on the solution.

Look at the table of her results.

Test	Method	Observations
Test 1	Flame test	Red flame seen
Test 2	Add dilute sodium hydroxide solution	White precipitate forms which re-dissolves in excess sodium hydroxide solution
Test 3	Add dilute nitric acid, then silver nitrate solution	White precipitate forms
Test 4	Add dilute hydrochloric acid, then barium chloride solution	No change – mixture stays clear and colourless

(a) Describe how the student does the flame test in **Test 1**.

You may draw a **labelled** diagram to help your answer.

.....

.....

.....

..... **[3]**

Flame tests were well known by the majority who answered this question. However, a minority of candidates did not attempt it.

Question 20(b)*

(b)* The student thinks that solid **X** contains only lithium ions, Li^+, and sulfate ions, SO_4^{2-}.

Use her results to explain if she is correct.

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..... **[6]**

Most candidates gained credit for stating that the red flame signifies lithium. Some gained extra credit for stating that the test was not definitive and that a 'red' flame could also have indicated calcium. A few of the higher ability candidates were also able to discuss the significance of the other tests, though the vast majority amalgamated Tests 2-4 and stated that they all confirmed the presence of sulfate.

Very able candidates realised that Test 2 was a test for zinc, and some also knew that Test 3 indicated the presence of a chloride. Very few candidates recognised the barium chloride test.

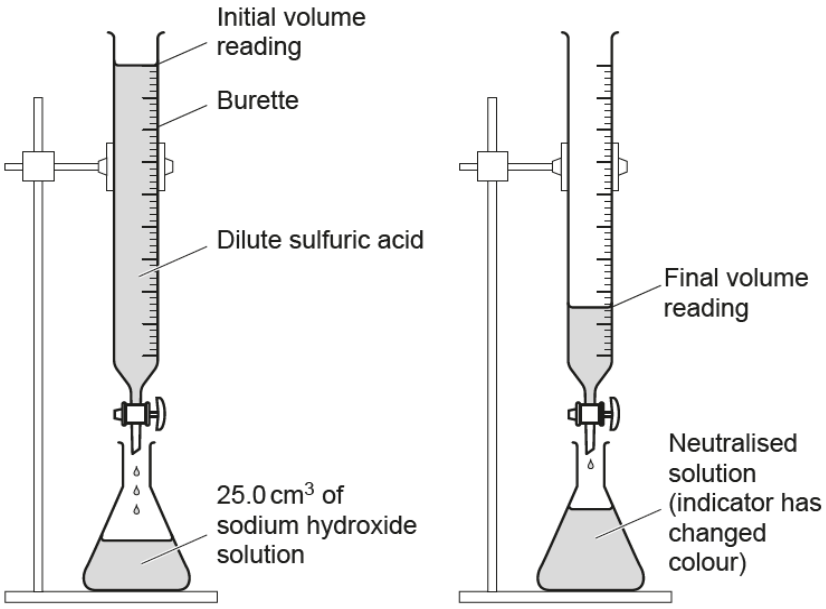
Some candidates copied out the tests without any analysis of what those tests indicated.

A number of candidates left this question blank.

Question 21(a)

21 A student does a titration with an acid and an alkali.

He uses dilute sulfuric acid, sodium hydroxide solution and an indicator solution.



The student's method is:

- Use a measuring cylinder to pour 25.0 cm^3 of sodium hydroxide solution into a conical flask
- Add a few drops of an indicator to the sodium hydroxide solution
- Use a burette to add dilute sulfuric acid to the sodium hydroxide solution until the indicator changes colour.

(a) The student wants to get a more accurate value for how much acid reacts with 25.0 cm^3 of sodium hydroxide solution.

Describe and explain how the student could improve his experiment to get a more accurate value.

.....

.....

.....

..... **[4]**

A minority of candidates showed a familiarity with titration as a procedure, and suggested adding the acid drop by drop and swirling the contents of the flask. Almost all suggested repeating the experiment, even though this did not actually answer the question. One of the most common suggestions was to count out the number of drops of indicator, and another was to replace the burette with a measuring cylinder.

Question 21(b)

(b) Another student does a titration. She also uses dilute sulfuric acid, sodium hydroxide solution and an indicator solution.

The table shows her results.

Titration number	**1**	**2**	**3**	**4**
Volume of acid (cm^3)	26.4	25.2	25.6	25.4

The student decides that the best value for the mean (average) volume of acid is 25.4 cm^3.

Show how she calculated this value.

.....

..... **[2]**

This question discriminated well, with the higher ability candidates appreciating that one value was an outlier and should be ignored.

Question 21(c)

(c) The equation for this reaction is

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

	Relative formula mass, M_r
H_2SO_4	98
NaOH	40
Na_2SO_4	142
H_2O	18

Water is a waste product in this reaction.

Calculate the **atom economy** for the reaction.

Give your answer to **1** decimal place.

Answer = ... **[3]**

Candidates of all abilities found the task of calculating atom economy to be difficult. Almost all of those who gained credit did so for aspects of their working rather than for their final answer. Not all candidates attempted the question.

Question 22(a)

22 Scientists are worried about the greenhouse effect.

(a) Complete the following paragraph about the greenhouse effect.

Use words from the list.

CFCs **cool** **Earth's**

hydrogen **infrared** **methane**

microwave **Sun's** **ultraviolet** **warm**

Greenhouse gases such as carbon dioxide and ..... absorb ..... radiation radiated by the ..... surface, then emit it in all directions. This greenhouse effect keeps the Earth and its atmosphere ..... enough for living things to exist. **[2]**

Most candidates were able to select two or three of the appropriate words from the list.

Question 22(b)

(b) Write about **two** possible ways that greenhouse gas emissions can be reduced.

.....

.....

.....

..... **[2]**

This question discriminated well, with many candidates realising that greenhouse gas emissions would be reduced if we burn less fossil fuels. 'Reduce the cow population' was often suggested, and was given credit.

However, many 'green' issues were conflated, so good answers often included other suggestions such as 'use less nuclear power' or 'recycle more polythene bags'.

Question 23(a)

23 This question is about metals and alloys.

(a) The table gives information about some alloys.

Alloy	Main metal or metals	Use
Brass	.....	Musical instruments and coins
Bronze	.....	Statues
Duralumin	.....	Aircraft parts
Solder	Lead and tin	Joining metals
Steel	Iron	Bridges, cars

Complete the table.

Choose your answers from the list.

Aluminium and copper

Aluminium and iron

Copper and tin

Copper and zinc

Copper and lead

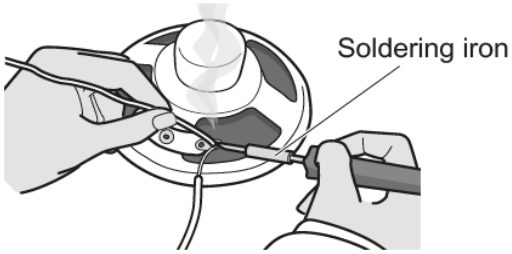
Lead and zinc

[3]

Few candidates of any ability knew the composition of any of these alloys. The most consistent response was to suggest that Duralumin is made of aluminium and iron. Those candidates who did know that brass and bronze contained copper and tin or zinc usually got them the wrong way round.

Question 23(b)

(b) Solder can be used to join metals together. A hot soldering iron is used to melt the solder.



The table gives some information about solder, copper and tin.

Metal	Melting point (°C)	Density (g/cm^3)	Relative hardness
Copper	1085	8.96	Soft
Tin	232	7.31	Soft
Solder	130	10.3	Quite hard

Solder is better than copper or tin for joining metals together.

Suggest why. Use the information in the table.

.....

.....

..... **[2]**

Higher ability and average ability candidates could demonstrate their ability in this question, and answered it well. Lower ability candidates often discussed boiling point rather than melting point, a confusion which was also evident in Question 24b. There were many references to how strong the solder is, despite that not being given in the table, suggesting a possible confusion between strength and hardness.

Question 23(c)

(c) Steel is an alloy containing iron.

Complete the **word equation** for the corrosion of iron.

Iron + ... + ... → .....

[2]

Most candidates found this question to be difficult, and those who did score a mark usually got it for identifying the reagents. 'Iron oxide' as the product was not sufficient; examiners were looking for hydrated iron oxide or, better still, hydrated iron(III) oxide.

Lower ability candidates appeared to treat this as an alloying problem, suggesting metals mentioned in the earlier sections of the question rather than using their knowledge of rusting.

A number of candidates did not attempt the question.

Question 23(d)(i)

(d) (i) Iron can be plated with a layer of **zinc** to prevent it corroding.

This is called **galvanising**.

Explain how galvanising prevents iron from corroding.

.....

.....

..... **[2]**

Higher ability candidates discussed the reactivity of zinc, while others suggested that zinc forms a protective layer and does not itself corrode.

Question 23(d)(ii)

(ii) Iron can also be plated with a layer of **tin** to prevent it corroding.

Describe a **disadvantage** of tin plating for preventing corrosion.

.....

..... **[1]**

Most candidates did not appear to be familiar with tin plating, and suggested that the tin itself would corrode.

Question 24(a)

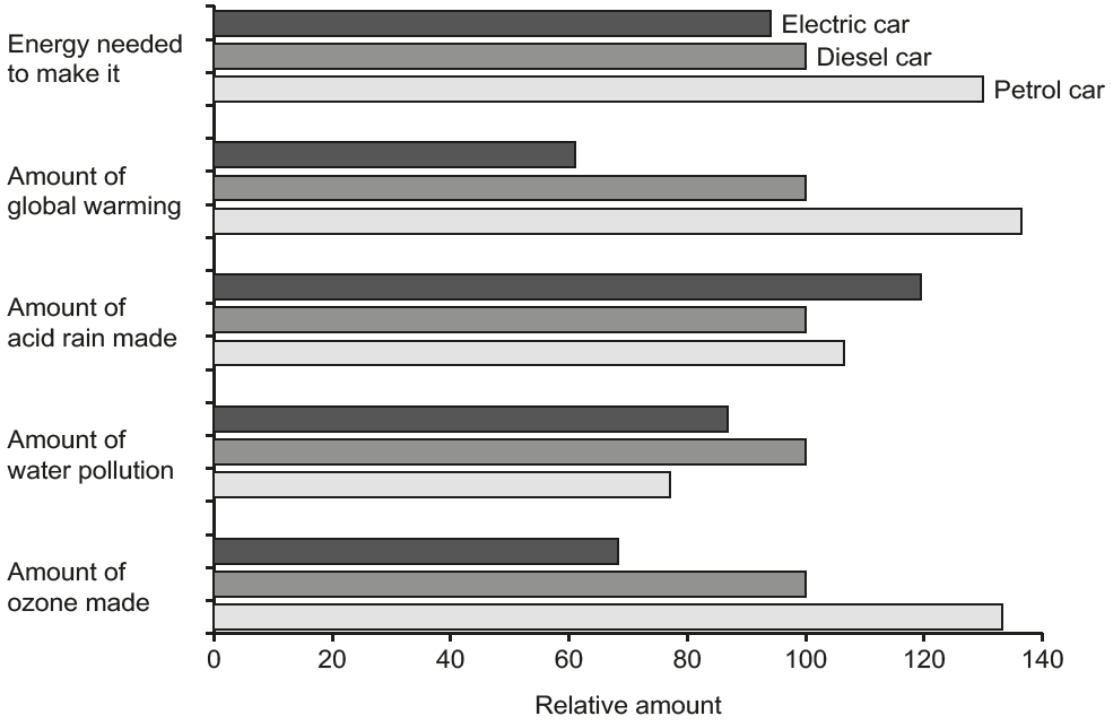
24 This question is about life-cycle assessment.

(a) A car company is developing three new cars:

- A petrol car
- A diesel car
- An electric car.

They do a life-cycle assessment of each car.

Look at the information about the life-cycle assessment of each car.



The company decides to manufacture and sell the electric car.

Explain why they make this choice.

Use the information from the life-cycle assessment to help you.

.....

.....

.....

..... **[3]**

This part discriminated well, with higher ability candidates identifying all the aspects where electric cars were best. Others extracted some of the information correctly, but often did not notice that the degree of water pollution was not as good as for petrol cars. Lower ability candidates sometimes missed the instruction to use the life-cycle assessment, and gave more general answers such as "electric cars are better for the environment" which did not gain credit.

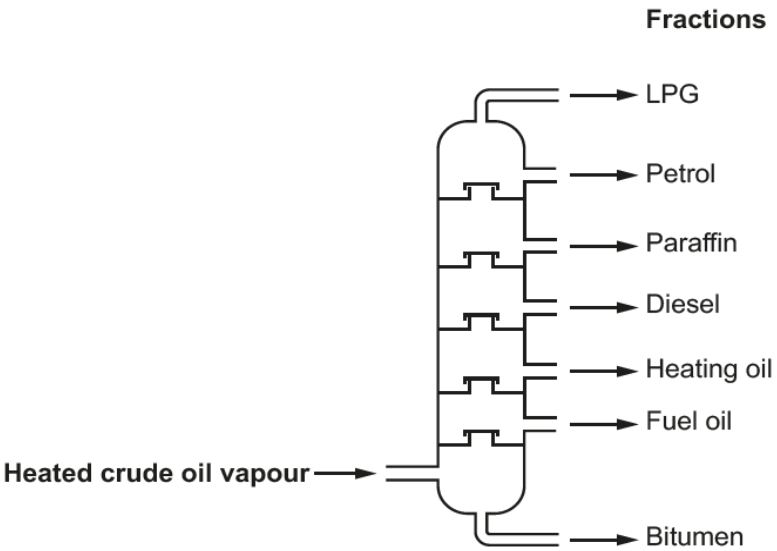
Candidates do need to refer to specific pieces of information rather than making more general observations about the information given. Answers such as "electric cars perform better in every respect except for acid rain" did not demonstrate enough specific analysis to be given credit.

Question 24(b)

(b) The fuels for the petrol and diesel cars are made from crude oil.

Crude oil is separated into different parts by **fractional distillation**.

The diagram shows a fractionating column.



Explain why crude oil **vapour** can be separated by fractional distillation.

.....

.....

.....

.....

..... **[3]**

Many candidates were clearly familiar with a fractionating column, but the need to identify what it is about crude oil that allows fractionation to work was something that caused enormous difficulty. Even those who either stated or implied that crude oil is a mixture had great difficulty taking this further.

Many candidates answered in terms of melting points, and so could not gain any credit. A minority discussed cracking.

Question 24(c)

(c) The table shows the boiling points of molecules present in different crude oil fractions.

Molecule	Boiling point (°C)
A	−2
B	125
C	216
D	502

Which molecule, **A**, **B**, **C** or **D**, is in the **LPG fraction**?

Explain your decision.

.....

..... **[2]**

Higher ability candidates realised that Molecule A was the LPG fraction, and could explain their reasoning. The other most frequent choice was Molecule D, which showed that, even though the candidates did not understand, they were showing sensible reasoning.

Question 24(d)

(d) Car manufacturers are developing cars that are powered by hydrogen/oxygen fuel cells.

The table shows some information about a 200 km journey using an electric car and a car using a fuel cell.

Feature	Electric	Fuel cell
Refuelling time (minutes)	360	4
Cost of refuelling (£)	3.20	4.20
CO_2 emitted (kg)	48	36
Mass of car (kg)	1550	1200

Evaluate the **advantages** and **disadvantages** of using a car powered by a fuel cell, rather than an electric car for the 200 km journey.

.....

.....

.....

.....

..... **[3]**

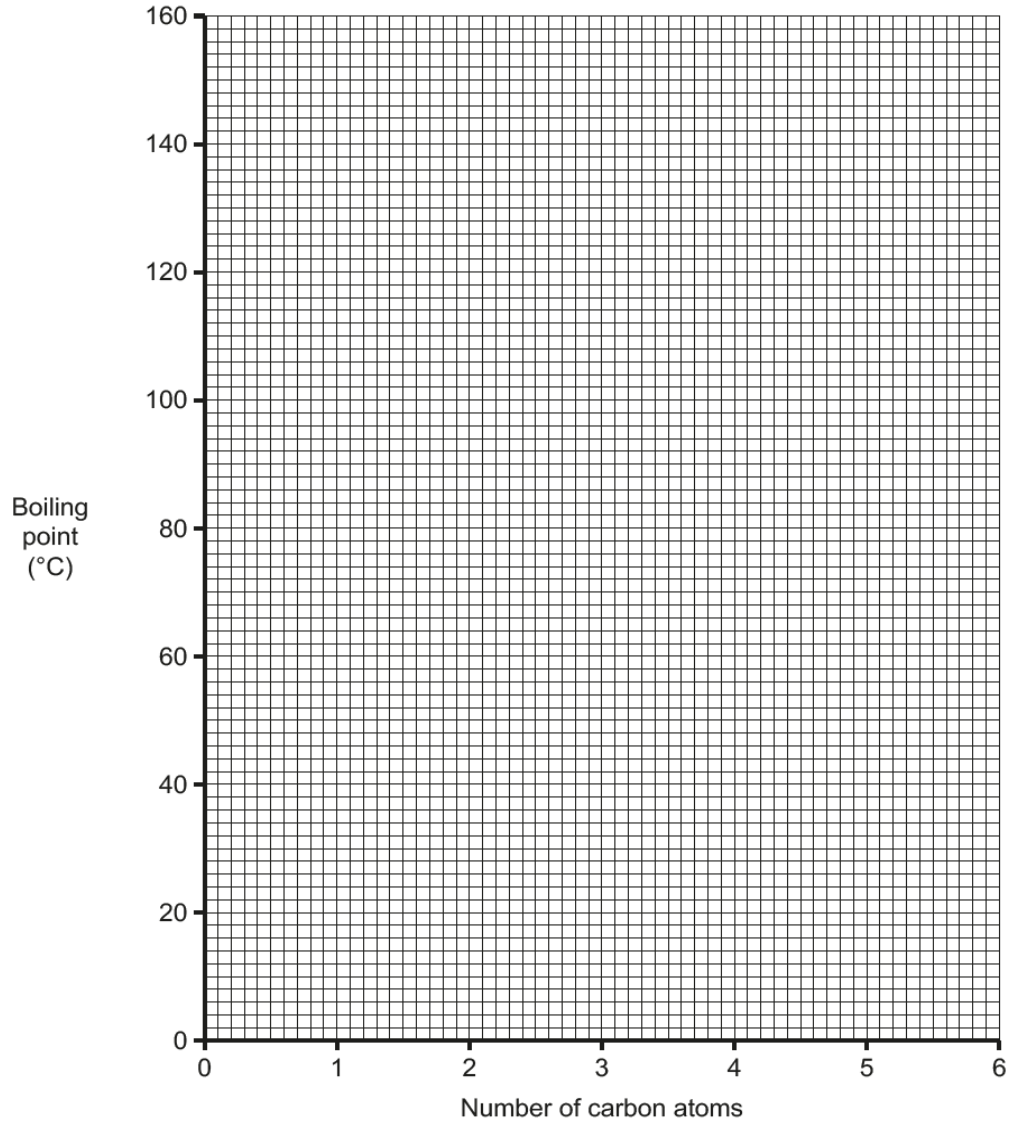
All but the lowest ability candidates were able to decide which were the advantages and which was the disadvantage in the table, and the question discriminated well. Interestingly, some candidates thought that fuel cell cars would only run for 4 minutes before they needed refuelling again.

Question 25(a)

25 A student is using the internet to find out about alcohols. The student finds the following information.

Name	Number of carbon atoms	Boiling point (°C)
Methanol	1	65
Ethanol	2	79
Propanol	3	97
Pentanol	5	138
Hexanol	6	156

(a) Plot a graph of the boiling points of the alcohols on the grid. Draw a line of best fit.



[3]

Most candidates marked all the points correctly. However, a number of candidates drew their line through the origin.

Question 25(b)(i)

(b) (i) The student could not find a value for the boiling point of butanol, C_4H_9OH.

Use the graph to estimate the boiling point of butanol.

Answer = ... °C **[1]**

The higher ability candidates followed the instruction to read the boiling point of butanol from their graph. However, many of the lower ability candidates did not seem to use the graph at all, and suggested temperatures that either lay some distance from their intercept or even lay off the scale of the graph.

Question 25(b)(ii)

(ii) Draw the **displayed formula** of butanol, C_4H_9OH.

[1]

The majority of candidates who did understand how to draw the formula of butanol did so with the OH group to the left of the molecule. Unfortunately, they forgot to rewrite this as HO–. Formulae with "OH–C-" could not be given credit. Others did not show the bonds between carbon and hydrogen, though included the bonds between the carbons within the chain. Many tried to introduce a double bond into their structure. A minority of candidates did not attempt this question.

Question 25(c)

(c) The alcohols all react in a similar way because they all contain the same **functional group**.

What is the functional group in an **alcohol** molecule?

..... **[1]**

Many, though not all, of the able candidates recognised that the functional group was the –OH group, though the most common functional group to be suggested was the alkenes. Many other candidates wrote down a number, usually between 1 and 18.

Question 25(d)

(d) Ethanol, C_2H_5OH, can be oxidised to **ethanoic acid** using potassium manganate(VII).

What is the formula of ethanoic acid?

..... **[1]**

This question was universally difficult. Many candidates tried to write a word or a formula equation for the reaction instead of suggesting a formula for ethanoic acid. The most common formula given was that of ethanol. A number of candidates left the question blank.

Erratum notice

Turn to **page 5** of the **question paper** and look at question **10**.

Cross out all of question 10 and do not attempt to answer it.

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