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Examiners' report

GATEWAY SCIENCE CHEMISTRY A

J248

For first teaching in 2016

J248/02 Summer 2024 series

Version 1

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Contents

Introduction

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

The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. A selection of candidate 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 2 series overview

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

Candidates approached this year's examination with confidence and compared with the last few years, there were far fewer scripts where most of the questions had not been attempted. Even when answers were incorrect it was obvious that the candidates had considered each question carefully and given plausible answers..

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• 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 underline key words in the command line(s) of the question • 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 • used the terms 'boiling point' and 'melting point' without confusion (**Question 17 (c) (i) and 17 (c) (ii) and Question 21 (a) (ii))** • in calculation questions, (**Questions 19e, 22c**) showed their working. Many candidates get the answers to calculations wrong, and their working is one way of gaining credit. Candidates are not penalised for incorrect working. • were able to balance simple equations (**Questions 7, 16 (b) and 21 (b) (iii)**) • had practical experience of handling laboratory glassware and performing such procedures as titrations for themselves (**Question 19**).	• had difficulty in basic mathematical manipulations (**Questions 13, 19 (e) and 22 (c)**) • gave explanations which, while relevant to the question, lacked sufficient detail, e.g. "pollution", or "harmful" (**Questions 18 (c) (ii) and 18 (d) (ii)**) • appeared to be unfamiliar with basic laboratory procedures such as titrations (**Question 19**).

Section A overview

Section A is made up of objective questions, and almost all candidates very sensibly attempted all the questions.

Question 1

1 What is the test for oxygen gas?

A Burns with a lilac flame

B Burns with a squeaky pop

C Relights a glowing splint

D Turns limewater milky

Your answer ☐ **[1]**

Most candidates recognised that oxygen relights a glowing splint, some went for the squeaky pop test.

Question 2

2 A student adds sodium hydroxide solution to copper sulfate solution.

What is the colour of the precipitate made?

A Blue

B Green

C Orange-brown

D White

Your answer ☐ **[1]**

Very few candidates knew that the copper forms a blue precipitate, many chose green or orange-brown.

Question 3

3 Which change would **decrease** the rate of a chemical reaction?

A Adding a catalyst

B Increasing the concentration of the solution

C Increasing the size of the solid pieces

D Increasing the temperature

Your answer ☐ **[1]**

That increasing size would slow the reaction was well understood. Candidates with less understanding often went for option A or B.

Question 4

4 What is the major source of oxides of nitrogen in the atmosphere?

A Combustion of impurities in coal

B High temperature reactions in car engines

C Incomplete combustion of fossil fuels

D Industrial processes such as metal extraction

Your answer ☐ **[1]**

As in other years very few candidates appreciated that car engines produce nitrogen oxides.

Question 5

5 How many different monomers (nucleotides) is DNA made from?

A 2

B 3

C 4

D 5

Your answer ☐ **[1]**

The answer to this question was well known, with A and B the most popular incorrect choices.

Question 6

6 What is the functional group in an alcohol molecule?

A –C–H

B –C=C–

C –COOH

D –O–H

Your answer ☐ **[1]**

Some of the higher scoring responses recognised that -OH is the functional group in alcohols. Option C was frequently chosen.

Question 7

7 What is the balanced equation for the reaction of sodium with oxygen?

A $Na + O \rightarrow NaO$

B $Na + O_2 \rightarrow NaO_2$

C $4Na + O_2 \rightarrow 2Na_2O$

D $Na_2 + 2O \rightarrow 2NaO$

Your answer ☐ **[1]**

Very few candidates could recognise which equation was balanced, and options such as B or D were chosen far more often than C.

Question 8

8 Which row describes the three halogens at room temperature?

	Chlorine	**Bromine**	**Iodine**
A	green gas	orange-brown gas	grey solid
B	green gas	orange-brown liquid	grey solid
C	green gas	orange-brown liquid	purple gas
D	green liquid	orange-brown liquid	grey solid

Your answer ☐ **[1]**

Higher scoring candidates remembered the room temperature states of all three halogens.

Question 9

9 The table shows the results of the reactions between four metals and their metal oxides.

Key: ✓ = reaction ✗ = no reaction

	Metal W oxide	Metal X oxide	Metal Y oxide	Metal Z oxide
Metal W		✗	✗	✗
Metal X	✓		✓	✗
Metal Y	✓	✗		✗
Metal Z	✓	✓	✓	

What is the correct order of reactivity of the metals, from the most reactive to the least reactive?

A W, Y, X, Z

B W, Z, Y, X

C Z, X, Y, W

D Z, Y, X, W

Your answer ☐ **[1]**

Almost all candidates interpreted the table correctly.

Question 10

10 Two chemicals react together over time to make a cloudy precipitate.

What is the best method for determining the rate of reaction?

A Measure the loss in mass using a balance.

B Use a gas syringe.

C Use a pH meter.

D Use the disappearing cross experiment.

Your answer ☐ **[1]**

The disappearing cross experiment was recognised by the majority of candidates.

Question 11

11 Which polymer would be best for making a washing up bowl?

Polymer	Maximum useable temperature (°C)	Strength
A	38	high
B	85	low
C	110	high
D	160	low

Your answer ☐ **[1]**

Almost all candidates answered this question correctly.

Question 12

12 4.8 dm^3 of air contains 0.12 dm^3 of water vapour.

What is the percentage of water vapour in the air?

A 0.3%

B 2.5%

C 12.0%

D 97.5%

Your answer ☐ **[1]**

Most candidates scored well on this question.

Question 13

13 Magnesium carbonate, $MgCO_3$, decomposes to make magnesium oxide, MgO.

Carbon dioxide is a waste product.

$MgCO_3 \rightarrow MgO + CO_2$

Relative formula mass (M_r): MgO = 40.3 CO_2 = 44.0

What is the atom economy of the reaction?

Use the equation: atom economy = $\frac{M_r \text{ of desired product}}{\text{total } M_r \text{ mass of all products}} \times 100$

A 47.8%

B 52.2%

C 91.6%

D 109.0%

Your answer ☐ **[1]**

Higher scoring candidates answered this well.

Question 14

14 Which substance is an **unsaturated** hydrocarbon?

A CH_4

B C_2H_6

C C_3H_6

D C_3H_8

Your answer ☐ **[1]**

Unsaturation was not widely recognised as the answer to this question.

Question 15

15 What happens when liquid bromine, Br_2, boils?

A Covalent bonds break

B Electrostatic forces break

C Intermolecular forces break

D Ionic bonds break

Your answer ☐ **[1]**

The nature of bonding continues to be a source of misunderstanding for most candidates, and option A was a frequent choice.

Section B overview

Section B contains a mixture of objective style questions and those requiring a longer response.

Question 16 (a)

16 This question is about compounds of carbon.

(a) The first member of the alkane homologous series is methane, CH_4.

State the name of the next alkane in the homologous series, C_2H_6.

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

While most of the higher scoring candidates answered this correctly, it might be productive to look at the types of errors made by the rest. Some candidates understood both what the question was asking and were familiar with the names in a homologous series, but suggested propane or butane. Others gave formulae such as C_3H_8 or suggested a range of elements.

Question 16 (b)

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

$$CH_4 + 2 \ldots\ldots\ldots \longrightarrow CO_2 + \ldots H_2O$$ **[2]**

The '2' in front of the water tended to be well answered, but it seemed that many candidates may not have realised that the term 'complete combustion' automatically involves oxygen unless stated otherwise. While high scoring candidates realised that the reactant was oxygen, it was sometimes written as O rather than O_2. H_2O was also frequently suggested, as were CO, CO_2 and OH.

Question 16 (c)

(c) Carbon monoxide, CO, is made in the **incomplete** combustion of methane.

State why carbon monoxide is a problem.

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

The toxic nature of carbon monoxide was well known. The most common alternative was that standard fallback, 'greenhouse gas' or a general statement about it being 'harmful'.

Question 16 (d)

(d) Methane is obtained from the fractional distillation of crude oil.

Complete the sentences to explain why crude oil is separated by fractional distillation.

Crude oil is separated by fractional distillation because the molecules have

different ....

Larger molecules have ..... intermolecular forces.

These intermolecular forces require more ..... to break.

[3]

High scoring candidates scored all 3 marks, and others were able to show at least partial understanding. The first line was sometimes left blank and not everyone realised that the forces require more energy to break them.

Question 16 (e)

(e) Fractional distillation produces a large amount of long chain molecules.

There is a high demand for short chain molecules.

Put a (ring) round the name of the process used to produce more short chain molecules.

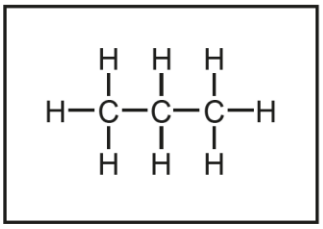
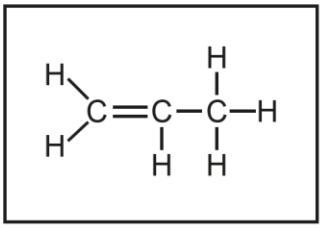
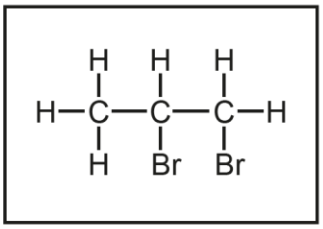
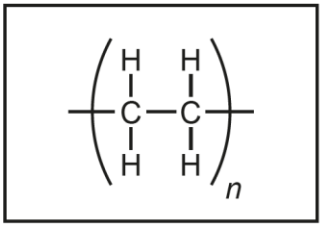
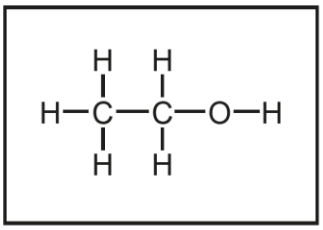
combustion **cracking** **oxidation** **polymerisation**

[1]

Most candidates correctly chose cracking. The main alternative choice was polymerisation, showing that at least they were thinking in the correct area of chemistry.

Question 16 (f)

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

Description	Structural Formula
Can be oxidised to a carboxylic acid	
Has the general formula C_nH_{2n+2}	
Decolourises bromine water	
Made in a polymerisation reaction	
	

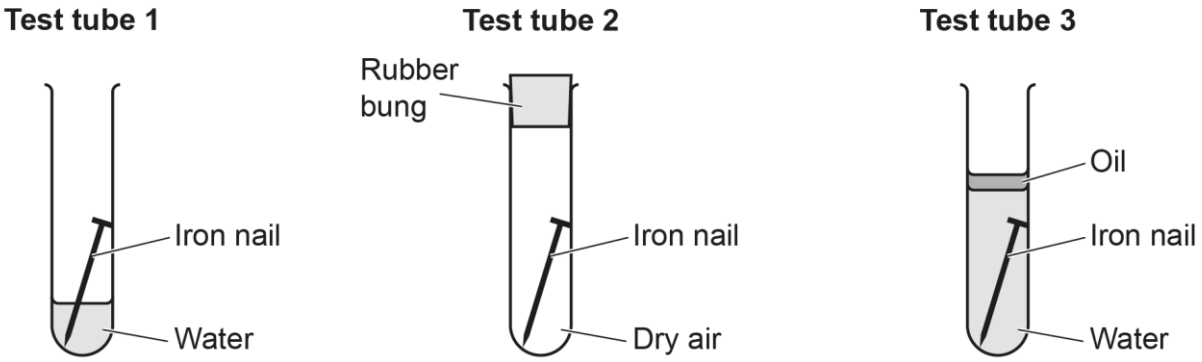
[4]

The alcohol to carboxylic acid was the best known of the links, and most candidates scored at least one of the others. There was no sense of random guesswork, all candidates made sensible suggestions, even when they were wrong. So the 'C_nH_{2n+2}' box was often connected to the repeating monomer, and the 'made in a polymerisation reaction' box to the propane. The only link that consistently caused problems was the 'Decolourises bromine water', which was in almost every case connected to the dibromopropane.

Question 17 (a)

17 A student sets up three test tubes to investigate the rusting of iron as shown in **Fig. 17.1**.

Fig. 17.1



The student measures the mass of each nail at the start and the end of the experiment.

Only the mass of the nail in test tube 1 increases.

(a) Explain why the iron nail in test tube 1 is the only nail that rusts.

.....

.....

.....

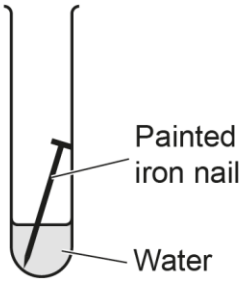
..... **[2]**

Almost all candidates linked the change to the presence of air or oxygen, with a considerable number also mentioning water, even if they showed some difficulty in tying that knowledge to the question.

Question 17 (b)

(b) The student sets up another test tube as shown in **Fig. 17.2**.

Fig. 17.2



The mass of this iron nail was unchanged after a week.

Explain why.

.....

.....

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

The barrier to water or oxygen aspect was well understood, though some candidates missed the significance of 'unchanged mass' and so didn't tie it in to rusting. It was not uncommon to see some confusion with galvanising and sacrificial anodes as some candidates tried to remember partially understood concepts.

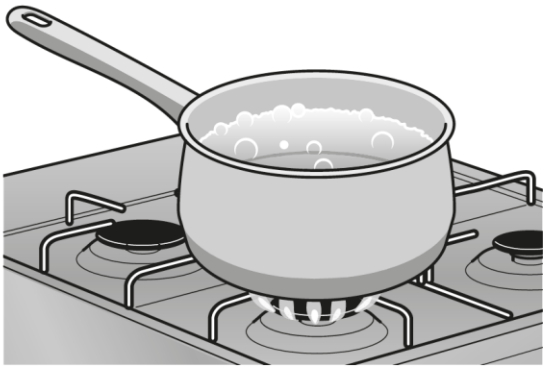
Question 17 (c) (i)

(c) **Table 17.1** shows some properties of three different materials.

Table 17.1

	Ceramic	Metal	Polymer
Melting point (°C)	2200	1083	204
Strength (MPa)	416	69	27
Relative thermal conductivity	18	388	0.21

(i) The diagram shows a pan of boiling water.



Which material would you choose to make the base of a pan?

Explain your choice using the information in **Table 17.1**.

Material .....

Explanation .....

.....

.....

[3]

Most candidates correctly chose metal. Here the question very deliberately gave candidates two types of information. While the melting point of the metal is by no means the highest, it is certainly adequate for the temperatures involved in cooking, whereas the relative thermal conductivity is the highest of the three. High scoring candidates made this distinction clearly and so gained full marks. Under the pressure of the exam conditions some candidates referred to boiling point when they clearly meant melting point.

A significant minority of candidates chose ceramic as the best material for the pan base.

Question 17 (c) (ii)

(ii) Estimate how many times higher the melting point of the ceramic is compared to the polymer.

You will need to round the melting points to 1 significant figure.

Answer = ... **[1]**

Many candidates read the question carefully, did the rounding to one significant figure as the first stage and so got the correct answer. However, there seemed to be examples of candidates, even those who were otherwise very successful, double thinking on this question, so performed some very complex calculation or worked out the boiling point ratio for ceramic to metal. In some cases candidates had problems with 'how many times higher' and subtracted one number from the other.

Question 17 (d)

(d) **Table 17.2** shows some information about recycling containers made from different materials.

Table 17.2

	Time powering a TV from the energy saved by recycling (hours)	CO_2 saved by recycling each year (kg)
Aluminium cans	4	294
Glass bottles	3	9
Plastic bottles	6	23

A student thinks that recycling aluminium cans is the most beneficial to the environment.

Explain why they are correct.

Use information from **Table 17.2**.

.....

.....

.....

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

This question used the same approach to tabular information as Question 17 (c) (i) and was well answered with many candidates even calculating a rough ratio of the CO_2 saving for aluminium compared to plastic. Many candidates gained the 'highest CO_2' mark here, even though they missed the 'highest thermal conductivity' mark earlier. Some candidates misunderstood the table and assumed it showed the amount of CO_2 produced rather than saved, but still managed to claim that the larger amount was a good thing.

Question 18 (a)

18

(a) The sentences describe one possible theory for how the Earth's atmosphere evolved.

A The Earth cooled.

B Carbon cycle now keeps the composition of the atmosphere almost constant.

C Carbon dioxide from the air dissolved in oceans.

D Water vapour condensed to form oceans.

E Plants evolved and used photosynthesis to take in carbon dioxide and make oxygen.

F Volcanoes released water vapour and carbon dioxide.

Write the letters in the boxes to show the correct order of the sentences.

Two have been done for you.

F			C		

[3]

Candidates scored the full range of marks on this question, and all their answers, even when incorrect, showed signs of careful thought. The main mistake was to put the formation of plants far too soon and the Earth's cooling much too late.

Question 18 (b)

(b) Complete the table to show the gases in the Earth's atmosphere today.

Gas	Percentage in Earth's atmosphere (%)
.....	78
.....	21
Carbon dioxide / noble gases / water vapour	1

[2]

Nitrogen and oxygen were the most commonly quoted gases, though often they were the wrong way round. Methane, hydrogen, or carbon dioxide were often given as the second gas.

Exemplar 1

(b) Complete the table to show the gases in the Earth's atmosphere today.

Gas	Percentage in Earth's atmosphere (%)
Oxygen	78
nitrogen	21
Carbon dioxide / noble gases / water vapour	1

[2]

As can be seen in this candidate response; the amount of oxygen in the atmosphere was often exaggerated in candidates' heads. This response was given 0 marks.

Question 18 (c) (i)

(c) Clean water is essential for life.

(i) State the name used for water that is safe to drink.

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

This question proved challenging as potable appeared to be a term not many candidates recognised.

Question 18 (c) (ii)

(ii) Explain why chlorine is added to water to make it safe to drink.

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

While many answers did little more than paraphrase the question with answers such as 'to make the water cleaner', others went on to discuss bacteria or microbes and so gained credit.

Question 18 (c) (iii)

(iii) Describe the test for chlorine gas.

.....

.....

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

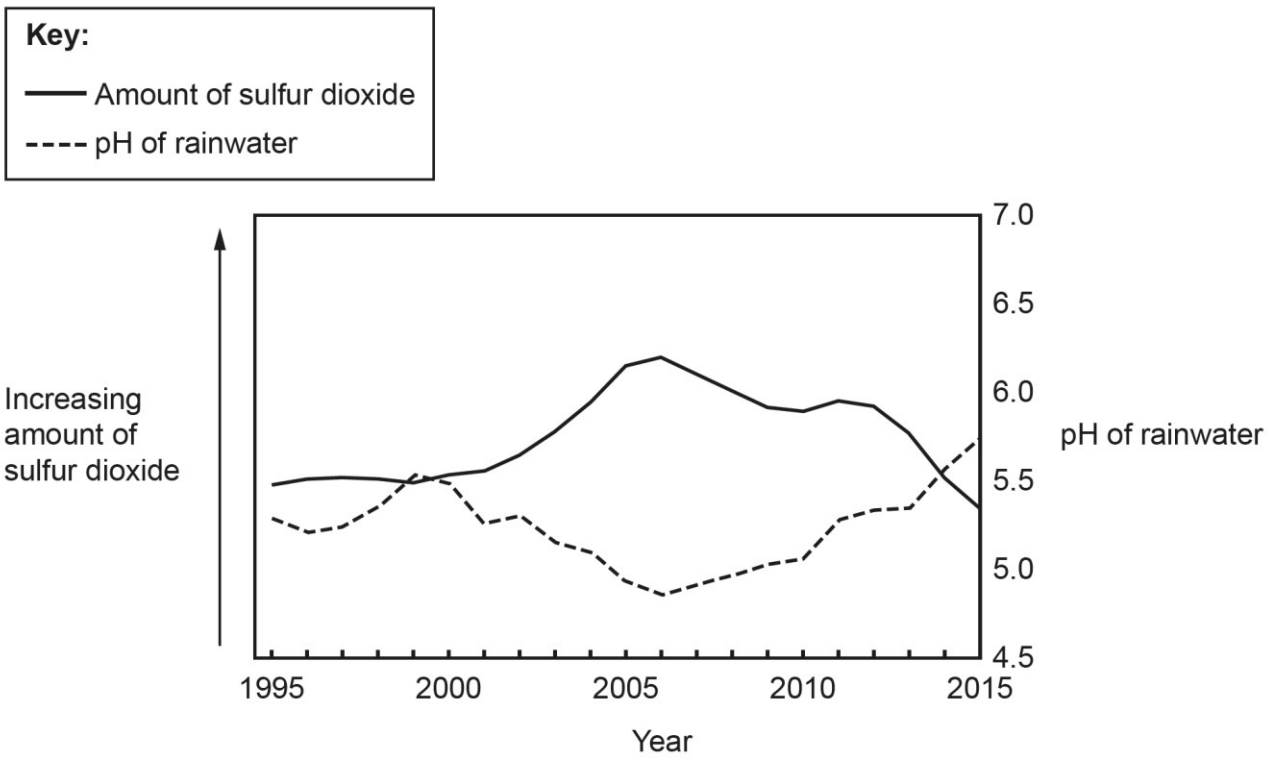
High scoring candidates discussed bleaching litmus, though it should be remembered that litmus does have to be damp. The squeaky pop test was often suggested, as was using lime water or looking for a flame colour. A significant number of candidates left this question blank.

Question 18 (d) (i)

(d) Sulfur dioxide is a pollutant in the atmosphere.

The graph shows how the amount of sulfur dioxide changed from 1995 to 2015.

The graph also shows how the pH of rainwater changed from 1995 to 2015.



Acid rain is an environmental problem.

(i) There is a link between the amount of sulfur dioxide in the atmosphere and the amount of acid rain.

Complete the table by correctly identifying which word finishes each sentence.

Put **one** tick (✓) in each row.

	Decreases	**Increases**	**Stays the same**
When the amount of sulfur dioxide increases the pH of rainwater...			
Rainwater is more acidic when the pH...			
When the rainwater is more acidic the amount of acid rain...			

[3]

This question was well answered, with the pH response causing the greatest problems.

Question 18 (d) (ii)

(ii) State **one** problem caused by acid rain.

.....

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

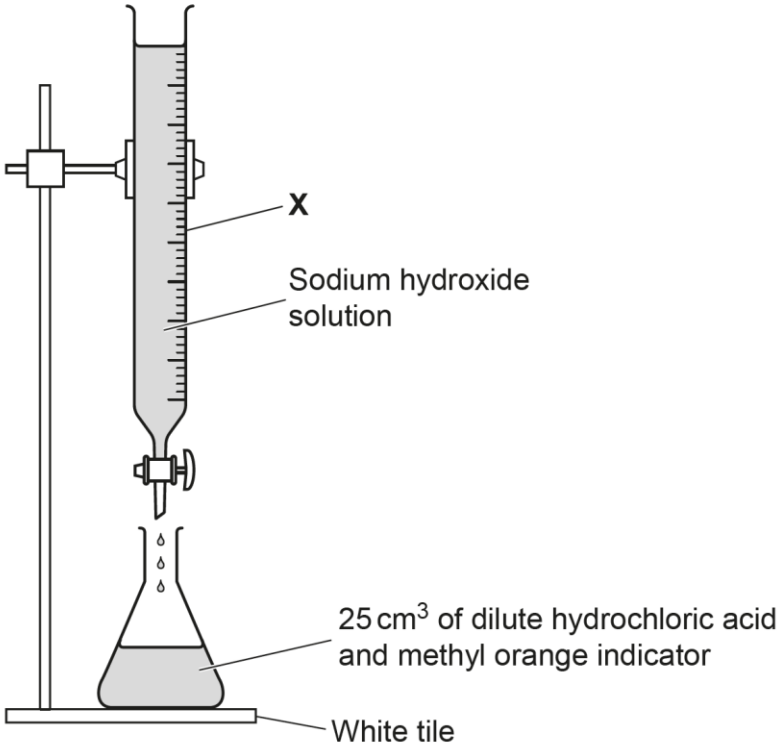
High scoring candidates answered this question well, though elsewhere there were many references to 'pollution', 'damage to habitats', 'global warming', and 'skin burns'.

Question 19 (a)

19 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) What is the name of the piece of equipment labelled **X**?

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

The highest achieving candidates were clearly familiar with this piece of apparatus, though in this case a range of highly idiosyncratic spellings had to be allowed. Many others made an educated guess and called it a titration tube.

Question 19 (b)

(b) The student places the conical flask on a white tile.

Explain why.

.....

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

Candidates who were familiar with titrations discussed being able to see the colour of the indicator, even if they didn't discuss the need to see the *change* in colour. Those with little experience made suggestions along the lines of preventing damage to the bench.

Question 19 (c)

(c) The student adds the alkali to the acid drop by drop near the endpoint of the titration.

Explain why.

.....

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

Candidates with first-hand experience of titrations discussed the rapidity of the change, others realised in more general terms that it would make the determination of the end point more accurate.

Exemplar 2

to know in wich drop exactly it will change

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

This candidate response shows clear familiarity with titration procedures. This response received 1 mark.

Question 19 (d)

(d) The neutralisation reaction between sodium hydroxide solution, NaOH, and dilute hydrochloric acid, HC*l*, makes a salt and water.

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

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

High attaining candidates recognised that the salt would be sodium chloride, even if they wrote it as $NaCl_2$. Others seemed unfamiliar with the term 'salt' and gave a wide variety of possible products. A significant number of candidates left this blank.

Question 19 (e)

(e) In another neutralisation reaction dilute sulfuric acid, H_2SO_4, reacts with potassium hydroxide solution, KOH.

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

Calculate the mass of potassium sulfate, K_2SO_4, that could be made from 6.54 g of dilute sulfuric acid, H_2SO_4.

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

Relative atomic mass (A_r): H = 1.0 K = 39.1 O = 16.0 S = 32.1

Mass of potassium sulfate = ... g **[4]**

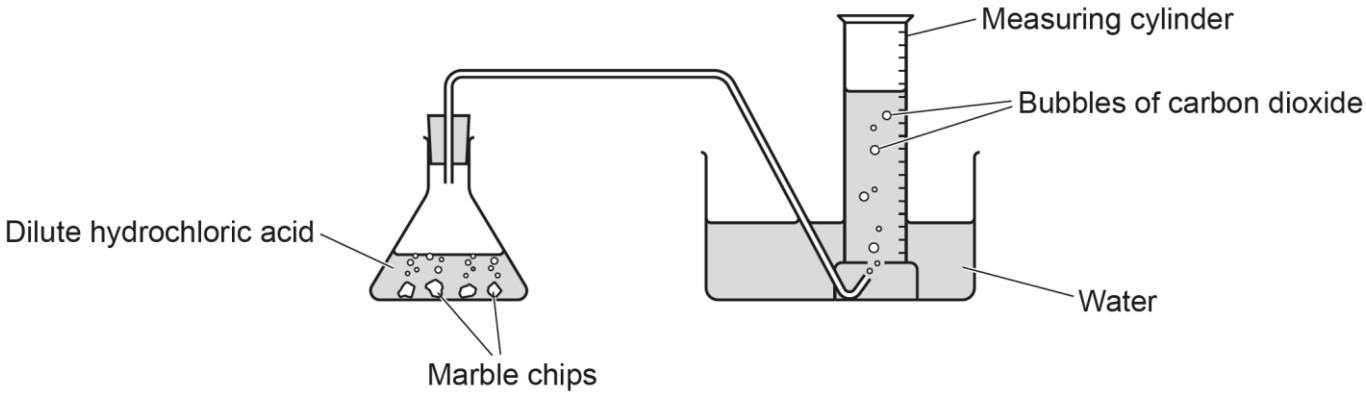
Many candidates scored at least partial credit by showing their working and had a basic idea of what sort of calculation should be performed. Values were often inserted into the wrong places, but examiners were able to award error carried forward marks for those who had attempted the correct type of calculation, and for those who had then adjusted their calculation answer to three significant figures.

Again, a significant number of candidates left this question blank.

Question 20 (a)

20 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) Which other piece of equipment could the student use to measure the volume of carbon dioxide gas collected?

Tick (✓) **one** box.

- Balance ☐
- Beaker ☐
- Gas syringe ☐
- Pipette ☐

[1]

This question was answered well; gas syringe was well known.

Question 20 (b) (i)

(b) The table shows the student's results.

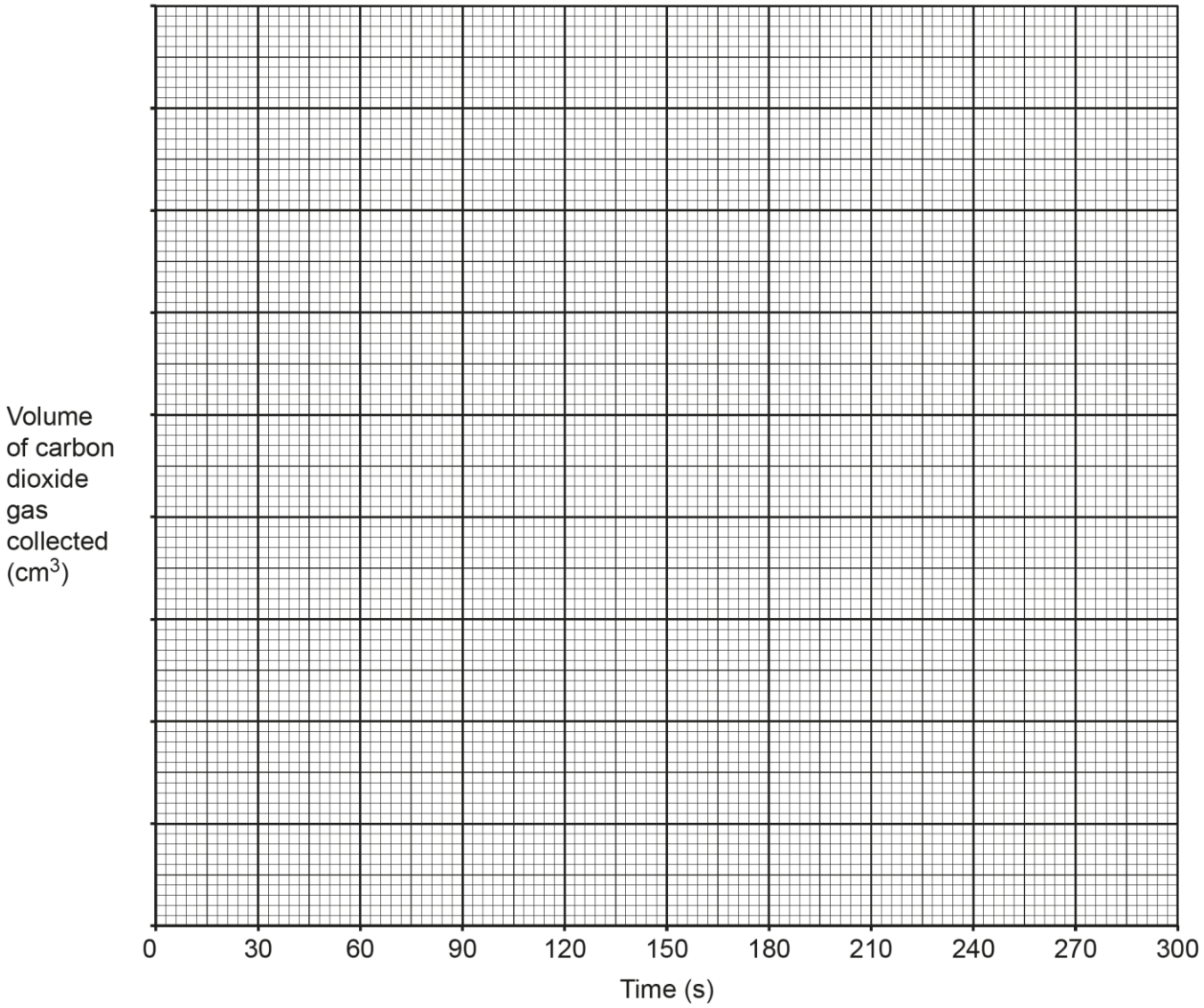
Time (s)	Volume of carbon dioxide gas collected (cm^3)
0	0
30	30
60	46
90	56
120	65
150	72
180	76
210	79
240	80
270	80

(i) Plot the results from the table on the graph. **[3]**

Choice of axes and point plotting was generally excellent, the only common mistake being the candidates not plotting the point at 0,0.

Question 20 (b) (ii)

(ii) Draw a curve of best fit. **[1]**



Candidates also attempted this part very well, drawing a smooth crisp curve that went through all the points. A few did not take their curve down to the 0,0 point, despite it being one of the values in the table, and some took the line above the 80 line to form a hump that then descended.

Question 20 (b) (iii)

(iii) State the time when the reaction stops.

Time = ... s **[1]**

This question was well answered, though some candidates went for 270 seconds.

Question 20 (b) (iv)

(iv) The student observes that there are still some marble chips in the conical flask when the reaction stops.

Explain why the reaction stops.

.....

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

High scoring candidates realised that the acid had been used up, many others made statements about there being no more gas left inside the marble.

Question 20 (c)*

(c)* 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
Reaction time (s)	225	25

Describe and explain the difference in the rate of reaction between the two experiments.
Use the student's results and the reacting particle model.

State how the student's experiment could be improved.

.....

.....

.....

.....

.....

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

Most candidates correctly linked reaction times to the idea of faster or slower, and many took this further and discussed rate of reaction. Some candidates wrote that the reaction rate was greater when the time was greater.

Higher attaining candidates understood the link between the size of the piece and surface area, but elsewhere there was a lot of confusion. Many candidates looked at the particles as individual pieces and stated that the larger pieces had a greater surface area, or that they took longer to break down because there's more to react with. A further feature was the number of candidates who linked size of piece to energy, suggesting that larger pieces require more energy to react, hence Experiment 1 was slower.

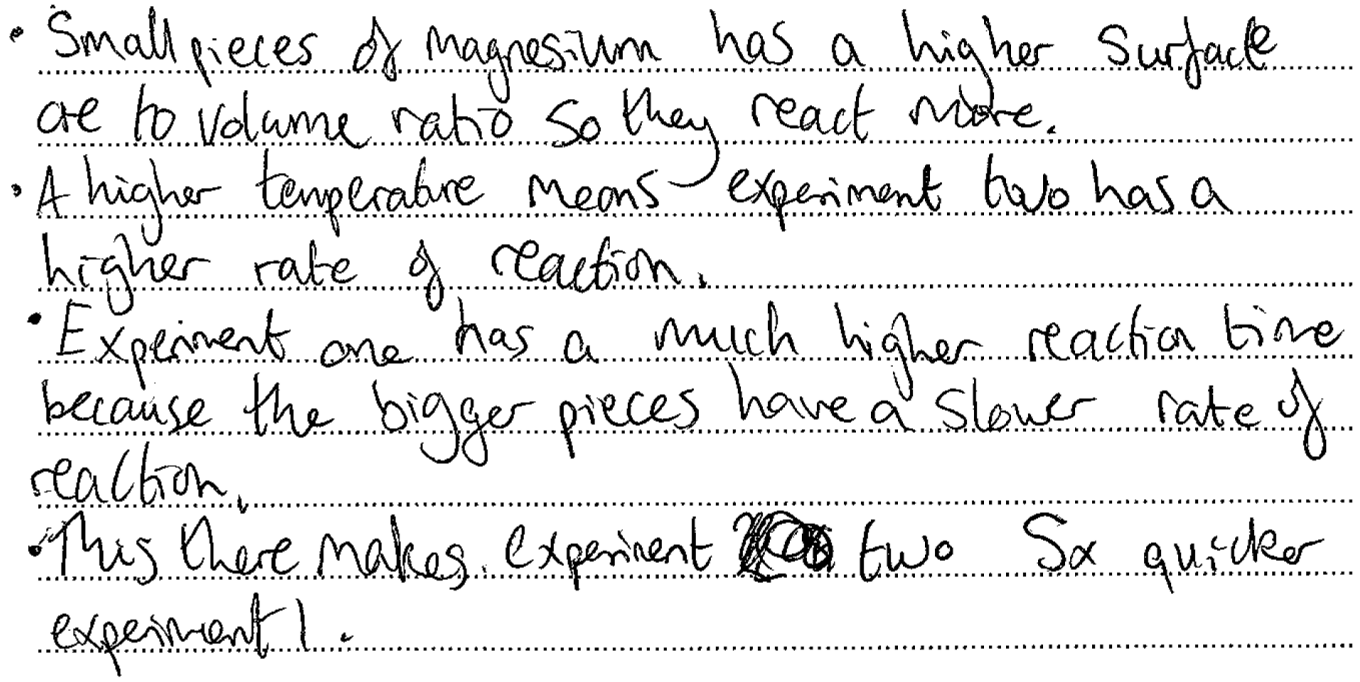
While those candidates who addressed the effect of varying the temperature often did so very well, there was a lot of confusion over causality, with many candidates stating that the faster reaction causes a temperature increase. A significant minority linked higher temperatures to increased catalytic effect.

Most candidates suggested improvements at some level, usually along the lines of 'do the experiment three times'. Candidates with better understanding suggested changing one or both of the variables, and the best answers realised that one variable should be held constant while the other one was changed. Some candidates had clearly been exposed to control of variables as a formal concept and wrote 'the variables need to be controlled', though unfortunately they were not always able to translate that statement into improvements for this particular experiment.

Misconception

While large pieces have large surface area as individuals, we don't deal with individual pieces but with the surface area of a collection of them. The surface area of each individual large piece is then swamped by the much greater surface area of the collection of small ones.

Exemplar 3



The candidate has given a clear description of the experiment and has appreciated that temperature and surface area are two separate variables. They have got surface area the right way round and have made a strong attempt at linking temperature and surface area to rate of reaction.

One major part of the question, suggested improvements, has not been addressed, so Level 3 is not a possibility. Also, no mention has been made of collision theory but the rest of this answer makes it a strong Level 2, 4 marks.

Question 21 (a) (i)

21

(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]**

High scoring candidates successfully suggested the decrease in boiling point or melting point down the group as the trend. Change in density was a much more problematic choice as the change down the group is not consistent.

Some candidates did not appear to realise that a 'trend' involves a continuous change and made statements such as 'the elements all have high boiling point'.

Assessment for learning

A trend is more than a statement of a simple property, it always involves a continuous change in that property.

Question 21 (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]**

Most candidates made very intelligent estimates. However, a large minority could not be given marks because they gave an estimated boiling point rather than the melting point.

Question 21 (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]**

Almost all the high attaining candidates wrote about there being one electron in the outer shell.

Question 21 (b) (ii)

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

Explain why.

.....

.....

.....

.....

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

Many candidates knew that the outer shell is significant but showed confused understanding. There were frequent references to 'more outer shells' and to 'more electrons in the outer shell'. The force of attraction was very often described as an intermolecular force. Candidates who didn't realise that reactivity depends on electrons often linked reactivity to density or boiling point.

Question 21 (b) (iii)

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

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

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

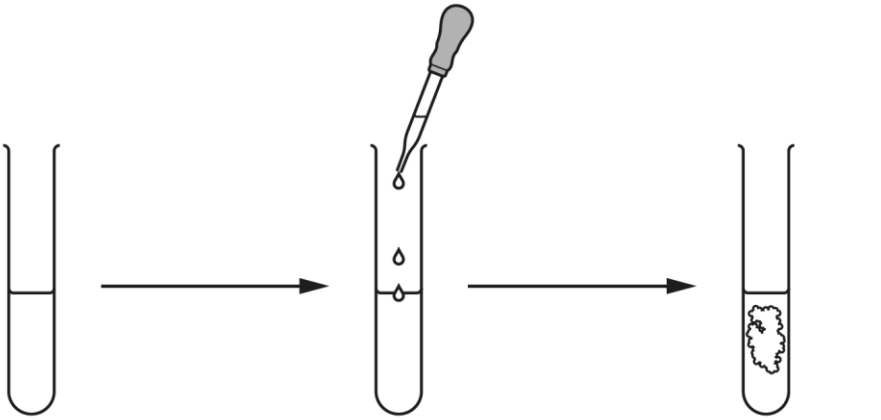
This was a very testing question, and candidates could either answer it completely or didn't really know where to start.

Question 21 (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]**

A handful of candidates seemed to be familiar with the concept of a false positive and identified the hydrochloric acid as the reason for this. However, the vast majority assumed that this was the wrong test and suggested bleaching litmus, flame tests or distillation. Many claimed that it didn't work because chloride ions were not in Group VII.

Assessment for learning

Sometimes a test does not work because it gives a positive result for the wrong reason.

Question 22 (a) (i)

22 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]**

The reversible symbol was correctly identified in this question by almost all candidates.

Question 22 (a) (ii)

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

.....

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

While the term was generally not recognised, there were many intelligent attempts, such as 'there is no energy transfer'. Some of the suggestions came very close, such as 'no more substance can be added'.

Question 22 (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]

This question was very well answered by the majority of candidates.

Question 22 (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]**

This question was very well answered, with temperature being the most frequent suggestion.

Question 22 (c)

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

They actually make 620 tonnes of ammonia.

Calculate the percentage yield of ammonia.

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

Many candidates performed the calculation with ease.

Question 22 (d)

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

Use the balanced symbol equation.

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

The task of articulating an explanation of why this has 100% atom economy proved to be a lot harder than performing atom economy calculations. Most candidates wrote out the equation but did not then give any explanation of what it showed.

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