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Oxford Cambridge and RSA

GCSE (9-1)

*Examiners' report*

# TWENTY FIRST CENTURY SCIENCE CHEMISTRY B

**J258**
For first teaching in 2016

## J258/01 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 J258/01 series overview

J258/01 is the first of two foundation tier papers for the revised specification for Chemistry B (Twenty First Century Science). It assesses breadth in chemistry, whereas its companion, J258/02, assesses depth. Both papers have a synoptic element.

***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.
- Were able to use ratios appropriately as part of their calculations.

Candidates who did less well on this paper still engaged with the questions in a thoughtful fashion and gave considered responses, and examiners commend them for this. Generally, they 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, whilst relevant to the question, lacked sufficient detail, e.g. "bad for the environment".
- Had difficulty in basic mathematical manipulations.

There was no evidence that any time constraints had led to a candidate underperforming and scripts where there was no response to the final question also had large sections of the paper which had not been tackled.

## Question 1(a)

**1** The greenhouse effect keeps the Earth warm so that life can survive.

**(a)** Carbon dioxide and water vapour are greenhouse gases.

Which gas in the list below is also a greenhouse gas?

Tick (✓) **one** box.

Hydrogen ☐

Methane ☐

Nitrogen ☐

Oxygen ☐

**[1]**

Most candidates successfully identified methane as the greenhouse gas, with a few suggesting nitrogen.

## Question 1(b)(i)

**(b)** This table shows the average surface temperature increase of the Earth since 1952.

| Year | Temperature Increase since 1952 (°C) |
|---|---|
| 1952 | 0.00 |
| 1962 | 0.05 |
| 1972 | 0.00 |
| 1982 | 0.14 |
| 1992 | 0.22 |
| 2002 | 0.62 |
| 2012 | 0.62 |

**(i)** Describe how the Earth's temperature has increased since 1952.

.......................................................................................................................................

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

Candidates are already told that the table shows temperature increase, so the important word in the command line is 'how'. Many candidates did appreciate that the increase was not regular, and so gained credit. A large minority of candidates answered a different question, "why", and so unfortunately gained no credit.

## Question 1(b)(ii)

**(ii)** Roughly how many times greater was the temperature increase in 2002 compared to the temperature increase in 1962?

Tick (✓) **one** box.

0.6 ☐

1.2 ☐

12 ☐

60 ☐

**[1]**

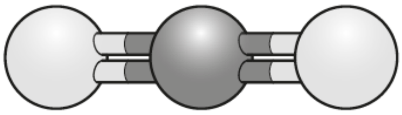
This question discriminated well. The most popular incorrect response was 0.6.

## Question 1(c)

**(c)** Here is a model of a molecule of carbon dioxide.

Draw lines to link parts of this model to the correct labels.

Some of the labels are incorrect.



Carbon dioxide

Carbon atom

Double bond

Hydrogen atom

Ionic bond

Oxygen atom

**[3]**

Most candidates correctly identified the carbon atom, double bonds and the oxygen atoms. The most frequent errors were to substitute hydrogen for oxygen and, less often, to connect the same part of the model to more than one box.

## Question 2(a)

**2** 'Sherbet' is a powder that fizzes on your tongue. This happens because the powder reacts with water.

**(a)** Beth thinks that the reaction between sherbet and water is endothermic.

She does an experiment to find out if she is right.

Describe what she does.

What result will she get if the reaction is endothermic?

.......................................................................................................................................

.......................................................................................................................................

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

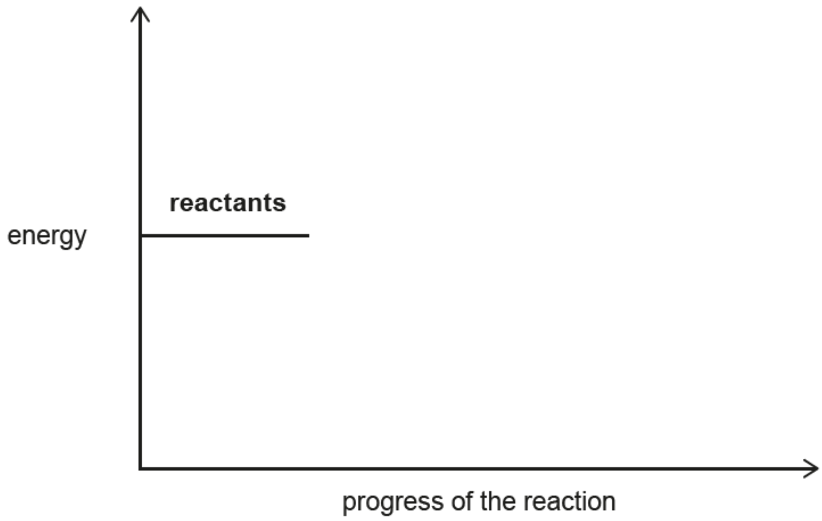
Almost all candidates, whatever their ability, responded to the second command line, though the concept of an endothermic reaction proved to be very problematic. Most candidates appreciated that endothermic reactions take in energy. Relating that energy change to temperature change was a much harder leap to make. Most candidates suggested that an endothermic reaction takes in heat from the surroundings and so warms up the contents of the beaker.

Higher ability candidates answered the first command line as well, giving an indication of how the experiment was performed. Even when that was not the case, sometimes enough detail leaked out incidentally and examiners were able to give credit.

## Question 2(b)

**(b)** Complete the reaction profile for an **endothermic** reaction.

Label your diagram with these words: **products**, **activation energy**




**[3]**

Examiners were pleased that most candidates were familiar with the concept of a reaction profile and their most common response, that of an exothermic reaction, was able to gain at least some credit. The answers showed a major disjunction between candidates' knowledge of the energy change and how it is represented diagrammatically, suggesting an insecure understanding. Most candidates who, in the previous question, stated that the reaction takes in energy, actually went on to put the product energy level *lower* than that for the reactant.

Higher ability candidates not only drew the correct graph shape, but indicated the activation energy. Unfortunately, in many cases the levels at which their arrows started and ended were not clear enough to gain credit.

## Question 3(a)(i)

3 Some farmers use manure from cows as a natural fertiliser. Other farmers use ammonium sulfate as a synthetic fertiliser.

(a) (i) The formula of ammonium sulfate is $(NH_4)_2SO_4$.

Which elements does ammonium sulfate contain?

Tick (✓) **four** boxes.

| | |
|---|---|
| Ammonia | ☐ |
| Hydrogen | ☐ |
| Nitrogen | ☐ |
| Oxygen | ☐ |
| Sodium | ☐ |
| Sulfur | ☐ |

**[1]**

This question discriminated well, with many candidates gaining credit.

## Question 3(a)(ii)

(ii) Plants need one of the elements in ammonium sulfate to grow faster.

Write down the name of this element.

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

More able candidates chose nitrogen, with the main incorrect choice being oxygen. This latter, whilst incorrect, struck examiners as an indication that less able candidates were thinking through the alternatives carefully.

## Question 3(b)(i)

(b) Farmers can choose manure or ammonium sulfate as a fertiliser.

Farmers need to consider the cost of the fertiliser.

(i) Suggest **one** reason, **other than cost**, why some farmers use manure rather than ammonium sulfate as a fertiliser.

........................................................................................................................

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

Examiners got the sense that, in this question, scientific thinking had been swamped by popular attitudes. Candidates of all abilities suggested that manure was used because ammonium nitrate contained either 'chemicals' or 'artificial chemicals'. Others suggested that manure is preferable because it is 'natural'. A minority of candidates gave more considered responses, including one excellent answer which discussed the ethics of public perception.

## Exemplar 1

**(i)** Suggest **one** reason, **other than cost**, why some farmers use manure rather than ammonium sulfate as a fertiliser.

It a natural source that they have easy access from as he is on a farm and can take it from the cows **[1]**

This answer was credited one mark for reference to using a resource/waste product that is produced by another part of the farm.

## Question 3(b)(ii)

**(ii)** Suggest **one** reason, **other than cost**, why some farmers use ammonium sulfate rather than manure as a fertiliser.

.......................................................................................................................................

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

Many candidates were able to make reasonable suggestions for the use of ammonium sulfate.

## Question 3(c)(i)

**(c)** Alex has a solution of ammonium sulfate.

**(i)** Alex uses barium chloride solution to show that the solution contains sulfate ions.

Describe what Alex sees **and** name the substance formed.

Alex sees .......................................................................................................

.......................................................................................................................

Name of substance formed .........................................................................

**[3]**

Few candidates appeared to recognise this test. Those candidates who did gain credit often did so by recognising that barium sulfate would be formed.

## Question 3 (c)(ii)

**(ii)** Alex wants to make **solid** ammonium sulfate from the solution of ammonium sulfate.

What would Alex do first?

Tick (✓) **one** box.

Distil the solution. ☐

Evaporate the solution. ☐

Filter the solution. ☐

Use chromatography. ☐

**[1]**

Filter or distil were chosen more frequently than the correct response, evaporate.

## Question 3(d)

**(d)** 132 g of ammonium sulfate contain 28 g of nitrogen.

Calculate the mass of nitrogen in **1.0 kg** of ammonium sulfate.

Give your answer in kg and to **2** decimal places.

Mass = ............................................... kg **[3]**

This question demanded an ability to handle ratios, and many candidates were able to score at least some credit. The requirement for two decimal places was generally well understood, though not by all. Almost half the candidates did not to answer this question correctly, but still gained some credit by showing their working.

## Question 4(a)

**4** Amir investigates the halogens.

**Table 4.1** shows some information about the halogens.

**(a)** Complete **Table 4.1** by filling in the missing information.

| | **Chlorine** | **Bromine** | **Iodine** |
|---|---|---|---|
| **Appearance and state at room temperature and pressure** | yellow-green gas | | grey solid |
| **Colour as a gas** | yellow-green | red-brown | |
| **Product when reacted with sodium** | | NaBr | NaI |

**[3]**

**Table 4.1**

Most candidates gave the correct formula for sodium chloride, and knew the colour of bromine. Unfortunately, they often missed out any reference to bromine being a liquid. Others suggested that it is a gas or a solid. The higher ability candidates were also able to give some variant of purple for the colour of iodine vapour.

## Question 4(b)(i)

**(b)** Amir reacts some chlorine solution with a solution of potassium bromide.

The solution turns brown.

**(i)** Complete **word** and **chemical** equations for the reaction that happens.

chlorine + potassium bromide → .................................... + bromine

$Cl_2$ + 2 ........................... → 2KCl + $Br_2$

**[2]**

This part was well answered. The most common mistakes were to write potassium chlor***ine*** instead of potassium chloride and, less frequently, to write the formula of potassium bromide as $KBr_2$.

## Question 4(b)(ii)

**(ii)** Use the equations in **(b)(i)** to explain why the solution turns brown.

..........................................................................................................................................

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

This part was well answered.

## Question 5(a)

5 **Table 5.1** shows some data for four elements **Q**, **R**, **T** and **X**.

| Element | Melting point (°C) | Boiling point (°C) | Electrical conductivity when solid | Reactivity |
|---|---|---|---|---|
| **Q** | −189 | −186 | none | unreactive |
| **R** | 98 | 883 | good | very reactive |
| **T** | −101 | −35 | none | very reactive |
| **X** | 119 | 445 | none | fairly reactive |

**Table 5.1**

**(a)** Which element in **Table 5.1** is a metal?

Explain your answer.

Element .......................................

Explanation ..........................................................................................................................

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

Most candidates identified R as the metal. They usually suggested that more than one property as being relevant, but almost always included electrical conductivity in their answer. Interestingly, higher ability candidates tended to put electrical conductivity first whereas others dealt with their chosen properties in the order in which they appear on the table.

## Question 5(b)

**(b)** Which element in **Table 5.1** is a liquid at 500 °C? ....................................... **[1]**

The higher ability candidates correctly identified the liquid. Others showed the usual problems with interpreting melting points and boiling points, and gave 'X' as their answer.

## Question 5(c)

**(c)** Which element in **Table 5.1** has an atom with eight electrons in its outer shell?

Explain your answer.

Element .......................................

Explanation ..........................................................................................................................

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

Most candidates could identify element Q, and many quoted lack of reactivity as the key factor. A small minority thought that eight electrons in the outer shell indicated high reactivity and suggested element T.

## Question 5(d)

**(d)** Element **T** in **Table 5.1** reacts with a metal to make a compound.

What type of structure does this compound have?

Tick (✓) **one** box.

Giant covalent ☐

Giant ionic ☐

Simple covalent ☐

**[1]**

Few candidates, even the most able, realised that element T was likely to form an ionic compound.

## Question 5(e)

**(e)** An element has an atomic number of 16.

How many electrons are there in an atom of this element?

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

This question was answered well. Even candidates who did not know the answer made intelligent suggestions.

## Question 6(a)

**6** A factory electrolyses sodium chloride solution to make useful products.

**(a)** The electrolysis produces chlorine.

Complete the sentence by putting a (ring) around one word in each pair.

The **chlorine / chloride** ions are attracted to the **positive / negative** electrode, where they lose **electrons / protons**.

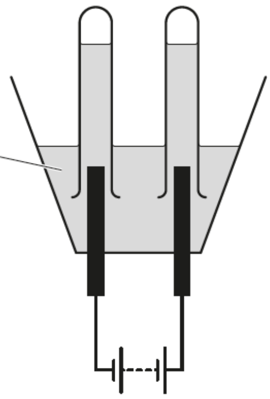
**[3]**

Most candidates knew that the ions lose electrons, and many that they were chloride ions. The higher ability candidates knew which electrode the ions were attracted to.

## Question 6(b)

**(b)** Nina electrolyses a solution of sodium chloride.

She uses this apparatus.




Nina thinks that the experiment makes chlorine gas at one electrode.

She is not sure if the gas at the other electrode is hydrogen or oxygen.

Describe the tests Nina can do to identify chlorine, hydrogen and oxygen **and** the results she should expect.

Chlorine ..................................................................................................................

..................................................................................................................

Hydrogen ..................................................................................................................

..................................................................................................................

Oxygen ..................................................................................................................

..................................................................................................................

**[3]**

A significant minority of candidates omitted this question. However, the majority who did answer it showed clear experience of the two most memorable tests, those for hydrogen and oxygen. Unfortunately, a significant number of these answers used descriptions such as "the squeaky pop test", or did not say if the splint was lit or glowing, and so did not gain credit. The test for chlorine was not well known, though in such cases candidates almost always made intelligent suggestions.

## Question 7(a)(i)

**7** Manganese is a metallic element. It is mixed with iron to make an alloy.

**(a)** Manganese is made by heating manganese oxide with carbon.

**(i)** Write a **word** equation for this reaction.

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

Most candidates wrote "manganese oxide + carbon → manganese". Some of the higher ability candidates realised the equation had to show what happened to the carbon.

Some candidates wrote word equations involving magnesium instead of manganese.

## Question 7(a)(ii)

**(ii)** Aluminium **cannot** be made by heating aluminium oxide with carbon.

Which of the statements below are **true** and which are **false**?

Put a tick (✓) in one box in **each** row.

| | True | False |
|---|---|---|
| Carbon is more reactive than aluminium. | | |
| Carbon reduces manganese oxide. | | |
| Aluminium is more reactive than manganese. | | |
| Carbon reduces aluminium oxide. | | |

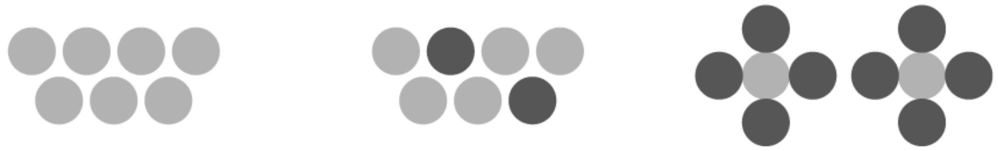
**[4]**

Most candidates gained some credit on this question. Examiners wondered how familiar a concept this was to candidates, as the higher ability candidates did not perform significantly better than the others.

## Question 7(b)(i)

**(b)** **(i)** Which model is an alloy?

Put a (ring) around the correct answer.



**[1]**

The higher ability candidates often recognised the significance of the second diagram, and correctly stated that this showed the alloy.

## Question 7(b)(ii)

**(b)** Kai buys two bottles of milk of magnesia, called **Gutcalm** and **Milkomag**.

He has a solution of hydrochloric acid.

He finds out how much acid is needed to neutralise 25 $cm^3$ from each bottle.

Here are Kai's results.

| | **Medicine** | |
|---|---|---|
| | **Gutcalm** | **Milkomag** |
| **Cost of a 250 $cm^3$ bottle** | £1.75 | £1.50 |
| **Volume of acid needed to neutralise 25.0 $cm^3$** | 24.0 $cm^3$ | 21.0 $cm^3$ |

**(i)** Which medicine gives the best value for money for neutralising acid?

**[2]**

Many candidates gave answers such as "positive" and "negative" for the two boxes. Others showed a partial understanding and correctly identified the electrons, sometimes even referring to them as delocalised. The left-hand box proved more problematic, with "protons" being a common response.

## Question 8(a)

**8** Milk of magnesia cures indigestion.

It neutralises acid in the stomach.

Milk of magnesia is a mixture of magnesium hydroxide and water.

The formula of magnesium hydroxide is $Mg(OH)_2$.

**(a)** Complete the equation for neutralisation.

$$H^+ + \text{..................} \rightarrow H_2O$$

**[1]**

This ionic equation proved to be highly problematic for most candidates, with many trying to include magnesium ions in their answer.

## Question 8(b)(i)

**(i)** Which medicine gives the best value for money for neutralising acid?

**[2]**

A minority of candidates realised that this question required a division calculation involving cost and price, and so gained at least some credit.

## Question 8(b)(ii)

**(ii)** Kai measures the 25 $cm^3$ of milk of magnesia using a beaker.

What could he do to measure the volume **more** accurately?

Tick (✓) **one** box.

Use a volumetric pipette. ☐

Use a conical flask. ☐

Use a large measuring cylinder. ☐

Use a gas syringe. ☐

**[1]**

The use of a volumetric pipette was well recognised.

## Question 9(a)

9 **Table 9.1** shows the properties of three polymers.

| Polymer | Relative breaking strength | Flexibility | Temperature at which it softens (°C) | Cost |
|---|---|---|---|---|
| **A** | very high | fairly flexible | 250 | very high |
| **B** | low | very flexible | 70 | low |
| **C** | fairly low | stiff | 150 | low |

**Table 9.1**

**(a)** A company wants to make cups to hold boiling water.

Which polymer, **A**, **B** or **C**, should the company choose?

Give **two** reasons for your choice using the information in **Table 9.1**.

Polymer ................................

Reason 1 ..........................................................................................................................

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

This question was answered well, with higher ability candidates gaining full credit. Some candidates confused the term "breaking strength" with "ease of breaking", and suggested that Polymer B had a low chance of breaking.

## Question 9(b)

**(b)** Which of polymers, **A**, **B** and **C**, has the **weakest** intermolecular forces?

Give a reason for your answer.

Polymer ................................

Reason ..........................................................................................................................

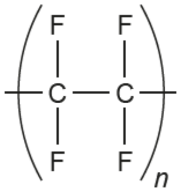
.......................................................................................................................... **[2]**

The consequences of weak intermolecular forces were well understood.

## Question 9(c)

**(c)** Polymer **A** is an addition polymer.

Draw the structure of the monomer that forms polymer **A**.

| **Repeating unit of polymer A** | **Structure of monomer** |
|---|---|
|  | |

**[1]**

This question exposed considerable uncertainty over the meaning of "monomer". By far the most common response was to draw the repeating unit without the brackets.

## Question 10(a)

**10** Some fractions from crude oil are cracked to give ethene, $C_2H_4$.

**(a)** Which homologous series is ethene a member of?

Tick (✓) **one** box.

Alcohols ☐

Alkanes ☐

Alkenes ☐

Carboxylic acids ☐

**[1]**

The majority of candidates knew that ethene is an alkene.

## Question 10(b)

**(b)** Some fractions from crude oil are used as fuels.

Some fractions are used as a feedstock to make chemicals like ethene.

In the future, more crude oil will be used as a feedstock and less will be used as a fuel.

Give **two** reasons for this.

1 ........................................................................................................................

........................................................................................................................

2 ........................................................................................................................

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

Many candidates knew that crude oil is not a sustainable resource, and some were able to give a second reason that went beyond 'it's good for the environment'.

## Question 10(c)(i)

**(c)** Compound **A** is a hydrocarbon in crude oil.

This equation shows the ratio of carbon atoms to hydrogen atoms in some hydrocarbons.

$$\frac{\text{number of carbon atoms}}{\text{number of hydrogen atoms}} = \frac{1}{3}$$

**(i)** The empirical formula of compound **A** is $CH_3$.

Does this formula agree with the equation?

Explain your answer.

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

This question discriminated well

## Question 10(c)(ii)

**(ii)** Explain why $CH_3$ **cannot** be the molecular formula of compound **A**.

........................................................................................................................

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

Most candidates had difficulty in expressing an explanation of why $CH_3$ cannot be the molecular formula.

## Question 10(c)(iii)

**(iii)** Another hydrocarbon has a formula which fits the equation.

The formula has two carbon atoms.

Draw a fully displayed formula for this hydrocarbon.

**[1]**

This question discriminated well.

## Question 11(a)

**11** Nanoparticles of cerium oxide, $CeO_2$, are added to diesel fuel.

**(a)** What is the size of a nanoparticle?

Tick (✓) **one** box.

0.1 nm ☐

10 nm ☐

150 nm ☐

1000 nm ☐

**[1]**

A minority of candidates could recall the size of a nanoparticle.

## Question 11(b)

**(b)** Cerium oxide is a very expensive solid.

The cerium oxide nanoparticles act as a catalyst.
They help the fuel to burn completely so that less pollutant gases are formed.

Nanoparticles have a much higher surface area to volume ratio than solids.

Explain the advantages of using cerium oxide in the form of nanoparticles rather than as a solid.

........................................................................................................................................

........................................................................................................................................

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

Explaining the advantage of using cerium oxide nanoparticles proved to be highly problematic for most candidates. There were many answers along the lines of "it works better".

## Question 11(c)

**(c)** Diesel is a fossil fuel.

Name **two** pollutants caused by the incomplete combustion of fossil fuels.

1 ........................................................................................................................................

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

The main problem was to miss the words 'incomplete combustion' in the command line, giving carbon dioxide as one of their answers. 'Methane' was the most common other answer.

## Question (d)(i)

**(d)** **(i)** $CeO_2$ contains $O^{2-}$ ions.

What is the charge on the cerium ion?

Put a (ring) around the correct answer.

**1+** **2+** **3+** **4+** **5+** **6+**

**[1]**

By far the most frequent choice was 2+.

## Question (d)(ii)

**(ii)** 160 g of $CeO_2$ contains 30 g of oxygen.

Calculate the percentage of **cerium** in $CeO_2$.

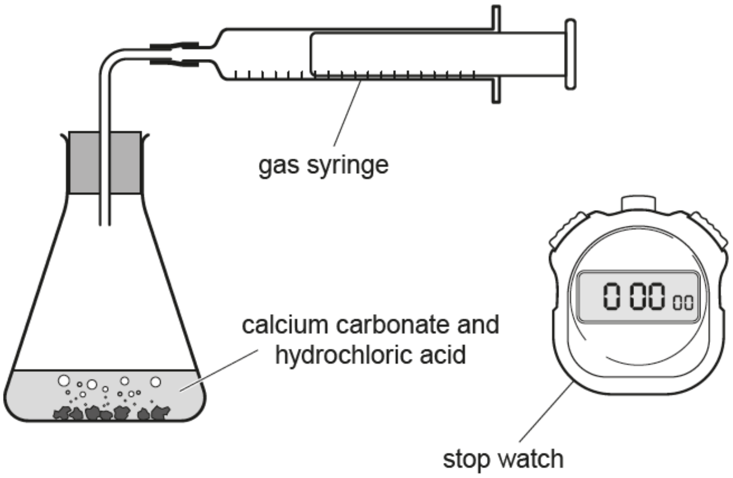
Percentage of cerium = ................................................ % **[3]**

Most candidates gained at least some credit on this question, usually for showing working that proved that the mass of cerium had been calculated. The higher ability candidates often gained full credit.

## Question 12(a)

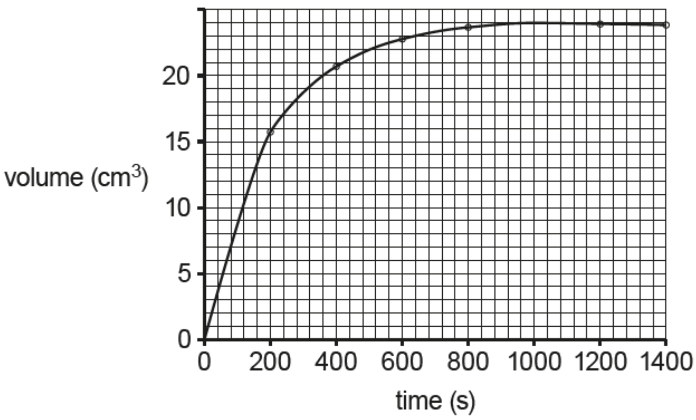
**12** Calcium carbonate reacts with excess hydrochloric acid to make carbon dioxide.

Here is the apparatus Jack uses to investigate the reaction.




Jack records the volume of carbon dioxide made every 200 seconds.

Here is a graph of his results.




**(a)** Use the graph to calculate the rate of reaction over the first 100 s.

Rate = ............................................... $cm^3$/s **[2]**

Question 12 is targeted at standard demand and is an overlap question with the higher tier paper.
The majority of candidates gained the first mark by reading off a suitable value from the graph, and the higher ability candidates went on to calculate the rate.

## Question 12(b)

**(b)** Amaya wants to repeat Jack's experiment.

She uses the same mass of calcium carbonate.

She uses the same volume and concentration of hydrochloric acid.

Which **two** other factors does she need to keep the same?

1 ................................................................................................................................

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

Candidates encountered surprising levels of difficulty with this question. Answers were often very general and focused on the equipment, "keep the apparatus the same" and "keep the syringe the same". The other main suggestion was "keep the timing the same", which again lacked sufficient detail to be awarded credit.

## Question 12(c)

**(c)** Jack repeats his experiment with more concentrated hydrochloric acid.

He keeps **all** other factors the same. The rate of reaction is faster.

Explain why.

Write about particles in your answer.

................................................................................................................................

................................................................................................................................

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

Almost all candidates attempted a basic explanation. Higher ability candidates took their explanations beyond discussing 'more particles' and 'more collisions' by discussing the space between the particles and the collision frequency rather than number, and so gained credit.

## Question 12(d)

**(d)** 0.10 g of calcium carbonate makes 24 $cm^3$ of carbon dioxide.

Jack uses 0.070 g of calcium carbonate.

What volume of carbon dioxide does he make?

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

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

This question discriminated well, with many candidates gaining at least some credit. This was usually because they had some intuitive sense of what to do with the numbers, and so gained credit for their working even when the answer was, as was often the case, incorrect. The requirement for two significant figures was also often noted and acted upon.

## Question 13(a)

**13** Fizzy water can be found naturally.

The water is fizzy because it contains dissolved carbon dioxide gas. The carbon dioxide comes from the decomposition of rocks that contain carbonate compounds.

One compound found in rocks is magnesium carbonate.

Ali investigates the decomposition of magnesium carbonate by heating a small amount in a test tube. This is the equation for the reaction.

$MgCO_3(s) \rightarrow MgO(s) + CO_2(g)$

**(a)** Ali weighs the test tube before and after heating.

The mass of the test tube after heating is less.

Ali says that this means the **law of conservation of mass** is not correct.

Explain why Ali is **wrong**.

..............................................................................................................................................

..............................................................................................................................................

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

Question 13 is targeted at standard demand and is an overlap question with the higher tier paper. A significant minority of candidates did not to attempt one or more parts of this question as a whole.

For part a), higher ability candidates often appreciated that a gas had been given off. This was most commonly described as 'evaporation'. Some higher ability candidates realised that the gas has mass.

## Question 13(b)

**(b)** Calculate the atom economy for the production of carbon dioxide in this reaction.

Use the formula: atom economy = $\frac{\text{mass of atoms in desired product}}{\text{total mass of atoms in reactants}} \times 100\ \%$

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

Atom economy = ............................................... % **[4]**

Many candidates gained some credit for their working, successfully calculating the relative molar masses of magnesium carbonate and of carbon dioxide, even if performing the division proved a lot more taxing.

## Question 13(c)(i)

**(c)** In theory, 42.0 g of $MgCO_3$ loses 22.0 g of carbon dioxide when it completely decomposes.

Ali heats 4.2 g of $MgCO_3$.

**(i)** Calculate the mass of carbon dioxide lost when 4.2 g of $MgCO_3$ completely decomposes.

Mass = ............................................... g **[1]**

This question discriminated well.

## Question 13(c)(ii)

**(ii)** In Ali's experiment, the mass of carbon dioxide lost is 1.8 g.

Calculate the percentage yield of carbon dioxide in Ali's experiment.

Percentage yield = ............................................... % **[1]**

Candidates were expected to know how to calculate percentage yield. Most candidates realised that they had to divide one number by another and multiply by 100, but experienced great difficulty in choosing the correct two numbers. Variants of an atom economy were often carried out.

## Question 13(d)

**(d)** Magnesium oxide, MgO, is an ionic compound.

Draw a 'dot and cross' diagram for the ions in magnesium oxide.

Show the outer electron shells only.

**[2]**

Many of the dot and cross diagrams resembled covalent compounds rather than ionic.

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