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Examiners' report

GCSE

COMBINED SCIENCE B (TWENTY FIRST CENTURY SCIENCE)

OCR Level 1/Level 2 GCSE (9-1) in Combined Science B (Twenty First Century Science)

J260

For first teaching in 2016

J260/06 Summer 2025 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 responses 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 Teach Cambridge.

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Paper 6 series overview

J260/06 is the Higher tier paper for the chemistry unit of the GCSE (9-1) Combined Science B (Twenty First Century Science). The paper covers all of the chemistry content of the specification.

To do well on this paper candidates need to have a good all-round knowledge and to be able to apply it in a structured and logical sequence.

They need to be able to analyse data, both numerical and verbal, in order to draw conclusions or make predictions.

They need to have experienced a range of practical techniques and be able to both recall them and to apply them to unfamiliar experiments.

They need to have a range of basic mathematical skills and the ability to follow a logical sequence in multi-step calculations.

Candidates were well prepared and most attempted all the questions. Candidates did, however, struggle to express themselves in longer written responses.

There was no evidence of issues with time management.

Most candidates showed some working in calculations enabling them to gain some marks even if they were able to reach the final answer. Some did not structure their working and so were unable to follow a sequence of steps in a multi-step calculation.

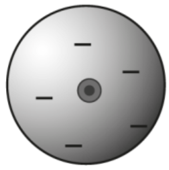
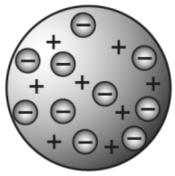
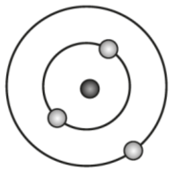
Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• structured longer answers in a methodical way and linked each thought to the next - Questions 4 (b), 5 (a) (i), 6 (a) (i), 6 (a) (iii), 9 (b), 9 (c) • used a logical sequence to complete multi-step calculations - Questions 2 (a), 4 (c) • balanced equations correctly and calculated relative formula masses - Questions 4 (a), 4 (c) (ii) • used knowledge of practical skills to plan an experiment - Questions 4 (b).	• did not plan before answering longer answers so did not always target what the question was asking • did not know basic practical skills, including names of apparatus and methods of making measurements - Questions 4 (b), 5 (a) (i), 8 (b) (i) • used numbers randomly in calculations so were unable to follow a sequence • could not balance ions to write formulae and vice versa - Questions 6 (b) • could not use ideas about attractions between particles to explain physical properties - Questions 6 (a) (iii), 9 (b), 9 (c).

Question 1 (a)

1 In the 1800s, Dalton did experiments to help produce a model for the atom.

(a) Later discoveries led to scientists suggesting new models for the atom.

Draw lines to connect each **discovery** with the **model** it led to.

Discovery	**Model**
Electrons are discovered.	
Electrons are in shells.	
Nucleus is discovered.	

[2]

Most candidates correctly linked the discoveries with the models shown. The best-known link was the model showing the electrons in shells.

Question 1 (b)

(b) The modern model of the atom consists of electrons, neutrons and protons.

Which statements about the modern model of the atom are **true** and which are **false**?

Tick (✓) **one** box in each row.

	True	**False**
Neutrons have a charge of 0.		
Protons and electrons are in the nucleus.		
Protons and electrons have a relative charge of –1.		
Protons and neutrons have a relative mass of 1.		

[3]

Most candidates showed a good understanding of the structure of the modern model of the atom. There was no particular part that candidates struggled with.

Question 1 (c)

(c) The diameter of an atom is 1×10^{-10} m and the diameter of a nucleus is 1.7×10^{-15} m.

Estimate how many times bigger the atom is compared to the nucleus.

Number of times bigger = ... **[2]**

Candidates were asked to estimate how many times bigger the atom is compared to the nucleus and so were expected to round the value of the diameter of a nucleus to make an estimate easier. Some candidates did this but then struggled to use the values in standard form correctly. Some understood that they needed to divide the size of the atom by the size of the nucleus while many just had a go at using the numbers by multiplying or subtracting.

Question 1 (d)

(d) The atomic number and mass number can be used to find the number of protons, neutrons and electrons in an atom.

The table shows information about an argon atom and a potassium atom.

Complete the table.

	Argon atom	**Potassium atom**
Atomic number	18	....
Mass number	40	....
Number of electrons	....	19
Number of neutrons	....	20
Number of protons	....	19

[4]

The connection between atomic and mass numbers with number of atomic particles was well understood by most candidates. The most common misconception was to use the relative atomic mass of potassium from the data sheet instead of working out the mass number of potassium from the numbers of neutrons and protons given.

Question 2 (a)

2 Zinc is extracted from its ore by separating the zinc compounds from the waste rock and then converting the zinc compounds into zinc.

(a) A company wants to extract 5.5 kg of zinc from an ore which contains 8.5% zinc.

Calculate the mass of ore needed.

Use the equation: percentage of zinc in ore = $\frac{\text{mass of zinc} \times 100}{\text{mass of ore}}$

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

Mass of ore = ... kg **[4]**

Most candidates were able to get the final answer by rearranging the formula, substituting in the correct values and quoting their answer to three significant figures. Some did not rearrange the equation given correctly, some converted the mass of zinc extracted to g, although the answer was expected to be in kg, and others changed the 85% to 0.085 before substituting into the equation.

Question 2 (b)

(b) The zinc compounds are heated strongly to produce zinc oxide.
The zinc oxide is then heated with carbon to produce zinc and carbon monoxide.

$ZnO + C \rightarrow Zn + CO$

Explain which substance is oxidised and which is reduced in this reaction.

Oxidised ....

....

Reduced ....

....

[2]

Most candidates understood that oxidation was when oxygen is gained and reduction was when it is lost but many were unable to identify the substances involved. Zinc and carbon monoxide were common incorrect answers.

Misconception

?

Many candidates do not understand that the substances being oxidised or reduced are reactants not products.

Question 2 (c)

(c) Many metals cannot be extracted using carbon.

Explain why zinc can be extracted using carbon but aluminium **cannot**.

Zinc ....

....

Aluminium ....

....

[2]

Most candidates understood that the relative reactivity of the metals compared to carbon was the reason that zinc can be extracted using carbon but aluminium cannot. Some just compared the relative reactivity of zinc and aluminium and some used ideas about structure of the atoms such as number of electrons in the outer shell.

Question 3 (a) (i)

3 Drinking water in the UK can be obtained from rivers. Rivers are a type of surface water.

(a) Surface water contains impurities. The table shows some stages of the treatment to make surface water more suitable for drinking.

(i) Complete the table to show which impurities are removed and how these impurities are removed at each stage shown.

Stage	**Impurities removed**	**How the impurities are removed**
Screening (pass the water through a wide mesh)	Leaves, branches, rubbish.	....
Filtration (pass the water through a bed of sand)	Soil	....
Disinfection (add chlorine to the water)	....	....

[4]

Most candidates showed a good knowledge of water purification techniques. Some were not able to explain that screening and filtration worked by preventing larger particles from passing through.

Question 3 (a) (ii)

(ii) Suggest why the water after these stages is still **not** considered scientifically pure.

....

.... **[1]**

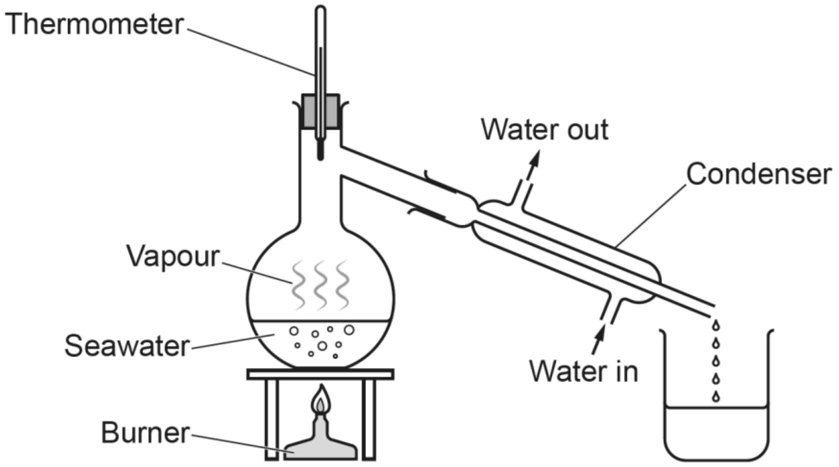
Most candidates understood that scientifically, pure water should have no other substances present, with some going on to suggest what else will be present such as dissolved minerals or chlorine. A few said that water could never be pure as it contained both hydrogen and oxygen and others referred to water being unsafe to drink.

Question 3 (b)

(b) Some countries get their drinking water from seawater. Seawater contains dissolved salts such as sodium chloride.

Distillation can be used to obtain drinking water from seawater.

The diagram shows how distillation is used in a laboratory.



Describe how distillation separates the dissolved salts from the water.

....

....

....

....

....

.... **[3]**

Many candidates correctly identified the sequence of changes involved in the separation as evaporation of water which then condenses elsewhere (condenser or beaker), leaving dissolved salts behind in the flask. Some answers referred to evaporation of the seawater instead of the water and some did not say what happened to the dissolved salts.

Question 3 (c) (i)

(c) Different countries choose different ways to produce drinking water.

The table gives information about two countries.

	Country A	**Country B**
Amounts of surface water	Unlimited	Limited
Amounts of seawater	Unlimited	Unlimited
Climate	Warm and wet	Hot and dry
Mean hours of sunshine per year	1700	3000
Cost of energy	High	Low
Main method of producing drinking water	From surface water	Distillation of seawater

(i) The cost of energy is generally lower in countries which can use solar power.

Suggest why this means the cost of energy is lower in Country **B**.

Use the table.

....

.... **[1]**

Most candidates understood that long hours of sunshine are needed to make solar power a good source of energy. They were able to use the table to state that Country B had long hours of sunshine or more hours of sunshine then Country A. Some just quoted the value from the table while others stated that it was because Country B was hot.

Question 3 (c) (ii)

(ii) Explain why country **A** chooses to use surface water to produce their drinking water.

You should refer to water availability and energy use in your answer.

....

....

....

.... **[2]**

The best answers showed that the candidates understood that Country A had unlimited supplies of both surface water and seawater but chose surface water because purification of seawater was more expensive for them because of high energy costs. Some also understood that the wet climate ensured that surface water supplies were replenished. Many explained the need for unlimited surface water but did not go on to explain why seawater was not used.

Exemplar 1

As they have unlimited amounts of surface water, it's easier to produce their drinking water as they don't have to distill seawater which uses a lot of energy. **[2]**
They already use a lot of energy, so they don't need the bill to be higher.

This candidate gains both marks as they explain the choice of surface water for use as drinking water, not only because there is a good supply of surface water but also because the purification of seawater requires a larger amount of energy.

Question 4 (a)

4 Many hydrocarbons are used as fuels. They burn in a large supply of air to form carbon dioxide and water.

(a) Complete the balanced symbol equation when hexane burns in air.

$$\ldots\ldots\ldots\ldots\ C_6H_{14} + \ldots\ldots\ldots\ldots\ O_2 \rightarrow \ldots\ldots\ldots\ldots\ CO_2 + \ldots\ldots\ldots\ldots\ H_2O$$

[2]

Many candidates successfully balanced the equation with some of them deciding to us $2C_6H_{14}$ in order to avoid fractions. Some of those using $2C_6H_{14}$ did not then double the number of carbons and hydrogens needed in the products. Some of those that struggled to balance the water and carbon dioxide were able to correctly balance the oxygen molecules needed for their error.

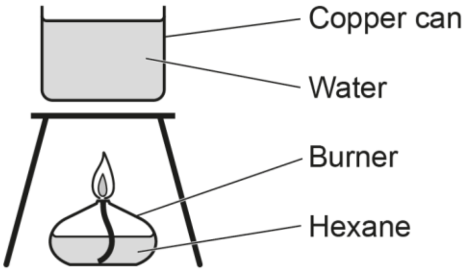
Assessment for learning

When candidates are balancing equations, they should be encouraged to balance elements that are only present in two compounds first (e.g. carbon and hydrogen in this question) and then go onto elements that are present in several compounds (e.g. oxygen in this question).

Question 4 (b)

(b) A scientist does an experiment to find the change in thermal energy of the water when 1 mole of hexane burns in air.

They use this apparatus:



They measure:

- the mass of water in the copper can
- the mass of hexane burned
- the temperature change of the water.

Describe how they do the experiment, including all equipment needed for the measurements.

....

....

....

....

....

.... **[4]**

Candidates were expected to use their practical knowledge to describe how the various measurements were taken and to name the equipment needed. Many candidates were able to choose suitable equipment to measure mass and temperature although some used 'a scale' instead of weighing scale or scales and others used equipment to measure volume.

There were some good responses that described this in detail. E.g. using a balance to measure the empty can (or setting the balance to zero with the empty can) and then measuring the can filled with water/measuring the temperature before and after heating with a thermometer/measuring the hexane burner before and after heating with a balance. Many just measured temperature change without describing how it was done.

Assessment for learning

Candidates struggle to transfer common practical skills they have used into less familiar contexts. Encouraging them to understand that basic techniques such as measuring a temperature change or the mass of a liquid can be used in any context will help them with this task.

OCR support

A number of the GCSE Examiner Reports this year have raised the concern that candidates' practical skills and knowledge is in decline. OCR has produced a wealth of practical resources to support teachers. Find them on Teach Cambridge now.

Question 4 (c) (i)

(c) The table shows their results.

Mass of hexane burned (g)	0.75
Temperature change of water (°C)	12.5
Mass of water in copper can (g)	500

(i) Calculate the change in thermal energy of the water.

Use the equation:

Change in thermal energy (kJ) = 4.2 × mass of water (kg) × temperature change (°C)

Change in thermal energy = ... kJ **[3]**

Most candidates were able to successfully substitute the correct values into the given equation and then evaluate. The most common error was in the conversion of grams of water into kilograms where some multiplied by 1000 instead of dividing and others just used the mass in grams. A few used the mass of hexane instead of the mass of water.

Question 4 (c) (ii)

(ii) The mass of 1 mole of a substance is its relative formula mass in grams.

Calculate the mass of 1 mole of hexane, C_6H_{14}.

Use the Data Sheet.

Mass of 1 mole of hexane = ... g **[2]**

Most candidates were able to calculate the relative formula mass of hexane correctly. Some use atomic numbers instead of relative atomic masses and some went on to calculate the number of moles in 0.75g of hexane.

Question 4 (c) (iii)

(iii) Calculate the change in thermal energy of the water when 1 mole of hexane burns.

Use the table and your answers to **(c)(i)** and **(c)(ii)**.

Change in thermal energy = ... kJ **[3]**

Some candidates understood that the answer to (c) (i) was the energy released by 0.75g of hexane and that the answer to (c) (ii) was the mass of one mole and so were able to link these together to find the energy released by one mole. Most used the equation given in part (c) (i) and just used 0.75 instead of 500.

Assessment for learning

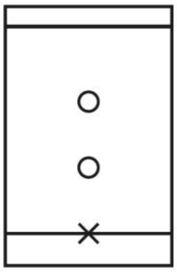
Candidates generally struggle with multi-step calculations. They should be encouraged to write down what they have found in the earlier parts before attempting to link them later on.

Question 5 (a) (i)*

5 A scientist is testing the purity of **solid** samples.

(a) The scientist decides to use paper chromatography to test the samples.

The diagram shows the results for one of the samples.



(i)* Describe how the scientist uses chromatography to test the samples for purity and how they can identify the substances in the samples using R_f values.

....

....

....

....

....

.... **[6]**

There were some good descriptions of the method with all the key steps plus extra details such as using a pencil for the base line. Most candidates understood the basic principles of chromatography but many struggled to include key steps such as leaving the solvent to rise. Some candidates limited the level they could achieve by not referring to R_f values as required in the question. Those who did include it showed a good understanding of what it was although some did not describe what measurements needed to be taken. Only a few understood how it could be used to identify the substances once it had been measured.

Exemplar 2

The scientist should use a pencil drawing the base line for where the ~~substance~~ sample will initially start. Place the chromatography paper in a tube of a solvent. The solvent must be below the base line. Apply the ~~substance~~ sample on the base line and cover the the top of the tube containing the chromatography paper. The ~~substance~~ sample is pure if it is more attracted to the stationary phase. To ~~check~~ identify the ~~substance~~ sample in the sample, the scientist can measure the Rf values using a ruler which ~~is~~ begins from the base line to the solvent front **[6]**

And measure the distance travelled by the ~~substance~~ sample from the baseline to the midpoint of the substance.

Rf value = $\dfrac{\text{Distance travelled by solvent}}{\text{Distance travelled by sample}}$.

The Rf value can be compared to the other samples

This candidate has described the basic method with some detail but does not reach Level 3 as key points missing, e.g. not leaving for the solvent to rise, how it shows purity. The description of use of Rf value has enough detail to have been Level 3, although would have been brought down within the level because the R_f equation is inverted. Overall, this is a strong Level 2, 4 marks.

Question 5 (a) (ii)

(ii) The scientist says that the results show that the sample is impure.

Explain why they are **correct**.

....

.... **[1]**

Most candidates understood that the diagram showed the presence of 2 substances and so the sample could not be pure.

Question 5 (a) (iii)

(iii) The scientist wants to increase the distance between the spots on the chromatogram.

How can the method be adapted to increase the distance between the spots?

Tick (✓) **one** box.

Add a locating agent. ☐

Leave the paper in the solvent for longer. ☐

Use more solid. ☐

Use more solvent. ☐

[1]

Many candidates realised that leaving the paper in the solvent for longer would lead to greater separation.

Question 5 (b)

(b) What **other** method could the scientist use to check the purity of the solid samples?

....

.... **[1]**

Most candidates did not know that purity of solids can be tested by measuring the melting point. Most quoted random techniques such as distillation, titration or pH.

Question 6 (a) (i)

6 The elements in Group 7 of the periodic table are called the halogens.

(a) The table shows some of the properties of the halogens.

	Formula	Boiling point (°C)	Colour and state at room temperature and pressure	Reaction with hydrogen
Fluorine	F_2	–188	Yellow gas	Explodes in cold and dark.
Chlorine	Cl_2	–35	Green gas	Explodes with flame or in sunlight.
Bromine	Br_2	59	Red liquid	
Iodine	I_2	184	Grey solid	Slow when heated strongly.

(i) Explain why the halogens all form molecules containing two identical atoms.

Use ideas about electrons and bonding.

....

....

....

....

....

.... **[3]**

There were some well-constructed answers linking the seven electrons in the outer shell to the need to share an electron with another atom in order to complete their outer shells. Some had the right idea but struggled to explain fully. A few responses referred to transfer of atoms instead of electrons and some said that ions would be formed.

Question 6 (a) (ii)

(ii) Predict the reaction of bromine with hydrogen.

....

.... **[1]**

Many candidates were able to predict a reaction which was less vigorous than the reaction of chlorine and more vigorous than the reaction with iodine. A common error was to refer to bubbles, fizzing or sparks.

Question 6 (a) (iii)

(iii) Explain the trend in boiling points shown in the table.

Use ideas about energy and forces.

....

....

....

....

....

.... **[3]**

Most candidates identified the trend of increasing boiling points down the group, with many going on to link this to the greater energy needed to break the increasing forces between the molecules. Some recognised the increased attractions but did not explain why this led to higher boiling points while others discussed attractions between the atoms rather than between molecules. Some candidates confused the question with reactivity and connected increased size of atoms with ideas of loss or gain of electrons.

Question 6 (b)

(b) Halogens react with metals to form metal halides.

Complete the table to show the ions present and the formulae of some metal halides.

Metal halide	Ions present	Formula
Sodium iodide	Na^+ and I^-	NaI
Magnesium chloride	Mg^{2+} and Cl^-	....
Iron bromide	.... and	$FeBr_3$

[2]

Some candidates were able to use the idea that charges on ions balance in the formula of a compound to successfully identify the correct formula for magnesium chloride and the charges on the ions in iron bromide. Some were only able to put ions together to produce the formula of magnesium chloride although many gave $MgCl$ or Mg_2Cl instead. Most struggled to identify the ions in iron bromide with many not even suggesting a charge on the particles.

Assessment for learning

Difficulties in balancing charges on ions in this way is a common problem and candidates need help in understanding the concept if they are to be able to apply it successfully.

Question 6 (c) (i)

(c) Chlorine gas reacts with aqueous potassium iodide to form a solution of iodine and potassium chloride.

$$Cl_2 + 2KI \rightarrow I_2 + 2KCl$$

(i) In the reaction, chlorine reacts with iodide ions to form chloride ions and iodine.

Write the balanced ionic equation for the reaction.

Include state symbols.

.... **[3]**

Again, candidates struggled to break down formulae into ions and so were unable to produce an ionic equation. Some did identify the ions but did not separate them or were unable to balance the equation. Some just rewrote the given equation while others just added random charges to the original formulae.

Question 6 (c) (ii)

(ii) The table shows what happens when some halogens are added to aqueous solutions of metal halides.

Complete the table.

Use the Data Sheet.

Halogen	Metal halide	Result
Chlorine	Potassium iodide	Iodine and potassium chloride formed
Iodine	Potassium chloride	No reaction
Bromine	Potassium iodide	....
Bromine	Potassium chloride	....

[2]

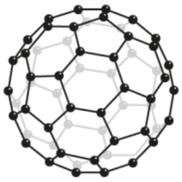
Most candidates had a good understanding of which halogens will displace which halide. Only a few got them the wrong way round.

Question 7 (a) (i)

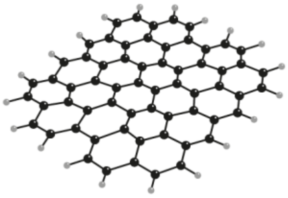
7 Nanoparticles are tiny particles with many important uses.

(a) Fullerene and graphene are nanoparticles made from carbon.

The diagrams show their structures.



Fullerene



Graphene

(i) State **two** similarities and **two** differences between the structures.

Similarity 1 ....

....

Similarity 2 ....

....

Difference 1 ....

....

Difference 2 ....

....

[4]

Most candidates were able to use the diagrams to identify some similarities and differences between the two structures. Many identified the hexagons present in the structure of both and the similarity in the number of bonds each carbon made. Some thought that both were giant structures. Many identified the spherical shape of the fullerene compared to the flat shape of graphene, although some confused graphene with graphite and described layers. Some were confused by the continuation bonds on the edges of graphene's layer and even thought that not all carbons were fully bonded. Some used their knowledge of properties or uses instead of looking at the structures.

Question 7 (a) (ii)

(ii) Explain why graphene is a very good conductor of electricity.

....

....

....

.... **[2]**

Most candidates identified the presence of unbonded or delocalised electrons present in graphene but few realised that these could move throughout the structure unlike the unbonded electrons in the fullerene depicted that can only move within the molecule.

Question 7 (b) (i) and (ii)

(b) The table shows the sizes of some particles.

Particle	Size (m)
A	1.6×10^{-7}
B	1.5×10^{-8}
C	3.9×10^{-9}
D	2.7×10^{-10}
E	3.3×10^{-10}
F	3.7×10^{-11}

(i) Which **two** particles are the **same** order of magnitude?

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

(ii) Nanoparticles are between 1×10^{-9} and 1×10^{-7} m in size.

Which **two** particles could be nanoparticles?

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

In (b) (i), candidates showed good understanding of orders of magnitude of numbers in standard form. Most were also able to identify, in (b) (ii), that particle B was within the range for the size of a nanoparticle. Many then chose A instead of C as they struggled to see that A was just too big for the range given.

Question 8 (a)

8 Zinc reacts with sulfuric acid to produce a salt and hydrogen.

(a) Describe the test to identify hydrogen.

Test ....

Positive result ....

[2]

The test to identify hydrogen was well known with many describing both the test and the expected result. Some were not clear that the splint must be lit but only a few chose the wrong test, e.g. the test for oxygen.

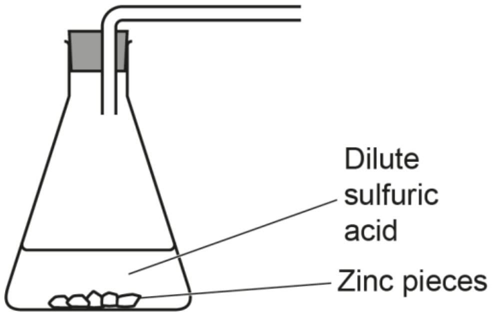
Question 8 (b) (i)

(b) A student does an experiment to investigate the effect of adding a catalyst on the rate of reaction between zinc and sulfuric acid.

This is the method:

- Add zinc pieces to dilute sulfuric acid.
- Measure the volume of hydrogen produced at regular time intervals.
- Repeat the experiment with the catalyst added to the zinc pieces and dilute sulfuric acid.

The diagram shows some of the apparatus used.



(i) The student decides to use a gas syringe to collect and measure the volume of hydrogen.

Describe **other** apparatus they could use to collect and measure the volume of hydrogen.

....

....

....

.... **[2]**

Collecting and measuring gases over water is a basic practical skill but few remembered it. Answers such as counting bubbles and condensing the gas were common.

Question 8 (b) (ii)

(ii) The student keeps the temperature and the concentration of the acid the same for the two experiments.

Identify **two** other factors which should be kept constant.

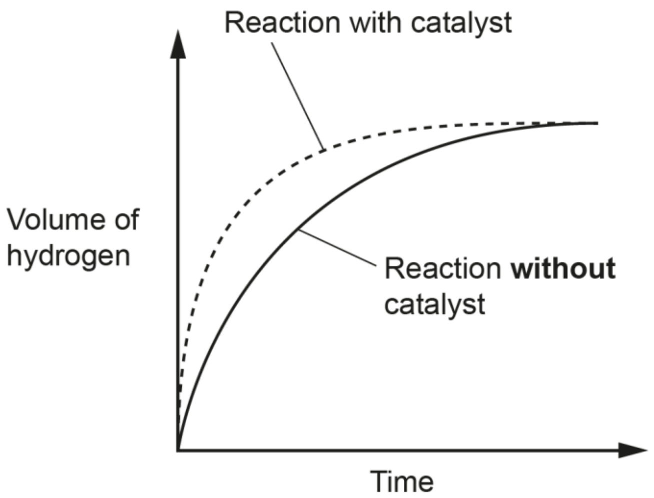
1 ....

2 ....
[2]

Most candidates had a good understanding of controlling variables in a practical although some were not specific about what to control and gave answers such as 'the zinc pieces' without explaining what needed to be kept the same, e.g. particle size or number. Some suggested the catalyst needed to be the same even though the effect of its presence was what was being investigated.

Question 8 (c)

(c) The student sketches their results on a graph as shown.



Explain how the shape of the lines on the graph show that the reaction has been catalysed.

....

....

....

.... **[2]**

Candidates were expected to show how the graph showed that a catalyst increased rate but did not affect yield. Most tried to explain how it showed an increased rate but many just compared the shapes of the two lines without saying that the catalysed reaction was faster. Few discussed the fact that the final volume of hydrogen produced was the same for the two reactions.

Question 8 (d)

(d) Explain why increasing the temperature of the sulfuric acid increases the rate of the reaction.

Use ideas about particles.

....

....

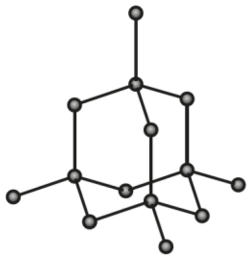
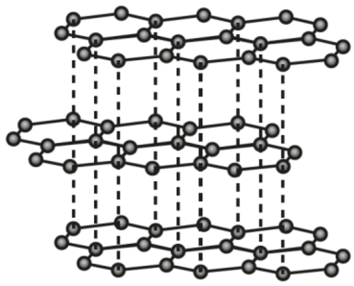
....

.... **[2]**

Most candidates showed that they understood why increasing the temperature of the acid increases the rate of reaction but many struggled to explain it. Descriptions of the particles increasing in energy or becoming more active were often given instead of the idea of increased kinetic energy or faster movement. Many did not make clear that the increase in rate was due to more successful collisions rather than just more (frequent) collisions.

Question 9 (a)

9 The table gives some information about diamond and graphite.

	Diamond	**Graphite**
Structure		
Type of bonds		Covalent
Arrangement of atoms		Each carbon bonded to 3 others. 2-dimensional layers.
Melting point	Very high	Very high
Hardness	Hard	Soft and slippery
Electrical conductivity	None	Good

(a) Describe the type of bonds and the arrangement of atoms in diamond.

Type of bonds ....

Arrangement of atoms ....

....

....

[3]

Most candidates identified diamond's bonds as covalent and many used the information given for graphite and the diagram of diamond to help them describe the structure of diamond as having each carbon bonded to four others in a 3-dimensional structure, although some did refer to 3-dimensional layers.

Misconception

? Some candidates do not understand that the structures are giant structures and so the outer atoms have further bonds to extend the structure.

Question 9 (b)

(b) Explain why diamond is hard but graphite is soft and slippery.

Use ideas about structure and bonding.

....

....

....

....

....

.... **[4]**

Candidates were more successful at describing the weak bonds between layers in graphite leading to layers sliding over each other than they were at describing the strong bonds in all directions in diamond being hard to break apart.

Exemplar 3

Diamond is hard as every carbon is bonded via strong covalent bonds to four other carbon atoms. This means lots of energy is needed to break these bonds as there are no weak forces / bonds. However, graphite is slippery due to it's 2D layered arrangement. Each layer can slide over each one easily as the intermolecular forces inbetween are weak compared to diamonds all strong covalent bonds. Furthermore, each carbon atom is only bonded to three other carbon atoms. Also diamond has 3D structure. **[4]**

This candidates gains all 4 marks for a clear description of how the properties of diamond and graphite are different due to the structural differences, identifying the fact that all bonds within the diamond's structure are strong, whereas graphite has weaker intermolecular forces between the layers.

Question 9 (c)

(c) Explain why the melting point of diamond is very high.

....

....

....

.... **[2]**

In Question 9 (b), candidates were expected to identify that diamond is hard as there are no weak bonds whereas graphite's structure has weaker forces between the layers. More were successful at describing the weak bonds between layers in graphite leading to layers sliding over each other than they were at describing the strong bonds in all directions in diamond being hard to break apart.

In Question 9 (c), more understood that high melting points are due to needing high energy to separate the particles, although they did not include the idea that many bonds need to be broken in a giant structure.

In both parts, some candidates incorrectly referred to intermolecular bonds when they meant bonds between atoms.

Assessment for learning

Use of the term intermolecular forces is often used by candidates to refer to any attraction between particles. Candidates should be encouraged to consider what particles are being attracted and then use that specifically., e.g. the attraction between molecules or the attraction between atoms.

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