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Examiners' Report
June 2024

GCSE Combined Science 1SC0 2CH

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June 2024

Publications Code 1SC0_2CH_2406_ER

Introduction

1SC0 2CH is the second Chemistry paper in the Combined Science Higher Tier suite. Some of the earlier questions also appear in the 2CF Foundation Tier paper. The Combined Science questions are a subset of the 1CH0 2H paper, comprising of six of the ten questions in that paper.

Question 1 (a)

The first question on the paper gave candidates the scenario of a student investigating the reaction between marble chips and dilute hydrochloric acid.

In part (a) candidates were asked to draw and label apparatus that could be used to collect and measure the volume of the carbon dioxide gas.

In general, candidates performed well in the question with the majority scoring and most gaining 2 marks. The use of a gas syringe was the most common response with fewer showing an upturned measuring cylinder or burette. When candidates did use the inverted measuring cylinder method, they often did not include water despite drawing a water trough.

Many diagrams were poorly drawn and led to marks being lost as the apparatus that was drawn meant that gas would escape and so would not collect and measure the gas.

Other errors included drawing condensers or test tubes or a delivery tube leading to another flask. In some cases, candidates were not precise with their answers and labelled their apparatus as 'syringe' rather than 'gas syringe' and so did not get the mark for the label.

1 A student investigates the reaction between marble chips and dilute hydrochloric acid.

The student measures the total volume of carbon dioxide gas produced each minute, for 10 minutes.

(a) Figure 1 shows part of the apparatus used in the experiment.

Complete Figure 1 by drawing and labelling apparatus that could be used to collect and measure the volume of the carbon dioxide gas.

(2)

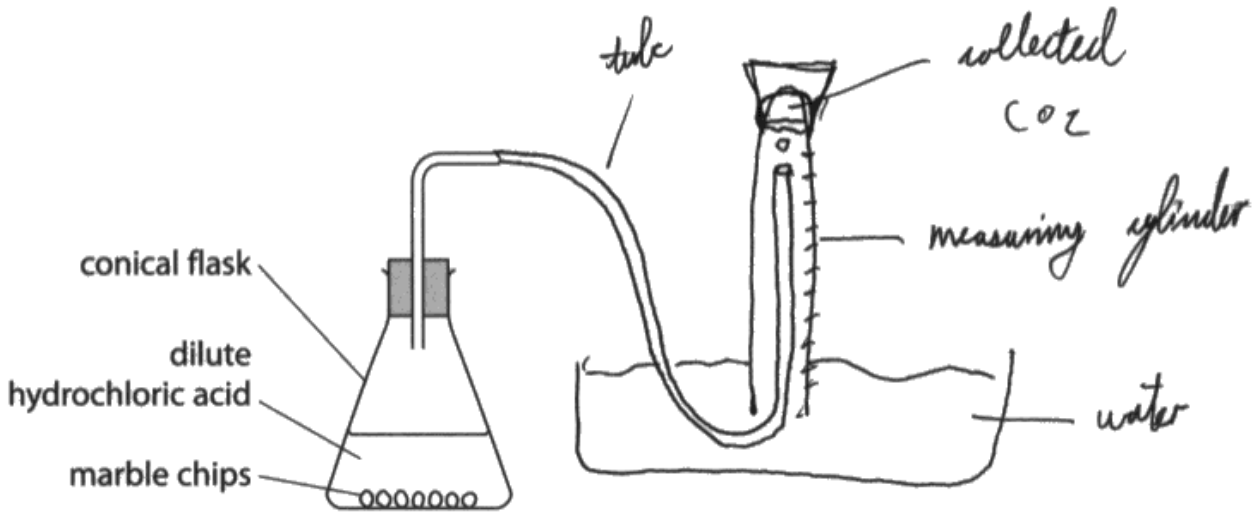

Figure 1

ResultsPlus
Examiner Comments

This example showed a good answer that scored both marks.

1 A student investigates the reaction between marble chips and dilute hydrochloric acid.

The student measures the total volume of carbon dioxide gas produced each minute, for 10 minutes.

(a) Figure 1 shows part of the apparatus used in the experiment.

Complete Figure 1 by drawing and labelling apparatus that could be used to collect and measure the volume of the carbon dioxide gas.

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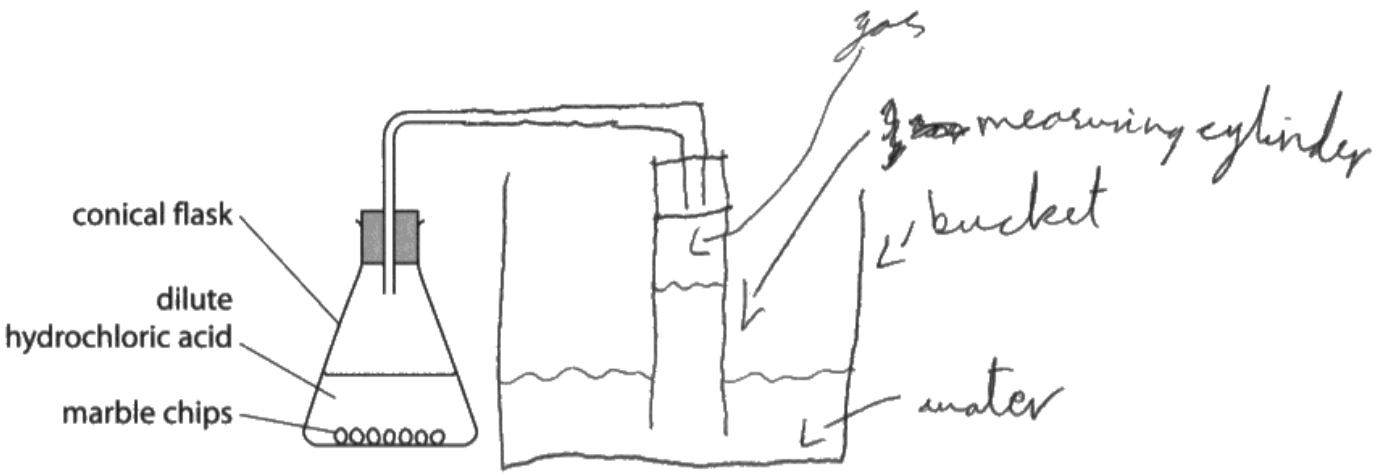


Figure 1

ResultsPlus
Examiner Comments

This example scored 1 mark. Whist the candidate has the right idea, the first marking point was not scored as the apparatus would not collect and measure the gas. The second mark was awarded for showing the understanding that a measuring cylinder was required with the label.

ResultsPlus
Examiner Tip

Practice drawing scientific diagrams accurately, ensuring that the set up would work to carry out the process necessary, ensure that there are no gaps for gas to escape for example, or drawing water in water troughs if they are drawn. Ensure that you are precise when naming any apparatus drawn.

1 A student investigates the reaction between marble chips and dilute hydrochloric acid.

The student measures the total volume of carbon dioxide gas produced each minute, for 10 minutes.

(a) Figure 1 shows part of the apparatus used in the experiment.

Complete Figure 1 by drawing and labelling apparatus that could be used to collect and measure the volume of the carbon dioxide gas.

(2)

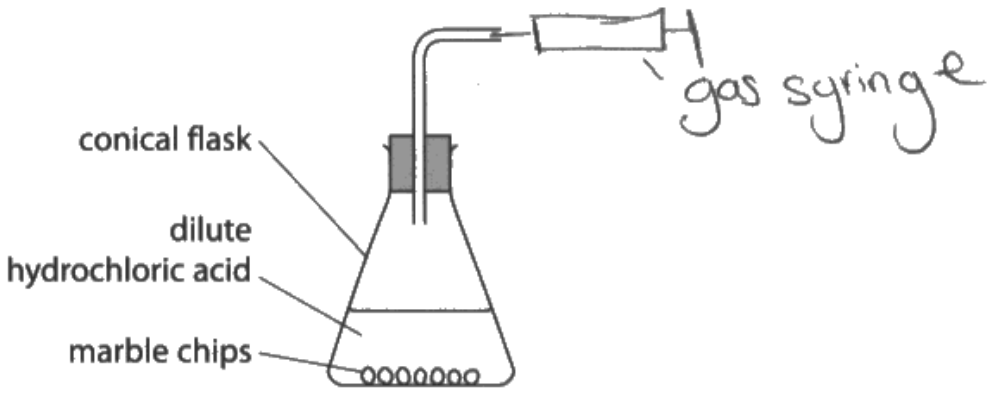


Figure 1

ResultsPlus
Examiner Comments

This example also scored 1 mark. The candidate was awarded 1 mark for labelling the gas syringe. Unfortunately, the candidate was not careful when drawing the gas syringe and drew a single line from the gas syringe to the delivery tube, this meant that the apparatus would not be able to collect and measure the gas and so the first marking point could not be awarded.

1 A student investigates the reaction between marble chips and dilute hydrochloric acid.

The student measures the total volume of carbon dioxide gas produced each minute, for 10 minutes.

(a) Figure 1 shows part of the apparatus used in the experiment.

Complete Figure 1 by drawing and labelling apparatus that could be used to collect and measure the volume of the carbon dioxide gas.

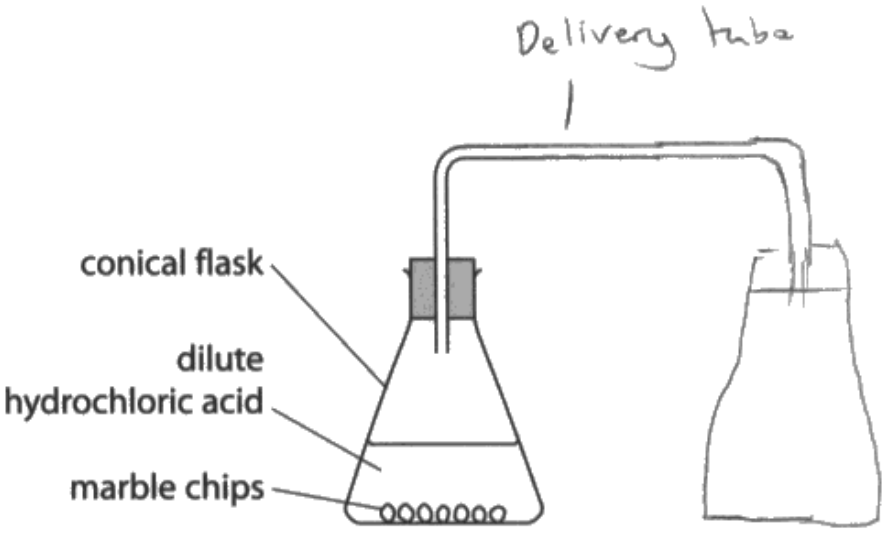


Figure 1

ResultsPlus
Examiner Comments

This response showed a common answer that did not score.

Question 1 (b)(i)

In part (b) Candidates were given a graph of results. In Part (i) candidates were asked to state the total volume of carbon dioxide produced in 3.5 minutes. The majority of candidates were able to use the graph to give a value of 47, some candidates were within the range allowed of 46-48 so gained the mark.

In some cases, candidates gave an answer of 44 so did not score.

(b) Figure 2 shows a graph of the results of the experiment.

A tangent has been drawn on the curve at a time of 3.5 minutes.

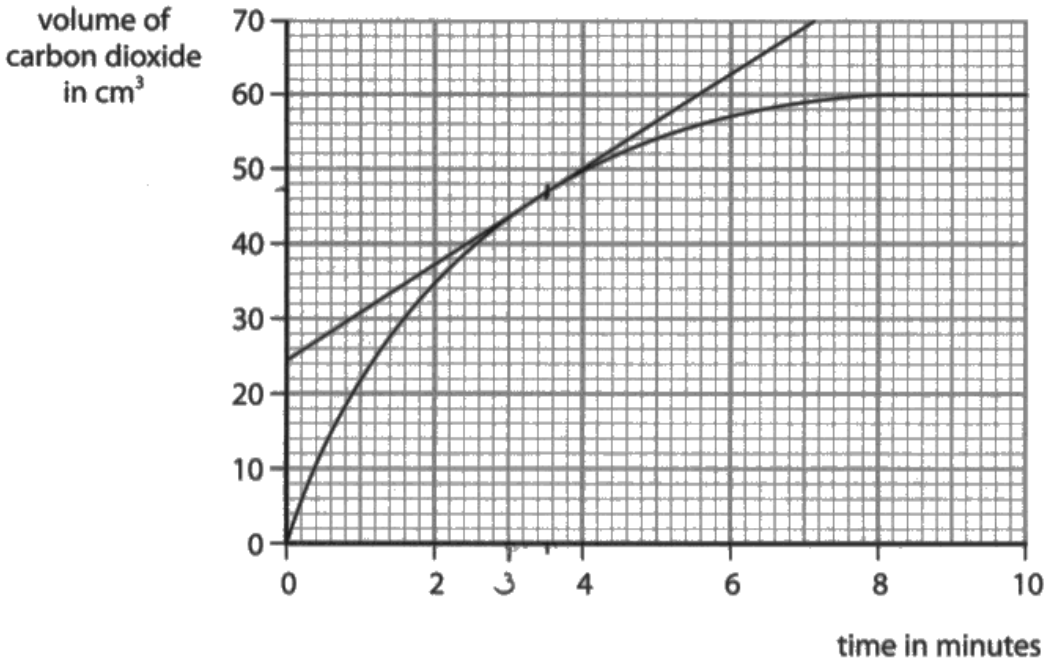


Figure 2

(i) State the total volume of carbon dioxide produced in the first 3.5 minutes.

(1)

volume = 47 cm³

ResultsPlus
Examiner Comments

This example showed a good answer that scored the mark.

(b) Figure 2 shows a graph of the results of the experiment.

A tangent has been drawn on the curve at a time of 3.5 minutes.

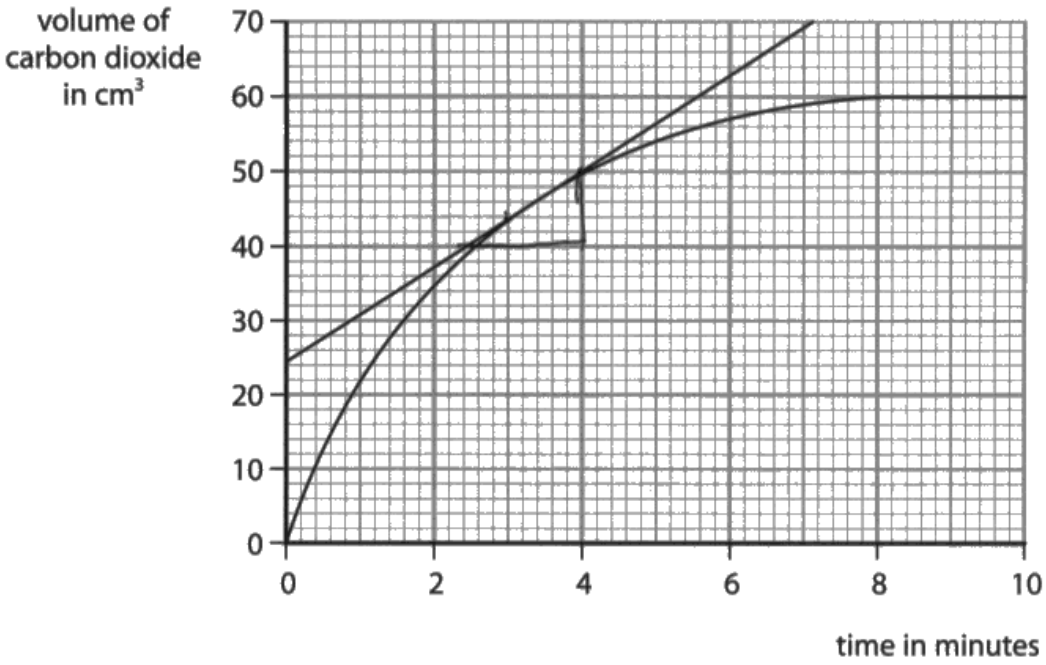


Figure 2

(i) State the total volume of carbon dioxide produced in the first 3.5 minutes.

(1)

volume = 44 cm³

ResultsPlus
Examiner Comments

Unfortunately, this answer was just outside of the allowable range and so did not score.

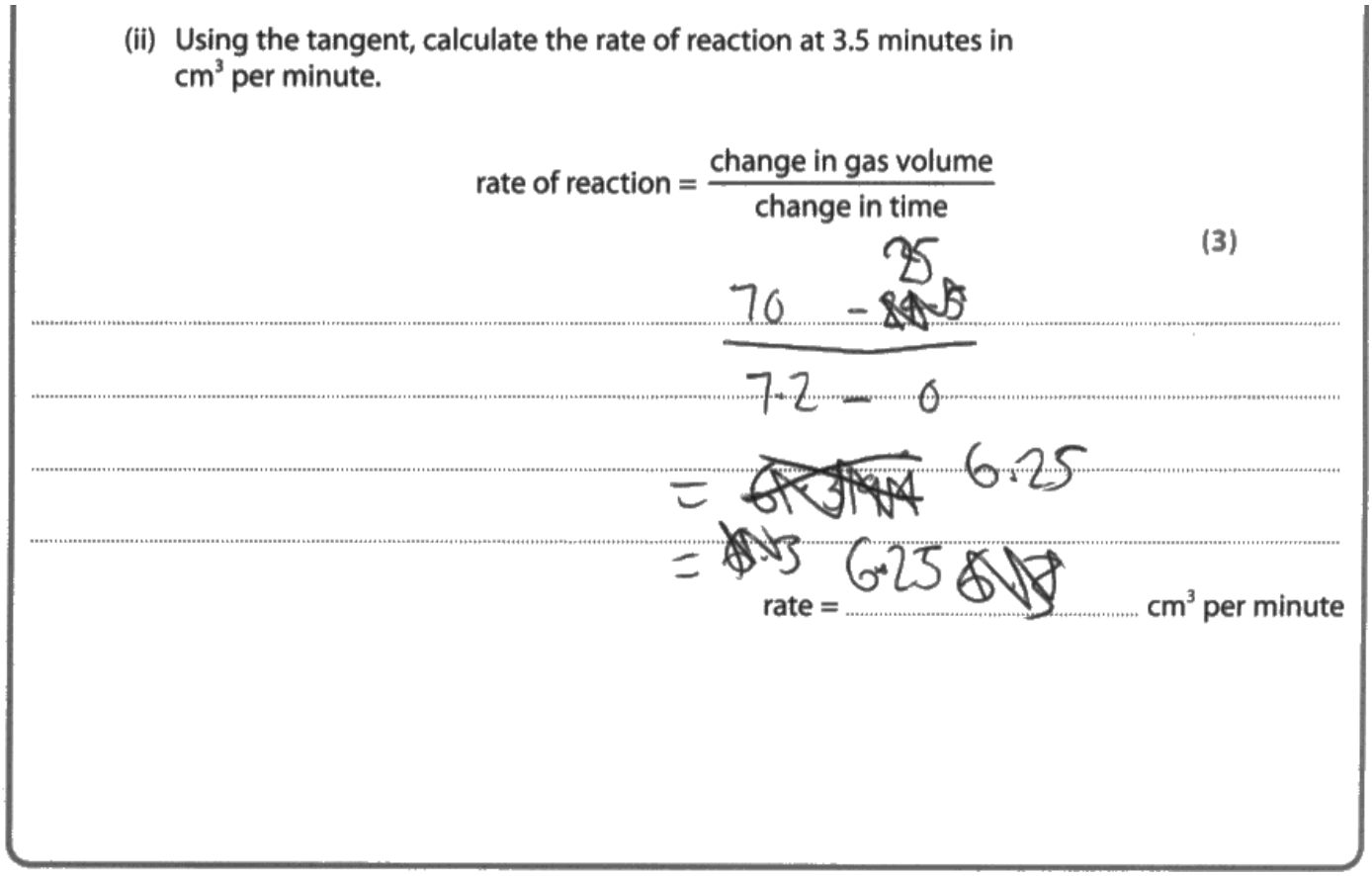
Question 1 (b)(ii)

In part (b)(ii) candidates were asked to calculate the rate of reaction at 3.5 minutes using the tangent that had been drawn on the graph. The candidates were given an equation to use to help them in the question, although in some cases, candidates did not use the equation given.

Candidates were able to access the question well and there was an even spread in the number of marks awarded.

It was common to see a calculation based simply on the volume of gas taken from the graph at 3.5 minutes rather than over a range of time using the tangent given.

Where final answers were rounded off, this was generally done correctly.


(ii) Using the tangent, calculate the rate of reaction at 3.5 minutes in cm^3 per minute.

$$\text{rate of reaction} = \frac{\text{change in gas volume}}{\text{change in time}}$$

(3)

$\frac{70 - 25}{72 - 0}$

$= 6.25$

$= 6.25$

rate = ... cm^3 per minute

ResultsPlus
Examiner Comments

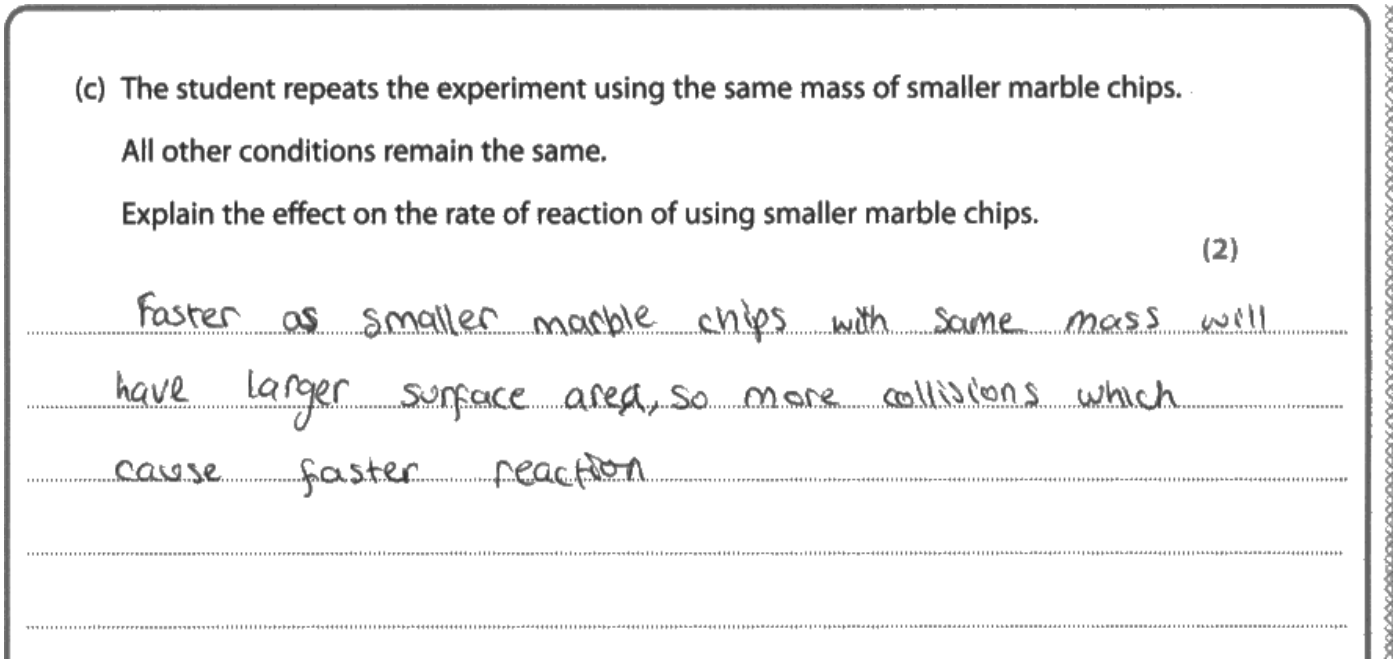
This response shows a good answer that scored all 3 marks.

Question 1 (c)

Question 1c asked candidates to explain the effect on rate of reaction of using smaller marble chips.

Candidates performed well with the majority of candidates scoring with many scoring both marks by stating that the rate increased due to smaller marble chips having a larger surface area.

A common misconception was that the rate increased because the surface area decreased, others did not really read the question carefully that stated that the same mass of smaller marble chips would be added, and thought that because the marble chips were smaller there would be less marble and so therefore the rate would decrease.



(c) The student repeats the experiment using the same mass of smaller marble chips.

All other conditions remain the same.

Explain the effect on the rate of reaction of using smaller marble chips.

(2)

faster as smaller marble chips with same mass will have larger surface area, so more collisions which cause faster reaction

ResultsPlus
Examiner Comments

This example shows a good answer that scored both marks.

(c) The student repeats the experiment using the same mass of smaller marble chips.

All other conditions remain the same.

Explain the effect on the rate of reaction of using smaller marble chips.

(2)

It gives a larger surface area allowing more frequent collisions to occur and increase the more frequent collisions. Also ~~increase~~ ensure

ResultsPlus
Examiner Comments

This response gained 1 mark, the candidate states that there is a larger surface area gains allowing more frequent collisions, but there is no reference to the rate increasing for the first marking point.

(c) The student repeats the experiment using the same mass of smaller marble chips.

All other conditions remain the same.

Explain the effect on the rate of reaction of using smaller marble chips.

(2)

The fact the marble chips are smaller, meaning that is a smaller surface area, means the rate of reaction is decreased.

ResultsPlus
Examiner Comments

In this example, the candidate has stated that the rate of reaction is decreased, this meant that the answer scored no marks.

Question 2 (a)

Question 2 of the paper was about the atmosphere. The first question asked candidates to describe the test to show that a gas is oxygen.

Around half of the cohort were able to describe that a glowing splint would relight in the presence of oxygen.

Many lost marks as they stated that a lit splint, rather than a glowing splint should be used. Many also tried to describe a glowing split, such as 'light a splint and blow it out' which was ignored. Most that knew that a glowing splint should be used went on to gain the second mark the glowing splint reignited.

2 This question is about the atmosphere.

(a) Describe the test to show that a gas is oxygen.

(2)

you would plight a splint then put it out then put it in a test tube containing the gas and if it relights its oxygen

ResultsPlus
Examiner Comments

'light a splint then put it out' is insufficient for 'glowing splint'.

The second mark was dependent of the first mark being scored, so even though the candidate has 'relights', the response scored 0.

2 This question is about the atmosphere.

(a) Describe the test to show that a gas is oxygen.

(2)

The glowing splint test.

ResultsPlus
Examiner Comments

This example gained 1 mark. The candidate has given the method of the test, but not given the expected result.

ResultsPlus
Examiner Tip

When describing gas test always remember to give the method of the test and the expected positive result of the test.

2 This question is about the atmosphere.

(a) Describe the test to show that a gas is oxygen.

(2)

put a glowing splint into a test tube and it will re-ignite if oxygen is present

ResultsPlus
Examiner Comments

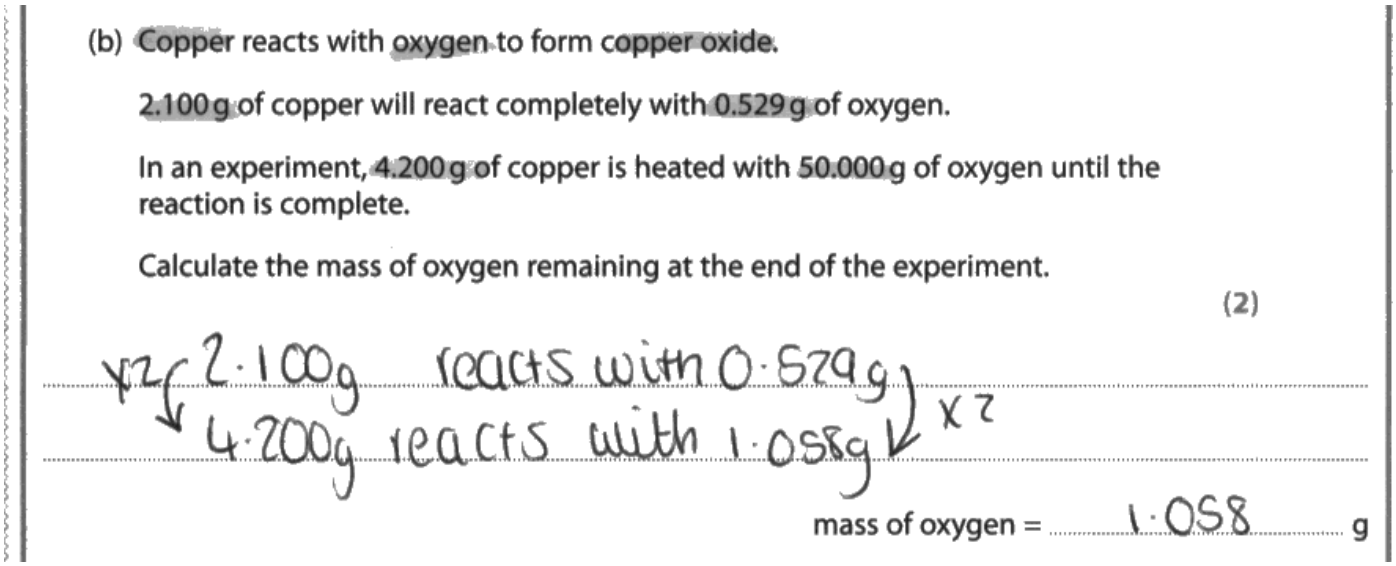
This example shows a good answer that scored both marks.

Question 2 (b)

In question 2b candidates were asked to calculate the mass of oxygen remaining at the end of reaction of copper with oxygen.

This calculation was correctly completed by most and therefore 2 marks was common.

Where candidates did not score, it was often because they forgot to subtract the mass of oxygen or divided or multiplied numbers from the provided data.



(b) Copper reacts with oxygen to form copper oxide.

2.100 g of copper will react completely with 0.529 g of oxygen.

In an experiment, 4.200 g of copper is heated with 50.000 g of oxygen until the reaction is complete.

Calculate the mass of oxygen remaining at the end of the experiment.

(2)

x2 2.100g reacts with 0.529g

4.200g reacts with 1.058g x2

mass of oxygen = 1.058 g

ResultsPlus
Examiner Comments

In this example, the candidate has calculated the mass of oxygen that has reacted but has forgotten to subtract this number from the initial mass of oxygen to address the question as to how much oxygen was remaining at the end of the experiment so just 1 mark was awarded.

(b) Copper reacts with oxygen to form copper oxide.

2.100 g of copper will react completely with 0.529 g of oxygen.

In an experiment, 4.200 g of copper is heated with 50.000 g of oxygen until the reaction is complete.

Calculate the mass of oxygen remaining at the end of the experiment.

(2)

0.529 x 2 = 1.058 50,000 − 1.058

mass of oxygen = 49998.942 g

ResultsPlus
Examiner Comments

A noticeable proportion of candidates misread the initial mass of oxygen as 50000g rather than 50.000g therefore giving a final answer of 49998.942 as in this example which scored 1 mark.

(b) Copper reacts with oxygen to form copper oxide.

2.100 g of copper will react completely with 0.529 g of oxygen.

In an experiment, 4.200 g of copper is heated with 50.000 g of oxygen until the reaction is complete.

Calculate the mass of oxygen remaining at the end of the experiment.

(2)

2.1 = 0.529

4.2 = 1.058 50 - 1.058 = 48.942

mass of oxygen = 48.9 g

ResultsPlus
Examiner Comments

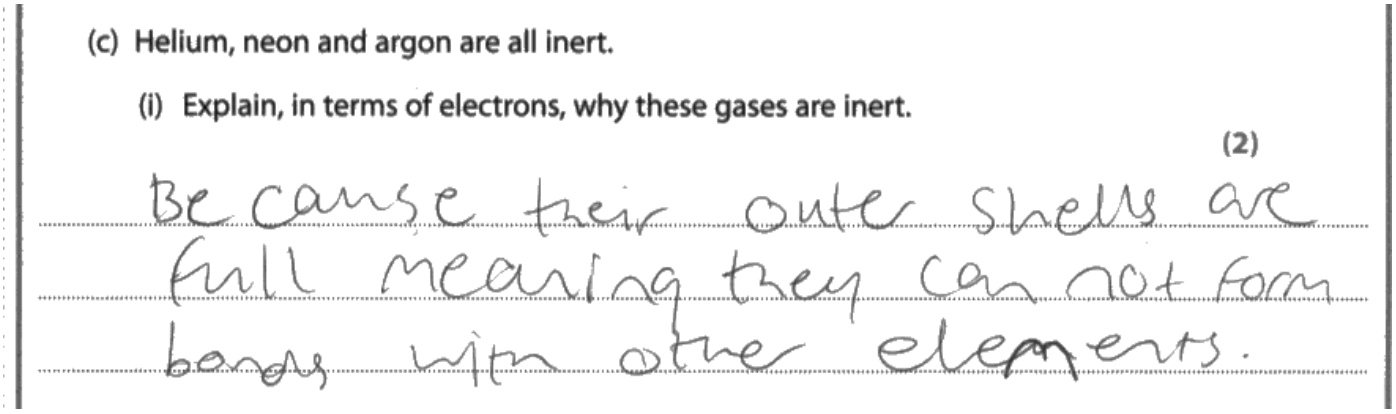
This example shows a good answer that scored both marks.

Question 2 (c)(i)

In question 2ci candidates were asked why helium, neon and argon are inert. Many candidates scored, but the most common mark awarded was 1 mark rather than 2.

Most students linked full outer shells to their inert behaviour though not all went on to explain that this meant that the elements do not gain, lose or share electrons which was required in the question.

A common mistake was not mentioning the outer shell or just stating that the gases were unreactive rather than electrons not being lost or gained.



(c) Helium, neon and argon are all inert.

(i) Explain, in terms of electrons, why these gases are inert.

(2)

Because their outer shells are full meaning they can not form bonds with other elements.

ResultsPlus
Examiner Comments

This response gained 1 mark, the candidate has stated that the outer shell is full to gain the first marking point. They go on to state that this means that they cannot form bonds, but they do not explain why in terms of electrons and so do not gain the second marking point.

ResultsPlus
Examiner Tip

When a question states to explain, in terms of electrons, ensure that your answer has an explanation which includes ideas about electrons to gain full marks.

(c) Helium, neon and argon are all inert.

(i) Explain, in terms of electrons, why these gases are inert.

(2)

They are noble gases and have a full outer shell making them unreactive (inert) because they don't need to lose or gain any electrons

ResultsPlus
Examiner Comments

This example shows a good response which scored both marks.

Question 2 (d)

Question 2d gave candidates a graph showing the relative amounts of carbon stored in plants and soils in different environments.

A large proportion of candidates scored 1 mark for showing an understanding that the coastal ecosystems store more carbon or carbon dioxide than forests, however few were then able to use the data to back up this statement.

Where answers included data from the graph they rarely added these together to give a total values for coastal ecosystems. Other students struggled to estimate where the bars ended, so did not identify accurate amounts.

(d) Carbon dioxide is removed from the atmosphere by plants and stored in plants and soil as carbon compounds.

Figure 3 shows the relative amounts of carbon stored in plants and soils in different environments.

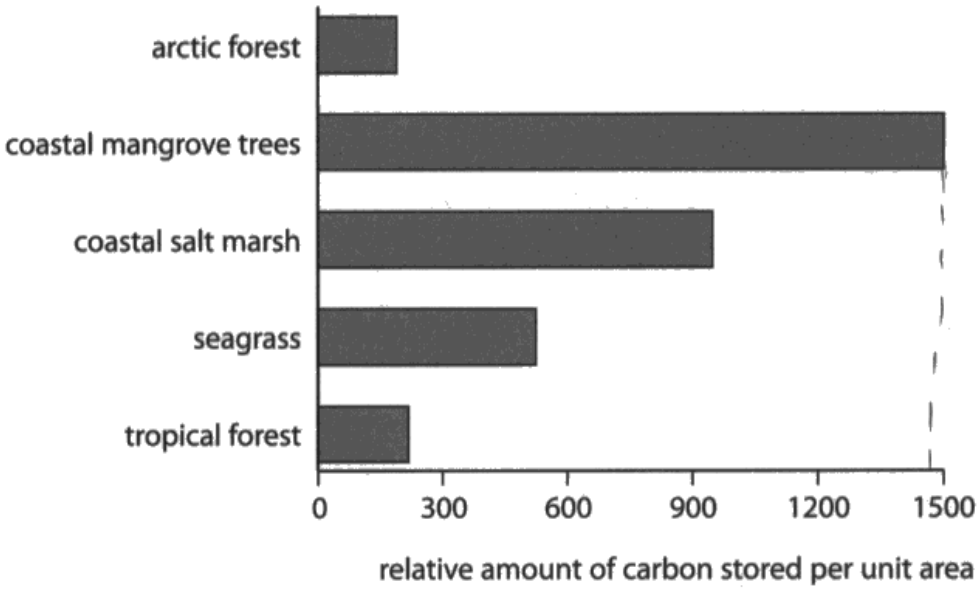


Figure 3

It has been suggested that preserving coastal ecosystems is more effective than reforestation in the mitigation of climate change.

Describe how the data in Figure 3 supports this suggestion.

(2)

In Figure 3, the plants seem to be storing a lot of carbon, for example coastal mangrove trees stores almost 1500, and it would be easier and cheaper to preserve these trees then to plant new ones.

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Examiner Comments

This example scored 0 marks, the candidate mentions storing more carbon or a higher amount than non-coastal ecosystems and although the candidate states numbers, the numbers given are not within the acceptable range and so did not score the second marking point.

(d) Carbon dioxide is removed from the atmosphere by plants and stored in plants and soil as carbon compounds.

Figure 3 shows the relative amounts of carbon stored in plants and soils in different environments.

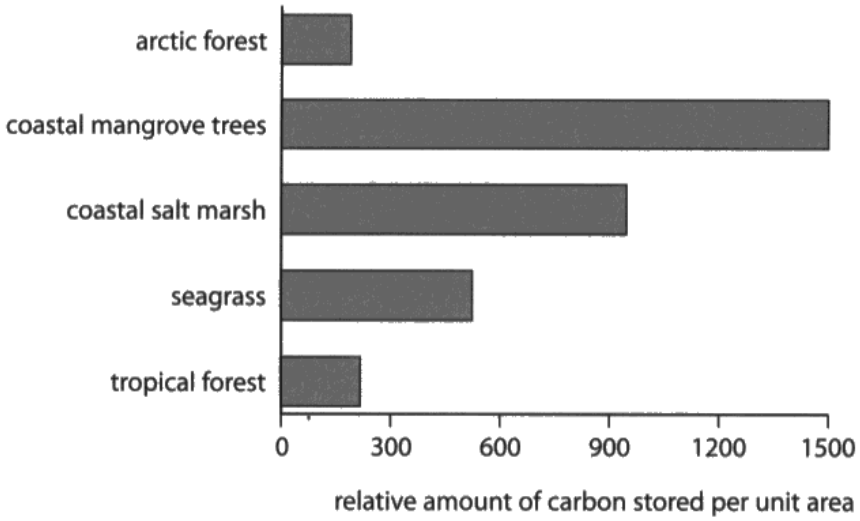

Figure 3

It has been suggested that preserving coastal ecosystems is more effective than reforestation in the mitigation of climate change.

Describe how the data in Figure 3 supports this suggestion.

(2)

because costal mangrove trees store 1,500 relative amount of carbon which is 1500 - 200 = 1300 more than a tropical forest stored showing how costal ecosystems are able to store way more carbon.

(Total for Question 2 = 9 marks)

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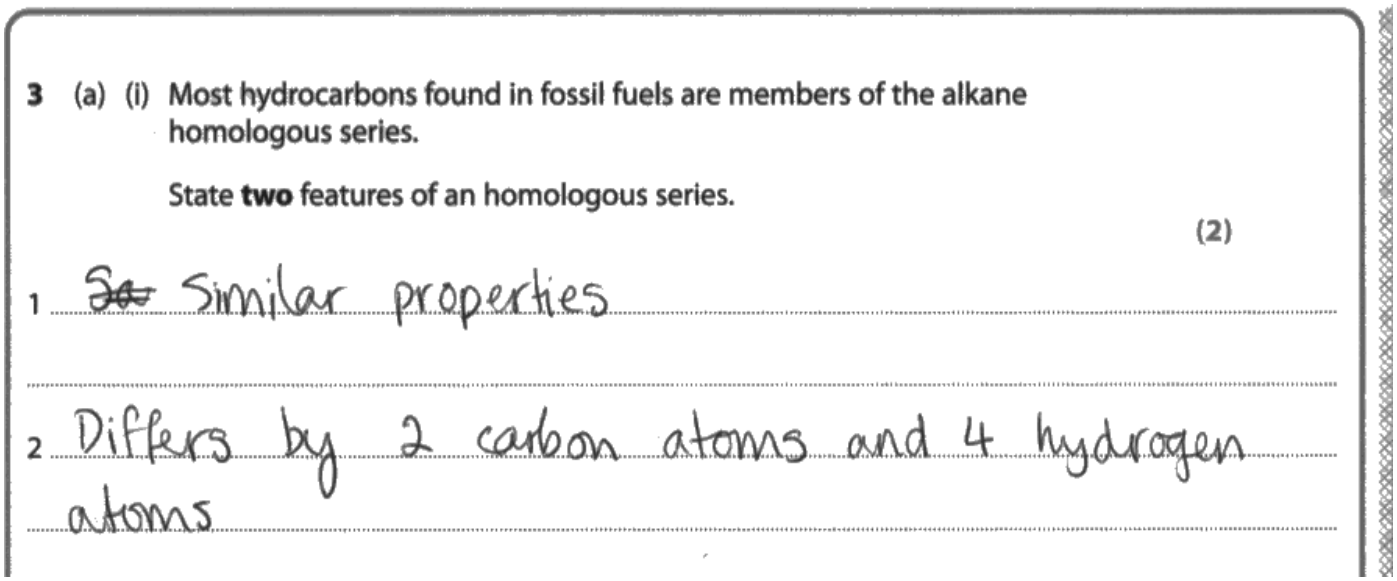
Examiner Comments

This response gained 1 mark, at the end of the response the candidate states that coastal is 'able to store way more carbon'. Unfortunately, the second mark point was not scored as the candidate has only considered the costal mangrove trees in the costal ecosystems.

Question 3 (a)(i)

Question 3 focused on hydrocarbons. Part (a) asked candidates to state two features of a homologous series. Candidates found this quite challenging with few being specific with their answers and the majority therefore not scoring.

Those that did score gave concise, accurate answers, often scoring for stating the homologous series had the same general formula and similar chemical properties.



3 (a) (i) Most hydrocarbons found in fossil fuels are members of the alkane homologous series.

State **two** features of an homologous series.

(2)

1 ~~So~~ Similar properties

2 Differs by 2 carbon atoms and 4 hydrogen atoms

ResultsPlus
Examiner Comments

This example scored no marks, similar properties was ignored, if the candidate had stated similar chemical properties or reactions then the fourth marking point from the mark scheme could have been scored.

The candidate has tried to give a difference in the number of carbon and hydrogens but has mis-remembered the numbers and so did not score. If they had stated that they differ by one carbon and two hydrogens this could have gained credit.

3 (a) (i) Most hydrocarbons found in fossil fuels are members of the alkane homologous series.

State **two** features of an homologous series.

(2)

1 Same general formula

2 Similar chemical properties.

ResultsPlus
Examiner Comments

This response shows a good answer that scored both marks.

Question 3 (b)

Question 3b asked candidates to how the products of complete combustion of a fossil fuel that contained sulfur and carbon would affect the environment.

Candidates found it challenging to score all 4 marks, with 2 being the most common mark scored.

In some cases, candidates knew the two products of combustion, but answers that were vague such as harmful to the environment did not score.

In other cases, candidates were able to explain the affect of carbon dioxide or of sulfur dioxide but did not give both and so only scored 2 marks.

Some lost marks as they did not give the product of combustion they just repeated the stem, stating that sulfur would cause acid rain and carbon would cause global warming, rather than stating sulfur dioxide and carbon dioxide.

(b) A fossil fuel contains carbon and sulfur. C_8H_{18}

Explain how the products of the complete combustion of this fossil fuel would affect the environment.

(4)

carbon is a green house gas and would contribute to climate change.

Carbon is a greenhouse gas so therfore would contribute to climate change. Affecting animal habbitats and the air humans breathe. However sulfur is also not good for the enviroment as it ~~be~~ can be harmfull to living things.

ResultsPlus
Examiner Comments

The following example scored no marks, the candidate has stated that carbon is a greenhouse gas rather than carbon dioxide so the first marking point is not scored. As the second mark point is dependent on the first being scored, The second mark point was also not scored. There is no reference to the formation of sulfur dioxide or sulfur trioxide, so the third mark point was not scored. Even if this had been scored, harmful to the environment would be too vague for the final mark point.

ResultsPlus
Examiner Tip

When asked about the affects on the environment, avoid giving vague responses such as harmful to the environment or pollution without more specific detail.

(b) A fossil fuel contains carbon and sulfur. C_5H_{20}

Explain how the products of the complete combustion of this fossil fuel would affect the environment.

(4)

sulfur in the fossil fuel would form into sulfur dioxide ~~gas~~, when it reacts with water and oxygen it forms acid rain - which destory buildings, kills fish and trees. The carbon would form CO_2, which would increase the greenhouse effect causing global warming. resulting in glaciers melting and floods to increase, reaching the environment.

ResultsPlus
Examiner Comments

This example shows a good answer which scored all 4 marks.

(b) A fossil fuel contains carbon and sulfur.

Explain how the products of the complete combustion of this fossil fuel would affect the environment.

(4)

Complete combustion produces water vapour and carbon dioxide which is a greenhouse gas that when exposed to the atmosphere thickens it and makes it so that the earth retains more heat from the sun contributing to global warming and climate change.

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Examiner Comments

This example scored 2 marks, the candidate has stated that carbon dioxide was formed and the affect that it would have on the environment. Unfortunately, they have not explained the effect of sulfur.

Question 3 (c)

Question 3c asked candidates to write the balanced equation for the incomplete combustion of heptane. Candidates found this very challenging a very small percentage of candidates scoring on the question.

Many students were unable to suggest the correct equation for incomplete combustion, with many not remembering water as a product and often giving hydrogen as a product instead.

The question stated that all the carbon atoms formed carbon monoxide, but many candidates still included carbon dioxide or carbon in the equation.

Mostly candidates did not know the correct formulae of oxygen with many giving O rather than O_2.

Of those that scored did score the first marking point for the formulae of all of the substances, many couldn't balance the equation properly with most giving 7 moles for oxygen.

(c) Incomplete combustion of fuels may produce carbon monoxide.

Write the balanced equation for the incomplete combustion of heptane, C_7H_{16}, where all of the carbon atoms form carbon monoxide.

$C_7H_{16} + O_2 \rightarrow CO + H_2O + CO_2$

ResultsPlus Examiner Comments

This example scored no marks an extra product, carbon dioxide, has been given so the first marking point is not scored. As the first marking point has not been scored, the second mark cannot be scored.

(c) Incomplete combustion of fuels may produce carbon monoxide.

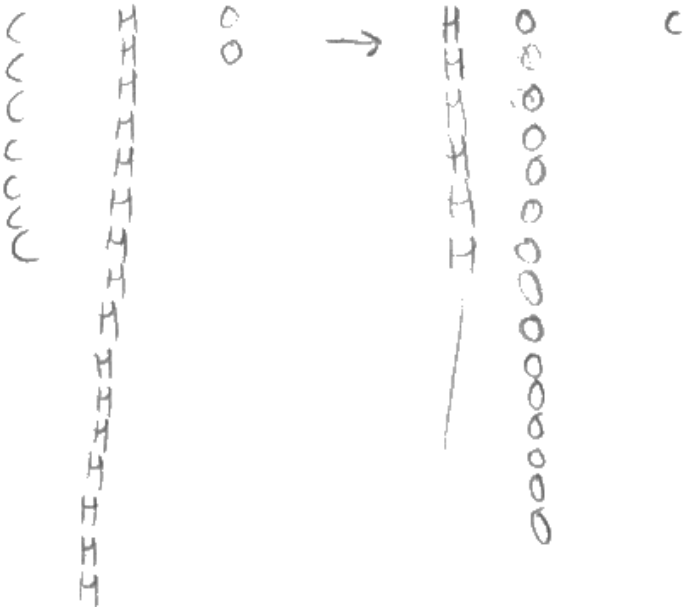
Write the balanced equation for the incomplete combustion of heptane, C_7H_{16}, where all of the carbon atoms form carbon monoxide.

(2)

$C_7H_{16} + 4O_2 \rightarrow 8H_2O + 7CO$

2CO ~~$2H_2O + H_2O$~~

(Total for Question 3 = 9 marks)



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Examiner Comments

This answer scored 1 mark, all formulae are correct, so the first mark is scored. The balancing is not however correct and so the second mark point was not scored.

(c) Incomplete combustion of fuels may produce carbon monoxide.

Write the balanced equation for the incomplete combustion of heptane, C_7H_{16}, where all of the carbon atoms form carbon monoxide.

(2)

$2C_7H_{16} + 15O_2 \rightarrow 14CO + 16H_2O$

ResultsPlus
Examiner Comments

A good answer that scored both marks.

Question 4 (a)(ii)

Question 4 showed candidates an experiment to investigate the percentage of oxygen in the atmosphere.

Question 4aii asked students to describe one improvement to the method to ensure that all of the oxygen in the measuring cylinder has reacted.

Candidates found this quite challenging with around a quarter of the cohort being able to gain 1 mark, but very few gaining both marks. Those that did score both marks often did so by stating iron wool was in excess.

Candidates who scored 1 mark often gave the first part of an answer. E.g. 'Leave for longer' or 'use more iron wool'. However, they often failed to follow this with the second marking point for any of the alternatives.

Common responses that did not score were giving the test for oxygen, heat the apparatus or add a catalyst to increase the rate of reaction, add a bung to the apparatus so the gas doesn't escape or add a gas syringe.

(ii) Describe **one** improvement the student could make to this method to ensure that all of the oxygen in the measuring cylinder has reacted.

(2)

Place glowing splint near cylinder, if splint relights then is not all of the oxygen has been reacted.

ResultsPlus
Examiner Comments

This example, giving the test for oxygen did not gain credit.

(ii) Describe **one** improvement the student could make to this method to ensure that all of the oxygen in the measuring cylinder has reacted.

(2)

leaving the tube to react for a longer amount of time or putting more damp iron wool in the top of the cylinder.

ResultsPlus
Examiner Comments

This example scored 1 mark. A mark could be awarded for leaving for longer or for adding more iron wool, neither suggestion was extended for the second mark so just 1 mark was scored.

(ii) Describe **one** improvement the student could make to this method to ensure that all of the oxygen in the measuring cylinder has reacted.

(2)

Use More iron Wool, So it is in excess, Meaning Oxygen Can react With it.

ResultsPlus
Examiner Comments

This shows a good response that scored both marks.

Question 4 (b)(i)

Question 4bi shows a hydrocarbon fuel being burned and a set of apparatus, they were asked to describe what should be done to the apparatus to collect the water and to show that carbon dioxide had been produced.

Most students misread or misunderstood this question with a large proportion not scoring, often because they were not precise with their answers.

Many candidates made reference to limewater, but few knew how to use it in the apparatus or where to place it. A noticeable proportion of candidates suggested adding a gas syringe to measure carbon dioxide, rather than giving a way to identify the carbon dioxide collected as requested in the question.

Many knew that the water vapour needed to be condensed but many stated to add a condenser rather than what could be done to the apparatus in Figure 5 as requested by the question.

(b) (i) When hydrocarbon fuels are burned, the products are water and carbon dioxide.

Describe what needs to be done to the apparatus in Figure 5 to collect the water and show that carbon dioxide has been produced.

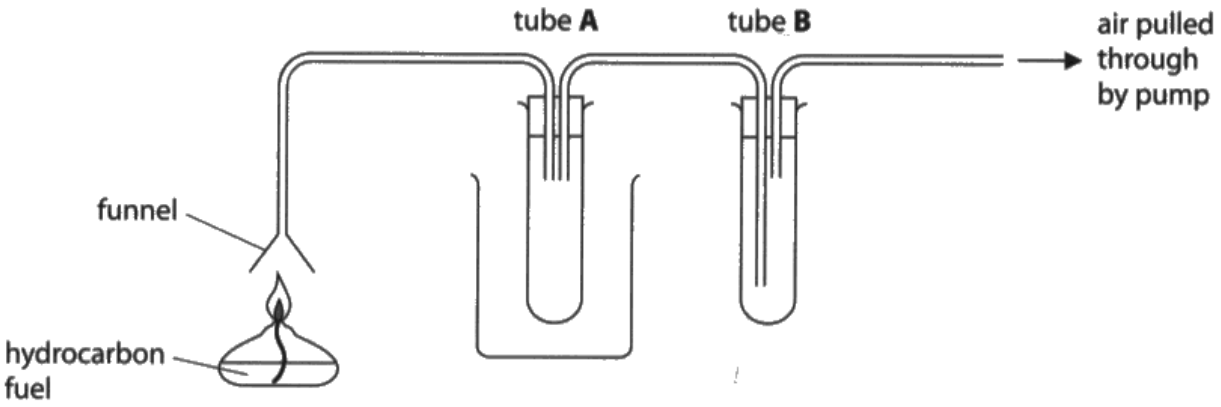


Figure 5

(2)

A condenser should be added to the apperatus, to collect water, and a gas syring should be added to collect CO_2.

ResultsPlus
Examiner Comments

This example scored 0 marks. A common mistake was to add in a condenser. The question does ask what must be done to the apparatus in Figure 5 so adding more apparatus was not creditworthy.

ResultsPlus
Examiner Tip

Ensure that you read the question carefully and check that your answer answers the question set. If you have time at the end of the examination, check through your answers checking that your answer, addresses the question set.

(b) (i) When hydrocarbon fuels are burned, the products are water and carbon dioxide.

Describe what needs to be done to the apparatus in Figure 5 to collect the water and show that carbon dioxide has been produced.

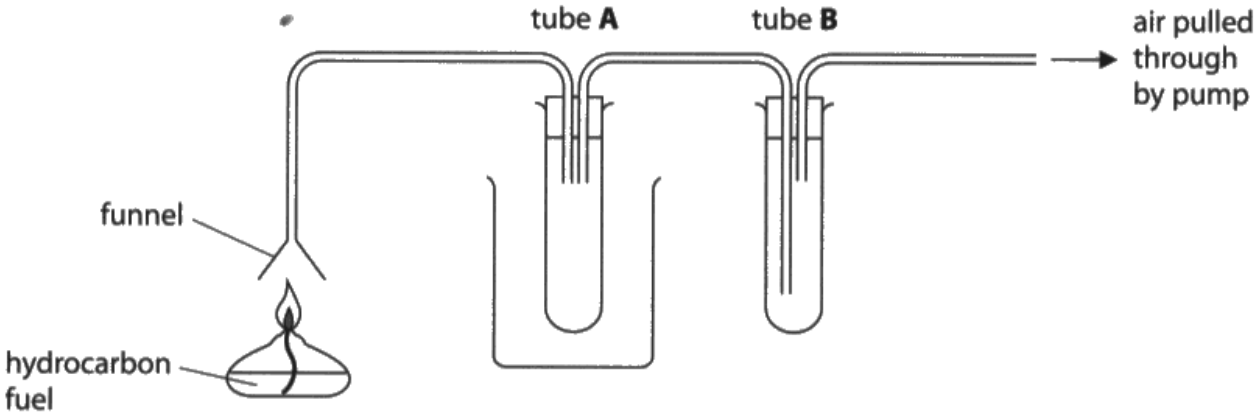


Figure 5

(2)

Add ice-cold water to the beaker around tube A

Add limewater to tube B

ResultsPlus
Examiner Comments

This shows a good example that scored 2 marks.

Question 4 (b)(ii)

In question 4bii, candidates were to calculate the molecular formula of the hydrocarbon.

Candidates found the question very challenging with very few gaining the full 4 marks available.

Candidates frequently used the empirical formula technique but did not multiply the moles of hydrogen by 2, leading to incorrect molecular formulae. If candidates showed their working partial marks could still be awarded.

(ii) A hydrocarbon, C_xH_y, is burned in excess oxygen, forming 26.4 g of carbon dioxide and 5.4 g of water.

The relative formula mass of C_xH_y is 78.

Calculate the molecular formula of the hydrocarbon C_xH_y.

(relative atomic masses: H = 1.0, C = 12;
relative formula masses: H_2O = 18, CO_2 = 44)

(4)

C_6H_6

molecular formula = ...

(Total for Question 4 = 9 marks)

ResultsPlus
Examiner Comments

This example gained 1 mark for the correct formula. There was no working that was worthy of credit for any further marks.

(ii) A hydrocarbon, C_xH_y, is burned in excess oxygen, forming 26.4 g of carbon dioxide and 5.4 g of water.

The relative formula mass of C_xH_y is 78.

Calculate the molecular formula of the hydrocarbon C_xH_y.

(relative atomic masses: H = 1.0, C = 12;
relative formula masses: H_2O = 18, CO_2 = 44)

(4)

CO_2 H_2O

1 mol = $\frac{26.4}{44}$ $\frac{5.4}{18}$ C_2H_1

÷small $\frac{0.6}{0.6}$ $\frac{0.3}{0.6}$ C_4H_2

C_6H_3

1 : 0.5

$C_6 : H_3$

molecular formula = ...

(Total for Question 4 = 9 marks)

ResultsPlus
Examiner Comments

This is a common answer that scored 2 marks. The candidate has calculated the moles of carbon for mark point 1. They have calculated the number of moles of water as 0.3 rather than 0.6, this was a common error, however with ECF, mark point 3 was given for the ratio of 1:0.5. mark point 4 is not awarded, as C_6H_6 does not appear.

Question 5 (a)

Question 5a, gave candidates the relative atomic mass of potassium and of argon and asked why potassium appears after argon in the periodic table.

Just over a quarter of candidates knew that the periodic table is arranged in order of atomic number or proton number and stated this to gain the mark.

Where candidates did not score, it was often due to the explanation being given in terms of the number of outer electrons possessed by the two elements, the number of shells, the electronic configuration or reactivity of the element. These ideas did not score.

5 (a) The relative atomic mass of argon is 40 and the relative atomic mass of potassium is 39 but potassium appears after argon in the periodic table.

State why potassium appears after argon in the periodic table.

(1)

~~key~~ because of the proton number

ResultsPlus
Examiner Comments

This example gained 0 marks, the candidate has stated that it is because of the proton number. This was too vague, if the candidate had stated that the proton number was higher then this could have scored.

5 (a) The relative atomic mass of argon is 40 and the relative atomic mass of potassium is 39 but potassium appears after argon in the periodic table.

State why potassium appears after argon in the periodic table.

(1)

potassium has 1 more proton

ResultsPlus
Examiner Comments

The fact that potassium has one more proton than argon scored the mark.

Question 5 (b)(i)

In part (b) of the question, candidates were asked to give the formulae of the two products of the reaction of potassium with water. Candidates found this very difficult with a very small percentage getting the formula of both products correct, indicating a lack of understanding of the reaction.

Common mistakes included giving names of the products rather than the formulae or suggesting incorrect products like potassium oxide or oxygen. Often where candidates knew that hydrogen was a product, they did not remember that hydrogen is diatomic and so did not gain the mark as they gave an answer of H rather than H_2.

(b) Potassium reacts with water to form two products.

(i) Give the formulae of both products.

(1)

Potassiumoxide and hydrogen

ResultsPlus
Examiner Comments

A common misconception was that potassium oxide, rather than potassium hydroxide was produced. This response scored 0 marks, they have the wrong products and used words instead of formula.

ResultsPlus
Examiner Tip

If asked for the formula for a substance, ensure you write your answer as a chemical formula, not as words.

(b) Potassium reacts with water to form two products.

(i) Give the formulae of both products.

(1)

K and H_2O

ResultsPlus
Examiner Comments

In this example, the candidate has not read the question carefully and has given the formula of the reactants rather than the products and so therefore scored no marks.

ResultsPlus
Examiner Tip

Ensure that you read the questions carefully and you understand what is meant by the terms reactant and product.

(b) Potassium reacts with water to form two products.

(i) Give the formulae of both products.

(1)

H_2 **and** KOH

ResultsPlus
Examiner Comments

This response shows a good answer which scored the mark.

Question 5 (b)(ii)

Question 5bii asked candidates to draw and label the reaction profile for the exothermic reaction.

Over half of candidates scored on the question, however the most common mark was 1, with a lower percentage gaining both marks. Whilst many responses had the correct arrangement of energy levels for the reactants and products, most labelled correctly, fewer were able to draw and label the activation energy accurately.

In some cases, candidates had drawn an endothermic rection profile rather than an exothermic profile, in these cases the identification of the activation energy was invariably incorrect.

(ii) The reaction of potassium with water is exothermic.

On Figure 6, draw and label the reaction profile diagram for this reaction, labelling the activation energy.

(2)

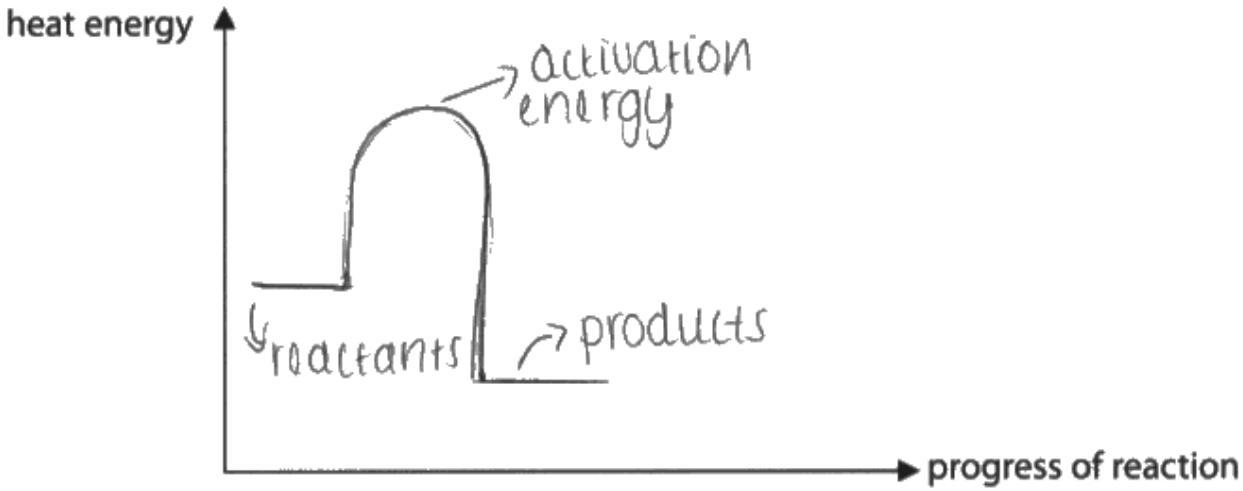


Figure 6

ResultsPlus
Examiner Comments

This example scored 1 mark, the reactant and product lines are in the correct position and labelled for the first mark point. A common error was to label the peak of the curve as the activation energy, as in this example. The second mark was therefore not awarded.

(ii) The reaction of potassium with water is exothermic.

On Figure 6, draw and label the reaction profile diagram for this reaction, labelling the activation energy.

(2)

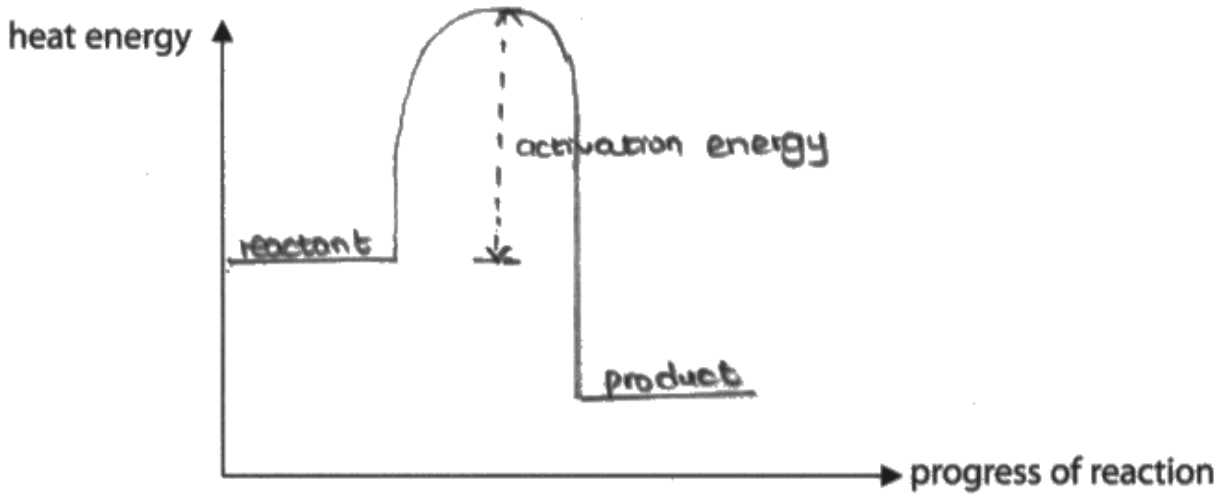


Figure 6

ResultsPlus
Examiner Comments

This response shows a good answer which scored both marks.

Question 5 (c)

Part (c) of question 5 asked candidates to explain, in terms of bond breaking and bond forming, while some reactions are endothermic.

In general, candidates found this very challenging. Whilst a good proportion were able to score at least one mark, fewer could gain 2 or 3 marks.

The majority of candidates knew that energy is required to break bonds.

In some cases, candidates did not read the question carefully and defined what an endothermic reaction is or what endothermic means without linking it to bond breaking or making as required in the question.

(c) **Some reactions are endothermic.**

Explain, in terms of bond breaking and bond forming, why some reactions are endothermic.

(3)

Some reactions are endothermic as they take in heat in order to break bonds. Bond forming is exothermic as heat is taken out to form bonds.

ResultsPlus
Examiner Comments

This example gained 2 marks, the candidate states that the reaction takes in heat to break bonds and that bond forming is exothermic. There is no reference to the amount of energy taken in and given out for the third marking point.

(c) Some reactions are endothermic.

Explain, in terms of bond breaking and bond forming, why some reactions are endothermic.

(3)

Bond breaking is endothermic as energy is needed to break bonds and bond making is exothermic as energy is released when bonds are made if the amount of energy needed to break bonds is greater than the amount of energy released when making bonds then a reaction is endothermic.

ResultsPlus
Examiner Comments

This example shows a good answer that scored all 3 marks.

Question 5 (d)

Question 5d asks candidates to calculate the bond energy for the reaction between ethene and hydrogen chloride. This question was well answered with a vast majority of students gaining marks here.

Most students knew they had to add up the bond energies, for each side but many made simple mathematical errors in doing so. This meant that they still scored well as everything but the adding was correct.

This example shows a well laid out answer that gained the full four marks.

Calculate the energy change for this reaction.

(4)

612 + 4(412) + 431 = 2691

5(412) 1348 + 431 = 2839

2839 - 2691 = 148

energy change = 148 kJ mol^{-1}

ResultsPlus
Examiner Comments

This example gains 2 marks, they have calculated the bonds broken correctly for the first marking point. They have not calculated the bonds made correctly and so marking point 2 was not scored. As the candidate has shown their working clearly, error carried forward was applied. The candidate has found the difference to gain mark point 3 but has the subtraction the wrong way around and so did not gain mark point 4.

Calculate the energy change for this reaction.

(4)

break

C=C = 612 + H-Cl = 431

C-H = 412 × 4 = 1648

612 + 1648 + 431 = 2691

make

Cl-C = 338

C-H = 412 × 5 = 2060

C-C = 348

338 + 2060 + 348 = 2746

2746 - 2691 = 55

energy change = 55 kJ mol^{-1}

ResultsPlus
Examiner Comments

This example shows a good answer, again the answer was well laid out but as the subtraction for the difference had been reversed and resulted in an answer of 55 rather than – 55 a mark of 3 was awarded rather than 4 marks.

Calculate the energy change for this reaction.

(4)

break in reactants	make in products	take
C=C x1 612	C-C x1 348	2691 - 2746 = -55
C-H x4 412x4=1648	C-H x5 412x5=2060	
H-Cl x1 431	C-Cl x1 = 338	
+= 2691	+= 2746	

energy change = -55 kJ mol^{-1}

ResultsPlus
Examiner Comments

This example shows a well laid out answer that gained the full four marks.

Question 6 (b)

Question 6b asked candidates to identify the solid made from the reaction of iron wool with bromine vapour.

Candidates found this quite difficult. A common error was to give an answer of iron bromine rather than iron bromide.

Some candidates did not interact with the question well to note what the starting materials in the reaction were and gave answers such as water, hydrogen or carbon dioxide.

(b) Iron wool is heated with bromine vapour as shown in Figure 8.

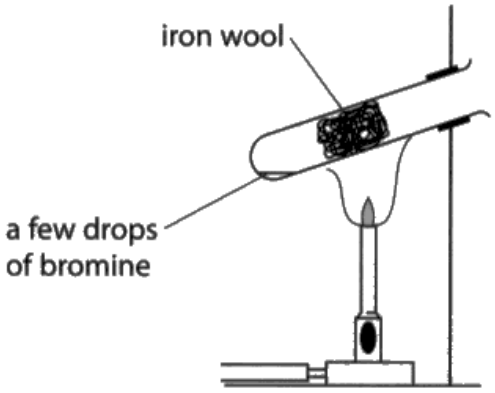


Figure 8

At the end of the reaction, a solid forms at the top of the test tube.

Identify the solid.

(1)

iron bromine

ResultsPlus
Examiner Comments

This response shows a common error which scored no marks.

(b) Iron wool is heated with bromine vapour as shown in Figure 8.

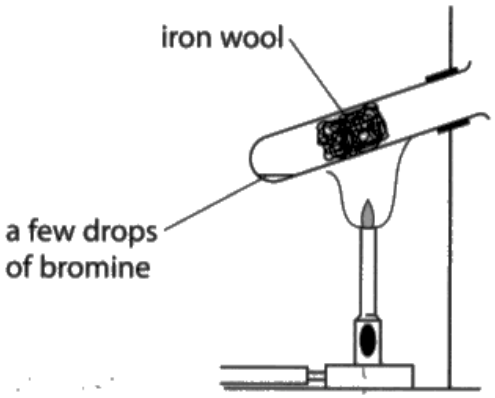


Figure 8

At the end of the reaction, a solid forms at the top of the test tube.

Identify the solid.

(1)

Iron Bromide

ResultsPlus
Examiner Comments

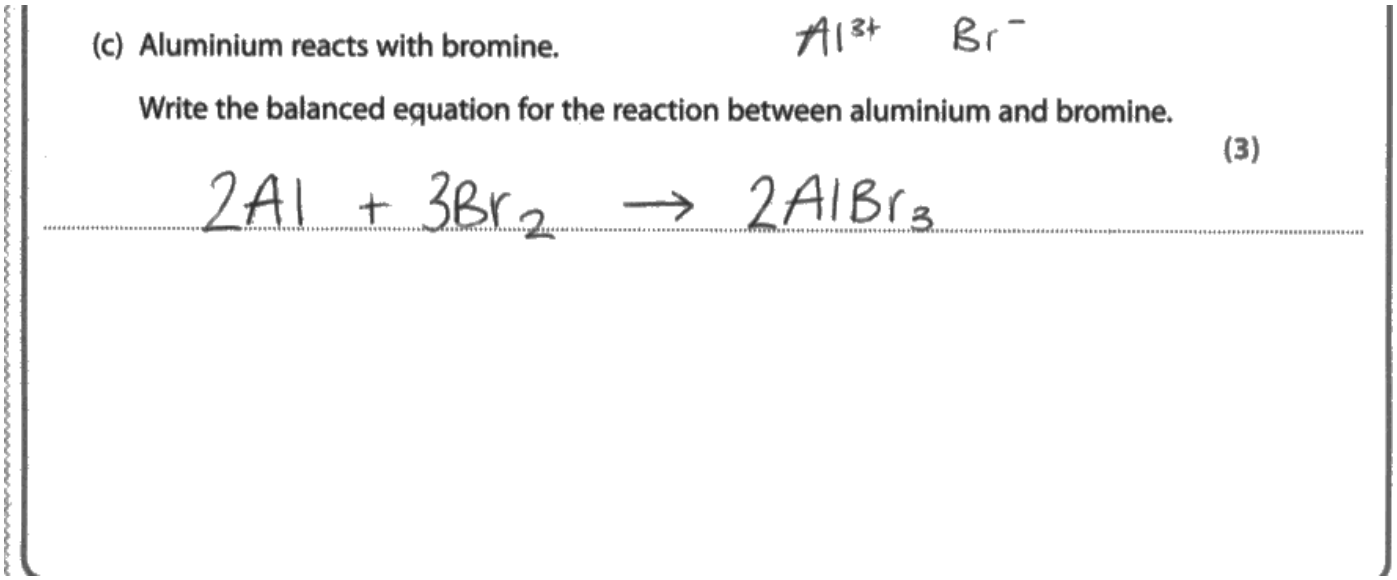
This example scored 1 mark.

Question 6 (c)

Question 6c asked candidates to balance the reaction between aluminium and bromine. Candidates found this very difficult with around two thirds of candidates not scoring and 1 mark being the most common mark.

Where candidates did score, it was often for the left hand side of the equation, indicating a struggle with deducing the correct product formulae for the aluminium bromide, often candidates gave other products as well as the aluminium bromide, quite a few candidates also didn't seem to understand that the elements in the reactants are the only elements that can appear in the product.

Although the reactants, left hand side, was the better answered part of the equation, many did not realise that bromine was diatomic so gave Br rather than Br_2.



(c) Aluminium reacts with bromine. Al^{3+} Br^-

Write the balanced equation for the reaction between aluminium and bromine.

(3)

$2Al + 3Br_2 \rightarrow 2AlBr_3$

ResultsPlus
Examiner Comments

This example shows a good response that scored all 3 marks.

(c) Aluminium reacts with bromine.

Write the balanced equation for the reaction between aluminium and bromine.

(3)

$4Al + 3Br_2 \rightarrow 2Al_2Br_3$

ResultsPlus
Examiner Comments

This example scored 1 Mark. The first marking point is awarded for the formulae on the left hand side. Al_2Br_3 is incorrect so the second mark was not awarded. As all formula were not correct, the third marking point could not be scored.

(c) Aluminium reacts with bromine.

Write the balanced equation for the reaction between aluminium and bromine.

(3)

$2Al + 3Br_2 \rightarrow 2AlBr_3$

ResultsPlus
Examiner Comments

This example shows a good response that scored all 3 marks.

Question 6 (d)(i)

Question 6di was the 6-mark question with a level-based mark scheme. Candidates were given a list of reagents and asked to describe experiments that could be carried out using the solutions to find the order of reactivity, explaining how the results would show the order of reactivity.

Most candidates described at least 1 experiment, and many candidates correctly identified the order of reactivity.

Common misconceptions included reacting the halogens with water, monitoring pH or temperature changes, measuring the volume of gas produced or reacting sodium rather than the sodium halides showing a lack of understanding or familiarity of the displacement reactions.

The best answers showed that candidates had practical experience of the reactions and included a grid of results, the answers were clear and concise and the candidates were careful when writing the names of the solutions as sodium iodide and sodium chloride rather than sodium iodine or sodium chlorine for example. They were able to show clearly the correct combinations for success or non-reaction and many were able to back this up with equations before finally coming up with the correct trend in reactivity

Even through equations were asked for in the question, they were rarely included. Where candidates did include symbol equations, they were often incorrect in terms of formula or balancing. Where candidates gave word equations, they often contained errors in the names of the substances.

Some candidates tried to give full explanations of the reactivity of the halogens using atomic radii/shielding though this was not required.

*(d) (i) The order of reactivity of the halogens can be found by displacement reactions.

A student was provided with

- solutions of bromine, chlorine and iodine
- solutions of sodium bromide, sodium chloride and sodium iodide.

Describe experiments the student could carry out using these solutions to find the order of reactivity of bromine, chlorine and iodine, explaining how the results would show the order of reactivity.

You should use equations to support your answer.

(6)

The student should use the sodium solutions and react them with the solutions of bromine, chlorine and iodine. This will show them which ~~reactions~~ ~~with~~ halogens are most reactive. They will be abre to see the most reactive ~~if~~ by seeing which halogens displace others for example when combining sodium bromide to iodine the idone will be more reactive and displace the sodium bromide. If they repeat theses steps and combine every halogen & then they can compare their results and ~~wod~~ work out the most reacting halogens and put them in a reactivity series.

ResultsPlus
Examiner Comments

This example scored 1 mark in level 1. The candidate starts by stating that the sodium solutions should be reacted with the solutions of the halogens, this gains 1 mark. There was nothing further in the answer that could be awarded credit.

*(d) (i) The order of reactivity of the halogens can be found by displacement reactions.

A student was provided with

- solutions of bromine, chlorine and iodine
- solutions of sodium bromide, sodium chloride and sodium iodide.

Describe experiments the student could carry out using these solutions to find the order of reactivity of bromine, chlorine and iodine, explaining how the results would show the order of reactivity.

You should use equations to support your answer.

(6)

• the student can react bromide with sodium chloride + sodium iodide, chlorine with sodium bromide + Sodiume iodide and iodine with sodium bramide + sodium chloride

• then, the student should observe the reaction, if any.

• then they should record the data.

• This would help find out the order of reactivity because the more reactive metal displaces the less reactive one.

• for example, ~~Chlorine~~

Chlorine + Sodium bromide → bromine + sodium chloride

which ~~can~~ shows chlorine is more reactive

ResultsPlus
Examiner Comments

This response gained 3 marks in level 2. The candidate has described all experiments and given one result with an equation. This was sufficient for level 2 – 3 marks.

*(d) (i) The order of reactivity of the halogens can be found by displacement reactions.

A student was provided with

- solutions of bromine, chlorine and iodine
- solutions of sodium bromide, sodium chloride and sodium iodide.

Describe experiments the student could carry out using these solutions to find the order of reactivity of bromine, chlorine and iodine, explaining how the results would show the order of reactivity.

You should use equations to support your answer.

(6)

Chlorine

- react chlorine with sodium bromide to form sodium chloride + bromine (displacement occured)
- react chlorine with sodium iodide to form sodium chloride + iodine (displacement occured)
- this would mean that chlorine is the most reactive of the 3

Bromine

- react bromine with sodium chloride to form sodium chloride + bromine (no displacement occured)
- react bromine with sodium iodide to form sodium bromide + iodine (displacement occured)
- this would mean that bromine is less reactive than chlorine but more reactive than iodine

Iodine

- reacting iodine with sodium chloride or sodium bromide would have no displacement occur
- this proves that iodine is the least reactive

- The order of reactivity is: Chlorine, Bromine, Iodine.

ResultsPlus
Examiner Comments

This response gained 5 marks in level 3. The candidate describes reacting all 9 mixtures and have stated the results of all of them. They understand which reactions would result in a displacement reaction and give the correct order of reactivity. They have not included any equations in their answer.

*(d) (i) The order of reactivity of the halogens can be found by displacement reactions.

A student was provided with
- solutions of bromine, chlorine and iodine
- solutions of sodium bromide, sodium chloride and sodium iodide.

Describe experiments the student could carry out using these solutions to find the order of reactivity of bromine, chlorine and iodine, explaining how the results would show the order of reactivity.

You should use equations to support your answer.

(6)

The student would make a reaction between ~~bromine~~ chlorine and sodium bromide where chlorine would displace bromine ($Cl_2 + 2NaBr \rightarrow 2NaCl + Br_2$) as it is more reactive - higher in the period so the attraction between the nucleus and electrons is stronger. Then he would react chlorine with sodium iodide and chlorine would displace iodine ($Cl_2 + 2NaI \rightarrow 2NaCl + I_2$) as it is also more reactive and higher in period. Therefore the student can be sure that chlorine is the most reactive from the three halogen gases. Then the student would react bromine with sodium iodide where bromine will displace iodine (~~$Br_2 + 2NaI \rightarrow 2NaI$~~ $(Br_2 + 2NaI \rightarrow 2NaBr + I_2)$ because it is more reactive ~~than~~ and is higher in period. Therefore the student will know that chlorine is the most reactive and bromine is more reactive that iodine. So the student will know: chlorine → bromine → iodine (in order of decreasing reactivity

ResultsPlus
Examiner Comments

This example shows a good answer that scored 6 marks in level 3. The candidate has described sufficient experiments to deduce the order of reactivity and given the results of the experiments. They have given the correct order of reactivity, and they have given correct equations.

Question 6 (d)(ii)

The last question on the paper asked candidates to explain why the displacement reactions of the halogens are redox reactions.

Candidates found this question challenging and it was noticed that many candidates left this answer blank.

Where candidates did score, they gave clear and precise answers which matched the mark scheme well.

Other candidates gave a correct definition of a redox reaction or of reduction and oxidation but then didn't go on to apply it to the question, others confused redox reactions with reversible reactions.

(ii) Explain why the displacement reactions of halogens are redox reactions.

(2)

They either oxidise and lose electrons or reduce & gaining electrons.

ResultsPlus
Examiner Comments

This example scored no marks, the candidate has given a generic definition of oxidation and reduction but there is no reference to halide (ions) or halogen (atoms) so no credit was awarded.

(ii) Explain why the displacement reactions of halogens are redox reactions.

(2)

Oxidation of halide ions (loss of electrons) and reduction of halogen ions (gain of electrons) happen @ the same time

ResultsPlus
Examiner Comments

This example scored 1 mark, the candidate gains the first mark for oxidation of halide ions. the second mark was not scored however as they stated that halogen ions rather than halogen atoms are reduced which is incorrect.

(ii) Explain why the displacement reactions of halogens are redox reactions.

(2)

The halide ions are oxidised (lose lost electrons) by and an displaced. The halogen is reduced (gains electrons), making it a redox reaction

ResultsPlus
Examiner Comments

This response shows a good answer that scored both marks.

Paper Summary

Based on their performance in this paper, candidates should:

- ensure that they are clear, accurate and precise with their language and avoid vague or general comments.
- know the difference between the different types of formula such as molecular formula, general formula and empirical formula.
- practice drawing scientific equipment and practical set ups, ensuring that the set up shown would work for example with no gaps for gases to escape.
- practice common calculations from the specification, showing your working at all times, practice rounding your answers to specific numbers of significant figures and decimal places.
- learn how to work out ionic formulae using the periodic table.
- practice recalling the formula for common compounds and substances from the specification and balancing equations involving these, remembering the molecules that are diatomic.
- consider how energy changes in reactions result from bond making and bond breaking.
- ensure that they are familar with the core practicals from the specification and can explain why each step in the method is carried out.

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