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June 2025

GCSE Chemistry 1CH0 1H

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June 2025

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Introduction

Paper 1H is the first of the two papers for GCSE Chemistry.

The paper consists of 10 questions, six of which also form one of the GCSE Combined Science higher tier papers.

Three of the ten questions also appear on the equivalent GCSE Chemistry foundation paper.

This paper is targeted from Grade 4 to Grade 9.

Most candidates made a good attempt at all of the questions on the paper with the most able candidates showing a wide range of skills and knowledge including calculations, application of chemistry, designing and evaluating practicals and interpreting data. The most able candidates were also able to use complex scientific vocabulary in clear and concise responses.

There are still frequent occasions where candidates are not fully understanding what the question is asking them to do. There is often confusion about command words and the incorrect use of science specific vocabulary that leads to candidates showing some scientific knowledge but not being able to write it in a creditworthy way.

Question 1(a)i

The first question on the paper asked candidates to identify the type of compound that must be present in an electrolyte. By definition this an ionic compound either molten or in solution. The majority of candidates had the right idea about this and most of these scored the mark for stating that the electrolyte must contain ions. However, some candidates did not score because they gave the names of specific ionic compounds. Other non-scoring responses commonly included the physical state of the electrolyte, ie molten or aqueous, but did not go on to state what type of compound was in the molten or aqueous state.

This response scored the mark.

1 (a) Figure 1 shows a chemical cell.

The chemical cell contains two metal electrodes placed into an electrolyte and connected in a circuit with a voltmeter.

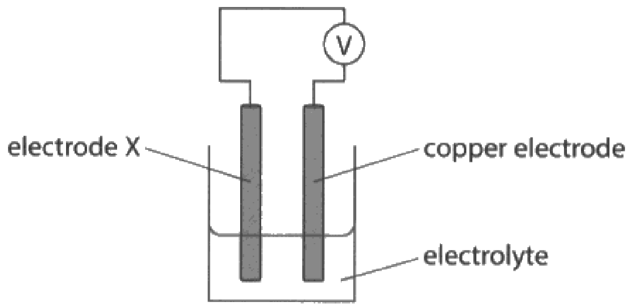

Figure 1

(i) State what type of compound must be present in the electrolyte.

(1)

ionic

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Examiner Comments

Reference to containing ions or ionic compounds was enough to score the mark.

This response did not score the mark.

1 (a) Figure 1 shows a chemical cell.

The chemical cell contains two metal electrodes placed into an electrolyte and connected in a circuit with a voltmeter.

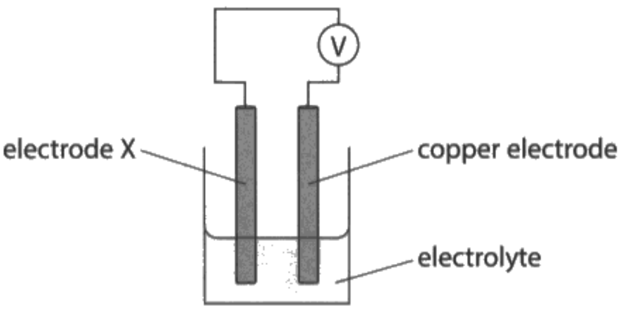


Figure 1

(i) State what type of compound must be present in the electrolyte.

(1)

aqueous

ResultsPlus
Examiner Comments

Here the candidate has attempted to use scientific language to describe an ionic solution. It's unlikely that they are aware that aqueous solutions are not necessarily ionic.

This response did not score.

1 (a) Figure 1 shows a chemical cell.

The chemical cell contains two metal electrodes placed into an electrolyte and connected in a circuit with a voltmeter.

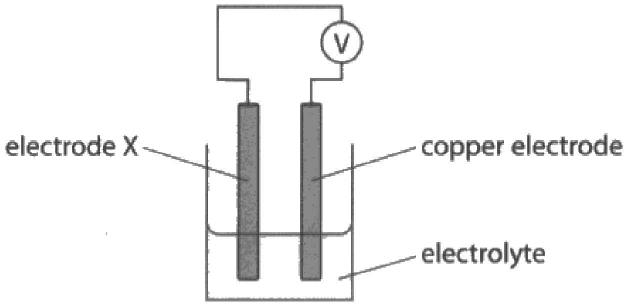


Figure 1

(i) State what type of compound must be present in the electrolyte.

(1)

Copper chloride.

ResultsPlus
Examiner Comments

The question asked what type of compound must be present in the electrolyte. Copper chloride is a named example of an electrolyte, so this response does not answer the question.

Question 1(a)iii

This part of the question asked candidates to suggest what would happen to the voltage once one of the reactants had been used up. Most candidates correctly concluded that if there were no more reactants then a voltage would no longer be produced. There were only a small number of responses that stated there would be no change to the voltage, or that it would increase. There were responses that stated that the voltage would 'go flat'. Unfortunately, this was too ambiguous to score here. Although the commonly used phrase of a 'flat battery' suggests that there is no voltage, the word 'flat' could also indicate a constant voltage and so no mark could be awarded.

This response scored the mark.

(iii) State what happens to the voltage when one of the reactants is used up.

(1)

It decreases until it reaches 0

ResultsPlus
Examiner Comments

This candidate has described exactly what would happen if one of the reactants was used up. Responses that suggested a decrease in voltage without stating that it would end at 0 were also awarded the mark.

This response did not score the mark.

(iii) State what happens to the voltage when one of the reactants is used up.

(1)

the voltage increases.

ResultsPlus
Examiner Comments

A small number of responses showed a lack of understanding about chemical cells and gave answers that suggested that a voltage would be produced only once the chemical reaction was complete.

This response did not score.

(iii) State what happens to the voltage when one of the reactants is used up.

(1)

voltage stays the same

ResultsPlus Examiner Comments

The most common incorrect answer seen usually suggested that the voltage would not change.

Question 1(b)i

The dot and cross diagram for oxygen is listed in the specification and should be familiar to all candidates – particularly on the higher tier paper.

This question was very well answered overall. When candidates correctly added a double bond into their diagram then it was almost always completely correct. It was very unusual to see a response that scored only 1 mark.

Some candidates did not attempt to draw oxygen at all and there were a surprisingly large number of responses that drew the dot and cross diagram for either water or methane.

This response scored both marks. In this case the candidate has used circles to represent the electrons on one of the atoms and crosses on the other atom.

It does not matter if all circles, all dots or all crosses are used, as long as there are the correct number of electrons in the overlap area and the correct number of electrons in total on the outer shell of each atom.

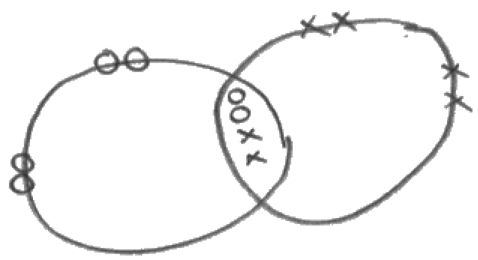
(b) Hydrogen-oxygen fuel cells can also be used to produce a voltage.

(i) Draw the dot and cross diagram for a molecule of oxygen, O_2.

An atom of oxygen has the electronic configuration of 2.6.

Show outer electrons only.

(2)



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Examiner Comments

The candidate has correctly drawn two shared pairs of electrons in the overlap area and then correctly added four more electrons to each atom.

This is an (unusual) example of a response that scored 1 mark.

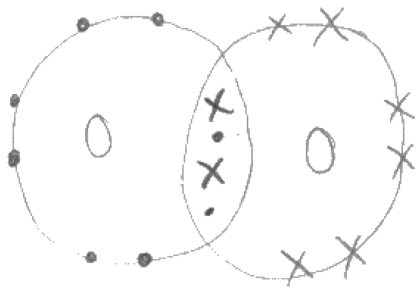
(b) Hydrogen-oxygen fuel cells can also be used to produce a voltage.

(i) Draw the dot and cross diagram for a molecule of oxygen, O_2.

An atom of oxygen has the electronic configuration of 2.6.

Show outer electrons only.

(2)



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Examiner Comments

The candidate has correctly included two shared pairs of electrons in the overlap area but has then gone on to add a further six electrons to each oxygen atom, giving a total of 10 electrons on each outer shell.

ResultsPlus
Examiner Tip

When drawing dot and cross diagrams, the total number of outer electrons in each atom should be 8, unless it is a hydrogen atom (which should have 2 outer electrons in total).

This response did not score any marks.

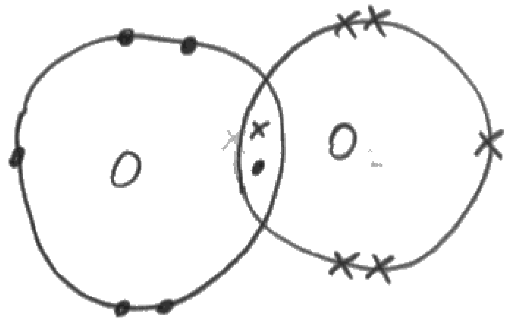
(b) Hydrogen-oxygen fuel cells can also be used to produce a voltage.

(i) Draw the dot and cross diagram for a molecule of oxygen, O_2.

An atom of oxygen has the electronic configuration of 2.6.

Show outer electrons only.

(2)



ResultsPlus
Examiner Comments

Although the candidate has the correct number of electrons for each atom, they have indicated a single shared pair of electrons rather than two shared pairs.

This response did not score.

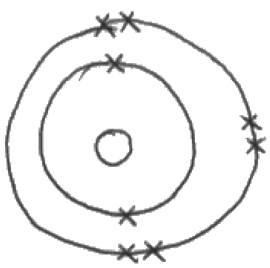
(b) Hydrogen-oxygen fuel cells can also be used to produce a voltage.

(i) Draw the dot and cross diagram for a molecule of oxygen, O_2.

An atom of oxygen has the electronic configuration of 2.6.

Show outer electrons only.

(2)



ResultsPlus
Examiner Comments

This candidate drew the electronic configuration for an atom of oxygen rather than a dot and cross diagram of an oxygen molecule.

ResultsPlus
Examiner Tip

A dot and cross diagram will include at least two atoms and at least one covalent bond.

Question 1(b)ii

The last part of this question asked candidates to state one advantage of fuel cells over chemical cells and there were a number of correct responses. A mark was awarded for water being the only product, the water being able to be reused for something else or that fuel cells produce a constant voltage as long as hydrogen is supplied.

This question was not well answered, with less than half of the candidates scoring a mark. It was common to see vague comments about emissions, pollution or greenhouse gases and there were a lot of responses that discussed the size and cost of fuel cells compared to chemical cells, which were not creditworthy for this question.

This response scored the mark.

(ii) Hydrogen-oxygen fuel cells are used in spacecraft.

Suggest **one advantage** of using fuel cells rather than chemical cells in spacecraft.

(1)

Fuel cells produce wate as the only product.

ResultsPlus
Examiner Comments

Some responses did state that water would be produced but not that it is the only product.

This response scored the mark.

(ii) Hydrogen-oxygen fuel cells are used in spacecraft.

Suggest **one advantage** of using fuel cells rather than chemical cells in spacecraft.

(1)

Fuel cells will keep producing a voltage as long as they have a suply of fuel (hydrogen, oxygen).

ResultsPlus
Examiner Comments

It was more unusual to see responses relating to producing a voltage as long as fuel is supplied.

This response did not score the mark.

(ii) Hydrogen-oxygen fuel cells are used in spacecraft.

Suggest **one advantage** of using fuel cells rather than chemical cells in spacecraft.

(1)

They are cheaper and more readily abundant and better for the environment.

ResultsPlus
Examiner Comments

Most responses were too vague to score or did not give relevant information. In this case the candidate has stated that fuel cells are better for the environment but not given enough detail as to why this is the case.

This response did not score the mark.

(ii) Hydrogen-oxygen fuel cells are used in spacecraft.

Suggest **one advantage** of using fuel cells rather than chemical cells in spacecraft.

(1)

Fuels cells are more sustainable because chemical cells have some wastefull outputs.

ResultsPlus
Examiner Comments

Another vague response. In order to score the candidate needed to be more specific about what exactly is sustainable or wasteful.

Question 2(a)i

The first part of Question 2 asked candidates to complete a table of information about the relative mass and relative charge on the three subatomic particles.

Overall candidates got this correct, with the most common errors being to confuse relative mass and relative charge.

2 (a) Atoms of neon are made up of subatomic particles.

(i) Figure 2 shows some information about the subatomic particles in neon atoms.

Complete Figure 2 with the missing information.

(3)

subatomic particle	relative charge	relative mass
proton	+1	1
neutron	0	1
electron	−1	negligible

Figure 2

ResultsPlus
Examiner Comments

This response scored 3 marks. The table is fully correct.

ResultsPlus
Examiner Tip

Make sure to include a + sign when talking about positively charged particles.

This response scored 2 marks. The candidate has correctly identified the charge of a proton and the mass of a neutron.

2 (a) Atoms of neon are made up of subatomic particles.

(i) Figure 2 shows some information about the subatomic particles in neon atoms.

Complete Figure 2 with the missing information.

(3)

subatomic particle	relative charge	relative mass
proton	+1	1
neutron	0	~~0~~ 1
electron	- 0.0005	negligible

Figure 2

ResultsPlus
Examiner Comments

The candidate has confused mass and charge, giving the mass of an electron along with a minus sign.

This response scored 1 mark for the charge on a proton. It is assumed that no sign indicates a +.

2 (a) Atoms of neon are made up of subatomic particles.

(i) Figure 2 shows some information about the subatomic particles in neon atoms.

Complete Figure 2 with the missing information.

(3)

subatomic particle	relative charge	relative mass
proton	1	1
neutron	0	– 1
electron	1	negligible

Figure 2

ResultsPlus Examiner Comments

The charge on a proton was the most commonly seen correct mark. This candidate has then also confused mass and charge, suggesting that neutrons have a negative mass.

ResultsPlus Examiner Tip

In chemistry, nothing has a mass lower than 0.

Question 2(a)ii

In this question, candidates were asked to state what information about subatomic particles could be determined from the atomic number of neon. Most candidates correctly identified that an atomic number of 10 indicates that there are 10 protons and 10 electrons in atoms of neon.

Where candidates did not score both marks, this was often due to incorrectly stating 10 protons and 10 neutrons. There were also a significant number of responses that did not score due to a lack of clarity in the written response, where it was unclear whether the candidate intended 10 protons and 10 electrons or 10 protons and electrons in total.

This response scored 2 marks.

(ii) All atoms of neon have an atomic number of 10.

Describe what information about the number of subatomic particles can be obtained from the atomic number of neon.

(2)

An atomic number of 10 tells us there are 10 protons and 10 electrons in the atom of neon.

ResultsPlus
Examiner Comments

This candidate has clearly stated 10 protons and 10 electrons here, with no ambiguity.

This response scored 1 mark.

(ii) All atoms of neon have an atomic number of 10.

Describe what information about the number of subatomic particles can be obtained from the atomic number of neon.

(2)

there is 10 protons & so there must
be 10 neutrons aswell

ResultsPlus
Examiner Comments

It was a common error to see the number of neutrons given, even though the atomic mass of the atom was not given in the question.

ResultsPlus
Examiner Tip

Both the atomic number and the atomic mass are needed in order to determine the number of neutrons in an atom.

This response did not score any marks.

(ii) All atoms of neon have an atomic number of 10.

Describe what information about the number of subatomic particles can be obtained from the atomic number of neon.

(2)

neon's atomic number shows 5 protons and 5 neutrons, its a noble gas in group 0.

ResultsPlus
Examiner Comments

Some candidates confused the definition of atomic number and atomic mass and thought that 10 was the total number of protons and neutrons.

This answer was too ambiguous to score any marks.

The candidate has given the definition of atomic mass rather than atomic number and then gone on to state that protons + neutrons = 10, which can be interpreted as either 10 of each or 10 in total.

(ii) All atoms of neon have an atomic number of 10.

Describe what information about the number of subatomic particles can be obtained from the atomic number of neon.

(2)

The amount of protons + the amount of neutrons = the atomic number.

Protons + Neutrons = 10

ResultsPlus
Examiner Comments

If the candidate had written 10 protons and 10 neutrons then this would have scored 1 mark.

Question 2(a)iii

It became apparent with this question that many candidates did not understand the meaning of the term 'electrically neutral'. Only about half of the responses scored full marks here, with many confused ideas about conducting electricity or giving an explanation as to why neon is inert rather than neutral.

When candidates did get the correct idea about protons and electrons, they sometimes did not state that these charges cancel each other out, or that there is no charge overall and simply repeated the stem of the question without defining what neutral actually means.

This response scored 2 marks.

(iii) Explain why atoms of neon are electrically neutral.

(2)

As they have ~~the~~ an equal amount of protons and electrons which cancel each other's charges out - there are 10 protons, so a +10 (positive) charge which is counteracted by a -10 (negative) charge hence neon atoms are electrically neutral

ResultsPlus
Examiner Comments

The candidate clearly states that there are 10 positive charges and 10 negative charges which cancel and leave a neutral charge.

ResultsPlus
Examiner Tip

Write your responses clearly and with enough detail so that the examiner knows exactly what you mean.

This response scored 1 mark.

(iii) Explain why atoms of neon are electrically neutral.

(2)

they are group 0, they have the same number of protons as electrons which balance out each other.

ResultsPlus
Examiner Comments

Unfortunately, there is no mention of charge at all in this response and therefore the second mark could not be awarded.

(iii) Explain why atoms of neon are electrically neutral.

(2)

they have a full outer shell of electrons - they don't need to gain or lose an electron

ResultsPlus
Examiner Comments

This response scored no marks. A common incorrect response was to explain why neon is inert rather than electrically neutral.

(iii) Explain why atoms of neon are electrically neutral.

(2)

Atoms of neon are electrically neutral as they have a full outer shell of electrons, so there are no delocalised electrons to carry a charge.

ResultsPlus
Examiner Comments

This response did not score. Some candidates seemed to think that electrically neutral has something to do with electrical conductivity.

ResultsPlus
Examiner Tip

Electrically neutral means that there is no overall charge.

Question 2(b)

The final part of this question asked candidates to calculate the relative atomic mass of a sample of neon atoms. Almost all candidates attempted this question and many scored both marks. Where marks were lost it was usually due to mathematical and processing errors rather than issues with understanding the chemistry.

This response scored both marks.

This answer clearly shows the working out and the correct answer is shown on the answer line.

(b) A sample of neon contains three isotopes

90.48% of neon-20

0.27% of neon-21

9.25% of neon-22

Using this information, calculate the relative atomic mass of this sample of neon.

(2)

$(90.48 \times 20) + (0.27 \times 21) + (9.25 \times 22)$

$1809.6 + 5.67 + 203.5$

$= 2018.77 = \frac{2018.77}{100} = 20.1877$

relative atomic mass = 20.1877

ResultsPlus Examiner Comments

Answers correctly rounded to three or more significant figures were accepted.

ResultsPlus Examiner Tip

Always show your working out and remember that your calculator follows BIDMAS rules.

(b) A sample of neon contains three isotopes

90.48% of neon-20

0.27% of neon-21

9.25% of neon-22

Using this information, calculate the relative atomic mass of this sample of neon.

(2)

$$\frac{(90.48\times20)+(0.27\times21)+(9.25\times22)}{100}$$

$=20.1877$

$=20$

relative atomic mass = 20

ResultsPlus
Examiner Comments

This response scored 1 mark. Although the candidate has shown the correct working and answer, they have then rounded this answer to the nearest whole number which is not correct.

ResultsPlus
Examiner Tip

Relative atomic mass should be a number greater than the lowest mass but smaller than the largest mass given in the question. It is not a whole number.

Question 3(a)i

Candidates were asked to complete a reaction equation by adding one formula and one state symbol.

This question was very well answered overall, with most candidates scoring both marks. Where mistakes were made it was usually an incorrect state symbol or using incorrect lowercase letters in the chemical formula.

There was enough information in the question for candidates to be able to deduce the answer to this question as they were told that the reactants were both solutions and given all but one of the chemical formulae.

This response scored 2 marks.

3 Silver nitrate and potassium chloride are ionic compounds that are soluble in water.

(a) When potassium chloride solution is added to a solution of silver nitrate, a white precipitate forms.

(i) Complete the equation for this reaction, including the missing state symbol.

(2)

$$AgNO_3(aq) + KCl(aq) \rightarrow AgCl(s) + KNO_3(aq)$$

ResultsPlus
Examiner Comments

The candidate has written both the state symbol and the formula correctly with the correct case of letter and a subscript number.

ResultsPlus
Examiner Tip

All solutions have the state symbol (aq).

3 Silver nitrate and potassium chloride are ionic compounds that are soluble in water.

(a) When potassium chloride solution is added to a solution of silver nitrate, a white precipitate forms.

(i) Complete the equation for this reaction, including the missing state symbol.

(2)

NO_3^{2-}

$AgNO_3(aq) + KCl(aq) \rightarrow AgCl(s) + K_2NO_3(aq)$

ResultsPlus
Examiner Comments

This response scored 1 mark. Unfortunately, the formula for potassium nitrate is not correct but the correct state symbol has been added.

This response scored 1 mark for the correct formula for potassium nitrate but the state symbol is incorrect.

3 Silver nitrate and potassium chloride are ionic compounds that are soluble in water.

(a) When potassium chloride solution is added to a solution of silver nitrate, a white precipitate forms.

(i) Complete the equation for this reaction, including the missing state symbol.

(2)

$AgNO_3(aq)$ + KCl(s) → AgCl(s) + KNO_3 (aq)

ResultsPlus
Examiner Comments

Where marks were lost it was more common to see an incorrect state symbol rather than an incorrect formula.

This response did not score.

3 Silver nitrate and potassium chloride are ionic compounds that are soluble in water.

(a) When potassium chloride solution is added to a solution of silver nitrate, a white precipitate forms.

(i) Complete the equation for this reaction, including the missing state symbol.

(2)

$AgNO_3(aq) + KCl(\cancel{l}\ s) \rightarrow AgCl(s) + KNO_3(aq)$

ResultsPlus
Examiner Comments

The candidate has used a lower case 'o' in the formula rather than a capital letter.

ResultsPlus
Examiner Tip

When writing chemical formulae, use the symbols for the elements exactly as they appear on the periodic table.

Question 3(a)ii

Candidates were asked to name the precipitate formed in the chemical reaction.

The reaction equation in the first part of the question gave the chemical formula as long as candidates were aware that the product with the (s) state symbol is the precipitate.

(ii) Give the name of the white precipitate that forms.

(1)

silver chloride

ResultsPlus
Examiner Comments

This response is correct. AgCl is the chemical formula for silver chloride.

This response is not correct.

(ii) Give the name of the white precipitate that forms.

(1)

Potassium nitrate

ResultsPlus
Examiner Comments

Potassium nitrate was the most commonly seen incorrect answer.

Question 3(a)iii

Questions about describing appropriate methods used to separate mixtures are commonly asked. This question was slightly different in that it asked candidates to explain their method rather than simply describe it.

As a result, there were a wide variety of marks awarded. Some candidates could clearly state filtration and then go on to explain how it works. Common errors here were to mix up the residue and the filtrate or not state where the precipitate would be after the filtration.

Some candidates described the process but did not explain how filtration works and were therefore limited to a maximum of 2 marks.

Other candidates described crystallisation or simple distillation.

(iii) State and explain how the white precipitate can be separated from the reaction mixture.

(3)

Line a filter funnel with filter paper and place it on top of a conical flask. Pour your Solution through the filter funnel. As the white precipitate is too big to fit through the Small holes in the filter paper, it would be left behind as residue. However the rest of the solution will go though the filter paper, seperating it from the white precipitate.

ResultsPlus
Examiner Comments

This response scored full marks. There were four marking points available, with a maximum score of 3 marks. This response describes the use of a filter funnel and then explains why the residue will be left in the paper and correctly explains that the solution will pass through the filter paper.

ResultsPlus
Examiner Tip

Residue is the solid left in the filter paper. Filtrate is the solution that passes through the filter paper.

(iii) State and explain how the white precipitate can be separated from the reaction mixture.

(3)

→ pour reaction mixture through filter paper

→ white precipitate ~~xx~~ is too big to go through filter paper so seperates from the mixture

→ leave the filter paper in a warm place for the remaining potassium nitrate to evaporate, leaving the white precipitate behind.

ResultsPlus
Examiner Comments

This response scored 2 marks. The candidate has described the process of filtration but not named it. They have also stated that the precipitate will remain in the paper but not said what happens to the rest of the mixture.

This response scored 1 mark.

The candidate has described how to obtain a pure, dry sample of a precipitate using filtration rather than explaining the choice of the separation method.

(iii) State and explain how the white precipitate can be separated from the reaction mixture.

(3)

- filter the solution using a filter funnel and filter paper
- rinse through with distilled water
- dry the precipitate between filter paper

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Examiner Comments

This response answers a slightly different question to the one being asked.

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Examiner Tip

Make sure that you know the difference between the command words 'describe' and 'explain'.

Many candidates did not identify the process of filtration to separate a precipitate from a mixture.

(iii) State and explain how the white precipitate can be separated from the reaction mixture.

(3)

The white precipitate can be seperated by distillation. You add the solution to a beaker and the solution will evaporate and the condense in the cooling tube. This will then pour and drip into another beaker. The white precipitate will be left in the beaker that ~~the~~ we started with, and the other solution will be in a separate beaker.

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Examiner Comments

This response did not score. It was common to see both simple distillation and crystallisation described as alternative separation methods.

Question 3(b)

The last part of this question asked candidates to explain how both silver metal and silver nitrate solution are able to conduct electricity. It was expected that candidates could identify the movement of charged particles and the type of charged particles present in each material.

Most candidates scored at least 2 marks, with many scoring all 3 marks for identifying the movement of delocalised electrons in silver and the movement of ions in silver nitrate solution.

By far the most common error was to state that both materials contained delocalised electrons. Some candidates did not describe the movement of the charged particles and instead gave suggestions such as 'carrying a charge' or 'electricity passing through' which were too vague to score.

(b) Silver nitrate solution conducts electricity.
Solid silver also conducts electricity.

Describe how silver nitrate solution conducts electricity and how solid silver conducts electricity.

(3)

Silver nitrate is an ionic solution and conducts electricity through its ions moving through the solution - creating a flow of charge through the non-fixed ionic bonds
Solid silver is a metal (held together by metallic bonding) which has layers of positive silver nuclei with a sea of their delocalised electrons surrounding them. It is this electrons which are free to move through the metal structure and carry a charge

ResultsPlus
Examiner Comments

This response scored 3 marks. The candidate has correctly identified ions in silver nitrate and delocalised electrons in silver. In both cases the response states that the ions and delocalised electrons are free to move.

(b) Silver nitrate solution conducts electricity.
Solid silver also conducts electricity.

Describe how silver nitrate solution conducts electricity and how solid silver conducts electricity.

(3)

Siwer nitrate solution is a molten ionic compound, so contains ions which can carry a charge. Solid silver has a metallic structure so there are delocalised electrons between the layers which can carry a charge.

ResultsPlus
Examiner Comments

This response scored 2 marks. The candidate has correctly identified the ions in silver nitrate and delocalised electrons in silver. Unfortunately, 'carry a charge' is not enough to suggest the movement of these particles and so the final mark is not awarded.

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Examiner Tip

An electrical current is produced when delocalised electrons or ions move.

This response states that both silver and silver nitrate have delocalised electrons.

As this is only correct for silver, only 1 mark is awarded.

There is no mention of the movement of the delocalised electrons so no further marks can be awarded.

(b) Silver nitrate solution conducts electricity.
Solid silver also conducts electricity.

Describe how silver nitrate solution conducts electricity and how solid silver conducts electricity.

(3)

Solid silver has delocalised electrons which carry electricity and so does silver nitrate

ResultsPlus
Examiner Comments

It is still very common for candidates to state that an electric current is due to the movement of delocalised electrons in all materials.

This response did not score.

The response uses the word 'atoms' throughout, rather than ions or delocalised electrons.

(b) Silver nitrate solution conducts electricity.
Solid silver also conducts electricity.

Describe how silver nitrate solution conducts electricity and how solid silver conducts electricity.

(3)

This is because solid silver is just silver so is a metal that has metallic bonds, this makes it a good conducter because the atoms aren't stuck in place. Silver nitrate solution can conduct as it is ~~ionic but~~ has ionic bonding but is a liquid so the atoms are free to move and conduct.

ResultsPlus
Examiner Comments

As atoms are not charged, no marks are awarded for the movement of atoms.

Question 4(a)ii

There were numerous ways that candidates could achieve the mark for this question, and many responses gave enough information to score.

It is apparent that there is still some misunderstanding about the difference between pH values and indicators and many responses were not well worded.

The most common correct response was that litmus can only tell if a substance is acid or alkali rather than recognising that litmus cannot be used to obtain a number for the pH value.

This response scored the mark.

Either stating that it only shows acid or alkali, or that it doesn't give the specific pH would have been enough to score.

(ii) State why litmus cannot be used to measure pH.

(1)

It only tests if its acid or alkali, not a specific pH.

ResultsPlus Examiner Comments

The colours in universal indicator can be used to obtain an approximate pH value but most indicators simply state whether a substance is acid or alkali.

ResultsPlus Examiner Tip

The pH scale is numerical and so the pH of a substance is always a number rather than a colour.

(ii) State why litmus cannot be used to measure pH.

(1)

because its used for chlorine. Its just a peice of paper. PH is H^+ & OH^- ions, and litmus paper cannot

ResultsPlus
Examiner Comments

This response did not score. Some candidates immediately associated litmus with the test for chlorine rather than answering the question being asked.

Question 4(b)

The most common mark awarded on this question was 1.

Many candidates gave the same marking point more than once, suggesting a better yield or faster growth of crops. Far fewer candidates were able to recognise that fertilisers provide specific mineral ions to the soil that plants require for healthy growth and only the most able were able to identify any of the ions present in fertilisers.

This response scored both marks.

The candidate has specifically mentioned phosphate ions in this case but the generic term 'nutrients' was also accepted for this mark – it was the most commonly seen correct response for this marking point.

(b) Phosphoric acid can react to form phosphate salts which are used in fertilisers.

Give **two** reasons why farmers use fertilisers on their fields.

(2)

1 To help crops grow

2 enrich the soil with phosphates and nitrates.

ResultsPlus
Examiner Comments

Candidates do not need details of what the ions in fertiliser are used for but should be able to identify some ions that are present in fertilisers.

(b) Phosphoric acid can react to form phosphate salts which are used in fertilisers.

Give **two** reasons why farmers use fertilisers on their fields.

(2)

1 Higher yield

2 Higher production rate.

ResultsPlus
Examiner Comments

This is an example of the most commonly seen response. Candidates often repeated the same marking point and did not mention mineral ions at all.

This response scored 0 marks.

(b) Phosphoric acid can react to form phosphate salts which are used in fertilisers.

Give **two** reasons why farmers use fertilisers on their fields.

(2)

1 To kill any unwanted bugs /weeds which could destroy the produce

2 To prevent diseases.

ResultsPlus
Examiner Comments

The most common incorrect responses suggested that fertilisers are used as some sort of pesticide.

Question 4(c)i

Candidates were given the equation and asked to calculate a percentage yield.

Almost all candidates scored both marks here, with only a very small minority scoring 1 or 0 marks.

When marks were lost it was usually due to transcription errors when writing the numbers from the question.

(c) An experiment was carried out to produce phosphoric acid.

(i) The actual yield for the experiment was 18.62 g.

The theoretical yield for the experiment is 24.50 g.

$$\text{percentage yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100$$

Calculate the percentage yield of this experiment.

(2)

$$\frac{16.62}{24.50} \times 100 = 67.8\%$$

percentage yield = 67.8%

ResultsPlus
Examiner Comments

This response scored 1 mark. The candidate has written the number in the question incorrectly but then gone on to evaluate their calculation correctly and so 1 mark can be awarded.

(c) An experiment was carried out to produce phosphoric acid.

(i) The actual yield for the experiment was 18.62 g.

The theoretical yield for the experiment is 24.50 g.

$$\text{percentage yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100$$

Calculate the percentage yield of this experiment.

(2)

$\frac{18.62}{24.50} \times 100 = 76$

percentage yield = 76 %

ResultsPlus
Examiner Comments

This response scored 2 marks. Almost all candidates scored both marks for this question.

(c) An experiment was carried out to produce phosphoric acid.

(i) The actual yield for the experiment was 18.62 g.

The theoretical yield for the experiment is 24.50 g.

$$\text{percentage yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100$$

Calculate the percentage yield of this experiment.

(2)

percentage yield = 74.53

Examiner Comments

This response did not score. Without any working out shown it is impossible to determine where the candidate got their final answer from and so no marks can be awarded.

Examiner Tip

Remember to show your working out for all calculations.

Question 4(c)ii

Candidates were given the formula for calculating atom economy and asked to calculate the atom economy for one product of the reaction.

This was a challenging calculation, both in terms of the number of reactants and products and the stoichiometry of the reaction equation but it was well answered with the majority of candidates scoring all 3 marks.

Where candidates did not score full marks the most commonly seen errors were to use only 1 mole of phosphoric acid or to give the total formula mass of reactants **and** products.

(ii) The equation for a reaction to make phosphoric acid, H_3PO_4, is

$$Ca_5(PO_4)_3OH + 5H_2SO_4 \rightarrow \underline{3H_3PO_4} + 5CaSO_4 + H_2O$$

Calculate the atom economy for the production of phosphoric acid in this reaction.

$$\text{atom economy (\%)} = \frac{\text{total formula mass of desired product}}{\text{total formula mass of all reactants or products}} \times 100$$

(relative formula masses: $Ca_5(PO_4)_3OH = 502$, $H_2SO_4 = 98$, $H_3PO_4 = 98$, $CaSO_4 = 136$, $H_2O=18$)

(3)

$98 \times 3 = \underline{294}$ $\qquad$ $98 \times 5 = 490$

$502 + 490 = 992$

$\frac{294}{992} \times 100 = 29.64$

atom economy = 29.64 %

ResultsPlus
Examiner Comments

This response scored 3 marks. The candidate has shown all working out and correctly calculated the total formula mass of phosphoric acid in the reaction along with the correct total formula mass of the reactants. The calculation is then correctly evaluated.

This response scored 1 mark.

The candidate has not considered the stoichiometry of the reaction and simply used 1 formula mass for the product and 1 for each of the reactants.

However, because they have identified the correct product, used all of the reactant formula masses and correctly evaluated their calculation, then 1 mark can be awarded.

(ii) The equation for a reaction to make phosphoric acid, H_3PO_4, is

sulfuric ~~[illegible]~~ water

$$Ca_5(PO_4)_3OH + 5H_2SO_4 \rightarrow 3H_3PO_4 + 5CaSO_4 + H_2O$$

Calculate the atom economy for the production of phosphoric acid in this reaction.

$$\text{atom economy (\%)} = \frac{\text{total formula mass of desired product}}{\text{total formula mass of all reactants or products}} \times 100$$

(relative formula masses: $Ca_5(PO_4)_3OH = 502$, $H_2SO_4 = 98$, $H_3PO_4 = 98$, $CaSO_4 = 136$, $H_2O=18$)

(3)

$$100 \times \frac{98}{502 + 98} = 16.3333$$

atom economy = 16.3 %

ResultsPlus
Examiner Comments

Without working out this response would not have scored any marks.

(ii) The equation for a reaction to make phosphoric acid, H_3PO_4, is

$$Ca_5(PO_4)_3OH + 5H_2SO_4 \rightarrow 3H_3PO_4 + 5CaSO_4 + H_2O$$

Calculate the atom economy for the production of phosphoric acid in this reaction.

$$\text{atom economy (\%)} = \frac{\text{total formula mass of desired product}}{\text{total formula mass of all reactants or products}} \times 100$$

(relative formula masses: $Ca_5(PO_4)_3OH = 502$, $H_2SO_4 = 98$, $H_3PO_4 = 98$, $CaSO_4 = 136$, $H_2O=18$)

(3)

$H_3PO_4 = 98$

$502 + (98 \times 5) + (3 \times 98) + (5 \times 136) + 18$

$502 + 490 + 294 + 680 + 18 = 1984$

$\frac{98}{1984} \times 100 = 4.94$

atom economy = 4.94 %

ResultsPlus
Examiner Comments

This response did not score any marks. One of the most common errors was to add together both the reactant and product formula masses rather than just one.

Question 4(c)iii

This question was poorly answered and the majority of candidates did not score any marks here.

Some candidates scored 1 mark, usually for the idea of finding a use for one of the other products, but only the most able candidates were able to explain why this would increase the atom economy.

The most common responses seen related to increasing the product yield rather than the atom economy and gave suggestions such as increasing the amount of reactants or allowing more time for the reaction to complete. Other responses seemed confused and gave suggestions about altering the position of a dynamic equilibrium.

(iii) The equation for a reaction to produce phosphoric acid is

$$Ca_5(PO_4)_3OH + 5H_2SO_4 \rightarrow 3H_3PO_4 + 5CaSO_4 + H_2O$$

Explain how the atom economy of the reaction can be increased.

(2)

If multiple products are used, instead of being waste products. Like if the H_2O (water) was used atom economy would increase because the total mass of the desired product increases.

ResultsPlus
Examiner Comments

It was very unusual to see responses scoring 2 marks, such as this one. Candidates struggled to explain that finding uses for the other products of the reaction would increase the mass of useful products (and therefore the atom economy).

(iii) The equation for a reaction to produce phosphoric acid is

$$Ca_5(PO_4)_3OH + 5H_2SO_4 \rightarrow 3H_3PO_4 + 5CaSO_4 + H_2O$$

Explain how the atom economy of the reaction can be increased.

(2)

Using the calcium sulfate and water for a process or product to increase the atom economy to 100%. Using all the products that are produced.

ResultsPlus
Examiner Comments

This response scored 2 marks for recognising the idea that if all of the products of the reaction were useful then the atom economy would be 100%.

ResultsPlus
Examiner Tip

The only way to increase the atom economy of a reaction without changing the reaction itself is by increasing the mass of useful products.

(iii) The equation for a reaction to produce phosphoric acid is

$$Ca_5(PO_4)_3OH + 5H_2SO_4 \rightarrow 3H_3PO_4 + 5CaSO_4 + H_2O$$

Explain how the atom economy of the reaction can be increased.

(2)

It could be increased by finding a use for the wasted products. For example, the water produced could be used for drinking water or in a lab making it useful and not wasted

ResultsPlus
Examiner Comments

This response scored 1 mark and is an example of the most commonly seen response that scored. Many candidates recognised that finding uses for the other products would increase atom economy but then gave further descriptions rather than any explanations.

This response did not score.

The majority of responses suggested ways of increasing the rate of reaction, shifting the position of a dynamic equilibrium or adding more reactants.

(iii) The equation for a reaction to produce phosphoric acid is

$$Ca_5(PO_4)_3OH + 5H_2SO_4 \rightarrow 3H_3PO_4 + 5CaSO_4 + H_2O$$

Explain how the atom economy of the reaction can be increased.

(2)

Increasing the temperature would increase particle interaction which would increase rate of reaction therefore increasing the atom economy

ResultsPlus
Examiner Comments

In this case the response describes how to increase the rate of reaction rather than the atom economy.

This response did not score.

(iii) The equation for a reaction to produce phosphoric acid is

$$Ca_5(PO_4)_3OH + 5H_2SO_4 \rightarrow 3H_3PO_4 + 5CaSO_4 + H_2O$$

Explain how the atom economy of the reaction can be increased.

(2)

increasing the amount of reactants, so there will be more product.

ResultsPlus
Examiner Comments

This response gives a suggestion about increasing the total yield of all products rather than the atom economy.

Question 5(a)

This question asked candidates to explain how electronic configuration and period of the periodic table are linked.

This was better answered than similar questions about period in previous series with most candidates scoring both marks. There were a number of commonly seen errors where candidates did lose marks including confusing period with group, using the term 'outer shells' instead of shells and not linking the electronic configuration back to the period that the elements are found in.

5 Nitrogen, N_2, oxygen, O_2 and fluorine F_2 are all gases.

(a) Nitrogen, oxygen and fluorine are in the same period of the periodic table.

Explain, in terms of electronic configuration, in which period of the periodic table nitrogen, oxygen and fluorine are located.

(2)

Nitrogen, oxygen, and fluorine are in period 2, because they all have 2 electron shells.

N_2 = 2:5 , O_2 = 2:6 , F_2 = 2:7

ResultsPlus
Examiner Comments

This response scored 2 marks. 1 mark was awarded for stating that each element has two electron shells or for giving the electronic configuration for each of the elements. The candidate has given both in this case. The second mark was awarded for correctly stating that the three elements are in period 2.

5 Nitrogen, N_2, oxygen, O_2 and fluorine F_2 are all gases.

(a) Nitrogen, oxygen and fluorine are in the same period of the periodic table.

Explain, in terms of electronic configuration, in which period of the periodic table nitrogen, oxygen and fluorine are located.

(2)

they are all in period 2 of the periodic table
which tells us there outer shell has 2 ~~[illegible]~~s electrons

ResultsPlus
Examiner Comments

This response scored 1 mark for correctly identifying that the elements are in period 2. The explanation given is incorrect as there are not 2 electrons in the outer shell of each element – this would put them into group 2 rather than period 2.

5 Nitrogen, N_2, oxygen, O_2 and fluorine F_2 are all gases.

(a) Nitrogen, oxygen and fluorine are in the same period of the periodic table.

2, 6, 8

Explain, in terms of electronic configuration, in which period of the periodic table nitrogen, oxygen and fluorine are located.

(2)

Nitrogen, oxygen and fluorine are located in period ~~2~~ 2 because they all have 2 electrons in their first shell.

ResultsPlus
Examiner Comments

This response scored 1 mark for identifying that the elements are in period 2. It is correct that these elements have 2 electrons in their first shell but this is not the reason why they are in period 2.

5 Nitrogen, N_2, oxygen, O_2 and fluorine F_2 are all gases.

2.8.4 2.8.6 2.8.8.1

(a) Nitrogen, oxygen and fluorine are in the same period of the periodic table.

Explain, in terms of electronic configuration, in which period of the periodic table nitrogen, oxygen and fluorine are located.

(2)

They are all in period 1. They don't have a full outer shell. Fluorine has to lose an electron. Oxygen has to gain 2. Nitrogen has to gain 4 electrons.

ResultsPlus Examiner Comments

There is nothing creditworthy in this response. The candidate has attempted to write the electronic configuration for each element and has also incorrectly stated that the elements are in period 1. There is also some irrelevant and incorrect information about electrons in each element.

ResultsPlus Examiner Tip

There are only 2 elements in period 1 – hydrogen and helium.

Question 5(b)i

In this question candidates were asked to explain why fluorine has a low boiling point.

Questions like this are common and it was surprising that candidates did not perform better here. Almost a third of responses did not score at all although there were a lot of near misses.

There is still a lot of confusion between covalent bonds and intermolecular forces and candidates are not always able to clearly distinguish between the two. Answers often talked about breaking bonds rather than intermolecular forces. There were also a large number of candidates that could recognise that the bonding in fluorine is covalent but very few stated that it has a simple molecular structure and therefore did not score the first mark.

(b) Fluorine has a boiling point of −188 °C.

(i) Explain why fluorine has a low boiling point.

(3)

Flourine is a simple covalent molecule. It has weak intermolecular forces that require ~~a~~ little energy to be overcome so it has a low boiling point. This is why it appears as a gas.

ResultsPlus Examiner Comments

This response scored 3 marks. The most able candidates were able to identify the structure and type of bonding present in fluorine and then link this to the low boiling point in terms of small amounts of energy required to overcome the weak intermolecular forces.

ResultsPlus Examiner Tip

Make sure to include both the structure and type of bonding in your answers. In this case simple molecular is the structure and covalent is the type of bonding.

(b) Fluorine has a boiling point of −188 °C.

(i) Explain why fluorine has a low boiling point.

(3)

Flourine as a low boiling point as it is a low density element that is gaseous at room temperature. It takes a very little amount of energy to boil Flourine as its density is so low.

ResultsPlus
Examiner Comments

This response scored 1 mark. Although there is no information about the structure and bonding in fluorine the response correctly identifies that small amounts of energy are needed to turn it into a gas.

(b) Fluorine has a boiling point of −188 °C.

(i) Explain why fluorine has a low boiling point.

(3)

Fluorine has a low boiling point as little amounts of energy is required to break the intermolecular forces of attraction, hence it having a low boiling point

ResultsPlus
Examiner Comments

This response scored 1 mark, for recognising that a small amount of energy is needed to overcome the intermolecular forces present. If the candidate had included that these intermolecular forces are weak then a second mark would have been awarded. There is no mention of structure and bonding.

(b) Fluorine has a boiling point of –188 °C.

(i) Explain why fluorine has a low boiling point.

(3)

Florine has ~~a~~ low boiling point as it is a poor conductor of heat meaning that the bonds are weaker and easier to ~~be~~ break when heated

ResultsPlus
Examiner Comments

This response did not score. A significant number of responses still refer to breaking bonds rather than overcoming intermolecular forces.

Question 5(c)

Candidates were asked to write a balanced symbol equation and were given the formulae of the reactants along with the name of the product.

The most common errors were in the formula of nitrogen dioxide with many variations of product formulae seen including nitrogen monoxide, nitrogen trioxide and nitrous oxide. If the response did not have the correct product formula, then the balancing mark could not be awarded.

If candidates did get the correct formula for nitrogen dioxide, then the balancing was almost always correct as well.

(c) At high temperatures, nitrogen, N_2, can react with oxygen, O_2, to form nitrogen dioxide only.

Write the balanced equation for this reaction.

(2)

$N_2 + 2O_2 \longrightarrow 2NO_2$

ResultsPlus
Examiner Comments

This response scored 2 marks. Many candidates were able to correctly deduce the formula of nitrogen dioxide and often went on to correctly balance the equation as well.

ResultsPlus
Examiner Tip

Dioxide means 'two oxygen atoms'.

(c) At high temperatures, nitrogen, N_2, can react with oxygen, O_2, to form nitrogen dioxide only.

Write the balanced equation for this reaction.

(2)

$N_2 + O_2 \rightarrow 2NO_2$

ResultsPlus Examiner Comments

1 mark responses were unusual, but in this case the candidate has not correctly balanced the equation.

This response did not score.

The candidate has written a correctly balanced equation; however, the product formula is N_2O rather than NO_2.

(c) At high temperatures, nitrogen, N_2, can react with oxygen, O_2, to form nitrogen dioxide only.

Write the balanced equation for this reaction.

(2)

$2N_2 + O_2 \rightarrow 2N_2O$

ResultsPlus
Examiner Comments

In order to score the balancing mark for equations all reactant and product formulae must be correct.

Question 6(a)ii

Candidates found this question particularly challenging with only a minority correctly identifying the precipitate as calcium carbonate, although most candidates did attempt to name the precipitate.

(ii) When carbon dioxide is bubbled through limewater, a precipitate forms.
This precipitate solid makes the limewater cloudy.

Name the precipitate that makes the limewater cloudy.

(1)

Calcium carbonate

ResultsPlus
Examiner Comments

Some candidates were able to identify the precipitate as calcium carbonate.

ResultsPlus
Examiner Tip

Limewater (calcium hydroxide solution) reacts with carbon dioxide to produce water and a white precipitate of calcium carbonate.

(ii) When carbon dioxide is bubbled through limewater, a precipitate forms.
This precipitate solid makes the limewater cloudy.

Name the precipitate that makes the limewater cloudy.

(1)

carbon dioxide

ResultsPlus
Examiner Comments

A significant number of incorrect answers suggested that the precipitate was carbon dioxide.

(ii) When carbon dioxide is bubbled through limewater, a precipitate forms.
This precipitate solid makes the limewater cloudy.

Name the precipitate that makes the limewater cloudy.

(1)

Carbonate

ResultsPlus
Examiner Comments

A lot of answers recognised that the precipitate would be a carbonate without identifying the other part of the compound. Unfortunately, this was not enough to score the mark.

Question 6(a)iii

This item required candidates to perform a multi-step calculation in order to calculate the maximum mass of copper oxide that could be formed in a decomposition reaction.

Approximately half of the candidates scored all 4 marks and most candidates were able to score some marks, even if they didn't have the correct answer, due to clearly showing their working out. Therefore, examiners could see where mistakes had been made and award error carried forward marks.

The most common errors made by candidates were often in the final steps of the calculation, either with the molar ratio or calculating the relative formula mass of copper oxide incorrectly.

(iii) The equation for the decomposition of malachite when it is heated is

$$Cu_2CO_3(OH)_2 \rightarrow 2CuO + CO_2 + H_2O$$

Calculate the maximum mass of copper oxide that can be formed when 22.1 g of malachite is decomposed completely.

(relative atomic masses: Cu = 63.5, O = 16.0, C = 12.0, H = 1.0)

(4)

M_r of $Cu_2CO_3(OH)_2 = (63.5 \times 2) + 12 + (16 \times 3) + 2(16+1) = 221$ Mols = $\frac{Mass}{Mr}$

Mols of $Cu_2CO_3(OH)_2 = 22.1/221 = 0.1$ Mass = Mols × Mr

$Cu_2CO_3(OH)_2$: CuO mass of CuO = $0.2 \times (63.5+16)$

1 : 2

0.1 : 0.2 mols $= 15.9$g

maximum mass of CuO = 15.9 g

ResultsPlus
Examiner Comments

This response scored 4 marks. The relative formula mass of malachite is correctly calculated followed by the correct number of moles of malachite used in the reaction. The candidate has shown the 1:2 ratio of reactant to products and then correctly calculated the relative formula mass of copper oxide along with the final mass of copper oxide produced.

This response scored 3 marks.

The candidate has correctly calculated the relative formula mass of malachite and the number of moles of malachite used in the reaction.

They have also recognised the 1:2 molar ratio but have then not calculated the relative formula mass of copper oxide correctly and so have not scored the final marking point.

(iii) The equation for the decomposition of malachite when it is heated is

$$\underline{Cu_2CO_3(OH)_2} \rightarrow \underline{2CuO} + CO_2 + H_2O$$

Calculate the maximum mass of copper oxide that can be formed when 22.1 g of malachite is decomposed completely.

(relative atomic masses: Cu = 63.5, O = 16.0, C = 12.0, H = 1.0)

(4)

mass
mols formula mass   malachite $63.5 + 63.5 + 12 + (16 \times 3) + 16 + 16 + 1 + 1 = 221$

$Cu_2CO_3(OH)_2 : 2CuO$ $22.1 \div 221 = 0.1$ mol

1 : 2   copper oxide $63.5 + 63.5 + 16 = 143$

0.1 : 0.2 $143 \times 0.2 = 28.6$

maximum mass of CuO = 28.6 g

ResultsPlus
Examiner Comments

3 marks were able to be awarded because the candidate has shown their working in a clear and coherent way.

(iii) The equation for the decomposition of malachite when it is heated is

$$Cu_2CO_3(OH)_2 \rightarrow \underline{2CuO} + CO_2 + H_2O$$

Calculate the maximum mass of copper oxide that can be formed when 22.1 g of malachite is decomposed completely.

(relative atomic masses: Cu = 63.5, O = 16.0, C = 12.0, H = 1.0)

(4)

63.5 x 2 = 127   16 x 3 = 48   16 x 2 = 32

127 + 12 + 48 + 32 + 2 = 221

~~221~~   22.1 ÷ 221 = 0.1

127 + 16 = 143

143 x 0.1 = 14.3 g

maximum mass of CuO = 14.3 g

ResultsPlus
Examiner Comments

This response scored 2 marks. The correct relative formula mass of malachite and number of moles are clearly calculated and shown within the working out. There is no indication of the 1:2 ratio and the relative formula mass of copper oxide is also incorrect and so the final 2 marks cannot be awarded.

(iii) The equation for the decomposition of malachite when it is heated is

22.1g ?

$$Cu_2CO_3(OH)_2 \rightarrow 2CuO + CO_2 + H_2O$$

Calculate the maximum mass of copper oxide that can be formed when 22.1 g of malachite is decomposed completely.

(relative atomic masses: Cu = 63.5, O = 16.0, C = 12.0, H = 1.0)

(4)

$mol = \frac{m}{Mr}$ $mol\ Cu_2CO_3(OH)_2 = \frac{22.1g}{221} = 0.1$

$Cu_2CO_3(OH)_2 = 2(63.5) + 12 + 3(16) + 2(16+1) = 221$

$Cu_2CO_3(OH)_2 : 2uO$

1 : 2

0.1 : 0.2

maximum mass of CuO = 31.8 g

$0.2 = \frac{x}{159}$ $2CuO = 2(63.5 + 16) = 159$

mass = $159 \times 0.2 = 31.8$

ResultsPlus
Examiner Comments

This response scored 3 marks. Again, the candidate has structured their calculation and shown each step so that the examiner can see where the error has happened. In this case the response shows the 1:2 ratio but also goes on to double the relative formula mass of copper oxide as well, essentially performing the same step twice and calculating double the correct answer.

ResultsPlus
Examiner Tip

When calculating the relative formula mass of a compound, don't include any numbers at the front of the formula in the balanced equation.

Question 6(b)

This question asked candidates to compare the strengths and weaknesses of two experimental methods for producing copper.

Many candidates simply repeated the information given in the method and stated that it was a strength or weakness without explaining why. There were a lot of near misses and most responses either did not score at all or scored 1 mark for explaining that mixing the reactants would potentially increase the yield of copper because more particles would be able to react.

It was very rare to see a response scoring more than 1 mark and if it did then it was usually due to candidates suggesting that the metal crucible might react or that reactants might be lost during transfer from the beaker into the crucible.

There were some misconceptions that were seen frequently by examiners. Candidates believe that glass will not get hot when heated and think that it will always crack or break when hot. There is also a common belief that a crucible has a lid even though this was not mentioned at all in the question. A significant number of candidates also believe that the orange flame on a Bunsen burner is the hottest.

(b) Copper can be extracted from copper oxide by heating the copper oxide with carbon.

A student investigated two methods to extract the maximum mass of copper from copper oxide.

Figure 3 shows the two methods.

method 1	method 2
step 1 place one spatula measure of copper oxide into a beaker	**step 1** place one spatula measure of copper oxide into a glass test tube
step 2 mix the copper oxide thoroughly with carbon powder	**step 2** carefully add carbon powder on top of the copper oxide
step 3 place the mixture into a metal crucible and heat the mixture with a roaring Bunsen flame	**step 3** heat the two layers with a roaring Bunsen flame

Figure 3

Comment on the strengths and weaknesses of these two methods.

(3)

A strength of method 1 is that it leaves behind only copper, as the carbon dioxide dissipates. A weakness of method 2 is that the copper oxide might not fully react with the carbon, as it hasn't been mixed. Another weakness for method 2 is that the test tube might damage under prolonged exposure to the roaring Bunsen flame, and also ~~it~~ the reaction will take longer.

ResultsPlus
Examiner Comments

This response scored 1 mark. The most commonly awarded mark was for the mixing of the reactants leading to a greater yield of copper.

(b) Copper can be extracted from copper oxide by heating the copper oxide with carbon.

A student investigated two methods to extract the maximum mass of copper from copper oxide.

Figure 3 shows the two methods.

method 1	method 2
step 1 place one spatula measure of copper oxide into a beaker	**step 1** place one spatula measure of copper oxide into a glass test tube
step 2 mix the copper oxide thoroughly with carbon powder	**step 2** carefully add carbon powder on top of the copper oxide
step 3 place the mixture into a metal crucible and heat the mixture with a roaring Bunsen flame	**step 3** heat the two layers with a roaring Bunsen flame

Figure 3

Comment on the strengths and weaknesses of these two methods.

(3)

Method 1 and 2 both say to place one spatula measure of copper oxide which is good. Method 1 says to add it to a beaker and method 2 says add it into a glass test tube. Adding it to a beaker would be the better choice (as it's bigger). ~~Th~~ Method 1 says to thourougly mix the copper oxide with the carbon powder which is correct as you need them to be mixed together ~~wothe~~ so method 2 needs to mix it together not just leave the carbon powder ~~ontn~~ on top of the copper oxide. They both say to use a roaring Bunsen flame which is a strength.

ResultsPlus
Examiner Comments

This response did not score any marks. Responses like this were common where the different steps were simply listed as strengths or weaknesses without giving any explanation at all.

ResultsPlus
Examiner Tip

Repeating information from the question without elaborating further will not score any marks.

Question 7(a)

Due to an error there were two correct responses to this multiple choice question.

Candidates were awarded the mark for either or both of the correct responses and nothing else.

Almost all candidates scored a mark on this question.

Question 7(b)

This question was well attempted by most candidates, with the majority scoring 2 or 3 marks.

Most candidates correctly stated that zinc is more reactive than iron and would therefore react instead of the iron, but this was not always identified as sacrificial protection. A significant number of responses described sacrificial protection and then named it as galvanising, indicating that there is a lack of understanding of the differences between these two methods.

This response scored full marks.

The candidate has named sacrificial protection and also explained how it works in terms of the reactivity of the two metals.

(b) Many ships are made of steel.
Steel is an alloy that contains iron.
Figure 4 shows blocks of zinc attached to a steel ship.

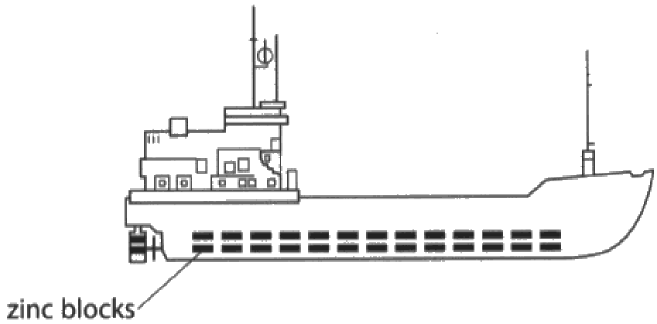


Figure 4

Explain how iron is protected from rusting by the zinc blocks.

(3)

zinc is more reactive than iron so oxygen will react with the zinc to corrode it, protecting the iron from rusting. This is called sacrificial protection as steel contains iron so the zinc will corrode before the iron is rusted.

ResultsPlus
Examiner Comments

The candidate has used the terms 'corrode' and 'rusting' in the correct context and not negated any of the marking points.

ResultsPlus
Examiner Tip

Rusting only occurs in materials that contain iron.

(b) Many ships are made of steel.
Steel is an alloy that contains iron.
Figure 4 shows blocks of zinc attached to a steel ship.

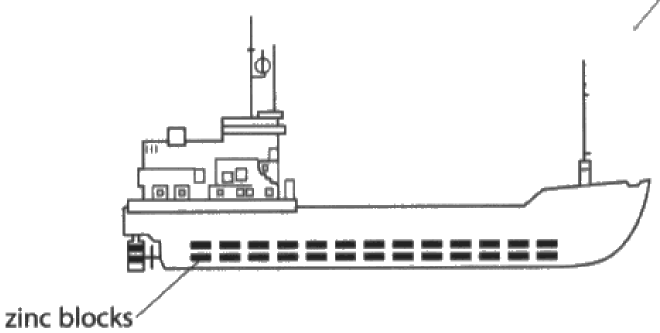


Figure 4

Explain how iron is protected from rusting by the zinc blocks.

(3)

Zinc is higher in the reactivity series than iron so it can protect it through sacrificial protection - the zinc will react with oxygen in the air and rust first (since it's more reactive) and this means the iron won't rust underneath the zinc blocks.

ResultsPlus
Examiner Comments

This response scored 2 marks. The candidate has covered all three marking points but then gone on to negate one of these by stating that zinc rusts instead of iron.

(b) Many ships are made of steel.
Steel is an alloy that contains iron.
Figure 4 shows blocks of zinc attached to a steel ship.

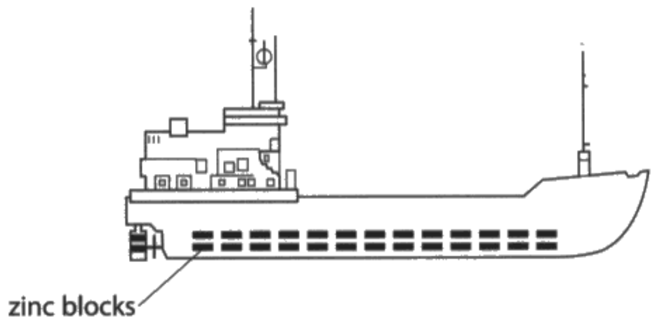


Figure 4

Explain how iron is protected from rusting by the zinc blocks.

(3)

- This is called galvanising
- As zinc is more reactive than iron, it displaces ~~#~~ iron and reacts with oxygen insteadd
- The products formed are zinc oxide and iron
- No iron oxide is produced for rusting.

ResultsPlus
Examiner Comments

This response scored 2 marks. The candidate has described how sacrificial protection works but incorrectly identified it as galvanising.

ResultsPlus
Examiner Tip

Galvanising involves coating steel with a layer of zinc, providing a physical barrier to stop oxygen and water coming into contact with the iron.

(b) Many ships are made of steel.
Steel is an alloy that contains iron.
Figure 4 shows blocks of zinc attached to a steel ship.

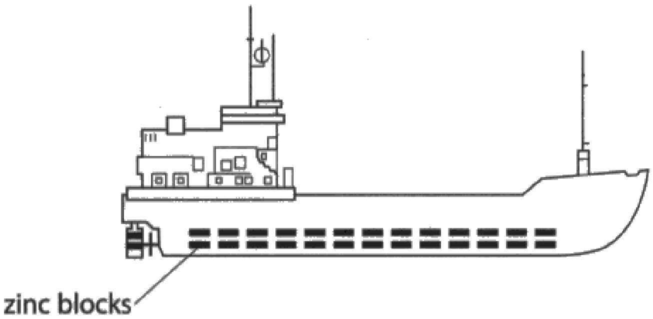


Figure 4

Explain how iron is protected from rusting by the zinc blocks.

(3)

Iron rusts when there is a lot of oxygen. when zinc is placed infront of iron it intakes the oxygen instead thereby protecting the iron from intaking oxygen and overall stopping the iron from rusting. Zinc is oxidised instead of the iron.

ResultsPlus
Examiner Comments

This response scored 1 mark. The candidate has stated that zinc will react with oxygen first but not explained why and they have not identified the name of the process.

(b) Many ships are made of steel.
Steel is an alloy that contains iron.
Figure 4 shows blocks of zinc attached to a steel ship.

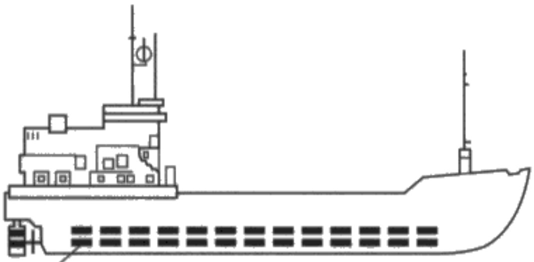


Figure 4

Explain how iron is protected from rusting by the zinc blocks.

(3)

Zinc is much less reactive than iron, and therefore protects the iron behind from any reactions

ResultsPlus
Examiner Comments

This response scored 0 marks. Some candidates incorrectly suggested that zinc would protect the iron because of a lower reactivity.

Question 7(c)

This question assessed a number of different skills around graph drawing and interpreting data.

The first part of the question gave a table of data and candidates needed to draw a graph. Most candidates were able to score some marks here with the most common errors being non-linear axes, scales that were too small or an incorrect line of best fit. The most able candidates realised that the most appropriate plot came when the Y axis did not start at 0.

The second part of the question required candidates to use their line of best fit to obtain data. This was the most accessible part of the question and where marks were not scored it was usually due to reading at the incorrect point on the X axis. Sometimes this was due to a non-linear scale being used which meant that 30% could not easily be determined on the X axis.

The last part of the question asked candidates to use their data to provide an explanation for the trend. Most candidates correctly described the trend shown by the graph but many of these did not then go on to explain the shape of the graph. Those candidates that attempted to explain the trend were usually able to give a basic explanation about the movement of the layers but it was less common (and often poorly worded) for candidates to identify that the maximum strength of the alloy occurs at the point of maximum disruption of the layers.

(c) Alloys of copper and nickel are used for some coins.

Figure 5 shows the relative strengths of copper and nickel and some of their alloys.

percentage of nickel	relative strength
0	1.00
20	1.52
35	1.77
65	1.90
80	1.78
100	1.56

Figure 5

(i) On Figure 6

- add suitable scales to the vertical and horizontal axes
- plot a graph of relative strength against percentage of nickel
- draw a curve of best fit.

(4)

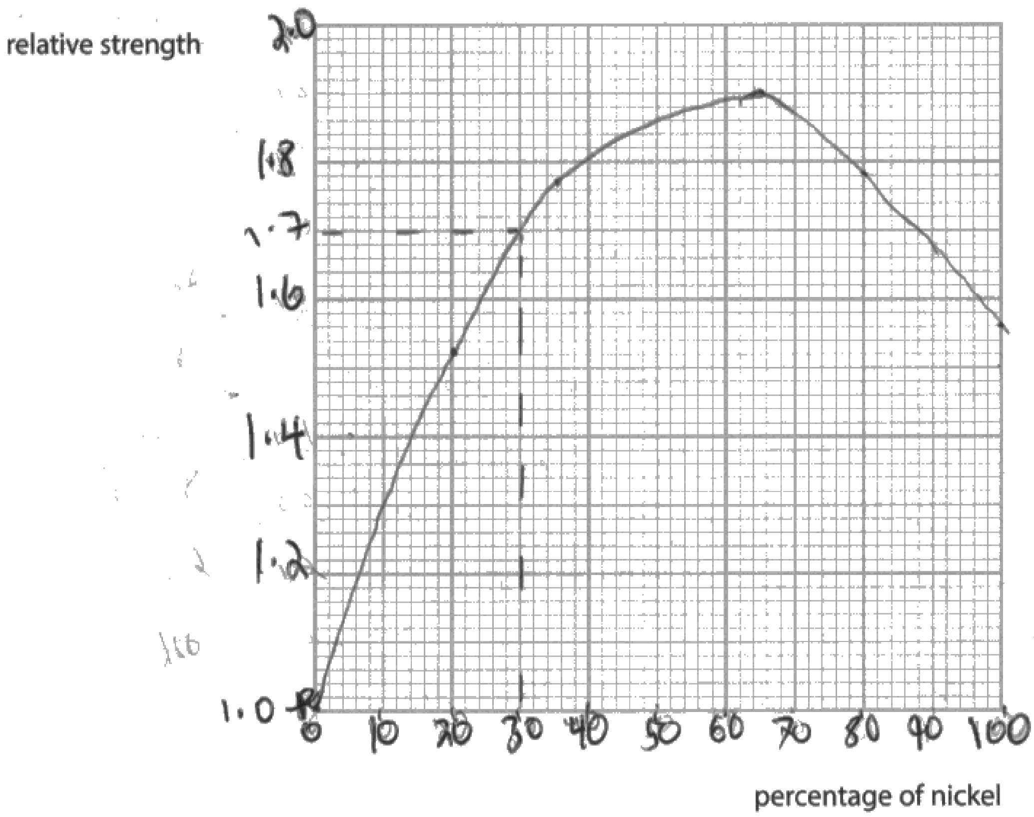


Figure 6

(ii) A coin is made from an alloy that contains 70% copper and 30% nickel.

Determine the relative strength of this coin from your graph on Figure 6.

(1)

relative strength of the coin = 1.7

(iii) Explain, using Figure 6, how the percentage of nickel affects the relative strength of the alloys of copper and nickel.

(3)

• when the percentage of nickel increases the relative strength increases between 0 to 65%.
• This is because the nickel atoms disrupt the regular lattice structure of pure copper making it harder for layers to slide over each other.
• When ~~ni~~ percentage of nickel increases from 65% to 100% the relative strength decreases again because there are now more nickel atoms which are same size

(Total for Question 7 = 12 marks)

ResultsPlus
Examiner Comments

This example scored full marks. 4 marks for the graph. The candidate has recognised that the most suitable scale on the Y axis should not start at 0. Both axes are linear and correctly labelled and the data points are plotted correctly. The candidate has drawn a single, smooth line of best fit through their plots. 1 mark for the data point. A line at 30% has been added to the grid and the relative strength read at that point. 3 marks for the explanation. The shape of the graph is correctly described, indicating an increase and then a decrease in relative strength. The candidate then goes on to explain that the disruption of atoms within the layers makes it more difficult for them to slide over each other. They then further explain that the strength decreases again once there is less disruption in the layers due to there being more atoms of the same size.

ResultsPlus
Examiner Tip

A curved line of best fit should be a single, freehand line.

(c) Alloys of copper and nickel are used for some coins.

Figure 5 shows the relative strengths of copper and nickel and some of their alloys.

percentage of nickel	relative strength
0	1.00
20	1.52
35	1.77
65	1.90
80	1.78
100	1.56

Figure 5

(i) On Figure 6
- add suitable scales to the vertical and horizontal axes
- plot a graph of relative strength against percentage of nickel
- draw a curve of best fit.

(4)

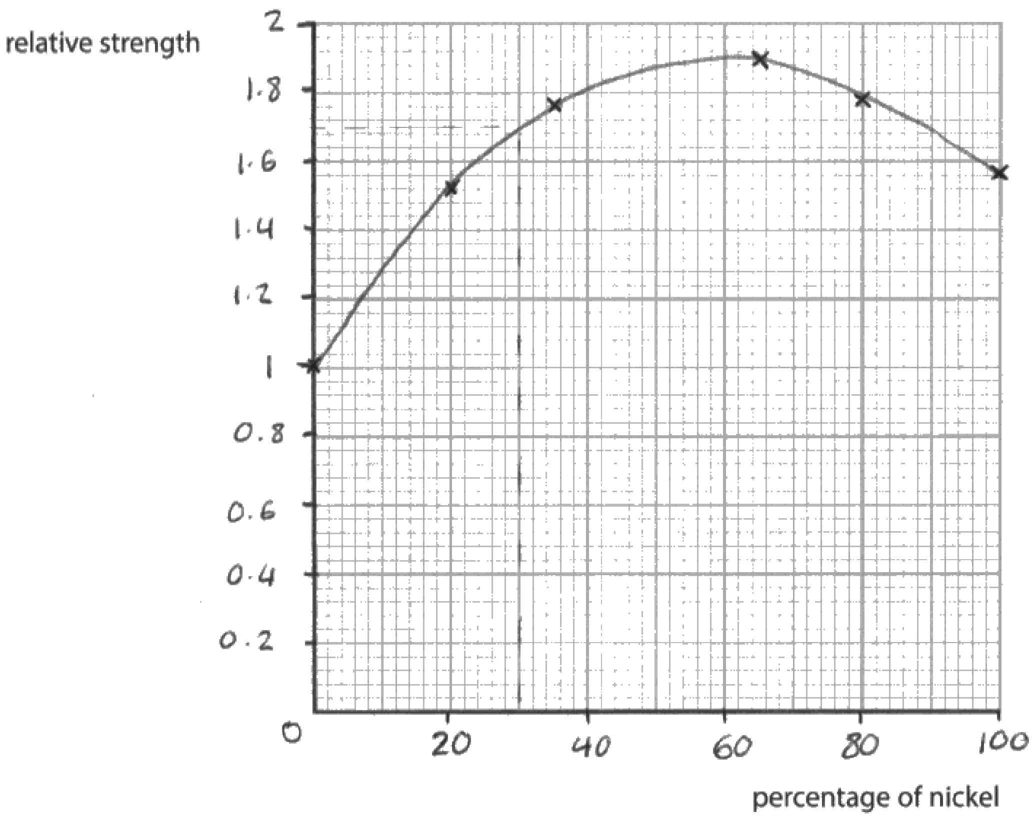


Figure 6

(ii) A coin is made from an alloy that contains 70% copper and 30% nickel.

Determine the relative strength of this coin from your graph on Figure 6.

(1)

relative strength of the coin = 1.7

(iii) Explain, using Figure 6, how the percentage of nickel affects the relative strength of the alloys of copper and nickel.

(3)

To begin with, as percentage of nickel increases so does relative strength. This is because the different sized nickel distorts the alloy's lattice preventing layers from sliding over each other, making the alloy stronger. However after around 60% nickel atoms, relative strength decreases as the alloy is now mostly nickel with fewer copper atoms to distort the lattice, making it weaker. The optimum percentage would be around 65% nickel and 35% copper.

(Total for Question 7 = 12 marks)

ResultsPlus
Examiner Comments

This example scored 7 marks. 3 marks for the graph. Many candidates assumed that the graph axes should start at 0 but this left over half of the axes empty so this is not a suitable scale. The axes are linear, the plots are correctly plotted and the line of best fit is suitable. 1 mark for the data point. A line at 30% has been added to the grid and the relative strength read at that point. 3 marks for the explanation. The candidate correctly describes the trend and then goes on to give a good explanation linking the amount of distortion in the layers with the relative strength of the alloy.

ResultsPlus
Examiner Tip

When drawing a graph ensure that axes are linear and that the data plots cover more than half of the grid.

Question 8(b)i

This question asked candidates to calculate the percentage by mass of oxygen in magnesium sulfate and to give their answer to 3 significant figures.

The vast majority of candidates scored 2 or 3 marks here. Where marks were lost there were two very common errors – either not rounding correctly to 3 significant figures or calculating the percentage mass for a single oxygen atom rather than the four in the compound.

This response scored 3 marks.

The candidate has clearly shown their working out and put the answer on the answer line, correctly rounded to 3 significant figures.

(b) (i) Calculate the percentage by mass of oxygen in magnesium sulfate, $MgSO_4$.

(relative atomic mass: O = 16.0
relative formula mass: $MgSO_4$ = 120)

Give your answer to 3 significant figures.

(3)

$O_4 = 64$ $\frac{64}{120} \times 100$

$MgSO_4 = 120$

$= 53.3$

percentage by mass = 53.3

ResultsPlus
Examiner Comments

Many candidates simply copied the answer directly from their calculator without any rounding and included the recurring dot as well.

(b) (i) Calculate the percentage by mass of oxygen in magnesium sulfate, $MgSO_4$.

(relative atomic mass: O = 16.0
relative formula mass: $MgSO_4$ = 120)

Give your answer to 3 significant figures.

(3)

$$\frac{(16 \times 4)}{~~\ldots~~120} \times 100$$

$$\frac{64}{120} \times 100 = 53.\dot{3}\,\%$$

percentage by mass = 53 %

ResultsPlus
Examiner Comments

This response scored 2 marks. Working out is clearly shown and the candidate has calculated the correct answer. Unfortunately, they have then rounded this to 2 significant figures rather than the 3 asked for in the question and so the final mark cannot be awarded.

ResultsPlus
Examiner Tip

If a question does not ask for a specific number of significant figures, then you should give your answer to the same number of significant figures as the numbers used in the question.

(b) (i) Calculate the percentage by mass of oxygen in magnesium sulfate, $MgSO_4$.

(relative atomic mass: O = 16.0
relative formula mass: $MgSO_4$ = 120)

Give your answer to 3 significant figures.

(3)

$\frac{16}{120} \times 100$

$= 13.3$

percentage by mass = 13.3

ResultsPlus
Examiner Comments

This response scored 2 marks. It was a common error for candidates to calculate the percentage by mass of one oxygen atom rather than the four that are present in magnesium sulfate. Working is clearly shown and their answer has been correctly rounded to 3 significant figures and so 2 marks can still be awarded.

Question 8(b)ii

Many candidates assumed that this question was a continuation from the previous item and attempted to use their previous answer in this part of the question, which made the calculation more difficult for them to complete and led to errors.

Approximately half of all responses scored 2 marks with the most common error being that candidates did not multiply their answer by 4 for the number of oxygen atoms. Sometimes candidates multiplied their answer by 6 – the total number of atoms in the compound.

This response scored 3 marks. The candidate has calculated the number of moles of magnesium sulfate present and multiplied this by the Avogadro constant.

They have then recognised that magnesium sulfate has four oxygen atoms and multiplied their answer by 4.

(ii) Calculate the number of oxygen atoms in 7.20 g of $MgSO_4$.

particles

(relative formula mass: $MgSO_4 = 120$
Avogadro constant $= 6.02 \times 10^{23}$)

(3)

mols = 7.20 ÷ 120 = 0.06

$0.06 \times 6.02 \times 10^{23} = 3.612 \times 10^{22}$

$3.612 \times 10^{22} \times 4 = 1.4448 \times 10^{23}$

number of oxygen atoms = 1.4448×10^{23}

ResultsPlus
Examiner Comments

This calculation is fully correct however, a number of candidates obviously struggle to use standard form on their calculators and this sometimes leads to the correct calculation being incorrectly evaluated.

Question 8(c)

The first of the six-mark questions on the paper asked about electrolysis of magnesium sulfate solution.

Candidates were expected to be able to identify the ions present in the electrolyte and explain the formation of hydrogen and oxygen at the electrodes in terms of oxidation and reduction.

This was a well attempted question and there were very few blank and 0 mark responses. In fact, the majority of candidate responses were in Level 2 or Level 3.

Candidates were usually able to identify the anode and cathode along with some of the ions present in the electrolyte. Weaker candidates mixed up the anode and cathode and tended to suggest that there were only magnesium and sulfur ions present and suggested that magnesium and sulfur would form as the products, in spite of being told otherwise in the question. More able candidates correctly identified that there would be hydrogen and hydroxide ions in the solution from the water and this led to the formation of hydrogen and oxygen. The most able candidates were able to explain why hydrogen and oxygen were formed in terms of reactivity and could write correct half equations for each of the electrodes. Most candidates attempted to explain reduction and oxidation and some did this very well but there were occasionally contradictions or mentions of loss and gain of oxygen rather than electrons.

*(c) Magnesium sulfate solution can be electrolysed using the apparatus shown in Figure 7.

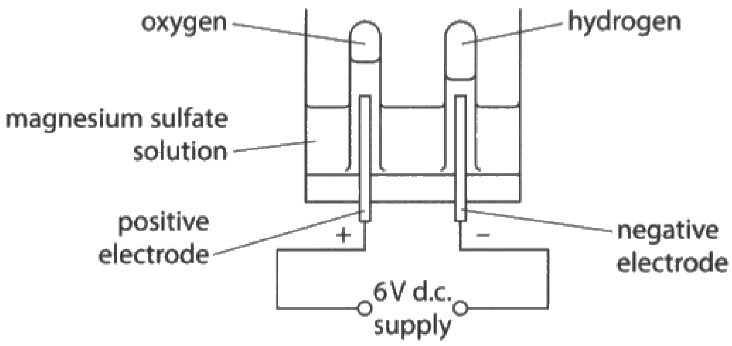


Figure 7

Explain how the products are formed at the electrodes in terms of

- the ions present in the solution
- the oxidation and reduction reactions that take place at the electrodes.

You should include ionic equations as part of your answer.

(6)

> the ions present are : H^+, OH^-, Mg^{2+}, SO_4^{2-}

(anions)

> OH^- and SO_4^{2-} is attracted to the +ve anode

> however only oxygen forms as there are no halides:

$4OH^- \rightarrow 2H_2O + O_2 + 4e^-$ / $2O^- \rightarrow O_2 + 2e^-$

> therefore oxidation at the anode (loss of electrons)

(cations)

> H^+, Mg^{2+} are attracted to the ~~the~~ -ve cathode

> however only hydrogen forms as magnesium is more reactive than hydrogen

$2H^+ + 2e^- \rightarrow H_2$

> reduction at the cathode (gain of electrons)

> electrolysis is the extraction of an element from its electrolyte using an electric current

> as ions are used up the voltage decreases as there are less ions to carry a charge

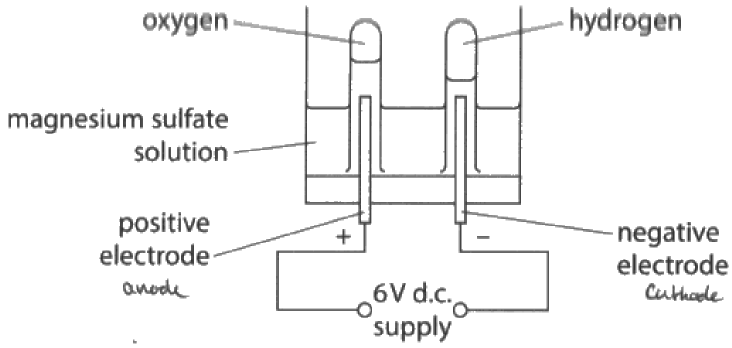
ResultsPlus
Examiner Comments

This is an example of a Level 3 response. The candidate has given their answer in concise bullet points with enough detail to award full marks. The ions are clearly identified, along with which are attracted to each electrode. There is an explanation of which ions will be discharged at each electrode along with correct equations, although the candidate has given a list of possible equations for the reaction at the anode and so this cannot be credited. The response also includes an explanation of reduction and oxidation at the electrodes. The candidate has given a detailed explanation and enough correct information for this response to be at the top of Level 3.

ResultsPlus
Examiner Tip

The examiner is looking for a detailed understanding of the chemistry in order to award marks in the top level. Answers can be bullet pointed, put into tables, given as equations or drawn as diagrams.

*(c) Magnesium sulfate solution can be electrolysed using the apparatus shown in Figure 7.



anions = −

Figure 7

Cations = +

Explain how the products are formed at the electrodes in terms of

- the ions present in the solution
- the oxidation and reduction reactions that take place at the electrodes.

You should include ionic equations as part of your answer.

(6)

- At the ~~Cathode~~ negative electrode Cations will be attracted to it.
- Anions will be attracted to the positive electrode
- Hydrogen is formed at the negative electrode as sulphate ions are reduced
  ↳ $S^{-2} \rightarrow S + 2e^-$
- Oxygen is formed at the positive electrode as magnesium ions are oxidised
  ↳ $Mg^{2+} + 2e^- \rightarrow Mg$

ResultsPlus
Examiner Comments

This is an example of a Level 1 response. The candidate has correctly identified the anode and cathode on the diagram, gives general information that cations go to the cathode, anions to the anode and has also identified that there are magnesium ions in the solution. There are no links and not enough specific detail to take the response into Level 2 – the equations are not linked to the products formed, the information about which ions go to each electrode is not related to the electrolyte in the question and the comments on reduction and oxidation are contradictory.

ResultsPlus
Examiner Tip

To get into Level 2 or Level 3 the candidate must demonstrate a detailed understanding by linking their knowledge and ideas together.

*(c) Magnesium sulfate solution can be electrolysed using the apparatus shown in Figure 7.

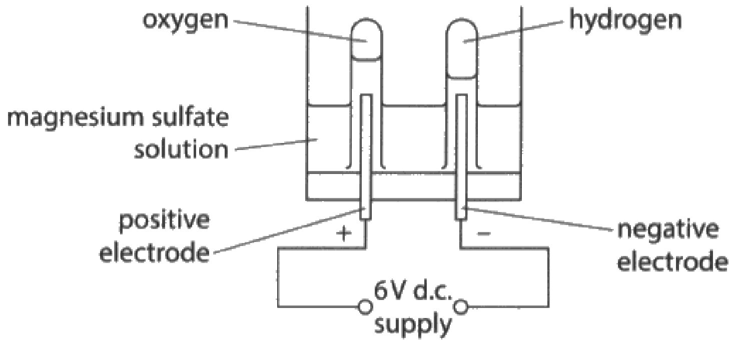


Figure 7

Explain how the products are formed at the electrodes in terms of

- the ions present in the solution
- the oxidation and reduction reactions that take place at the electrodes.

You should include ionic equations as part of your answer.

(6)

The products formed at the cathode is hydrogen this ~~t~~ is because the H^+ ions are attracted to the negative charge of the cathode. Hydrogen is formed at the cathode because it isn't more reactive than magnesium. ~~so bubble~~

Oxygen is formed at the anode because the positive O^- ions are attracted to the positive charge of the anode.

At the cathode, oxidation occurs as electrons are lost whilst the anode has reduction taking place because they gain anions.

$$MgSO_4 + OH^- \longrightarrow MgSO_4 + H + O$$

ResultsPlus
Examiner Comments

This is an example of a Level 2 response. The response is short but it has enough detail in it to award a mark in Level 2. The candidate has correctly identified the anode and the cathode and explained why hydrogen is formed in preference to magnesium at the cathode. This is enough to get the response into Level 2. The rest of the response is a little confused in terms of the ions present and their charges and it has mixed up the redox reactions happening at each electrode, although the definitions are correct. There is nothing creditworthy in the equation.

Question 9(a)

Question 9 proved to be the most challenging question on the paper overall and there was a noticeable dip in the performance of candidates throughout this question. Although this question has been targeted towards the higher grades, a lack of knowledge and understanding about ammonia and equilibrium was apparent across all items in the question.

The first item asked why litmus paper needed to be damp in order to test for ammonia gas. It was expected that candidates would be able to explain that ammonia dissolves in water to form hydroxide ions that turn red litmus paper blue. However, very few responses mentioned hydroxide ions at all.

Over half of all responses scored no marks at all, although there were a lot of near misses. Candidates had the idea that ammonia needed to dissolve but often said that it would dissolve into or react with the litmus paper itself rather than the water.

Other candidates immediately associated litmus paper with the test for chlorine, stating that it would be bleached. While the idea of a colour change was accepted, the idea of bleaching litmus paper was not.

9 This question is about ammonia.

(a) Ammonia is a gas.

Suggest why the litmus paper used to test for ammonia gas has to be damp.

(2)

The paper has to be damp so that the ammonia can dissolve into the water & form ammonium ions, turning the blue litmus paper red.

ResultsPlus
Examiner Comments

This response scored 2 marks. Answers including the formation of hydroxide ions were very rare (the incorrect colour change is ignored). The candidate has also identified that the ammonia will dissolve in the water to form the hydroxide ions.

9 This question is about ammonia.

(a) Ammonia is a gas.

Suggest why the litmus paper used to test for ammonia gas has to be damp.

(2)

The litmus paper will not change colour from a gas, so the water ~~at~~ on the red litmus paper allows the ammonia to dissolve into it, turning the litmus paper blue and proving that ammonia has been evolved.

ResultsPlus
Examiner Comments

This response scored 2 marks. There were alternative ways of scoring a second marking point and more candidates scored through mentioning that the colour of the litmus paper would change.

9 This question is about ammonia.

(a) Ammonia is a gas.

Suggest why the litmus paper used to test for ammonia gas has to be damp.

(2)

So it can react with ammonia and the colour change can be visible.

ResultsPlus
Examiner Comments

This response scored 1 mark. Ambiguous answers often did not score. In this case the candidate has referred to 'it' rather than the water. The way the response reads suggests that 'it' is the paper rather than the water. The mark for stating that there would be a colour change was scored.

ResultsPlus
Examiner Tip

Be specific when writing answers so that the examiner can be certain that you understand.

9 This question is about ammonia.

(a) Ammonia is a gas.

Suggest why the litmus paper used to test for ammonia gas has to be damp.

(2)

The litmus paper has to be damp for ammonia gas to react with it and therefore bleach it. This is because Ammonia gas reacts with H_2O. If it was not damp the ammonia gas would have nothing to react with on the litmus paper.

ResultsPlus
Examiner Comments

This response scored 1 mark for the idea of ammonia reacting with water. Whilst incorrect colour changes were ignored, references to bleaching the litmus paper were rejected.

Question 9(b)i

This question asked for the definition of a dynamic equilibrium.

Approximately half of the candidates were able to state that at dynamic equilibrium the rate of the forward and reverse reactions are equal. The most common error made here was to state that the reactions happen at the same time rather than the same rate, suggesting a lack of understanding of the difference between rate and time.

Only a small percentage of responses correctly identified that the concentration of reactants and products remain constant. Again, this was often due to poor scientific literacy where candidates suggested that the concentrations would be equal.

The weakest candidates gave information about the Haber process rather than answering the question that had been asked.

(b) Ammonia can be made on an industrial scale using the Haber process.

The equation for the reaction is

$$3H_2(g) + N_2(g) \rightleftharpoons 2NH_3(g)$$

The reaction can reach a dynamic equilibrium.

(i) Explain what happens when the reaction reaches dynamic equilibrium

(2)

The forwards and backwards reaction occur at the same rate. The concentration of products and reactants are constant.

ResultsPlus
Examiner Comments

This response scored 2 marks. The candidate uses the correct scientific language and gives a clear and concise definition of dynamic equilibrium.

ResultsPlus
Examiner Tip

At dynamic equilibrium there is no overall change in the concentration of reactants and products. This does not mean that the concentrations are equal.

(b) Ammonia can be made on an industrial scale using the Haber process.

The equation for the reaction is

$$3H_2(g) + N_2(g) \rightleftharpoons 2NH_3(g)$$

The reaction can reach a dynamic equilibrium.

(i) Explain what happens when the reaction reaches dynamic equilibrium

(2)

When the rate of the forward reactions is happening at the same time with the backwards reaction.

ResultsPlus
Examiner Comments

This response did not score any marks. The candidate has confused rate and time in this case and states that both reactions happen at the same time rather than at the same rate.

(b) Ammonia can be made on an industrial scale using the Haber process.

The equation for the reaction is

$$3H_2(g) + N_2(g) \rightleftharpoons 2NH_3(g)$$

The reaction can reach a dynamic equilibrium.

(i) Explain what happens when the reaction reaches dynamic equilibrium

(2)

when it reaches dynamic equilibrium the amount of reactants and product will be equal

ResultsPlus
Examiner Comments

This response did not score any marks. The candidate has stated that there will be equal amounts of reactants and products rather than no change in the amount of reactants and products.

Question 9(b)iii

For this question, candidates were given some information about how pressure affects the equilibrium yield of ammonia and asked to predict what would happen to the position of the dynamic equilibrium if an even lower pressure were used.

Most candidates were correctly able to state that reducing the pressure would decrease the yield or shift the equilibrium to the left but only about half of these were able to explain why the yield would decrease.

Some candidates lost out on marks by contradicting themselves and stating that the yield of ammonia would reduce because the position of the equilibrium would shift to the right.

(iii) In industry, a pressure of 200 atmospheres is used for the Haber process.

Using Figure 8, explain what happens to the position of dynamic equilibrium if the process is carried out at 100 atmospheres.

(2)

When pressure decreases, the equilibrium favours the side with more moles which is the left side (reactants side) in the Haber process so less yield of the product ammonia is produced.

ResultsPlus
Examiner Comments

This response scored 2 marks. Although the candidate has not stated which direction the equilibrium will move, they have correctly identified that there will be a lower yield of ammonia. They have also explained that the equilibrium will favour the side of the reaction with more moles.

ResultsPlus
Examiner Tip

Check the stoichiometry of the reaction to determine which side of the equation has the greater number of moles.

(iii) In industry, a pressure of 200 atmospheres is used for the Haber process.

Using Figure 8, explain what happens to the position of dynamic equilibrium if the process is carried out at 100 atmospheres.

(2)

A lower pressure means the equilibrium will shift to the side with more molecules to counteract the change. This means it will shift to the forwards reaction, so more ammonia will be produced.

ResultsPlus
Examiner Comments

This response scored 1 mark. The candidate has correctly identified that the equilibrium will favour the side of the reaction with the greater number of molecules but then incorrectly states that this will be the forward reaction.

(iii) In industry, a pressure of 200 atmospheres is used for the Haber process.

Using Figure 8, explain what happens to the position of dynamic equilibrium if the process is carried out at 100 atmospheres.

(2)

If the process is carried out at 100 atmospheres, this will shift and favour the backwards reaction resulting in decreases of yeild of ammonia.

ResultsPlus
Examiner Comments

This response scored 1 mark. The same marking point is given twice – the reduced yield of ammonia and the position of the equilibrium moving towards the reverse reaction. There is no explanation and so a second mark cannot be awarded.

ResultsPlus
Examiner Tip

If the total number of moles on either side of the reaction equation are equal then changing the pressure will have no effect on the position of the dynamic equilibrium.

This response did not score any marks.

The candidate has given their answer in terms of rate of reaction rather than the position of the dynamic equilibrium.

(iii) In industry, a pressure of 200 atmospheres is used for the Haber process.

Using Figure 8, explain what happens to the position of dynamic equilibrium if the process is carried out at 100 atmospheres.

(2)

The yield increases as there are more frequent and successful collisions.

ResultsPlus
Examiner Comments

Candidates often confused the rate of attainment of equilibrium with the equilibrium yield.

Question 9(c)

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

Most responses suggested that the ammonium chloride evaporated at high temperatures and then was deposited back as a solid once the temperature cooled at the top of the tube. Whilst this did allow candidates to access up to 2 marks, many did not show any understanding of how changing the temperature affected the reversible reaction or even acknowledged that there was a reaction happening at all.

Where responses did have the idea of the reversible reaction there were often errors in the explanation, suggesting that hydrochloric acid was produced in the forward reaction or not mentioning that the reverse reaction was happening where the temperature was cooler at the top of the tube.

(c) Ammonia can also be made by heating ammonium chloride.

$$NH_4Cl(s) \rightleftharpoons NH_3(g) + HCl(g)$$

A sample of solid ammonium chloride is heated in a boiling tube.

After a few minutes ammonium chloride, a white solid, is also seen at the top of the boiling tube, as shown in Figure 9.

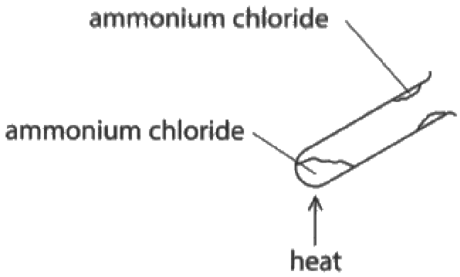


Figure 9

Explain how ammonium chloride is formed at the top of the boiling tube.

(4)

as the Ammonium chloride is heated, it becomes $NH_3(g)$ and $HCl(g)$. These gases rise to the top of the boiling tube where they cool down and react together and form Ammonium chloride again. This is because this reaction is reversable with temperature.

ResultsPlus
Examiner Comments

This is an example of a fully correct response. The candidate has correctly identified the production of ammonia and hydrogen chloride gases in the forward reaction, which then rise and cool at the top of the tube, leading to the reverse reaction occurring.

ResultsPlus
Examiner Tip

Changes in temperature will affect the concentration of reactants and products in a reversible reaction.

(c) Ammonia can also be made by heating ammonium chloride.

cooler

$$NH_4Cl(s) \rightleftharpoons NH_3(g) + HCl(g)$$

A sample of solid ammonium chloride is heated in a boiling tube.

After a few minutes ammonium chloride, a white solid, is also seen at the top of the boiling tube, as shown in Figure 9.

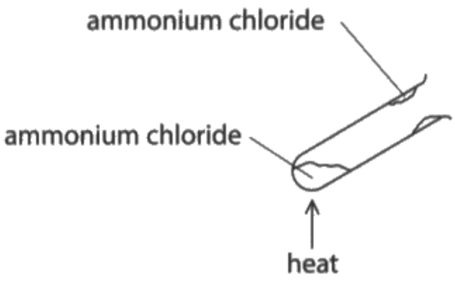


Figure 9

Explain how ammonium chloride is formed at the top of the boiling tube.

(4)

Ammonium chloride forms at the top of the boiling tube because, as the solid ammonium chloride is heated, ammonia and hydrochloric acid is produced as gases. These gases will then rise up, away from the hot heat at the bottom of the boiling tube, toward the top. The top is cooler, favouring the formation of the endothermic reaction to produce ammonium chloride, so the gases react at the top, and ammonium chloride is formed as a white solid around the neck of the boiling tube.

ResultsPlus
Examiner Comments

This response scored 3 marks. The candidate has incorrectly identified one of the products as hydrochloric acid gas.

(c) Ammonia can also be made by heating ammonium chloride.

$$NH_4Cl(s) \rightleftharpoons NH_3(g) + HCl(g)$$

A sample of solid ammonium chloride is heated in a boiling tube.

After a few minutes ammonium chloride, a white solid, is also seen at the top of the boiling tube, as shown in Figure 9.

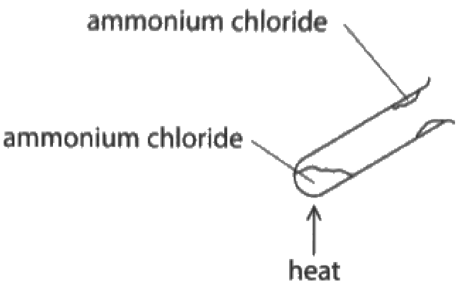


Figure 9

Explain how ammonium chloride is formed at the top of the boiling tube.

(4)

As the ~~one~~ ammonium ~~eth~~ chloride is heated, it turns to a gas which then moves around the tube, reaching the top. Since the top of the tube is cooler, and ammonia becomes solid at room temp, the gas solidifies, leaving ammonium chloride at the top of the tube.

ResultsPlus
Examiner Comments

This is an example of a 2 mark response. Answers like this were the most commonly seen by examiners – suggesting no reactions but simply changes of state with changes in temperature.

Question 10(b)i

In this question candidates were asked to explain how rinsing a burette with distilled water would affect the results of a titration.

There were 2 marks available, with most candidates scoring either 1 mark or nothing.

It was quite common to see the mark awarded for recognising that the water would dilute the sulfuric acid but most candidates could not explain this in a way that would allow them to access the second mark. Most explanations were too vague, simply stating that the results would be affected or that the titre would not be accurate rather than recognising that a greater volume of acid would be required to neutralise the alkali.

Weaker candidates suggested that adding water would make the titration take longer.

(b) The student uses the apparatus shown in Figure 10 to carry out the titration.

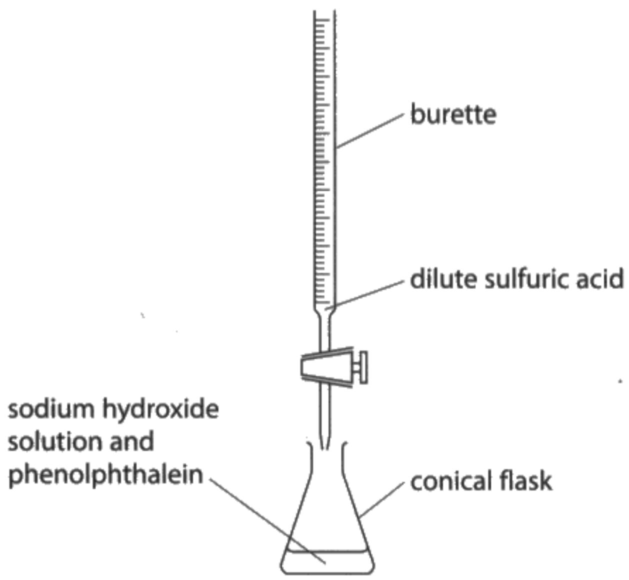


Figure 10

Before using the apparatus, the student rinses the burette with distilled water.

This is an error.

(i) Explain what effect this error has on the result of the titration.

(2)

It will dilute the acid and increase the volume of acid required to neutralise the solution.

ResultsPlus
Examiner Comments

This response scored both marks. The candidate has stated that the concentration of acid has decreased and therefore the volume of acid required would increase.

ResultsPlus
Examiner Tip

An explanation must include a linked idea.

(b) The student uses the apparatus shown in Figure 10 to carry out the titration.

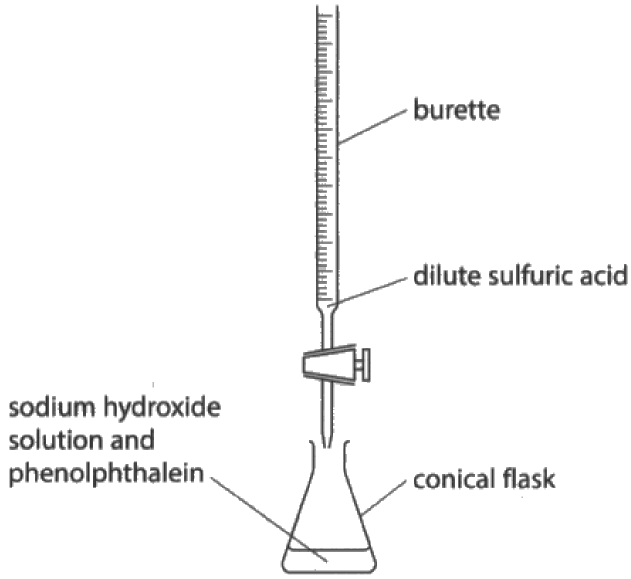


Figure 10

Before using the apparatus, the student rinses the burette with distilled water.

This is an error.

(i) Explain what effect this error has on the result of the titration.

(2)

It may effect the volume of acid that is measured to be able to neutralise the alkali. Increases the volume of acid that is thought to neutralise the alkali. increases the titre of acid.

ResultsPlus
Examiner Comments

This response scored 1 mark. The candidate has correctly stated that the volume of acid required for neutralisation would increase but has not explained why this is the case.

(b) The student uses the apparatus shown in Figure 10 to carry out the titration.

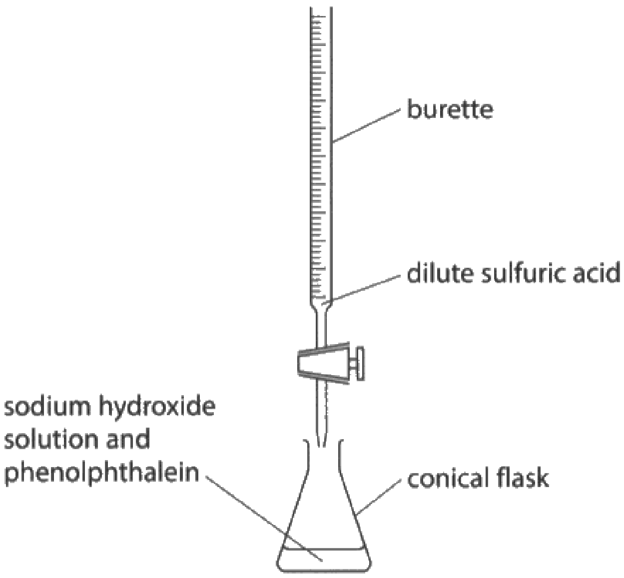


Figure 10

Before using the apparatus, the student rinses the burette with distilled water.

This is an error.

(i) Explain what effect this error has on the result of the titration.

(2)

By rinsing the burette with distilled water they are contaminating the burette as there will be some of the water left behind in the burette, that will affect the accuracy of the titration.

ResultsPlus
Examiner Comments

This response scored 0 marks. The candidate has correctly stated that there will be some water left behind in the burette but has not said how this will affect the concentration of the acid. The response then goes on to say that it will affect the result of the titration but not given any explanation as to how the result will be affected.

Question 10(b)ii

This question was about the experimental method of titration and it was expected that candidates would be aware that the burette should be rinsed through with the reagent prior to carrying out the titration.

Just less than half of responses scored the mark for rinsing the burette with sulfuric acid. Most candidates stated that the burette should be dried or a different burette should be used. A few candidates suggested rinsing the burette with the wrong reagent.

(ii) State what the student should do to correct the error.

(1)

rinse it with dilute sulfuric acid.

ResultsPlus
Examiner Comments

This response scored the mark for correctly identifying that the burette should be rinsed with sulfuric acid prior to the titration.

This response did not score the mark.

Drying the burette is difficult and not a realistic way to correct the error.

(ii) State what the student should do to correct the error.

(1)

dry the burette efficiently

ResultsPlus
Examiner Comments

Candidates appear to be unfamiliar with all of the steps required to set up and perform a titration.

(ii) State what the student should do to correct the error.

(1)

Rinse the burette with dilute HCl

ResultsPlus
Examiner Comments

This response did not score the mark. Candidates sometimes had the correct idea of rinsing the burette with something else but then stated the incorrect reagent. Most commonly seen was hydrochloric acid, sodium hydroxide and tap water.

Question 10(c)

The second of the six-mark questions asked candidates how to carry out a titration and use their results to determine the concentration of sodium hydroxide.

This question was well answered overall with most candidates giving Level 2 or Level 3 responses. Most could give a description of the steps involved in a titration and explain why these were done and then give some detail of the calculation required. Responses tended to better at describing the experimental procedure than the calculation where the responses were sometimes confused.

Some candidates gave a description of how to set up the equipment and fill the burette although this was already given in the diagram and so was not worthy of any credit. Some candidates also described using different indicators, suggesting that they had not considered the information given to them in the question.

*(c) The equation for the reaction in the titration is

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

Explain how the equation for the reaction and the apparatus in Figure 10 can be used to find the concentration of 25.0 cm³ of sodium hydroxide solution using the 0.250 mol dm⁻³ sulfuric acid.

(6)

~~$\frac{m}{Mr}$~~ $c = \frac{n}{v}$ $n = \frac{M}{Mr}$

The equation for the reaction and the apparatus in Figure 10 can be used to find the concentration by adding acid drop by drop into the flask, until the phenolthaline turns from pink to colourless, to show the alkali has been neutralised. The difference between the initial and final reading should then be calculated. This should then be repeated 2 to 3 times and concordant results (which are within 0.1 of each other should be found and used to find the mean.

~~With this results,~~ This result can then be substituted into the formula $c = \frac{n}{v}$ as the volume. The concentration used will be 0.250 mol dm^{-3}. This will allow us to find the number of moles of sulfuric acid. As shown by the equation, sodium hydroxide has twice the number of moles as sulfuric acid. Therefore the value for n should be doubled and then divided by 25.0 cm³ to find the concentration.

ResultsPlus
Examiner Comments

This is an example of a Level 3 response. The candidate has given some relevant detail about performing the titration and linked some ideas together – identifying that when the phenolphthalein turns from pink to colourless then the sodium hydroxide has been neutralised. They then go on to give a detailed description of how to carry out the titration calculation, correctly stating how to calculate the number of moles of acid used, the number of moles of alkali used and the final concentration of the alkali. Both parts of the question have been explained with a good explanation of the calculation and a partial explanation of the titration procedure and is enough to score full marks.

ResultsPlus
Examiner Tip

In order to score marks in Level 3, all parts of the question must be answered.

mass = mr moles

moles

conc | vol

*(c) The equation for the reaction in the titration is

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

Explain how the equation for the reaction and the apparatus in Figure 10 can be used to find the concentration of 25.0 cm^3 of sodium hydroxide solution using the 0.250 mol dm^{-3} sulfuric acid.

(6)

Sodium hydroxide — Sulfuric acid

volume : 0.025 dm — conc : 0.250

First need to find out the volume of dilute sulfuric acid used. You can do this by using the readings on the burette. Substract the initial volume by the final to find the volume of sulfuric acid used. To find the concentration of sodium hydroxide you do moles ÷ volume. We know the volume is 0.025dm. To find the moles you ~~find them~~ do mass ÷ Mr. or find the number of moles of H2 SO4 by doing its concentration of 0.250 × its volume (reading from burette). And times that by 2 to find the moles of sodium hydroxide solution.

ResultsPlus
Examiner Comments

This is an example of a Level 2 response. The candidate has given a correct description of most of the calculation along with the correct formulae and this is enough to award a mark in Level 2. There is no description of the titration procedure and so no further marks can be awarded and the response cannot be considered in Level 3.

*(c) The equation for the reaction in the titration is

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

Explain how the equation for the reaction and the apparatus in Figure 10 can be used to find the concentration of 25.0 cm^3 of sodium hydroxide solution using the 0.250 mol dm^{-3} sulfuric acid.

(6)

• you would place drops of the sulphuric acid into the sodium hydroxide and phenolphthalein and keep mixing it until there is a colour change from pink to colourless and stop adding sulphuric acid. You would then take the original reading of the burette and subtract the final reading to work out how much sulphuric acid you needed to add to make it neutral which would be the perfect 2:1 ratio of the equation. Using the know concentration of the sulphuric acid you can work out the concentration of sodium hydroxide by using both volumes and the known concentration with the ratio of moles

ResultsPlus
Examiner Comments

This is an example of a Level 2 response. The candidate has given a partially linked description of the titration stating that drops of acid need to be added and mixed until the phenolphthalein turns from pink to colourless. They have also briefly mentioned the calculation in terms of identifying the correct molar ratio. This is better than Level 1 as there are some links but there is not enough detail for a Level 3 mark.

*(c) The equation for the reaction in the titration is

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

Explain how the equation for the reaction and the apparatus in Figure 10 can be used to find the concentration of $25.0\,cm^3$ of sodium hydroxide solution using the $0.250\,mol\,dm^{-3}$ sulfuric acid.

(6)

The burette allows for drops of ~~sa~~ sulfuric acid to be added methodically and with the phenolphthalein in the sodium hydroxide solution, you'll be able to see when the sodium hydroxide solution changes colour, showing its concentration, when enough sulfuric acid is added, which can be put next to a chart to see the concentration of the solution, using its final colour. This is all shown in Figure 10.

The equation of the reaction shows that Na_2SO_4 is formed with ~~and~~ water, which could suggest a precipitate forming, which could have its colour inspected to determine its concentration and pH via the addition of the sulfuric acid.

ResultsPlus
Examiner Comments

This is an example of a Level 1 response. There is a lot of vague information in this answer that is not creditworthy and there is very little detail. There is no mention at all of how to do the calculation. The candidate has correctly stated that the acid should be added to the alkali and that there will be a colour change but they have not said anything about mixing and have stated that the sodium hydroxide will change colour rather than the indicator. Correct statements are enough to score a mark in Level 1.

ResultsPlus
Examiner Tip

It is the indicator that changes colour, not the reactant.

Paper Summary

Based on their performance on this paper, candidates are offered the following advice:

- Make the effort to write clearly and legibly. Examiners are only able to mark work that they can read.
- Become familiar with the different command words used in exam questions, particularly 'describe' and 'explain.
- Practice linking ideas together for exam questions that are worth more than one mark.
- Practice using scientific terminology and improving their scientific literacy.
- Clearly show all working out for calculation questions.
- Ensure that their calculation answers are rounded correctly and given to the correct number of significant figures if this is asked for in the question.
- Make sure that they have experience of all of the chemistry core practicals as a minimum.
- Give suggestions for improving experimental procedures in terms of both equipment and method.
- Focus on their understanding of reversible reactions and dynamic equilibrium and the factors that affect the position of a dynamic equilibrium.
- Centres are encouraged to make use of past GCSE questions to target particular topics and different assessment objectives.

Grade boundaries

Grade boundaries for this, and all other papers, can be found on the website on this link: https://qualifications.pearson.com/en/support/support-topics/results-certification/grade-boundaries.html

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