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June 2025

GCSE Combined Science 1SC0 1CH

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Introduction

The examination paper was based on the 9-1 Chemistry specification that was first assessed in 2018. The paper consisted of six questions, questions 1 and 2 were common with the 1CH0_1CF Combined Science (Chemistry) paper and all the questions were common with the 1CH0_1H Chemistry (Higher) tier paper. As with the other examination papers that have assessed the current specification, a wide variety of question types were used that were suitable for this level, which included multiple choice, short open response, interpreting diagrams of apparatus and graphs and calculations appropriate for the Higher tier.

This examination paper also assessed writing simple balanced and half (ionic) equations and writing open-ended answers in the 4-mark and 6-mark questions. Paper 1 assesses the following topics:

Topic 1 – Key Concepts in Chemistry (also assessed in Paper 2).

Topic 2 – States of Matter and Mixtures.

Topic 3 – Chemical Changes.

Topic 4 – Extracting Metals and Equilibria.

This examination paper targeted grades 4–9 with about half the marks targeting grades 4 and 5. It was also noted that there were many blank responses on the open-ended questions as well as where practical knowledge was being tested.

Question 1(a)i

Most candidates knew the charges on the protons and electrons and knew the relative mass of the neutron to score all three marks. The errors seen were with the mass of the neutron, suggesting that its mass is '0', and the charge on the electron as just '1' without the negative sign.

Question 1(a)ii

Most candidates answered this well by stating electrons and protons and giving the correct number of each. Where errors occurred, this was generally due to candidates including neutrons, which were ignored, but these were included often at the expense of the electrons. Some candidates tried to incorporate the relative atomic mass at this point in order to give the number of neutrons, but that was out of the scope of this question.

(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)

it has a full outer shell of electrons in the configuration 2,8.

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Examiner Comments

1 mark. This mark was given for stating the electronic configuration of neon – 2, 8 – which can be deduced from the atomic number of neon.

(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 is 10 meaning that it contains 10 protons and 10 electrons. If you take the atomic number from the relative atomic mass it gives you the number of neutrons. 20 - 10 = 10 so neon also has 10 ~~pr~~ neutrons

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Examiner Comments

2 marks. There were many answers similar to this, having stated the number of protons and electrons that can be deduced from the atomic number of neon, it then went on to explain how the number of neutrons could be obtained, but this was ignored.

(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)

Atomic number tells us the amount of protons in an atoms nucleus in this case it is 10. This means electrons are 10 and we can work out the amount of neutrons by minising 10 from the Atomic mass which for neon is 10 because 20-10=10

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Examiner Comments

2 marks. This was quite a long answer that gave the correct information. The part of the answer on the number of neutrons was ignored.

(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)

10 protons and 10 electrons

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Examiner Comments

2 marks. A very succinct answer.

Question 1(a)iii

There were different ways in which candidates scored marks here. Some referred to the same number of protons and electrons in atoms of neon, some gave the actual number of each, while others had given the number of ‘+’ charges and ‘–‘ charges present. The second mark could only be scored if the candidate referenced the charges cancelling or the sum of the charge equalled zero. Saying that the atoms contained an equal number of protons and electrons, so they were (electrically) neutral only scored the first mark and 'electrically neutral' was given in the question.

A significant number of candidates misunderstood the question and wrote about neon having a full outer shell so not wanting to lose/gain/share electrons.

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

(2)

They ~~out~~ have a full outer shell, tos has the same amount of protons and electrons.

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Examiner Comments

1 mark. Only marking point 1 was scored here for stating that there was the same amount of protons and electrons. The first part about the full outer shell was ignored.

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

(2)

- There are an equal amount of protons and electrons
- Protons are positive, electrons are negative so the charge cancels out.

ResultsPlus
Examiner Comments

2 marks. The answer indicated that the number of protons and electrons in a neon atom were the same – scoring marking point 1, and because of the charges on the particles this made the charges cancel – scoring marking point 2.

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

(2)

Because they have 8 electrons in the outer shell therefore making them neutral

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Examiner Comments

0 marks. Several candidates answered in a similar way by stating that the outer shell was full so it must be neutral.

Question 1(b)

About half the candidates could calculate the relative atomic mass of neon using the information about the abundance of its isotopes.

There were many different types of error seen here:

- Approximating the isotopic abundances to the nearest whole number.
- Errors in multiplying the abundance x isotopic mass.
- Adding the isotopic masses together: '20 + 21 + 22 = 63'.
- Forgetting to find the average mass by dividing the total mass contributions by 100.
- Rounding errors in the final answer.

It was disappointing to see the number of candidates who did not attempt this straightforward calculation.

(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)

$$\frac{(90.48 \times 20)+(0.27 \times 21)+(9.25 \times 22)}{100} = \cancel{20.188}$$

20.1877

relative atomic mass = 20.1877 or 20

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Examiner Comments

1 mark. The candidate produced a well-executed answer, gave the correct answer of 20.1877, but then lost the second mark by adding 'or 20'. Correct final answers given to 3 or more significant figures were needed to score the second mark, but with one correct and one incorrect answer, the second mark was not scored.

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Examiner Tip

By giving two answers like this, the candidate is asking the marker to choose the 'better' answer which unfortunately means that that mark is not scored.

(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)

0.9048 × 20 = 18.096

0.0027 × 21 = 0.567

0.0425 × 22 = 2.035

= 20.698

$\frac{20.698}{0.567}$ = 36.50440917

relative atomic mass = 36.504

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Examiner Comments

0 marks. There were two errors contained in this answer which lost the marks. The first error happened when the candidate calculated the contribution of Ne-21. 0.0027 x 21 = 0.0567, not 0.567 – this lost marking point 1. The second error was made by dividing the total 20.698 by 0.567 – this lost marking point 2.

ResultsPlus
Examiner Tip

Practice calculations of this type – they have often appeared in these examination papers.

(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)

$$\frac{(90.48 \times 20) + (0.27 \times 21) + (9.25 \times 22)}{100}$$

$= 20.1877$

relative atomic mass = 20.187

ResultsPlus Examiner Comments

1 mark. A well-executed calculation leading to an answer of 20.1877. However, incorrect rounding of this answer to 20.187 lost the second mark.

ResultsPlus Examiner Tip

Take care when rounding numbers to a smaller number of significant figures – it's not just simply chopping off the last few numbers.

(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)

$$\frac{(90.48 \times 20) + (0.27 \times 21) + (9.25 \times 22)}{100} = 20.1877$$

relative atomic mass = 20.2

ResultsPlus
Examiner Comments

2 marks. A well-executed calculation with a correct approximation to 3 significant figures.

Question 2(a)i

Many candidates scored both for the state symbol and for the formula of missing product.

The main error on the state symbol was when candidates used (s) for the state symbol of the solution, despite silver nitrate solution being used in the stem and the state symbol shown for that in the equation was given as (aq). There was a wide variety of formulae seen to balance the equation but there were several errors shown as variations of the formula for potassium nitrate: NO_3K was acceptable, but K_3NO, NKO_3 and other permutations were not accepted.

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

(2)

KNO_3

$AgNO_3(aq) \;+\; KCl(aq) \;\rightarrow\; AgCl(s) \;+\; \ldots\ldots \;(aq)$

ResultsPlus
Examiner Comments

2 marks. Both state symbol and formula of the potassium nitrate were correct.

ResultsPlus
Examiner Tip

Learn the four state symbols.

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

(2)

$$AgNO_3(aq) \; + \; KCl(\cancel{g}\,s) \; \rightarrow \; AgCl(s) \; + \; NO_3K \; (aq)$$

ResultsPlus Examiner Comments

1 mark. We allowed the formula of potassium nitrate to be written as NO_3K.

ResultsPlus Examiner Tip

The formula of metal salts such as potassium nitrate always has the metal as the first part of the name and of its formula.

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

(2)

$$AgNO_3(aq) \;+\; KCl(\overset{s}{\cancel{aq}}) \;\rightarrow\; AgCl(s) \;+\; \text{KNo}_3\ (aq)$$

ResultsPlus
Examiner Comments

0 marks. This had an incorrect state symbol and the formula contained a lower case 'o' so the formula was not credited with a mark.

ResultsPlus
Examiner Tip

Make sure you use correct size letters when writing the chemical formulae.

Question 2(a)ii

It was disappointing to see how many candidates could not identify the precipitate as silver chloride. It appears that many candidates do not know the state symbols and so missed the (s) in the equation next to the silver chloride, thinking that the precipitate was the potassium nitrate judging by how many gave that as their answer here.

Question 2(a)iii

This should have been a straightforward question for candidates to answer. Filtration will be the first separation technique that candidates would encounter, yet about half scored no marks here. The remainder managed to identify the process of filtration, with fewer being able to give detail about the process and say where the precipitate would be collected. Some suggested filtration, then described other separation techniques such as distillation which only allowed them to score just that one mark.

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

(3)

using filteration. Pouring the solution through a funnel lined with filter paper. The percipitate will be collected in the funnel

ResultsPlus
Examiner Comments

A very succinct answer scoring 3 marks for: filtration, pouring the solution through the funnel with filter paper, stating where the precipitate would be retained.

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

(3)

- Get a beaker ~~conical flask~~
- Get filter paper and fold into a funnel
- Pour solution into the funnel
- Let it filter
- White precipate will remain on funnel
- Process of Filtration

ResultsPlus
Examiner Comments

3 marks. This answer scored the marks by identifying the process of filtration and then for explaining the process of pouring the solution and where the precipitate would collect.

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

(3)

~~Use the gas syringe to measure the white precipitate.~~

filter out the white precipitate // the excess solid.
heat it up gently
allow it to cool

ResultsPlus
Examiner Comments

1 mark. Only the mark for 'filter out...' scored. The rest of the answer concerned another process and so was ignored.

Question 2(b)

Describing how various substances and solutions conduct electricity has been asked several times in the past papers. However, this was the first time that two substances both conducting electricity was asked about – one a metal and one a salt solution. Many candidates struggled to identify the correct moving charged particles that allowed that particular substance to conduct electricity – ions in the silver nitrate solution and delocalised electrons in the solid silver. There were many misconceptions seen here – these substances conduct because electricity can fit between the atoms / ions / electrons was one of the many incorrect descriptions. The weaker candidates thought silver nitrate solution conducted electricity just because it contained silver and many just thought that both the solid and solution conducted electricity because they 'both contain 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)

Silver nitrate has ions that are free to move and carry charge and flow. Solid silver is a metal and metals can conduct electricity.

~~Silver contains~~

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Examiner Comments

2 marks. The answer scored for ions in silver nitrate solution and that they move. There was no indication as to which particles carried the charge in silver.

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Examiner Tip

Know that ions move in molten metal salts and metal salt solutions and delocalised electrons move in metals – these are the particles that allow these materials to conduct electricity.

(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 made with ionic bonds
and its an ionic compound, the compound
~~not~~ has no free electrons but when as a solution or molten
the electrons become free or delocalised and can conduct a
charge, silver is a metal and has delocalised electrons
so it conducts and allows a current

ResultsPlus
Examiner Comments

1 mark. The answer stated erroneously that silver nitrate has free electrons. It did identify the particles of delocalised electrons in silver, but did not state that they moved when conducting an electrical current.

(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 solution has freely moving ions which can carry charge
- Solid silver contains a sea of delocalised electrons and can therefore carry charge

ResultsPlus
Examiner Comments

3 marks. This was a really good answer stating which particles move in the two substances which caused them to conduct an electrical current.

Question 3(a)

Many candidates managed to make the link between the period number of the element and the number of electron shells within an atom of that element. Several candidates used the term 'row' and this was allowed in place of 'period'. However, stating the three elements had two outer shells was not accepted for the second marking point. About half the candidates scored both marks.

3 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, this means that they all have 2 ~~shells~~ outer shells.

ResultsPlus
Examiner Comments

1 mark. The answer scored one mark for stating that the elements were in period 2 but lost the second mark for saying that they all had two outer shells. Many candidates made this fundamental mistake.

ResultsPlus
Examiner Tip

An atom can only have 1 outer electron shell.

3 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)

7

nitrogen = 2 : 5 period 5 5 electrons in outer shell

Oxygen = 2 : 6 period 6 6 electrons in outer shell

fluorine = 2 : 7 period 7 7 electron in outer shell

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Examiner Comments

1 mark was scored for the correct electronic configurations being stated for all 3 elements since they were made up of 2 shells. The candidate erroneously thought that the period number came from the number of electrons in the outer shell of the atom.

3 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)

N_2, O_2, and F_2 are all located in the second period. This means that they all have the same number of electron shells.

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Examiner Comments

1 mark. The period number was identified, but the reason why was not.

Question 3(b)i

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

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

(3)

Fluorine has a low ~~boiling~~ boiling point because it has weak bonds that can be easily broken. This is due to it not having a full outer electron shell.

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Examiner Comments

0 marks. Many candidates tried to link the idea of weak bonds to incomplete outer electron shells. There was nothing here to score.

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

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

(3)

Due to flourine haveng weak intermolecular forces and covalent bonds, and a simple structure this results in flourine having a low boiling point.

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1 mark. The mark was awarded for stating that fluorine had weak intermolecular forces. Fortunately the candidate did not state that these were between covalent bonds as this would have lost the mark. Many candidates made that mistake. 'Simple structure' was not a suitable alternative for 'simple molecular' or 'simple covalent' for the first marking point.

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

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

(3)

~~Because the inter~~ Because fluorine is a simple molecular substance that has small amounts of covalent bonds, which means it will have very weak intermolecular forces inbetween each bond, meaning that it ~~ta~~ needs very little energy to break down the bonds.

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1 mark. The mark was scored for correctly identifying the structure type: simple molecular. The rest of the answer contained errors that prevented the other 2 marks being awarded: '... have very weak intermolecular forces in between each bond ...', '... it needs very little energy to break down the bonds' – 'the bonds' – was that the covalent bonds or the weak intermolecular forces?

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Examiner Tip

'Intermolecular' means between molecules and not between anything else.

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

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

(3)

Flourine (Fl_2) is a simple covalent molecule.
The intermolecular porces between flourine molecules
are very weak, so not alot ~~go~~ energy is required
to break them.

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Examiner Comments

3 marks. Despite the spelling in 'flourine' (sic) and the incorrect atomic symbol 'Fl' (sic), the content of the answer scored full marks for the type of structure shown in fluorine and why the boiling point is low as a result.

Question 3(c)

The formulae of nitrogen and oxygen were given, so the two aspects of writing the balanced equation were working out the formula of nitrogen dioxide and then balancing the equation.

Many candidates gave the formula of nitrogen dioxide as NO. This then meant that no marks were scored. There were other incorrect formulae given for nitrogen dioxide, including NCO_2 and NCO which seemed to be the common errors on the formulae. A significant number of candidates did have the correct formula of the product, but then omitted the 2 in front of the oxygen when attempting to balance the equation which limited them to just scoring 1 mark.

(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)

$N_2 + O_2 \rightarrow 2NO_2$

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Examiner Comments

2 marks. Only about a third of the candidates gave the correct formula of the product and balanced the equation to score both marks.

(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

0 marks. The formula for dinitrogen oxide was given by a small number of candidates but with an incorrect formula, the overall answer scored 0.

(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)

$N_2 + O_2 \rightarrow NO_2$

ResultsPlus
Examiner Comments

1 mark. The correct formula of the product was given and this scored the first marking point. However, the candidate did not balance the equation.

(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)

$N_2 + O_2 \rightarrow 2NO$

ResultsPlus
Examiner Comments

0 marks. It was very common to see the use of the formula NO for the product. The balancing mark was awarded only where the correct formula of nitrogen dioxide was used. As a result, no marks were scored in answers like this.

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

$N_2 + O_2 \rightarrow NCO$

Write the balanced equation for this reaction.

(2)

$N_2 + O_2 \rightarrow 2NCO$

ResultsPlus
Examiner Comments

0 marks. An incorrect formula of the product was given. Many candidates did not appear to know the formula of nitrogen dioxide or even to think of another dioxide – eg carbon dioxide – on which to base the formula with 2 oxygen atoms in the formula.

Question 4(a)ii

Only a small number of candidates scored a mark for calcium carbonate being the precipitate that forms when limewater turns cloudy. Probably the greater majority of candidates had misread the question – they thought it was asking them which substance caused the limewater to go cloudy – they gave the answer 'carbon dioxide'. The other answer that appeared fairly frequently was 'copper oxide'.

(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

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Examiner Comments

1 mark. Very few candidates knew the answer to this question.

(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 hydroxide
~~Carbon dioxide~~ ~~Carbon sulfate~~

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Examiner Comments

0 marks. The answers given here, including the two that have been crossed out, were seen far more often than the correct answer.

(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.

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Examiner Comments

0 marks. Carbon dioxide was seen quite often, but this shows that the candidate misunderstood the word 'precipitate' that led to giving the name of a gas as the answer.

Question 4(a)iii

This calculation required the candidate to:

- work out the formula mass of malachite.
- using the mass of malachite then work out the number of moles of malachite.
- use the mole ratio from the equation to work out the number of moles of copper oxide formed.
- using the formula mass of copper oxide, then work out the maximum mass of copper oxide formed.

As in any calculation, errors were carried forward, so it is a good idea for candidates to show their working rather than just writing down the final answer. In this situation, even if the final answer without working was even 0.1 away from the correct answer, 0 marks would be given. Probably the most seen errors included missing out step 3 which then gave an answer of 7.95 g and with working that was given 3 marks out of the 4. The weaker candidates struggled with this calculation and only scored 1 mark for the formula mass of the malachite.

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

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

22.1 g

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)

Mr of CuO = 63.5 + 16 = 79.5 mass = mole x Mr

Mr of malachite = (63.5 x 2) + 12 + 48 + 34 = 221

mole of u = $\frac{22.1}{221}$ = 0.1 mole

mass of CuO = 0.1 x 79.5 = 7.95

maximum mass of CuO = 7.95 g

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3 marks. Marking point 1 is scored for the formula mass of malachite (221) and marking point 2 is scored for the number of moles of malachite (0.1). The candidate has not used the mole ratio of malachite : copper oxide from the equation and so does not score marking point 3. Marking point 4 is scored for the final step, carrying the error forward, which ends up with 3 marks scored for the whole calculation.

(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)

	2CuO	$Cu_2CO_3(OH)_2$
mass	31.8	22.1
Ar/Mr	159	221
moles	0.2	0.1
ratio	2	1

moles = $\frac{\text{mass}}{\text{Ar/Mr}}$ = $\frac{22.1}{221}$ = 0.1

mass = moles × Ar/Mr

? = 0.2 × 159

= 31.8

~~Ar of~~ malachite

maximum mass of CuO = 31.8 g

= (63.5×2)+(12.0)+(16.×3)+(16×2)+(1×2)

2CuO = (63.5×2)+(16×2) = 159

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Examiner Comments

3 marks. The answer contains the correct formula mass of malachite – 221 – and so scores marking point 1. In the table, marking point 2 is scored for the number of moles of malachite – 0.1 and marking point 3 is scored for the molar ratio of 1 mole of malachite : 2 moles of copper oxide. So the candidate has already taken account of the 1:2 ratio, but makes the error of multiplying the moles of copper oxide (0.2) by 159 (which is 2 x formula mass of copper oxide) – and so ends up with a calculated mass that is twice as large as it should be. Marking points 1, 2 and 3 are scored, but not 4.

(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)

$63.5 \times 2 = 127$ $\quad 16 \times 3 = 48$ $\quad (16+1) \times 2 = 34$

$127 + 48 + 34 + 12 = 221$ $\quad 63.5 \times 2 = 127$

$\frac{22.1}{221} = 0.1$ $\quad \frac{22.1}{127}$

maximum mass of CuO = ... g

ResultsPlus Examiner Comments

2 marks. The formula mass of malachite was calculated correctly for marking point 1 along with the number of moles of malachite for marking point 2. After that, it appeared that the candidate was unsure how to proceed. 2 marks were scored for this attempt of the calculation.

ResultsPlus Examiner Tip

Practice mass-mass calculations, they have appeared in many examination papers.

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

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

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)

$$\left.\begin{array}{l} Cu \times 2 \times 63.5 = 127 \\ C \times 1 \times 12 = 12 \\ O \times 3 \times 16 = 48 \\ O \times 2 \times 16 = 32 \\ H \times 2 \times 1 = 2 \end{array}\right\} 221$$

maximum mass of CuO = 221 g

ResultsPlus
Examiner Comments

1 mark. This scores just for calculating the relative formula mass of the malachite. There was no evidence of further calculations.

form of soot

(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.

$\frac{g}{Mr/ar}$

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

(4)

Cu = 63.5 × 2 = 127
C = 12 = 12
O = 16 × 3 = 48
O = 16 × 2 = 18 + = 66
H = 1 × 2 = 2 = 2
+ = 207

$\frac{22.1}{207} = 0.12$

maximum mass of CuO = 0.12 g

ResultsPlus
Examiner Comments

0 marks. The candidate made an error in calculating the relative formula mass of the malachite – down the left side, the oxygen has 2 x 16 = 18. This error was then carried forward into calculating the number of moles of malachite, but the evaluation of this was incorrect – 22.1 / 207 = 0.12, the evaluated answer should be 0.107. Marking point 2 then did not score. There was no evidence for marking points 3 or 4. So overall this scored 0 marks.

ResultsPlus
Examiner Tip

If you get time, always check numerical answers by doing the calculations again.

Question 4(b)

To avoid giving marks for copying from the question, examiners had to think the following before awarding an idea 1 mark: method? – factor? – strength/weakness? – why?

This was a very hard question and was written as a hard question. Candidates had to write more than a few words to score even 1 mark.

One mark was most often given for: Method 1, the reactants were mixed, which would be a strength as this would give rise to most reduction of the metal oxide or the reverse for method 2, where the reactants were not mixed was seen as a disadvantage as only a small amount of copper oxide would be reduced.

Other commonly seen answers were where candidates thought that using the metal crucible in method 1 would be an advantage as it would conduct more heat than the test tube in method 2.

Generally, candidates managed to identify suitable factors from a method, state whether it was a strength or weakness, but then did not explain why.

This question was asking the candidate to 'comment on strengths and weaknesses' of the two methods given in the question.

To score a mark, the candidate needed to:

- identify the method.
- state the 'factor'.
- indicate strength or weakness.
- explain why.

(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 2 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 2

Comment on the strengths and weaknesses of these two methods.

(3)

◦ Strength of method 1 is that they thoroughly mixed the copper oxide and carbon powder to make sure the reaction took place, but method 2 didn't do this, and is a weakness.

◦ A strength of method 1 is that they used a crucible and method 2 didn't.

◦ A weakness of both is that they should have added one reactant in excess: the carbon powder.

ResultsPlus
Examiner Comments

1 mark. This was given for the first bullet point which gave the mixing of the reactants in method 1 as an advantage, and explained why it was a strength. The rest of the answer did not score since the strengths or weaknesses were not explained.

Comment on the strengths and weaknesses of these two methods.

(3)

- Both heating with a roaring flame ensures mixture gets hot enough
- method 1 mixes the ~~copper~~ carbon powder in with copper oxide which is better than method 2 as now all of the copper can be displaced by carbon. Method 2 heats in a test tube which is good as it stops potential loss of product when switching containers like in method 1. Method 1 heats in a metal container which could be beneficial as metal conducts heat so it will heat quicker

(Total for Question 4 = 9 marks)

ResultsPlus
Examiner Comments

3 marks. This scored marks for: Heating in both methods with a roaring Bunsen flame, the mixing of reactants in method 1, heating in a metal container. Not many candidates scored 3 marks.

Comment on the strengths and weaknesses of these two methods.

(3)

methad 1 the instructians were clearer then methad 2 but methad 2 had saftey because of the ward carefully. methad 1 was mare accurate.

ResultsPlus
Examiner Comments

0 marks. This candidate chose to critique the two methods, but didn't give sufficient explanation or justification to score a mark.

Comment on the strengths and weaknesses of these two methods.

(3)

method 1 ~~The~~ then

weakness- metal crucible could melt

strength- copper oxide mixed thorougly so ~~that~~ that

it can react with as much powder.

method 2

weakness - not mixing the powder

strength - no metal crucible.

ResultsPlus
Examiner Comments

1 mark. The mark was given for the comment about mixing of reactants in method 1. Where candidates scored marks, this was the most common reason for giving a mark.

Question 5(b)i

This was a very straightforward percentage of an element in a compound calculation.

The 3 steps were:

- mass of 4 oxygen atoms (in one formula unit of $MgSO_4$) / 120 (formula mass of $MgSO_4$).
- answer from the first step x 100 to get a percentage value.
- round the answer from the second step to 3 significant figures.

Just under half the candidates scored full marks.

Errors occurred by:

- using only the mass of 1 oxygen in step – this gave the answer 13.3, with working, for 2 marks.
- forgetting to multiply by 100 – this gave an answer of 0.533, with working, for 2 marks.
- incorrect rounding in the final step, so gave the answer as 53.3333% or as 53%, which again scored for 2 marks.

Despite the formula mass of magnesium sulfate being given in the question, some candidates attempted to calculate that value and obtained a different value. This was another way in which an error could be introduced.

(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)

$16 \times 4 = 64$ $\qquad \frac{64}{120} = 0.5\dot{3}$ $\qquad \times 100 = 53.\dot{3}$

53%

percentage by mass = 53%

ResultsPlus
Examiner Comments

2 marks. A correct calculation. Unfortunately, it lost the third mark as the answer was given to 2 significant figures rather than 3.

(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)

$(120 - (16 \times 4)) \div 120 \times 100$

$= 46.7$

percentage by mass = 46.7%

ResultsPlus
Examiner Comments

2 marks. The first step was incorrect – for some reason, the candidate subtracted the relative atomic mass contribution from the relative formula mass. A significant number of candidates made this error. The second and third marking points were scored in this answer.

(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)

$\frac{16.0}{120} \times 100 = 13.\dot{3}$

percentage by mass = 13.3

ResultsPlus
Examiner Comments

2 marks. An error had been made in the first step – the mass of only one O atom was used rather than 4. The second and third marking points were given.

(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)

$\frac{120}{16.0} \times 100$

= 75

percentage by mass = 75

ResultsPlus
Examiner Comments

1 mark. The main calculation was incorrect, but the second marking point (multiplying by 100) was given as an appropriate Ar value had been used – 16.0 for oxygen – but the answer was only given to 2 significant figures so did not score the third mark.

ResultsPlus
Examiner Tip

Practice calculating the percentage of an element in a variety of compounds. This type of question often comes up.

Question 5(b)ii

The 3 steps to this calculation were:

- calculate the number of moles of magnesium sulfate (mass / relative formula mass).
- calculate the number of moles of oxygen atoms (no of moles from above x 4).
- calculate the number of oxygen atoms (no of moles of O atoms x Avogadro constant).

Half the candidates scored at least one mark, usually for calculating the number of moles of magnesium sulfate; very few obtained the final correct answer of 1.445 x 1023.

Errors occurred in many places:

- despite giving the candidates the relative formula mass of magnesium sulfate, some made their own attempts and produced an incorrect value.
- some inverted the fraction to calculate the number of moles of magnesium sulfate (120/7.2).
- some forgot that each formula unit contained 4 oxygen atoms and ended with a final number of 3.612×10^{22} and with working shown, scored 2 marks.
- some chose to multiply the number of moles of magnesium sulfate by 6 – presumably the number of atoms in one formula unit.
- many candidates divided a number by the Avogadro number and ended up with a negative power of 10, but didn't think that the answer could be wrong.

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

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

(3)

moles = number of atoms x 6.02x10^23   ~~120~~ $\frac{7.20}{120}$ = 0.06

$\frac{\text{moles}}{6.02 \times 10^{23}}$ = number of atoms.

$\frac{0.06}{6.02 \times 10^{23}}$ = ~~[illegible]~~ 9.97 = 10

number of oxygen atoms = 10

ResultsPlus
Examiner Comments

1 mark. This was given one mark for calculating the number of moles of magnesium sulfate – 7.20/120 = 0.06. The other calculation steps did not gain credit.

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

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

(3)

$\frac{7.20}{120} = 0.06$

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

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

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

ResultsPlus
Examiner Comments

3 marks. This calculation was logically set out. It showed calculating the number of moles of magnesium sulfate as a first step. Then came the number of magnesium sulfate formula units in that amount of magnesium sulfate. Finally taking into account the number of O atoms in one formula unit, the last step gave the number of O atoms in 7.20 g magnesium sulfate. Many candidates missed out the last step.

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

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

(3)

~~7.20x~~ , moles = $\frac{mass}{Mr}$ 7.20/180 = 0.06

~~7.20/120 = 0.06 x 6.02 x10^23 =~~

7.20 x 53.3% = 3.84 3.84/64 = 0.06

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

number of oxygen atoms = 3.612×10^{22}

ResultsPlus
Examiner Comments

2 marks. The first step is to calculate the number of moles of magnesium sulfate that was clearly shown at the start. The next step shown was a little unusual. The candidate had transferred the percentage of oxygen atoms present in magnesium sulfate from part (i) and calculated the mass of oxygen atoms present in 7.20 g magnesium sulfate. Dividing by the relative atomic mass of oxygen would have given the number of moles of oxygen atoms – 0.24, but an error was introduced here, but in the next step, benefit of doubt had to be given on which '0.06' was used. The final step shown is the 0.06 x Avogadro constant to give the number of $MgSO_4$ formula units. This scored the second mark.

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

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

(3)

0.06 : 0.1125
8 : 15

moles = $\frac{mass}{Mr}$ $\frac{7.20}{120} = 0.06$ $\frac{0.06}{0.1125} = 0.5\dot{3}$

$0.5\dot{3} \times 6.02 \times 10^{23}$
$= 3.21066666 7 \times 10^{23}$

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

$16 \times 4 = 64$ $\frac{7.20}{64} = 0.1125$ $\frac{0.1125}{0.06} = 1.875$

$1.875 \times 6.02 \times 10^{23} = 1.2875 \times 10^{24}$

number of oxygen atoms = ...

ResultsPlus
Examiner Comments

0 marks. There are three separate calculations here with a different answer for each. The candidate is now asking the examiner to choose the best answer – that's not how it works. Had the candidate written the answer of 3.612×10^{22} on the answer line, then two marks could be awarded, but as it stands, this answer scores 0 marks.

ResultsPlus
Examiner Tip

It's up to the candidate to decide which answer should be marked. Crossing out the unwanted answers would achieve that or in the case of a calculation like this, putting the final answer for marking consideration on the answer line.

Question 5(c)

Electrolysis is a hard topic for many candidates, and despite trying to give credit where possible, sometimes the answers produced were very confusing and it was difficult to see where credit could be given.

For those candidates who had revised and understood the topic on electrolysis, this was quite a straightforward question to answer and to include half equations for the formation of hydrogen and oxygen at the electrodes. Many candidates found it difficult and often confused which electrode would attract which ion; many missed that the diagram in the question showed that the gaseous products hydrogen and oxygen were formed but instead wrote about how magnesium and sulfur would be formed during the electrolysis. It was this latter group that also confused which ion would be attracted to which electrode as well as what happened at the electrode in terms of electron loss or gain to form the product atoms. Attempts at writing half equations were successful for the stronger candidates, but many candidates were often confused and showed that they did not know how to write that type of equation. For many candidates, the use of the terms oxidation and reduction was either confused or limited to the loss or gain of oxygen. It was not uncommon to see 'magnesium goes to the anode and is reduced because it loses oxygen'.

*(c) Magnesium sulfate solution can be electrolysed using the apparatus shown in Figure 3.

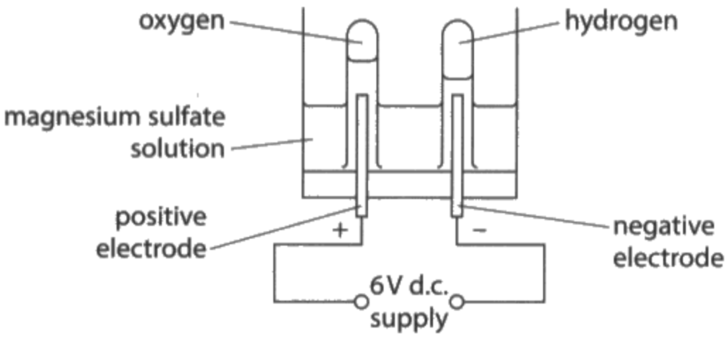


Figure 3

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)

-Because Magnesium is more reactive than hydrogen at the negative electrode, the hydrogen ions will discharge and be collected

= At the positive, ~~the sulphate~~ because the sulphate is ~~less~~ not a halogen, it will cause the ~~OH 4~~ O^- particles to discharge and be collected

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

Hydrogen is being ~~oxidised~~ reduced as it's ~~loosing~~ gaining 2 electrons

~~$OH^- + e^- \rightarrow OH, + e^-$~~

~~Hydroxide is being oxidised as it is losing electrons~~

$2O^- + e^- \rightarrow O_2$

Oxygen is being oxidised

O
I
L
r
i
G

ResultsPlus
Examiner Comments

3 marks, Level 2. There was mention of the hydrogen ions being discharged at the negative electrode and justified by applying the reactivity of the metals (and hydrogen) to the situation. There was an attempt at a half equation, but the 2e was on the right rather than the left side of the half equation. However, the description below the half equation is only missing the word 'ion' from it being a good explanation. At the positive electrode, the candidate had originally included the OH^-, but then crossed them out and replaced it with O^-, which may have followed the part about OH^- ions losing electrons and being oxidised. Overall, this was a reasonable attempt at answering a hard question – credit must go to the candidate for attempting to write half equations. Very few answers contained them.

*(c) Magnesium sulfate solution can be electrolysed using the apparatus shown in Figure 3.

Positive Anode Negative is Cathode

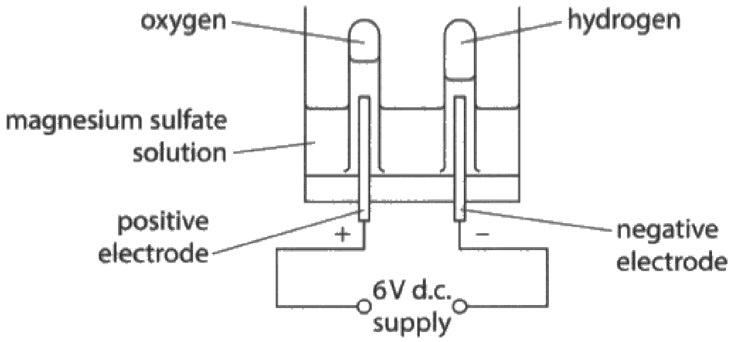


Figure 3

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)

- Positive ~~anions~~ Cations are ~~attracted~~ attracted to the positive anode.
- Negative anions ~~can~~ are ~~attract~~ ~~at~~ attracted to the ~~neg~~ negative ~~cation~~ cathode.
- A redox reaction takes place at the electrodes. this is when oxidation and reduction occur at the same time

ResultsPlus
Examiner Comments

1 mark, Level 1. This answer contained some basic statements about the movement of ions in general. In addition, a general comment was made about electrolysis involving REDOX, but did not say at which electrode the reduction or oxidation reactions took place. Had this answer identified the ions present, it could have been awarded 2 or 3 marks, particularly if the movement to the correct electrodes had also been described.

*(c) Magnesium sulfate solution can be electrolysed using the apparatus shown in Figure 3.

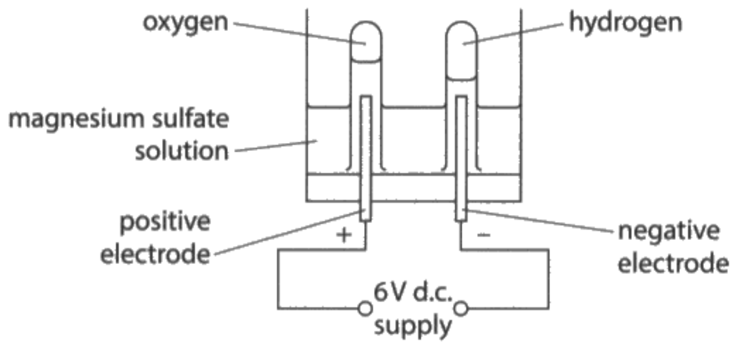


Figure 3

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)

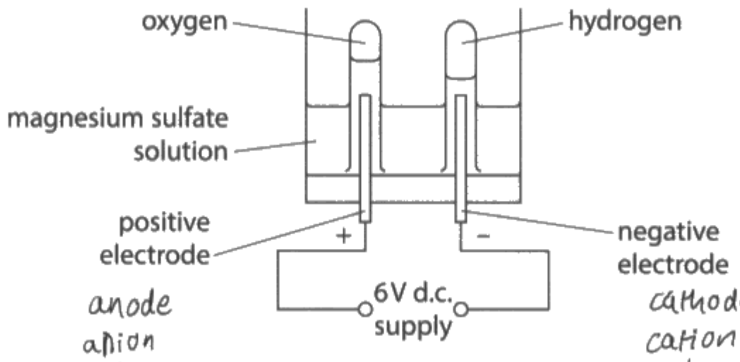
Oil rig - Oxidation loses
reduction gains
the positive cation attract the negative ~~electrons~~ ions. while the anion ~~e~~ attracts ions the positive ~~electron~~

Electrolysis is used to seperate an ionic compound by electricity

ResultsPlus
Examiner Comments

0 marks. There was nothing here to gain credit. Oxidation and reduction were mentioned but 'electrons' were missing from the statement. The candidate also has confused the terms 'cathode' and 'cation', and 'anode' and 'anion' when trying to describe the movement of ions.

*(c) Magnesium sulfate solution can be electrolysed using the apparatus shown in Figure 3.



anode
anion
↓
oxygen or halide ion

Figure 3

cathode
cation
↓
metal or hydrogen

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)

sulfate ions as well as magnesium atoms are present in the solution. OH^- ions as well as H^+ ions are also present. the cathode, the negative electrode, attracts the cations which are the metal ions but only if they are less reactive than hydrogen. Magnesium is more reactive and so instead of magnesium forming at the cathode, hydrogen is formed from the H^+ ions in the solution instead as they are reduced and gain an electron to become hydrogen atoms

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

At the anode, the anion is turned into an atom through oxidation the loss of electrons. However, as there are OH^- ions present in solution and the sulfate ion is not a halide ion, the OH^- ions are attracted to the ~~cathode~~ anode instead, losing ~~an~~ ~~electron~~ electrons to become oxygen atoms while also forming water.

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

The magnesium sulfate is left in solution while oxygen and hydrogen are formed at the electrodes.

ResultsPlus
Examiner Comments

6 marks, Level 3. This was a really good answer. All the ions present in the magnesium sulfate solution were identified and the candidate had correctly included the ions that came from water – H^+ and OH^- ions. The candidate also said which ions moved to cathode and to the anode. In addition, the candidate justified why the hydrogen ion would be the one being reduced at the cathode and why the hydroxide ion would be the one being oxidised at the anode. The two reactions were correctly explained and together with the correct half equations certainly deserved a mark of 6 for the whole answer.

ResultsPlus
Examiner Tip

Electrolysis is a hard topic. Know that reduction takes place at the cathode and oxidation takes place at the anode.

Question 6(a)

The majority of the candidates did not know how to answer this question. The majority were on the right lines of thinking that the ammonia interacted with the dampness, but few candidates said the ammonia reacted with or dissolved in the water; most candidates used terms such as the water allowed the ammonia to stick to the litmus paper, which was not credited.

Any colour change of litmus was accepted, but not if mentioned that ammonia bleached the indicator paper. Many candidates made this error, possibly because they had encountered the use of litmus paper when testing for chlorine.

6 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 ammonia needs to react with the water ~~on~~ (H_2O) on the litmus paper for a colour change to ~~been~~ be seen.

ResultsPlus
Examiner Comments

2 marks. This answer scored for the ammonia reacting with the water and for a colour change to be seen. There were very few answers of this calibre.

6 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 bleach to White faster and it Speeds up the process

ResultsPlus
Examiner Comments

0 marks. We were prepared to accept any colour change but not bleaching the litmus.

ResultsPlus
Examiner Tip

The gas that bleaches damp litmus paper or damp universal indicator paper is chlorine.

6 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)

~~pa~~ Ammonia particles can't attach to the litmus paper when its dry.

ResultsPlus
Examiner Comments

0 marks. We were not accepting the idea of ammonia attaching to the litmus paper for the first marking point.

6 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 the litmus paper can absorb the gas and therefore a colour change in the litmus paper occurs.

ResultsPlus
Examiner Comments

1 mark. This scored the second marking point for a colour change to be seen. There was nothing in the answer about the role of water that would lead to the colour change.

Question 6(b)i

Many candidates showed an understanding of the principles of an equilibrium – that both forward and backward reactions happen at the same time, but few mentioned that both forward and backward reactions happened at the same rate in a dynamic equilibrium and that there was no overall change in the system as a result. Several candidates did obtain a mark for saying that the amounts of reactants and of products remained constant, but many spoilt their answer by saying that those amounts were 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)

~~concentrations rem~~ At dynamic equilibrium the forwards and backwards reaction occur at the same rate. The concentrations remain constant and the its in an enclosed system.

ResultsPlus
Examiner Comments

2 marks. This answer scored on both marking points and was seen in only a relatively small number of answers.

(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 forwards and ~~back~~ backwards reaction is is happening at the same rate.

This means the same amount of products and reactants are being produced.

ResultsPlus
Examiner Comments

2 marks. A clear succinct answer scoring both marks.

(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 forwords ond backwords reactions are happening at the same rate and time, always changing directions so ~~now~~ no reactents or products run out.

ResultsPlus
Examiner Comments

1 mark. Of the two marking points for this question, the more commonly known one that scored was that the rate of the forward reaction and the rate of the backward reaction were the same.

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

The equation for the reaction is

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

hydrogen = 6 N = 2 N2 H = 6

The reaction can reach a dynamic equilibrium.

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

(2)

When this reaction meets dynamic equilibrium it doesn't move to the left or the right this is because the amount of reactants is equal to the amount of product. This means that the ~~er~~ reaction is reversible forming equal substances.

ResultsPlus
Examiner Comments

0 marks. The amounts of reactants and products are not necessarily 'equal' in a dynamic equilibrium. It is the amount of reactants and the amount of products that remain constant. Many candidates made this mistake thinking that they should be 'equal'.

Question 6(b)iii

Most candidates found it difficult to explain what happened to the equilibrium when the pressure was reduced to 100 atm. Some did say that there would be a lower yield (of ammonia) and that the equilibrium would move to the left, which was the same marking point. Very few candidates mentioned that it moved to the left because there were more moles / molecules of the reactants on that side and so would occupy a larger volume resulting from the fall in pressure.

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

Using Figure 4, explain what happens to the position of dynamic equilibrium if the process is carried out at 100 atmospheres.

(2)

The percentage yield at 200°C will be lower than at 1000 atm

ResultsPlus
Examiner Comments

1 mark. This scored for stating that the yield of ammonia would be lower. We were looking for that comparative in the marking of this question.

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

Using Figure 4, explain what happens to the position of dynamic equilibrium if the process is carried out at 100 atmospheres.

(2)

The ~~reaction~~ position will shift to the side with more moles inorder to increase the pressure of the reaction and counter the change made to the pressure.

ResultsPlus
Examiner Comments

1 mark. This answer correctly stated that the equilibrium would move to the side that had the greater number of moles, but didn't say which side – reactants or products.

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

Using Figure 4, explain what happens to the position of dynamic equilibrium if the process is carried out at 100 atmospheres.

(2)

The ~~equibil~~ equilibrium is Shifted to the left.

ResultsPlus
Examiner Comments

1 mark. The candidate scores a mark for stating that the equilibrium would be shifted to the left, but didn't say why.

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

Using Figure 4, explain what happens to the position of dynamic equilibrium if the process is carried out at 100 atmospheres.

(2)

pressure is decreased
The position of the equilibrium will move to the left because it equals the molecules in the reactants. The pressure is decreased and moves to the side with more molecules to even out the reaction.

ResultsPlus
Examiner Comments

2 marks. This was a good answer. It included the direction and the reason why.

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

Using Figure 4, explain what happens to the position of dynamic equilibrium if the process is carried out at 100 atmospheres.

(2)

Position of dynamic equilibrium will increase due to the ~~temperature~~ pressure being lower so will ~~take~~ take longer for dynamic equilibrium to happen.

ResultsPlus Examiner Comments

0 marks. This example was seen quite often where the candidate wrote about the position of equilibrium increasing or decreasing rather than stating the direction the equilibrium would favour. The question was about the position of equilibrium as a result of a different pressure being used rather than rate at which equilibrium was reached.

ResultsPlus Examiner Tip

When describing changes that are made to a dynamic equilibrium, the direction in which the equilibrium position moves is important. Using terms such as 'to the left', 'to the products side' and 'in the backward direction' clearly state the movement of the equilibrium position.

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

Using Figure 4, explain what happens to the position of dynamic equilibrium if the process is carried out at 100 atmospheres.

(2)

o At a pressure of 100 atm the ~~pe~~ ~~dyna~~ dynamic equilibrium will favour the backwards reaction
o This can be seen by 1000 atm producing a higher percentage yield than 300 atm, this suggests as the pressure decreases less products will be created

ResultsPlus
Examiner Comments

1 mark. The first sentence of the answer scored 1 mark for stating that the equilibrium would favour the backward reaction. The second sentence contained the effect this would have, the candidate used the term 'less product will be created' which was an allow on the additional guidance of the mark scheme for the first marking point. For the second mark, there needed to a reference to there being a greater number of moles of substance on the reactants side of the equilibrium.

Question 6(c)

Unfortunately, many candidates did not use the information given about the reversible reaction: $NH_4Cl \rightleftharpoons NH_3 + HCl$. Many candidates answered this based on the sublimation of ammonium chloride and so lost out on the first and last marking points for the decomposition of the ammonium chloride into ammonia and hydrogen chloride and later the reaction between the two gases to reform ammonium chloride. Many candidates did score the second and third marking points for the gas rising in the boiling tube and for some mention that the top of the boiling would be cooler. Only the minority of candidates scored 3 or 4 marks on this demanding question.

Paper Summary

The candidates who performed well on this paper were those who had read and understood the questions and answered them succinctly without repeating the question. They also answered the extended writing questions in a logical manner, answering the questions as set. Calculations were also set out in full, so it was easy to see how the final answer was obtained.

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

- Make use of the past GCSE papers that their teachers can provide – the bank of these is now large.
- Read the whole question to ensure that they know what is needed for the answer and avoid straying off topic.
- The core practicals form the basis of many of the questions covering practical work. Make sure these have been revised thoroughly.
- Practice writing and balancing equations as well as ionic and half equations.
- Inspection of the past papers will show the range of calculation types that have been set. Practice answering these types of calculations and know how to round a numerical answer to the required number of significant figures or decimal places.
- There are different types of reactions covered in the course, eg neutralisation, equilibria, redox and those taking place at electrodes in electrolysis. Make sure these are understood, particularly how changing conditions will affect a reaction in equilibrium.
- Learn the gas tests.
- Learn how to separate mixtures of substances.

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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