Pearson
Edexcel

Examiners' Report
June 2024

GCSE Chemistry 1CH0 1H

ResultsPlus

Edexcel and BTEC Qualifications

Edexcel and BTEC qualifications come from Pearson, the UK's largest awarding body. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information visit our qualifications websites at www.edexcel.com or www.btec.co.uk.

Alternatively, you can get in touch with us using the details on our contact us page at www.edexcel.com/contactus.

ResultsPlus

Giving you insight to inform next steps

ResultsPlus is Pearson's free online service giving instant and detailed analysis of your students' exam results.

- See students' scores for every exam question.
- Understand how your students' performance compares with class and national averages.
- Identify potential topics, skills and types of question where students may need to develop their learning further.

For more information on ResultsPlus, or to log in, visit www.edexcel.com/resultsplus. Your exams officer will be able to set up your ResultsPlus account in minutes via Edexcel Online.

Pearson: helping people progress, everywhere

Pearson aspires to be the world's leading learning company. Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your students at: www.pearson.com/uk.

June 2024

Publications Code 1CH0_1H_2406_ER

Introduction

1CH0 1H is this first of two papers for GCSE Chemistry Higher Tier. Some of the earlier questions also appear in the 1F Foundation Tier paper. The Combined Science paper 1SC0 1CH is composed of six of the ten questions in this paper.

Question 1 (a)

In general, candidates performed well in this first question on the paper with the majority scoring at least one mark for stating that the voltage decreases, fewer scored a second mark for stating that the voltage reduced to zero. Many candidates stated that the voltage increased initially, this was ignored, very few stated that the voltage was constant before decreasing. Some stated that the voltmeter would go flat, showing a misunderstanding.

Answer ALL questions. Write your answers in the spaces provided.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 (a) Chemical cells produce a voltage.

A chemical cell can be made by placing the metals copper and iron in a beaker of sodium chloride solution as shown in Figure 1.

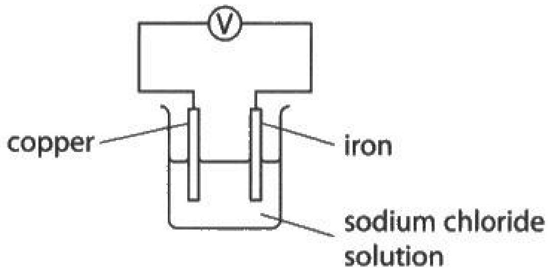


Figure 1

Describe what will happen to the reading on the voltmeter over a long period of time.

(2)

will ~~[crossed out]~~ increase as the chemical cell is made and produces a voltage.

ResultsPlus
Examiner Comments

This example scored 0 marks, the candidate has stated that the reading would increase which was ignored, but there is no reference to the voltage showing a constant voltage, decreasing or moving to 0V.

Answer ALL questions. Write your answers in the spaces provided.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 (a) Chemical cells produce a voltage.

A chemical cell can be made by placing the metals copper and iron in a beaker of sodium chloride solution as shown in Figure 1.

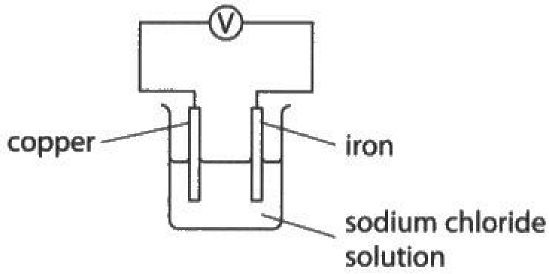


Figure 1

Describe what will happen to the reading on the voltmeter over a long period of time.

(2)

The reading of the voltmeter will decrease over a long period of time.

ResultsPlus
Examiner Comments

This example scored 1 mark for stating that the reading will decrease.

Answer ALL questions. Write your answers in the spaces provided.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 (a) Chemical cells produce a voltage.

A chemical cell can be made by placing the metals copper and iron in a beaker of sodium chloride solution as shown in Figure 1.

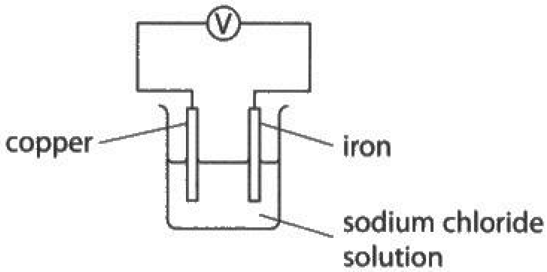


Figure 1

Describe what will happen to the reading on the voltmeter over a long period of time.

(2)

The voltage will be high and then slowly decrease until it goes to 0.

ResultsPlus
Examiner Comments

In this example, the candidates states that the voltage would be high, which did not score. They then state that it would slowly decrease to 0 to score 2 marks.

Question 1 (d)

Question 1d asked candidates to explain which of the three alloys is the strongest. Candidates performed very well in this question with the vast majority being able to explain that alloy C was the strongest because it contained the most copper atoms.

(d) Figure 2 shows the arrangement of atoms in three different alloys of copper and zinc, **A**, **B** and **C**.

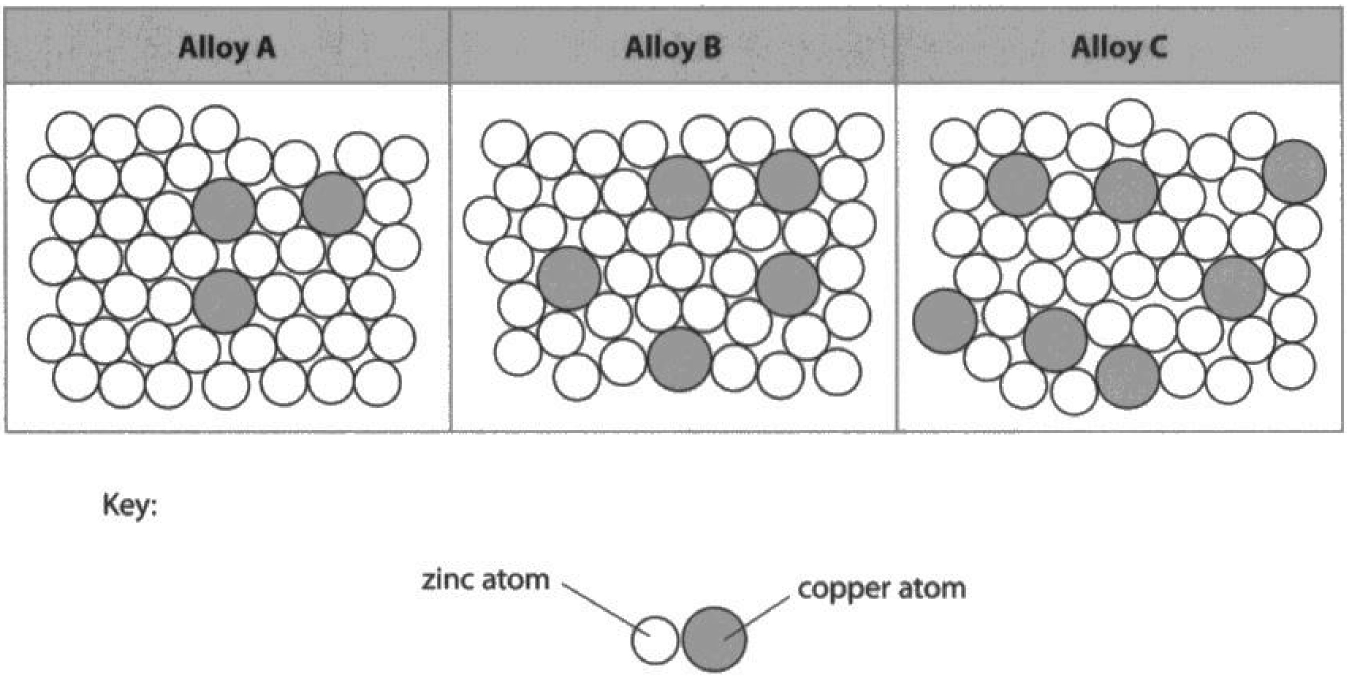


Figure 2

Explain which of the three alloys, **A**, **B** and **C**, is the strongest.

(2)

Alloy C is the strongest alloy, as it has the most copper atoms. The copper atoms a larger than the zinc atom, and stop the atoms from rolling over eachother. Alloy C is the strongest as it has the strongest structure.

ResultsPlus
Examiner Comments

This example shows a good response which gained the 2 marks. The candidate has stated that Alloy C is the strongest and explained that the alloy had the most copper atoms, they also explain this partially in terms of the greatest disruption of layers, but the second mark had already been scored.

(d) Figure 2 shows the arrangement of atoms in three different alloys of copper and zinc, **A**, **B** and **C**.

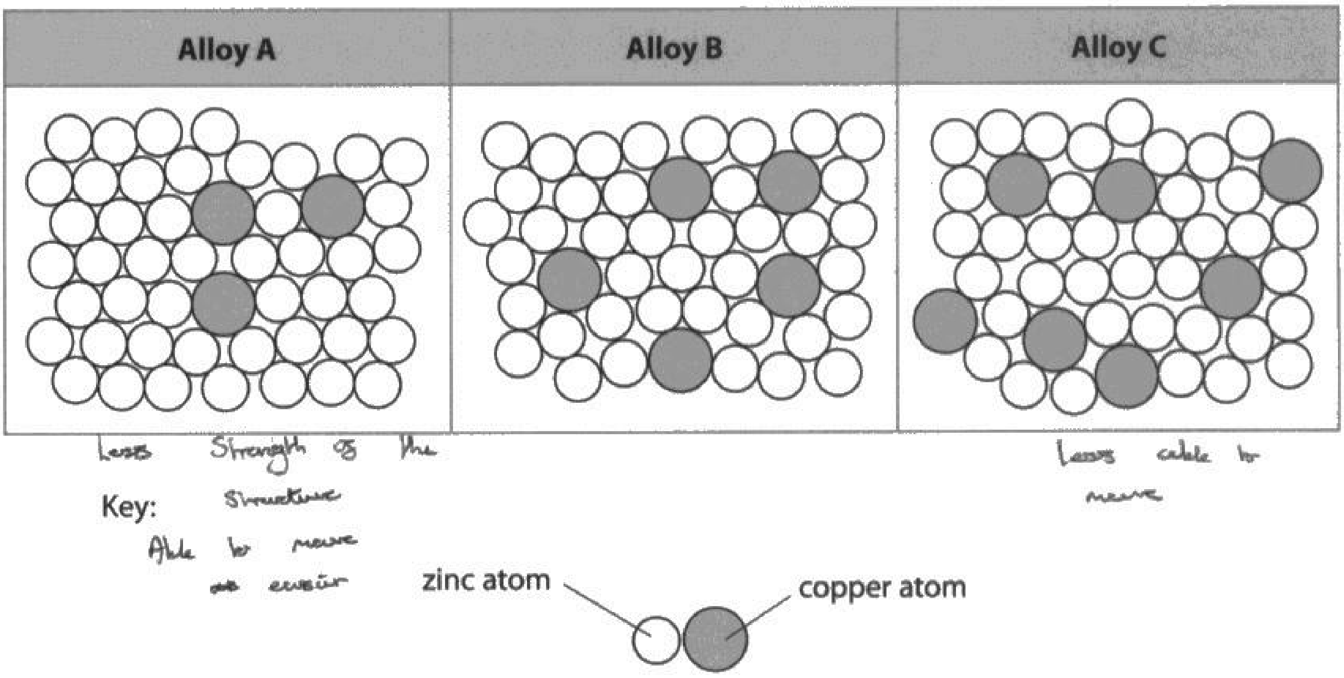


Figure 2

Explain which of the three alloys, **A**, **B** and **C**, is the strongest.

(2)

Alloy A is the strongest because there are a lesser number of copper atoms meaning a stronger lattice structure and harder to break down. Zinc atoms are held more firmly in place because of the lack of copper atoms

ResultsPlus
Examiner Comments

In the last example, the candidate has stated that alloy A is the strongest, the second marking point was dependent on the correct alloy being selected and so therefore no marks were awarded.

(d) Figure 2 shows the arrangement of atoms in three different alloys of copper and zinc, **A**, **B** and **C**.

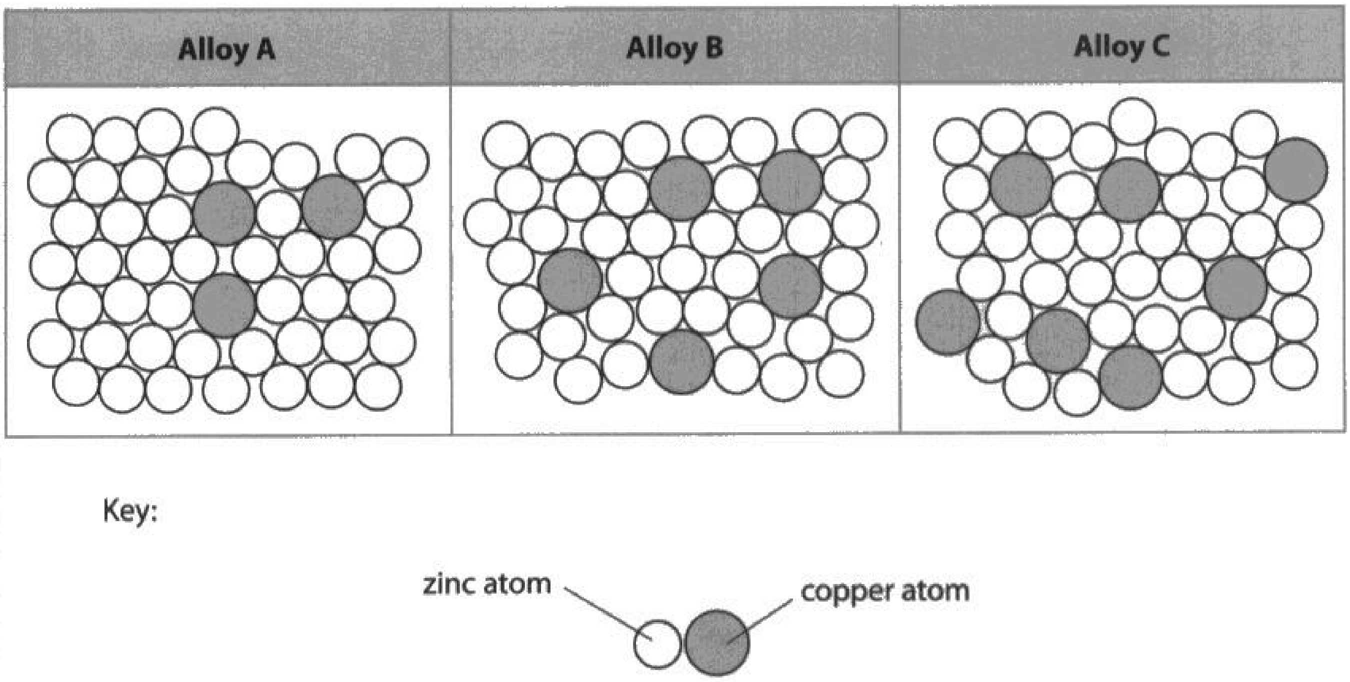


Figure 2

Explain which of the three alloys, **A**, **B** and **C**, is the strongest.

(2)

Alloy C is the strongest because it has the most number of zinc atoms which means they cause more ~~to~~ disruption to the layers of the ~~cod~~ copper atom, ~~so~~ making them less easily to slide past each other. therefore making them the strongest.

ResultsPlus
Examiner Comments

In this example, the candidate understands that alloy C is the strongest, but they then have the copper and the zinc around the wrong way and so no further credit was awarded.

Question 2 (a)(i)

Candidates were required to complete the balanced equation in 2ai. Candidates performed well in this question with the vast majority being able to complete the equation correct with a 2 in front of the HCl.

2 Barium hydroxide reacts with dilute hydrochloric acid to form barium chloride solution and water.

(a) (i) Complete the balanced equation for the reaction by adding a **number** in front of HCl(aq).

(1)

H- | H-4
Cl- | Cl-2

$Ba(OH)_2(s)$ + ...2.... $HCl(aq) \rightarrow BaCl_2(aq) + 2H_2O(l)$

ResultsPlus
Examiner Comments

This example scored 1 mark.

Question 2 (a)(ii)

Question 2(a)(ii) gave learners the scenario of barium hydroxide reacting with dilute hydrochloric acid to form barium chloride and water. They were asked what would be seen during the reaction.

Candidates did not perform well in this question with many candidates believing that all reactions result in fizzing, effervescence, or bubbling. Some learners gave incorrect or inaccurate observations and so did not score. Some candidates tried to state what type of reaction it was rather than what would be seen.

Where candidates did score, it was for stating that barium hydroxide dissolved, disappeared or that it would become clear without mentioning bubbling in addition.

(ii) State what you would **see** during the reaction.

(1)

~~As~~ The solid would seem to disappear and bubbles will start to form ~~colourless liquid will form with a colored liquid below~~

ResultsPlus
Examiner Comments

This answer scored no marks, the solid would disappear would have gained the mark, however the reference to bubbles was rejected and so therefore the mark was not awarded.

ResultsPlus
Examiner Tip

Candidates should be precise when describing observations of chemical reactions studied. It should be made clear that not all chemical reactions produce observable fizzing or effervescence.

(ii) State what you would **see** during the reaction.

(1)

A colour change.

ResultsPlus
Examiner Comments

In this example, the candidate has stated that there was a colour change, this was ignored and the answer scored no marks. If the candidate had stated that it would become clear then the answer could have been scored.

ResultsPlus
Examiner Tip

Candidates should be taught to be specific with their answers, just stating that there would be a colour change will often be insufficient for credit.

(ii) State what you would **see** during the reaction.

(1)

Fizzing

ResultsPlus
Examiner Comments

This answer shows a common answer that scored no credit.

Question 2 (b)(i)

In (b)(i) of question 2, a good proportion of candidates were able to name a piece of equipment that could be used to measure the pH of substance more accurately than universal indicator paper.

Where candidates did not score, it was often as they gave a different indicator rather than a piece of equipment such as a pH meter or pH probe.

(i) Name a piece of equipment that could be used to measure the pH of a substance more accurately than universal indicator paper.

(1)

methl orange

ResultsPlus
Examiner Comments

This example scored no marks.

(i) Name a piece of equipment that could be used to measure the pH of a substance more accurately than universal indicator paper.

(1)

pH meter

ResultsPlus
Examiner Comments

This example scored 1 mark.

Question 2 (b)(ii)

In part (b)(ii) candidates were asked to explain why the mixture was stirred after adding the barium hydroxide. Many were able to score at least 1 mark for stating that it was make the substances react or dissolve. A smaller percentage of candidates were able to score both marks for knowing that it ensures the mixture was evenly spread to make sure all of the substances reacts.

In some cases, candidates stated that it was to make the experiment more accurate or more valid or a fair test alone. This did not score, if the candidates were more specific with their explanation by explaining that this would make the pH more accurate then this would have scored.

(ii) Explain why, in step 3, the mixture was stirred after adding the barium hydroxide.

(2)

so that the pH is the same throughout
↳ to make sure the barium hydroxide
is incorporated throughout

ResultsPlus
Examiner Comments

This example scored 1 mark, the candidate scored the first marking point for stating that it so the pH is the same throughout. They also stated that it is so that the barium hydroxide is incorporated throughout but this is part of the first marking point also, so did could not score again.

(ii) Explain why, in step 3, the mixture was stirred after adding the barium hydroxide.

(2)

This was done to cause the rate of collisions to increase so that any ~~colour change or~~ reaction would occur faster, so an accurate result could be taken

ResultsPlus
Examiner Comments

In this example, the candidate has scored 1 mark for stating that it would i ncrease the rate of reaction.

The candidate states that this means that there would be an accurate result. This was ignored, if the candidate had stated that it would make the **pH** more accurate then the first mark could have been scored.

ResultsPlus
Examiner Tip

Candidates should be taught to be specific with their answers not give generic answers such as this would the experiment more valid, to make it a fair test or more accurate alone.

(ii) Explain why, in step 3, the mixture was stirred after adding the barium hydroxide.

(2)

To evenly ~~[illegible]~~ distribute the barium hydroxide, so it fully reacts with dilute hydrochloric acid

ResultsPlus
Examiner Comments

This example scored 2 marks.

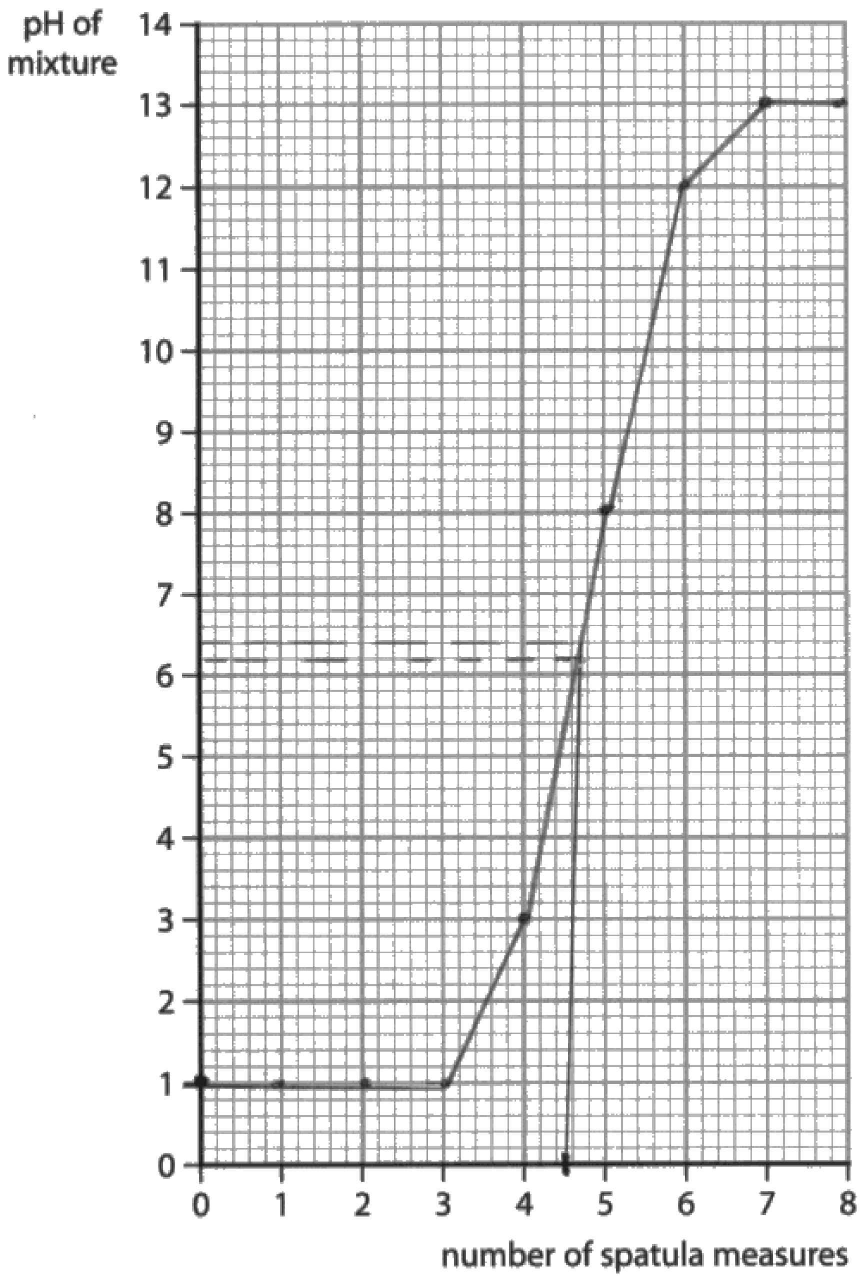
Question 2 (b)(iii-iv)

Part b(iii) of question 2 asked learners to plot a graph of the student's results. It was pleasing to see that candidates performed well in this question, with the majority scoring the full 3 marks available for plotting the points correctly and drawing an S-shaped line of best fit. Where candidates lost marks, it was often as they drew dot-to-dot lines of best fit, or drew a line that started from the origin.

In part (b)(iv), a smaller percentage of candidates were able to score the mark for being able to use their graph to find the pH of the mixture when 4.5 spatula measures of barium hydroxide were added.

Plot a graph of the pH of the mixture against the number of spatula measures of barium hydroxide.

(3)



(iv) Use the graph to find the pH of the mixture when 4.5 spatula measures of barium hydroxide are added.

(1)

pH of the mixture = 6.2

ResultsPlus
Examiner Comments

In this example, two marks were awarded for the graph as all 9 points have been plotted correctly. The line of best fit is dot to dot, which was rejected for the line of best fit mark.

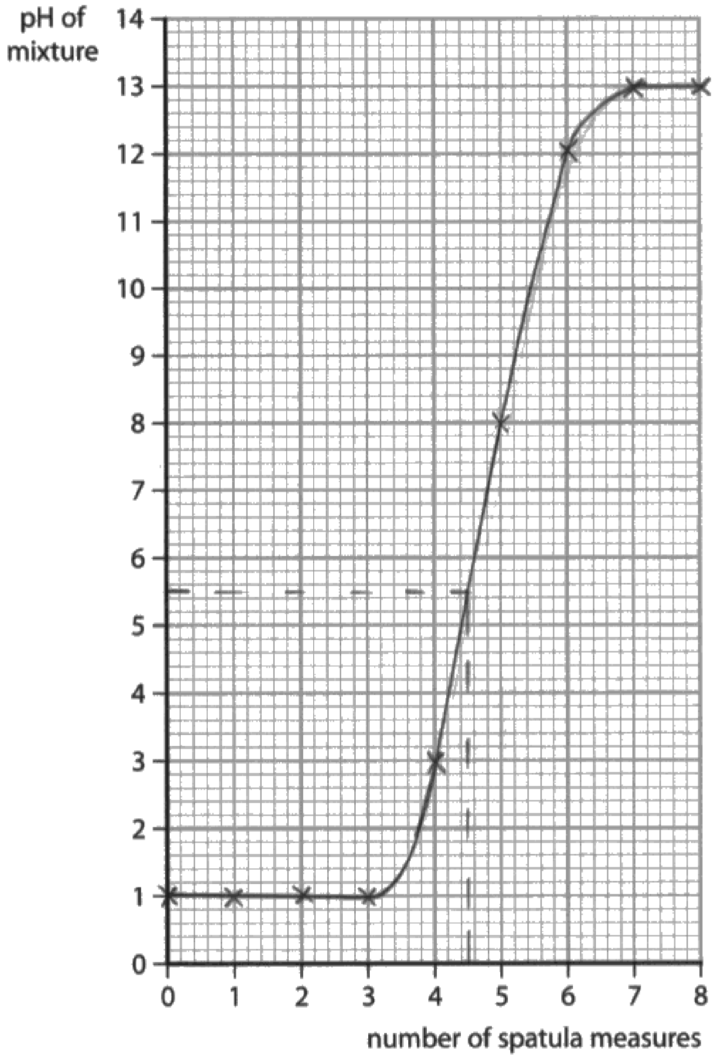
The candidate has tried to use their line of best fit to estimate the pH of the solution when 4.5 spatulas of barium hydroxide are added. However, their guide line is angled and this has led them to over estimate the pH and the mark was not awarded.

ResultsPlus
Examiner Tip

Candidates should practice drawing smooth lines of best fit, rather than drawing dot-to-dot lines. candidates should ensure that they do not tramline their lines.

Plot a graph of the pH of the mixture against the number of spatula measures of barium hydroxide.

(3)



(iv) Use the graph to find the pH of the mixture when 4.5 spatula measures of barium hydroxide are added.

(1)

pH of the mixture = 5.5

ResultsPlus
Examiner Comments

In this example, the candidate scored the full three marks for the graph and have used their graph to correctly find the pH of the mixture when 4.5 spatula measures of barium hydroxide are added.

Question 3 (a)(ii)

Question 3 asked about sodium carbonate, in part (a)(ii) candidates were asked to explain why solid sodium carbonate cannot conduct electricity but a solution of sodium carbonate can conduct electricity.

A large proportion of candidates did not score on this question, a common error was where candidates mistakenly discussed delocalized electrons instead of ions as charge carriers, leading to lost marks.

(ii) Explain why solid sodium carbonate **cannot** conduct electricity but a solution of sodium carbonate **can** conduct electricity.

(3)

Sodium Carbonate solid has no free delocalised electrons, meaning there are no electrons able to carry a charge. When sodium carbonate is ~~for~~ in a solution, there are delocalised electrons which are able to carry electrical charges making it a conductor.

ResultsPlus
Examiner Comments

A common answer that scored no marks due to the idea that electrons are moving (or not) rather than ions.

ResultsPlus
Examiner Tip

Candidates should be taught to take care when using terms such as ions and electrons.

(ii) Explain why solid sodium carbonate **cannot** conduct electricity but a solution of sodium carbonate **can** conduct electricity.

(3)

Solid Sodium carbonate cannot conduct electricity because there are no delocalised / free electrons for the current to flow as it is a solid lattice structure. Whereas a solution of Sodium carbonate can because there are free /delocalised electrons between layers.

ResultsPlus
Examiner Comments

In this example, the candidate has scored 1 mark. They have stated that solid sodium carbonate is in a lattice structure scored mark point 1. Unfortunately, the candidate has written about electrons rather than ions, this reference to electrons is a reject for both mark point 2 and mark point 3.

(ii) Explain why solid sodium carbonate **cannot** conduct electricity but a solution of sodium carbonate **can** conduct electricity.

(3)

• ~~Solid so~~ In Solid sodium carbonate the ions are in a lattice structure fixed so can't move to conduct electricity but in a solution the ions are free to move so can conduct electricity

ResultsPlus
Examiner Comments

This example scored 3 marks, the candidate scored 1 mark for stating that the ions are in a lattice structure, they then state that the ions in a solid can't move and in a solution the ions are free to move for the last two marks.

(ii) Explain why solid sodium carbonate **cannot** conduct electricity but a solution of sodium carbonate **can** conduct electricity.

(3)

Sodium carbonate is an ionic compound and when solid ~~have~~ was no freely flowing ions that carry a charge but when a solution the ions are able to freely flow and therefore can conduct electricity.

ResultsPlus
Examiner Comments

Of those that did score, 2 marks was the most common mark seen. Candidates that knew that ions are fixed in a solid but can move in a solution often did not state that solid was a lattice or was held together by strong attractions as in this example.

Question 3 (b)

Question 3b asked candidates to calculate the percentage by mass of sodium in sodium carbonate.

In general, candidates performed well with most candidates scoring the full three marks, where full marks were not scored, it was often as they did not multiply the relative atomic mass of sodium by 2 and so lost the second mark or because they rounded their answer incorrectly.

(b) Calculate the percentage by mass of sodium in sodium carbonate, Na_2CO_3.

$$\text{percentage by mass of element} = \frac{\text{total relative atomic mass of element}}{\text{relative formula mass of compound}} \times 100$$

(relative atomic masses: C = 12, O = 16, Na = 23)

$(23 \times 2) + 12 + (16 \times 3)$ (3)

$46 + 12 + 48$

$= 106$

$\frac{23}{106} \times 100$

$= 21.69811321$

percentage by mass of sodium = 22 %

ResultsPlus
Examiner Comments

This example scored two marks, the candidate has correctly calculated the relative formula mass of sodium carbonate to score the first mark.

The have incorrectly used 23 instead of 46 (2 x 23), so do not score MP2. This was found to be a common error.

The candidate has then multiplied their answer by 100 to get the answer 21.6981132 and have rounded their answer to 2 sig figs for the second mark.

ResultsPlus
Examiner Tip

Ensure that you understand and can apply chemical formulas accurately to calculate masses without errors in addition of atomic mass.

(b) Calculate the percentage by mass of sodium in sodium carbonate, Na_2CO_3. solution.

$$\text{percentage by mass of element} = \frac{\text{total relative atomic mass of element}}{\text{relative formula mass of compound}} \times 100$$

(relative atomic masses: C = 12, O = 16, Na = 23)

(3)

$$\frac{23 \times 2}{(23 \times 2) + 12 + (16 \times 3)} \times 100$$

$$\frac{23}{53} \times 100$$

percentage by mass of sodium = 43.396%

ResultsPlus
Examiner Comments

This example shows a good answer that gained the full three marks.

(b) Calculate the percentage by mass of sodium in sodium carbonate, Na_2CO_3.

$$\text{percentage by mass of element} = \frac{\text{total relative atomic mass of element}}{\text{relative formula mass of compound}} \times 100$$

(relative atomic masses: C = 12, O = 16, Na = 23)

(3)

23x2= 46 $\frac{46}{106}$ = 0.4334 x100 = 43.3 %

(23x2) + 12 + (16x3) = 106

percentage by mass of sodium = 43.3%

ResultsPlus
Examiner Comments

This answer also gained two marks. The candidate has correctly calculated the relative formula mass of sodium carbonate (106) for the first mark.

They have then divided 46 by 106 to score the second mark.

Unfortunately, the candidate has rounded their answer incorrectly and so the final mark is not scored.

ResultsPlus
Examiner Tip

Candidates should practice rounding answers correctly.

Question 4 (a)(i)

Question 4 asked candidates about the extraction of titanium from titanium oxide. Part (a)(i) asked candidates to calculate the percentage yield of titanium and gave the equation for the percentage yield. The vast majority were able to correctly calculate the percentage yield giving their answer to one decimal place.

4 (a) Titanium can be extracted from titanium oxide, TiO_2, by reaction with magnesium.

(i) 100 tonnes of titanium oxide was heated with magnesium.
The titanium formed in the reaction was separated and purified.
The mass of titanium was then determined.

The results are shown in Figure 4.

	mass in tonnes
mass of titanium oxide	100.00
mass of titanium produced	45.26
theoretical mass of titanium formed	60.00

Figure 4

Use the information in Figure 4 to calculate the percentage yield of titanium in this process.

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

Give your answer to 1 decimal place.

(3)

$\frac{45.26}{60} \times 100 = 75.4\dot{3}\%$

percentage yield = $75.4\dot{3}$

ResultsPlus
Examiner Comments

In this example, the candidate has calculated the percentage yield of titanium correctly to gain 2 marks, but then did not give their answer to 1 decimal place so did not gain the last marking point.

ResultsPlus
Examiner Tip

Ensure that you practice rounding to different numbers of decimal places and significant figures and that you watch out for this when answering calculation questions.

4 (a) Titanium can be extracted from titanium oxide, TiO_2, by reaction with magnesium.

(i) 100 tonnes of titanium oxide was heated with magnesium.
The titanium formed in the reaction was separated and purified.
The mass of titanium was then determined.

The results are shown in Figure 4.

	mass in tonnes
mass of titanium oxide	100.00
mass of titanium produced	45.26
theoretical mass of titanium formed	60.00

Figure 4

Use the information in Figure 4 to calculate the percentage yield of titanium in this process.

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

Give your answer to 1 decimal place.

(3)

100 − 45.26

$\frac{54.74}{60} = 0.9123 \times 100 = 91.23$

percentage yield = 91.2

ResultsPlus
Examiner Comments

In some cases, candidates subtracted the actual yield from 100, resulting in an incorrect calculation, where this was rounded correctly and working was shown, this scored 2 marks.

ResultsPlus
Examiner Tip

Ensure that you always show your working so that part marks can be awarded.

4 (a) Titanium can be extracted from titanium oxide, TiO_2, by reaction with magnesium.

(i) 100 tonnes of titanium oxide was heated with magnesium.
The titanium formed in the reaction was separated and purified.
The mass of titanium was then determined.

The results are shown in Figure 4.

	mass in tonnes
mass of titanium oxide	100.00
mass of titanium produced	45.26
theoretical mass of titanium formed	60.00

Figure 4

Use the information in Figure 4 to calculate the percentage yield of titanium in this process.

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

Give your answer to 1 decimal place.

(3)

$\frac{45.26}{60} \times 100 = 75.43$

percentage yield = 75.4 %

ResultsPlus
Examiner Comments

The following example shows a good answer which scored the full three marks.

Question 4 (a)(ii)

Part (ii) of question 4(a) asked candidates to give two reasons why the percentage yield of this process is less than 100%. This question was generally well answered with the around the same proportion of candidates scoring 1 and 2 marks.

Common correct responses included mentioning incomplete reactions and side reactions as factors affecting yield, where candidates did not score, it was often because they gave vague responses such as "product lost" or references to human error without being specific.

(ii) Give **two** reasons why the percentage yield for **this process** is less than 100%.

(2)

1 Some product was lost during purification

2 There were unintended by-products of the reaction

ResultsPlus
Examiner Comments

This example scored 2 marks, the candidate has stated that some product was lost during purification' – some product lost alone or some spilled would be be insufficient for the mark. They scored the second mark for the reference to unintended by-products for side reactions.

(ii) Give **two** reasons why the percentage yield for **this process** is less than 100%.

(2)

1 Becaue the oxygen could have been let out

2 Could've been weighed wrong

ResultsPlus
Examiner Comments

The following example scored no marks.

ResultsPlus
Examiner Tip

Ensure that you are specific with your answers as in this example to ensure you gain the full marks available.

Question 4 (a)(iii)

Part (a)(iii) asked candidates to calculate the atom economy of the reaction and asked to give their answer to 2 significant figures, again the equation for atom economy was given.

Around the same proportion of learners gained 2 and 3 marks, and only a small percentage gained 1 or no marks.

Where candidates did not score 3 marks, it was often as they did not give their answer to 2 significant figures.

(iii) The balanced equation for this process is

$$TiO_2 + 2Mg \rightarrow Ti + 2MgO$$

Calculate the atom economy of this process to produce titanium.

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

Give your answer to 2 significant figures.

(relative atomic masses: O = 16, Mg = 24, Ti = 48)

(3)

Ti = 48

TiO_2 + 2Mg

48 (16×2) (24×2)

16×2 = 32

24×2 = 48

48+32+48 = 128

$= \frac{48}{128} \times 100 = 37.5\%$

= 38 %

atom economy = 38 %

ResultsPlus
Examiner Comments

This example shows a good answer, which scored all 3 marks.

(iii) The balanced equation for this process is

$$TiO_2 + 2Mg \rightarrow Ti + 2MgO$$

Calculate the atom economy of this process to produce titanium.

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

Give your answer to 2 significant figures.

(relative atomic masses: O = 16, Mg = 24, Ti = 48)

(3)

24+16=40 40×2=80 $\frac{48}{122}$ ×100 = 39%

80+42=122

atom economy = 39 %

ResultsPlus
Examiner Comments

This example scored 2 marks, the total formula mass of all reactants or products is incorrect so the first mark is not awarded, but as the candidate has shown their working error carried forward is allowed and the calculation of the atom economy using the incorrect sum of formula mass gains a mark. The final answer is given to 2 sig figs so gains a second mark.

(iii) The balanced equation for this process is

$$TiO_2 + 2Mg \rightarrow Ti + 2MgO$$

Calculate the atom economy of this process to produce titanium.

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

Give your answer to 2 significant figures.

(relative atomic masses: O = 16, Mg = 24, Ti = 48)

(3)

$\frac{45.26}{124} \times 100 = 43.519... = 44$

$48 + (16 \times 2) +$

atom economy = 44 %

ResultsPlus
Examiner Comments

0 marks were scored in this example, the candidate has not given the correct total formula mass of all reactants or products, there is no working to show how this number has been obtained and so no error carried forward can be awarded. If not correct, marking point 3 could only be scored for correct rounding to 2 significant figures of an incorrectly calculated values if marking point 2 had been scored. In this case it had not so marking point 3 was also not scored.

ResultsPlus
Examiner Tip

It is important that you understand the concept of atom economy, specifically the correct identification of reactants and products and their masses in the formula.

Question 4 (b)(i)

Candidates generally performed well in question 4bi, with a good proportion of candidates understanding that the hydration of ethene has an atom economy of 100% because only one product was formed, some candidates stated that there were no by-products or no unwanted products, this was allowed and the mark awarded.

Those candidates that did not score, often did so because they were not careful and incorrectly referred to "ethene" as the product, demonstrating confusion about the specific product of the reaction. Some candidates mentioned generic statements applicable to all reactions, such as "the reactants were used to make the products," which did not address the specific conditions of atom economy.

(b) Ethanol, C_2H_5OH, can be produced by two different methods.

- by the hydration of ethene, C_2H_4

  $C_2H_4 + H_2O \rightarrow C_2H_5OH$ atom economy = 100%

- and by the fermentation of a carbohydrate, e.g. sucrose, $C_{12}H_{22}O_{11}$

  $C_{12}H_{22}O_{11} + H_2O \rightarrow 4C_2H_5OH + 4CO_2$ atom economy = 51.1%

(i) State why the hydration of ethene has an atom economy of 100%. **(1)**

As no product is lost during the process

ResultsPlus Examiner Comments

In this example, the candidate is confusing this with calculation of percentage yield and scored no marks.

(b) Ethanol, C_2H_5OH, can be produced by two different methods.

- by the hydration of ethene, C_2H_4

  $C_2H_4 + H_2O \rightarrow C_2H_5OH$ atom economy = 100%

- and by the fermentation of a carbohydrate, e.g. sucrose, $C_{12}H_{22}O_{11}$

  $C_{12}H_{22}O_{11} + H_2O \rightarrow 4C_2H_5OH + 4CO_2$ atom economy = 51.1%

(i) State why the hydration of ethene has an atom economy of 100%.

(1)

There are no waste products

ResultsPlus
Examiner Comments

This example was allowed and gained the mark.

Question 4 (b)(ii)

Candidates found it harder to explain how the atom economy of the fermentation reaction can be improved with a small percentage gaining both marks and the majority of candidates not scoring. Where candidates scored one mark, it was often for identifying a use for carbon dioxide, such as in fizzy drinks. However, fewer explained that finding a use for the carbon dioxide then made it a useful product or meant that the mass of useful product would increase.

Common errors included suggesting alternative reactants or changing reaction conditions to reduce carbon dioxide emissions, which did not address the question's focus on improving atom economy through product usefulness.

(ii) **Explain how the atom economy of the fermentation reaction can be improved.**

(2)

collect and Use the Carbond dioxide producesd for something else (~~phot~~ plants could use it to photosynthesise?)

ResultsPlus
Examiner Comments

This example gained 1 mark, "Use the carbon dioxide produced for something else" gains MP1 for find a use for carbon dioxide – the idea of using it to photosynthesise plants would also score MP1. There is no explanation of how this would increase the atom economy to gain the second mark.

(ii) Explain how the atom economy of the fermentation reaction can be improved.

(2)

Finding a use for the carbon dioxide produced so that all of the products formed in the reaction are useful - and hence the atom economy will increase to 100%.

ResultsPlus
Examiner Comments

The following example shows a good answer that scored both marks.

Question 5 (a)

Question 5 asked about the extraction of metals. Part (a) asked candidates to give two advantages of obtaining metals by recycling rather than extracting them from their metal ores. Most candidates were able to score at least one mark by identifying benefits such as preserving ores, using less energy, and reducing waste. However, many responses were vague, focusing on general benefits like being "cheaper" or "better for the environment," which did not earn marks.

5 This question is about the extraction of metals.

(a) Give **two** advantages of obtaining metals by recycling rather than by extracting them from their metal ores.

(2)

1 Decreases pollution

2 Doesnt ~~harm~~ damage ~~any ecosystem~~ The envirment

ResultsPlus
Examiner Comments

This example scored no marks, vague answers such as decreases pollution and doesn't damage the environment were too vague for credit.

ResultsPlus
Examiner Tip

Avoiding answering questions such as these with vague or generic statements about cost or general environmental benefits without giving evidence or examples, for example the environmental impacts of mining and resource extraction, such as habitat destruction and pollution.

5 This question is about the extraction of metals.

(a) Give **two** advantages of obtaining metals by recycling rather than by extracting them from their metal ores.

(2)

1 decreases our need for constantly using up finite resources.

2 ~~bette for the en~~ less energy in production

ResultsPlus
Examiner Comments

This example gained the two marks available.

Question 5 (b)(i)

In part (b)(i), candidates were asked why the displacement reaction can be described as a redox reaction. Generally, the question was well answered with the biggest proportion of candidates scoring 3 marks. Common errors included not specifying that it was cadmium **ions** gaining electrons. A noticeable proportion of candidates used half-equations to support their explanation, with some demonstrating excellent clarity and detail.

greenhouse gases which cause climate change.

(b) (i) Small amounts of some metals are extracted using displacement reactions.

In one process, zinc dust is used to precipitate cadmium metal from a solution containing cadmium ions.

$$Cd^{2+}(aq) + Zn(s) \rightarrow Cd(s) + Zn^{2+}(aq)$$

cadmium ions — cadmium

Explain why this displacement reaction can be described as a **redox reaction**.

(3)

Electrons are both gained (reduction) and lost (oxidation). In Cadmium, 2 electrons are gained from the zinc, causing it to be reduced. The zinc which loses electrons is oxidised, as oxidation is losing electrons. Having both reduction and oxidation, makes it a redox reaction.

ResultsPlus
Examiner Comments

This example scored 2 marks, the first mark is awarded as within the answer the candidate has stated that both oxidation and reduction are taking place. The second mark was scored for stating that zinc loses electrons and is oxidised. Unfortunately, the last mark was not scored as they have stated that cadmium gains electrons and gets reduced rather than cadmium **ions** gain electrons and get reduced.

ResultsPlus
Examiner Tip

Ensure that you are specific when writing your answers, especially when describing the species in redox reactions as ions or atoms.

(b) (i) Small amounts of some metals are extracted using displacement reactions.

In one process, zinc dust is used to precipitate cadmium metal from a solution containing cadmium ions.

$$Cd^{2+}(aq) + Zn(s) \rightarrow Cd(s) + Zn^{2+}(aq)$$

cadmium ions — cadmium

Explain why this displacement reaction can be described as a **redox reaction**.

(3)

The oxidation and reduction reaction both happend in a single chemical reaction. As Zn is oxidised from atom to ion : $Zn_{(s)} \rightarrow Zn^{2+}_{(aq)} + 2e^-$. And Cd^{2+} is reduced from ion to atom : $Cd^{2+}_{(aq)} + 2e^- \rightarrow Cd_{(s)}$.

ResultsPlus
Examiner Comments

This example shows a good answer that scored all three marks, the candidate has used half equations to explain part of their answer which was allowed.

Question 5 (c)

Question 5c was generally well-answered by candidates, with most scoring the mark for giving one disadvantage of bioleaching using bacteria. Where candidates gained the mark, it was typically because they stated that bioleaching is slow or results in low yield. Where they lost marks, it was often because they have gave vague statements such as it damages the environment, causes pollution alone or produces harmful substances.

(c) One of the alternative biological methods of extracting metals from very low-grade ores is bioleaching using bacteria.

Give one **disadvantage** of this method of extracting metals from low-grade ores.

(1)

Still need to perform electrolysis to extract from leachate solution.

ResultsPlus Examiner Comments

This example shows a good answer that gained a mark for the idea that the leachate needs further processing.

(c) One of the alternative biological methods of extracting metals from very low-grade ores is bioleaching using bacteria.

Give one **disadvantage** of this method of extracting metals from low-grade ores.

(1)

It is very expensive and requires a long period of time for the ~~the~~ method to work

ResultsPlus Examiner Comments

This example gained the mark, ideas about cost were ignored and so the fact that it requires a long period of time gained the mark.

Question 5 (d)

Question 5d asked candidates to describe a method to obtain a sample of lead from some lead oxide in the laboratory. In general, candidates performed well in this question with many understanding that carbon could be used to obtain the sample of lead. Fewer added the specific detail of needing to add heat when using carbon for reduction.

In some cases, candidates described using electrolysis to obtain the lead which was accepted. However, candidates found it hard to specify that the lead oxide needs to be dissolved in an acid or molten for this method to work effectively to gain the second mark.

In other cases, candidates stated that a more reactive metal could be used to displace the lead, this was allowed, but where candidates stated that metals such as sodium were suggested, these were not allowed as it would not be an appropriate method to extract the lead.

(d) Lead is low in the reactivity series. Pscmacz

Describe how to obtain a sample of lead from some lead oxide in the laboratory.

(2)

As lead is less reactive ~~tha~~ than carbon, Lead can be displaced by carbon. ~~X~~ To do this place Lead oxide in a crucible and to make sure the ~~Ree~~ reaction is complete, heat till constant mass by using a bunsen burner. ~~the~~ Lead should be remaining in the ~~s~~ crucible.

ResultsPlus Examiner Comments

This example shows a good answer that scored both marks.

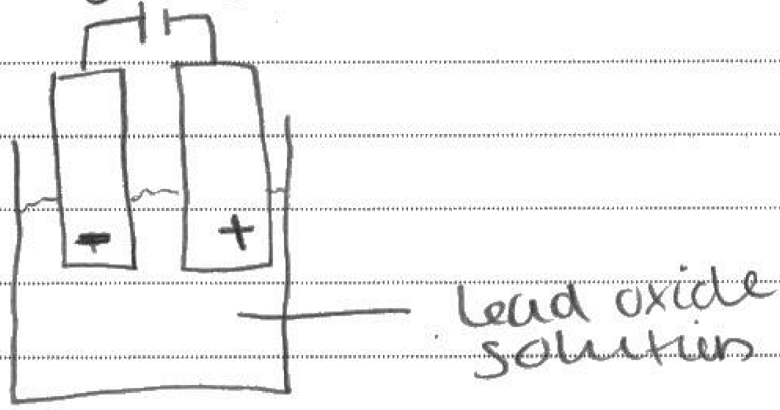
(d) Lead is low in the reactivity series.

Describe how to obtain a sample of lead from some lead oxide in the laboratory.

(2)

Electrolysis. Pour the lead oxide

Lead ox will form at electrode ... and you can remove it from there



ResultsPlus
Examiner Comments

This example scored 1 mark. The candidate has suggested using electrolysis which gained the first mark, however they have then suggested using a solution of lead oxide which was insufficient for credit. If they had stated to use a solution formed with an acid, liquid lead oxide or molten lead oxide this could have scored.

(d) Lead is low in the reactivity series.

lead oxide + potass

Describe how to obtain a sample of lead from some lead oxide in the laboratory.

(2)

- react lead oxide (powder) with a more reactive metal e.g ~~potass cation~~ strip of sodium so the lead can be displaced

· ~~lead oxide + potassium~~

lead oxide + sodium —> lead + sodium oxide

ResultsPlus
Examiner Comments

This example scored no marks as the candidate has suggested using sodium to displace the lead.

Question 6 (a)

Question 6 focused candidates on a titration between dilute hydrochloric acid and barium hydroxide solution. Part (a) asked candidates to explain the effect, if any, that traces of water in the pipette and conical flask after rinsing could have on the titration results. Candidates found this question very difficult with the vast proportion of candidates scoring no marks.

Many candidates misunderstood the role of the pipette (or confused it with a burette) and incorrectly assumed it was being used to measure the acid, where the pipette was being used to measure barium hydroxide.

Candidates often didn't connect the concept that traces of water left in the conical flask would not affect the amount of barium hydroxide in the conical flask and so therefore would not affect the titration result.

6 Titration can be used to find the volume of dilute hydrochloric acid needed to neutralise 25.0 cm^3 of barium hydroxide solution.

(a) Before the titration is carried out, the pipette and conical flask are rinsed out with pure water.

Explain the effect, if any, that traces of water in the pipette and conical flask after rinsing could have on the titration result.

(4)

pipette

This may dilute the acid and so more of it is needed to neutralise the alkali affecting the result

conical flask

This could dilute the alkali and so less acid is needed to neutralise it. affecting the result

ResultsPlus
Examiner Comments

This is a common example response that gained 0 marks. The candidate has incorrectly identified the substance in the pipette as the acid. This is rejected for the first mark. They then incorrectly state that the titration result will increase so does not gain the second mark. They state that in the conical flask, alkali would be diluted, this is insufficient for the mark. They then state that the titration result will change so no MP4

6 Titration can be used to find the volume of dilute hydrochloric acid needed to neutralise 25.0 cm^3 of barium hydroxide solution.

(a) Before the titration is carried out, the pipette and conical flask are rinsed out with pure water.

Explain the effect, if any, that traces of water in the pipette and conical flask after rinsing could have on the titration result.

(4)

→ alkak

pipette

~~ox~~ as there is water in the pipette, ~~there~~ ~~is~~ less alkali will be measured than if there was no water which would have an effect on the result as ~~more~~ less acid is needed to neutralise it

conical flask

there is no effect as the same concentration of acid is still needed to neutralise the barium hydroxide even if the concentration is lower

ResultsPlus
Examiner Comments

This example scored 3 marks. The candidate refers to there being a lower amount of barium hydroxide so less acid would be needed which scored 2 marks for the pipette. For the Conical flask, they state that the concentration of acid is the same so did not gain marking point 3, but they do correctly state that the titration will be unaffected so scored marking point 4.

6 Titration can be used to find the volume of dilute hydrochloric acid needed to neutralise 25.0 cm^3 of barium hydroxide solution.

(a) Before the titration is carried out, the pipette and conical flask are rinsed out with pure water.

Explain the effect, if any, that traces of water in the pipette and conical flask after rinsing could have on the titration result.

(4)

pipette

It could dilute the alkali, leading to a lower concentration, which means that a smaller volume of acid might be needed to neutralise the barium hydroxide solution because although there is the right volume of alkali present, there would be less moles

conical flask

It wouldn't have an effect on the result because although the barium hydroxide would be diluted, the same moles of alkali would be present, so the volume of acid needed would be the same

ResultsPlus
Examiner Comments

The following example shows an excellent answer that scored all 4 marking points.

Question 6 (b)(i)

Question 6(b) asked candidates to state the change in colour of phenolphthalein at the end point of the titration. Just over half of candidates knew that the indicator would turn from pink to colourless. Other candidates described colour changes that did not correspond to phenolphthalein, such as red to green, green to red, black to blue, orange to green, or red to purple

(b) In the titration, a few drops of phenolphthalein indicator are added to the barium hydroxide solution.

(i) State the change in colour of phenolphthalein at the end point, when the barium hydroxide solution has just been neutralised.

(1)

from colourless to pink

ResultsPlus
Examiner Comments

In this example, the candidate has the correct colour change but the wrong way around so did not score the mark.

(b) In the titration, a few drops of phenolphthalein indicator are added to the barium hydroxide solution.

(i) State the change in colour of phenolphthalein at the end point, when the barium hydroxide solution has just been neutralised.

(1)

from pink to colourless

ResultsPlus
Examiner Comments

This example shows a good answer that scored the mark.

won't be ~~[illegible]~~ . accurate.

(b) In the titration, a few drops of phenolphthalein indicator are added to the barium hydroxide solution.

(i) State the change in colour of phenolphthalein at the end point, when the barium hydroxide solution has just been neutralised.

(1)

from ......Pink...... to ......Clear......

ResultsPlus
Examiner Comments

In this example, the candidate did not gain the mark as they have stated that the indicator would turn clear, this was ignored.

ResultsPlus
Examiner Tip

Ensure you use precise language when describing chemical reactions and colour changes. Practice identifying and communicating scientific observations such as colour changes for the indicators in the specification accurately.

Question 6 (b)(ii)

Part (ii) of question 6(b) asked candidates to write the ionic equation for the neutralisation reaction. Candidates found this very challenging with around a quarter of candidates scoring on the question. However, of those that did score often gained both marks.

Many candidates did not attempt to write an ionic equation, indicating a misunderstanding or lack of knowledge about what constitutes an ionic equation. In many cases, candidates wrote all of the formula but then were unable to take this any further by removing the spectator ions.

(ii) Write the ionic equation for the neutralisation reaction that occurs when hydrochloric acid is added to barium hydroxide solution.

(2)

$Ba(OH)_2 + HCl \rightarrow BaCl_2 + H_2O$

$Ba(OH)_2 + HCl \rightarrow BaCl_2 + H_2O$

ResultsPlus
Examiner Comments

A common error was to try to write a balanced equation rather than an ionic equation, this scored no marks.

ResultsPlus
Examiner Tip

Ensure that you are aware of the different types of equation that can be asked in the specification and what is required for each. Word equations, balanced symbol equations, ionic equations and half equations.

(ii) Write the ionic equation for the neutralisation reaction that occurs when hydrochloric acid is added to barium hydroxide solution.

(2)

$OH^- + H^+ \rightarrow H_2O$

$Ba(OH)_{2(aq)} + 2HCl_{(aq)} \rightarrow BaCl_{2(aq)} + 2H_2O_{(l)}$

~~Ba^{2+}~~ $2OH^-$ $2H^+$ ~~$2Cl^-$~~ $\rightarrow$ ~~Ba^{2+}~~ ~~$2Cl^-$~~ $2H_2O$

$2OH^- + 2H^+ \rightarrow 2H_2O$

ResultsPlus
Examiner Comments

This example shows a good answer that scored both marks.

Question 6 (c)

The last part of question 6 asked candidates to describe an experiment to obtain a sample of pure, dry barium sulfate from the contents of the conical flask. Candidates found this application of practical procedures question challenging with around half of candidates not scoring.

Many candidates did not read the question carefully to note that there was a precipitate formed in the conical flask and therefore described the process of crystallisation rather than obtaining the precipitate from the mixture. A significant number of candidates missed the step of washing the precipitate of barium sulfate after filtration.

(c) When barium hydroxide solution is neutralised by dilute sulfuric acid, a white precipitate of barium sulfate is formed in the conical flask.

Describe an experiment to obtain a sample of pure, dry barium sulfate from the contents of the conical flask.

(3)

First we can filter the solution, to get rid of the excess products.

Then ~~we~~ we can rinse the barium sulfate with distilled water

Then, ~~I~~ leave the barium sulfate to dry in a warm oven.

ResultsPlus
Examiner Comments

This example shows a good, clear, answer that scored 3 marks.

(c) When barium hydroxide solution is neutralised by dilute sulfuric acid, a white precipitate of barium sulfate is formed in the conical flask.

Describe an experiment to obtain a sample of pure, dry barium sulfate from the contents of the conical flask.

(3)

~~Pour~~ Through crystillisation, pure, dry barium sulfate is produced firstly be pouring the mixture into an evaporating dish and heating on a tripod over a busen burner. When crystals begin to develop around the edges, the concentration has increased and you should remove the heat. Filter the mixture using filter paper and leave to dry for a few days in a warm, dry environment ~~[illegible]~~ and crystals will form.

ResultsPlus
Examiner Comments

This answer shows a common response that scored no marks. The candidate has described crystallisation then this was rejected for the first marking point. If marking point 1 had not been scored then the marks for washing and leaving to dry could not be scored.

(c) When barium hydroxide solution is neutralised by dilute sulfuric acid, a white precipitate of barium sulfate is formed in the conical flask.

Describe an experiment to obtain a sample of pure, dry barium sulfate from the contents of the conical flask.

(3)

~~Heat up the solution until most of at least half of it been evaporated.~~

~~leave the salt to evaporate~~ Filter the solution so that only the precipitate remains in the filter paper. ~~Scrape precipitate onto a~~ ~~to~~ leave precipitate in a dry and warm place so that the white precipitate dries.

ResultsPlus
Examiner Comments

This example showed a common answer which scored 2 marks. The candidate has described filtering the barium sulfate and then drying the precipitate, there is no reference to washing the precipitate for the second marking point.

(c) When barium hydroxide solution is neutralised by dilute sulfuric acid, a white precipitate of barium sulfate is formed in the conical flask.

Describe an experiment to obtain a sample of pure, dry barium sulfate from the contents of the conical flask.

(3)

· filtration can be used
· put filter paper in a cone ~~of~~ over ~~all~~ a different beaker
· pour the content of the conical flask through the filter paper
· the white precipitate will not go through and stay on the filter paper while the solution goes through into the beaker

ResultsPlus
Examiner Comments

This example scored 1 mark, the candidate has explained how to filter the precipitate from the solution. They have not described the rest of the experiment.

ResultsPlus
Examiner Tip

Ensure that you know the difference between different command words such as explain and describe.

Question 7 (a)(i)

Question 7 asked candidates about the electrolysis of water, acidified with dilute sulfuric acid.

The first question asked why acidified water is an electrolyte.

A good proportion of candidates were able to score with a slightly higher percentage gaining 2 marks than 1. Where candidates did not score, if was often as they incorrectly mentioned electrons moving instead of or as well as ions when discussing the process of electrolysis, this was rejected for both mark points.

7 (a) Water, acidified with dilute sulfuric acid, was electrolysed for 10 minutes using inert electrodes.

Figure 5 shows the apparatus used.

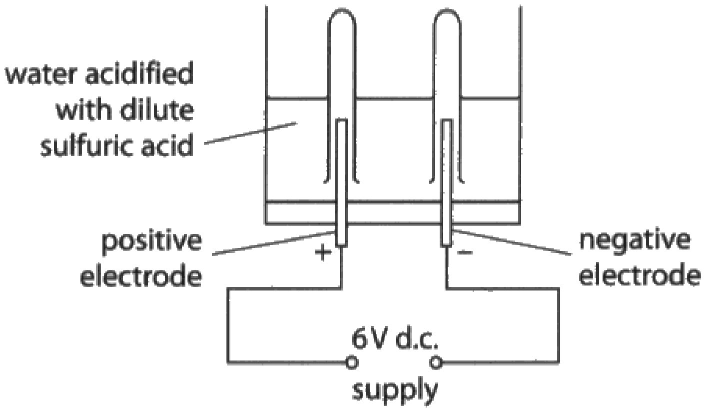


Figure 5

(i) In this electrolysis, the acidified water is an electrolyte.

Explain why acidified water is an electrolyte.

(2)

The acidified water would need to contain the sulfuric acid ions and delocalised electrons that could be carried through the wires for electrolysis.

ResultsPlus
Examiner Comments

This response shows a common answer which scored no marks.

7 (a) Water, acidified with dilute sulfuric acid, was electrolysed for 10 minutes using inert electrodes.

Figure 5 shows the apparatus used.

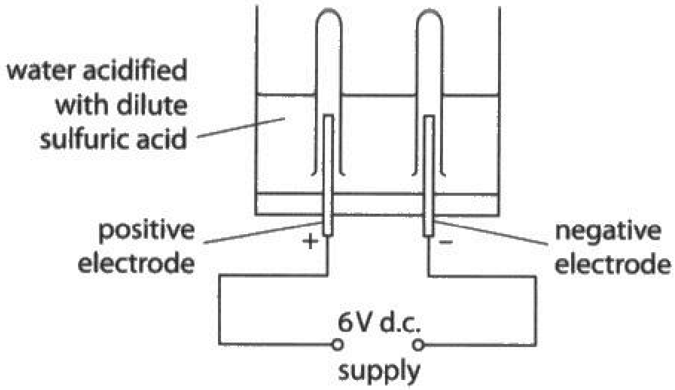


Figure 5

(i) In this electrolysis, the acidified water is an electrolyte.

Explain why acidified water is an electrolyte.

(2)

Because it contains H^+ ions and can carry an electrical current.

ResultsPlus
Examiner Comments

This example scored 1 mark, the candidate knows that the solution contains ions, but does not refer to these ions moving for the second mark.

7 (a) Water, acidified with dilute sulfuric acid, was electrolysed for 10 minutes using inert electrodes.

Figure 5 shows the apparatus used.

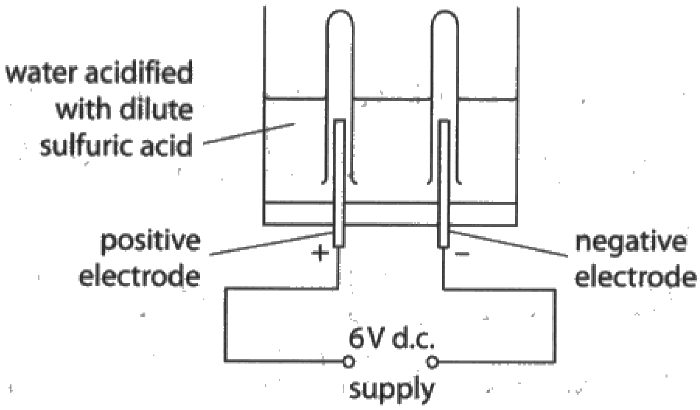


Figure 5

(i) In this electrolysis, the acidified water is an electrolyte.

Explain why acidified water is an electrolyte.

(2)

Because the ions are free to move hence they can carry a charge. ~~and~~ allows the current to go through it.

ResultsPlus
Examiner Comments

The following shows a good response which scored both marks.

Question 7 (a)(iii)

Part (iii) of question 7(a) asked candidates to complete and balance the half equation for the formation of oxygen at the positive electrode in the electrolysis.

A good proportion were able to score at least 1 mark, often for knowing the water and oxygen were formed.

A common error seen was that candidates incorrectly wrote the product of the reduction reaction as "H_2" instead of "H_2O", indicating a misunderstanding of the products formed.

$2H_2O + O_2$

(iii) Complete and balance the half equation for the formation of oxygen at the positive electrode in this electrolysis.

(2)

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

ResultsPlus
Examiner Comments

This was a common 1 mark answer where the candidates has omitted the electrons from the half equation.

(iii) Complete and balance the half equation for the formation of oxygen at the positive electrode in this electrolysis.

(2)

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

ResultsPlus
Examiner Comments

This example shows a good answer that scored both marks.

Question 7 (b)(i)

Question 7b describes the electrolysis of copper sulfate solution using copper electrodes. Part (i) of the question asked candidates to describe what should be done to the copper cathode after it has been removed from the copper sulfate solution before its final mass is determined.

The vast majority of candidates were able to score 1 mark, this was because they focused solely on drying the electrodes after cleaning, omitting the important step of washing or rinsing beforehand.

Many candidates that scored 0 marks, did so as they suggested using sandpaper or emery paper to clean the electrodes. Some candidates mentioned usings other solvents that would not be suitable for cleaning electrodes in this context and so did not score.

(b) Copper sulfate solution was electrolysed for 10 minutes using copper electrodes.

Figure 6 shows the mass of the cathode and the appearance of the copper sulfate solution before electrolysis and after electrolysis.

	mass of cathode in g	appearance of copper sulfate solution
before electrolysis	5.32	pale blue solution
after electrolysis	5.87	pale blue solution

Figure 6

(i) Describe what should be done to the copper cathode, after it has been removed from the copper sulfate solution, before its final mass is determined.

(2)

It should be cleaned toremove any extra mass

ResultsPlus
Examiner Comments

This example scored no marks. The candidate has stated that the cathode should be cleaned but there is no indication as to how this should be done and so no marks could be awarded.

(b) Copper sulfate solution was electrolysed for 10 minutes using copper electrodes.

Figure 6 shows the mass of the cathode and the appearance of the copper sulfate solution before electrolysis and after electrolysis. PANIC

	mass of cathode in g	appearance of copper sulfate solution
before electrolysis	5.32	pale blue solution
after electrolysis	5.87	pale blue solution

Figure 6

(i) Describe what should be done to the copper cathode, after it has been removed from the copper sulfate solution, before its final mass is determined.

(2)

It should be dried to ensure ~~the~~ there is no liquid ~~electrolyte~~ ~~prest~~ present during the determining of the mess, as it would increase the mass

ResultsPlus
Examiner Comments

This example scored 1 mark, the candidate explains that the electrode should be dried, but there is no description of washing the electrode first.

(b) Copper sulfate solution was electrolysed for 10 minutes using copper electrodes.

Figure 6 shows the mass of the cathode and the appearance of the copper sulfate solution before electrolysis and after electrolysis.

	mass of cathode in g	appearance of copper sulfate solution
before electrolysis	5.32	pale blue solution
after electrolysis	5.87	pale blue solution

Figure 6

(i) Describe what should be done to the copper cathode, after it has been removed from the copper sulfate solution, before its final mass is determined.

(2)

It should be gently cleaned by running the electrode under pure water and then dryed so there is only Copper atoms being weighed.

ResultsPlus
Examiner Comments

This example scored 2 marks, the candidate described cleaning the electrode by running under pure water for marking point 1, they then describe drying the electrode to score the second mark.

Question 7 (b)(ii)

Part (ii) of question 7(b) asked candidates to explain, in terms of ions, the change in mass of the cathode shown in Figure 6.

A good proportion were able to gain 1 mark for stating that copper ions move to the cathode, but fewer were able to give a full explanation in terms of the copper ions gaining electrons to form copper atoms on the cathode.

A small number of candidates provided half-equations to describe the reduction process occurring at the cathode which were accepted for both mark points.

(ii) Explain, in terms of ions, the change in mass of the cathode shown in Figure 6.

(2)

The negative cathode will increase in mass as copper ions will become copper atoms. $Cu^{2+} + 2e^- \rightarrow Cu$, therefore increasing the mass as copper will form at the cathode.

ResultsPlus
Examiner Comments

The following example shows a good answer that scored both marks. The candidate shows the copper ions gaining electrons clearly in the half equation and also the copper atoms being formed.

(ii) Explain, in terms of ions, the change in mass of the cathode shown in Figure 6.

(2)

The mass of the cathode increases because the Cu^{2+} ions in the solution were attracted to the negative cathode ~~so~~ and gained electrons and were reduced at the cathode so the cathode gained mass.

ResultsPlus
Examiner Comments

This example scored 1 mark. The candidate states that Cu^{2+} ions are attracted to the negative cathode and that they gain electrons and were reduced to gain a mark. There is no reference to the atoms forming to gain the second marking point.

(ii) Explain, in terms of ions, the change in mass of the cathode shown in Figure 6.

(2)

The cathode was reduced so it gained electrons, negative ions, and increased the cathode's mass

ResultsPlus
Examiner Comments

This answer scored no marks and shows the importance of using key terms correctly. Although the response mentioned the gaining of electrons and correctly labels this as reduction, it is suggesting that the cathode itself is reduced rather than the copper ions so the mark cannot be awarded. There is also no mention of atoms being formed for the second marking point.

ResultsPlus
Examiner Tip

Ensure that you are confident in using the correct terms such as ions, atoms, reduction, and electrons in the context of electroplating and that you are careful to use them accurately.

Question 7 (b)(iii)

The last part of question 7, 7(b)(iii) asked candidates to explain why the appearance of the copper sulfate solution did not change during the electrolysis. Candidates found it difficult to correctly link the maintenance of the blue colour to the fact that copper ions are both deposited at the cathode and replenished by copper atoms from the anode. Understanding this dynamic process is crucial for explaining why the solution's colour remains constant.

Some candidates misunderstood that it is specifically copper ions (Cu^{2+}) that give the solution its blue colour. Instead, they mentioned sulfate ions or other incorrect species, which led to incorrect answers.

Some candidates focused on why the solution is blue rather than why the colour remains unchanged during electrolysis. This suggests a misunderstanding of the question's focus on the absence of a visible change rather than the colour itself.

(iii) Explain why the appearance of the copper sulfate solution did not change during the electrolysis.

(2)

Because the concentration of copper ions in the copper sulfate solution has not changed. ~~As many~~ The same amount of copper ions ~~enter~~ enter the solution at the anode, as they exit at the cathode.

ResultsPlus
Examiner Comments

This example shows a good answer that scored both marks.

(iii) Explain why the appearance of the copper sulfate solution did not change during the electrolysis.

(2)

The solution remained blue as the concentration of copper sulfate remained the same, ~~no copper~~ none is lost or gained.

ResultsPlus
Examiner Comments

This example scored 1 mark for stating that the concentration of copper sulfate remained the same, just stating that none is lost or gained is not sufficient for the reason why as there is no reference to the copper ions entering at the anode and leaving at the cathode for the first marking point.

Question 8 (a)(i)

Question 8 was about the properties of different substances. Part (a) asked about the simple molecular covalent compound silicon tetrachloride. The first part asked candidates to draw the dot and cross diagram of a molecule of silicon tetrachloride. Candidates responded well to the question with the majority scoring the full two marks. Candidates who accurately depicted electrons in pairs found it easier to draw and score well.

Some candidates made errors in counting electrons, particularly in the outer shell of chlorine atoms. This often resulted in missing or incorrect placement of electrons, affecting the clarity and correctness of their diagrams.

8 This question is about the properties of different substances.

(a) Silicon tetrachloride is a simple molecular covalent compound.

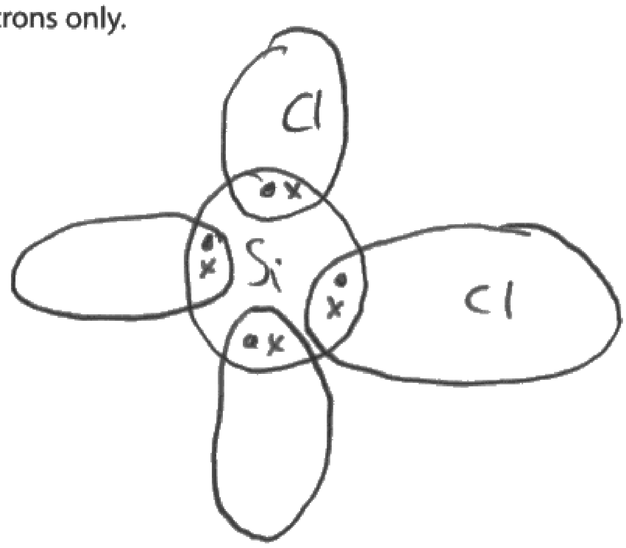
(i) A molecule of silicon tetrachloride is composed of a silicon atom and four chlorine atoms.

- a silicon atom has 4 outer electrons
- a chlorine atom has 7 outer electrons

Draw a dot and cross diagram of a molecule of silicon tetrachloride, $SiCl_4$.

Show outer electrons only.

(2)



ResultsPlus
Examiner Comments

In some cases, candidates scored just 1 mark as they were able to draw the four bonding pairs of electrons to score the first mark, but did not draw the rest of the molecule correct to gain the second mark as in this example.

8 This question is about the properties of different substances.

(a) Silicon tetrachloride is a simple molecular covalent compound.

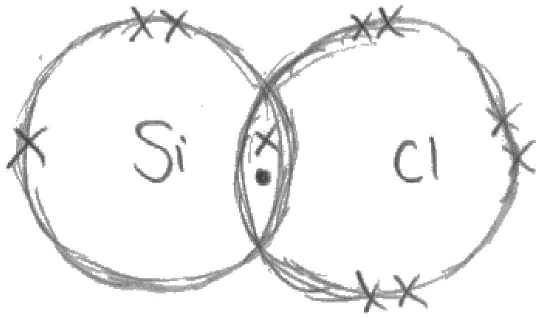
(i) A molecule of silicon tetrachloride is composed of a silicon atom and four chlorine atoms.

- a silicon atom has 4 outer electrons
- a chlorine atom has 7 outer electrons

Draw a dot and cross diagram of a molecule of silicon tetrachloride, $SiCl_4$.

Show outer electrons only.

(2)



ResultsPlus
Examiner Comments

Where candidates scored no marks, it was often as they had not used the stem of the question to obtain the formula of the molecule and so therefore did not score, as in this example which scored no marks.

ResultsPlus
Examiner Tip

Ensure that you read the stem of the question carefully and use the information there to help form your answer.

8 This question is about the properties of different substances.

(a) Silicon tetrachloride is a simple molecular covalent compound.

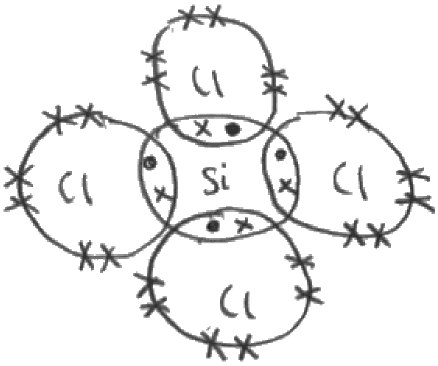
(i) A molecule of silicon tetrachloride is composed of a silicon atom and four chlorine atoms.

- a silicon atom has 4 outer electrons
- a chlorine atom has 7 outer electrons

Draw a dot and cross diagram of a molecule of silicon tetrachloride, $SiCl_4$.

Show outer electrons only.

(2)



ResultsPlus
Examiner Comments

This example shows a good example that scored both marks.

ResultsPlus
Examiner Tip

When drawing dot and cross diagrams it can be useful to pair electrons in the outer shell of atoms, as in this example, as this simplifies the process of drawing the diagrams and improves accuracy.

Question 8 (a)(ii)

Candidates found it more challenging to explain why silicon tetrachloride has a low melting and boiling point in 8(a)(ii) with fewer scoring the full two marks.

A common misconception seen was where candidates mistakenly referred to weak covalent bonds between atoms. In the second marking point, candidates often lost marks as they used terms such as "less energy" or "easy to break" , this was not sufficient for "little/small amount of energy to break.

(ii) Explain why simple molecular covalent compounds such as silicon tetrachloride have low melting and boiling points.

(2)

Simple molecular covalent compounds have low melting and boiling points because of their week bonds. These ~~weak bonds~~ weak bonds therefore require little heat energy to break and therefore have low melting and boiling points

ResultsPlus
Examiner Comments

In this example, the candidate has scored 1 mark. Weak bonds is insufficient for weak intermolecular forces and so did not gain mark point 1, if the candidate had stated weak intermolecular bonds or weak bonds between molecules, this could have gained credit.

They did understand that the melting point was low because little energy was needed to break and so the second mark point was awarded.

ResultsPlus
Examiner Tip

It's important to ensure that you use the correct terms when answering questions on melting and boiling point, remembering that intermolecular forces occur between molecules, not within them.

(ii) Explain why simple molecular covalent compounds such as silicon tetrachloride have low melting and boiling points.

(2)

they have weak intermolecular bonds so less energy is needed to break them.

ResultsPlus
Examiner Comments

This example also scored 1 mark. The candidate states that there are weak intermolecular bonds for the first mark. Unfortunately, they state that less energy to break which is ignored for the second mark.

ResultsPlus
Examiner Tip

When talking about energy required to overcome forces, ensure you terms such as little heat or energy or a large amount of heat or energy, rather than less or more.

(ii) Explain why simple molecular covalent compounds such as silicon tetrachloride have low melting and boiling points.

(2)

- In silicon tetrachloride the inter molecular forces of attraction between molecules are very weak and easy to overcome, so only a small amount of energy is needed to over come the forces of attraction giving simple molecular covalent compounds low melting and boiling points

ResultsPlus
Examiner Comments

This example shows a good answer which scored both marks.

Question 8 (c)

The last question in question 8 was the first extended open response question of the paper with a levelled based mark scheme. Candidates were given a diagram of the structures of diamond and graphite and some properties and uses of the forms of carbon. They were asked to explain, in terms of the structure and bonding, the properties given.

Many candidates demonstrated a good understanding of the structures and properties of diamond and graphite. They were able to describe these allotropes and link their structures to their respective properties with a good spread of marks seen across the cohort but with the majority of candidates scoring marks in level 3.

Those candidates that did not score full marks often showed misconceptions in their understanding. There was some confusion between intermolecular forces and covalent bonds and some candidates incorrectly referred to strong electrostatic forces or ionic bonding instead of describing the covalent nature of bonds in diamond and graphite.

*(c) Diamond and graphite are two forms of carbon.

Figure 8 shows how the carbon atoms are arranged in a part of the structure of each of these forms of carbon.

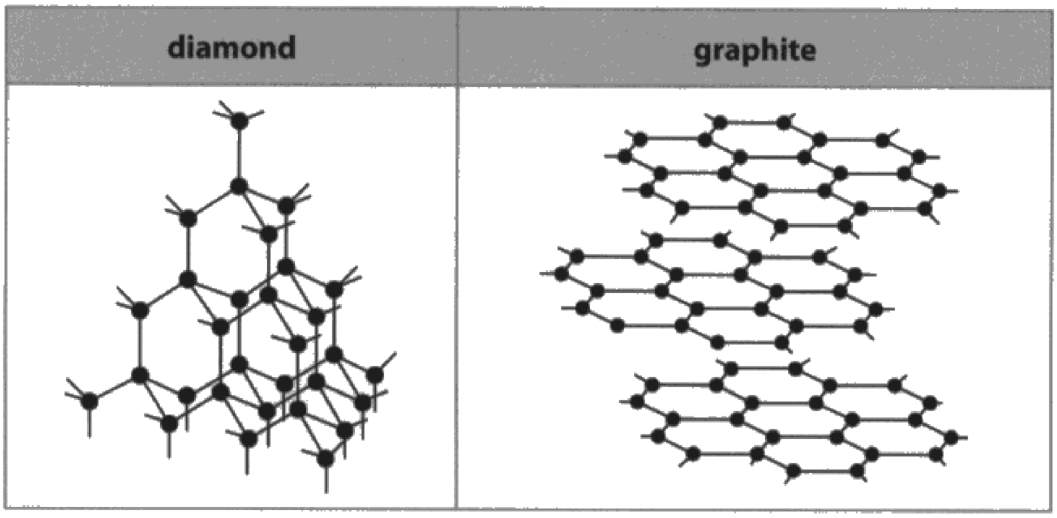


Figure 8

- diamond is one of the hardest known substances on Earth and is used in cutting tools.
- graphite is soft and flaky.
- diamond is a poor electrical conductor, but graphite is a good electrical conductor.

Explain, in terms of structure and bonding, these properties of diamond and graphite.

(6)

Diamond= It is a giant ~~lattice~~ covalent in a regular lattice arrangement. Due to its strong covalent bonds between its atoms, it has very high melting and boiling points. This is because the strong covalent bonds require lots of energy to break. It has 4 carbon atoms that each have 4 covalent bonds. It is also really hard due to its lattice arrangement which its particles hard to move. It can't conduct as it has no delocalised electrons holding it together.

Graphite = It's ~~a~~ simple covalent bond. It has weak ~~forces~~ intermolecular forces holding it together therefore it has low melting ~~to~~ and boiling points as not much energy is required to break the forces. It's layers can slide over eachother, so it's used in pencils. It has 3 carbon atoms that each have 3 covalent bonds. It's able to conduct because it has delocalised electrons that also act ~~as~~ it's bonds but also allows them to conduct and carry charge.

ResultsPlus
Examiner Comments

This example scored 4 marks in level 2. The candidate has explained the hardness of diamond fully.

The electrical conductivity of diamond, and graphite and the hardness of graphite have just partial explanations. They have described the structure of graphite and diamond.

Full credit in level 2 was awarded.

*(c) Diamond and graphite are two forms of carbon.

Figure 8 shows how the carbon atoms are arranged in a part of the structure of each of these forms of carbon.

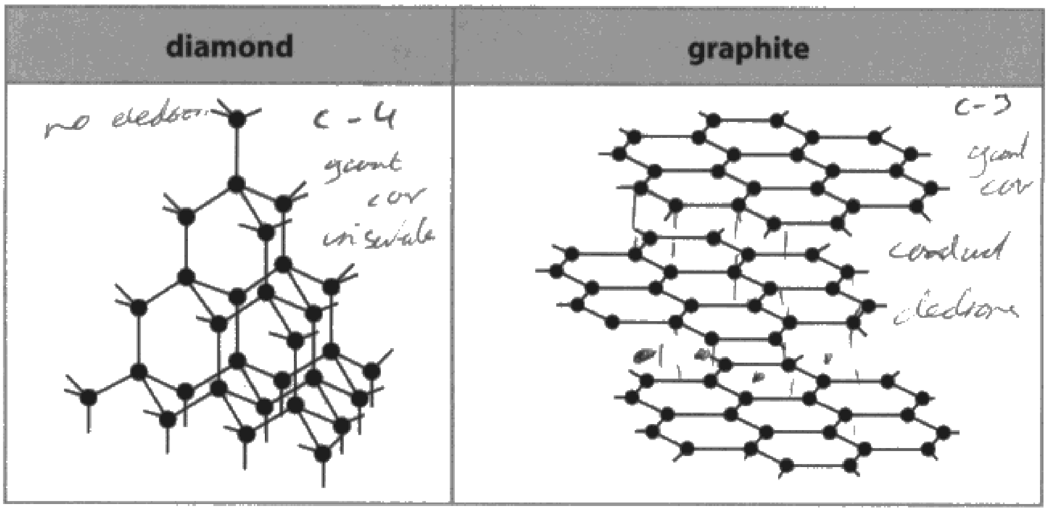


Figure 8

- diamond is one of the hardest known substances on Earth and is used in cutting tools.
- graphite is soft and flaky.
- diamond is a poor electrical conductor, but graphite is a good electrical conductor.

Explain, in terms of structure and bonding, these properties of diamond and graphite.

(6)

Diamond

- Each carbon atom is bonded with 4 other carbon atoms so they have strong bonds which make it a hard substance
- Diamond has no freely moving electrons so cannot conduct electricity as there are no electrons to carry the charge through the substance.
- Giant covalent structures have very high boiling and melting points due to there strong bonds which require high number of thermal energy to break

Graphite

- Graphite has many layers with a sea of delocalised electrons between. This means that graphite can slide over layers so can be used in pencils, or as a lubricant
- Flaky due to the weak inter molecular forces between layers which are easy to overcome with little energy
- Good conductor as there is a sea of delocalised electrons between the layers which can carry the charge through the substance
- Each carbon atom is bonded to only 3 other, not the optimum 4, so isn't as strong as diamond.

ResultsPlus
Examiner Comments

This example scored 6 marks in level 3. The candidate has described the structure of both allotropes.

They have explained all four properties with detail and gains full credit in level 3.

*(c) Diamond and graphite are two forms of carbon.

Figure 8 shows how the carbon atoms are arranged in a part of the structure of each of these forms of carbon.

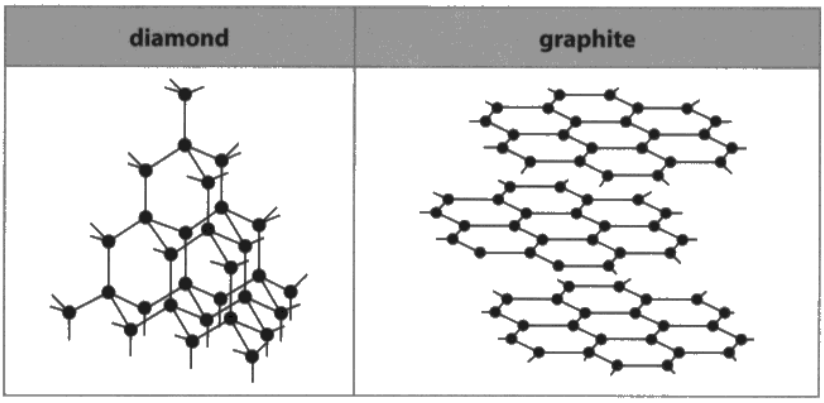


Figure 8

- diamond is one of the hardest known substances on Earth and is used in cutting tools.
- graphite is soft and flaky.
- diamond is a poor electrical conductor, but graphite is a good electrical conductor.

Explain, in terms of structure and bonding, these properties of diamond and graphite.

(6)

Diamond	Graphite
Giant ~~Covalent~~	Simple molecular bonds
Covalent bonds	Arranged in 2d lattice
Arranged in a 3d	Structure
lattice	3 bonds of carbon
4 bonds ~~of~~ of carbon	Less energy required
More energy required	to break bonds
to break bonds.	

ResultsPlus
Examiner Comments

This example scored 2 marks in level 1. Whilst the format of using a table is fine and full marks could be awarded for a table if the explanations were contained. The candidate has only given a couple of unlinked basic correct facts, this is just sufficient for 2 marks at level 1.

Question 9 (a)(i)

Question 9(a) described an investigation into the reactivity of four metals, D, E, F and G.

Candidates were given the observations of 3 of the metals and asked to suggest the observations for metal G. Candidates performed well in the question with the majority scoring and most scoring the full two marks.

Where candidates did not score, it was often as they struggled with the comparative aspect of the question, where they needed to analyze the amount of bubbles produced relative to other metals.

9 (a) An investigation was carried out on the reactivity of four metals, **D**, **E**, **F** and **G**.

Equal sized pieces of these metals were placed in excess dilute hydrochloric acid and left for three minutes.

Figure 9 shows the observations of the reactions for metals **D**, **E** and **F**.

metal	observations with dilute hydrochloric acid
D	Bubbles formed quickly. After three minutes all the metal had reacted.
E	Bubbles formed very quickly. No metal remaining after three minutes.
F	A few bubbles were seen to form. The metal looked unchanged after three minutes.
G	

Figure 9

The order of reactivity for these metals is shown in Figure 10.

E	**D**	**G**	**F**

most reactive — least reactive

Figure 10

(i) Use the information in Figure 9 and Figure 10 to suggest the observations that would be made for metal **G**.

(2)

Some bubbles were formed, after three minutes some of the metal had reacted, but some remained unchanged

ResultsPlus
Examiner Comments

This example scored 2 marks for stating that some bubbles would be formed and that some of the metal reacting would react.

Question 9 (a)(ii)

Part (ii) of question 9(a) asked candidates to explain the meaning of the terms dilute and strong acid. Many candidates struggled to answer accurately when defining the terms, this seemed to be most prevalent when trying to the term dilute correctly. Candidates were more successful with their definition of a strong acid being an acid which fully dissociates into hydrogen ions.

(ii) The dilute hydrochloric acid used in this reaction is a strong acid.

Explain the meaning of the terms **dilute** and **strong acid**.

(4)

dilute

A dilute acid means the conc of ~~give~~ H^+ ions in a given area is low, this doesn't necessarily mean it is a weak acid.

strong acid

~~Fully dissociates into H^+ ions~~ An acid which fully dissociates into H^+ ions, ~~meaning more H^+ ions per in a given volume than weaker acids.~~ Strong acids can be diluted to increase their pH. This does not affect strength only concentration

ResultsPlus
Examiner Comments

The following example shows a good response which scored all 4 marks.

(ii) The dilute hydrochloric acid used in this reaction is a strong acid.

Explain the meaning of the terms **dilute** and **strong acid**.

(4)

dilute

A low concentration of acid in the solution making it dilute and react slower.

strong acid

A high concentration of acid in the solution making it strong and react quickly.

ResultsPlus

Examiner Comments

This example scored 2 marks. The candidate states that there is a low concentration of acid. There is no mention of the acid dissociation or hydrogen ions so no further credit is awarded.

(ii) The dilute hydrochloric acid used in this reaction is a strong acid.

Explain the meaning of the terms **dilute** and **strong acid**.

(4)

dilute

~~A lower concentration of acid~~ Not just pure acid in the solution, other things too.

strong acid

A high concentration of acid

ResultsPlus
Examiner Comments

The following example scored no marks. A common misconception seen was that a strong acid meant that there was a high concentration of acid.

Question 9 (b)

Question 9(b) gave the formula of lead ethanoate and asked candidates to calculate the number of atoms that combine together to form 16.25g of lead ethanoate. While many candidates demonstrated proficiency in calculating moles and using Avogadro's number, a significant number missed the final step of multiplying by the correct number of atoms and so gained 3 rather than 4 marks. It was found that candidates that laid out their answers logically tended to do better than those that did not.

(b) The formula of lead ethanoate is $Pb(CH_3COO)_2$.

Calculate the number of **atoms** that combine together to form 16.25 g of lead ethanoate.

(relative atomic masses: H = 1.00, C = 12.0, O = 16.0, Pb = 207

Avogadro number = 6.02×10^{23})

(4)

moss = 16·25

mr = 207 + 2(12 + 3 + 12 + 16 + 16) = 325

mols = 0·05

Avo = ~~[illegible]~~ amount / mol   Avo × mol = amount

= $3 \cdot 01 \times 10^{22}$

number of atoms = $3 \cdot 01 \times 10^{22}$

ResultsPlus
Examiner Comments

This example scored 3 marks as the candidate has missed the final step to calculate the number of atoms and shows the importance of showing working so that intermediate marks can be awarded.

(b) The formula of lead ethanoate is $Pb(CH_3COO)_2$.

Calculate the number of **atoms** that combine together to form 16.25 g of lead ethanoate.

(relative atomic masses: H = 1.00, C = 12.0, O = 16.0, Pb = 207

Avogadro number = 6.02×10^{23})

(4)

207 + 12 + 12 + 6 + 12 + 12 + 16 + 16 + 16 + 16 = 325

325 ÷ 16·25 × 6·02 × 10^{23} = 1·204 × 10^{25}

number of atoms = 1·204 × 10^{25}

ResultsPlus
Examiner Comments

This example scores 2 marks, the candidate has correctly calculated the relative formula mass of the lead ethanoate to score the first marking point. The second marking point has not been scored for calculating the number of moles as they have the division the wrong way around. As they have shown their working, error carried forward can be awarded and marking point 3 can be awarded for calculating the number of "$Pb(C_2H_3O_2)_2$". If they had then multiplied this by 15 a further mark could have been awarded.

ResultsPlus
Examiner Tip

Always show your working in calculation questions so that marks can be awarded for intermediate steps in your working as in this example.

(b) The formula of lead ethanoate is $Pb(CH_3COO)_2$.

Calculate the number of **atoms** that combine together to form 16.25 g of lead ethanoate.

(relative atomic masses: H = 1.00, C = 12.0, O = 16.0, Pb = 207

Avogadro number = 6.02×10^{23})

(4)

moles lead ethanoate = $\frac{16.25}{207+2(12+3+12+16+16)}$

= 0.05

number of atoms in lead ethanoate : 15

number of atoms in 16.25g is = $0.05 \times 15 \times 6.02 \times 10^{23}$

= 4.515×10^{23}

number of atoms = 4.515×10^{23}

ResultsPlus
Examiner Comments

This response shows a good, well laid out, answer that scored 4 marks.

ResultsPlus
Examiner Tip

Showing your working in a clear, logical way, as in this example will help you to arrive at the required answer without missing steps.

Question 9 (c)

The last part of question 9 gave candidates two possible balanced equations for the reaction of iron with copper nitrate. Candidates were asked to carry out a calculation to show which equation represents the reaction taking place. Most candidates attempted the question, and a pleasing number achieved full marks, indicating overall competence in the topic, with many correctly applying the first method outlined in the mark scheme.

In some cases, candidates completed the calculations correctly but forgot to explicitly state which equation they were referring to therefore not gaining the final marking point.

(c) Iron is more reactive than copper.

Iron will displace copper from copper nitrate solution.
Two possible balanced equations for the reaction are

Equation **1** $Fe + Cu(NO_3)_2 \rightarrow Fe(NO_3)_2 + Cu$

Equation **2** $2Fe + 3Cu(NO_3)_2 \rightarrow 2Fe(NO_3)_3 + 3Cu$

It was found that 2.24 g of iron reacted with excess copper nitrate solution to form 3.81 g of copper.

Carry out a calculation, using the information above, to show which equation represents the reaction taking place.

(relative atomic masses: Fe = 56.0, Cu = 63.5)

$\frac{2.24}{56.0} = 0.04$

$\frac{3.81}{63.5} = 0.06$

ResultsPlus
Examiner Comments

The following example scored 2 marks. The candidate has calculated the number of moles of iron and of copper to gain the first two marking points but failed to calculate the ratio or state which reaction would represent the reaction taking place for the third marking point.

(c) Iron is more reactive than copper.

mass = Mr moles

Iron will displace copper from copper nitrate solution.
Two possible balanced equations for the reaction are

1 : 1

Equation **1** $Fe + Cu(NO_3)_2 \rightarrow Fe(NO_3)_2 + Cu$

Equation **2** $2Fe + 3Cu(NO_3)_2 \rightarrow 2Fe(NO_3)_3 + 3Cu$

3 : 2

It was found that 2.24 g of iron reacted with excess copper nitrate solution to form 3.81 g of copper.

Carry out a calculation, using the information above, to show which equation represents the reaction taking place.

(relative atomic masses: Fe = 56.0, Cu = 63.5)

(3)

Fe: ~~56 × 63 × 1~~ Cu

$\frac{2.24}{56}$ = 0.04mol $\frac{3.81}{63.5}$ 0.06

1 : 1.5

ResultsPlus
Examiner Comments

This example also gained two marks, The candidate has calculated the number of moles of iron and of copper to gain the first two marks, they have gone on to identify the ratio is 1:1.5 but have not identified which is the correct equation for the reaction taking place and so does not gain the third marking point.

(c) Iron is more reactive than copper.

Iron will displace copper from copper nitrate solution.
Two possible balanced equations for the reaction are

Equation **1** $Fe + Cu(NO_3)_2 \rightarrow Fe(NO_3)_2 + Cu$

Equation **2** $2Fe + 3Cu(NO_3)_2 \rightarrow 2Fe(NO_3)_3 + 3Cu$

It was found that 2.24 g of iron reacted with excess copper nitrate solution to form 3.81 g of copper.

Carry out a calculation, using the information above, to show which equation represents the reaction taking place.

(relative atomic masses: Fe = 56.0, Cu = 63.5)

(3)

Fe $\frac{2.24}{56} = 0.04$ Cu $\frac{3.81}{63.5} = 0.06$

$\frac{0.04}{0.04} = 1$ $\frac{0.06}{0.04} = 1.5$

$1 \times 2 = 2$ $1.5 \times 2 = 3$

It is equation 2 as ratio from Fe : Cu is 2 : 3 like in equation 2.

(Total for Question 9 = 13 marks)

ResultsPlus
Examiner Comments

The following response shows a good answer which scores 3 marks.

Question 10 (a)(i)

Question 10 was the last question on the paper focused on the reaction of methane with steam to produce hydrogen. In the first part of the question, candidates were asked to describe the effect of the catalyst on the rate of attainment of equilibrium and on the equilibrium yield of the products. Most candidates demonstrated understanding of the concept, with a majority scoring at least one mark and many achieving full marks for stating that a catalyst increases the rate of the reaction without affecting the equilibrium yield.

10 Hydrogen can be produced by the reaction of methane with steam.

(a) Methane reacts with steam in the presence of a nickel catalyst to produce hydrogen and a dynamic equilibrium is reached.

The equation for this equilibrium reaction is

$$\underset{\text{methane}}{CH_4(g)} + 2H_2O(g) \rightleftharpoons 4H_2(g) + CO_2(g)$$

The forward reaction takes in heat energy and is endothermic.

(i) Describe the effect of the catalyst on the rate of attainment of equilibrium and on the equilibrium yield of products.

(2)

rate of atainment will be faster and the equilibrium yield will stay the same

ResultsPlus
Examiner Comments

This example shows a good answer that scored 2 marks.

10 Hydrogen can be produced by the reaction of methane with steam.

(a) Methane reacts with steam in the presence of a nickel catalyst to produce hydrogen and a dynamic equilibrium is reached.

The equation for this equilibrium reaction is

$$CH_4(g) + 2H_2O(g) \rightleftharpoons 4H_2(g) + CO_2(g)$$

methane

The forward reaction takes in heat energy and is endothermic.

(i) Describe the effect of the catalyst on the rate of attainment of equilibrium and on the equilibrium yield of products.

(2)

the catalyst will cause both the yield & rate to increase, whilst staying in equilibrium

ResultsPlus
Examiner Comments

In some cases, candidates incorrectly assumed that the use of a catalyst would increase the yield of the reaction as well as the rate as in this case which scored 1 mark.

Question 10 (a)(ii)

Part (a)(ii) of question 10 was the second of the two extended open response questions with a level-based mark scheme. Candidates were asked to explain what effect there would be on the rate of attainment of and the equilibrium yield of hydrogen if the manufacturer were to use a higher temperature and a lower pressure without changing the catalyst.

Many candidates demonstrated a good understanding of how temperature and pressure affect equilibrium, with a good range of marks seen across the cohort and a pleasing number achieving Level 3 for being able to predict and explain the effect of changes in temperature and pressure on equilibrium yield and rate of reaction.

The best responses effectively applied Le Chatelier's Principle to explain how changes in temperature and pressure affect the position of equilibrium, clearly distinguishing between their impact on reaction rate and equilibrium yield. Candidates who structured their answers by clearly addressing each component of the question (temperature effect on rate and yield, pressure effect on rate and yield) tended to perform the best.

Some responses included irrelevant details, such as discussing the effect of catalysts, which were not part of the question's scope.

Some candidates struggled with using correct chemical terminology, such as referring to reactants and products incorrectly, which affected the clarity of their answers *(ii) A manufacturer produces hydrogen by the reaction of methane with steam in the presence of a nickel catalyst using the conditions

temperature 600 °C
pressure 20 atmospheres

Explain what effect there would be on the rate of attainment of equilibrium and the equilibrium yield of hydrogen if the manufacturer were to use a higher temperature of 1000 °C at a lower pressure of 10 atmospheres without changing the catalyst.

(6)

- Pressure

As pressure is lowered, ~~right~~ forward reaction is favoured as there is a higher number of moles which will cancel out the change, increasing yield

- As pressure is lowered, particles become further apart, meaning less frequent successful collisions will occur and rate of attainment will decrease

Temperature

- Forward reaction will be favoured as temperature increases as it is endothermic meaning it will take the thermal energy and cancel the change brought about, increasing yield
- As temperature increases, the kinetic energy of particles increases meaning they move more, meaning they are more likely to collide meaning rate of attainment will increase as more frequent successful collisions occur

ResultsPlus
Examiner Comments

This example shows a good answer which scored 6 marks in level 3.

*(ii) A manufacturer produces hydrogen by the reaction of methane with steam in the presence of a nickel catalyst using the conditions

temperature	600 °C
pressure	20 atmospheres

Explain what effect there would be on the rate of attainment of equilibrium and the equilibrium yield of hydrogen if the manufacturer were to use a higher temperature of 1000 °C at a lower pressure of 10 atmospheres without changing the catalyst.

(6)

A higher temperature would favour the foward reaction. Shifting equilibrium right, giving a higher yield of hydrogen. Decreasing pressure will favour the side with the most moles. Shifting equilibrium right. Increasing yield of hydrogen

ResultsPlus
Examiner Comments

This example scored 4 marks in level 2. The learner has stated that the higher temperature favours the forward reaction, giving a higher yield. They state that decreasing pressure will favour the side with less moles increasing yield of hydrogen.

The candidate has explained the effect of temperature and pressure on yield.

There is no reference effect of temperature and pressure on rate and so this is just level 2 – 4 marks.

ResultsPlus
Examiner Tip

In order to gain marks in level 3, you must ensure that you answer the whole of the question posed.

*(ii) A manufacturer produces hydrogen by the reaction of methane with steam in the presence of a nickel catalyst using the conditions

temperature 600 °C
pressure 20 atmospheres

Explain what effect there would be on the rate of attainment of equilibrium and the equilibrium yield of hydrogen if the manufacturer were to use a higher temperature of 1000 °C at a lower pressure of 10 atmospheres without changing the catalyst.

(6)

Not Changing the catalyst would cause the reaction to stay the same and then increasing the temperature would cause the reaction to go faster But a lower atmosphere could also make it slower.

ResultsPlus
Examiner Comments

This example scored 2 marks in level 1. The candidate has stated that increase in temperature causes the reaction to go faster, but lower atmosphere makes it slower.

The effect of both conditions on rate only has been described to gain full credit in level 1.

Question 10 (b)

Question 10 (b) asked candidates to calculate the maximum volume of products that could be formed from the complete reaction of 650 dm^3 of methane. Candidates found this difficult with a large proportion scoring no marks and a noticeable proportion leaving the question blank.

(b) Using the equation for the reaction

$$CH_4(g) + 2H_2O(g) \rightleftharpoons 4H_2(g) + CO_2(g)$$

calculate the maximum volume of products, in dm^3, that could be formed by the complete reaction of 650 dm^3 of methane.

(assume all volumes of gases are measured under the same conditions of temperature and pressure)

(2)

650 × 4 = 2600

maximum volume of products = 2600 dm^3

ResultsPlus
Examiner Comments

In some cases, candidates knew how to calculate the volume but only considered the volume of hydrogen rather than the volume of hydrogen and carbon dioxide, this scored just 1 mark.

(b) Using the equation for the reaction

$$CH_4(g) + 2H_2O(g) \rightleftharpoons 4H_2(g) + CO_2(g)$$

calculate the maximum volume of products, in dm^3, that could be formed by the complete reaction of 650 dm^3 of methane.

(assume all volumes of gases are measured under the same conditions of temperature and pressure)

(2)

~~moles = 27083~~ 1:5 ratio

= 650 × 5

= 3250

maximum volume of products = 3250 dm^3

ResultsPlus
Examiner Comments

This response shows a good answer that scored both marks.

Question 10 (c)

The last question on the paper asked candidates to calculate the maximum mass, in g, of carbon dioxide for every 1800 dm^3 of hydrogen produced in the reaction. Candidates found the question challenging but a good proportion scored the full 3 marks available.

(c) Using the same equation for the reaction

$$CH_4(g) + 2H_2O(g) \rightleftharpoons 4H_2(g) + CO_2(g) \quad \frac{mol}{vol}$$

calculate the maximum mass, in g, of carbon dioxide for every 1800 dm^3 → vol of hydrogen, measured at room temperature and pressure, produced in this reaction.

(relative formula mass: CO_2 = 44;
1 mol of any gas at room temperature and pressure occupies 24 dm^3)

(3)

~~1800~~ ~~mol = mass/mr =~~ mass = mr x mol

= 44 x 75

1 → 24 dm^3 = 3300

75 mol → 1800 dm^3

mass of carbon dioxide = 3300 g

ResultsPlus
Examiner Comments

Where candidates did not score 3 marks, the most common incorrect answer was 3300 g, where candidates did not consider the stoichiometric ratio as in this example which scored 2 marks.

(c) Using the same equation for the reaction

$$CH_4(g) + 2H_2O(g) \rightleftharpoons 4H_2(g) + CO_2(g)$$

1800dm³

calculate the maximum mass, in g, of carbon dioxide for every 1800 dm³ of hydrogen, measured at room temperature and pressure, produced in this reaction.

(relative formula mass: CO_2 = 44;
1 mol of any gas at room temperature and pressure occupies 24 dm³)

(3)

Vol = mol x 24   mol = $\frac{mass}{Mr}$

1800 = mol x 24

1800 ÷ 24 = 75   18.75 = $\frac{mass}{44}$

4 : 1 ratio

75 ÷ 4 = 18.75   18.75 x 44 = mass = 825

mass of carbon dioxide = 825 g

ResultsPlus
Examiner Comments

The following example shows a good example which scores 3 marks.

Paper Summary

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

- It is important to explicitly mention key concepts and avoid generalisations such as ‘harmful to the environment’ or ‘costs more’.
- When performing calculations, candidates should pay attention to units, significant figures or decimal places required and show their working in a clear and logical way to help them arrive at the correct answer.
- Ensure that they are using key scientific terms such as atom, ion and electron accurately and consistently throughout their work to avoid contradictions.
- Candidates should ensure that they answer all aspects of the question, this was especially evident in 6 mark question where candidates that did not perform as well often did so as they only answered part of the question posed.
- Pay careful attention to when carrying out practical methods during class activities so that they describe and explain different aspects of the practical methods when required.
- Ensure that they use the information in the stem of the question to help them to inform their answer, consider using a highlighter to highlight key terms, numbers or specific parts of the question.

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

Pearson Education Limited. Registered company number 872828
with its registered office at 80 Strand, London WC2R 0RL.