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Examiners' Report
June 2022

GCSE Combined Science 1SC0 1CH

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Introduction

Paper 1CH is the first of two Chemistry papers in the suite of six papers for Combined Science. The six questions in this paper are six of the ten questions in GCSE Chemistry Higher Tier Paper 1. The first two questions in this paper are also found towards the end of the equivalent Foundation Tier papers.

This is the first set of summer GCSE examinations that have been sat since summer 2019. The papers were set and marked as usual, with the paper being targeted at grades 4 and above. The setting of grade boundaries was adjusted under Ofqual rules so that the standards were midway between 2019 and 2021.

An Advance Notice was issued giving some information about the topic areas that made up more than 5% of the total marks on the paper and those that would not appear across the two papers at all.

Overall, candidates made a good attempt at all the questions on this paper with the most able being able to apply their knowledge to unfamiliar situations and clearly explain themselves in their responses using the correct scientific language.

Question 1 (b)(i)

Many candidates correctly identified equipment that is more accurate than a measuring cylinder for measuring volumes of liquid, however there were a significant minority that did not score here. Common errors included beaker, measuring jug, scale and some responses simply stated ‘measuring cylinder’ which was the equipment already being used.

Question 1 (b)(ii)

Most responses correctly identified that the universal indicator paper would change colour, with many of these then going on to correctly link the colour change to acid, neutral and alkali.

It was far less common that responses then went on to compare the colour change to a pH chart, and very rare for candidates to score this mark without scoring the first mark.

(ii) Describe how the pH of the mixture is determined when a drop of it is placed on the universal indicator paper.

(2)

When a drop is placed on the universal indicator purple it will start to immediately change colour. This will determine whether the pH is ~~strong~~ a low or high, suggesting whether it is acid or alkaline.

ResultsPlus
Examiner Comments

A common response that scored 1 mark. The candidate identifies that there will be a colour change but then fails to link the colour change to determining the pH.

(ii) Describe how the pH of the mixture is determined when a drop of it is placed on the universal indicator paper.

(2)

- when dropped on the paper a colour change will occur
- compare the colour change to an ~~[illegible]~~ pH chart to determine pH level.

ResultsPlus
Examiner Comments

A good example that scored both marks.

(ii) Describe how the pH of the mixture is determined when a drop of it is placed on the universal indicator paper.

(2)

using a PH probe, the PH is measured

ResultsPlus
Examiner Comments

This response scored 0 as it does not answer the question, which specifically asks how universal indicator paper can be used to measure pH.

Question 1 (b)(iii)

This question was not as well answered as the previous question, with far fewer candidates showing an understanding of how litmus paper works compared to universal indicator paper. Some responses suggested that many candidates have only used litmus to test for chlorine and a description of this test was a commonly seen error. Other common errors here included that the paper would not change colour or would dissolve in the solution.

The responses that scored marks almost always stated that litmus could only show acid or alkali, or red and blue, but the explanation of why this was not suitable was often less clear with vague statements about accuracy or precision rather than determining exactly how acid or alkaline the solution is.

(iii) In the method, universal indicator paper is used to determine the pH.

Explain why litmus paper would not be a suitable indicator to use in this experiment.

(2)

Litmus paper does not turn green to show a neutral solution. It will stay red from the acid until the mixture becomes ~~[illegible]~~ alkali and turns blue.

ResultsPlus Examiner Comments

This response scored 1 mark for identifying that litmus shows only two colours. It did not link this to determining the pH of the mixture.

(iii) In the method, universal indicator paper is used to determine the pH.

Explain why litmus paper would not be a suitable indicator to use in this experiment.

(2)

Litmus paper only determins if something is an acid or alkeli, not the exact pH of a substance therefore wouldn't be suitable for this experiment due to accuracy.

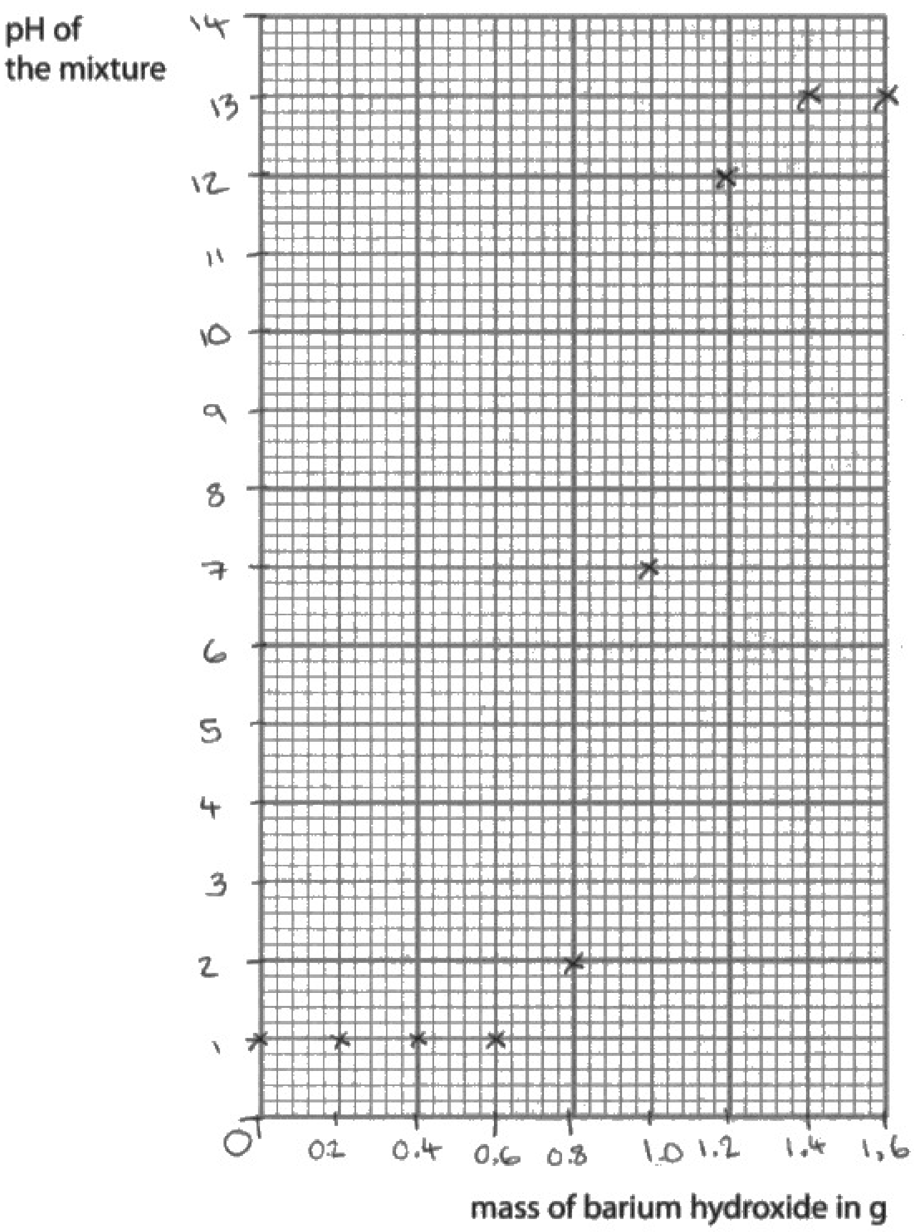
ResultsPlus
Examiner Comments

This answer scored both marks for stating that litmus would only show acid or alkali and not the exact pH.

Question 1 (b)(iv)

Many candidates scored full marks on this question, with clear scales and plots for all data points. Most also included a line of best fit, although this was not asked for in the question. This was not a problem if candidates had used crosses to plot their data points and they could still be marked. It was more difficult to mark instances where candidates had used dots to plot points and then added a line of best fit.

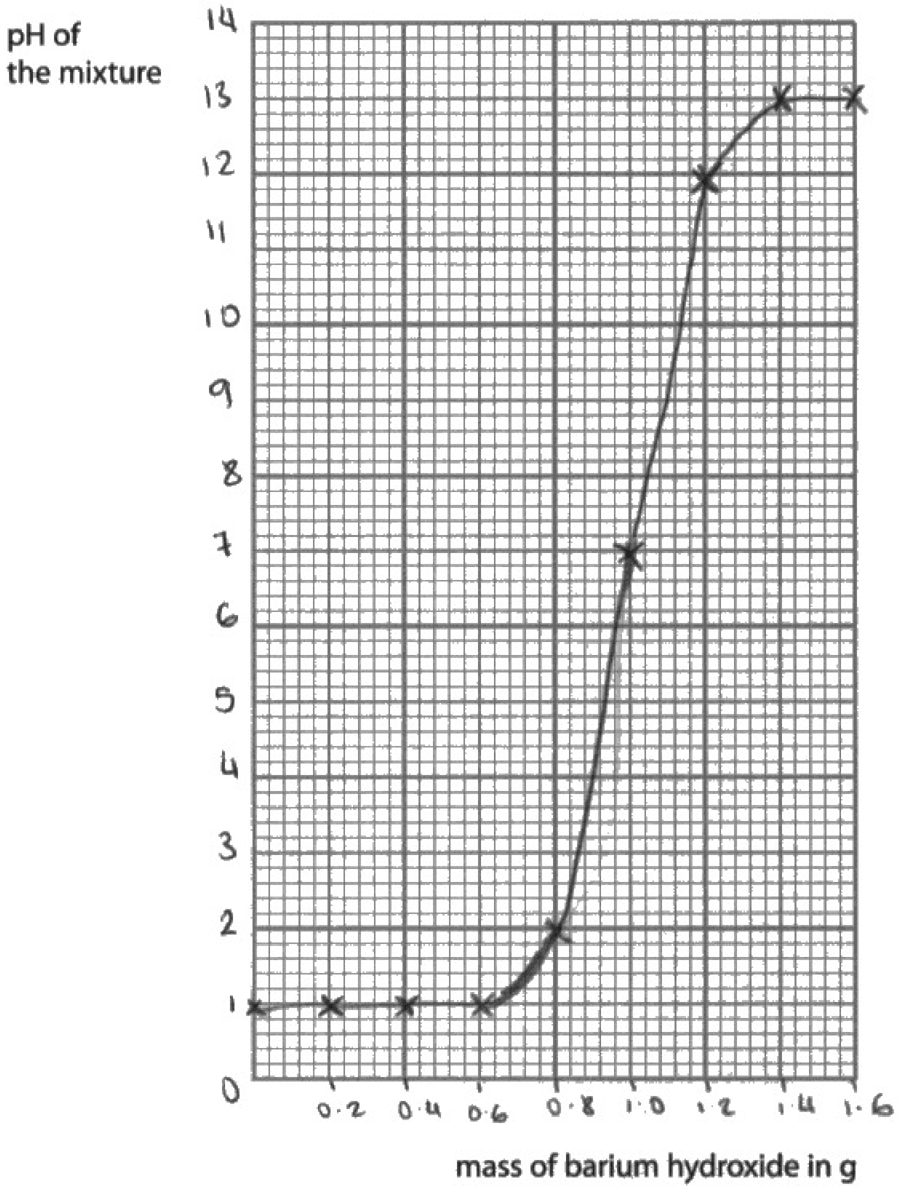
Most marks that were lost were usually due to inappropriate selection of the scales, particularly for the X-axis. Although the grid was large enough for a scale of 0.2, some candidates selected a scale of 0.5 and this made the data points more difficult to plot and errors were sometimes made here. Other candidates also chose scales that did not cover more than half of the graph paper and lost a mark. There were only a few examples of non-linear scales seen.



ResultsPlus
Examiner Comments

This is an example of a model answer, scoring full marks.

The full grid is used, with suitable, linear axes and the data points are clearly marked with crosses, without a line of best fit.



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Examiner Comments

An example of the graph with a line of best fit included. This response scored full marks as the data points are clearly marked and can be seen. The line of best fit was ignored so there was no credit for including it.

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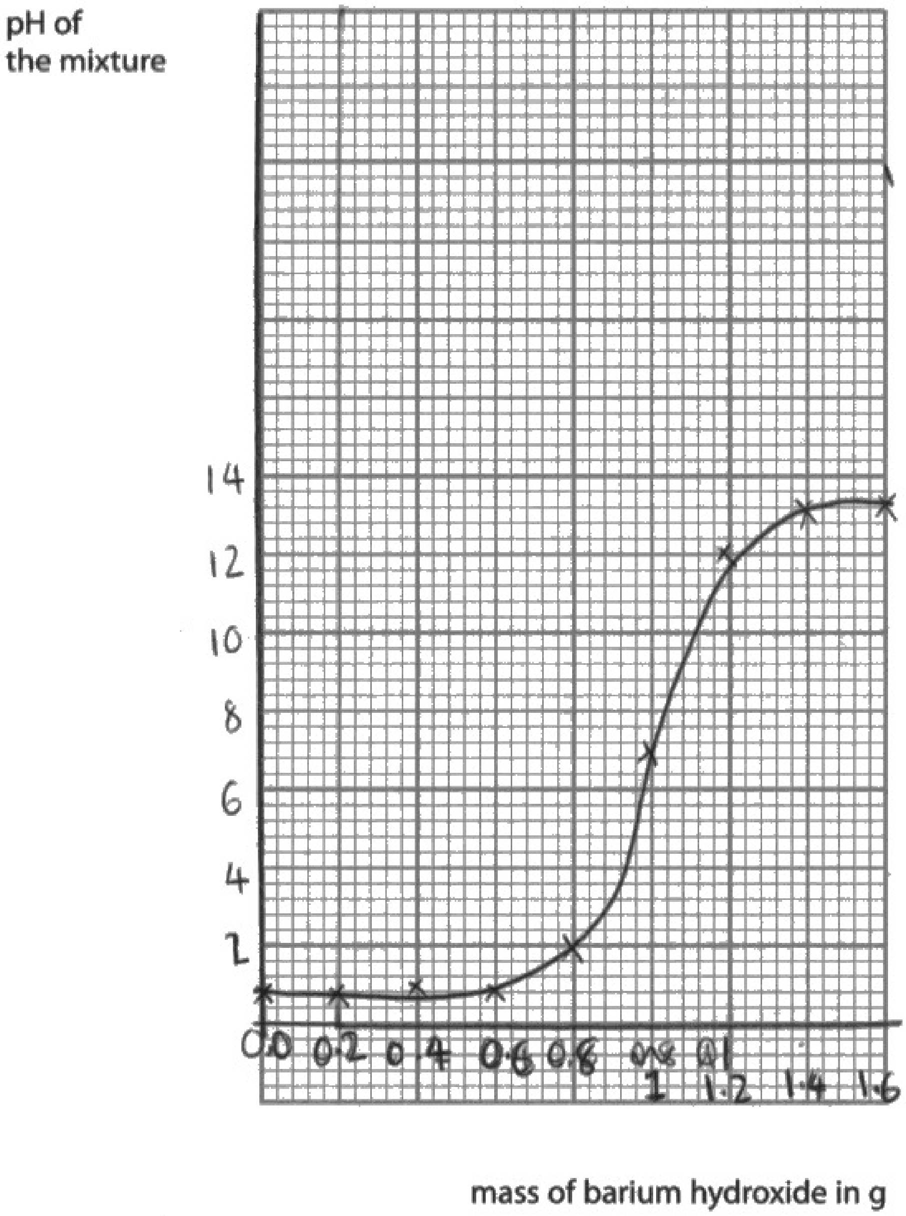
Examiner Tip

Only include the graph – not the table.



ResultsPlus
Examiner Comments

The data plots do not cover more than half of the grid in both directions and so this response only scored 2 marks.

ResultsPlus
Examiner Tip

Use the full grid available to plot the graph and make sure that suitable, linear scales are used. Axis values can be on the edges of the grid.

Question 2 (a)(ii)

This question was looking for a comparison of conductivity between metals and ionic compounds and whilst most responses scored some marks this concept was either not well understood or explained by many candidates and very few responses scored all 3 marks.

The point that was awarded most often was that for recognising the movement of delocalised electrons in magnesium although many responses referred to 'carrying charge' which is not correct and so did not score. Credit was also given for magnesium carbonate not containing delocalised electrons, which was suitable for this question but did not show a good understanding of the nature of solid ionic compounds. Some responses negated the awarding of the first mark by referring to intermolecular forces – this is a term that seems to be used regardless of the type of bonding and often leads to candidates losing marks. It was also quite common to see responses that suggested the addition of non-metals in the form of carbon and oxygen meant that the compound would not conduct any more as non-metals don't conduct. This shows that candidates do not understand that elements and compounds have different properties.

(ii) Explain why solid magnesium carbonate cannot conduct electricity but solid magnesium can.

(3)

as a solid the ions in magnesium carbonate cannot move which means they can't collide to be able to conduct electricity. In magnesium the metal has delocalised electrons which means there are electrons able to move and conduct electricity

ResultsPlus
Examiner Comments

This answer scored full marks. The candidate recognised that there are ions in solid magnesium carbonate that cannot move while solid magnesium has delocalised electrons that can move.

ResultsPlus
Examiner Tip

Electric current is a movement of charged particles. This could be ions or delocalised electrons.

(ii) Explain why solid magnesium carbonate cannot conduct electricity but solid magnesium can.

(3)

Magnesium carbonate cannot conduct electricity because it is not a pure metal and the carbonate does not conduct electricity.

ResultsPlus
Examiner Comments

It was surprisingly common to see suggestions that adding non-metals limited conductivity.

ResultsPlus
Examiner Tip

Compounds have different properties to the elements that they are made from.

Question 2 (b)

Most candidates made some attempt at this question and many scored full marks. When full marks were not scored, most managed to correctly calculate the formula mass of magnesium carbonate. There was some confusion about which numbers to use to calculate the percentage and sometimes a mark was lost for incorrect rounding, where candidates rounded 28.57 down to 28.5 rather than up to 28.6.

Where errors are made in calculations, examiners do try and follow through working and award marks where possible. This is easier if the work is clearly set out and working out is shown throughout.

(b) Calculate the percentage by mass of magnesium in magnesium carbonate, $MgCO_3$.

(relative atomic masses: C = 12.0, O = 16.0, Mg = 24.0)

(3)

$\frac{24}{24 + 12 + (16 \times 3)} = \frac{24}{24+12+48} = \frac{24}{84}$

$\frac{24}{84} \times 100 = 28.571428 = 28.6$

percentage by mass of magnesium = 28.6 %

ResultsPlus
Examiner Comments

The candidate has clearly shown their working out, which makes it much easier for the examiner to check the work if the correct answer is not on the answer line. In this case the candidate has calculated the correct answer and rounded it to a suitable number of significant figures.

(b) Calculate the percentage by mass of magnesium in magnesium carbonate, $MgCO_3$.

(relative atomic masses: C = 12.0, O = 16.0, Mg = 24.0)

(3)

$24 + 12 + (3 \times 16) = 84$

ResultsPlus
Examiner Comments

This scored 1 mark for the correct calculation of relative formula mass even though no further calculation was carried out.

Question 2 (c)

Deducing the formulae of ionic compounds remains challenging to many candidates and this was no exception. Candidates should be encouraged to make upper and lower case letters clear and to use subscript numbers when writing chemical formulae. Common errors included MgCl, Mg2Cl and adding superscript numbers and charges to the formula. Some answers showed a real lack of understanding, simply repeating the formula of one of the reactants or products.

(c) Magnesium carbonate reacts with dilute hydrochloric acid.
Water and carbon dioxide are two of the products of the reaction.

Complete the balanced equation for this reaction.

(1)

$MgCO_3$ + 2HCl → MgCl + H_2O + CO_2

ResultsPlus
Examiner Comments

The most common mistake was to give the formula of magnesium chloride as MgCl.

(c) Magnesium carbonate reacts with dilute hydrochloric acid.
Water and carbon dioxide are two of the products of the reaction.

Complete the balanced equation for this reaction.

(1)

$MgCO_3$ + 2HCl → 2MgCl + H_2O + CO_2

ResultsPlus
Examiner Comments

This candidate recognised the need to add a 2 but put it in the wrong place.

(c) Magnesium carbonate reacts with dilute hydrochloric acid.
Water and carbon dioxide are two of the products of the reaction.

Complete the balanced equation for this reaction.

(1)

$MgCO_3$ + 2HCl → $MgCl_2$ + H_2O + CO_2

ResultsPlus
Examiner Comments

A correct answer, clearly written.

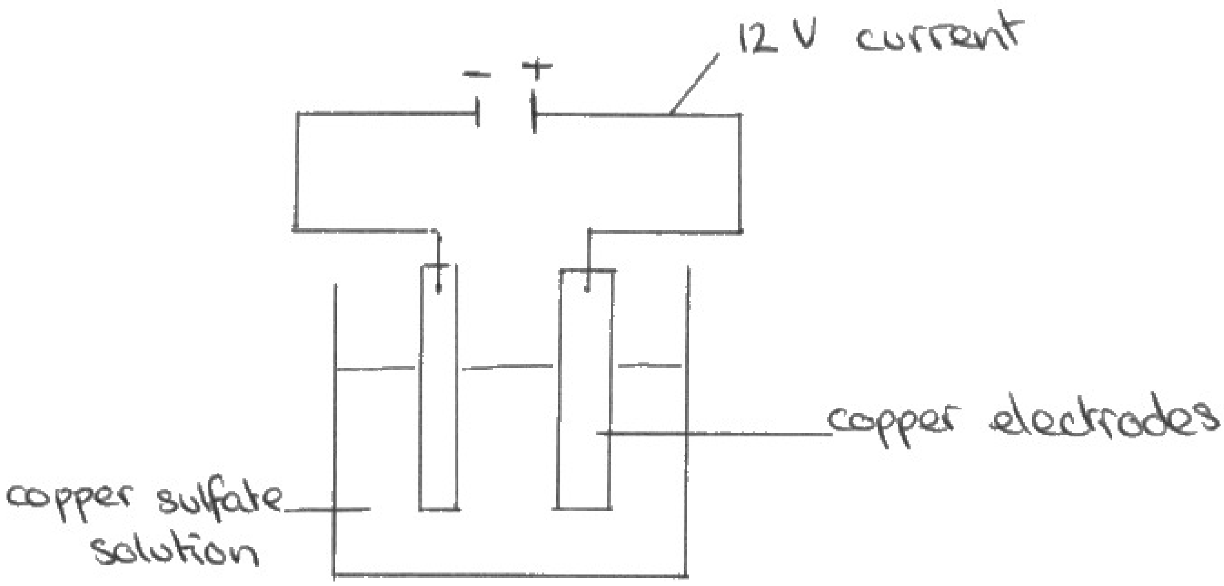
Question 3 (a)

This question asked for a labelled diagram of electrolysis equipment. The quality of the diagrams was variable with the best drawn with a pencil and ruler and clearly labelled; but most candidates managed to draw two electrodes in a beaker of liquid. Fewer candidates then went on to correctly connect their electrodes to a source of direct current and lost a mark for various reasons including wires not connected to the electrodes, no power supply or wires forming a single connection point to the power supply. Some candidates lost a mark for not reading the question properly and incorrectly labelling the electrodes as graphite or the solution as water, or both.

Full marks were not awarded without labels being added to the diagram and some candidates lost a mark here as well, again suggesting that the question had not been read properly.

(a) Draw a labelled diagram to show the apparatus that can be used to electrolyse copper sulfate solution using copper electrodes.

(2)

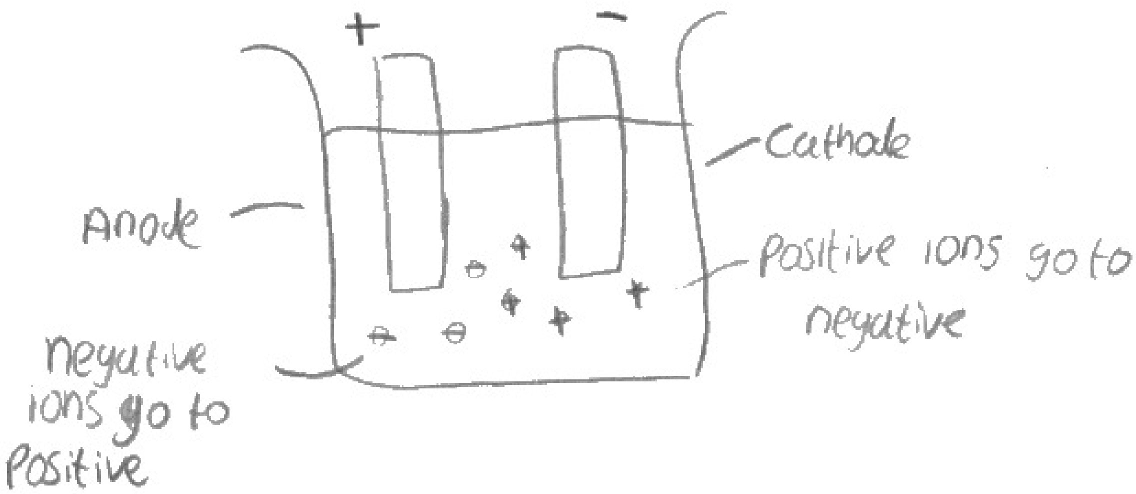


ResultsPlus
Examiner Comments

This response scored full marks. The diagram is clearly drawn, using a ruler, and there are enough labels to award both marks. The electrodes are in the correct solution and connected to a source of direct current.

(a) Draw a labelled diagram to show the apparatus that can be used to electrolyse copper sulfate solution using copper electrodes.

(2)



ResultsPlus
Examiner Comments

This response scored 1 mark for electrodes in an electrolyte, however they are not connected to any source of direct current.

The labels for the anode and cathode are not in the correct places so this would not have scored full marks even if the electrical circuit had been included.

Question 3 (b)

This question was not well answered overall, with many candidates not understanding what they were being asked and instead describing how they would deal with the electrodes after electrolysis rather than before. It was obvious that candidates were familiar with this practical but not necessarily with this part of it. Responses were often vague with suggestions of cleaning electrodes, which was just enough to score unless the response went on to suggest cleaning with water. However, those that remembered dipping electrodes into propanone as a quick drying method luckily managed to score a mark for cleaning the electrodes in this instance. The best responses gave a more detailed and correct method of cleaning and why this needed to be done, while the weakest responses suggested making the electrodes the same size or measuring their mass.

DO

(b) Before the electrolysis is carried out, the mass of each electrode is determined.

Explain what should be done to the copper electrodes before their masses are determined.

(2)

Rub down with sand paper and washed to get rid of impurites from previous experiments and then dry.

ResultsPlus
Examiner Comments

The candidate recognised that the electrodes should be rubbed down to remove anything that is not copper.

(b) Before the electrolysis is carried out, the mass of each electrode is determined.

Explain what should be done to the copper electrodes before their masses are determined.

(2)

Rough the edges of the copper with sand paper or ~~another~~ Another rough surface that will ~~scratch~~ scratch copper.

ResultsPlus
Examiner Comments

This scored 1 mark for correctly identifying what should be done to the electrodes but the candidate did not explain why the electrodes needed to be sanded.

Question 3 (c)(i)

Most responses to this question scored either 0 marks or 1 mark, with only the most able candidates correctly able to explain what was happening during electrolysis. Some candidates simply quoted numbers from the table and stated that the mass of the electrodes changed and didn't answer what the question was asking.

Some candidates stated that the change in mass at each electrode was due to the loss and gain of electrons themselves, rather than ions and atoms – demonstrating a poor understanding of what was happening.

This question also highlighted the importance of candidates being able to use the terms 'atom' and 'ion' correctly, as many had the right idea of what was happening at each electrode but were not able to express this using the correct language in their answers and therefore did not score marks.

Some responses correctly used the half equations for the anode and cathode and were able to score 2 marks with this alone, with the best responses also indicating the movement of cations to the cathode. Use of the equations meant that the candidates were already identifying the species correctly so could score marks for processes at both the anode and the cathode.

(i) **Explain, in terms of ions, the changes in mass of the two electrodes shown in the results in Figure 2.**

(3)

The anode will be lighter because it has passed the electrons to the cathode, and the cathode will be heavier because it has gained all of the electrons.

ResultsPlus
Examiner Comments

A number of candidates suggested that the changes in mass at the electrodes were due to the loss and gain of electrons.

(i) Explain, in terms of ions, the changes in mass of the two electrodes shown in the results in Figure 2.

(3)

The anode lost positive cations, which ~~moved~~ were attracted to the negative cathode during electrolysis. This meant that the anode lost mass due to the loss of cations from the copper. The negative cathode would have lost some negative anions which moved to the posit anode, however it gained more than it lost.

ResultsPlus
Examiner Comments

This response scored 2 marks. The candidate gave a good explanation of what was happening at the anode as well as the ions moving to the cathode. Unfortunately the information about the ions at the cathode is incorrect.

(i) **Explain, in terms of ions, the changes in mass of the two electrodes shown in the results in Figure 2.**

(3)

After 30minuetes of the power supply being on the Cu^+ ions will be attracted to the cathode. Also ~~Whereas~~ the copper ions from the copper anode will be attracted to the cathode. This increases the mass of the cathode and decreases mass of anode.

ResultsPlus
Examiner Comments

The most common marking point awarded was for correctly identifying that the copper ions would be attracted to the cathode. Many candidates did not go on to explain what was happening in terms of ions at the anode and the cathode to cause the changes in mass.

ResultsPlus
Examiner Tip

The command word explain requires the candidate to give a response that includes why something is happening as well as what is happening.

Question 3 (c)(ii)

Most responses scored 1 mark on this question for correctly identifying that increasing one factor (usually current, voltage or concentration) would result in an increased mass of the cathode in the same amount of time. Far fewer candidates spotted that the mass increase was three times that of the initial increase and so did not score a second mark. The most common incorrect responses suggested increasing the volume of solution (not realising that this would not affect the rate of the reaction) and leaving the experiment for a longer period of time (which indicated that the candidate had not read the question properly).

(ii) The electrolysis was repeated using another pair of copper electrodes of the same masses.

Explain a change that could be made to the electrolysis experiment to cause the mass of the cathode to increase by 2.34 g in 10 minutes.

(2)

The current flowing through the electrodes could be increased. It could be increased from 0.2A to 0.5A, for example. This can result in cations forming around the cathode quicker.

(Total for Question 3 = 9 marks)

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Examiner Comments

Most responses were similar to this in recognising that increasing current would lead to an increase in mass.

(ii) The electrolysis was repeated using another pair of copper electrodes of the same masses.

Explain a change that could be made to the electrolysis experiment to cause the mass of the cathode to increase by 2.34 g in 10 minutes.

(2)

6.78 x 3 = 2.34g

Increase amount of copper sulfate solution by 3x

~~Inc~~ Increase current by 3x

Increase voltage by 3x

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Examiner Comments

This candidate identified the factor of 3 between as well as stating that current or voltage could be increased in order to bring about this increase.

Question 4 (a)

By far the most common answer to this question was related to aluminium being more reactive than carbon and therefore heating with carbon would not displace aluminium from its oxide. The preferred answer of aluminium being very reactive and therefore requiring a large amount of energy to displace was rarely seen. However, many students did score one or two marks on this question. One of the most common mistakes was to suggest that aluminium requires electrolysis because it is unreactive.

4 The method used to extract a metal from its ore depends on the position of the metal in the reactivity series.

(a) Aluminium is extracted from its ore by electrolysis.

Explain why this method is used to extract aluminium from its ore.

(2)

This method is used because aluminium is higher than carbon in the reactivity series making it more reactive, so this means its more reactive, and it wouldn't be displaced by carbon, so therefo it can't be extracted.

ResultsPlus
Examiner Comments

This type of response was the most common seen and scores both marks.

4 The method used to extract a metal from its ore depends on the position of the metal in the reactivity series.

(a) Aluminium is extracted from its ore by electrolysis.

Explain why this method is used to extract aluminium from its ore.

(2)

This method is used because aluminium is very low on the reactivity series.

ResultsPlus
Examiner Comments

A surprising number of candidates incorrectly stated that aluminium is low on the reactivity series and therefore had to be extracted by electrolysis.

Question 4 (b)(i)

This response was poorly answered overall and very few candidates scored full marks. A number of candidates seem to think that redox is an alternative word for reversible and therefore did not manage to score any marks. Where candidates were able to identify redox as reduction and oxidation then they often went on to score another mark for identifying the oxidation of magnesium. However, failure to identify the species being reduced (ions) and just mentioning titanium was not enough to score the reduction mark, as without specifying atoms or ions it is assumed that the candidate means the atom. When candidates scored all three marks this was often due to the inclusion of a correct ionic equation rather than a correct description.

There were also a lot of responses discussing oxidation and reduction of chlorine/chloride which was irrelevant as the chloride ion is a spectator ion in this equation.

(b) (i) One step in the extraction of titanium metal involves the displacement reaction between titanium chloride, $TiCl_4$, and magnesium.

ore.

$$TiCl_4 + 2Mg \rightarrow Ti + 2MgCl_2$$

This equation can be simplified as

Oxidation Is Loss of Elec

$$Ti^{4+} + 2Mg \rightarrow Ti + 2Mg^{2+}$$

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

(3)

Because oxidation & reduction both happen in this reaction. As the Ti^{4+} (Titanium) ion has been through reduction because it gains 4 electrons. ~~Mg (Magnesium)~~ ~~has~~ forming Ti (Titanium) and Magnesium (Mg) has lost 2 electrons - oxidation, and forms magnesium ions (Mg^{2+})

ResultsPlus
Examiner Comments

A well explained response scoring all three marks. The candidate firstly gives a definition of redox followed by an explanation of the reduction of titanium ions to titanium and the oxidation of magnesium atoms to magnesium ions.

(b) (i) One step in the extraction of titanium metal involves the displacement reaction between titanium chloride, $TiCl_4$, and magnesium.

OILRIG

$$TiCl_4 + 2Mg \rightarrow Ti + 2MgCl_2$$

This equation can be simplified as

$$Ti^{4+} + 2Mg \rightarrow Ti + 2Mg^{2+}$$

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

(3)

This is because the titanium is reduced causing it to gain 4 electrons. Its charge decreases from 4+ to 0. The Magnesium is oxidised causing it to lose electrons and have an increased charge.

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Examiner Comments

An example of a response that scored 2 marks but could have scored 3 with the addition of a single word (ion). The candidate indicates that titanium rather than titanium ions have been reduced, but gives the correct explanation.

ResultsPlus
Examiner Tip

Ions and atoms are not the same thing. If the name of an element is used without the word ion, it is assumed that the candidate is talking about atoms.

(b) (i) One step in the extraction of titanium metal involves the displacement reaction between titanium chloride, $TiCl_4$, and magnesium.

$$TiCl_4 + 2Mg \rightarrow Ti + 2MgCl_2$$

This equation can be simplified as

$$Ti^{4+} + 2Mg \rightarrow Ti + 2Mg^{2+}$$

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

(3)

we can see that both oxidation and
reduction has taken place and that the
chlorine has been displaced in that
equation.

ResultsPlus
Examiner Comments

A definition of redox was enough to score one mark.

Question 4 (c)

The most common correct answer was about the slowness of the process. Far too many candidates focussed on cost which is not a relevant argument in this instance . Many talked in vague terms about environmental damage, ignoring the fact that the process actually offers environmental advantage in removing low levels of heavy metals from the ground. They also talked about the greenhouse effect of carbon dioxide being released when the plants are burned, ignoring the fact that the carbon dioxide had only just come out of the atmosphere and was not adding to the net amount in the environment. Some candidates also took information about low grade ores from the stem of the question and used this to suggest that phytoextraction was not suitable for use on high grade ores.

(c) Phytoextraction is an alternative biological method that can be used to extract metals from very low-grade ores.

Give **one** disadvantage of phytoextraction as a method of extraction of metals.

(1)

slow , takes time for plants to grow

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Examiner Comments

This was the most common, correct answer.

(c) Phytoextraction is an alternative biological method that can be used to extract metals from very low-grade ores.

Give **one** disadvantage of phytoextraction as a method of extraction of metals.

(1)

it is expensive

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Examiner Comments

A common incorrect answer.

ResultsPlus
Examiner Tip

Vague responses to questions such as 'expensive', 'harmful' or 'polluting' do not score marks.

Question 4 (d)

Candidates generally gave poor responses to this question, suggesting that only some had seen the reduction of copper oxide in the laboratory. Almost all of the responses that scored mentioned reacting copper oxide with another element – usually carbon but sometimes hydrogen or a more reactive metal. Often these responses did not score 2 marks because there was no mention of heating the reactants.

Many candidates discussed the electrolysis of copper oxide, neglecting the fact that the question had asked about a simple laboratory experiment and the fact that copper oxide is insoluble in water and has a melting point over 1300 ° C.

Other responses suggested methods to separate mixtures rather than a compound – such as heating/burning the oxygen off, filtering, crystallisation and distillation. A few candidates also wanted to use a blast furnace to extract the copper.

(d) Copper is low down in the reactivity series and can be obtained from copper oxide.

Devise a simple method to obtain a sample of copper from copper oxide in the laboratory.

(2)

~~By using~~ By electrolysis. The electricity will break down the oxide and leave a sample of copper.

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Examiner Comments

In order to obtain a sample of copper using electrolysis in a laboratory, the copper oxide would first need to be reacted with an acid to obtain a soluble salt that could then be electrolysed.

(d) Copper is low down in the reactivity series and can be obtained from copper oxide.

Devise a simple method to obtain a sample of copper from copper oxide in the laboratory.

(2)

first place the copper oxide into a crucible over a tripod, gauze, and bunsen burner. Heat the copper oxide until the oxygen has been fully burnt.

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Examiner Comments

A number of responses suggested that simply heating the copper oxide would separate the copper from the oxygen.

(d) Copper is low down in the reactivity series and can be obtained from copper oxide.

Devise a simple method to obtain a sample of copper from copper oxide in the laboratory.

(2)

Copper oxide can be heated with carbon, the carbon will displace the copper to form carbon dioxide. You will then have just copper and carbon dioxide. Heat the copper oxide with carbon.

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Examiner Comments

This is a good answer that scored both marks.

Question 5 (b)

The most commonly awarded mark in this question was for identifying that there are delocalised electrons in graphite. The explanation for why there are delocalised electrons in graphite was not well done, with only some candidates identifying that each carbon atom bonds to three other atoms and only very few stating that each carbon atom has four outer shell electrons available for bonding.

There was some obvious confusion between graphene and graphite as responses mentioned layers sliding, or electrons moving between layers. Other incorrect ideas included the open structure of the graphene allowing current to flow through, or the movement of positive ions.

Explain why graphene will be a good conductor of an electric current.

(3)

Each carbon atom is attached to 3 other atoms. A carbon atom can have a maximum of 4 bonds. Graphene can conduct electricity because there are delocalised electrons which can carry electricity.

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It was unusual to see responses like this one, which scored full marks.

Explain why graphene will be a good conductor of an electric current.

(3)

Graphene contains a sea of delocalised electrons and is very thin. Its electrons can freely move around and allow an electric current to flow through.

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Examiner Comments

Many candidates scored a mark for identifying the movement of delocalised electrons.

Explain why graphene will be a good conductor of an electric current.

(3)

This is because graphene has one delocalised Ions flowing and it can carry charge and ~~[illegible]~~t conduct electricity.

ResultsPlus
Examiner Comments

Common incorrect responses included references to the movement of ions, carrying charge or current flowing between layers.

Question 5 (c)

A familiar question asking for an explanation for high melting point of a substance. Most candidates scored at least one mark here for correctly identifying that bonds need a lot of energy to break, although some responses still refer to a high temperature and do not score. The best responses linked the large amount of energy to the strong forces between opposite ions but recognition of ionic bonds or an ionic lattice was enough to score. Unfortunately a significant number of responses then went on to negate the bonding mark by mentioning intermolecular forces, molecules or atoms rather than electrostatic forces and ions.

Explain why potassium chloride has a high melting point.

(2)

This is Since Potasium Chloride has a Strong Molecular bond. this means it is harder to Seperate them.

ResultsPlus
Examiner Comments

This response did not score as there is no mention of energy and the incorrect type of bonding has been identified.

Explain why potassium chloride has a high melting point.

(2)

The positive and negative lattice is held by strong electrostatic forces of attraction, requiring lots of heat energy to break them.

ResultsPlus
Examiner Comments

A good response, using the correct terminology, that scored both marks.

Explain why potassium chloride has a high melting point.

(2)

~~pottas~~ potassium chloride has a high melting point as it is in a lattice structure with strong electrostatic forces between molecules and atoms, therefore a lot of energy is needed to overcome them.

ResultsPlus
Examiner Comments

In this response, the candidate mentions strong electrostatic forces which would have been enough to score the first mark. Unfortunately the candidate then goes on to use the words 'molecule' and 'atom' which contradict the correct response and so the first mark was not awarded.

ResultsPlus
Examiner Tip

The terms molecule and intermolecular are not correct when talking about ionic compounds or metals.

Question 5 (d)

Most candidates attempted this question and there were very few blank responses, although the quality of answers was variable and there was a lot of repetition within the answers. Most students could recognise that the models showed 1 carbon and 4 hydrogen atoms and there were some good explanations of the dot and cross diagram (B). Very few candidates could recognise the displayed formula (C) and incorrectly stated that this model did not show the type of bonding. It was obvious that a significant number of candidates had not seen 3D models before and the descriptions of models D and E were poor. Candidates found it more difficult to discuss the limitations of the models and some responses here were too vague to score (confusing, not easy to understand etc). There was a lot of repetition for limitations and between descriptions of D and E. Some candidates discussed the properties of methane or its structure without relating it to the diagrams.

A very high proportion of candidates were able to gain either level 1 or level 2 responses based solely on their consideration of Structures A & B. Only the most able candidates were able to give a good enough variety of information about the other structures that was required to get into level 3.

Describe what information can be obtained from each model representation including the limitations of these representations of methane.

(6)

we can see in B that it is covalent bonded together meaning that the boiling and melting point of methane is quite low and doesn't require a lot of energy to break down. ~~the~~ In A its the formula but it doesn't tell us much about the structure of methane. We ~~said~~ know methane has 4 hydrogen however.

ResultsPlus
Examiner Comments

An example of a level 1 response. The candidate has included only the most basic information about bonding and elements in the molecule, and refers only to models A and B.

Describe what information can be obtained from each representation including the limitations of these representations of methane.

(6)

A Shows us ~~that~~ what methane is made of and demonstrates the chemical formula for it however it doesnt represent its structure.

B Shows us ~~How many single covalent bonds methane has~~ ~~giving~~ gives us an idea about how many electrons each atom of in methane shares. Similarly C shows us how many covalent bonds ~~are made~~ methane has.

D and E give us an idea of the structure of methane ~~atoms~~ molecules however the diagrams aren't laybelled, so if they were to be the only diagrams to appear it would be difficult ~~to~~ determine which atom is which

ResultsPlus
Examiner Comments

This is an example of a level 2 response. The candidate gave limited information and limitations about all of the models, but this was sometimes repetitive or irrelevant.

Describe what information can be obtained from each representation including the limitations of these representations of methane.

(6)

A → A Gmpirical formula

✓ It shows us how many hydrogen atoms are needed for each carbon atom

✓ It shows us the formula of the molecule

✗ It does not show us the number of bonds

✗ It is ~~Pog~~ ~~a~~ 2D

✓ - Shows us simplest ratio

x does not show us the bonds

x does not show us the atoms

B

✓ Dot and Cross

✓ It shows us the number of bonds

✓ Shows us the number of electrons shared

✓ Shows us the full outer shell and number of electrons needed to complete it

✗ Does not show us the size

x 2D

x only outer shell

C

• Stick diagram

✓ Shows us how many hydrogen atoms are needed for ~~1~~ 1 carbon atom

✓ Shows us the number of bonds

✓ Can show us the length of each molecule

✗ does not show us the electrons

✗ does not show us the share of electrons

✗ It is 2D, there no shape of electron

D

• Ball and stick diagram

✓ Shows us a 3D representation

✓ how many hydrogen to carbon

✓ how ~~hony~~ many bonds

✗ does not show us which ~~mole~~ atom is which

✗ not to scale

E

✓ Shows us how many atoms all together

✓ Shows us how many ~~ato~~ hydrogen is needed for a carbon

✗ does not draw it to scale

✗ does not show the bonds

✗ does not show which atoms are which

A, B, C, D, E

✓ · All show how many hydrogen to each carbon

✗ · Not an accurate representations as electons / atoms / moleculs don't always stay in the same place, they are always vibrating, does not show how they move.

ResultsPlus
Examiner Comments

This is an example of a level 3 response. Although the information is sometimes repetitive, all models are covered in terms of information and drawbacks and there are a lot of examples for each model.

The response does not need to be written in paragraphs in order to score full marks.

ResultsPlus
Examiner Tip

Extended response questions do not have to be written in paragraphs. Tables, diagrams and bullet points will all be marked.

Question 6 (a)(i)

This question was well answered with most candidates correctly putting the metals in order from least to most reactive.

Question 6 (a)(ii)

This was the most challenging question on the paper with only a very few candidates scoring any marks at all.

The most common responses were that one of the reactants had been used up, even though the question stated that sulfuric acid was in excess and that some metal remained. Other responses suggested that the acid was not concentrated enough or that the metal had neutralised all of the acid or that the production of hydrogen prevented further reaction occurring. The idea of an insoluble product forming a physical barrier seemed to be a completely unknown concept.

(ii) The experiment was repeated using an excess of dilute sulfuric acid in place of the dilute hydrochloric acid.

metal + sulfuric acid → metal sulfate + hydrogen

When metal **Y** reacts with dilute sulfuric acid, bubbles form quickly at first and then the reaction stops.
Most of the solid metal remains.

Explain why the reaction between metal **Y** and excess dilute sulfuric acid stopped even though there was solid metal **Y** left.

(2)

There is not enough dilute sulfuric acid to react with all of metal Y.

ResultsPlus
Examiner Comments

It was common to see responses suggesting that the acid or metal had been used up, even though the question specifically stated that there was metal left and that the acid was in excess.

(ii) The experiment was repeated using an excess of dilute sulfuric acid in place of the dilute hydrochloric acid.

metal + sulfuric acid → metal sulfate + hydrogen

When metal **Y** reacts with dilute sulfuric acid, bubbles form quickly at first and then the reaction stops.
Most of the solid metal remains.

Explain why the reaction between metal **Y** and excess dilute sulfuric acid stopped even though there was solid metal **Y** left.

(2)

~~The metal that was left was a~~ the surface of metal Y had been turned to metal Y sulfate stoping the sulfuric acid from reaching the ~~metal~~ rest of the metal

ResultsPlus
Examiner Comments

A very rare example of a fully correct response recognising that the metal sulfate would physically prevent the acid and metal from reacting further.

Question 6 (a)(iii)

A surprising number of candidates did not seem to know the difference between a weak acid and a dilute acid, and many answers simply stated that weak acids have higher pH than strong acids.

Those candidates that scored usually got a mark for recognising the partial dissociation of hydrogen into ions and describing this in some way. Others scored a mark by stating that weak acids contain a lower concentration of hydrogen ions than expected. Some did not score here because they did not use a comparative term and simply stated a low concentration. The best responses scored full marks by linking the two points together.

(iii) The reactions between metals and dilute ethanoic acid are slower than reactions between metals and dilute hydrochloric acid.
This is because ethanoic acid is a weak acid.

Explain the meaning of the term **weak acid**.

(2)

An acid that doesnt dissociate/ionise fully as it has a lower concentration of H^+ ions.

ResultsPlus
Examiner Comments

A good example that scored both marks.

(iii) The reactions between metals and dilute ethanoic acid are slower than reactions between metals and dilute hydrochloric acid.
This is because ethanoic acid is a weak acid.

Explain the meaning of the term **weak acid**.

(2)

A weak acid has a higher PH level compared to a stronger acid. This means the acid is less reactive to elements and is close to being neutral with PH 7 which has no reaction.

ResultsPlus
Examiner Comments

A higher pH level is not equivalent to having a lower concentration of hydrogen ions and so this response did not score. Responses related to reactivity also did not score.

Question 6 (b)

This calculation had a number of different steps that were required to obtain the correct answer.

- Calculation of the relative formula mass of aluminium sulfate
- Calculation of the number of moles of aluminium sulfate present in 5.13g
- Identifying the number of atoms in aluminium sulfate
- Multiplying moles by atoms by the Avogadro number to obtain the correct answer.

A mark was deducted if an error was made but then the remainder of the response was marked with the error carried forward.

The most common error, seen in the majority of responses, did not include the 17 atoms present in aluminium sulfate. However, candidates that had presented their work clearly and shown working out still scored 3 marks out of 4.

It was also common to see the incorrect calculation of relative formula mass, and the mole calculation upside down, but error carried forward still allowed these responses to score some marks.

(b) The formula of aluminium sulfate is $Al_2(SO_4)_3$.

Calculate the total number of atoms that combine to form 5.13 g of aluminium sulfate.

(relative atomic masses: O = 16.0, Al = 27.0, S = 32.0
Avogadro number = 6.02×10^{23})

(4)

mass = mols × Mr moles = mass ÷ Mr

$Al_2 \ (SO_4)_3$

$\frac{5.13}{342} = 0.015$

27 × 2 ~~32~~ × 3 64 × 3

64 + 96 + 192 = 342

$0.015 \times 6.02 \times 10^{23}$

= number of atoms

$= 9.03 \times 10^{21}$

number of atoms = 9.03×10^{21}

ResultsPlus
Examiner Comments

The most common response seen, scoring 3 marks. The candidate has set their work out clearly and neatly and the examiner can clearly see where to award marks as full marks cannot be awarded here because the seventeen atoms in aluminium sulfate have not been included.

(b) The formula of aluminium sulfate is $Al_2(SO_4)_3$.

Calculate the total number of atoms that combine to form 5.13 g of aluminium sulfate.

(relative atomic masses: O = 16.0, Al = 27.0, S = 32.0
Avogadro number = 6.02×10^{23})

(4)

$\underbrace{(2 \times 27)}_{54} + 2(\times\ 32 + 64)$

$54 + \cancel{192}\ 288 = \cancel{246}\ 342$

$\cancel{\frac{5.13}{246} = 0.22 \text{ moles}}$ $\frac{5.13}{342} = 0.015 \text{ moles}$

number of atoms = 0.015

ResultsPlus
Examiner Comments

This response scored 2 marks. It can clearly be seen that the formula mass and number of moles have been calculated but no further calculation means that no more marks could be awarded.

ResultsPlus
Examiner Tip

Calculations should be set out clearly and neatly so that examiners can award marks if the response is not fully correct.

(b) The formula of aluminium sulfate is $Al_2(SO_4)_3$.

Calculate the total number of atoms that combine to form 5.13 g of aluminium sulfate.

(relative atomic masses: O = 16.0, Al = 27.0, S = 32.0
Avogadro number = 6.02×10^{23})

(4)

$27 \times 2 = 54$ $\quad 32 \times 3 = 96 \quad (16 \times 4) \times 3 = 192$

$\cancel{54 + 32 + 192} = 54 + 96 + 192 = 342 \quad$ RAM = 342

$\frac{5.13}{342} = 0.015 \quad$ 0.015 moles $\quad 0.015 \times (6.02 \times 10^{23}) =$

9.03×10^{21}

$(9.03 \times 10^{21}) \times 17 = 1.5351 \times 10^{23}$

$\simeq 1.54 \times 10^{23}$

$2 + 3 + (4 \times 3) = 17$ ~~atoms~~

number of atoms = 1.54×10^{23}

ResultsPlus
Examiner Comments

All four marking points are clearly shown here, with the correct answer on the answer line.

Question 6 (c)

Most candidates attempted to show something here, but a lot of work was not well set out and therefore difficult for examiners to award marks for. Some candidates hedged their bets and guessed which reaction without showing any working and did not score marks.

There were a number of ways to work out the answer to this question and many candidates correctly calculated the number of moles of each metal and scored 2 marks. Only some then went on to link this to the ratio of the two equations and correctly identify the correct one.

Some candidates used the method of calculating how much lead would be produced from 4.48g of iron in each reaction in order to determine which was taking place.

Unfortunately it was very common to see random numbers or a number of different methods all in the same space and neither of these were able to score anything.

(c) Iron is more reactive than lead.
Iron reacts with lead nitrate solution to form solid lead.
Two possible balanced equations for the reaction are

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

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

In one experiment, it was found that 4.48 g of iron reacted with excess lead nitrate solution to form 24.84 g of lead.

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

(relative atomic masses: Fe = 56.0, Pb = 207)

Pb = 207

(3)

Fe = 56 Pb = 24.84

reacted = 4.48 0.08 0.12

2Fe 3Pb

1 : 1.5 } ×2

2 : 3

(Total for Question 6 = 13 marks)

ResultsPlus
Examiner Comments

The candidate has correctly calculated the number of moles, linked this to a 2:3 ratio and then highlighted equation 2 in the question and so scores all three marks.

(c) Iron is more reactive than lead.
Iron reacts with lead nitrate solution to form solid lead.
Two possible balanced equations for the reaction are

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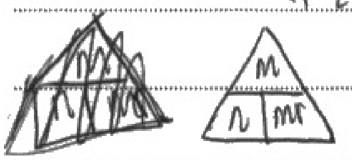
Carry out a calculation, using the information above, to show which equation represents the reaction taking place.

(relative atomic masses: Fe = 56.0, Pb = 207)

(3)

~~56~~ $Fe(NO_3)_2$ $2Fe(NO_3)_3$

1 + 2 + 6 = 9 atoms 2 + 3 + 9 = 14 atoms



$\frac{4.48}{56} = 0.08$ $\frac{24.84}{207} = 0.12$

ResultsPlus
Examiner Comments

The candidate has correctly calculated the number of moles and scores 2 marks. However, there is no linking this back to the correct equation in the question and so the final mark could not be awarded.

Paper Summary

Based on their performance in this paper, candidates should:

- Consider practical work in more detail, from beginning to end. Consider which equipment is used and why and clearly explain the steps in carrying out each experiment. It is obvious when candidates have had experience of a wide range of practical activities.
- Be able to explain the effects of changing variables in practical activities and identify control variables.
- Understand that compounds are different to the elements that they are made from and therefore have different properties.
- Practice rounding and the use of significant figures in calculations.
- Set out calculations clearly and practice how to calculate the number of moles of a substance.
- Know that the terms molecule and intermolecular forces apply to simple covalent compounds only and should not be used for every example of bonding.
- Recognise the difference between atoms and ions and become familiar with using these terms.
- Explain the difference in the way that ionic compounds conduct electricity compared to metals.
- Describe what is meant by a redox reaction and practice writing half equations to show these reactions.
- Recognise that electrolysis involves the decomposition of an electrolyte and that this is an example of a redox reaction.
- See different models of simple covalent molecules, including 2D and 3D and recognise the benefits and limitations of these models.

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