



Examiners' Report

June 2024

GCSE Combined Science

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Introduction

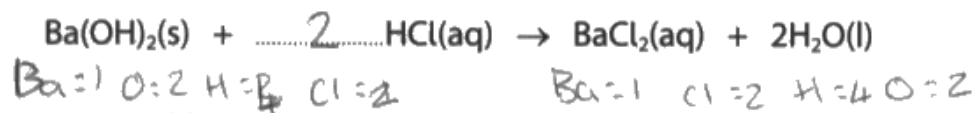
Paper 1SC0/1CH is the first of two chemistry papers in the suite of six papers for the Combined Science Higher Tier GCSE. All six questions are also found in paper 1 of Higher Tier GCSE Chemistry. Some of the earlier questions in the paper overlap with Foundation Tier GCSE Combined Science and GCSE Chemistry.

Question 1 (a)(i)

Nearly all candidates could complete this simple piece of balancing.

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

(1)



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It is a good idea to count the number of atoms of each element as this candidate has done.

Question 1 (a)(ii)

Many candidates talked about fizzing/ bubbles as this seems to be a common default answer for an observation; it appeared that they were not proficient in using the state symbols to deduce what would be seen. The best answers talked about the solid “dissolving”, with only a small number referring to the barium hydroxide actually disappearing. Any answers to do with the solution talked about a colour change occurring – again a common default answer. Some candidates referred to a type of reaction eg neutralisation or displacement – whether correct or otherwise, not an observation.

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

You would see bubbling/fizzing



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Examiner Comments

Many candidates automatically give fizzing as an observation even when no gas is formed.

Question 1 (b)(i)

A pH probe was a more common response than a pH meter, which is piece of equipment schools are encouraged to demonstrate or to get students to use. Many candidates mentioned some form of indicator – including iodine in a few cases.

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

litmus paper



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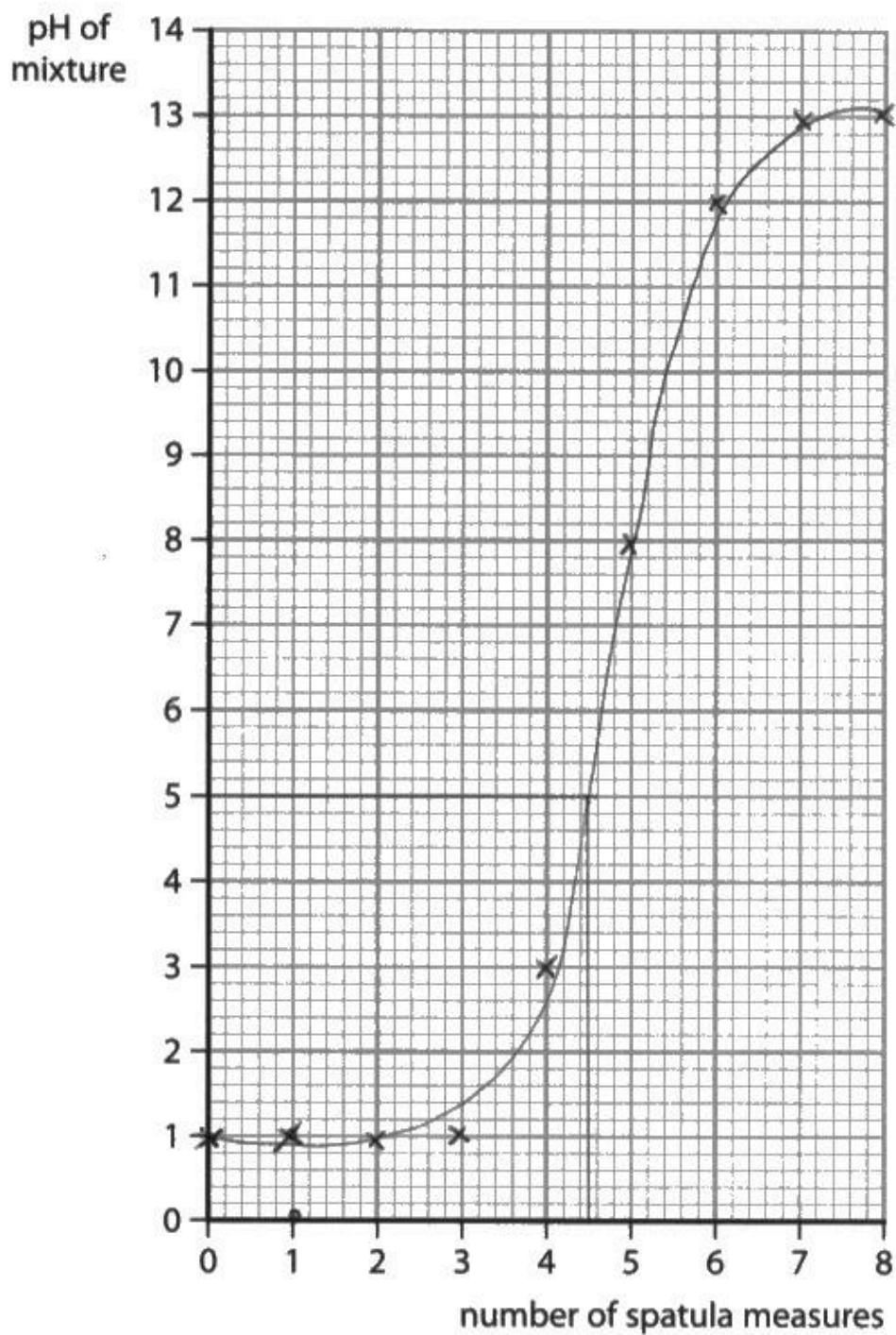
Litmus paper cannot be used to measure pH.

Question 1 (b)(ii)

The most common way of scoring marks was to say that stirring would make the barium hydroxide dissolve, and that this would cause the substances to react or speed up the reaction. Quite a few candidates talked about how this gave accurate results – but were not able to link stirring to giving a homogenous mixture and hence an accurate pH.

Question 1 (b)(iii-iv)

On the whole the graph was well drawn and the majority of candidates scored well for accurate plotting and a smooth S-shaped curve. There were a few (non-scoring) bar-charts, and it was unfortunate that some candidates either drew no line at all, drew multiple lines or just drew from dot to dot. The prediction of the pH for 4.5 spatulas was in most cases spot on, or close enough. Those that lost the mark here tended to have non-vertical lines on their working out which yielded an inaccurate answer.

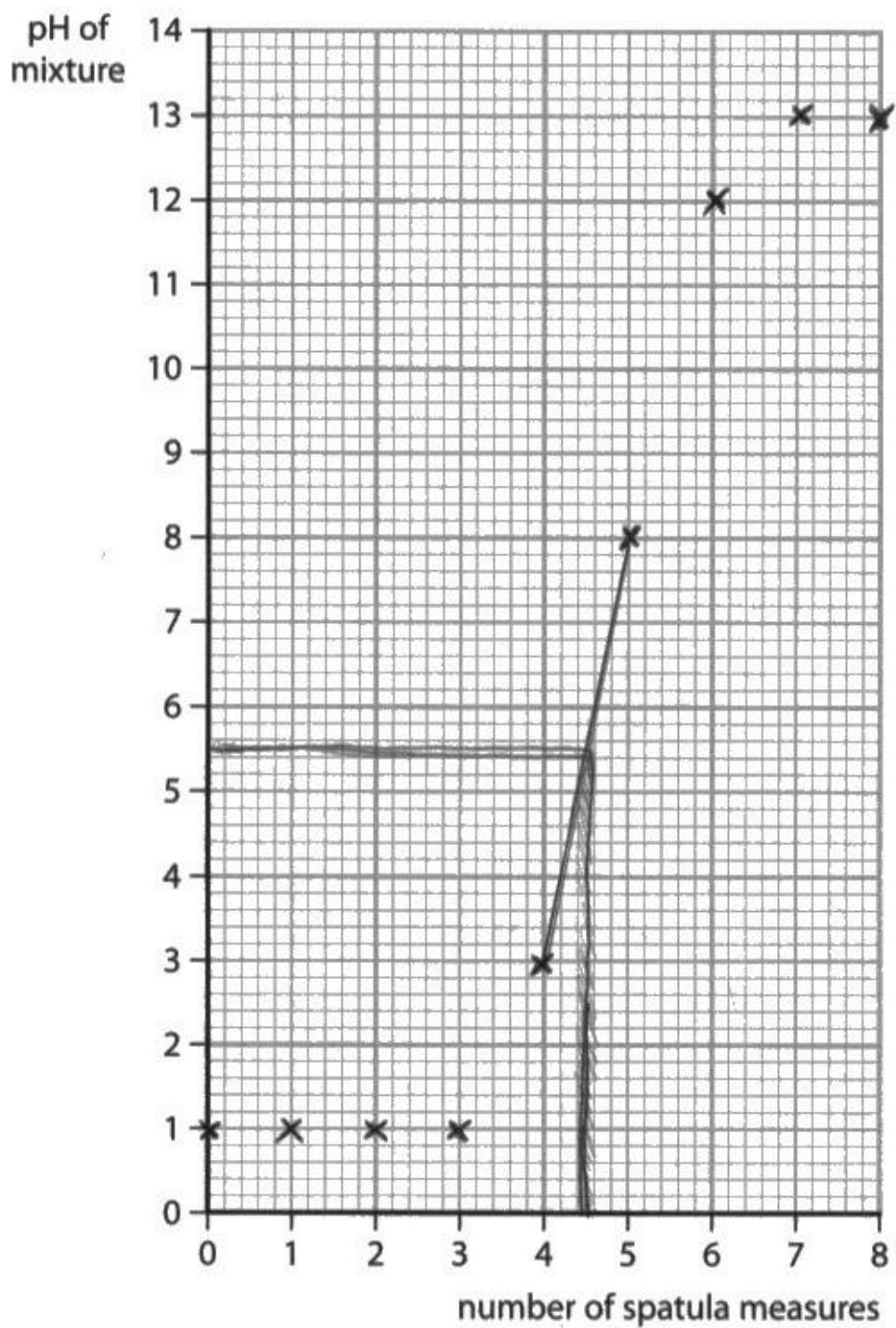


- (iv) Use the graph to find the pH of the mixture when 4.5 spatula measures of barium hydroxide are added.

pH of the mixture = 5



The points are plotted correctly, but a rather careless curve has been drawn.



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

pH of the mixture =5.5.....

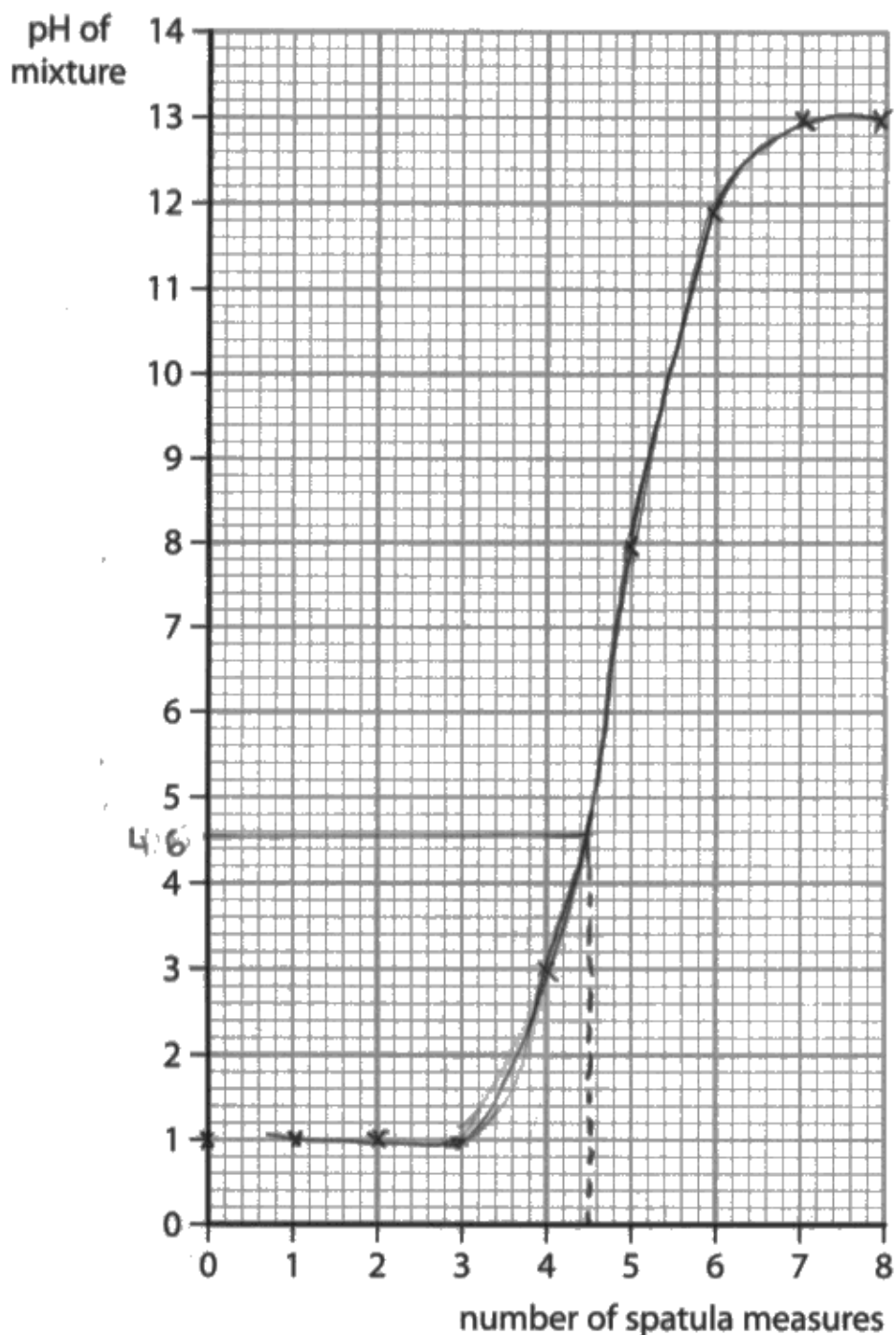


The points have been plotted but the curve is incomplete.



When taking a reading from a graph it is a good idea to add lines from the axes as here, but a ruler-drawn line is more likely to give a correct answer.

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



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

pH of the mixture = 4.6



When drawing a curve, draw a single line on your graph. Here, this is not the case, and also the line does not start at the first plotted point.

Question 2 (a)(ii)

Unfortunately, the majority of candidates fell back on using electrons as the means of conduction, stating whether delocalised electrons could move or not and hence scoring 0 marks. Some talked about unspecified particles. Fewer mentioned ions fixed in a solid lattice which could then move in solution.

Solid sodium carbonate has no delocalised electrons, so it cannot conduct electricity, but the solution of sodium carbonate -e has delocalised (free) electrons so it can conduct electricity.



It was a common error to talk about delocalised electrons.

because the ions in solid sodium carbonate are not free to move. 494
However when in a solution the ions dissolve and the ions are then free to move so they can carry the flow of the charge (electricity)

so the charge cannot be carried or flow.

2 / 3



An example correctly using ions – however, it does not say why the ions cannot move in the solid.

Question 2 (b)

The majority of candidates gained marks on this question, perhaps assisted by the stated equation. Common errors were careless calculation of Mr for the compound ($23 + 12 + 16 = 51$, for example), and/or using 23 instead of 46 for the sodiums. It was notable that even with the stated equation some candidates put the numbers the wrong way round in the division. There were some rounding errors.

$$12 + (16 \times 3) + (23 \times 2) = 106$$

$$23 \times 2 = 46$$

$$\begin{array}{r} 106 \\ \underline{46} \\ 46 \\ \underline{46} \\ 106 \end{array}$$

$$\text{percentage by mass of sodium} = 43.39$$



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Show working in calculations. It is not perfect here (there is no $\times 100$) but it can be followed.

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

$$\text{Na} = 2 \times 23 = 46$$

$$\text{C} = 12 = 12$$

$$\text{O} = 3 \times 16 = 48$$

$$= 106$$

106

$$\frac{51}{106} \times 100 = 48.1\%$$

(3)

percentage by mass of sodium = 48.1%



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Examiner Comments

The candidate has all the working but has used $12+16+23$ for the numerator.

Question 3 (a)

Many candidates were able to score by talking about the finite supply of ores or that recycling uses less energy, that the 'waste' of metal resources is prevented or that less carbon dioxide is emitted. Less successful responses talked about cost (which is not credited), or giving generalised non-scoring answers such as "it is more sustainable" (why?) or "better for the environment" (why?) or "takes less time". Many talked about less mining but did not justify why mining is a problem.

- 1 one advantage is that obtaining metals by recycling is easier and faster than extracting from metal ores
- 2 another advantage is that it is not as expensive as extracting them from their metal ores.



You should learn scientific reasons for questions like this. This answer did not score.

- 1 It means that the earth's resources of ores can be preserved and last longer.
- 2 recycling uses up less energy and produces less greenhouse gases, meaning it's better for the environment.



Two valid scientific reasons are given here.

Question 3 (b)(i)

Many candidates talked about simultaneous oxidation and reduction and scored a mark (although quoting OILRIG by itself is meaningless). It was critical in this question to distinguish between cadmium ions and cadmium atoms – the cadmium **ions** are reduced/ gain electrons was required. Inevitably, some candidates got the redox the wrong way round. A small number failed to recognise that the reaction involves oxidation and talked about just reduction or displacement – usually trying to link in the reactivity of cadmium or zinc. Some talked about a transfer of positive charge.

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

A redox reaction is a reaction, $\text{OILRIG} \rightarrow \text{gain}$ (3)

where both oxidation and reduction takes place. In this displacement reaction, Cadmium ions gained electrons to become cadmium atom, so it is reduced. However, zinc have lost electrons to become a zinc ion, so it is been oxidised.



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This is an excellent answer, where cadmium ions and atoms and zinc and zinc ions have been correctly referred to. (Ideally it would be 'zinc atoms' but 'zinc' here was allowed).

Because in a displacement reaction, the oxidation (loss of electrons) and reduction (gain of electrons) happens simultaneously, making it a redox reaction.



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Examiner Comments

Oxidation and reduction are correctly described here – but they have not been linked to THIS displacement reaction. Always use any example/ equation you have been given.

Question 3 (c)

Many candidates recognised that biological extraction was a slow process, and others talked about a low yield instead. Some mentioned toxicity, and specifically sulfuric acid. General statements about “damaging the environment” did not qualify without specific reasons, along with responses that would never score – “it is expensive” or “bacteria will be a hazard”.

^{could}
~~could~~ release chemical gases that can be harmful

Potassium
Sulfate



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Examiner Comments

Whilst harmful products are released, this answer is too unspecific to score.

you still have to do electrolysis after
doing bioleaching, so its expensive



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Examiner Comments

This is a good scientific reason.

Question 3 (d)

Many candidates recognised the need for a reaction with a more reactive element, with carbon being the most common choice – although some failed to talk about the need to heat it and just mixed the substances expecting a reaction to occur. Unfortunately, sodium and potassium were not uncommon choices of a more reactive metal, not a good choice in a laboratory. If electrolysis was chosen as the method it tended to score just 1 mark as candidates did not then go into the need to melt the sample – instead they went on to talk about how it would work in separating the lead and oxygen (not the practical description asked for). Some tried to dissolve the insoluble lead oxide – melting is always the best choice in these questions. Candidates who did not score gave a range of physical processes, including fractional distillation, filtration and crystallisation, or non-laboratory methods such as phytoextraction and bioleaching.

(2)

One can use a displacement reaction using carbon where you heat it using a bunsen burner which ~~all~~ create lead and Carbon dioxide. The carbon dioxide will be ~~apart~~ ~~ago~~ and the lead will ~~stay~~ ~~remain~~ in the ~~box~~ ~~box~~ ~~box~~ be a liquid heating to 600/800; the cement.



This is a good answer explaining what needs to be done.

(2)

- by doing a displacement reaction
with carbon

- as carbon is higher in the reactivity
series ~~but~~ ^{than} lead



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Examiner Comments

The question says 'Describe how...'. This answer does not say what you would do, (heat with carbon) so only gets 1 mark.

Question 4 (a)(i)

Most candidates did not appreciate that ions were necessary for conduction, and hence the presence of ions was the reason that acidified water is an electrolyte. Many focussed on the fact that it conducts electricity (so a conductor, but does not explain why it is an electrolyte). Many linked electrons to why the solution conducted – see also Q02aii. Those that mentioned ions could state that they moved to the electrodes, with H^+ being the most commonly mentioned ion in the acidified water (followed by OH^-) with very few mentioning SO_4^{2-} .

Acidified water has ^{many} charged ions that are attracted to the oppositely charged electrode. (4)

are free to move and



This answer acknowledged that an electrolyte needs free moving ions.

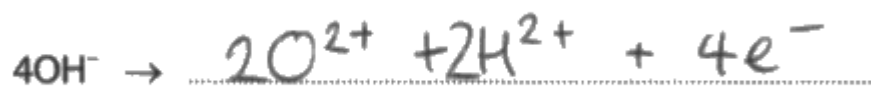
Acidified water is a good conductor as it has lots of free moving electrons, meaning it carries electricity well as there is high concentration ^{are extra} hydrogen atoms about. (4)



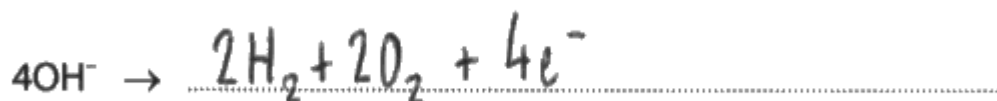
A common error was to talk about electrons in an electrolyte.

Question 4 (a)(iii)

Not unexpectedly, half-equations are found difficult. Candidates should be encouraged to balance the atoms first (quite a few did not include oxygen in any form at all). Then, the charges can be balanced with electrons (it was pleasing to see that even when the half-equation was not fully balanced, many included 4 electrons on the right-hand side of the equation).



Many candidates had improbable species to try to balance this half-equation.



In half-equations, the atoms and the charges must balance. Here, whilst they do, hydrogen is not a product at the positive electrode.

Question 4 (b)(i)

Many candidates scored 1 mark for some method of drying, but fewer talked about washing/rinsing to start with. Some were clearly confusing this with pre-treatment of the cathode, talking about the use of emery paper or sandpaper, which of course would remove all of the deposited copper.

It should have been washed with distilled water and carefully patted dry.



A fully correct answer.

It should be cleaned and then re-weighed



This answer says 'cleaned' – but how would you do this in a laboratory? Give practical methods – as you did when doing the core practical.

Question 4 (b)(ii)

Some candidates knew that cations move to the cathode (but some were too vague and just said "ions", or worse, said that anions went to the cathode). Far fewer got into the necessary detail, and referred to reduction of copper cations or those ions gaining electrons, hence forming atoms. Unfortunately, some felt that the cathode gained mass because of the electrons being gained there, or because copper ions stuck to the electrode (without forming ions).

The ions at the cathode have gained 3 electrons to become an atom so the mass has increased.



This candidate had the idea of reduction, explained concisely but well.

The mass increases at the cathode as it attracts the negative ~~cations~~ ~~anions~~ which stick to it and increase the mass. (2)



Learn which ions go to which electrode – the cations go to the cathode, not the anions. There they are reduced to form atoms which is why the cathode's mass increases.

Question 4 (b)(iii)

This question was not well understood, with answers ranging from “there is no reaction”, “it was not left for long enough” to “it still has some copper in it”. Only a few understood that the copper ions entered and left the solution at equal rates. Of those that had some idea, sadly some thought that the blue colour was due to sulfate ions. Some suggested that the solution was blue as it was alkaline.

The appearance will not change because ~~also~~ ^{although} the mass will change copper and Sulfur will still be present in the mixture.



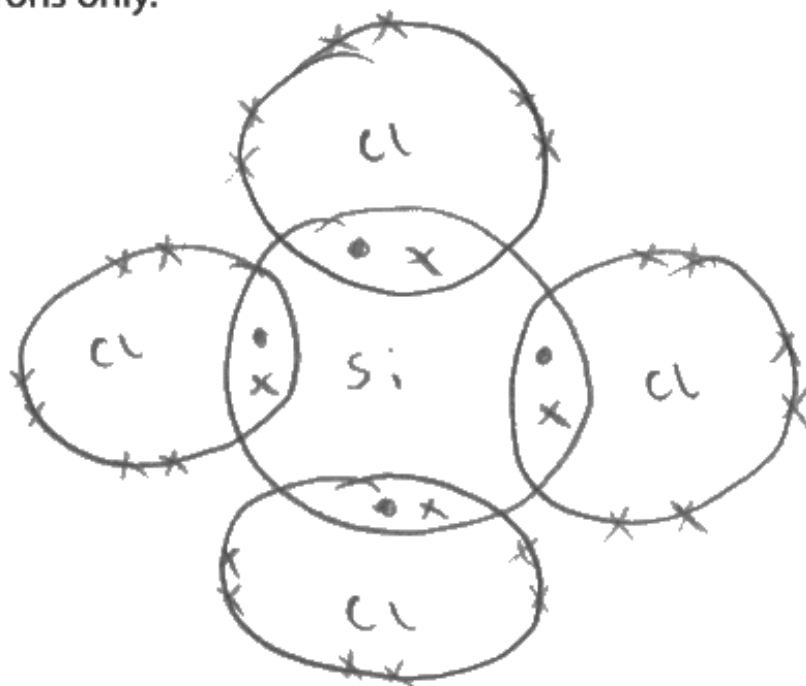
This might be heading towards a correct answer but is too vague and inaccurate to score.

Question 5 (a)(i)

This question was well answered with the majority of candidates gaining both marks for a clear, well drawn and easy to read diagram with circles (which are not required, but very helpful). Where a mistake did occur, one chlorine atom was sometimes missing an electron (or the silicon had extras), atoms were mislabelled (S and C), the molecule was SiCl, or ionic bonding was attempted.

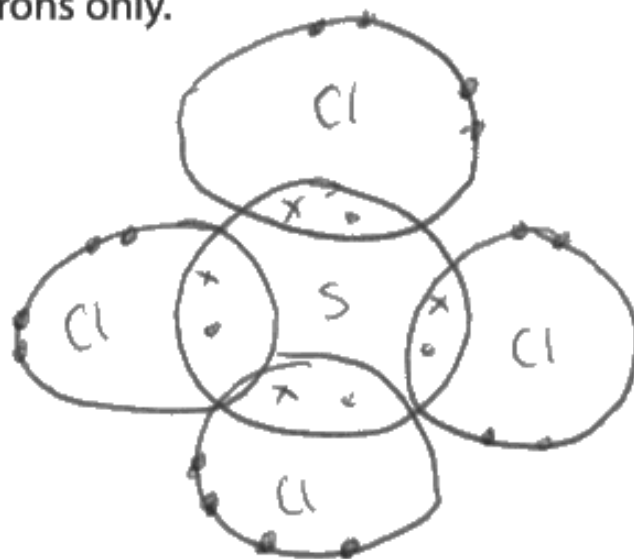
Draw a dot and cross diagram of a molecule of silicon tetrachloride, SiCl₄.

Show outer electrons only.



A clearly drawn diagram with correct dots and crosses and clear shells.

Draw a dot and cross diagram of a molecule of silicon tetrachloride, SiCl_4 .
Show outer electrons only.



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Examiner Comments

Count electrons carefully – chlorine is in group 7.

Question 5 (a)(ii)

This question was well answered with many candidates quoting weak intermolecular forces and then linking it to the energy required. Where incorrect, candidates either got the bonding wrong – weak (covalent/ ionic) bonds, weak forces between atoms – or mentioned about less energy being needed (than what?), or said that it was “easy to break” the forces.

they have low melting and boiling points because they are simple molecular covalent compounds, which means ^{their} these bonds are easier to break so they only require low melting and boiling points.



Bonds are not broken – only IMF. A common error.

(2)

weak intermolecular forces which require less energy to break giving it a low melting and boiling point.



Read your answers to see if they make sense. Here, "...less energy to break..." does not make sense – less than what?

(2)

The have low melting + boiling points because ~~to~~ between each molecule there is weak intermolecular forces. so not much energy is required to split them apart. so less heat needed = low mp + bp.



This candidate has the correct idea.

Question 5 (c)

For a very standard question, answers were rather more variable than might be expected.

For diamond, the description was often reasonable but sometimes too vague – using the correct terms such as giant lattice was most helpful. The idea that each carbon was joined to four others was sometimes garbled. Many stated that diamond had strong bonds (so was hard), or that it didn't conduct because there are no delocalised electrons. Some errors included that diamond is tightly packed and so there is no space for electricity to move, diamond has strong intermolecular bonds.

For graphite, many candidates seemed to know that each carbon was bonded to three others, but again this could be garbled. They knew that graphite had delocalised electrons, so could conduct. Some errors included that graphite has “spaces” so electricity can move through them, graphite is in layers which can slide over one another, then it must be malleable (c.f. metals) (rather than soft or flaky).

Despite the question asking about “these properties” (conductivity and hardness/ flakiness), some wasted time discussing in detail the high (or low) melting point of the structures. The language used about bonding was frequently inaccurate (giant covalent bonds).

Many answers were in Level 2 (3-4 marks) and usually linked in delocalised electrons to conductivity or they talked about the structure without linking in hard/flaky. Many fewer gave a detailed enough description and explanation to score Level 3 (5-6 marks). Good examples of detailed explanations included: diamond is hard because it has lots of strong covalent bonds which require a lot of energy to break; diamond doesn't conduct because each carbon atom forms 4 covalent bonds, so it doesn't have delocalised electrons that can move; graphite conducts because it has delocalised electrons that are free to move; graphite is soft because it has layers that are held together by weak forces of attraction so they can slide past each other.

Diamond and graphite are both allotropes of carbon. Each carbon atom in diamond is bonded to 4 other carbon atoms by covalent bonds in a tetrahedral shape. This makes diamond very strong and gives it a very high melting and boiling point as you will need to break the strong covalent bonds which requires a lot of energy. Diamond also has no moving electrons therefore it can not conduct electricity making it a

poor electrical conductor.

Graphite Each carbon atom in graphite is bonded to 3 other carbon atoms by ^{strong} covalent bonds. This gives it a high melting and boiling point as it requires a lot of energy to break the strong covalent bonds. Unlike diamond graphite is structured in layers which can slide over each other this makes graphite soft and flaky while diamond is not as it has a rigid structure. Graphite can conduct electricity because there are moving electrons between the layers of graphite therefore allowing them to carry a charge. This makes graphite a good electrical conductor.



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Examiner Comments

This is a Level 3 answer. Whilst some material is irrelevant, it is well structured and has sufficient detail.

- Diamonds are bonded in form of four carbon atoms while graphite is bonded in form of three carbon atoms therefore diamond has a higher boiling point and melting point while graphite have both low melting and boiling point.

- Diamond is in a tetrahedral form as they're atoms are tightly packed together therefore they're poor conductors of electricity. On the other hand, graphite's atoms are widely spread apart therefore making them very soft and flaky and also very good conductors of electricity.

- Diamond is very hard as it can be used for different things like cutting objects etc. and graphite is a soft substance that can be used in the making of oil and screen protectors.



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Examiner Comments

This is a Level 1 answer. Whilst quite a lot has been written, there is almost no correct scientific information relating to the question.

10)

Diamond is a ^{structure} allotope of carbon and a giant covalent lattice. This means that each carbon atom is ^{covalently} bonded to four other carbon atoms. By having four covalent bonds the intermolecular forces between the carbon atoms are very strong and very ~~difficult~~ difficult to overcome. As a result diamond has a high melting and boiling point. These bonds also make diamond very durable and resistant. However diamond does not have any free electrons, as a result it cannot

conduct electricity.

Graphite is also an allotrope of carbon and a giant covalent structure (lattice). Each carbon atom is ^{covalently} bonded to another three carbon atoms. As a result, graphite also has a high boiling and melting point like diamond. However, graphite has weak ~~bonds~~ simple covalent bonds between layers that make it less durable and more soft and flaky. In comparison to diamond graphite has ~~one~~ free electrons within the structure that allows it to conduct electricity well and is often used to make electrodes.



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This is a Level 2 answer. Some of the material is incorrect, irrelevant or contradictory, but there is sufficient explanation of some properties.

Question 6 (a)(i)

The majority understood this easily, and referred to the bubble formation ("some bubbles" – although some said "few bubbles", identical to F) and the metal reaction. However, a small number seemed to look at the box order in the table rather than the reactivity order and talked about how G would have no reaction at all.

(4)

The bubbles formed at a moderate pace
and after three minutes some of the
metal had reacted.



The candidate has correctly stated the observations to be more vigorous than F but less than D.

Question 6 (a)(ii)

The idea of 'dilute' proved quite difficult to accurately define, with some candidates instead defining a weak acid or mentioning pH, and surprisingly few mentioning concentration.

Strong acids were better defined – talking about the amount of H^+ ions and quite often ions dissociating – but this was often mixed up with a concentrated acid.

dilute

(4)

has a higher pH as it is weakened
with other liquids so is used when you
don't want as strong of a reaction

strong acid

The particles dissolve fully in acid. and
has a very low pH. Is used when
you want a big reaction.



Neither comment has correctly defined the terms.

Question 6 (b)

Most candidates got the general idea here, calculating the moles and then multiplying by the Avogadro number. However, there were many errors. At the first stage, the Mr could be incorrectly calculated, or moles calculated as $325 \div 16.25 = 20$. Most then multiplied by the Avogadro number, although some divided. The most common error was not multiplying by 15. Where errors were made, candidates with clear working were able to achieve part marks.

$$\begin{aligned} & \text{Ans } \cancel{207} + 2 \times 16 + 3 \times 12 + 1 \times 3 \times 12 + 16 + 16 & (4) \\ & = 325 & 16.25 / 325 = 0.05 \\ & (6.02 \times 10^{23}) \times 0.05 = 3.01 \times 10^{22} \\ & = 15 \text{ atoms per ethanoate} \\ & = (3.01 \times 10^{22}) \times 15 = 4.515 \times 10^{23} \end{aligned}$$

$$\text{number of atoms} = 4.515 \times 10^{23}$$



The correct answer, and well set out.

(4)

$$\text{Moles} = \frac{\text{mass}}{\text{molar mass} \cdot (M_r)}$$

$$(1 \times 207) + (2^4 \times 12) + (6 \times 1) + (4 \times 16) = 325 \quad (M_r)$$

$$\text{Moles} = \frac{16.25}{325} = 0.05$$

$$0.05 \times (6.02 \times 10^{23}) = 3.01 \times 10^{22}$$

$$\text{number of atoms} = 3.01 \times 10^{22}$$



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Examiner Comments

A common error is illustrated here – omitting the $\times 15$.

Question 6 (c)

Many candidates calculated the number of moles of iron and copper correctly. Surprisingly, there were a few who did all the hard work on moles and the ratio of 2:3 but then failed to actually state which equation was correct. Some could not proceed because they tried to calculate moles with an inverted fraction. A few others tried to turn the ratio into an empirical formula. Others tried to prove it by balancing the equations instead. There were also many responses involving random combinations of the numbers given. Some appeared to guess equation 2 – with no justification this scored 0 marks.

(3)

$$\text{Fe} + \text{Cu(NO}_3)_2 \rightarrow \text{Fe(NO}_3)_2 + \text{Cu}$$

	2.24g	
Ar =	56	3.81g
0.04	= 0.04	63.5
0.06	0.04	= 0.06
	= 1g	0.04
	= 2	1.5g

Equation 2 is correct because for every 2 Fe, 3 Cu will be produced.

(Total for Question 6 = 13 marks)



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This candidate used the expected method to find the 2:3 ratio, hence equation 2.

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

① $56 \xrightarrow{\times 0.04} = 2.24g$

$63.5 \xrightarrow{\approx \times 0.06} = 3.81$

X (3)

② $112 \xrightarrow{\times 0.02} = 2.24$

$190.5 = 3.81$

$\frac{2.24}{112} = \boxed{0.02}$

$\frac{3.81}{190.5} = \boxed{0.02}$

Equation 2 represents the reaction



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Examiner Comments

This is an unusual method, but scientifically valid, and was fully credited.

Paper Summary

On the basis of the performance in this paper, candidates are advised to:

- learn how to interpret state symbols in equations to give expected observations
- practise how to deduce the electronic configurations of atoms **and ions**
- understand how conductivity is due to free electrons in metals and graphite, but free ions in ionic solutions and liquids
- review thoroughly the core practical on copper sulfate electrolysis
- learn the difference between strong & weak acids and dilute & concentrated acids
- practise calculating number of moles
- show clearly all steps in calculations

use accurate and detailed scientific vocabulary in descriptions and explanations

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