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Examiners' Report
March 2013

GCSE Chemistry 5CH2H 01

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March 2013

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Introduction

This was the third C2 Higher Chemistry examination for the GCSE Science specification. Candidates' knowledge and understanding of chemistry and the way that they communicate this knowledge are improving, although there is still room for further improvement.

Some excellent answers were seen across the paper from the most successful candidates, who were able to explain and describe key ideas and principles. It was pleasing to see these stronger candidates beginning to be able to describe practical aspects of chemistry in a more comprehensive way. Candidates are beginning to improve in their responses to the 6-mark questions but many still fail to achieve marks as they do not address the whole of the question posed.

Less able candidates found difficulty in writing chemical formulae of common compounds in the unit and could not explain or describe practical-based chemistry. Many found recalling definitions of key terms such as 'theoretical yield' very difficult and some still lose marks for using incorrect scientific terms or just not explaining themselves fully. Many candidates are still contradicting themselves in their answers.

This report provides exemplification of candidates' work, together with tips and/or comments, for a selection of questions. The exemplification will come mainly from questions that required more complex responses from candidates.

Salts

Question 1(b)

This question was generally well answered. Candidates lost marks when the formula had not been written in the correct format.

(b) Copper chloride contains copper ions, Cu^{2+}, and chloride ions, Cl^-.
Give the formula of copper chloride.

(1)

$CuCl_2$

ResultsPlus
examiner comment

A good example, with a subscript 2.

(b) Copper chloride contains copper ions, Cu^{2+}, and chloride ions, Cl^-.
Give the formula of copper chloride.

(1)

$Cu\,Cl^{2}$

ResultsPlus
examiner comment

This candidate has not scored the mark as they have written the formula in an incorrect way.

ResultsPlus
examiner tip

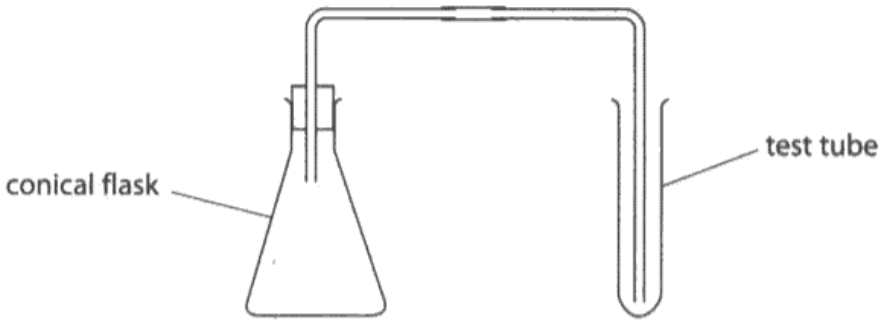
Ensure when you are writing chemical formulae that you use subscript and superscript numbers correctly.

Question 1(d)

In most cases this question was answered well. Where marks were lost it was because candidates had failed to address the question and state how the apparatus was used. A common mistake was to put reactants and limewater in the wrong part of the apparatus or not explain at all where they would be put. The limewater test was well known by candidates.

(d) Describe how this apparatus can be used to show that sodium carbonate reacts with dilute acid to form carbon dioxide.

(3)



You can use this equipment by putting/mixing the sodium carbonate and dilute acid together in the test tube. They will react and produce a gas which will travel along the tubing and into the conical flask where it can be tested for to reveal if it is CO_2 or not.

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examiner comment

A common mistake was to put the reactants and limewater in the wrong parts of the apparatus, which would not work.

ResultsPlus
examiner tip

When explaining practical detail, ensure that what you write will work in a practical context.

Question 1(e)

Many candidates scored well on this question, showing a good understanding of how a pure, dry, insoluble salt could be prepared.

(e) Copper carbonate is an insoluble salt.

Describe how you would use sodium carbonate and copper chloride to produce a pure, dry sample of copper carbonate.

(3)

The sodium carbonate is ~~mixed~~ dissolved in distilled water as well as copper chloride (separately). They are then mixed together thoroughly. Then, this mixture is filtered and the copper carbonate is collected in the filter paper. To ensure its pure, it is rinsed with distilled water and then left to dry, ~~on~~ giving a pure dry sample of copper carbonate.

(Total for Question 1 = 9 marks)

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examiner comment

An excellent answer that covers all points.

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examiner tip

When describing practicals remember to give each step of the practical and check back to the question to see that it has been addressed, eg pure – rinse with distilled water; dry – leave it to dry, or dry in the oven.

Rates of reaction

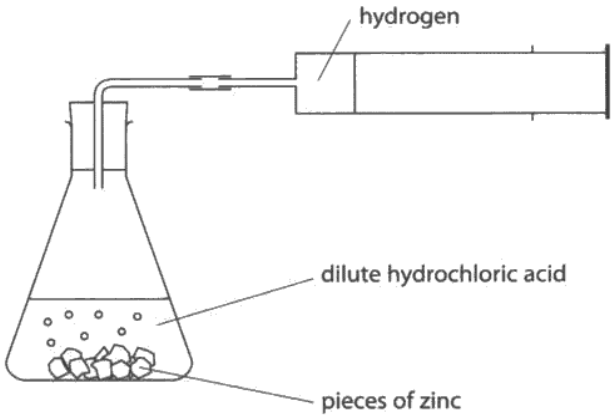
Question 2(a)(i)

The majority of candidates scored just 1 mark on this question for understanding that the line of the graph should have a gradient that is lower than the gradient for the initial investigation. Many candidates lost the second mark as they did not understand that reducing the temperature of the reaction does not have an effect on the yield of the reaction.

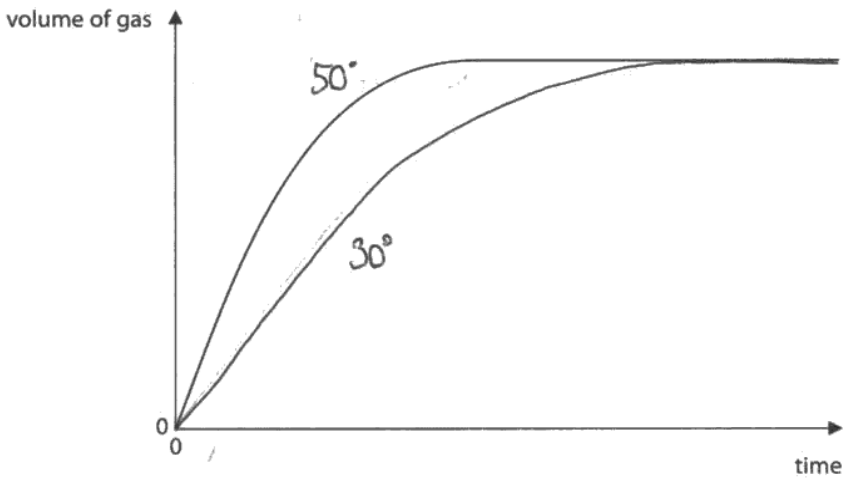
2 (a) Zinc is a metal.

Zinc reacts with dilute hydrochloric acid to produce zinc chloride and hydrogen.

Edward used this apparatus to investigate the speed of the reaction between zinc and dilute hydrochloric acid.



(i) Edward's results for 50 °C are shown on the graph.



Sketch a line on the graph to show the results that Edward should expect to obtain if he carried out the experiment to completion at 30 °C.

(2)

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examiner comment

A good answer. Candidates need to know that a change in temperature affects the rate, but not the yield, of the reaction.

Question 2(a)(ii)

Most candidates were able to explain that by using zinc powder rather than zinc pieces the surface area of the zinc increases. However, candidates found it hard to explain further how this change made the reaction faster.

(ii) When zinc powder is used, instead of larger pieces of zinc, the reaction is faster.

Explain, using ideas about particles, why the reaction is faster when zinc powder is used.

(2)

The reaction is faster because the surface area of zinc has increased. Therefor there's more area exposed for the particles to collide with, causing more frequent collisions.

ResultsPlus
examiner comment

A good answer.

(ii) When zinc powder is used, instead of larger pieces of zinc, the reaction is faster.

Explain, using ideas about particles, why the reaction is faster when zinc powder is used.

(2)

The reaction is faster because by reducing the size and using powder it creates a larger surface area which means more space available ~~to~~ for the reaction to happen.

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This candidate has gained the first mark for explaining that the surface area of the zinc has increased but has not gone on to explain how this makes the reaction faster.

Question 2(a)(iii)

Candidates seemed to find this a good way of showing their understanding of balancing equations, with 92% getting the correct value.

Question 2(a)(iv)

Candidates found this question very tricky to answer, with only the strongest candidates scoring full marks. Many did not read the question and just gave the definition of an exothermic reaction; many offered a very confused response and reversed the energy transfers associated with bond breaking and bond making; others described both processes as the same.

(iv) The reaction between zinc and dilute hydrochloric acid is exothermic.

Explain, in terms of breaking and forming bonds, why this reaction is exothermic.

(3)

The reaction is exothermic as during the reaction bonds are broken, when bonds are broken it gives out heat which is exothermic. By giving out heat this would have resembled a rise in temperature during the reaction. It is not endothermic as no energy was taken in to form new bonds.

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This candidate has, as many others did, given the energy transfers the wrong way round.

ResultsPlus
examiner tip

Remember that breaking bonds requires an input of energy.

(iv) The reaction between zinc and dilute hydrochloric acid is exothermic.

Explain, in terms of breaking and forming bonds, why this reaction is exothermic.

(3)

. Because more energy is needed to break the bond than to make them.
. Heat is being released - tempeature rises - feels warmer.

ResultsPlus
examiner comment

This is an example of how poor use of language has lost the candidate marks. Had this response said 'Because less energy is needed to break the bonds than is produced by forming bonds', full marks would have been awarded. This answer implies that the candidate thinks that energy is needed to break and to make bonds.

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When answering 'explain' questions, ensure that you give as much detail as you can to show your understanding.

Question 2(b)

The majority of candidates could answer this question well; often candidates gave more information than was required.

(b) Catalysts are added to some reactions.

State the effect of catalysts on reactions.

(1)

Catalysts increase the rate of reaction. Speed increases!

ResultsPlus
examiner comment

A good answer.

Mixtures

Question 3(b)(i)

It was pleasing to see that the majority of candidates could correctly draw a dot and cross diagram for a molecule of oxygen.

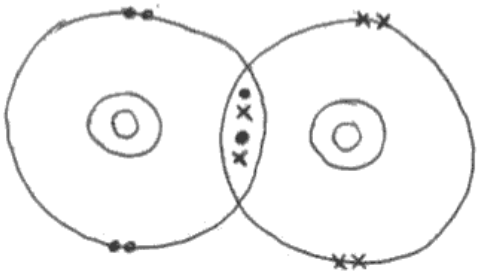
(b) Oxygen is a simple molecular, covalent substance.

(i) The electronic configuration of oxygen is 2.6.

Draw a dot and cross diagram for a molecule of oxygen, O_2.

Show the outer electrons only.

(3)



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Excellent.

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It is useful to show different atoms with different symbols for the electrons (dots or crosses) so that you can see where electrons have come from.

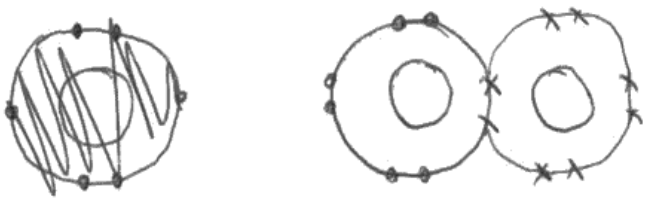
(b) Oxygen is a simple molecular, covalent substance.

(i) The electronic configuration of oxygen is 2.6.

Draw a dot and cross diagram for a molecule of oxygen, O_2.

Show the outer electrons only.

(3)



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examiner comment

A common error was to draw just one shared pair of electrons between the two oxygen atoms.

Question 3(b)(ii)

Candidates who scored well on this question were clear in their answer and used the correct terms. Many lost marks as they did not link the weak forces between the molecules to a low amount of heat/energy needed to break these forces.

(ii) The boiling point of oxygen is –183 °C.

Explain, in terms of the forces between the molecules, why oxygen has a very low boiling point.

(2)

Because the molecules have ~~bonds~~ weak not bonds so it takes less energy to break them.

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This exemplifies how important it is for candidates to ensure, in questions like this where there could be some doubt, that their meaning is very clear. Does this candidate mean there are weak bonds in the molecules or weak forces between the molecules?

ResultsPlus
examiner tip

It is essential to use the correct terms and to make sure your answer is not ambiguous.

(ii) The boiling point of oxygen is –183 °C.

Explain, in terms of the forces between the molecules, why oxygen has a very low boiling point.

(2)

oxygen has a low boiling point because the bonds joining the atoms are weak which means not a lot of energy is needed to break them.

ResultsPlus
examiner comment

Here it is clear that the candidate is talking about bonds between the atoms, not forces between the molecules, which makes the second part also incorrect.

(ii) The boiling point of oxygen is –183 °C.

Explain, in terms of the forces between the molecules, why oxygen has a very low boiling point.

(2)

The inter-molecular forces between the molecules of oxygen are very weak therefore ~~they~~ does it does not take much energy to break these apart.

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An excellent answer. This candidate has described the forces between the molecules as weak and linked this to the question by stating that it does not take much energy to break the weak forces.

ResultsPlus
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Always check back to ensure that the response you have given answers the question that has been asked.

Question 3(c)

This question was not very well answered. Many candidates neglected to read the question and gave a very long-winded account of how liquid air is cooled and how impurities/other substances are removed.

(c) Describe how oxygen and nitrogen are obtained from liquid air by fractional distillation.

(3)

Air is filtered to remove dust. It is then cooled to around -200°C at which point water vapour condenses and is removed and carbon dioxide freezes and is removed. The mixture is then slowly heated in a fractioning ~~column~~ column, causing liquid oxygen and argon to come out the bottom and nitrogen gas to come out the top. The oxygen and argon can then be seperated.

(Total for Question 3 = 9 marks)

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examiner comment

Although this candidate has scored full marks, the first three lines of the answer are irrelevant to the context of the question and wasted precious time in the examination.

ResultsPlus
examiner tip

Ensure that you are clear what the question is asking; look for important details, 'liquid air' in this case.

(c) Describe how oxygen and nitrogen are obtained from liquid air by fractional distillation.

(3)

When the air is pumped into the fractional distillation chamber it first has to pass through cooling tubes, these are so cold that (liquid) oxygen forms and is removed, it is then cooled even further, which causes nitrogen to become liquid and drop to the bottom of the distillation tower

(Total for Question 3 = 9 marks)

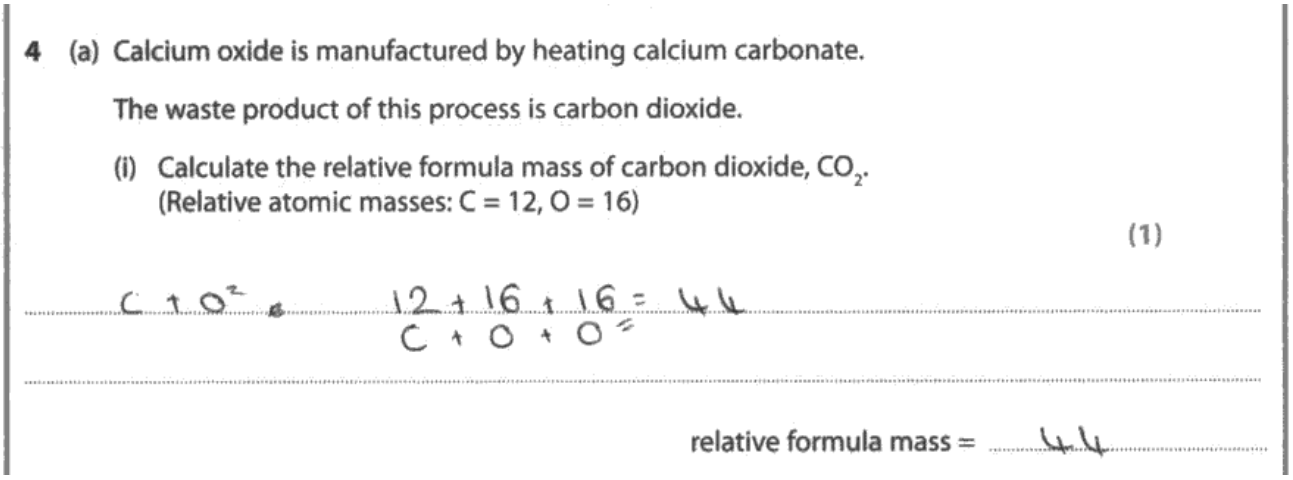
ResultsPlus
examiner comment

A confused answer which gains no marks.

Calcium carbonate

Question 4(a)(i)

Many candidates performed well on this question with 77% able to calculate the relative formula mass of carbon dioxide. Where candidates lost marks, this was because they failed to multiply the relative atomic mass of oxygen by 2.



4 (a) Calcium oxide is manufactured by heating calcium carbonate.

The waste product of this process is carbon dioxide.

(i) Calculate the relative formula mass of carbon dioxide, CO_2.
(Relative atomic masses: C = 12, O = 16)

(1)

C + O^2 = 12 + 16 + 16 = 44
C + O + O =

relative formula mass = 44

ResultsPlus
examiner comment

A good answer. The candidate has shown all the working so if they had not written 44, they still would have got the mark.

ResultsPlus
examiner tip

Remember always to show your working; marks are awarded for your knowledge of chemistry so if mistakes are made in the end result, marks can still be awarded for the working, which demonstrates your understanding.

Question 4(a)(ii)

Many candidates calculated the relative formula masses of calcium carbonate and calcium oxide but then could not do the final part of the calculation.

Question 4(b)(i)

Many candidates lacked detail in their answer ('the yield that you would expect to get'), or simply restated the question ('the theoretical yield is the yield that you get in theory'), neither of which was sufficient to gain the mark.

Question 4(b)(ii)

This question was well answered, with many candidates able to give all three points from the mark scheme.

(ii) Explain why the actual yield for a reaction is usually less than the theoretical yield for the reaction.

(2)

The reaction is incomplete, or other unwanted reactions took place, or product was lost during preparation for the reaction.

ResultsPlus
examiner comment

A good answer.

Question 4(c)

The majority of candidates scored at least 1 mark for stating that this would increase profit/save money.

(c) Many industrial processes produce waste products.

Suggest reasons why manufacturers try to find uses for these waste products.

(2)

It is more cost effective and efficient to have useful waste products that can be used for other purposes and it would mean that the waste products would not have to be manually disposed off so it would cost less and possibly less harmful for the environment.

(Total for Question 4 = 9 marks)

ResultsPlus
examiner comment

A good answer.

Group 1

Question 5(b)

This question was poorly answered with many candidates describing the reactivity of the alkali metals in terms of their electronic configuration and not explaining the properties detailed in the question stem.

(b) When sodium is added to cold water, it forms a molten ball which floats on the surface of the water.

Explain why this happens.

(2)

The reaction of the sodium and water makes the sodium form the molten ball. ~~It~~ The density of the sodium makes it float on the water.

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This response gets very close to scoring towards the end but due to a lack of detail does not score any marks. The candidate first rewrites the question, which scores no marks, then addresses the fact that sodium floats on the water but does not state why.

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Ensure that you do more in your response than simply restate the question; there will be no marks for this and it will waste time in the examination.

Question 5(c)

Candidates found this question very difficult. The formulae of sodium and water were well known but the products of the reaction were not. Candidates who did have a good idea lost marks as they did not know the formula (many gave sodium oxide) or forgot that hydrogen was a diatomic molecule. Those who did know the formulae of both the reactants and products were able to balance the equation.

(c) Write the balanced equation for the reaction of sodium with water. (3)

$Na + H_2O \rightarrow 2NaH_2O$

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This candidate has the formulae of the reactants correct but has not shown the correct formula for sodium hydroxide.

Question 5(d)

There were some very good answers explaining why potassium is more reactive than sodium. Candidates do need to be careful with language, however; some muddled up the name of particles, eg it was not always an electron in the outer shell of the potassium that was being referred to, which meant that 5 marks were awarded, rather than 6.

The similarities between sodium and potassium were less well explained, with many candidates simply stating that they both have one electron in the outer shell. They needed to relate this to reactivity by stating that both lose this electron easily when they react.

*(d) Sodium and potassium react with cold water to give similar products.

The electronic configuration of sodium is 2.8.1.
The electronic configuration of potassium is 2.8.8.1.

Explain the similarities and differences in the way sodium and potassium react with cold water by considering their reactions and their electronic configurations.

(6)

The Similarites between sodium and potassium are that they both have 1 electron in there outter shell, ionic bonding takes place so that they have a full outter shell. They both lose an electron when they react with water to become positive

The difference is that as you go down the alkali metals they become less reactive, so Sodium is more reactive than potassium.

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This response has given a correct similarity and also states that both lose an electron when they react. However, the difference that has been given is incorrect. This is a Level 1 response.

*(d) Sodium and potassium react with cold water to give similar products.

The electronic configuration of sodium is 2.8.1.
The electronic configuration of potassium is 2.8.8.1.

Explain the similarities and differences in the way sodium and potassium react with cold water by considering their reactions and their electronic configurations.

(6)

Sodium and potassium are both in group one and contain 1 electron on their outer shell and so react similar in that they emit light, produce hydrogen gas, became a hydroxide and float on the surface of the water. However potassium's reaction with water is more vigorous as potassium is more reactive than sodium as the outermost electron of potassium is easier to removed in a reaction than sodium's because it is further away from the positive nucleus so the electrostatic force holding it in place is weaker so the last electron of potassium is easier to remove causing a more vigorous, faster and hotter reaction than that of sodium's.

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This response gives a good detailed description of the reactions of sodium and potassium, and adds an explanation. The difference between sodium and potassium is also stated, and an explanation in terms of electronic configuration is offered. A Level 3 response.

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Ensure that all parts of the question have been addressed.

Isotopes

Question 6(a)(i)

This question was well answered, with 90% of candidates able to give the correct electronic configuration of boron.

Question 6(a)(iii)

This question was generally well answered with the majority of candidates scoring full marks.

Question 6(b)

In general, candidates performed well on this question. Many candidates could give a good description of why the relative atomic mass of boron was 10.8; however, some gave a more limited description by simply stating that it was nearer 11 than 10 as there was more of boron-11 than 10.

When describing the boron-11 atom, many candidates gave a more generic definition of an isotope and simply stated that there were more or a different number of neutrons in the boron-11 atom; stronger candidates applied their knowledge of isotopes to the boron-11 atom and described the number of all of the sub-atomic particles that are present.

*(b) A sample of boron contains 20% boron-10 and 80% boron-11.

In part (a) you were given the structure of a boron-10 atom.

Describe the structure of a boron-11 atom and explain why, in this sample, boron has a relative atomic mass of 10.8.

(6)

Boron-11 is very similar to Boron-10 in the way it has 5 protons in the nucleus, and 5 electrons with a configuration of 2.3. However Boron-11 has 6 neutrons in the nucleus whereas Boron-10 has 5. Boron has a relative atomic mass of 10.8 because there is more Boron-11 than Boron-10 and so the relative atomic mass is closer to 11 than to 10. This is because the relative atomic mass takes into account isotopes. and there in the sample there is 80% boron-11 and 20% boron-10.

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examiner comment

This response shows a limited description of the relative atomic mass of the boron-11 atom and a limited explanation of why the relative atomic mass is 10.8. It achieved a mark in Level 2.

*(b) A sample of boron contains 20% boron-10 and 80% boron-11.

In part (a) you were given the structure of a boron-10 atom.

Describe the structure of a boron-11 atom and explain why, in this sample, boron has a relative atomic mass of 10.8.

(6)

Boron - 11 atom has [illegible] a different atomic form but in the same element where the proton numbers are the same but its neutron numbers are different. So boron - 11 has 6 neutrons, 5 electrons and 5 protons. Boron - 11 has a relative atomic mass of 10.8 due to their being 2 boron - 11 with every 1 boron - 10

ResultsPlus
examiner comment

This response gives a description of the boron-11 atom; however, the explanation for the relative atomic mass is incorrect so did not gain any credit. It achieved a mark in Level 1.

*(b) A sample of boron contains 20% boron-10 and 80% boron-11.

In part (a) you were given the structure of a boron-10 atom.

Describe the structure of a boron-11 atom and explain why, in this sample, boron has a relative atomic mass of 10.8.

(6)

A boron-11 atom has 6 neutrons and 5 protons in its nucleus which gives the nucleus a overall positive charge and most of the mass of the atom. Boron-11 has a total of 5 electrons, 2 on the first shell and 3 on the outer shell. These shells give the atom its shape and balances out (as electrons are negative) the positive charge of the nucleus to give the atom a neutral charge overall. In this sample boron has a relative atomic mass of 10.8 because 80% of the particles are boron-11 and only 20% are boron 10. So: $\frac{(10 \times 20) + (80 \times 11)}{100} = 10.8$.

Therefore in this sample of boron, the relative atomic mass of boron is 10.8.

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This response gives a detailed and comprehensive description of the boron-11 atom and an explanation of the relative atomic mass of the boron sample. Quality of written communication (QWC) is good. This candidate gained full marks.

Question 6(c)

The majority of candidates scored 1 mark on this question. One problem was that it was not always clear whether the answer was providing a similarity or a difference. The most common answer stated that Mendeleev left gaps and the modern periodic table has these gaps filled.

Summary

In future, candidates need more practice in answering questions that involve describing experiments. Some candidates would benefit from revising atomic structure and bonding and others need to practise simple calculations.

Based on their performance on this paper, candidates should:

- read the question carefully and make sure that they are answering the question asked and using the information given
- learn the formulae of elements and simple compounds in the unit
- practise balancing chemical equations
- practise the calculations in the specification
- practise writing descriptions of carrying out experiments.

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