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Examiners' Report
June 2013

GCSE Chemistry 5CH2H 01

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June 2013

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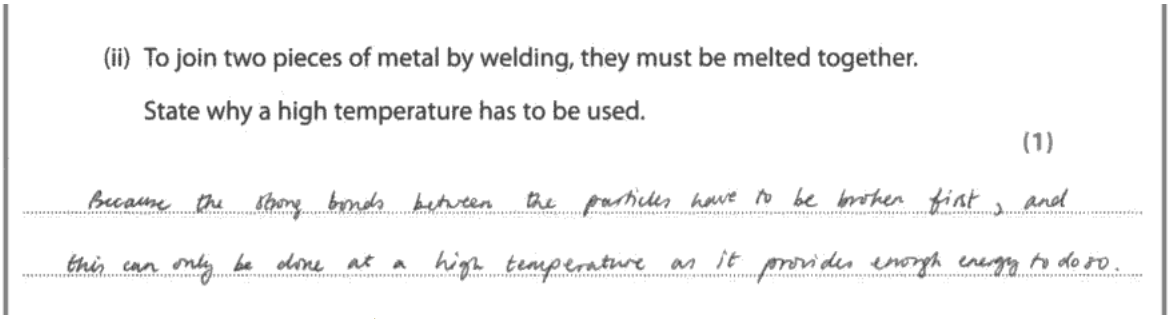
Introduction

This was the fourth C2 Higher Chemistry examination for the GCSE Science specification. Candidates seemed to find the majority of the paper accessible and they were able to display their knowledge and understanding of chemistry across a variety of types of question. Some excellent answers were seen and it was particularly pleasing to see good responses to the free-response six mark questions although some candidates still need to improve their organisation in their answers. It was evident that some candidates had not learned the test for ions. The answers to the question requiring an explanation of relative atomic mass were of a low standard. It is still very disappointing to see the difficulty so many candidates have in writing the chemical formulae of common compounds such as sulfuric acid. Many still lose marks for using scientific terms incorrectly and many candidates contradict themselves in their answers, often at the end of their answer, and so spoil their earlier good work.

Question 1 (a) (ii)

Many candidates gave the expected answer of high melting point but others answered in terms of energy required to break bonds and many of these answers were correct. However some incorrectly made references to ionic or covalent or intermolecular bonds. A small minority of the candidates discussed a high boiling point while others effectively just repeated the question.



(ii) To join two pieces of metal by welding, they must be melted together.

State why a high temperature has to be used.

(1)

Because the strong bonds between the particles have to be broken first, and this can only be done at a high temperature as it provides enough energy to do so.

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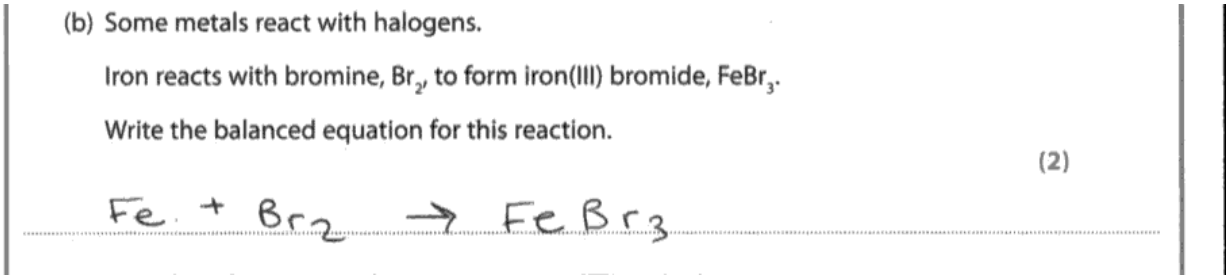
An acceptable way of answering the question worth the mark.

Question 1 (a) (iii)

Many candidates gained one mark by correctly stating that argon is inert or unreactive or a noble gas. Some candidates then went on to gain a second mark by explaining this idea using the idea of the full outer shell and some others explained that oxygen would react with the metal. However, a significant number of candidates did not gain a second mark as they answered in terms of argon not reacting with oxygen or not being flammable and a surprising number thought argon was a catalyst.

Question 1 (b)

Many candidates who gave correct symbols and formulae could also balance the equation. Some lost a mark by using the wrong case letters and others gave the wrong formula for $FeBr_3$ and/or Br_2 which should not have happened as these were given in the question. Other errors included putting charges or oxidation states on the iron or trying to balance the equation by putting a number in the middle of the formula, e.g. Fe2Br3.



(b) Some metals react with halogens.

Iron reacts with bromine, Br_2, to form iron(III) bromide, $FeBr_3$.

Write the balanced equation for this reaction.

(2)

$Fe + Br_2 \rightarrow FeBr_3$

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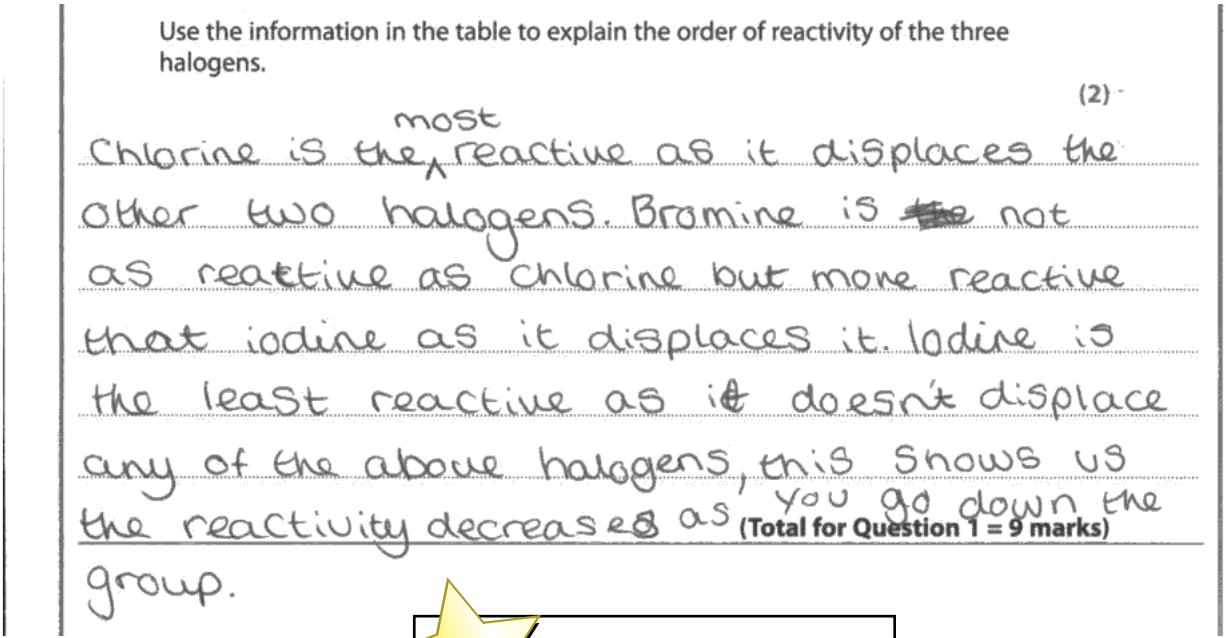
Correct formulae but not balanced so worth 1 mark.

Question 1 (d)

The majority of candidates seemed to know the order of the reactivity of the halogens. However there was a good deal of confusion as to when to use the name of the halogen and when to use the name of the halide ion e.g. candidates referred to bromide and iodide being displaced. Some failed to score marks as they referred to the order of reactivity of the halide ions instead of the halogens. Some weaker candidates thought chlorine was the least reactive giving the reason that chloride would not react with any of the halogens.



Use the information in the table to explain the order of reactivity of the three halogens.

(2)

Chlorine is the most reactive as it displaces the other two halogens. Bromine is ~~the~~ not as reactive as chlorine but more reactive that iodine as it displaces it. Iodine is the least reactive as it doesn't displace any of the above halogens, this shows us the reactivity decreases as you go down the group.

(Total for Question 1 = 9 marks)

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An answer worth two marks.

Use the information in the table to explain the order of reactivity of the three halogens.

(2)

chlorine is the highest in reactivity order because it reacts with bromide ion and iodide ion, second is bromine which reacts with iodide ion, and third is iodine which reacts with none of the halide ions.

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A good answer for two marks.

Use the information in the table to explain the order of reactivity of the three halogens.

(2)

the most reactive halogen out of these three is chlorine as it causes A displacement reaction with a bromide and iodide ion, Bromine is the second most reactive as it is below Chlorine in the periodic table, Iodine is the least reactive as it doesn't cause any displacement reactions, Iodine is below Bromine in the periodic table.

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Examiner Comments

A good answer for 2 marks.

Question 2 (a) (i)

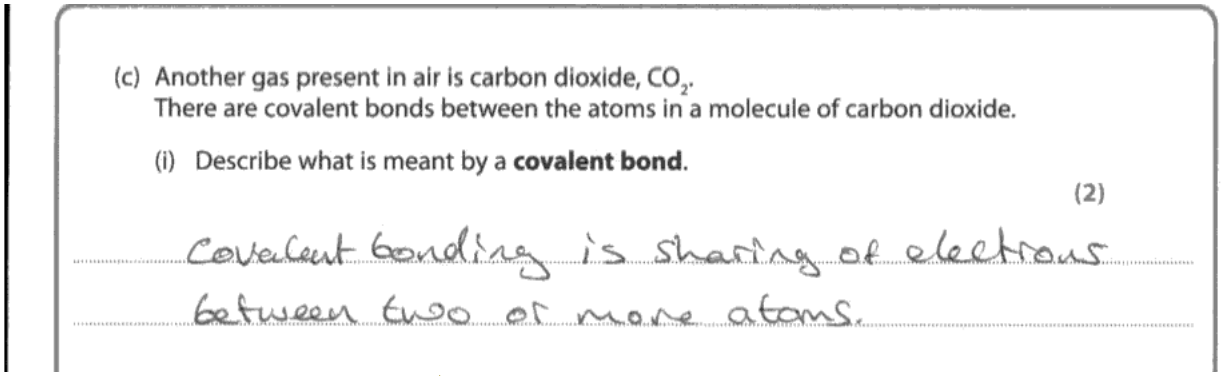
Fractional distillation was correctly given by about two thirds of candidates but some omitted the word fractional.

Question 2 (a) (ii)

Although many candidates gave a correct answer, quite frequently in terms of removing water or carbon dioxide, there were a surprising number of misconceptions including those who thought cooling was to remove dust particles and others simply stated that cooling the air would make it all the same temperature. Others tried to bring in rates of reaction and talked about a lower temperature stopping the air reacting.

Question 2 (c) (i)

Many candidates scored 1 mark for stating that covalent bonding involves the sharing of electrons, but they usually failed to gain the second mark for stating that a pair of electrons are shared.



(c) Another gas present in air is carbon dioxide, CO_2.
There are covalent bonds between the atoms in a molecule of carbon dioxide.

(i) Describe what is meant by a **covalent bond**.

(2)

Covalent bonding is sharing of electrons between two or more atoms.

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Examiner Comments

A typical answer worth one mark.

Question 2 (c) (ii)

The large majority of candidates gave the correct configuration.

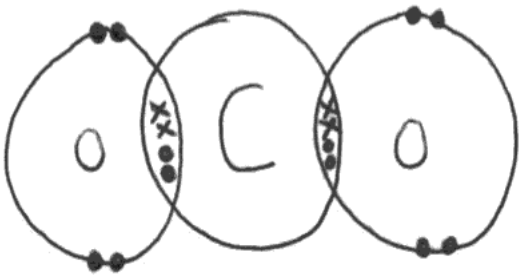
Question 2 (c) (iii)

Most scored a mark for correctly showing a shared pair of electrons in a molecule of carbon dioxide. A common error was to show single bonds between the atoms rather than double bonds and a few candidates who did show double bonds lost marks by putting extra electrons on carbon and/or oxygen. Some candidates lost both marks as they failed to draw a correct CO_2 molecule, CO was often seen and sometimes COC.

(iii) Draw a dot and cross diagram of a molecule of carbon dioxide.

Show outer electrons only.

(2)



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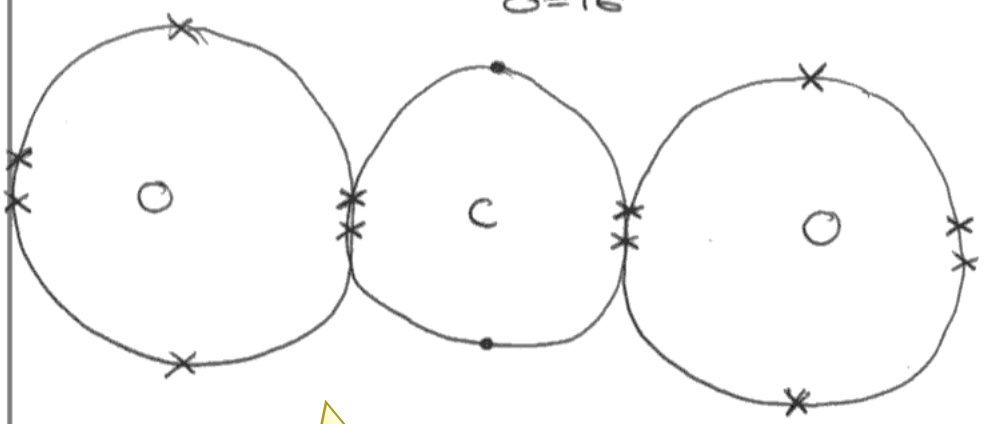
Examiner Comments

A well drawn answer for two marks.

(iii) Draw a dot and cross diagram of a molecule of carbon dioxide.

Show outer electrons only. C = 12 O = 16

(2)



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An answer worth 1 mark for showing a shared pair of electrons in a CO_2 molecule.

Question 3 (a)

Candidates often scored 2 marks for mentioning carbon dioxide and describing a correct limewater test. However the need to add acid to the calcium carbonate or to heat it to produce the carbon dioxide was often omitted with a large number of candidates suggesting that the calcium carbonate should be added directly to the limewater. Some candidates described a flame test approach to identify calcium ions rather than the carbonate in calcium carbonate and so gained no credit.

3 In industry sodium carbonate is made from sodium chloride solution and calcium carbonate in the Solvay Process.

(a) Describe the test to show that calcium carbonate contains carbonate ions.

(3)

Add ~~calcium~~ the calcium carbonate to limewater. After stirring, the limewater will turn cloudy if a carbonate is present.

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Examiner Comments

Quite a common answer which was awarded one mark for the result of a limewater test.

3 In industry sodium carbonate is made from sodium chloride solution and calcium carbonate in the Solvay Process.

(a) Describe the test to show that calcium carbonate contains carbonate ions.

(3)

Firstly, add dilute nitric acid ~~acid~~ to the calcium carbonate. Then, pass the gas given off through limewater, if it turns milky carbonate ions are produced/present.

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A good answer worth all three marks.

3 In industry sodium carbonate is made from sodium chloride solution and calcium carbonate in the Solvay Process.

(a) Describe the test to show that calcium carbonate contains carbonate ions.

(3)

Carbonates give off carbon dioxide when heated. If you heat the calcium carbonate the tube off what gases are released into limewater, the limewater will turn milky.

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Examiner Comments

An acceptable method of heating the calcium carbonate to produce the carbon dioxide and then correctly testing for it and so worth 3 marks.

Question 3 (b)

The majority of candidates got this correct although there were the occasional addition errors, and a few candidates forgot to multiply 35.5 by 2. Some were awarded the mark (which was for the working) for doing the correct calculation but giving the answer as 110. Some weaker candidates gained no marks for incorrect calculations or did not attempt the question.

(b) Another product of the Solvay Process is calcium chloride.

Calculate the relative formula mass of calcium chloride, $CaCl_2$.
(Relative atomic masses: Ca = 40; Cl = 35.5)

(1)

$40 + (35.5 \times 2) = 71.$

35.5
35.5
71.0

relative formula mass = 71.0

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Examiner Comments

This gained the mark as it was given for showing the correct working despite the careless error in evaluating the answer.

(b) Another product of the Solvay Process is calcium chloride.

Calculate the relative formula mass of calcium chloride, $CaCl_2$.
(Relative atomic masses: Ca = 40; Cl = 35.5)

(1)

2 + (40 x 35.5)

relative formula mass = 1422

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It was surprising what some candidates did with the relative atomic masses.

(b) Another product of the Solvay Process is calcium chloride.

Calculate the relative formula mass of calcium chloride, $CaCl_2$.
(Relative atomic masses: Ca = 40; Cl = 35.5)

(1)

40 + 40 + (35.5 x2) = 151

relative formula mass = 151

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Some multiplied the Ar of calcium by two as well.

Question 3 (c)

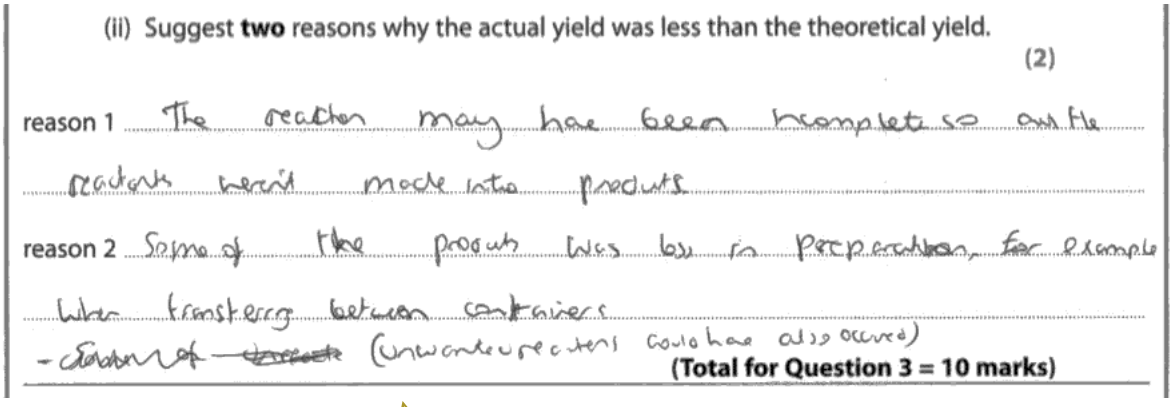
Stronger candidates answered this reacting mass calculation very well. Less confident candidates mixed up the numbers in the calculation e.g. (100x40)/106, but others did not seem to know how to approach it and performed random calculations with the numbers given. Others simply did not attempt it.

Question 3 (d) (i)

The majority of candidates answered this correctly. Many were awarded one mark for showing 10.4/15.0 but were not awarded the second mark as they had not multiplied by 100. The most common error was made by those who got the calculation the wrong way round and divided 15.0 by 10.4. They seemingly failed to realise that 144% was not a sensible answer for a percentage yield.

Question 3 (d) (ii)

Many students seem to have been well trained in their answers to this question. However a range of non-creditworthy answers were suggested. Some of these involved giving definitions of theoretical yield or referred to the difference between theoretical and actual yield or stated that yield calculations are simply inherently faulty. Others made vague suggestions such as "human error" or errors due to parallax and the need to measure solutions at eye level.



(ii) Suggest **two** reasons why the actual yield was less than the theoretical yield.

(2)

reason 1 The reaction may have been incomplete so all the reactants haven't made into products

reason 2 Some of the product was lost in preparation, for example when transfering between containers

- Side reactions (unwanted reactions could have also occured)

(Total for Question 3 = 10 marks)

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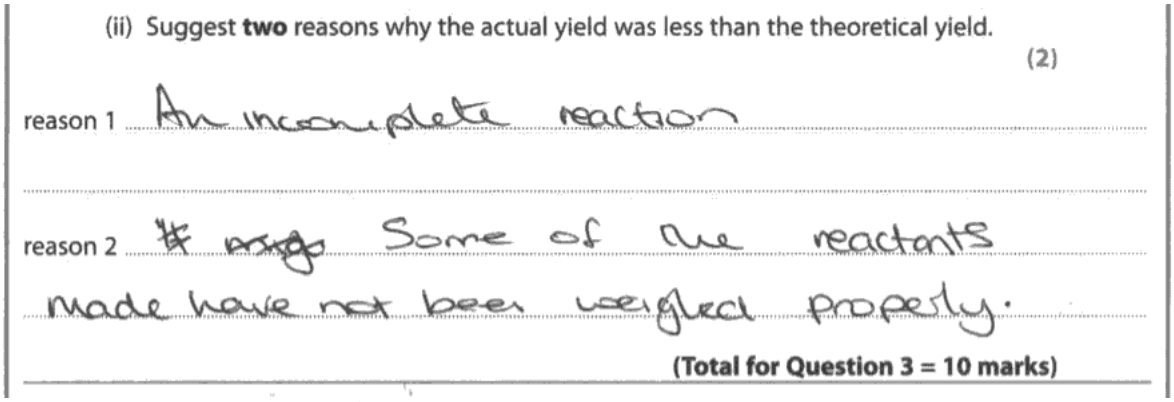
An answer worth both marks.



(ii) Suggest **two** reasons why the actual yield was less than the theoretical yield.

(2)

reason 1 An incomplete reaction

reason 2 ~~# angry~~ Some of the reactants made have not been weighed properly.

(Total for Question 3 = 10 marks)

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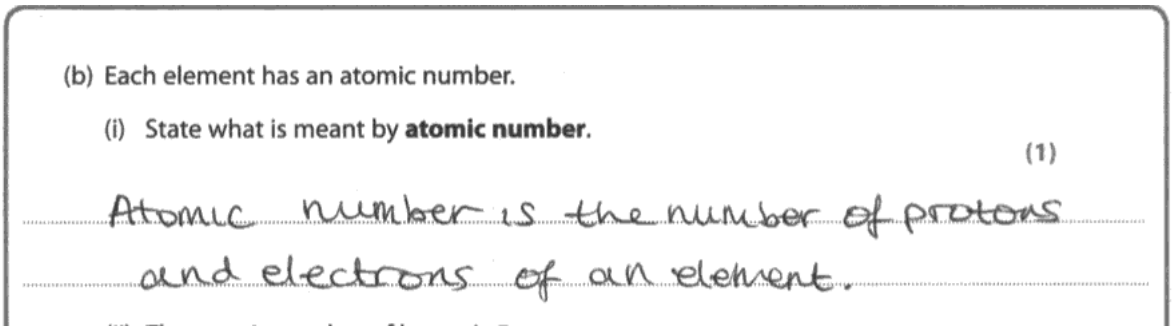
Examiner Comments

The first reason is correct but errors in weighing were not acceptable.

Question 4 (b) (i)

The definition of atomic number was well known by most candidates although many needed the benefit of 'the number of protons and electrons' being accepted. Of the incorrect responses, some confused atomic number with mass number and a few lost the mark by saying it was the number of electrons without referring to protons and a minority suggested it meant the number of atoms.



(b) Each element has an atomic number.

(i) State what is meant by **atomic number**.

(1)

Atomic number is the number of protons and electrons of an element.

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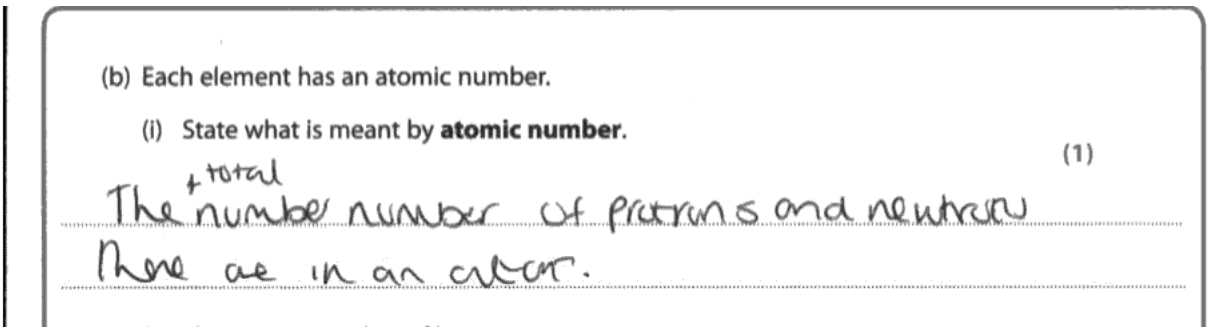
This was given the benefit of the doubt and accepted for a mark.



(b) Each element has an atomic number.

(i) State what is meant by **atomic number**.

(1)

The + total number number of protons and neutrons in an atom.

ResultsPlus
Examiner Comments

Some confused it with mass number.

Question 4 (b) (ii)

The definition of an isotope was well known by many who gave the more generic answer involving atoms having the same number of protons but different number of neutrons, rather than referring specifically to boron. Some lost one mark as they did not refer to protons in their answer.

Question 4 (c) (i)

This proved to be a very difficult question for all except the very strongest candidates. Even of those, very few candidates scored both marks. Most answers seen referred to "the number of protons and neutrons added together" without any mention of relative atomic mass being an average. Very few referred to carbon-12. A quite frequently seen incorrect answer was a reference to "the top number on the symbol in the periodic table".

(c) (i) Explain what is meant by the term relative atomic mass.

(2)

Relative atomic mass is the mass of the particles in the nucleus ~~electro-~~ ns protons and neutrons.

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An all too common answer which did not gain any marks.

Question 4 (c) (ii)

Many of the stronger candidates knew how to do this calculation and scored full marks with ease. A few scored the first two method marks but then failed to divide by 100 or divided by 21 so lost the third mark. Those who did not know the method required, either used the numbers in a random manner or did not attempt the question at all.

(ii) A sample of boron contains
19.7% of boron-10.
80.3% of boron-11.

Use this information to calculate the relative atomic mass of boron. **(3)**

$\frac{(19.7 \times 10) + (80.3 \times 11)}{(19.7 + 80.3)}$ $\frac{197 + 883.3}{100}$

$= 10.803$

Relative atomic mass = 10.8

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A well-presented answer for full marks.

(ii) A sample of boron contains
19.7% of boron-10.
80.3% of boron-11.

Use this information to calculate the relative atomic mass of boron. **(3)**

Boron - 10 = 19.7 %

Boron - 11 = 80.3 %

$(10 \times 19.7) + (11 \times 80.3)$

$197 + 883.3$

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This candidate gained the first two marks but did not divide by 100 so did not gain the third mark.

Question 5 (a) (ii)

The high melting point of sodium chloride was well explained by large numbers of candidates with many scoring full marks. The majority of incorrect answers were in terms of molecules, or intermolecular forces. Marks were usually achieved by reference to strong (ionic) bonds and a lot of energy being needed to break them. However even strong candidates rarely mentioned the attraction between oppositely charged ions.

(ii) Sodium chloride has a melting point of 801 °C.

Explain why the melting point of sodium chloride is high.

(2)

Sodium chloride is an ionic compound which means a lot of energy ('heat') is needed to break the strong ionic bonds

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A typical way in which both marks were gained.

(ii) Sodium chloride has a melting point of 801 °C.

Explain why the melting point of sodium chloride is high.

(2)

Sodium chloride has a high melting point due to its strong lattice structure where there are strong electrostatic forces of attraction

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Candidate gains one mark for correctly mentioning the strong electrostatic forces of attraction but like many others did not refer to them being between oppositely charged ions and so did not gain the second mark.

Question 5 (a) (iii)

Strong candidates knew this test and gave a perfect answer. A few lost the first mark for failing to add nitric acid or adding hydrochloric acid instead. Some added the nitric acid and failed to mention silver nitrate so also lost out on the precipitate mark. Some candidates attempted an alternative method of determining if a chloride was present. Of these some gained a mark for mentioning electrolysis but then took it no further. Surprisingly, many candidates thought you could test for chloride ions using a flame test.

(iii) Describe how you would test for the presence of chloride ions in a solution of sodium chloride.

(3)

flame test would show chloride ions as lilac.

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This sort of answer was surprisingly seen quite often.

(iii) Describe how you would test for the presence of chloride ions in a solution of sodium chloride.

(3)

To test for chloride ions, a few drops of dilute hydrochloric acid is added to the sodium chloride solution and is shaken. Then a few drops of silver nitrate solution is added. If a white precipitate of silver chloride forms, chloride ions are present.

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Like quite a few others, this candidate incorrectly used hydrochloric acid (others simply said use an acid) but was able to score the other marks available.

Question 5 (b)

It was pleasing to see good attempts being made in this free response question with over half of the candidates producing an answer worthy of level 2 or 3. A good understanding of the formation of magnesium oxide was demonstrated by many candidates with the transfer of electrons from magnesium to oxygen being well described, though fewer candidates could provide the correct formulae of the two ions formed. Surprisingly, significant numbers tried to explain the formation of magnesium oxide in terms of covalent bonding even though they were told in the question that magnesium oxide was an ionic compound. The structure of solid magnesium oxide often received scant treatment, and this was the major reason for not achieving level 3. Some candidates did refer to a lattice structure but often did not mention electrostatic attraction between the oppositely charged ions. Some candidates correctly described properties of magnesium oxide but such answers were not answering the question and so did not gain credit.

*(b) Magnesium has an electronic configuration of 2.8.2.
Oxygen has an electronic configuration of 2.6.

Explain, in terms of their electronic configurations, how magnesium and oxygen atoms react to form the ionic compound magnesium oxide, MgO, and include a description of the structure of solid magnesium oxide.

(6)

Magnesium has 3 shells of electrons with ~~two~~ electrons on the outer most shell. Oxygen has 2 shells of electrons and has ~~6 stable~~ six electrons on the outer most shell. To make each element stable there needs to be a complete shell of eight electrons on the outer most shell. So magnesium gives out two electrons while oxygen gains two electrons. The two free electrons on the outer most shell of magnesium breaks away and joins the oxygen atom. So now ~~both~~ both elements ~~are~~ have complete outer shells of eight and are combined together creating a solid compound of Magnesium Oxide. Magnesium has an ionic charge of +2 as it gives out electrons and oxygen has an ionic charge of -2 as it takes electrons.

$Mg + O \rightarrow MgO_{(s)}$

$Mg^{2+} + O^{2-} \rightarrow MgO_{(s)}$

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Examiner Comments

A decent description of the formation of the ions and the charges on them are shown but no reference to the structure of magnesium oxide so this was a level 2 answer and given four marks.

*(b) Magnesium has an electronic configuration of 2.8.2.
Oxygen has an electronic configuration of 2.6.

Explain, in terms of their electronic configurations, how magnesium and oxygen atoms react to form the ionic compound magnesium oxide, MgO, and include a description of the structure of solid magnesium oxide.

(6)

Magnesium ~~has~~ has an atomic mass of 24 and an atomic number of 12. This means that the electronic configeration for this is 2, 8, 2. This also means that it has 12 ~~protons~~ electrons ~~and~~, protons and neutrons. Oxygen has the atomic mass of 16 and the atomic number for it is 8. This means that the electronic configeration for it is 2, 6 and it has 8 electrons, 8 protons and 8 neutrons. These two react to form the ionic compound magnesium oxide. The structure of this simple molecular covalent. ~~It has a low melting and boiling point and the electrons are quite far away from eachother and has weak forces of attraction between them.~~

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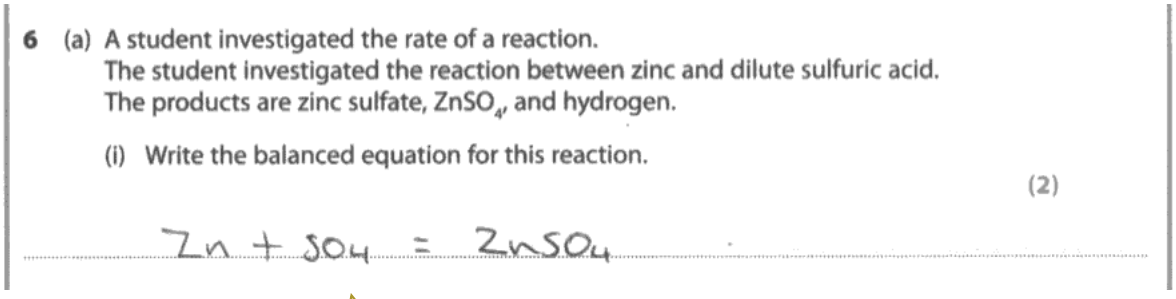
Regrettably even though the candidate has written quite a lot they have not described the ion formation and despite saying it is an ionic compound have then contradicted themself by saying the structure is simple molecular covalent. Hence there is nothing creditworthy here.

Question 6 (a) (i)

Very few candidates could write a correct formula for sulphuric acid. SO_4 was often seen even though hydrogen still appeared on the right-hand side of the equation. More candidates gained the mark for correct products as the formula for zinc sulphate was given but some even lost this mark as they wrote hydrogen as H.



6 (a) A student investigated the rate of a reaction.
The student investigated the reaction between zinc and dilute sulfuric acid.
The products are zinc sulfate, $ZnSO_4$, and hydrogen.

(i) Write the balanced equation for this reaction.

(2)

$Zn + SO_4 = ZnSO_4$

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A common incorrect attempt for the formula of sulfuric acid.

Question 6 (a) (ii)

This proved to be a very accessible and hence well answered question, with the large majority of candidates producing a level 2 or 3 answer. Most candidates demonstrated a good understanding of the collision theory. The effect of the changed conditions was often well described, with the best answers containing separate considerations of the effect of concentration and temperature. However many candidates did not distinguish between their explanations for temperature and concentration and gave a combined answer rather than explaining each factor in turn. As a result these candidates often referred to an increase in concentration making the particles move faster or having more energy. Sometimes candidates lost marks because they only referred to concentration effects or temperature effects, rather than both. Many candidates omitted the need for successful collisions, simply stating that collision frequency would be increased.

Evaluate these results, explaining the reasons why the rate of reaction in experiment 2 is faster than the rate of reaction in experiment 1.
In your answer you should refer to the frequency and energy of collisions between particles.

(6)

The rate of reaction is higer in experiment 2 because the temprature is higer. This is because higher temprature give the particles more energy, this means the particles will be moving at a greater speed. If they are moving at a greater speed it increases the chance of a sucsessful collishion. If their are more sucsessful collishions happening at a faster rate this means the reaction will happen quicker.

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This answer contains a good description of the effect of increasing temperature but does not mention concentration and so is unable to access level 3.

Evaluate these results, explaining the reasons why the rate of reaction in experiment 2 is faster than the rate of reaction in experiment 1.
In your answer you should refer to the frequency and energy of collisions between particles.

(6)

The rate of reaction was alot faster due to the difference between the tempurature that was use in experiment 1+2. In experiment 1 the temp was 20 and 2 the temp was 40. this proves that the higher the temp the quicker the reaction is. Also using different amounts of Concentrated Sulfuric acid helps to increase the rate of reaction. This is because the peiece of zinc would have more to react with making the reation stronger.

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This answer just gives a limited description and so is a level 1 response.

Evaluate these results, explaining the reasons why the rate of reaction in experiment 2 is faster than the rate of reaction in experiment 1.
In your answer you should refer to the frequency and energy of collisions between particles.

(6)

As the concentration of sulfuric acid and the temperature increases, the rate of the reaction also increases. When the concentration increases, there are more particles per cm^3 which means there are more frequent collisions between the particles. More frequent collisions means more successful collisions. When the temperature is increased, the particles move a lot faster. When the particles move faster, they move with a lot more energy which means there are more frequent collisions. The more frequent the collisions are, the more successful the collisions are and therefore the rate of the reaction increases.

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A detailed description of the effect of increasing the concentration and temperature and worthy of six marks.

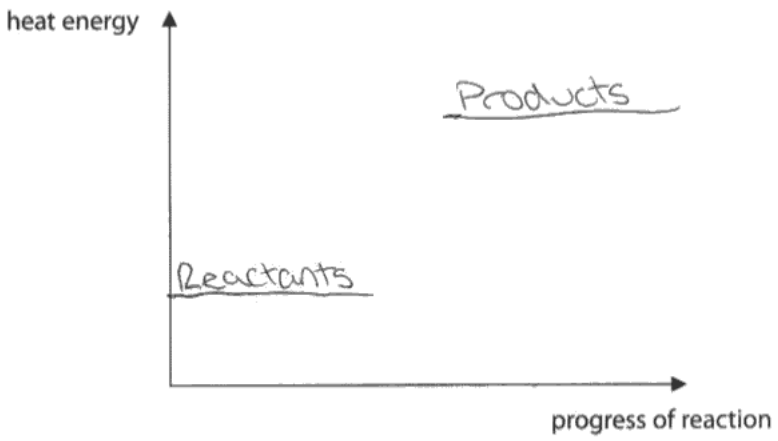
Question 6 (b) (ii)

Many candidates scored both marks but some lost a mark by either labelling the lines incorrectly or not labelling them at all. Many candidates drew a reaction profile diagram and put in the activation energy "hump" which was obviously acceptable. Some thought the products would be at a higher level than the reactants but others did not draw any horizontal lines and seemingly tried to plot some sort of graph.

(ii) This reaction is exothermic.

On the diagram below draw labelled lines to show the relative energies of the reactants and products in this reaction.

(2)



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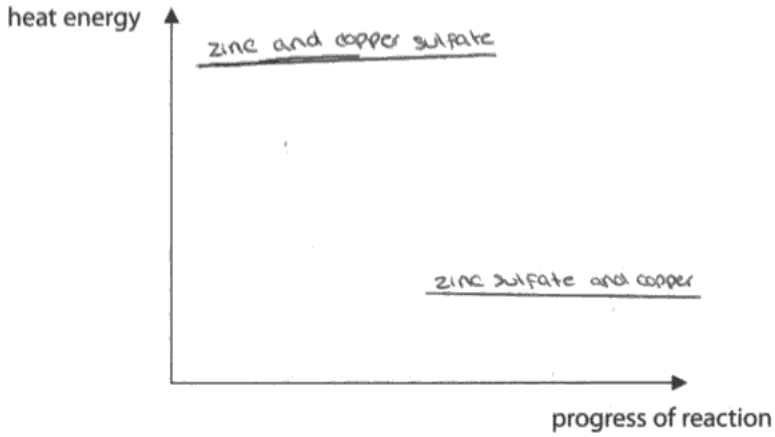
This is worth one mark as the products line is to the right of the reactants but does not gain the second mark as it shows an endothermic reaction.

(ii) This reaction is exothermic.

On the diagram below draw labelled lines to show the relative energies of the reactants and products in this reaction.

(2)



ResultsPlus
Examiner Comments

A good answer giving the names of the reactants and products (although just "reactants" and "products" was also acceptable) in their correct relative positions.

Paper Summary

On the basis of their performance on the current examination candidates are offered the following advice to improve their performance:

- learn definitions of key terms
- try out many calculations including particularly reacting mass calculations
- learn the formulae of elements and simple compounds
- make sure you can balance chemical equations
- learn the tests for ions
- make sure you understand and can describe how practical work is carried out

Grade Boundaries

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