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Examiners' Report
November 2012

GCSE Chemistry 5CH2H 01

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November 2012

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Introduction

This was the second 5CH2H paper to be offered; the first being set in June 2012. This question paper assessed the specification items to be in Unit 2 Discovering Chemistry which forms part of the Additional Science course along with the corresponding biology and physics units, and also as part of the GCSE Chemistry course where much of the fundamental theory and ideas of chemistry are established as a precursor to the extension topics of Unit C3.

In common with all the other science GCSE examination papers for the current specification, this was a one hour, 60-mark paper. Like the previous paper, the paper contained six questions based largely around one of the topics in the specification. The last two questions each contained an extended writing part worth 6 marks.

Candidates should be familiar with the format of the paper having previously taken other examinations in Science and Additional Science. Many candidates would have been prepared for this examination by the use of the previous paper and the sample assessment material.

Successful candidates:

- can write and balance chemical equations
- know how to explain a phenomenon rather than just describe it
- use correct scientific explanations and terminology
- carry out and manipulate calculations at this level
- can give good explanations to the 6-mark questions.

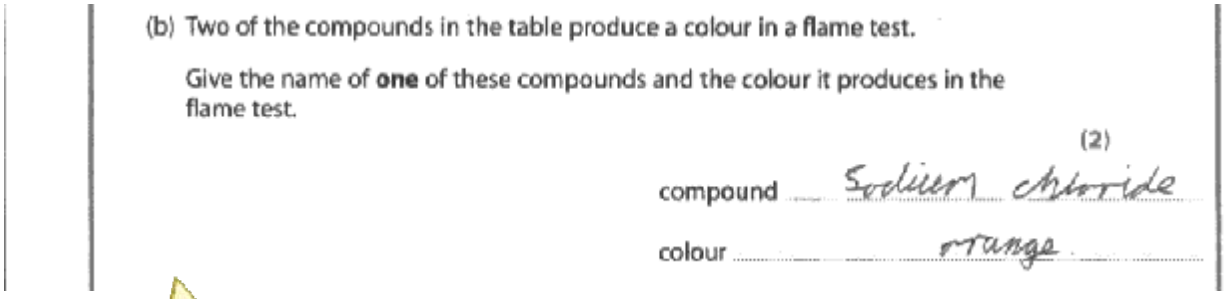
Less successful candidates:

- focus more on rewriting the question rather answering it
- are unsure about chemical formulae of simple substances
- cannot write balanced equations
- confuse ionic and covalent bonding situations
- are unsure about how to calculate relative atomic masses from isotopic data, and empirical formulae from constituent masses.

This report will provide 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.

Question 1(b)

Most candidates scored both marks here, although it should be noted that in this specification yellow is the accepted flame colour for sodium compounds and not yellow-orange or orange. A significant number just gave the name of the metal (eg sodium) with an associated flame colour. Surprises that arose from this question included naming a potassium compound (not listed in table) and giving the flame colour of brick-red for sodium chloride.


(b) Two of the compounds in the table produce a colour in a flame test.

Give the name of **one** of these compounds and the colour it produces in the flame test.

(2)

compound Sodium chloride

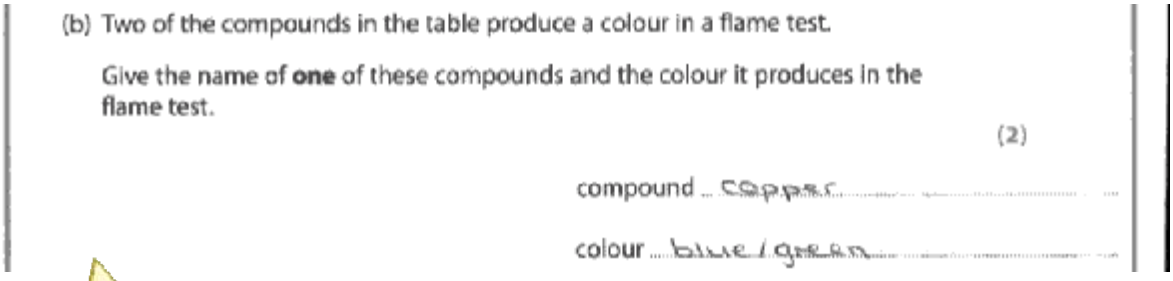
colour orange

ResultsPlus
examiner comment

A correct compound, but the flame colour here was not acceptable. 1 mark awarded.

ResultsPlus
examiner tip

Yellow is the accepted flame colour for sodium compounds in this specification.


(b) Two of the compounds in the table produce a colour in a flame test.

Give the name of **one** of these compounds and the colour it produces in the flame test.

(2)

compound copper

colour blue / green

ResultsPlus
examiner comment

A correct flame colour which scored a mark, but only the name of the metal was given.

ResultsPlus
examiner tip

The question asked for the name of a compound.

Question 1(c)(i)

Judging by the answers seen, many candidates think that when liquids boil, the molecules break up and the bonds break between atoms. This misconception was seen numerous times showing a misunderstanding of the term **intermolecular force**. Many missed the second mark due to not appreciating the need for a small amount of energy required to separate the molecules, stating that they are easy to break.

(c) Hexane is a covalent compound containing simple molecules.
It has a low boiling point.

(i) Explain why it has a low boiling point.

(2)

Hexane has a simple molecular covalent structure, therefore it is only joined together by weak forces, which is why it has a low boiling point.

ResultsPlus
examiner comment

It was not clear what was being 'joined together by weak forces'. Also the low boiling point was not explained. 0 marks.

ResultsPlus
examiner tip

Intramolecular forces (between atoms in molecules) are strong;
intermolecular forces (between molecules) are weak.

(c) Hexane is a covalent compound containing simple molecules.
It has a low boiling point.

(i) Explain why it has a low boiling point.

(2)

It has a low boiling point because it is a simple covalent compound. This means that bonds between atoms are strong but bonds between molecules are weak, so it takes little energy to break bonds between molecules causing low boiling and melting points.

ResultsPlus
examiner comment

An ideal answer containing a clear explanation. Both marks were given.

ResultsPlus
examiner tip

Candidates should remember that bonds between atoms are strong, those between molecules are weak.

Question 1(c)(ii)

Many candidates got into difficulty when they could not remember the name of the apparatus used (but gained marks from a correct description), and then inadequately described the procedure. Those that did know about using a separating funnel usually picked up both marks. Several candidates confused separating funnel with a filter funnel. The use of fractional distillation was not accepted as some water would vaporise with the hexane in that situation.

(ii) Hexane and water are immiscible.

Describe how separate samples of hexane and water can be obtained from a mixture of hexane and water.

(2)

Hexane and water can be seperated by ~~a funnel,~~ infiltration the so by ~~because infiltration~~ using a funnel ~~that~~ with a tap the samples can be seperated

ResultsPlus
examiner comment

The use of 'funnel with a tap' as a description of a separating funnel scored the mark here.

ResultsPlus
examiner tip

Sometimes a suitable description can be used in place of the name of a piece of equipment.

(ii) Hexane and water are immiscible.

Describe how separate samples of hexane and water can be obtained from a mixture of hexane and water.

(2)

I would put them in a long flash ~~type thing~~ type thing with a tap at the bottom. The water will settle on the bottom with the hexane on top (as water is more dense) To seperate them I will put a beaker underneath and turn the tap on. Once that level has gone down to the

ResultsPlus
examiner comment

This answer had a suitable description of a separating funnel and a lengthy description of how the mixture would be separated. Both marks were given.

ResultsPlus
examiner tip

Candidates should try to be concise in their answers.

(ii) Hexane and water are immiscible.

Describe how separate samples of hexane and water can be obtained from a mixture of hexane and water.

(2)

They are immiscible which means they do not dissolve. When mixed, the higher density substance will go to the bottom of the container whereas the lower density substance will form a layer on top, thus separating them.

ResultsPlus
examiner comment

The candidate clearly understood the situation and was awarded the second mark. It was unfortunate there was no mention of a separating funnel.

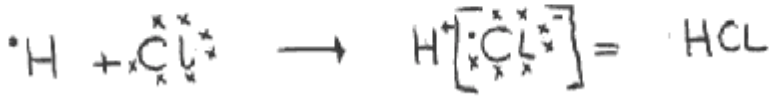
Question 1(d)

Most candidates scored both marks for a correct dot and cross diagram. The idea of shared pairs of electrons seems reasonably well understood. The most common errors included putting an extra electron on hydrogen or showing ionic bonding. Many lost marks for getting chemical symbols incorrect. Candidates should be advised to take care with writing symbols – in some cases it was difficult to discern whether the Cl was upper or lower case. A few incorrect molecules were seen, most commonly 2 hydrogen atoms and 1 chlorine atom, possibly a confusion with water.

(d) Draw a dot and cross diagram of a molecule of hydrogen chloride.

Show outer electrons only.

(2)



ResultsPlus
examiner comment

The candidate has shown ionic bonding, so no marks.

ResultsPlus
examiner tip

Candidates should practise drawing dot and cross diagrams for the simple molecules CH_4, H_2O, Cl_2 and HCl.

(d) Draw a dot and cross diagram of a molecule of hydrogen chloride.

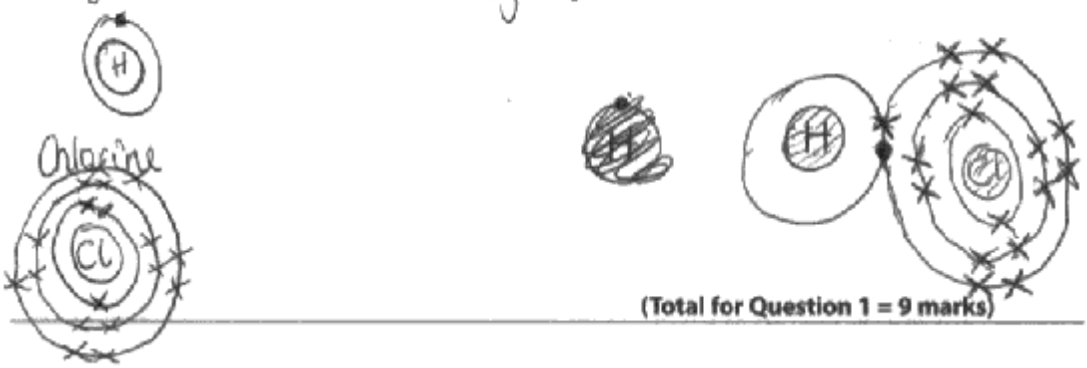
Show outer electrons only.

(2)

Hydrogen

Hydrogen chloride

Chlorine



(Total for Question 1 = 9 marks)

ResultsPlus
examiner comment

2 marks scored. Inner electron shells were shown. Fortunately they are correct. Candidates should only include these if they have been asked for.

ResultsPlus
examiner tip

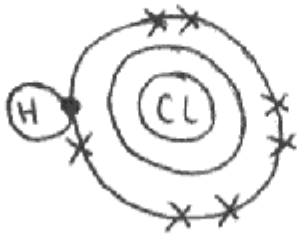
Incorrect inner shells would lose a mark.

(d) Draw a dot and cross diagram of a molecule of hydrogen chloride.

Show outer electrons only.

1 17 → 2,8,7

(2)



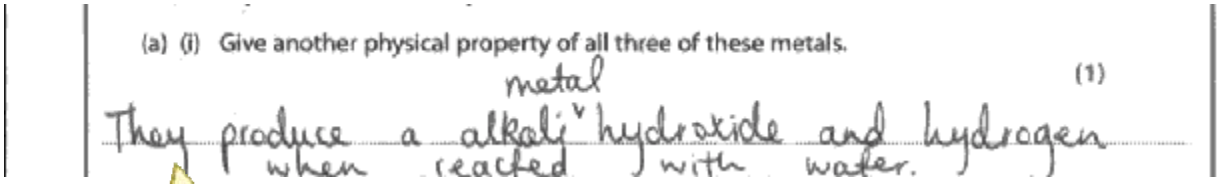
(Total for Question 1 = 9 marks)

ResultsPlus
examiner comment

Unfortunately neither mark was scored. The shared pair has to be where the circles representing the electron shells overlap.

Question 2(a)(i)

Most candidates scored the mark here with soft as the answer. Malleable was often seen but invariably misspelled. The biggest misconception seen was the understanding of the term physical property. This caused many candidates to write about electron arrangements, reactions and location in the periodic table.


(a) (i) Give another physical property of all three of these metals.

(1)

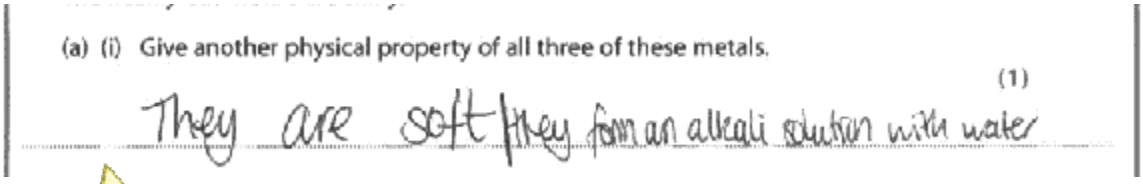
They produce a alkali metal hydroxide and hydrogen when reacted with water.

ResultsPlus
examiner comment

Although a correct statement, an incorrect answer to the question stopped the mark from being awarded.

ResultsPlus
examiner tip

Candidates should know the difference between physical and chemical properties.


(a) (i) Give another physical property of all three of these metals.

(1)

They are soft they form an alkali solution with water

ResultsPlus
examiner comment

A correct physical property is given. However, the chemical property negates the mark.

ResultsPlus
examiner tip

An incorrect answer will negate the mark for a correct answer.

Question 2(a)(ii)

This question was mostly answered well by candidates, but some missed the point about 'group 1' by writing that these elements had the same number of electrons in the outer shell. Not often seen, but a few candidates erroneously suggested that there was one electron missing from the outer shell.

(ii) Explain, in terms of electrons in their atoms, why lithium, sodium and potassium are in group 1 of the periodic table.

(2)

They are all in group one as they all have an extra electron that they need to get rid of to become stable

ResultsPlus
examiner comment

Here 'an extra electron' is not the same as 'one electron'. There was no mention of an outer shell, so no marks awarded.

ResultsPlus
examiner tip

Candidates should avoid using ambiguous terms such as **extra** or **spare** electron.

(ii) Explain, in terms of electrons in their atoms, why lithium, sodium and potassium are in group 1 of the periodic table.

(2)

Lithium and Sodium and potassium are in group 1 because they have a nearly a full outer shell and only need to either gain or lose 1 [illegible] electron to become stable

ResultsPlus
examiner comment

Neither mark was scored here.

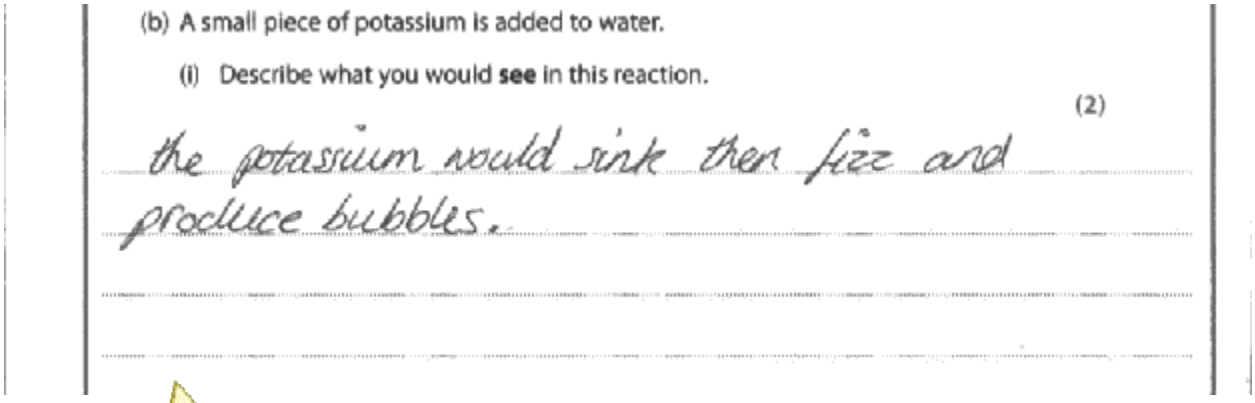
ResultsPlus
examiner tip

Giving an opposing explanation as well as the correct one loses the mark.

Question 2(b)(i)

With so many possible observations, it was inevitable that this question would be answered well. Only a few did not manage to score here, but some candidates did confuse observations with interpretations by writing that potassium reacted to give hydrogen and potassium hydroxide, and some tried to change the question by

inclusion of an indicator in the water. Several candidates thought that the potassium 'ignites' on contact with water.


(b) A small piece of potassium is added to water.

(i) Describe what you would **see** in this reaction.

(2)

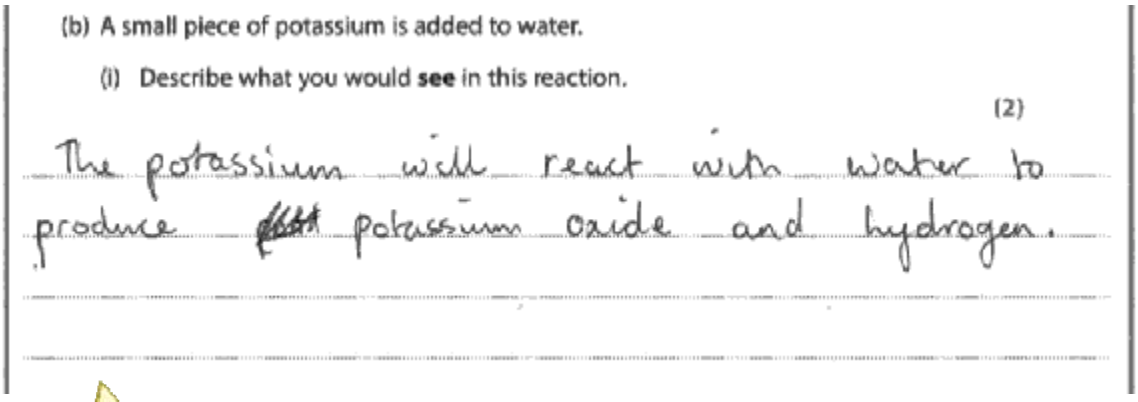
the potassium would sink then fizz and produce bubbles.

ResultsPlus
examiner comment

Although two correct observations were given, fizz and bubbles mean the same and so scored only 1 mark.

ResultsPlus
examiner tip

Answers to this question needed two different observations for the 2 marks available.


(b) A small piece of potassium is added to water.

(i) Describe what you would **see** in this reaction.

(2)

The potassium will react with water to produce ~~potassium~~ potassium oxide and hydrogen.

ResultsPlus
examiner comment

Here the candidate has given an interpretation rather than observations about the reaction, so gains no marks.

Question 2(c)

There were a few weak answers seen such as more outer shells or atoms in the outer shell. However, most candidates mentioned more shells/increased size of the atom and increasing ease of losing the outer electron. Only a few responses showed the idea of electron shielding by inner shells. For the candidates who lost marks, it was mainly for restating the information given in the question such as, 'As you go down

group 1 the elements get more reactive. This means potassium is more reactive than lithium.' Several candidates erroneously thought there was a 'magnetic pull' on the electrons by the nucleus.

(c) There is an increase in reactivity of these group 1 metals from lithium to potassium.

Explain this increase in reactivity.

(2)

As you move down the periods, each atom has more shells, therefore there are more electrons between the outer electron and the nucleus. This means that the outer electron and the nucleus have a weaker attraction, and so it ~~is~~ becomes easier for the atom to lose that electron.

(Total for Question 2 = 8 marks)

ResultsPlus
examiner comment

A good clear answer scoring both marks.

(c) There is an increase in reactivity of these group 1 metals from lithium to potassium.

Explain this increase in reactivity.

(2)

As you go down the group of group 1 each metal gains an electron shell. This means the electrons are getting further away from the positive nucleus so this cause the reactivity to increase.

ResultsPlus
examiner comment

Here the candidate has just mentioned the idea of increased number of electron shells and not explained the impact of this on reactivity. 1 mark only.

ResultsPlus
examiner tip

Candidates should re-read their answers to make sure they have answered the question completely.

Question 3(a)(i)

Most candidates were able to identify the metallic elements from the five elements shown on the outline periodic table. Clear references to elements A, B, C, D and E were made twice in the stem of the question and candidates were asked to identify those that were metals by using the letters, but some candidates went to the extent of using the periodic table on page 2 of the paper and named or gave the atomic symbols for the actual elements for no extra credit.

Question 3(a)(ii)

Again most candidates were able to identify elements A and B as the two with the most similar chemical properties.

Question 3(b)

Most candidates showed good understanding of atomic structure and could correctly state how many more protons there are in an atom of element B compared to an atom of element A.

Question 3(c)(ii)

This question proved to be a good differentiator. Some weak candidates just added the 2 numbers of 20 and 22 or carried out other irrelevant calculations. Some knew to multiply the mass by the abundance, but then were unable to achieve the final mark as they did not know what to do with the sums of these calculations. More able candidates could set out the calculation with clarity.

(ii) 10% of the atoms in a sample of element **E** have a mass number of 22.
All the other atoms in this sample have a mass number of 20.

Calculate the relative atomic mass of element **E**.

(3)

$\frac{20 \times 9 + 22 = 202}{10} = 20.2$

relative atomic mass = 20.2

ResultsPlus
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Another way in which the relative atomic mass could be calculated based on the abundance ratio of 9:1. All 3 marks were scored.

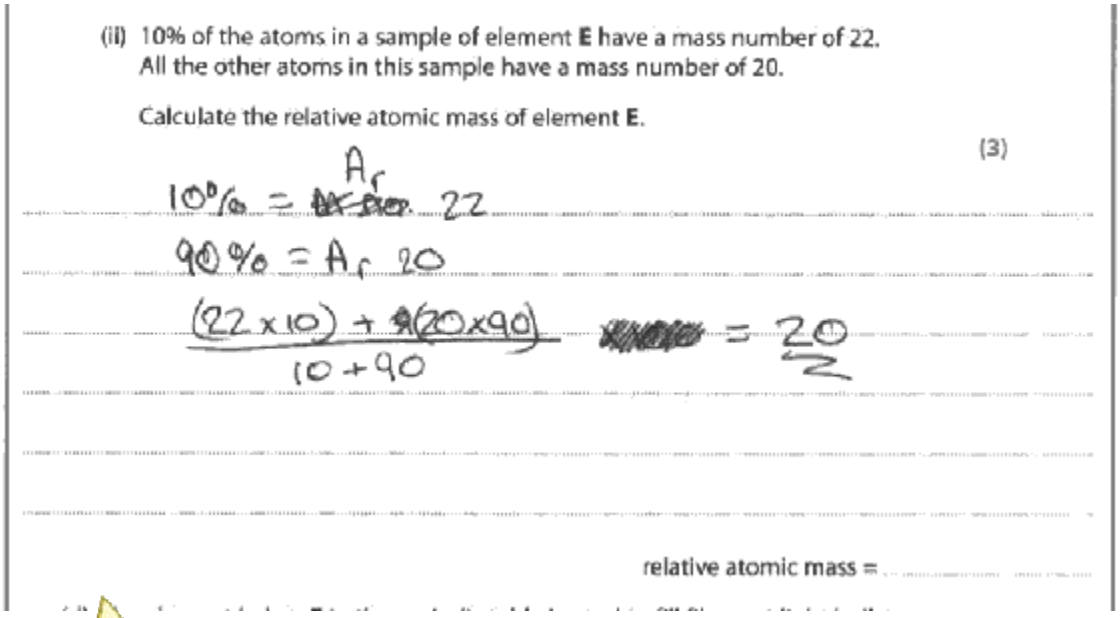
ResultsPlus
examiner tip

Care needs to be taken when setting out calculations that logical steps can be seen.

(ii) 10% of the atoms in a sample of element **E** have a mass number of 22.
All the other atoms in this sample have a mass number of 20.

Calculate the relative atomic mass of element **E**.

(3)



ResultsPlus
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The three marking points are present here, despite the approximation made to the final answer.

ResultsPlus
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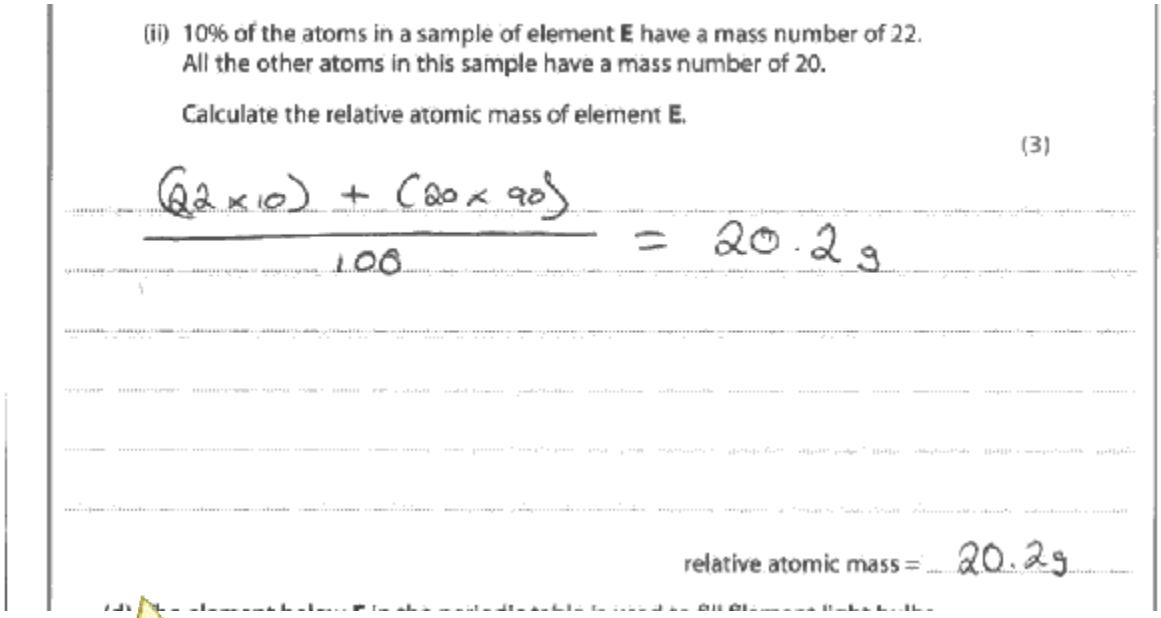
The calculation steps are clearly laid out. Candidates should not be tempted to approximate the final answer.


(ii) 10% of the atoms in a sample of element **E** have a mass number of 22.
All the other atoms in this sample have a mass number of 20.

Calculate the relative atomic mass of element **E**.

(3)

$$\frac{(22 \times 10) + (20 \times 90)}{100} = 20.2\text{ g}$$

relative atomic mass = 20.2g

ResultsPlus
examiner comment

An ideal answer, clearly laid out. 3 marks scored.

ResultsPlus
examiner tip

Candidates should practise the calculation using isotopic data for various elements.

Question 3(d)

Many candidates confused the use of argon in a filament bulb with a discharge tube, where the argon would glow. It was often seen that candidates achieved the first mark for describing it as being unreactive or inert, but did not to link this to the fact that the noble gases have a full outer shell of electrons. Other candidates just wrote the first point in three ways with 'the element was a noble gas, in group 0 and inert', and a significant number who stated that the gas conducted electricity.

(d) The element below **E** in the periodic table is used to fill filament light bulbs.

Explain why this element is suitable for this use.

(2)

This is because in Group 0 that E is in all the elements are inert meaning that they do not react as they are stable. It is used in filament lamps so that it doesn't react with the filament when it gets it. Oxygen does react with it meaning that the filament will break. Oxygen will oxidise the filament.

(Total for Question 3 = 9 marks)

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2 marks: both marking points present about group 0 elements being unreactive and so not able to react with the filament.

ResultsPlus
examiner tip

Explanations require answers that show some detailed thought rather than a description.

(d) The element below **E** in the periodic table is used to fill filament light bulbs.

Explain why this element is suitable for this use.

(2)

It can conduct electricity and when it reacts it produces a light which is suitable for use in a light bulb.

(Total for Question 3 = 9 marks)

ResultsPlus
examiner comment

Possible confusion here with discharge lamps or a misunderstanding of why noble gases can be used in light bulbs: 0 marks.

ResultsPlus
examiner tip

The properties and uses of noble gases can be explained by their electronic structures. Because of the full outer shell in their atoms, noble gases are not likely to react; this makes them stable.

(d) The element below **E** in the periodic table is used to fill filament light bulbs.

Explain why this element is suitable for this use.

(2)

Argon is used to fill filament bulbs because it is a noble gas this means that all it's electron shells are full so it won't react with anything this makes it inert. This means it won't react with anything inside the bulb this makes it safer.

(Total for Question 3 = 9 marks)

ResultsPlus
examiner comment

Both marking points covered by this detailed explanation.

Question 4(a)

Generally, this was answered well. Most candidates got the idea of not enough oxygen, or an incomplete reaction, but there were a significant number of responses suggesting that oxygen escaped when the lid was raised, or that too much pressure in the experiment could cause 'explosions'. Several examiners reported that it appeared many candidates may not have carried out this experiment.

(a) Suggest why the lid had to be raised from time to time during the experiment.

(1)

To let in the oxygen, so it can react with magnesium

ResultsPlus
examiner comment

A clearly written answer matching the mark scheme: 1 mark.

ResultsPlus
examiner tip

Revise the experiments covered in the course.

(a) Suggest why the lid had to be raised from time to time during the experiment.

(1)

more oxygen was produced

ResultsPlus
examiner comment

The answer implies that the reaction is producing oxygen rather than using it. 0 marks.

ResultsPlus
examiner tip

Magnesium forms magnesium oxide in this experiment. The magnesium used up the oxygen rather than produced it.

(a) Suggest why the lid had to be raised from time to time during the experiment.

(1)

So oxidation could occur to allow combustion

ResultsPlus
examiner comment

Oxidation is the same as requiring oxygen: 1 mark.

(a) Suggest why the lid had to be raised from time to time during the experiment.

(1)

~~pern~~ For the carbon dioxide that was ~~reabsorbed~~ produced to be realeased.

ResultsPlus
examiner comment

The candidate clearly is not sure about what is happening during the experiment. 0 marks.

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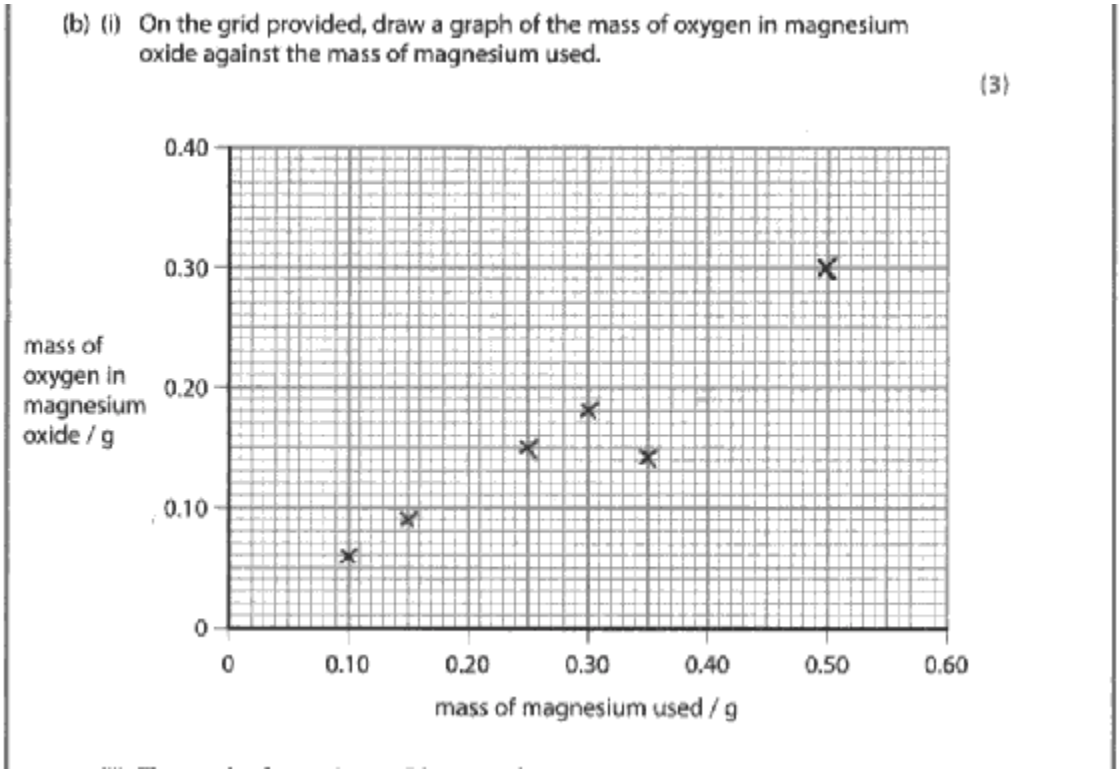
examiner tip

Read the details of the experiments carefully so you understand what is happening.

Question 4(b)(i)

A surprising number of candidates plotted the points (accurately) and then failed to draw the line. Those that did draw the line of best fit often included the anomalous point in their line. Some candidates plotted the wrong column from the table, for example, mass of magnesium used against mass of magnesium oxide formed.



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examiner comment

No line of best fit. 2 marks for the correctly plotted points.

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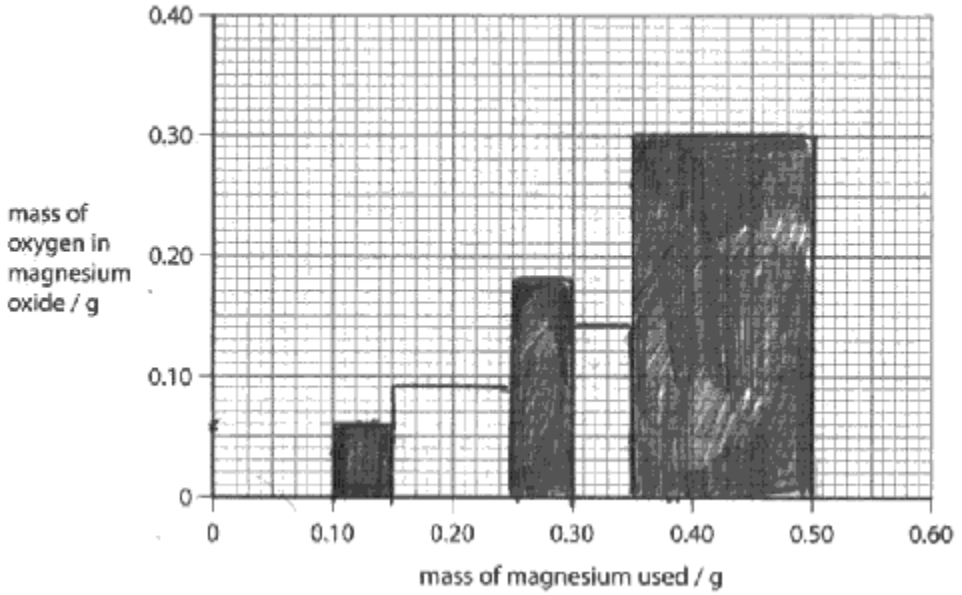
Drawing a graph includes the plotting of points and drawing the line of best fit.

(b) (i) On the grid provided, draw a graph of the mass of oxygen in magnesium oxide against the mass of magnesium used.

(3)



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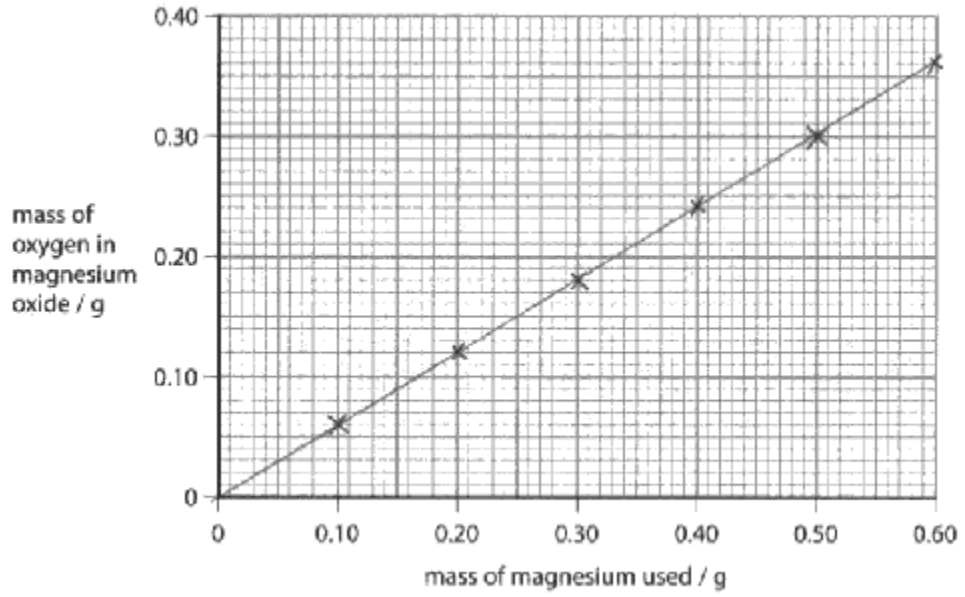
examiner comment

Bar charts have their uses, particularly where discontinuous variables are involved. Here a line graph should be drawn.

The centres of the tops of the bars do not match with the correct points so no marks can be given.

(b) (i) On the grid provided, draw a graph of the mass of oxygen in magnesium oxide against the mass of magnesium used.

(3)



ResultsPlus
examiner comment

Not often seen. Although not certain, it looks like the candidate plotted the first point, drew the straight line and then marked the other points. 1 mark was given for the line of best fit.

ResultsPlus
examiner tip

Take care when plotting graphs. Plot all the points, then draw the line of best fit.

Question 4(b)(ii)

Most candidates answered this question correctly with the idea of not enough oxygen, or an incomplete reaction. Some suggested there was too much oxygen or that another reaction had taken place. Stating that oxygen was lost from the crucible was a common misconception.

(ii) The result of experiment 5 is anomalous.
The masses were all measured accurately.

Suggest what might have caused this anomalous result.

(1)

The lid may not have been lifted off the crucible as frequently as it was in the other experiments

ResultsPlus
examiner comment

Clearly the candidate has recognised that insufficient oxygen had reacted with the magnesium. 1 mark given.

ResultsPlus
examiner tip

Candidates should think carefully about what could cause an anomalous result. There is usually a reasonable explanation.

(ii) The result of experiment 5 is anomalous.
The masses were all measured accurately.

Suggest what might have caused this anomalous result.

(1)

the lid may have been left off for too long and some of the magnesium oxide would have escaped.

ResultsPlus
examiner comment

Another very good answer where the candidate had clearly thought about possible explanations. Here, it was explaining why was the mass of magnesium oxide lower in this case. 1 mark given.

ResultsPlus
examiner tip

There may be several possible explanations why anomalous results can be obtained. The prompt word here, **suggest**, is indicating that candidates are not expected to know it but to offer a possible explanation.

Question 4(c)

The able candidates correctly provided a balanced equation, but a surprisingly large number of candidates thought the formula for magnesium oxide was MgO_2 or did not oxygen as diatomic molecules.

Unfortunately, the two equations $Mg + O_2 \rightarrow MgO_2$ and $Mg + O \rightarrow MgO$ were seen more frequently than the correct answer.

(c) Write the balanced equation for the reaction of magnesium with oxygen to form magnesium oxide.

(3)

$2Mg_{(s)} + O_{2(g)} \longrightarrow 2MgO_{(s)}$

ResultsPlus
examiner comment

Marks were awarded for correct reactants, correct products and balancing of correct formulae. State symbols were not expected.

ResultsPlus
examiner tip

Although not asked for here, candidates should make sure they understand and know the state symbols used in equations as they may be asked to give them.

(c) Write the balanced equation for the reaction of magnesium with oxygen to form magnesium oxide.

(3)

2Mg + O2 → 2MgO2

2,8,2 (4+2)

ResultsPlus
examiner comment

A variation of a common incorrect answer. 1 mark was given here for the correct reactants only.

ResultsPlus
examiner tip

Candidates should practise writing and balancing equations for a variety of reactions they have come across in the course.

Question 4(d)

Many good answers were seen where the calculation was logically set out and the steps were easy to follow. Where errors occurred, these often included the fractions being upside down which led to the empirical formula Pb_2O, or where candidates inexplicably multiplied the numbers rather than dividing them. Some candidates were able to work out the ratio of 0.002:0.004 or as 1:2, but often did not take it further and so did not score the third mark for the empirical formula PbO_2. Some lost the final mark by giving the empirical formula as Pb_2O_4 and didn't use the simplest ratio. The weaker candidates did not know what to do with the data and some did not seem to know what an empirical formula was.

(d) An oxide of lead was analysed.
0.414 g of lead was combined with 0.064 g of oxygen in this oxide.

Calculate the empirical formula of this lead oxide.

(relative atomic masses: O = 16, Pb = 207)

(3)

$\frac{0.414}{207} = \frac{2 \times 10^{-3}}{2} = 1 \times 10^{-3}$ Lead

$\frac{0.064}{16} = \frac{4 \times 10^{-3}}{2} = 2 \times 10^{-3}$ oxygen

empirical formula PbO_2

(Total for Question 4 = 11 marks)

ResultsPlus
examiner comment

The correct division of (mass of element) / (relative atomic mass) and the correct ratio were awarded two marks. Unfortunately an incorrect symbol of lead (pB) stopped the third from being given.

ResultsPlus
examiner tip

Candidates should ensure they use the correct atomic symbols in equations and formulae of substances.

(d) An oxide of lead was analysed.
0.414 g of lead was combined with 0.064 g of oxygen in this oxide.

Calculate the empirical formula of this lead oxide.

(relative atomic masses: O = 16, Pb = 207)

(3)

0.414g : Pb — 0.064g : O

207 — 16

0.414 / 207 — 16 / 0.064 = 250

207 / 0.414 = 1.468

1.468 : 5.9 = 5:6

1.468 / 250 — 250 / 250 = 1

empirical formula Pb_6O

(Total for Question 4 = 11 marks)

ResultsPlus
examiner comment

No marks were given for the incorrect division and incorrect ratio obtained. However, using the ratio to obtain an empirical formula of Pb_6O was awarded 1 mark.

ResultsPlus
examiner tip

Candidates should learn how to carry out empirical formula calculations. The setting out of the work here was clear, even though it was incorrect.

(d) An oxide of lead was analysed.
0.414 g of lead was combined with 0.064 g of oxygen in this oxide.

Calculate the empirical formula of this lead oxide.

(relative atomic masses: O = 16, Pb = 207)

(3)

Lead — Oxygen

0.414g — 0.064g

0.414 ÷ 207 = 0.002 — 0.064 ÷ 16 = 0.004

0.002 × 1000 = 2 — 0.004 × 1000 = 4

4 : 2

2 : 1

empirical formula 2 : 1

(Total for Question 4 = 11 marks)

ResultsPlus
examiner comment

A correct division was given and the correct ratio was produced (although it has been turned around). Unfortunately the empirical formula was not given so only 2 marks were awarded.

ResultsPlus
examiner tip

Empirical formulae show the whole number ratio of atoms of each element in a compound and not just the number ratio.

(d) An oxide of lead was analysed.
0.414 g of lead was combined with 0.064 g of oxygen in this oxide.

Calculate the empirical formula of this lead oxide.

(relative atomic masses: O = 16, Pb = 207)

(3)

	Pb	O
mass	0.414	0.064
mass ÷ relative atomic mass	0.414 / 207	0.064 / 16
	1/500 :	1/250
×500	1 :	2

= PbO_2

empirical formula PbO_2

(Total for Question 4 = 11 marks)

ResultsPlus
examiner comment

A clearly laid out calculation. This was often seen in this examination. 3 marks given.

ResultsPlus
examiner tip

Practise calculations of this type.

(d) An oxide of lead was analysed.
0.414 g of lead was combined with 0.064 g of oxygen in this oxide.

Calculate the empirical formula of this lead oxide.

(relative atomic masses: O = 16, Pb = 207)

(3)

0.414 ÷ 207 = 0.002 ← lead divide the mass
0.064 ÷ 16 = 0.004 ← oxygen by the relative
0.002 ÷ 0.002 = 1 atomic mass
0.002 ÷ 0.004 = 0.5 divide the smallest
1 lead 2 oxygen answer by both
results

empirical formula PbO_2

(Total for Question 4 = 11 marks)

ResultsPlus
examiner comment

This candidate has provided a very clear answer – instructions as well! It fully deserves the maximum marks 3 marks.

ResultsPlus
examiner tip

Giving the instructions is not necessary but setting out the calculations will help the examiner see if marks can be awarded resulting from any errors made.

Question 5(a)

This question, seemingly straightforward, caused problems for many candidates. There were those who knew that a temperature fall meant an endothermic reaction. But it was where candidates confused temperature with heat that problems arose. 'Exothermic reaction because heat was given off' was often seen. Several candidates erroneously tried to link the temperature to bond breaking and bond making which did not answer the question. Had the experiment results shown a temperature rise, the overwhelming majority would have scored both marks. For many candidates the concept of an endothermic reaction is difficult.

Explain what the temperature readings show about the type of heat change occurring when ammonium chloride dissolves in water.

(2)

The temperature change is a decrease of 4°C, showing it was an endothermic reaction which used heat from the surroundings to break more bonds than what is being created.

ResultsPlus
examiner comment

All three marking points were present, so both marks were scored.

ResultsPlus
examiner tip

Candidates should make sure they know the difference between endothermic and exothermic energy changes.

Explain what the temperature readings show about the type of heat change occurring when ammonium chloride dissolves in water.

(2)

The reaction was and exothermic ~~endothermic~~ ~~exothermic~~ because it exothermic because it gave out heat (lost heat) during the reaction meaning the temperature decreased.

ResultsPlus
examiner comment

Two incorrect statements were given about the type of reaction and the direction of energy change. Credit could not be given for the correct temperature change.

ResultsPlus
examiner tip

Know the difference between the terms temperature and heat. When a reaction loses heat energy we recognise it as a temperature rise – an exothermic reaction.

Explain what the temperature readings show about the type of heat change occurring when ammonium chloride dissolves in water.

(2)

The heat change decreases meaning the reaction is exothermic. This means more energy is needed to make the bonds than break the bonds.

ResultsPlus
examiner comment

Confusion here between heat change and temperature change. This was quite a common answer to the question. 1 mark for stating that the energy change was endothermic.

ResultsPlus
examiner tip

The question is asking about the temperature change and the type of heat change, not about bond breaking and bond making.

Question 5(b)

This was generally very well answered. The most common mistake was indicating that the products were at a higher energy level than the reactants. A few candidates were clearly unsure of what an energy level diagram was and drew a sketch of a line graph mostly heading towards the horizontal axis. Many candidates included the activation energy curve into the graph. It should be noted that activation energies are not included on the specification and this would not be expected to be seen on energy level diagrams.

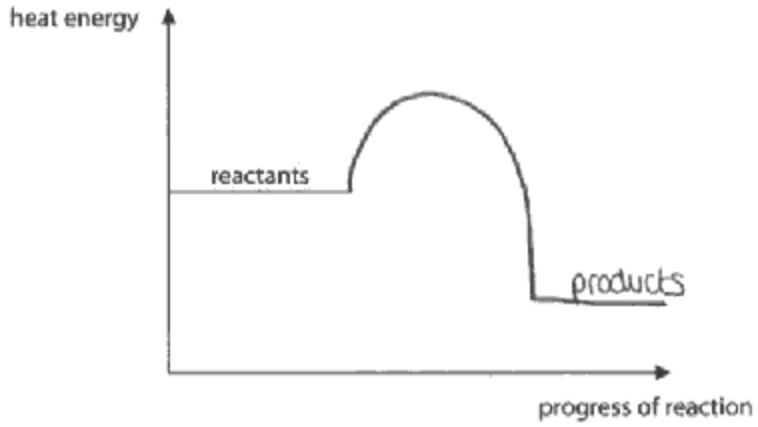
(b) When zinc reacts with copper sulfate solution, copper and zinc sulfate solution are formed.

$$Zn + CuSO_4 \rightarrow Cu + ZnSO_4$$

This reaction is exothermic.

Use this information to complete the diagram.

(2)



ResultsPlus
examiner comment

The marks were for the position of the product line. The curve representing the activation energy is not needed at this level and will not be expected. 2 marks.

ResultsPlus
examiner tip

Candidates should know how to draw energy level diagrams for both exothermic and endothermic reactions.

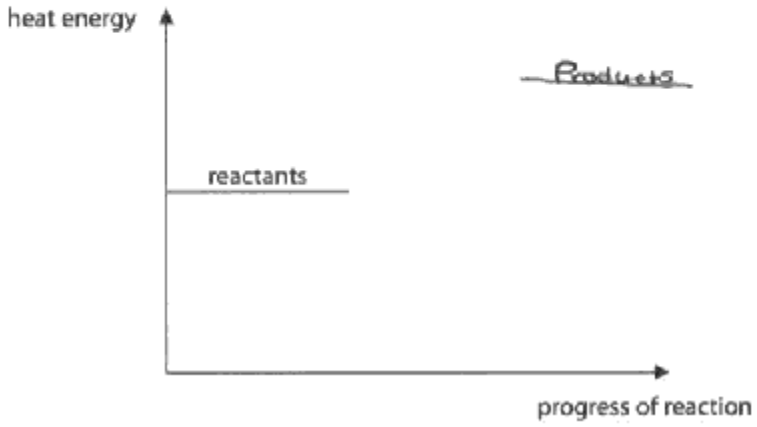
(b) When zinc reacts with copper sulfate solution, copper and zinc sulfate solution are formed.

$$Zn + CuSO_4 \rightarrow Cu + ZnSO_4$$

This reaction is exothermic.

Use this information to complete the diagram.

(2)



ResultsPlus
examiner comment

The product line is to the right of the reactants – this scored a mark. However, in exothermic reactions the energy level of the products is lower than that of the reactants, so the second mark is not scored.

ResultsPlus
examiner tip

The reaction is exothermic, so energy has been lost. This is why the product should be lower than the reactant line.

Question 5(d)

Many candidates provided good explanations but then provided unnecessary information by describing the converse. Collision theory was generally well-understood. However, many omitted to describe collisions as being 'successful', resulting in reaction. Most candidates went into great detail for one factor, but fewer mentioned both temperature and particle size. Many were confused about how surface area is related to particle size and some thought that increasing the surface area of a solid increased the energy of the particles which in turn caused an increased reaction rate. Although a few mentioned activation energy and understood the implications, some were confused and gave descriptions of the type 'increased temperature increased activation energy which made the reaction faster'. Again it should be noted that activation energies are not covered by the specification and are not expected to be included in answers to questions of this type.

Although many good answers were seen, the quality often varied greatly.

- Many candidates were not clear on how they were changing the factors – eg 'If the temperature is changed…' rather than 'If the temperature is increased…'.
- There was a fairly widespread misunderstanding of breaking down a solid into small pieces increases the surface area rather than decreasing.
- Answers were often not specific – a great explanation of how temperature increase could affect collisions was given but then there was no link to how the rate of the reaction was affected.
- It was often obvious that candidates had begun writing their answer with no real idea of where their explanation was going.
- Some had however planned very briefly at the top of the page and this seemed to benefit them.
- The answers often lacked structure and evidence of logical thought.
- It appeared that there were many candidates concentrating on using good English and connectives in their answers but who lacked scientific vocabulary and understanding of concepts.

*(d) Reactions can occur when particles collide.
Rates of reactions can be altered by changing conditions.

Explain how the rate of reaction between a solid and a liquid is altered by changing the size of the pieces of solid and by changing the temperature of the liquid.

4 more surface area
6 particles faster
4 more collisions

(6)

The reaction of a solid and liquid can be increased by increasing the temperature of the liquid and solid. This will cause the particles to move at a higher speed, which causes the particles to have more energy in order to break the bonds of the solid. By increasing the temperature this also means that there is more collisions that will take place because it is faster.

Another factor that will increase the reaction is increasing the size of the pieces of solid. By increasing the surface area there are more particles for the reactant to collide with. This also allows the reaction to be quicker.

ResultsPlus
examiner comment

A level 2 answer – 4 marks. The candidate started well by focussing the first line on increasing the temperature. The answer then relates the increased temperature to increased energy of particles and an increased number of collisions. However there was no mention of what happened to the rate.

The second paragraph looked at the change in surface area and how that affected the rate of reaction. Although it was mentioned that there were more particles available to collide, there was no real indication of an increased number of collisions.

For this to be a level 3, a clear statement of how changing the temperature would change the rate of reaction is needed as well as an indication of the idea of more successful collisions or particles having sufficient energy that will lead to reaction.

ResultsPlus
examiner tip

Candidates should plan their answers to the 6-mark questions. This candidate did make some sort of plan as can be seen by the notes attached to the question.

*(d) Reactions can occur when particles collide.
Rates of reactions can be altered by changing conditions.

Explain how the rate of reaction between a solid and a liquid is altered by changing the size of the pieces of solid and by changing the temperature of the liquid.

(6)

Changing the temperature of liquid affects the rate of reaction in that it increases it. This happens because when the liquid is heated, this energizes the particles in the liquid, thus increasing their speed, and therefore the amount of successful collisions with solid particles, increasing the rate of reaction, as the rate of reaction is proportional to the amount / rate of successful particle collisions.

Changing the size of the pieces of solid affects the rate of reaction in the capacity that it increases it. This happens because this increases the surface area of the solid, and therefore the ~~area~~ area in which reaction can occur. This increased reaction area results in a larger amount of successful collisions, and therefore a faster rate of reaction.

(Total for Question 5 = 11 marks)

ResultsPlus
examiner comment

A level 3 answer – 6 marks. Although not absolutely clear to start with, it becomes apparent that as the temperature is raised, so the rate is increased. The more complex idea of increased successful collisions leading to a faster reaction is clear. Although it is not a perfect answer there is more than enough detail for level 3.

ResultsPlus
examiner tip

Make sure answers are written clearly using appropriate scientific terminology.

*(d) Reactions can occur when particles collide.
Rates of reactions can be altered by changing conditions.

Explain how the rate of reaction between a solid and a liquid is altered by changing the size of the pieces of solid and by changing the temperature of the liquid.

(6)

Changing the size of the pieces of solid but not the mass is changing surface area. Should surface area increase, the number of collisions would increase because there are more particles available to react. This is is increasing collision frequency. Should surface area decrease, more particles will be in the interior of the solid, rendering them unable to react and reducing collision frequency, ~~As~~ and therefore reducing reaction rate. As for the temperature of the liquid, ~~=~~ thermal energy is created by the movement of particles, should this increase, the kinetic energy of the particles will increase. With a higher kinetic energy will mean each particle will cover a more distance in less time, making it is more likely to collide and react with other particles. Higher kinetic energy also means particles collide harder resulting in an increase in successful collision frequency and increasing reaction rate.

(Total for Question 5 = 11 marks)

ResultsPlus
examiner comment

A level 3 answer – 6 marks. Not a perfect answer, but this one which is well within this category. This has it all – clear statements detailing how increasing surface area and increasing temperature leads to an increased rate of reaction. The candidate did, however, write about decreasing surface area, which was the reverse argument.

ResultsPlus
examiner tip

Having written an explanation, there is no point in writing the converse (unless it is asked for) – it adds nothing of credit to the answer.

*(d) Reactions can occur when particles collide.
Rates of reactions can be altered by changing conditions.

Explain how the rate of reaction between a solid and a liquid is altered by changing the size of the pieces of solid and by changing the temperature of the liquid.

(6)

Changing the mass of a solid can either increase or decrease the rate of reaction. When the solid is a large amount, it's harder to break down, but is it's in smaller pieces it's easier to break up increasing the rate of reaction. Changing the temperature of the water can also sped up or decrease the rate of reaction. If the water is hot the atoms move quicker and can break up solids quicker and is it was cold water the solid would just simply dissolve without increasing the reaction rate.

(Total for Question 5 = 11 marks)

ResultsPlus
examiner comment

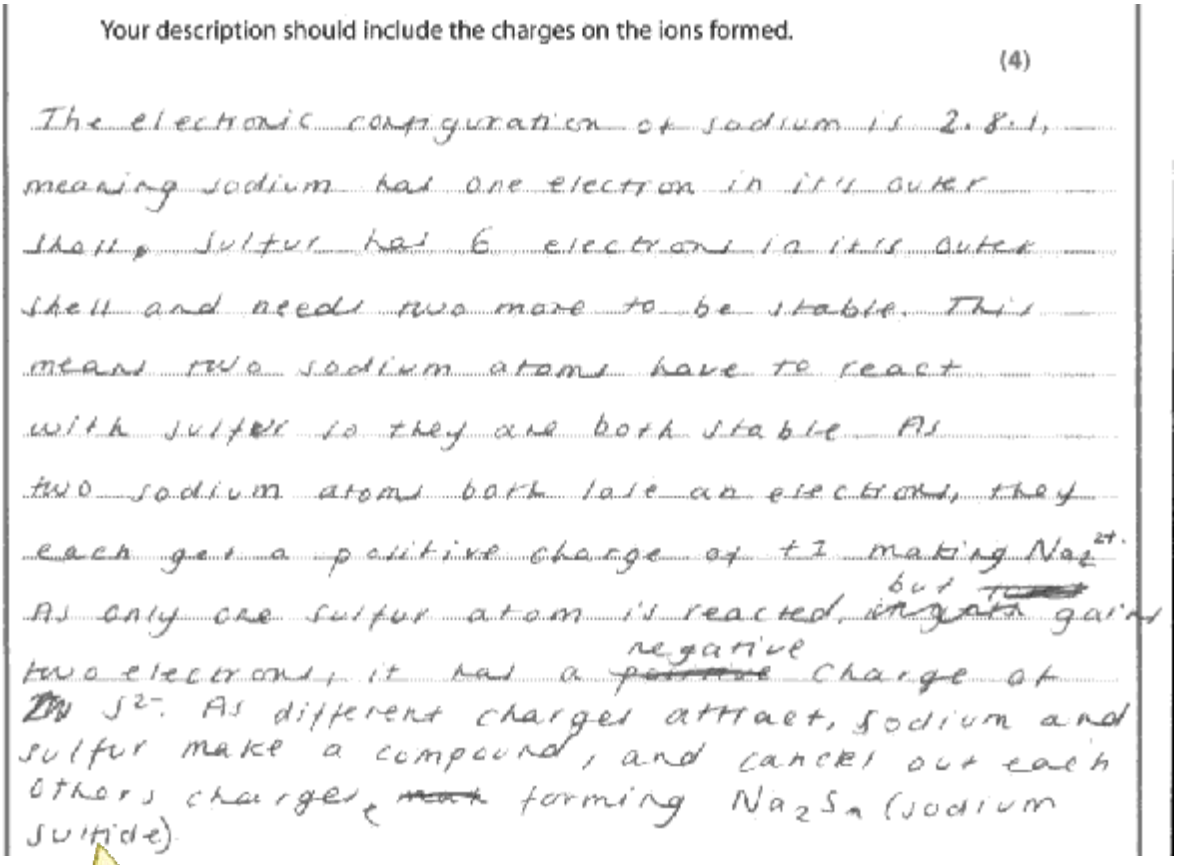
A level 1 answer – 2 marks. The answer does not get off to a good start as 'changing the mass' is not altering particle size. However, there is some indication that the candidate knows that smaller particle increases the rate of reaction in line 3. Again, in the final sentence there is also some indication that the candidate knows increasing the temperature of a reaction increases its rate. Not well expressed, but the indicators for level 1 are just about there.

ResultsPlus
examiner tip

Candidates should read the question twice to make sure they understand what their answer should focus on.

Question 6(c)

There were many marking points for this question and consequently many candidates scored full marks. However, several answers were confused when referring to charges. Several had the idea of sodium having 'spare' electrons. Some candidates gave conflicting descriptions about ionic and covalent bonding – sodium losing its outer electron and being shared with sulphur. Another common error was seen where sulphur only gained one electron to form S^- ions. There did not always seem to be a link between the number of electrons lost/gained and the formula: NaS was common. Sometimes it was difficult picking out the marking points from the written text where answers had little structure. A few candidates thought that sodium was positive to start with and sulfur negative, and when they lost and gained elections they became neutral. Despite that, many examiners reported that there were some outstanding responses from candidates with correct scientific and chemical ideas well explained.



Your description should include the charges on the ions formed.

(4)

The electronic configuration of sodium is 2.8.1, meaning sodium had one electron in it's outer shell, sulfur had 6 electrons in its outer shell and needed two more to be stable. This mean two sodium atoms have to react with sulfur so they are both stable. As two sodium atoms both lose an electron, they each get a positive charge of +1 making Na_2^{2+}. As only one sulfur atom is reacted, ~~it gains~~ but ~~two~~ gains two electrons, it had a ~~positive~~ negative charge of S^{2-}. As different charges attract, sodium and sulfur make a compound, and cancel out each others charges ~~mark~~ forming Na_2S (sodium sulfide)

ResultsPlus
examiner comment

Many of the marking points are present in this answer – electronic configuration of sodium atoms, how sodium atoms form ions, the ion that is formed, the number of electrons gained by a sulfur atom, formula of both the sulfide ion and sodium sulfide. 4 marks scored.

ResultsPlus
examiner tip

Candidates should read through their work and ensure they have provided a clear and unambiguous answer.

Your description should include the charges on the ions formed.

(4)

An ion is a atom of a group of atoms with a charge.
Sodium is in group 1, therefore has 1 electron in its outer shell
For it to become a full shell it has to gain 7 electrons, therefore
it is easier to lose 1. To lose 1 electron it must find a non-metal
to give it to. Sulfur is in group 6, therefore has 6 electrons in
its outer shell. As it needs to gain 2, and sodium can only give
1, it ~~needs~~ takes another sodium. Therefore each sodium can
lose there outer electron and dispose of their outer shell, and
Sulfur can gain the two electrons it needs to full its outer
shell.

ResultsPlus
examiner comment

A very clear answer containing many of the marking points. All 4 marks scored.

ResultsPlus
examiner tip

Candidates should organise their thoughts and plan their written answers carefully.

Your description should include the charges on the ions formed.

(4)

The sodium atom will join together with the sulfur atom, this is because Sodium has 11 electrons meaning it will have just one spare electron ~~with~~ in it's outer shell. Sulfur has 16 electrons, so 6 in it's outer shell. ~~The two atoms bond together by the use of a covalent bond.~~ The two atoms then covalently bond together.

ResultsPlus
examiner comment

1 mark for one electron in the outer shell of sodium and 1 mark for six electrons in the outer shell of sulfur.

ResultsPlus
examiner tip

Avoid the term spare electron. All the electrons have their uses, so therefore they are not spare or extra. The question is about an ionic compound – don't confuse this with covalent bonding.

Your description should include the charges on the ions formed.

(4)

They would react by transfering electrons to each other to give them 7 electrons in their outer shell, because the electrons configuration of sodium is 2.8.1 and sulfur is 2.8.6 which means sulphur has ~~16~~ 6 electrons in its outer shell and sodium has one. This transfer gives sodium a 7 electron outer shell and sulfur too. This results in an overall positive charge on the ions formed.

ResultsPlus
examiner comment

Marks here were given just for the electronic configurations of the sodium and sulfur atoms, so 2 marks. The following statement about numbers of electrons in the outer shells was just a repeat of the electronic configurations. Nothing else warranted a mark.

ResultsPlus
examiner tip

Candidates should make sure they know which way electrons are transferred in ionic bonding. Stable ions have full outer shells of eight electrons.

Question 6(d)

Many misconceptions about conductivity were seen in responses to this question. Although there were clear statements about solid sodium chloride not conducting and molten sodium chloride able to conduct, for many this was where explanations resulted in numerous problems. Often sodium chloride was recognised as being an ionic compound, few went on to describe what happened when sodium chloride melted and correctly identify why it could conduct.

A remarkable number of answers referred to movement of (delocalised) electrons, even when an ionic lattice was clearly described. In addition, many believed that delocalised meant the same as able to move. For example, 'cannot conduct as no delocalised electrons'.

The main misconception was that many thought that it was free electrons that allowed molten ionic compounds to conduct electricity; very few were able to identify that it was free ions, suggesting that candidates were confusing metallic and ionic bonding. A small number of candidates suggested that solids were better conductors due to the proximity of atoms so allowing conduction. Most candidates knew that solid ionic compounds did not conduct and that in a molten state they would, but could not explain why this was. Also, a significant minority of candidates simply referred to the presence or absence of space between the particles which allowed the electrons to flow. Very few explained the lack of conductivity of solid sodium chloride in terms of its immobile ions. Some discussed aqueous sodium chloride rather than molten

Other misconceptions evident here included:

- the regular structure of the solid allowing electrons to pass through more easily
- sodium is a metal so metallic bonding is present
- sodium chloride contains layers which can slide over each other
- as with the other 6-mark question there was a lack of clarity in answers; many candidates are writing paragraphs and paragraphs of prose that do not seem to have much structure or logical progression.

In summary the most common level achieved was level 1 because of the ideas of about free electrons. Had candidates given the same explanation using ions instead of electrons, a level 3 would have been seen. Just a handful of level 2 answers were seen where movement of particles or atoms was mentioned but they were not specific enough to achieve level 3.

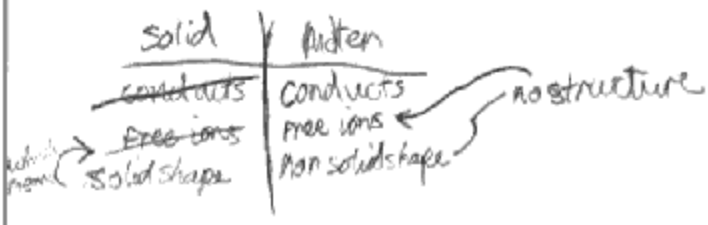
*(d) Explain the difference in the ability of solid sodium chloride and molten sodium chloride to conduct electricity in terms of their structures.

(6)

Solid sodium chloride cannot conduct electricity because it has a a solid shape and structure so ~~~~ there are no free ions moving around inside and therefore a current can't pass through it. On the other hand molten sodium chloride can conduct electricity because there is no structure and so there are free ions floating around within it. ~~~~ These ions are charged and so they can conduct the current through the molten sodium chloride.

(Total for Question 6 = 12 marks)

TOTAL FOR PAPER = 60 MARKS



ResultsPlus
examiner comment

A level 3 answer, but only just. This answer clearly identifies the particles responsible for conductivity – ions. It also clearly identifies how the ions are arranged in both the solid and in the molten state. 6 marks given.

ResultsPlus
examiner tip

A little planning paid off for this candidate.

*(d) Explain the difference in the ability of solid sodium chloride and molten sodium chloride to conduct electricity in terms of their structures.

(6)

When Sodium chloride is a solid it is a very rigid shape, therefore the delocalised ~~electrons~~ ions cannot move about freely to conduct electricity. However, when sodium chloride becomes molten, the delocalised ~~electrons~~ ions are able to move freely which then allows them to be able to conduct electricity.

ResultsPlus
examiner comment

A level 2 answer – 4 marks. Fortunately the candidate spotted the fundamental error and changed electrons into ions.

ResultsPlus
examiner tip

Metals conduct electricity through delocalised electrons. Molten ionic compounds conduct because of the freely moving ions, not electrons. A very common mistake on this examination paper.

*(d) Explain the difference in the ability of solid sodium chloride and molten sodium chloride to conduct electricity in terms of their structures.

(6)

Solid sodium chloride is unable to conduct electricity. Although the compound has charged particles these particles are held in a regular lattice arrangement, with strong electrostatic forces of attraction between oppositely charged ions which means that the charged particles can not move so they can't conduct an electronic charge.

However Sodium Chloride in a molten solution can conduct electricity. This is because when sodium chloride is in a molten solution the heat energy breaks the bonds between the ions and separates the ions out from the structure of the lattice arrangement. This allows the ions to move around freely so that they can conduct electricity.

This is because for a substance to conduct and carry electricity it has to contain charged particles that are free to move. In molten sodium chloride this is because the ions are free to move while in solid sodium chloride they aren't free to move. Not allowing it to conduct electricity.

(Total for Question 6 = 12 marks)

TOTAL FOR PAPER = 60 MARKS

ResultsPlus
examiner comment

A level 3 answer – 6 marks. This proved to be a very good explanation that had everything expected at this level, even with the reason why ions cannot move in the solid sate.

ResultsPlus
examiner tip

Candidates should ensure they have the necessary knowledge and use scientific explanations wherever possible.

*(d) Explain the difference in the ability of solid sodium chloride and molten sodium chloride to conduct electricity in terms of their structures.

(6)

Solid sodium chloride doesn't conduct electricity because there are no free moving electrons in the lattice structure of the compound. This means the electrons cannot collide with eachother and pass electricity on. When the bonds are broken when heat is added the electrons become delocalised meaning they can now collide + move freely to conduct electricity.

ResultsPlus
examiner comment

A level 1 answer – 2 marks. This candidate had written the key details for level one, but then went to include ideas about delocalised electrons. Unfortunately answers containing ideas about delocalised electrons being responsible for conductivity in this situation was seen by many examiners. It was a common misconception.

ResultsPlus
examiner tip

Attempt all questions in the paper. Even with a limited knowledge. important marks may be gained.

Paper Summary

In order to improve their performance, candidates should:

- learn to write and balance equations using correct symbols for the elements and compounds found within the specification
- learn how ionic and covalent bonding occurs and understand how the properties of substances are related to their structure and bonding type
- be able to explain the trends seen in group 1 and group 7 of the periodic table
- revise the experiments carried out during the course
- practise answering the 6-mark questions

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