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Examiners' Report June 2018

GCSE Science 1SC0 2CH

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Introduction

This examination paper was the first of this series for the Combined Science Chemistry Higher tier. This paper, like all the Combined Science examinations, contains six questions giving a total of 60 marks. These 6 questions also appear on the Chemistry Higher tier paper.

This paper contains items worth 16 marks that also appear on the Foundation paper. These overlap items are the whole of question 2 and the first three items of question 3. The paper was targeted at grades 9 to 4, with about half the marks for grades 6 to 4.

The paper made use of a variety of question types suitable for candidates at this level; multiple choice, calculations and short answer questions being the frequent types. The paper contained only one extended open response question (6-mark), but 4-mark questions will feature more prominently in future papers. As with the other Chemistry papers, a minimum of 20% of the marks were for maths, a minimum of 15% for testing practical skills and a maximum of 15% on knowledge in isolation (recall) questions.

Question 1 (a)

A question very similar to this has appeared on many papers in the previous specification where they performed well. It was disappointing to see that on this occasion that few students appreciated that as a result of the cooling Earth and its atmosphere that the water vapour would condense, fall as rain and form the seas and oceans. Many students surprisingly thought that increasing oxygen or carbon dioxide levels or global temperatures were the cause. Many students also thought that as a result of increasing animal and/or human life caused a greater increase of water usage causing a fall in the amount of water vapour in the atmosphere.

1 The Earth's atmosphere contains several gases.

(a) Figure 1 shows the relative amounts of gases thought to be in the Earth's early atmosphere.

gas	relative amount in Earth's early atmosphere
oxygen	small
carbon dioxide	large
nitrogen	small
water vapour	large

Figure 1

The amount of water vapour in today's atmosphere is much less than the amount in the Earth's early atmosphere.

Explain why the amount of water vapour in the atmosphere has decreased.

(2)

This is because water vapour changed into carbon dioxide which has increased the green house effect, causing higher temperatures which means that water vapour decreased. ~~water~~ ~~the~~ water vapour also changed into oceans.

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Examiner Comments

Markers ignore any irrelevant writing as long as it does not contradict any of the marking points, which applied to most of this answer. Many students thought that the decrease in amount of water vapour had something to do with carbon dioxide or the greenhouse effect.

There was nothing that could be credited for the first mark, but the second mark was given for 'oceans formed'.

1 mark

1 The Earth's atmosphere contains several gases.

(a) Figure 1 shows the relative amounts of gases thought to be in the Earth's early atmosphere.

gas	relative amount in Earth's early atmosphere
oxygen	small
carbon dioxide	large
nitrogen	small
water vapour	large

Figure 1

The amount of water vapour in today's atmosphere is much less than the amount in the Earth's early atmosphere.

Explain why the amount of water vapour in the atmosphere has decreased.

(2)

The water vapour in the air made the seas in the early atmosphere, this is why there is a lot less in the atmosphere now.

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Examiner Comments

Cooling of the Earth or its atmosphere was not mentioned so the first mark was not given. However 'water vapour turned into seas' was given the second mark. 1 mark overall.

Question 1 (b) (i)

Although the calculation was quite straightforward taking the difference in volume and converting that into a percentage, many students simply took the 40 dividing by 50 and converting that into a percentage giving the value of 80% and failed to relate that back to the first line where it stated that the apparatus was used to find the percentage of oxygen in dry air. It was thus surprising to see that they were happy to accept that as the value. However, about half the students carried out a correct calculation to obtain a value of 20%. Some carried out the correct (to give 20%) and the incorrect (to give 80%) calculations but did not then commit themselves. For that they were not credited with full marks.

(i) The following results were obtained

initial volume of air in apparatus = 50 cm^3

final volume of gas in apparatus = 40 cm^3

Calculate the percentage of oxygen in this sample of dry air.

(2)

~~80 ÷ 40 = 4.25~~

40 ÷ 50 = 0.8 × 100 = 80

percentage oxygen in the air = 80 %

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Examiner Comments

1 mark was given here.
The student had not worked out the change in volume of gas so lost the first mark.
But conversion into a percentage by correctly dividing the volume by 50 and multiplying by 100 and evaluating their answer scored the second mark.

This was a frequently seen answer.

(i) The following results were obtained

initial volume of air in apparatus = 50 cm^3

final volume of gas in apparatus = 40 cm^3

Calculate the percentage of oxygen in this sample of dry air.

(2)

50 − 40 = 10 ÷ 50 = 0.2 = 20 %

percentage oxygen in the air = 20%

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Examiner Comments

Correct calculation of change in volume which was then divided by 50, although the student did not show the multiplication by 100 it is clear this is what they have done as their final answer is correct. Both marks were awarded here.

Question 1 (c)

Many students appreciated that the change resulted from the increased levels of oxygen scoring the first mark, but then through incorrect terminology did not score the second one.

(c) The Earth's earliest rocks contained iron sulfide and no iron oxide. Later the rocks contained iron oxide as well as iron sulfide.

Explain what happened to allow this change to occur.

(2)

The increasing rates of oxygen combined with the iron sulfide in the rock, then causing iron oxide and iron sulfide to be present.

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Examiner Comments

The first mark was not scored - 'increasing rates of oxygen' was not considered to be the same as increasing levels of oxygen. However, the second mark was given for oxygen combining with iron sulfide.
1 mark overall.

(c) The Earth's earliest rocks contained iron sulfide and no iron oxide.
Later the rocks contained iron oxide as well as iron sulfide.

Explain what happened to allow this change to occur.

(2)

Over the years, cyano bacteria in Stromatolites have been producing oxygen from taking in carbon dioxide within the ocean. This has caused more oxygen in the atmosphere, so therefore iron oxide is more present.

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Examiner Comments

The first mark was given for more oxygen in the atmosphere, but there is no mention of the oxygen reacting with iron sulfide or with iron for the second mark.

Question 2 (a) (i)

Most students scored the mark by giving the answer of 35, but some thought they could simply use the value given on the periodic table, but this is the **relative atomic mass** of 35.5 and not the **mass number** of that particular atom. A few students chose to add together the numbers of all sub-atomic particles, but this was rarely seen.

Question 2 (a) (ii)

Most scored with the correct answer of 2.8.7, but a few either had an extra shell of electrons or a different set of numbers that added to 17.

Question 2 (b)

The complete result of the test for chlorine is that the indicator paper would turn red first then bleached was given by less than a third of the students. However, many scored for either the indicator paper turning red or being bleached. Those who had the order the wrong way round were not credited with the marks. It was, however, surprising to see the number who thought that chlorine would turn the paper purple because it is alkaline.

(b) Describe what you would **see** if damp, blue litmus paper is placed into chlorine gas.

(2)

When damp blue litmus paper is exposed to Chlorine it bleaches White to Show Clorine is present.

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Examiner Comments

Many students just scored the 2nd marking point with answers similar to this. It is possible they missed the point that damp blue litmus paper was used, so on exposure to chlorine the litmus paper would first turn red momentarily before being bleached.

(b) Describe what you would **see** if damp, blue litmus paper is placed into chlorine gas.

(2)

The blue litmus paper would turn red for a moment (because chlorine is acidic) and would then be bleached white

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Examiner Comments

This was the ideal answer to the question, but only seen in just over a quarter of the answers. Both marks were scored here.

Question 2 (c) (i)

This question has been asked in this format for many years, but it was surprising to see how few scored the two marks. Many scored just one for just a description involving the sharing of an electron or the sharing of electrons. Students should be deterred from describing a covalent bond as being between 'two **or more**' elements or atoms or molecules; they should just stick to it being between two atoms.

(c) Chlorine exists as diatomic molecules.

In a molecule, two chlorine atoms are joined by a covalent bond.

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

(2)

a ~~tog~~ bond that binds atoms together sharing their electrons

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Examiner Comments

The majority of students had an answer similar to this where the sharing of electrons scored a mark. There was no mention of how many electrons were shared so only one mark.

(c) Chlorine exists as diatomic molecules.

In a molecule, two chlorine atoms are joined by a covalent bond.

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

(2)

A covalent bond is a strong bond between atoms where a pair of electrons is shared in order to fill both of the atoms' outer shells.

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Examiner Comments

This scored both marks for the idea of electrons being shared and it was a pair of them. Only a relatively small number of students gave an answer that included both points.

Question 2 (c) (ii)

The majority of students scored just the one mark for stating that chlorine has a low boiling point as the explanation for chlorine being a gas at room temperature. A low melting point did not score here. Explanations in terms of intermolecular forces being weak were rarely seen; often answers were given in terms of 'bonds' which limited the mark students could score consequently. Note : the term intermolecular force is that used in this specification, intermolecular bond could be confused with a dative covalent bond (not on the specification), so is not acceptable.

(ii) Explain why chlorine is a gas, rather than a liquid, at room temperature.

(2)

Covalent bonds have low boiling points because they have weak ~~electrostatic~~ intermolecular ~~to~~ forces joining the atoms.

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Examiner Comments

The weak intermolecular forces are between the molecules and not between the atoms, meaning this answer did not gain the first marking point.
The student identified that the intermolecular forces are weak, but here they are joining **atoms**, so did not gain the second marking point.
The third marking point was not awarded because the first line starts with 'covalent bonds' and that negated the possibility of a mark here.
Overall mark 0.

(ii) Explain why chlorine is a gas, rather than a liquid, at room temperature.

(2)

chlorine is a gas at room temprature because it has a low boiling point. It's low boiling point means it will evaporate into a gas quickly, therefore it is a gas not a liquid at room temprature

ResultsPlus
Examiner Comments

The majority of students gave an answer similar to this with the idea of chlorine having a low boiling point as to why it is a gas rather than a liquid at room temperature. 1 mark only.

Question 2 (d)

The answer of the solution being acidic was looked for, but surprisingly many thought it was alkaline or that it turned red because chlorine was present in the hydrochloric acid.

(d) When the gas hydrogen chloride, HCl, is dissolved in water, a solution forms. Blue litmus paper dipped in this solution turns red.

State why the litmus paper turns red.

(1)

The litmus paper turns red because the pH of hydrogen is acidic.

ResultsPlus
Examiner Comments

A very confused answer - 0 marks.

Several students showed misconceptions as illustrated by these responses here.

(d) When the gas hydrogen chloride, HCl, is dissolved in water, a solution forms. Blue litmus paper dipped in this solution turns red.

State why the litmus paper turns red.

(1)

the litmus paper turns red because HCl has been reacted with H_2O.

Repeating the question in an answer is not going receive credit – 0 marks.

(d) When the gas hydrogen chloride, HCl, is dissolved in water, a solution forms. Blue litmus paper dipped in this solution turns red.

State why the litmus paper turns red.

(1)

Because the solution must have a high acidic PH

ResultsPlus Examiner Comments

It is acidic but is not a high pH - so no mark was given as this was a contradiction - 0 marks.

Question 3 (a)

Many students demonstrated that they could calculate the empirical formula with about a third scoring all 3 marks. A variety of errors were seen and marking was consequential on that. Although students made the first correct step of dividing the mass by the relative atomic mass, many had that division as relative atomic mass / mass, some had mass of sodium / relative atomic mass of oxygen (and the other combination). From there many, but not all, managed to obtain a whole number ratio and produce a formula based on that. Several students performed a correct first step calculation, got as far as a 2:1 ratio and stopped there without writing the empirical formula. But it was surprising to see how many students who could not make any decent headway with this calculation and so scored 0. Students should be advised that when calculations of this type are set, the masses of elements chosen will result in a whole number ratio being produced and no rounding will be necessary.

3 Lithium, sodium and potassium are reactive metals in group 1 of the periodic table.

(a) Sodium metal tarnishes in air to form a layer of sodium oxide on its surface.
0.92 g of sodium combined with 0.32 g of oxygen in this oxide.

Calculate the empirical formula of this sodium oxide.
(relative atomic masses: O = 16, Na = 23)

You must show your working.

(3)

Na_2O.

(23 × 2) = 46

1 mol Na = 46) ÷ 50   1 mol O2 = 16) ÷ 50

0.02 = 0.92   0.02 = 0.32

empirical formula of sodium oxide = ...

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Examiner Comments

This answer starts with the empirical formula of sodium oxide - so cannot score the formula mark.
The student has not used the information to calculate the empirical formula but to show that the masses given fit the formula.
Zero marks

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Examiner Tip

Do not start an empirical formula calculation with the compound's formula, even if it may be correct. The question is about using the data to obtain the empirical formula.

3 Lithium, sodium and potassium are reactive metals in group 1 of the periodic table.

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Calculate the empirical formula of this sodium oxide.
(relative atomic masses: O = 16, Na = 23)

You must show your working.

(3)

$Na = \frac{0.92}{23} = 0.04$

$O = \frac{0.32}{16} = 0.02$

Na O
1 : 2

NaO_2

empirical formula of sodium oxide = NaO_2

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Examiner Comments

1st marking point: dividing the mass of the element by the relative atomic mass has been carried out correctly - 1 mark
2nd marking point: correct moles but incorrect whole number ratio - 0 marks
3rd marking point: correct formula from incorrect whole number ratio - 1 mark
Two marks

3 Lithium, sodium and potassium are reactive metals in group 1 of the periodic table.

(a) Sodium metal tarnishes in air to form a layer of sodium oxide on its surface.
0.92 g of sodium combined with 0.32 g of oxygen in this oxide.

Calculate the empirical formula of this sodium oxide.
(relative atomic masses: O = 16, Na = 23)

You must show your working.

(3)

23 ÷ 0.92 = 25   16 ÷ 0.32 = 50

25 : 50 ÷25 ÷25 = 1 : 2 = NaO_2

empirical formula of sodium oxide = NaO_2

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Examiner Comments

Answers similar to this with the inverted first step calculation were frequently seen.

First marking point: division carried out the wrong way - relative atomic mass divided by mass - 0 marks
Second marking point: correct whole number of 1:2 from 1st step (error carried forward) - 1 mark
Third marking point: correct empirical formula from whole number ratio - 1 mark
Two marks overall

3 Lithium, sodium and potassium are reactive metals in group 1 of the periodic table.

(a) Sodium metal tarnishes in air to form a layer of sodium oxide on its surface.
0.92 g of sodium combined with 0.32 g of oxygen in this oxide.

Calculate the empirical formula of this sodium oxide.
(relative atomic masses: O = 16, Na = 23)

You must show your working.

(3)

	O	NA
N A D D	16 / 8	23 / 11
	2 / 0.32	2.09 / 0.92
	6.25 / 6.25	2.271 / 6.25
	1	0.3632

empirical formula of sodium oxide = SO

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First marking point: 0 marks - has taken relative atomic mass divided by atomic number - then those answers divided by the masses of the elements
Second marking point: 0 marks - correct ratio not found by dividing by the smaller number - the larger number was used
Third marking point: 0 marks - incorrect formula from ratio obtained

Overall this scored 0 marks

ResultsPlus Examiner Tip

Relative atomic masses will always be given if you need to use them.

Other data such as atomic numbers, molar volume of gas, Avogadro number will always be given if you need to use them. No atomic numbers were given so were not needed in this calculation.

Question 3 (b)

The greater majority of the students could balance the equation. However, of more concern is the knowledge of state symbols. This part of the question was poorly answered. At this level it would be expected for students to know the state symbols. Too often numbers were seen as state symbols or where students thought that the formula needed to be completed, eg Na(OH) where OH was written in the space for the state symbol.

Complete the balancing of the equation for this reaction and add the state symbols for each substance.

(3)

2 Na(aq) + $2H_2O$(aq) → 4 NaOH(gas) + H_2(gas)

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Examiner Comments

Only the first marking point for balancing number of Na atoms was given here. NaOH was incorrectly balanced and state symbols were incorrect.

About half the students did not score the mark for the state symbols.

(b) Sodium reacts with water to form sodium hydroxide solution and hydrogen.

Complete the balancing of the equation for this reaction and add the state symbols for each substance.

(3)

4 Na(s) + $2H_2O$(l) → 4 NaOH(aq) + H_2(g)

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Only 1 mark here for the correct state symbols.

Question 3 (d)

Over half the students knew that on going down group 1, the number of shells increased, but only about a third of those related that to the outer electron then being easily removed. Many had the misconception that on going down the group the outer shell contained more electrons or that the outer electron was more difficult to be removed, despite the question stating that the reactivity increased from lithium to sodium to potassium. A few gave correct electron configurations which was acceptable for the first marking point.

Question 4 (b) (ii)

This was another question that was similar to those set on the previous specification and similarly to Q1(a) the response by students was frequently poor. Although many students made the point that alkanes contain only hydrogen and carbon, some spoilt their answer by using mixture of hydrogen and carbon or hydrogen molecules and carbon molecules.

(ii) Explain why alkanes are described as hydrocarbons.

(2)

because they only contain hydrogen and carbon molecules.

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The final word 'molecules' resulted in this answer scoring zero. Similarly if the answer was given as 'a mixture of carbon and hydrogen only', this too would have scored zero because of 'mixture' in the answer.

(ii) Explain why alkanes are described as hydrocarbons.

(2)

Because alcanes are made up of hydrogen and carbons with a strong bond between them.

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'... made up of hydrogen and carbons ...' scored a mark. The inclusion of 'only' before or after the two elements would have scored the second mark. 1 mark only.

About a quarter of the students gave an answer similar to this scoring only 1 mark.

Question 4 (c)

The greater majority of the students could describe the pattern in terms of the greater the number of carbon atoms in a molecule of alkane, the higher the boiling point, but only a small number could explain that in terms of intermolecular forces increasing with increased molecule size. A high number of students thought that at the boiling point, the alkane molecules broke up or carbon-carbon bonds were broken.

Explain the pattern shown by this graph.

(2)

The boiling points of alkanes increase as they have a larger number of carbon atoms. This is because longer chain alkanes have ~~increasing~~ ~~a~~ larger intermolecular forces of attraction, which takes lots of energy to break

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Examiner Comments

Answers of this quality were rarely seen to score 2 marks. The overwhelming majority just had something similar to the first line of this answer and so only scored 1 mark.

Explain the pattern shown by this graph.

(2)

As the number of atoms in molecules increase, the temperature that they break at increase. This is because as number of atoms increase, more energy it's required to break the bonds between the atoms.

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Examiner Comments

This answer was given in terms of breaking bonds between atoms - i.e. the covalent bonds. This misconception about boiling breaks covalent bonds was frequently seen.

0 marks given.

Explain the pattern shown by this graph.

(2)

the more carbon atoms in an molecule of alkane the higher the melting and boiling point this is due to the strong intermolecular forces of attraction, ~~att~~ they need more energy for the bonds to be broken. so they will require a higher melting/boiling point.

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Examiner Comments

The correct trend scored the first mark.
However, the use of 'bonds to be broken' and the lack of a comparative (strong vs stronger) stopped the award of the second mark.
1 mark given

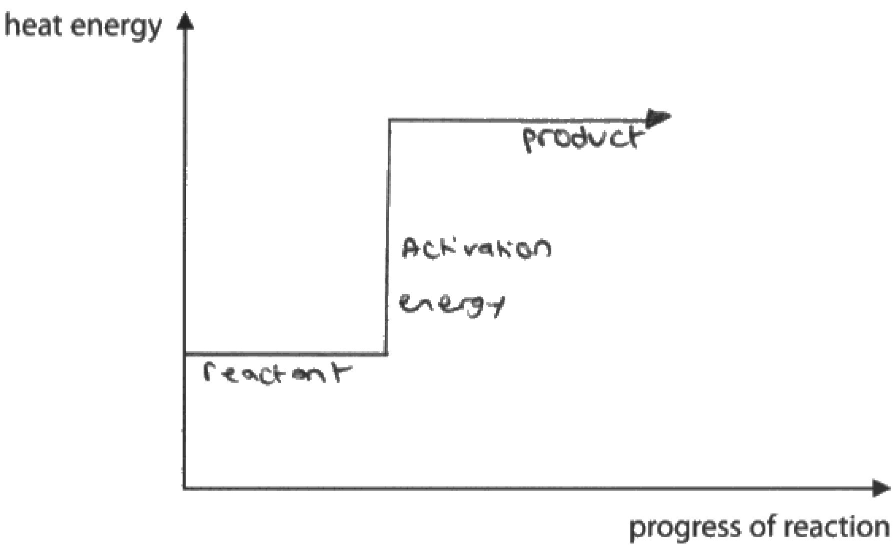
Question 4 (d) (i)

A slight majority of the students identified fuel oil as the fraction that was most likely to be cracked. Nearly everyone else misunderstood the question and gave petrol as the answer.

Question 4 (d) (ii)

The endothermic reaction profile was known only to about half the students. Only a small number could show the activation energy correctly on an endothermic reaction profile. Consequential marking was in place for those who drew an exothermic reaction profile. Incorrect diagrams included random straight lines starting from the origin, others drew a line similar to that produced from a rates of reaction curve and a few drew curves to show what happened to the amount of reactant and to the amount of product formed during a reaction.

(3)



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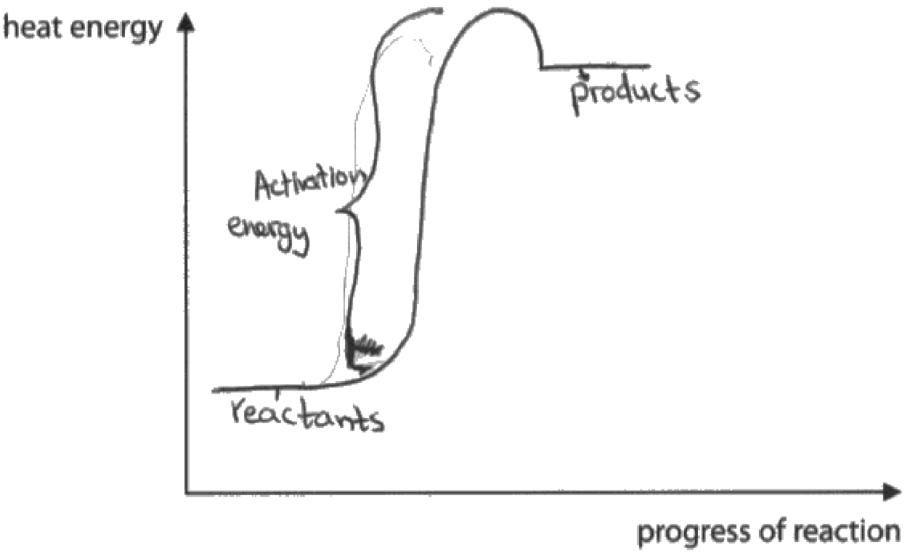
Examiner Comments

This basic energy level diagram scored 2:

1 - for reactants energy level lower than that of products

1 - for reactants and products labels in the correct positions

(3)



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Examiner Comments

In addition to the first two marking points as on the other example, this scored the 3rd mark for the correct 'hump' and label showing the activation energy.

Question 4 (d) (iii)

Surprisingly, not many could work out the formula of a single product to balance the equation. A common misconception seen here was to give $2C_3H_7$ as the answer.

Question 5 (a)

This question was disappointing, relatively few candidates gave a complete correct answer of describing the appearance of the starting solution and that of the solution after the reaction. Some students gave an appropriate description such as a yellow solution formed, but the majority missed the point of the question. A common error seen was where students stated that the solution would change in colour without stating the change. Some candidates wasted time and space describing how chlorine water is added to potassium bromide solution.

5 (a) Describe what is **seen** when chlorine water is added to potassium bromide solution and the mixture shaken.

(2)

Chlorine is more reactive than bromine so displaces it in the reaction forming an orange liquid to form.

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Examiner Comments

This scored 1 mark for ' ... an orange liquid to form.' The appearnce of potassium bromide before chlorine water was missing.

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Examiner Tip

When asked 'Describe what is **seen** ...', the starting appearance and final appearance are needed.

5 (a) Describe what is **seen** when chlorine water is added to potassium bromide solution and the mixture shaken.

(2)

potassium bromide is a red/brown liquid at room temperature. When added with chlorine water and shaken, it turns very cloudy.

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Examiner Comments

Not many reponses gave observations, but here the observations 'red/brown liquid' (for potassium bromide soltuion) and 'turns cloudy' (product) did not score.

Question 5 (b)

Similarly to the previous question, only a small number could give an appropriate explanation in part (i) and a correct half equation in part (ii). The most frequent mark awarded was for explaining that chlorine has been reduced by gaining electrons, but this not awarded if this was qualified by saying that the electron came from the potassium. Very few students stated that the product of the reduction was the chloride ion. Overall, the ionic equation was very poorly attempted. In most cases, where attempted, the bromide ion had no charge, the electrons were being added to the bromide ions or some form of equation was written in reverse.

(i) In this reaction, chlorine has been reduced.

Explain, using the equation, how you know that chlorine has been reduced.

(2)

In reduction, electrons have been gained. The reactant, Cl_2, becomes 2KCl, we can tell it has been reduced as the charge of 2 that it previously had has been lost due to reduction.

(ii) Write the half equation for the formation of bromine from bromide ions.

(2)

$Br + 2e^- \longrightarrow Br_2$

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Examiner Comments

5(b)(i) – Reduction is the gain of electrons and scored the first mark, but 'chloride / Cl^-' was not mentioned for the second mark.
1 mark only

5(b)(ii) – The bromide ion on the left was frequently shown like this without charge. Electrons being 'added' on the left was also incorrect.

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Examiner Tip

Practice writing half equations and remember that the charges must balance as well as the particles.

(i) In this reaction, chlorine has been reduced.

Explain, using the equation, how you know that chlorine has been reduced.

(2)

• Chlorine has been reduced because it has gained electrons.
• This is a redox reaction, meaning both oxidation and reduction need to take place, and if bromide has been oxidised to bromine, than chlorine has been reduced to chloride.

(ii) Write the half equation for the formation of bromine from bromide ions.

(2)

$2Br^- + 2e^+ \longrightarrow Br_2$

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Examiner Comments

5(b)(i) – Chlorine gains electrons scored the first mark and to form 'chloride' was sufficient for second mark as 'chloride (ion) or Cl-' is required.
So 2 marks

5(b)(ii) – Br^- and Br2 are correct but e^+ was not correct and so no marks were given for this answer.

Question 5 (c)

Just over half the students were given a mark for the correct formulae of the reactants, but then only a small minority could give the correct formula of aluminium chloride and even fewer could produce a complete balanced equation. Common errors included giving the formula of aluminium as Al_2, chlorine as just Cl and aluminium chloride as either AlCl or as $AlCl_2$.

(c) Aluminium reacts with chlorine to form aluminium chloride.

Write the balanced equation for this reaction.

(3)

$Al_3 + Cl_2 \rightarrow Al_2Cl_3$

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Examiner Comments

Incorrect throughout. It is possible that the student based the formula of the product on that of aluminium oxide. No marks scored here.

(c) Aluminium reacts with chlorine to form aluminium chloride.

Write the balanced equation for this reaction.

(3)

$2Al + Cl_2 \rightarrow 2AlCl$

ResultsPlus
Examiner Comments

This was a common answer - correct formulae of reactants and incorrect formula of aluminium chloride. So only 1 mark scored here for the formulae of the reactants.

Question 5 (d)

Describing the simple experiment here involved stating how the experiment could be carried out and how that experiment would show that ions would be present. About half the students gained a mark for stating either the idea of the solution conducts electricity or use electrolysis. Only half of those gave some detail such as describing the circuit but few gave an appropriate observation to show that ions were present. Most of the errors centred around measuring the boiling point of the solution or similar.

(d) A solid ionic compound is dissolved in water to form a solution.

Describe a simple experiment to show that charged particles are present in this solution.

(3)

You could filter the solution into a beaker and then heat the solution to see whether the particles have energy. Or, you could place a cathode and anode into two seperated beakers of the solution, then see whether cations and ions move to both. If they do, this will show that charged particles are present.

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Examiner Comments

The filtration of the solution could be ignored as it did not impede anything that followed.

Placing a cathode and an anode into two separate beakers without any indication that they are connected together in a circuit then stopped the award of the first marking point.
There was no connection made with a cell/battery – so no second marking point.
No description of what would be seen to show that ions are present – no 3rd marking point.

This scored 0 .

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Examiner Tip

Don't give alternatives for your answer. If one is incorrect, then the whole answer is incorrect. Examiners do not pick the best answer from a range of alternatives.

(d) A solid ionic compound is dissolved in water to form a solution.

Describe a simple experiment to show that charged particles are present in this solution.
(3)

use electrolysis, put two metal rods into the solution and connect the two rods to an energy source one of the metal rods is positive (anode) and the other negative (cathode) the positive ions in the solution will go to the cathode and the negative ions will go to the anode.

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Examiner Comments

About a a quarter of the students scored 2 with a similar answer to this:

2nd marking point scored from electrolysis
1st marking point scored from use of rods
Ions moving was not enough for 3rd marking point as this could not be observed easily.

(d) A solid ionic compound is dissolved in water to form a solution.

Describe a simple experiment to show that charged particles are present in this solution.

(3)

Create a circuit with a power pack, light bulb and wires connect them but put the two ends of the wire into the Solution to include the Solution in the Circuit. Turn the power pack on, if there are charged particles the bulb will turn on.

ResultsPlus
Examiner Comments

Wires into the solution –- scored 1st marking point

Connecting up the circuit with power packetc – scored the 2nd marking point

Evidence – 'bulb will turn on' – scored the third marking point

Few candidates scored all three mainly as a result of not stating the evidence.

Question 6 (a) (i)

Several students gave an appropriate means of measuring the volume of gas more accurately and of those the overwhelming majority gave gas syringe as their answer. The most common error was an answer that involved measuring the mass rather than the volume.

Question 6 (a) (ii)

Just over a third of the students could make an attempt at calculating the gradient at the point shown by using the tangent line. Some made errors in reading the graph to calculate the gradient. The most obvious error seen was where students calculated the average gradient by dividing the volume at that point (29 cm^3) by the time (30 s). Many others used numbers that were difficult to identify how they were obtained. It seemed that few students knew how to calculate the gradient of the line shown.

(ii) A tangent has been drawn to the line on the graph in Figure 7.

Calculate the rate of reaction at this point.

(2)

volume ÷ time

~~32~~ 30 ÷ 32 = 0·9375

rate of reaction = 0·9375 $cm^3 s^{-1}$

ResultsPlus
Examiner Comments

The figures of 30 and 32 were for a particular point of the graph and calculating a rate of reaction using those figures only gave an average rate to that point rather than the rate as shown by the tangent on the graph.
So 0 marks were given.

(ii) A tangent has been drawn to the line on the graph in Figure 7.

Calculate the rate of reaction at this point.

(2)

time vol time vol
0,15 = beginning 60,44 = end

44 - 15 = 29 (change in vol)
29 ÷ 60 = 0.483 = 0.5 to 1dp
time

rate of reaction = 0.5 $cm^3 s^{-1}$

ResultsPlus
Examiner Comments

0,15 and 60,44 refered to the start and end points of the tangent line shown on the graph.
The change in volume was correct (44-15 = 29)
Calculating the rate – i.e. the gradient of the line 29 / 60 = 0.483 was correct, so this answer scored two marks.
A degree of flexibility was given in reading points on the graph as the scale was so small.

Question 6 (a) (iii)

It was disappointing to see how few could sketch an appropriate graph showing the behaviour of an equal mass of powdered magnesium. The most common 'error' was where no line was shown, other errors included a straight line going through the origin, where the line levelled off either above or below 40 cm^3.

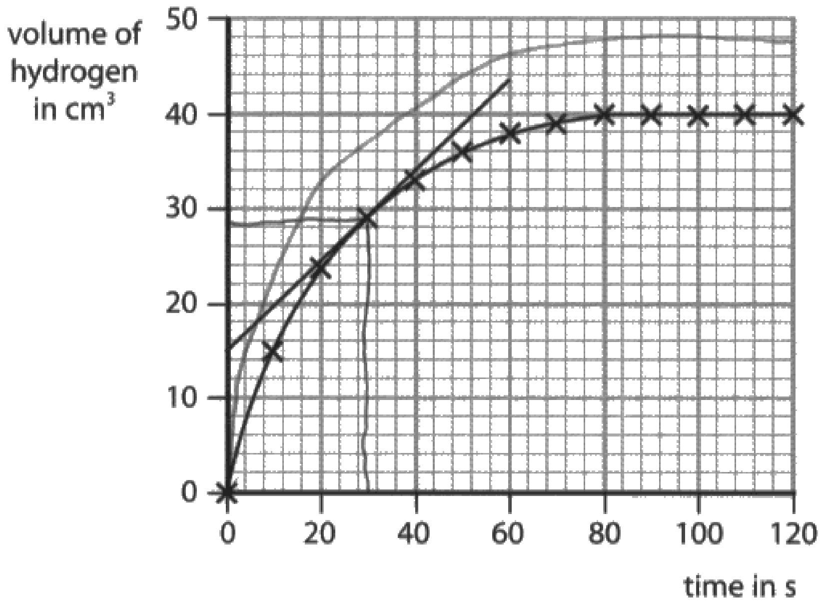

Figure 7

ResultsPlus
Examiner Comments

The line is correctly drawn to the left of the curve, showing the student understood that the rate would be greater for powdered magnesium. However, the student did not appreciate that the same mass of powdered magnesium would give the same volume of hydrogen as in the first experiment, as shown by the line reaching a higher volume, so 0 marks.

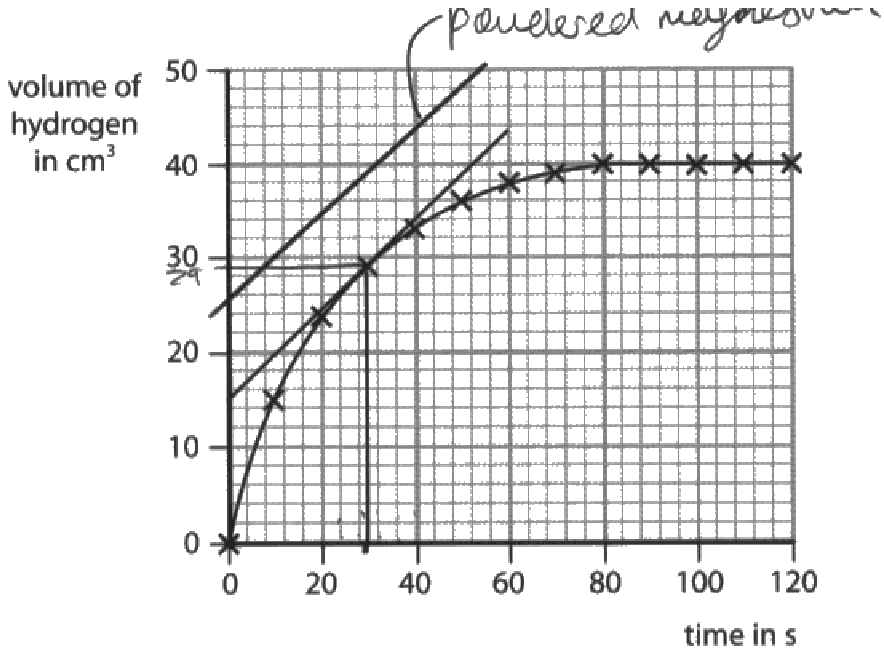

Figure 7

ResultsPlus
Examiner Comments

It looks like the student has mistaken the tangent as being the line of reference. Random lines similar to this were seen on many answers.

Question 6 (b) (i)

Some students could correctly calculate the number of moles of magnesium, but there were many who used the two numbers of 0.1 and 24 in various other ways such as 24/0.1 or 0.1 x 24. Of those who had the numbers in a correct fraction, some spoilt their answers by an incorrect approximation – 0.0416 is incorrect. Equally, leaving the answer as 0.1/24 was not accepted, the evaluation of the fraction is expected as the answer.

(b) The balanced equation for this reaction is

$$Mg + 2HCl \rightarrow MgCl_2 + H_2$$

(i) In another experiment, 0.1 moles of hydrochloric acid, HCl, were reacted with 0.1 g of magnesium ribbon.

Calculate the number of moles of magnesium, Mg, in the 0.1 g sample of magnesium ribbon.
(relative atomic mass: Mg = 24) 6.02×10^{23}

(1)

0.1 ÷ 24 = 0.00416 ~~× 6.02 × 10^23 = 2.5 × 10^21~~

number of moles = 0.00416

ResultsPlus
Examiner Comments

There was no dot above the 6 to indicate the repeating numbers. So this means that this has been incorrectly rounded. 0 marks
Many answers showed correct rounding as 0.0042 (2 sig fig) or to 3 sig figs this would be 0.00417.

Calculate the number of moles of magnesium, Mg, in the 0.1 g sample of magnesium ribbon.
(relative atomic mass: Mg = 24)

(1)

~~$\frac{0.1}{24} = 0.00416$~~

$24 \times 0.1 = 2.4$

number of moles = 2.4

ResultsPlus
Examiner Comments

Here the student has multiplied the mass of magnesium by its relative atomic mass. This was a very common error. 0 marks.

Question 6 (b) (ii)

Only a few students understood the question as evidenced by how few scored the one mark. Many just left a blank space or rewrote the equation. Many tried to justify their answer by use of relative atomic masses.

(ii) In a further experiment, 0.5 mol of hydrochloric acid, HCl, were mixed with 0.5 mol of magnesium, Mg.

Use the equation to show that, in this experiment, the magnesium is in excess.

(1)

0.5 0.5 0.25 0.25

2HCl + Mg ⟶ $MgCl_2$ + H_2

mr= 37.5 mr= 24 mr= 95 mr=2

Magnesium should be 0.25 moles.

ResultsPlus
Examiner Comments

The student has implied that the ratio is 2:1 by their conclusion that the amount of magnesium that should be added is 0.25 moles and so scored the mark.

Had they simply rewritten the equation without any form of explanation or conclusion regarding the ratio they would score 0 marks.

(ii) In a further experiment, 0.5 mol of hydrochloric acid, HCl, were mixed with 0.5 mol of magnesium, Mg.

Use the equation to show that, in this experiment, the magnesium is in excess.

(1)

Mg : 2HCl = 1:2 mol ratio 0.5 x2 = 1mol of HCl needed 1 mol > 0.5 mol ∴ There is too little hydrochloric acid and therefore magnesium is in excess.

ResultsPlus
Examiner Comments

The student correctly identified the ratio of 1:2 and then went on to calculate the number of moles of HCl required to fully react with 0.5 moles of Mg, which was correct and so did not contradict the first part of their answer.

1 mark scored.

(ii) In a further experiment, 0.5 mol of hydrochloric acid, HCl, were mixed with 0.5 mol of magnesium, Mg.

Use the equation to show that, in this experiment, the magnesium is in excess.

(1)

Magnesium mass = 0·5x24=12g

HCl mass = 0·5x36·5 = 18.25g

You only need 0·04 mol magnesium to react 0.1 mol of hydrochloric acid, So magnesium is in excess by a large margin.

ResultsPlus
Examiner Comments

The calculation simply identified the mass of 0.5 moles of each reactant, which did not answer the question, so was insuffcient to score the mark. So 0 marks were given here.

(The 0.004 moles of magnesium required to neutralise the 0.1 moles of hydrochloric acid are figures taken from the previous question and used incorrectly.)

ResultsPlus
Examiner Tip

Relative atomic masses were not given in the question, so they were not needed to answer the question.

Question 6 (c)

Looking at the overall marks awarded for all the students, just over a quarter gave a level 3 answer, a similar number a level 2 answer and a good level 1 answer. A significant number scored zero mostly as a result of rewriting the details given in the question without application of their meaning. The typical level 1 answer contained a simple application of the data such as increasing the temperature increased the rate of reaction. To get to level 2, it was necessary for students to make direct reference to data given in the question and with some explanation in terms of particles. A level 3 answer needed an explanation of the connection between both temperature and concentration, shown by the data, and reaction rate together with explanations in terms of particles.

*(c) Two substances, **A** and **B**, each form a colourless solution.
If the solutions are mixed in a beaker, **A** and **B** react to form a coloured product.
The rate of the reaction between **A** and **B** can be investigated by placing the beaker containing the mixture on a cross on a piece of paper and timing how long it takes for enough coloured product to be produced to make the cross invisible when viewed from above, through the solution.

	experiment 1	experiment 2	experiment 3
concentration of **A in solution** in g dm^{-3}	10	10	40
temperature in °C	20	40	40
time for cross to become invisible in s	320	80	20

Figure 8

more collisions persecond.

Use the results of these experiments to explain, in terms of the behaviour of particles, the effect of changing temperature and the effect of changing the concentration of **A** in solution on the rate of this reaction.

(6)

Concentration = more particles in area = more collisions per second.
Temp = more energy = faster = more collisions per second.

The results show that a ~~low~~ low concentration and a low temperature (experiment 1) cause a slow rate of reaction (320s) because there are little collisions per second. Concentration is the amount of particles in an area and ~~temperature~~ temperature is the energy of the particles. In experiment 2, the temperature is raised to 40°C, meaning the particles have more kinetic energy, resulting in more collisions per second between the particles. This makes the rate of reaction 240s faster. In reaction 3, the concentration is increased by 30g/dm³, as well as the temperature being 40°C. This causes a very

~~for~~ fast rate of reaction because there ~~are~~ are more particles in the area, ~~and~~ and these particles have lots of kinetic energy ~~due to~~ due to vibrating more. This causes more collisions per second, meaning the rate of reaction is 300 seconds faster ~~car~~ than reaction ~~1~~ 1. This shows us that a higher concentration and temperature ~~[illegible]~~ cause a faster rate of reaction, due to ~~more collisions per a second~~ the particles colliding more times per second.

ResultsPlus
Examiner Comments

Reading through the whole answer, it was considered to be a 'good' answer even though not all the indicative points were covered.

A 'good' answer because there was an explanation of the effect of increasing temperature in terms of the kinetic energy of the particles and concentration in terms of the proximity of particles to one another.

There was a little 'clumsiness' in expression: 'little' for 'fewer' collisions and 'area' for 'volume' when discussing concentration, but, as we were not marking Quality of Written Communication, the intention of the student was clear and unambiguous.

A level 3 answer with 6 marks.

*(c) Two substances, **A** and **B**, each form a colourless solution.
If the solutions are mixed in a beaker, **A** and **B** react to form a coloured product.
The rate of the reaction between **A** and **B** can be investigated by placing the beaker containing the mixture on a cross on a piece of paper and timing how long it takes for enough coloured product to be produced to make the cross invisible when viewed from above, through the solution.

the higher the concentration, the quicker the time

the higher the temperature the quicker the time

	experiment 1	experiment 2	experiment 3
concentration of **A in solution** in g dm^{-3}	10	10	40
temperature in °C	20	40	40
time for cross to become invisible in s	320	80	20

Figure 8

Use the results of these experiments to explain, in terms of the behaviour of particles, the effect of changing temperature and the effect of changing the concentration of **A** in solution on the rate of this reaction.

(6)

The higher the concentration of substance A, the faster it is for the cross to become invisible. In experiment 3, the concentration of A was 40, whereas the concentrations of A in experiments 1 and 2 were 10. The time for the cross to become invisible was 20 seconds, whereas the time for experiment 1 was 320 and experiment 2 was 80.

Another reason the time for experiment 1 was so long was because of the temperature. The temperature of experiment 1 was 20°c, unlike the temperature for experiment 2 and 3, which was 40°c. This shows that the two substances react a lot quicker at higher temperatures. Enzymes work best at their optimum temperature, which is 43°c. If the temperature is below this they will work a lot slower, and if the temperature is above this, the enzymes will denature.

Therefore, the particles in experiment 3 would be ~~working~~ moving around a lot more than the ones in experiment 1 and 2 because the concentration of the solution A and temperatures were lower than experiment 3.

ResultsPlus
Examiner Comments

Much of this answer contained a rewrite of the details in the question and was ignored.

Although the student made reference to experiments 1,2 and 3, it was not made clear how the variables have been controlled. So this was considered to be a 'poor' answer and could not reach level 2. However, there was a true statement linking temperature with rate change which mean which placed this in level 1 with 2 marks.

ResultsPlus
Examiner Tip

Do not repeat anything given in the question such as in this example - it is ignored by the examiners.

*(c) Two substances, **A** and **B**, each form a colourless solution.
If the solutions are mixed in a beaker, **A** and **B** react to form a coloured product.
The rate of the reaction between **A** and **B** can be investigated by placing the beaker containing the mixture on a cross on a piece of paper and timing how long it takes for enough coloured product to be produced to make the cross invisible when viewed from above, through the solution.

	experiment 1	**experiment 2**	**experiment 3**
concentration of **A in solution** in g dm^{-3}	10	10	40
temperature in °C	20	40	40
time for cross to become invisible in s	320	80	20

Figure 8

Use the results of these experiments to explain, in terms of the behaviour of particles, the effect of changing temperature and the effect of changing the concentration of **A** in solution on the rate of this reaction.

(6)

In experiment 1 the concentration was at 10 g dm^{-3} while the temperature was at 20°c, and the time taken was 320 s. When looking at experiment 2 the concentration remained the same, however the temperature increased by 10°c, and the time taken decreased to 80s.

I think this is because the particles gained more heat energy due to the increase in temperature meaning the particles had more kinetic energy which meant the process was quicker.

In experiment 3 the concentration increased to 40 gdm-3 while the temperature stayed the same at 40°c. This time it took even less time (20s) because the concentration was higher, so there was more of substance A for B to react with. Furthermore, because the temperature remained fairly high, the particles had heat energy to transfer to kinetic energy to react with all of particles A quicker to decrease the time taken.

ResultsPlus
Examiner Comments

The data for experiments 1 & 2 for temperature change, and 2 & 3 for concentration change have been correctly used.
However, there was no mention of particle or collisions for concentration changes so this would only be level 2 and not level 3. This could not be classified as a 'good' answer and was given 4 marks.

Paper Summary

Based on their performance on this paper, candidates are offered the following advice;

- Practise a variety of calculations as described in the specification.
- Learn the formulae of gases and simple compounds as used in the specification.
- Practise writing and balancing equations.
- Practise writing and balancing ionic equations.
- Learn the tests for gases.
- Learn the meaning of terms used in the specification such as covalent bond, alkane, hydrocarbon.
- Practise drawing reaction profiles for both exothermic and endothermic reactions.
- Learn how to calculate the gradient of a straight line.
- Practise answering extended open-response questions.
- To help with the above, there are plenty of examples in examination papers of the previous specification where there was similar coverage.

Grade Boundaries

Grade boundaries for this, and all other papers, can be found on the website on this link:

http://www.edexcel.com/iwantto/Pages/grade-boundaries.aspx

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