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Examiners' Report
June 2023

GCSE Combined Science 1SC0 2CH

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June 2023

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Introduction

1SC0 2CH is the second Chemistry paper in the Combined Science Higher Tier suite. Some of the earlier questions also appear in the 2CF Foundation Tier paper. The Combined Science questions are a subset of the 1CH0 2H paper, comprising of six of the ten questions in that paper.

Question 1 (a)

The majority of candidates scored full marks for plotting at least 6 points correctly and drawing a smooth line of best fit through the origin. Occasionally, marks were lost when candidates drew ruler straight, dot to dot lines. Some very poor, sketchy lines and tramlines were seen which made it very difficult to award marks. An occasional error was starting the line of best fit at one minute, as opposed to the origin. Careless overshooting of the line of best fit beyond $100cm^3$ also lost some candidates marks.

1 A student used the apparatus shown in Figure 1 to investigate the reaction between marble chips and dilute hydrochloric acid.

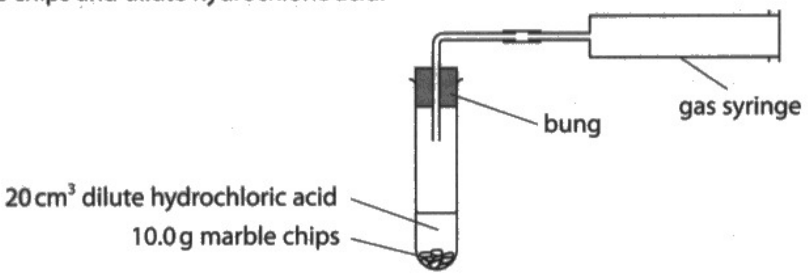


Figure 1

The student recorded the volume of gas every minute as shown in Figure 2.

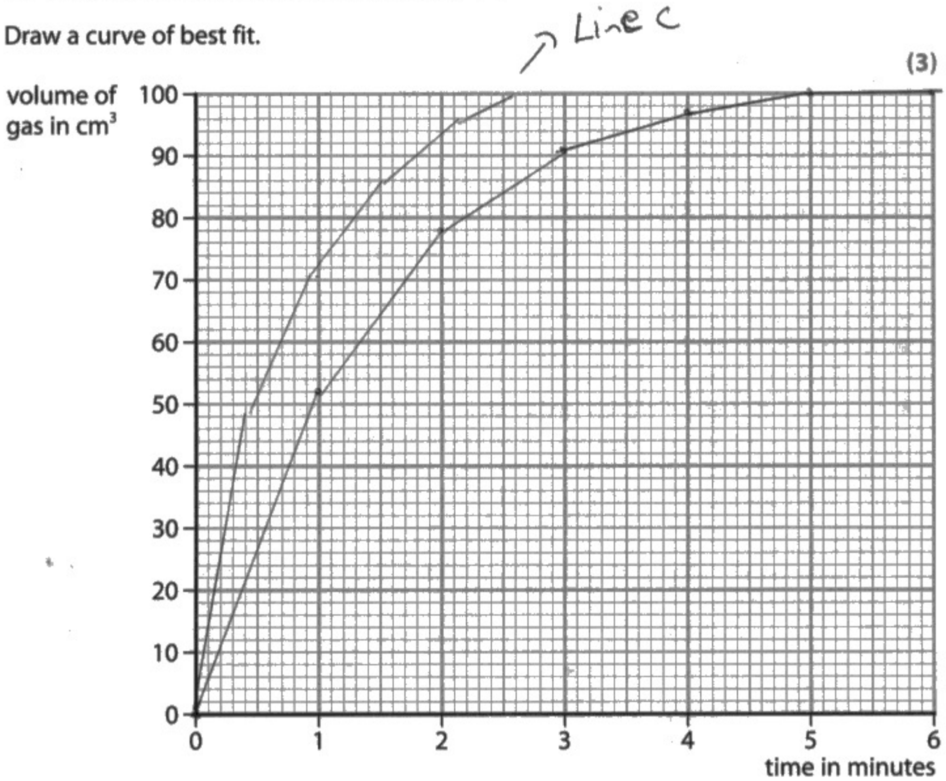
time in minutes	0	1	2	3	4	5	6
volume of gas in cm^3	0	52	78	91	97	100	100

Figure 2

(a) On the grid, plot the results shown in Figure 2.

Draw a curve of best fit.

(3)



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Examiner Comments

The points in the main curve have been joined with a ruler – so the mark for the curve is lost (although the plotting marks are still scored). Note also that line C should extend to 6 minutes.

ResultsPlus
Examiner Tip

Draw best fit lines with a single, smooth curve. Do not use a ruler for a curve.

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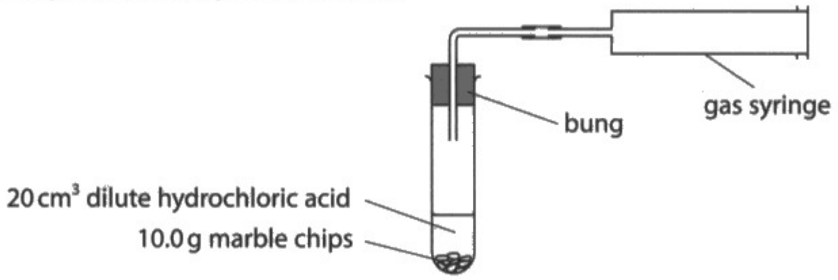

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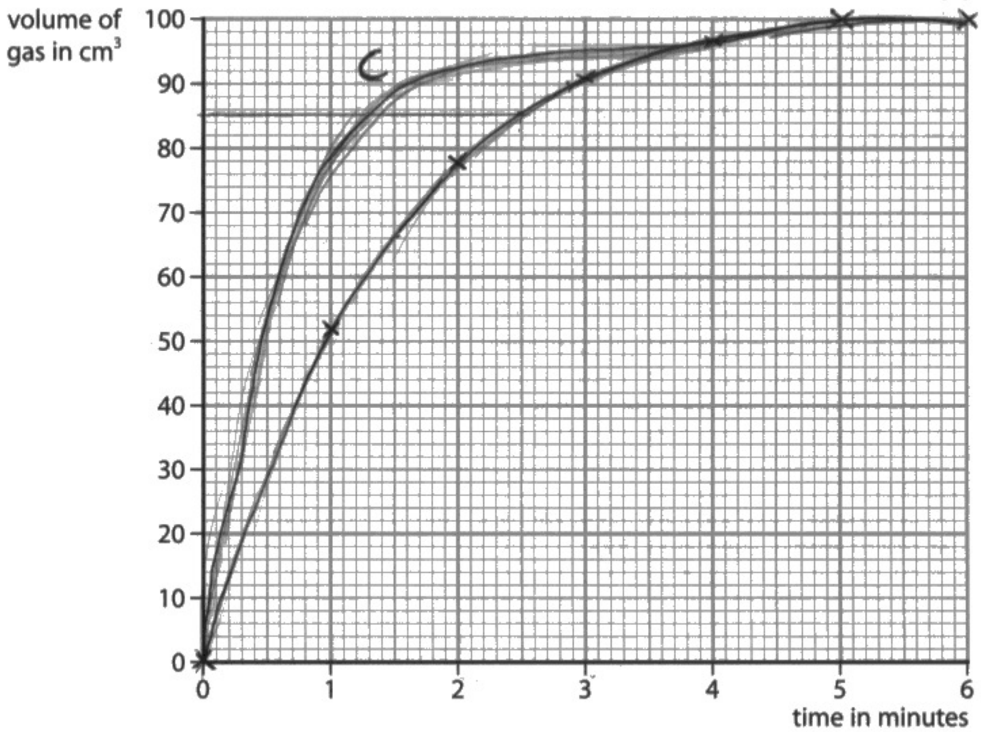

ResultsPlus
Examiner Comments

The first part of the curve is good, but from 4.5-6 minutes it looks like a second part has been joined on – this should be avoided and a single curve is wanted. (Note also that curve C ends too low).

Question 1 (b)(i)

Most candidates achieved this mark by calculating (91-78)/1. Some candidates noticed that 52/26 equalled 2 and 6/3 equalled 2, so they undertook 26/2 to achieve the correct answer of 13. However, a similar method also lead some candidates to doing 6x2 =12 which did not score. Some tried to give the mean value of 12 and 13 (12.5). Occasionally, candidates attempted to calculate the gradient of the line at 1 minute or 2 minutes but, unfortunately, this was an incorrect method for a range of time. A few candidates achieved the answer of 13 but then went onto further process this, for example dividing by 60 (perhaps assuming the units were cm^3s^{-1}). Candidates should be aware of looking out for the number of marks a question is worth, so they can tailor their answer accordingly.

(b) Rate of reaction can be calculated using

$$\text{rate of reaction} = \frac{\text{volume of gas produced in 1 minute}}{\text{1 minute}}$$

Figure 3 shows the rates of reaction calculated from the results of this experiment.

The rate of reaction for the time interval 2 to 3 minutes is missing.

time interval	0 to 1 minute	1 to 2 minutes	2 to 3 minutes	3 to 4 minutes	4 to 5 minutes
rate of reaction in $cm^3 min^{-1}$	52	26	13	6	3

Figure 3

(i) Calculate the rate of reaction for the time interval 2 to 3 minutes.

(1)

26 ÷ 2 = 13

52 = 1m 60s

rate of reaction = 13 $cm^3 min^{-1}$

ResultsPlus
Examiner Comments

This candidate has spotted the pattern in the data, but this method will not always work.

(b) Rate of reaction can be calculated using

$$\text{rate of reaction} = \frac{\text{volume of gas produced in 1 minute}}{\text{1 minute}}$$

Figure 3 shows the rates of reaction calculated from the results of this experiment.

The rate of reaction for the time interval 2 to 3 minutes is missing.

time interval	0 to 1 minute	1 to 2 minutes	2 to 3 minutes	3 to 4 minutes	4 to 5 minutes
rate of reaction in $cm^3 min^{-1}$	52	26	7	6	3

Figure 3 78 91

(i) Calculate the rate of reaction for the time interval 2 to 3 minutes.

(1)

91 - 78 = 13 $\frac{13}{1}$

rate of reaction = 13 $cm^3 min^{-1}$

ResultsPlus
Examiner Comments

This is the correct method that will always work.

Question 1 (b)(ii)

This question was not so well answered in general. Many candidates incorrectly stated the reaction rate increased at the start. Luckily if candidates subsequently went on to say the rate then decreased, they were allowed this error. Some candidates had the idea the rate was decreasing and tried to prove this with figures and calculations, treating this like a 'describe' question, rather than 'explain' and thus achieving the first marking point only. Some candidates described how the volume of gas increased and levelled off, not relating this to the rate of reaction and therefore not achieving marks. It was clear that many believed the rate was increasing because the volume of gas was increasing. Occasionally, candidates wrote about the rate increasing 'less quickly' over time so could not score. Some candidates were able to recognise that the decrease in rate was due to one of the reactants being used up and some were able to explain the rate in terms of the decrease in collision frequency.

However, few candidates scored both of these marking points. Vague language lost marks, such as 'less particles over time' with no mention of reactant. A lot of candidates wrote about marble chips dissolving as opposed to reacting. Some candidates got the answer completely the wrong way round, writing about an increase in rate due to more frequent collisions, suggesting they had learned an answer without really understanding the concepts. A few candidates incorrectly linked rate to energy changes.

(ii) State and explain what happens to the rate of reaction as the acid reacts with the marble chips in this experiment.

(3)

As the volume of gas increases with each minute the experiment is ~~the rate of reaction~~ continuing ~~increases~~. Gas is an indicator of a reaction taking place so the rate of reaction shows that as time increases so does the produce of the marble chips ~~reactants react~~ and hydrochloric acid. The volume of gas stops increasing once the reaction is complete

ResultsPlus
Examiner Comments

This answer refers to the volume of gas produced and has no relevant comment about the rate of reaction.

(ii) State and explain what happens to the rate of reaction as the acid reacts with the marble chips in this experiment.

(3)

As the acid reacts the rate of reaction slows down as more of the marble chips have been used up so less successful collisions are occuring.

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Examiner Comments

This answer scores all of the marks.

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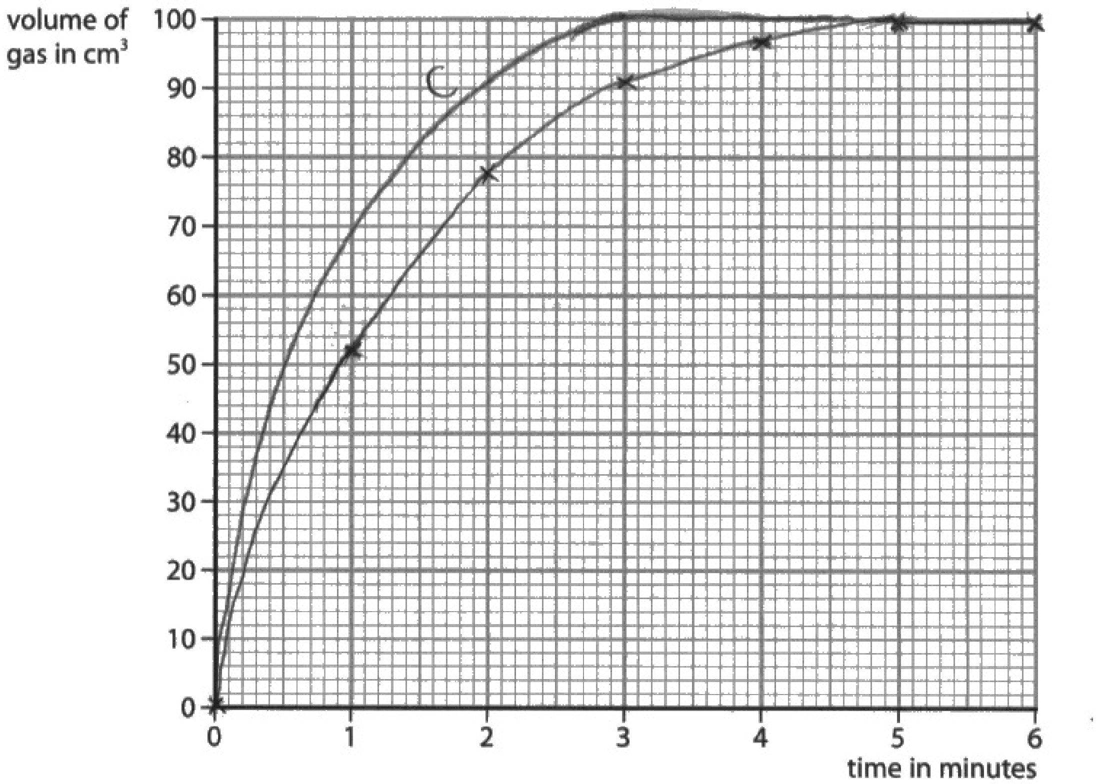
Examiner Tip

It is better to say 'there are less frequent successful collisions' as this is the fully accurate way to explain a drop in rate of reaction.

Question 1 (c)

This question generated a real mix of responses and many excellent lines were seen. Incorrect responses involved drawing a tangent and labelling this line C, alongside some unusual vertical and horizontal lines. Some candidates were able to achieve a mark for a steep line to the left of the original which sadly did not then level off. On a few occasions, no attempt was made at drawing this second line. Occasional feathering of the line above $100cm^3$ made the decision to award the second mark difficult.



(c) The student repeated the experiment using the same volume of acid and the same mass of marble chips but used smaller marble chips. of reaction is faster

All other conditions remained the same.

The student found that the reaction with the smaller marble chips was faster to start with but produced the same volume of gas.

Using this information, draw a line on the grid to show the results for the reaction with the smaller marble chips.

Label this line 'C'.

ResultsPlus
Examiner Comments

Curve C is correct – but care needs to be taken that it does not go over $100cm^3$.

Question 2 (a)

The majority of candidates knew that Group 1 metals had one electron in their outer shell. A common misconception was the need to 'gain' one electron which was incorrect. Some candidates included physical and chemical properties of Group 1 elements, which were ignored. Electron configurations alone were seen on occasion and ignored. Some candidates wrote about the increase in reactivity down Group 1 due to the number of shells, indicating they had not read the question carefully. Occasionally, candidates wrote about there being one outer shell, as opposed to one electron in the outer shell.

2 Figure 4 shows some information about the group 1 metals.

group 1 metal	atomic number	relative atomic mass
lithium	3	7
sodium	11	23
potassium	19	39
rubidium	37	85
caesium	55	133

Figure 4

(a) Explain, in terms of their electronic configurations, why these metals are placed in group 1 of the periodic table.

(2)

~~They~~ Lithium, sodium, potassium, rubidium and caesium all ~~have~~ are in group 1 because they have one electron in their outershell. they dont have a full outershell.

ResultsPlus
Examiner Comments

A correct answer.

2 Figure 4 shows some information about the group 1 metals.

group 1 metal	atomic number	relative atomic mass
lithium	3	7
sodium	11	23
potassium	19	39
rubidium	37	85
caesium	55	133

Figure 4

(a) Explain, in terms of their electronic configurations, why these metals are placed in group 1 of the periodic table.

(2)

these metals are placed in group one of the periodic table because each one has a low reaction rate and isn't very reactive

ResultsPlus
Examiner Comments

This does not score.

ResultsPlus
Examiner Tip

The question says 'in terms of their electronic configuration' so you must use the electronic configuration to answer the question.

Question 2 (c)

The majority of candidates scored full marks here. Occasionally, it was too difficult to discern if the state symbol was g or s and a mark could not be awarded. The aqueous state symbol was the most common error. Some blank responses were seen.

(c) The word equation for the reaction of potassium with bromine is

potassium + bromine → potassium bromide

K || | K ||
Br || | Br ||

Add the missing state symbol and balance the equation for this reaction.

(2)

2 K(l) + Br_2(g) → 2 KBr(s)

ResultsPlus
Examiner Comments

Potassium is a group 1 metal, so must be a solid.

(c) The word equation for the reaction of potassium with bromine is

potassium + bromine → potassium bromide

3
K = 3
3 1
1 1

Add the missing state symbol and balance the equation for this reaction.

(2)

2 K 3 K
3 = BR 3 BR

~~2~~ 3 K(s) + Br_2(g) → 3 KBr(s)

ResultsPlus
Examiner Comments

There are different numbers of Br atoms on each side of the equation.

Question 2 (d)(i)

Some candidates wrote excellent descriptions of isotopes in terms of proton and neutrons. However, candidates must beware of saying 'elements' as isotopes are, of course, always the same element. A lot of candidates mistook relative atomic mass for mass number. Some candidates sadly negated their 'different neutron' marking point by stating 'different electrons' as well. There were a lot of contradictions in candidates' answers, for example 'same atomic number, different protons'. Some candidates thought that an isotope was an ion and gave a definition in terms of atoms gaining or losing electrons. It was surprisingly unusual to see the phrase 'atoms of the same element'.

(d) A sample of potassium contains three isotopes, potassium-39, potassium-40 and potassium-41.

(i) Explain the meaning of the term **isotopes**.

(2)

isotopes are atoms with the same number of protons ~~and the~~ but different numbers of neutrons

ResultsPlus
Examiner Comments

Fully correct answer.

(d) A sample of potassium contains three isotopes, potassium-39, potassium-40 and potassium-41.

(i) Explain the meaning of the term **isotopes**.

(2)

atoms with a different Number electron and Same number of Neutrons

ResultsPlus
Examiner Comments

Candidates should learn basic definitions of simple concepts such as isotopes.

Question 2 (d)(ii)

This question was answered quite well on the whole. Most candidates showed their working and therefore 39 on the answer line was acceptable. Candidates who guessed at 39 alone did not score any marks. Common misconceptions were dividing by 120 (the sum of 39, 40 and 41) rather than 100, or dividing by 3 (the number of isotopes). If errors, such as writing 0.08 rather than 0.008, are made, marks can subsequently be awarded as long as working is clear. Some candidates tried to answer this like an empirical formula question and did not score any marks. Some marks were lost due to rounding errors (e.g. 36.36 from 36.3675).

(ii) This sample of potassium contains

93.25% potassium-39

0.02% potassium-40

6.73% potassium-41

Calculate the relative atomic mass of this sample of potassium.

(2)

93.25% × 39 + 0.02% × 40 + 6.73% × 41

= 36.3675 + 0.008 + 2.7593

= 39.1348

relative atomic mass = 39.1348

ResultsPlus Examiner Comments

This candidate scores both marks and has clearly shown their working.

(ii) This sample of potassium contains

93.25% potassium-39

0.02% potassium-40

6.73% potassium-41

Calculate the relative atomic mass of this sample of potassium.

(2)

~~93.25 ÷ 39 = 2.39~~

~~0.02 ÷ 40 = 200~~

39 ÷ 93.25 = 0.418

40 ÷ 0.02 = 2000

41 ÷ 6.73 = 6.092 +

20006.51

relative atomic mass = 2006.51g

(Total for Question 2 = 9 marks)

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Examiner Comments

Percentages incorrectly calculated by division not multiplication.

ResultsPlus
Examiner Tip

Always check that your answers make sense – a mean of a sample with values 39, 40 and 41 must be between 39 and 41.

Question 3 (b)

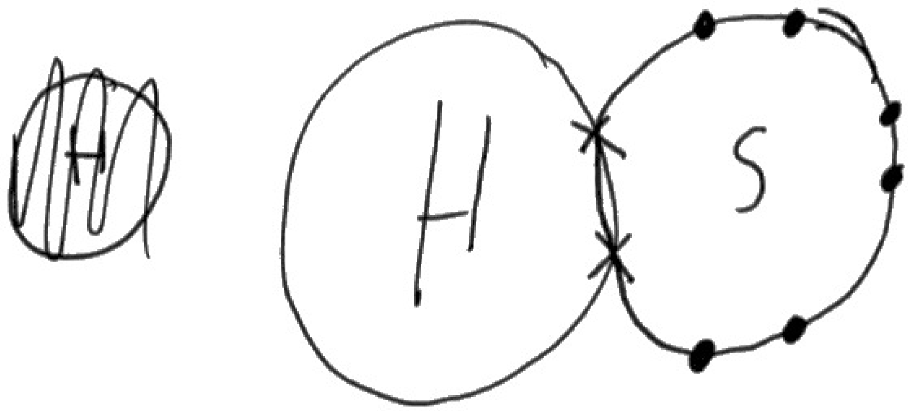
This question lead to a huge range of responses. Many candidates drew the bonding for an HS molecule, not reading the formula carefully in the question. For some candidates, it was clear they understood what to do, but sloppy diagrams where electrons were outside the overlap of shells could not score. Some ionic bonding diagrams and double covalent bonds were seen. A lot of candidates wasted time by drawing inner shells, ignoring the instructions in the question. Some candidates understood that there had to be a bonding pair of electrons between the atoms to score one mark, but then drew an incorrect number of electrons for the remainder of the structure. Some candidates drew multiple, different answers so it was impossible to award a mark. A lot of diagrams were seen where three circles all overlapped. Another common mistake was drawing one giant atom with an inordinate amount of electrons and H_2S written in the middle.

(b) It is thought that small quantities of hydrogen sulfide, H_2S, were also in the Earth's early atmosphere.

Draw the dot and cross diagram for a molecule of hydrogen sulfide.

Show outer electrons only.

(2)



ResultsPlus
Examiner Comments

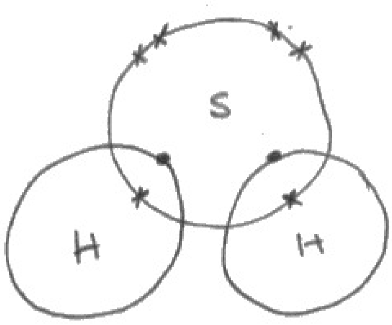
The formula for the molecule is in the question, so two H atoms are needed.

(b) It is thought that small quantities of hydrogen sulfide, H_2S, were also in the Earth's early atmosphere.

Draw the dot and cross diagram for a molecule of hydrogen sulfide.

Show outer electrons only.

(2)



ResultsPlus
Examiner Comments

A clearly drawn correct answer. The use of dots for H electrons and crosses for S electrons makes it even clearer.

Question 3 (c)

A lot of candidates did not score for this question as they wrote about fossil fuels burning without mentioning impurities. A common misconception was that burning caused the impurities themselves to be released. One mark was often awarded for either sulfur or sulfur dioxide, much less often were both correctly mentioned. Language was sometimes vague, with candidates writing about ‘sulfur’ reacting with the clouds, sulfur dioxide ‘mixing’ with the clouds or just ‘pollutants’ in general. Many candidates thought the sulfur dioxide condenses to form acid rain. Some candidates wrote about sulfur oxide. There were many responses about nitrogen oxides being responsible for the acid rain, indicating candidate revision but not applying it to the correct context. Some candidates thought carbon dioxide and carbon monoxide were responsible. A lot of responses detailed the effects of acid rain which were irrelevant and wasted time.

(c) Acid rain is caused by some pollutant gases present in the atmosphere.

Explain how impurities in fossil fuels can result in acid rain.

(3)

It results in acid rain because they are impure and polluted. The fossil fuels have chemically changed and this means that when they reach the clouds, the clouds will pour down acidic rain which is dangerous to crops and it makes buildings corrode.

ResultsPlus
Examiner Comments

This answer has not mentioned the sulfur impurities at all and does not score.

(c) Acid rain is caused by some pollutant gases present in the atmosphere.

Explain how impurities in fossil fuels can result in acid rain.

(3)

Impurities in fossil fuels, like sulphur impurities, can oxidise when the fossil fuel is combusted. This forms sulphur dioxide which can be oxidised by O_2 in the air to form sulphurous acid. This sulphurous acid is then ~~oxidised~~ combined with ~~by~~ water vapour forming sulfuric acid which is acid rain. ~~Nitrogen can form~~

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Examiner Comments

This is an excellent answer scoring all 3 marks.

Question 3 (d)(i)

Universal Indicator was a common response, pH meter and pH probe were less frequently seen. Litmus paper was unfortunately a common response, or vague references to pH strips, scales or machines. Sometimes two answers were given and one contradicted the other (e.g. UI and litmus). Iodine was surprisingly common. Other laboratory apparatus, such as measuring cylinders and pipettes were common and ignored.

(d) A student investigates the effect of acid rain on cress plants.

The student uses this method.

step 1 grow 20 cress plants in each of two dishes, **A** and **B**

step 2 water the cress plants in dish **A** with 10 cm^3 of dilute hydrochloric acid with a pH of 2

step 3 water the cress plants in dish **B** with 10 cm^3 of pure water with a pH of 7

step 4 repeat steps 2 and 3 every day for one week

step 5 count how many plants are still alive after one week.

(i) State what piece of equipment the student could use to measure the pH of each liquid.

(1)

an indicator

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Examiner Comments

A specific indicator is required to answer the question – Universal Indicator.

Question 3 (d)(ii)

Many candidates focused on improvements for reliability such as carrying out repeats, using more cress plants and comparing results with peers, rather than concentrating on improving validity. The length of time the cress plants were left was mentioned often. Some candidates had the idea of controlling variables, but were not then able to explain why this was important for the second mark. The most common way of achieving two marks was using a higher pH, more similar to that of acid rain. Unfortunately, some candidates wrote about using a 'stronger acid' instead. The use of sulfuric acid or rainwater was rare. The use of a wider range of pHs was common for one mark but, again, often with no further explanation.

(ii) Explain **one** improvement that the student could make to the method to make the results more valid.

(2)

The student could use a different acid such as sulfur dioxide + water as it is present in acid rain while hydrochloric acid is not. This means that the experiment investigates the effect of pH rather than acid rain.

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Examiner Comments

This candidate has the idea that to investigate acid rain, the correct acid should be used.

(ii) Explain **one** improvement that the student could make to the method to make the results more valid.

(2)

use more ~~different pH's that are at a similar level~~ cress plants to cut out ~~too~~ a lot of anomolies

ResultsPlus
Examiner Comments

This would not make the results more valid.

(ii) Explain **one** improvement that the student could make to the method to make the results more valid.

(2)

they could keep the dishes in the same room ~~with~~ making sure they had the same amount of sunlight acess and temperature.

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Examiner Comments

The same amount of sunlight or same temperature are good ideas.

ResultsPlus
Examiner Tip

For both marks, the answer should explain why controlling conditions is useful.

Question 4 (a)(ii)

One mark was frequently achieved for the use of goggles as a precaution. However, this was usually incorrectly linked to chlorine, rather than corrosive HCl. When candidates did achieve a mark for chlorine being toxic, this was often unfortunately linked to a mask as a precaution, as opposed to a fume cupboard. It was surprising how little candidates mentioned the use of a fume cupboard and it suggested perhaps they have not observed their use in practical lessons. Occasionally, a 'closed environment' or 'gas chamber' was given in its place. Marks were often lost for vague language, such as dangerous, deadly or harmful. Careful disposal of reactants was rarely seen. Some candidates confused the oxidising hazard symbol for flammable and gave precautions involving fire safety. General safety advice, such as tucking bags under tables and tying hair back was occasionally seen.

(ii) Explain **one** precaution that should be taken when preparing the sample of chlorine gas.

(2)

precaution

do not let chlorine gas near any flammable materials or bunsen burners

reason

can catch on fire.

ResultsPlus
Examiner Comments

The hazard symbol for chlorine is oxidising, not flammable.

(ii) Explain **one** precaution that should be taken when preparing the sample of chlorine gas.

(2)

precaution

~~standing far awo~~ ~~Using~~ wearing gloves while dealing with chlorine gas

reason

Chlorine gas is toxic for humans, it is toxic ~~on your~~ for your skin.

ResultsPlus
Examiner Comments

Using gloves is not a suitable precaution for a gas.

(ii) Explain **one** precaution that should be taken when preparing the sample of chlorine gas.

(2)

precaution

Wear a gas mask

reason

Chlorine gas is toxic to the lungs

ResultsPlus
Examiner Comments

For toxic gases, a fume cupboard must be used.

Question 4 (b)

The transport of incorrect substances such as potassium manganate was frequent and occasionally the direction of travel was incorrect. Preventing the gas escaping was common, but not quite informative enough to award a mark. There were a lot of cases of misnaming the glassware, referring to the conical flask as a beaker, and to the gas jar as a test tube. Quite a few candidates thought the delivery tube was a condenser. 'Collect the gas' was common, as was 'deliver the gas to the litmus paper' which didn't fit the diagram provided.

(b) State the purpose of the delivery tube.

(1)

To catch the chlorine gas so it doesnt diffuse into the surondings.

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Examiner Comments

This answer does not say to where the chlorine gas is directed by the delivery tube.

(b) State the purpose of the delivery tube.

(1)

~~the~~ to condense the gas back into liquid and so it passes directly into the gas jar and not to the surroundings

ResultsPlus
Examiner Comments

The delivery tube is not a condenser.

(b) State the purpose of the delivery tube.

(1)

to transfer the produced chlorine gas into the gas jar

ResultsPlus
Examiner Comments

The answer has used the diagram to see where the chlorine is directed.

Question 4 (c)

A pleasing number of candidates wrote about the test for chlorine and the bleaching of the litmus paper for two marks. Some candidates thought the litmus paper was there to test the pH and others thought it was there to prevent the chlorine escaping (as opposed to detection).

(c) Suggest why damp blue litmus is placed at the top of the gas jar.

(2)

So that it is able to test if there is ~~tests~~ chlorine gas in the jar at the end of the result as it will turn red then bleach

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Examiner Comments

The full result for the test for chlorine is given.

(c) Suggest why damp blue litmus is placed at the top of the gas jar.

(2)

So it can measure the pH of the gas as it reaches the mineral ~~[illegible]~~ wool.

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Examiner Comments

The litmus paper is to detect chlorine, not to measure pH.

Question 4 (d)

Some candidates constructed formulae to suit the balancing, rather than writing the correct formulae first and balancing later. Cl was a common error, as was KCl_2. Candidates who wrote the correct formulae on each side of the arrow were able to achieve two marks, which may be a lesson for future candidates if they find balancing difficult.

(d) In the reaction, potassium manganate(VII), $KMnO_4$, reacts with hydrochloric acid to form manganese chloride, $MnCl_2$, potassium chloride, chlorine and water.

Write the balanced equation for the reaction.

(3)

$2KMnO_{4(aq)} + 16HCl_{(aq)} \rightarrow 2MnCl_{2(aq)} + 2KCl_{(aq)} + 5Cl_{2(g)} + 8H_2O_{(l)}$

ResultsPlus Examiner Comments

The best candidates on this question designed to be difficult, scored all the marks.

ResultsPlus Examiner Tip

There is no need to give state symbols unless you are asked for them.

(d) In the reaction, potassium manganate(VII), $KMnO_4$, reacts with hydrochloric acid to form manganese chloride, $MnCl_2$, potassium chloride, chlorine and water.

Write the balanced equation for the reaction.

(3)

$KMnO_4 + 6HCl \rightarrow MnCl_2 + KCl_2 + 2Cl + 4H_2O$

ResultsPlus Examiner Comments

These formulae errors were not uncommon.

Question 5 (b)(ii)

This was a poorly answered question. Candidates frequently wrote ‘it takes more energy to break bonds than to make bonds’ which scored 0. Candidates who separated their answer into short sentences achieved the most marks, for example ‘Breaking bonds is endothermic. Making bonds is exothermic. More energy was given out than taken in.’ (2 marks). Candidates who tried to write the concepts all in one sentence often contradicted themselves, for example ‘it took more energy to break bonds which was endothermic than it takes to make bonds’. Although some correct chemistry is given, the taking in of energy to make bonds contradicts the process being exothermic. Many candidates only described the energy level diagram and wrote about the ‘reactants or products needing more energy’.

(ii) Describe what the reaction profile shows about the energy involved in bond breaking and bond making in this reaction.

(2)

The profile shows it is an exo thermic reaction as the products have less energy, meaning it is given out. Exo thermic means bonds are ~~broken~~ ~~ex~~formed as energy is given out

ResultsPlus
Examiner Comments

The first part of the answer is not relevant. It then describes bond formation correctly, but unfortunately not bond breaking.

(ii) Describe what the reaction profile shows about the energy involved in bond breaking and bond making in this reaction.

(2)

More energy is required to make the bonds in the products than what is needed to break them in the reactants.

ResultsPlus
Examiner Comments

Unfortunately, this answer says energy is required to make and to break bonds.

Question 5 (b)(iii)

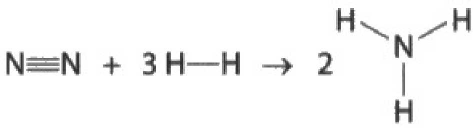
The question was answered very well on the whole, with a lot of candidates achieving full marks for – 76 or 3 marks for 76 (the subtraction being done the wrong way round). Many marks were able to be given for other single errors as long as the working was clear. The energy needed to break the bonds (2252) was very common, but there were more errors with the energy released (some candidates were unsure whether to multiply 388 by three or two...or both!). 1088 was a very common answer too.

(iii) Figure 9 shows the energies of some bonds.

bond	bond energy in $kJ\,mol^{-1}$
N≡N	944
H—H	436
H—N	388

Figure 9

The equation for the reaction between nitrogen and hydrogen to form ammonia is



Calculate the energy change, in $kJ\,mol^{-1}$, for this reaction.

(4)

Reactants — Products

(1) N≡N = 944 — H-N × 3 = 388 × 3 =

(3) H-H = 1308 — 1164 × 2 = 2328 — 1164

2252

2252 − 2328 = −76

energy change = −76 $kJ\,mol^{-1}$

ResultsPlus Examiner Comments

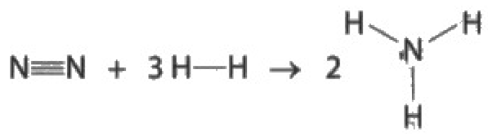
Correct answer with very clearly shown working.

(iii) Figure 9 shows the energies of some bonds.

bond	bond energy in $kJ\,mol^{-1}$
N≡N	944
H—H	436
H—N	388

Figure 9

The equation for the reaction between nitrogen and hydrogen to form ammonia is



Calculate the energy change, in $kJ\,mol^{-1}$, for this reaction.

(4)

944 +(3× 436) → 2 (3× 388)

944 + 1308 → 2328

2252 → 2328

2328 - 2252 = 76

energy change = 76 $kJ\,mol^{-1}$

ResultsPlus
Examiner Comments

The two energy values are correct, but have been subtracted the wrong way round.

Question 5 (c)

A lot of candidates understood that the reason for the difference in boiling point was that more energy was needed to break the attractions in silicon dioxide than ammonia. However, this was often linked to the wrong bonding. Many candidates wrote about covalent bonding being broken in ammonia or conversely intermolecular forces being broken in silicon dioxide. Contradictions were frequent e.g. giant covalent structure in silicon dioxide with strong intermolecular forces. Some candidates wrote about reactivity of the two compounds, trying to relate their boiling points to numbers of shells and abilities to lose or gain electrons. Vague language lost marks, such as 'more temperature needed to break ammonia' with no mention of energy or forces. Often candidates wrote that it was harder/easier to break bonds, again without mention of energy. Some candidates thought that the boiling points were an average of all the different atoms in a molecules, writing statements such as 'nitrogen has a low boiling point and so does hydrogen, so ammonia is low'.

(c) Ammonia, NH_3, and silicon dioxide, SiO_2, are both compounds that are made of two non-metallic elements.

Ammonia has a boiling point of –33 °C.
Silicon dioxide has a boiling point of 2230 °C.

Explain why the boiling points of ammonia and silicon dioxide are so different.

(3)

the boiling point of silicon dioxide is so high because it is an ionic bond and therefore a giant ionic lattice, which have very high boilings points and Ammonia has a very small/low boilling point because of its small structure.

ResultsPlus Examiner Comments

No credit here.

(c) Ammonia, NH_3, and silicon dioxide, SiO_2, are both compounds that are made of two non-metallic elements.

covalent

Ammonia has a boiling point of −33 °C. low
Silicon dioxide has a boiling point of 2230 °C. high

Explain why the boiling points of ammonia and silicon dioxide are so different.

(3)

The inter molecular forces of attraction in the covalent bond of Ammonia (NH_3) are weak, so less energy is needed to breake the forces. The intermolecular forces in the covalent bonds of silicon dioxide are more stronger; so a higher energy and boiling point is needed to break these forces.

low boiling point

ResultsPlus
Examiner Comments

Confusion is common between covalent bonds and intermolecular forces.

(c) Ammonia, NH_3, and silicon dioxide, SiO_2, are both compounds that are made of two non-metallic elements.

Ammonia has a boiling point of −33 °C.
Silicon dioxide has a boiling point of 2230 °C.

Explain why the boiling points of ammonia and silicon dioxide are so different.

(3)

Because ammonia is a simple covalent compound, so it has weak intermolecular bonds which require little energy to overcome, so it therefore has a low boiling point. However, silicon dioxide is a giant covalent compound, so it has very strong intermolecular bonds which require a high amount of energy to overcome, so it has a very high boiling point.

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Examiner Comments

It's a pity that poor use of terms mars this answer.

Question 6 (a)(ii)

This was poorly answered, with most candidates repeating the information given in the question only, e.g. 'viscosity increases down the column' with no explanation. 1 mark was occasionally awarded for the length of hydrocarbon chain, but rarely for the strength of the intermolecular forces and almost never full marks for both. Some candidates wrote in detail about the pattern in boiling point down the column, rather than viscosity. Some vague language lost candidates marks, such as 'bigger bonds' down the column.

Question 6 (b)

This question generated a mixture of responses, with all possible marks being awarded. Sadly, C_4H_8 and $C_{10}H_{22}$ were frequently seen alone and therefore were awarded a maximum of two marks due to lack of working. A good number of candidates simply added the two formulae mentioned in the question to give C_7H_{16}. Some candidates gave the numerical answer of 142 (from 86 + 56) as their final answer. However, a pleasing number deduced C_4H_8 and $C_{10}H_{22}$ showing their working in a number of alternative ways and were able to achieve full marks. Some candidates further processed $C_{10}H_{22}$ into an empirical formula (C_5H_{11}).

(b) Hydrocarbon **X** was cracked to form one molecule of hexane, C_6H_{14}, and one molecule of alkene **Y**.

$$X \rightarrow C_6H_{14} + Y$$

The relative formula mass of **Y** is 56.
The empirical formula of **Y** is CH_2.

Deduce the molecular formula of hydrocarbon **X**.

Show your working.

(relative atomic masses: H = 1.0, C = 12)

(4)

2 + 12 = 14   Y = C_4H_8
56 ÷ 14 = 4
C_4H_8

X = C_6H_{14} + C_4H_8 = $C_{10}H_{22}$

molecular formula of **X** = $C_{10}H_{22}$

ResultsPlus Examiner Comments

There is sufficient working here to follow the candidate's correct method.

(b) Hydrocarbon **X** was cracked to form one molecule of hexane, C_6H_{14}, and one molecule of alkene **Y**.

$$X \rightarrow C_6H_{14} + Y$$

The relative formula mass of **Y** is 56.
The empirical formula of **Y** is CH_2.

Deduce the molecular formula of hydrocarbon **X**.

Show your working.

(relative atomic masses: H = 1.0, C = 12)

(4)

$CH_2 = 12 + 2(1) = 14$

$\frac{56}{14} = 4$

$4 \times CH_2 = C_4H_8$

molecular formula of **X** = C_4H_8

ResultsPlus
Examiner Comments

The candidate has correctly deduced the formula of Y, but has not gone on to find X.

Question 6 (c)

A good range of answers were seen here.

Answers could be very brief and to the point but still achieve full marks. For example:

'An open hole allows oxygen to enter, leading to complete combustion which produces carbon dioxide, a greenhouse gas. A closed hole limits the amount of oxygen that can enter, leading to incomplete combustion which produces toxic carbon monoxide'.

A lot of unnecessary detail was frequently given about flame colours and temperature of the flame. A lot of candidates did not consider the **products** of combustion and instead wrote long answers about the effect of methane as a greenhouse gas. Many candidates believed an open hole would lead to methane escaping and showed a lack of understanding about the functionality of a Bunsen burner.

The most common 1 mark answer was awarded for oxygen entering when the hole is open.

Most answers that mentioned carbon monoxide went on to describe its toxicity and binding to haemoglobin.

*(c) Large quantities of methane are used as a fuel.

Figure 11 shows a Bunsen burner.

Methane can be used as fuel for the Bunsen burner.

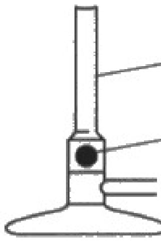

Figure 11

The air-hole on the chimney of the Bunsen burner can be opened and closed.

Explain the effect of opening and closing the air-hole of the Bunsen burner on the products of combustion of methane and the harm that using large quantities of methane as a fuel can cause.

(6)

the air-hole of the bunsen burner can be opened in order to let oxygen in as complete combustion only occur when there is enough oxygen supply. complete combustion releases carbon dioxide and water, it also releases a huge amount of energy. If the air-hole is not opened then there will be insufficient supply of oxygen which results in incomplete combustion. incomplete combustion releases carbon monoxide and soot which can be harmful.

using large quantities of methane as fuel can cause incomplete combustion as there may not be enough oxygen which results in incomplete combustion leading to the release of harmful gases such as carbon monoxide. carbon monoxide behaves as a toxic gas as when it is inhaled it can react with the haemoglobin which results in less oxygen being carried around the body which can cause dizziness and it could be fatal and lead to death.

complete combustion of methane releases large amount of carbon dioxide which can harm the environment. carbon dioxide is a greenhouse gas which means that it contributes to global warming which causes climate change and rise in sea levels.

ResultsPlus
Examiner Comments

An excellent answer, well structured.

ResultsPlus
Examiner Tip

Ensure you cover all aspects of a 6-mark question here, products when air hole open, when closed and the harms.

*(c) Large quantities of methane are used as a fuel.

Figure 11 shows a Bunsen burner.

Methane can be used as fuel for the Bunsen burner.

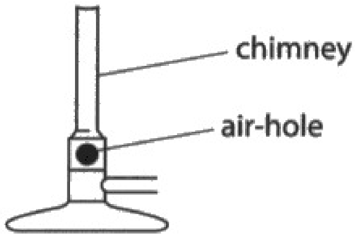

Figure 11

The air-hole on the chimney of the Bunsen burner can be opened and closed.

Explain the effect of opening and closing the air-hole of the Bunsen burner on the products of combustion of methane and the harm that using large quantities of methane as a fuel can cause.

(6)

The air hole on the bunsen allows different quantities of methane gas to be released

Depending on how open the air hole is depends on how much oxygen methane has to react with.

If there is more oxygen there will be a larger orange flame produced. This allows for bigger combustion.

If there is less oxygen there will be a smaller 'roaring' blue flame produced. This means there is smaller combustion.

Using large quantities of methane gas, especially incorrectly, can cause harm to people, organisms and the environment.

If a large quantity of methane gas was released, and it reacted with oxygen, it would cause a large and dangerous combustion. This could damage the surrounding area

If living organisms breathe in methane gas - e.g. humans or animals - it could have a toxic impact and make them ill, or even kill them.

ResultsPlus
Examiner Comments

This answer shows very little scientific knowledge.

Paper Summary

Based on their performance in this paper, candidates should:

- Write as clearly as they can, as legibility was an issue raised by some examiners. Candidates should strive to use precise scientific language when describing phenomena. Vague generalisations often lead to a loss of marks. Key ideas and terms should be explicitly mentioned.
- Practise drawing best-fit curves with one smooth curve through all or most of the points
- Learn how to explain changes in rate of reaction over time in terms of particles and collision frequency.
- Always show your working in calculations and ensure that you can correctly round answers. Use past papers to practise the different types of calculation.
- Learn how to work out ionic formulae using the periodic table. The molecules for all gas elements (except noble gases) are all diatomic.
- Practise carefully how to describe bonding in ionic and covalent substances – particularly in simple covalent molecules.
- Consider how energy changes in reactions result from bond making and bond breaking.

Grade boundaries

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