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Examiners' Report
June 2019

GCSE Combined Science 1SC0 2CH

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Introduction

The Combined Science paper 2CH followed the normal format of six questions (all of which are found in GCSE Chemistry Paper 2). Early questions are also found in the foundation tier paper. There is one six mark question. Examiners noted some good responses to the questions, although some candidates showed a lack of basic knowledge and understanding at this tier and may have been better suited to the foundation tier paper. In general, some basic skills limited candidates' performance – notably, literacy (the ability to express their ideas using clear scientific language) and numeracy (the ability to calculate percentages and use significant figures). However, many were able to write well, and, for example, give a coherent account of the application of collision theory in the 6 mark question.

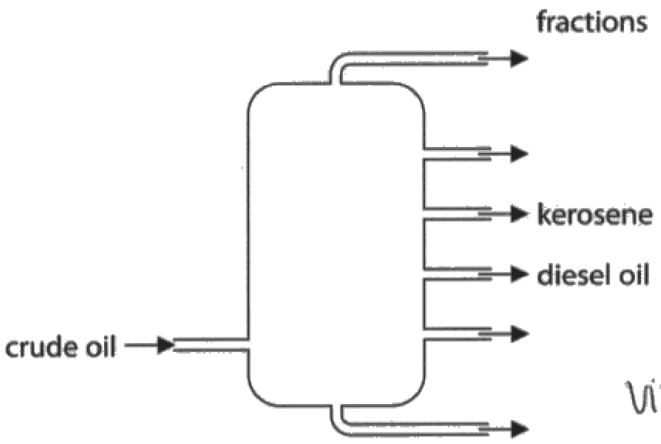
Question 1 (b) (i)

Most candidates achieved both marks, with the most common response for kerosene being plane fuel and for diesel oil car fuel. Some candidates tried to hedge their bets by putting more than one answer – if two answers are given both must be correct to score a mark, so this is a risky strategy. Errors included generic comments such as 'factories', 'industry' or misusing 'petrol' for fuel eg use of diesel oil – petrol for cars.

Question 1 (b) (ii)

Most candidates understood the question and knew appropriate properties, such as boiling and melting points, viscosity and ease of ignition, compared between kerosene and diesel oil. However, a significant number stated kerosene had a higher boiling point or was more viscous. A number of answers did not get credit by referring to chain length (not a 'property') or statements such as 'kerosene has a higher temperature' (or 'lower temperature') perhaps talking about the fractionating column or the boiling point.

(ii) Figure 1 shows where the fractions kerosene and diesel oil are produced in the fractionating column.



viscosity

Figure 1

Kerosene is obtained higher up the column than diesel oil.
Kerosene and diesel oil fractions have slightly different properties.

Choose a property.
State how this property for kerosene compares with the property for diesel oil.

(1)

property Viscosity

comparison Disel is more viscous (thicker) than Kerosene (it is thinner)

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Examiner Comments

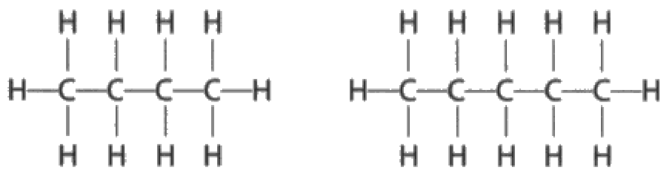
This answer was laid out clearly as expected.

Question 1 (c) (i)

Generally, the idea in Q02ci was well understood, but candidates frequently could not express themselves very clearly. The mark for the same homologous series was perhaps more often scored, simply by stating that they were alkanes and/or giving the general formula for alkanes.However, many referenced that they were hydrocarbons which is not sufficient to show that they are alkanes. The general formula was sometimes given incorrectly, for example as 2n + 2, and some were unclear about the difference between a molecular formula and a general formula. Some candidates just wrote about the two molecules having similar properties.

The second mark was for giving a reason that the molecules were neighbouring members. A large number of candidates stated the number of carbon atoms (butane has 4, pentane has 5) rather than how the molecules differed (ie by 1 carbon atom). ('The two differed in their formulae by one carbon **molecule**' was not credited). Others just quoted the molecular formulae with no explanation.

(c) Figure 2 shows the formulae of a molecule of butane and of a molecule of pentane.
Butane and pentane are neighbouring members of the same homologous series.



butane pentane

Figure 2

(i) Explain, using these formulae, why butane and pentane are neighbouring members of the same homologous series.

(2)

they are ~~neighbouring~~ neighbouring members because their formulae differ by a CH_2

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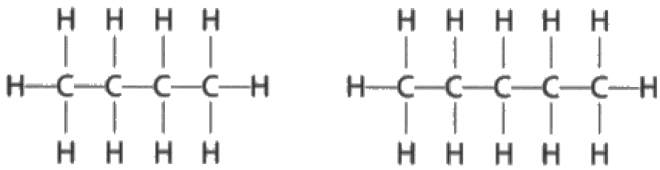
Examiner Comments

This answer has explained why the molecules are neighbours, but not why they are both alkanes. 1 mark scored.

(c) Figure 2 shows the formulae of a molecule of butane and of a molecule of pentane. Butane and pentane are neighbouring members of the same homologous series.



butane pentane

Figure 2

(i) Explain, using these formulae, why butane and pentane are neighbouring members of the same homologous series.

(2)

The same homologous series means that they share the same formula which is C_nH_{2n+2}, so butane is C_4H_{10}, and pentane is C_5H_{12}.

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Examiner Comments

By contrast, this answer has explained why they are in the same homologous series, but has not clearly stated why the molecules are neighbours.

Question 1 (c) (ii)

Many candidates were awarded a mark for calculating 48 (12 x 4). Others worked out 100/58 but got no further in the calculation. A good number did calculate the correct answer but it was disappointing that not all of these rounded their answer to 82.8g as required. Examiners are able to award part marks where the method can be followed, and candidates are strongly advised to set out their work clearly. This would help them, because some correct methods had careless errors which resulted in lost marks and could have been avoided by candidates checking their calculations through.

Question 2 (b)

Candidates do not find this type of mass:mass calculation straightforward, and they are advised to set out clearly a 'standard' method to help structure their answers. Most candidates could calculate the relative formula mass of MgO as 40 (or 2MgO as 80), however a surprising number in this tier incorrectly calculated the Mr to be 64 for 2MgO (2x24 + 16). The majority of successful answers arrived at the correct value by calculating moles of Mg and then multiplying by the M_r of MgO. Some students calculated the mass of magnesium oxide using by adding the mass of oxygen to magnesium, using conservation of mass principles.Many candidates inverted fractions e.g. 24/1.35 was given instead of 1.35/24.

(b) Magnesium burns in excess oxygen to form magnesium oxide.
The balanced equation for this reaction is

$$2Mg + O_2 \rightarrow 2MgO$$

1.35

Starting with 1.35g of magnesium, calculate the maximum mass of magnesium oxide that could be formed in this reaction.
(relative atomic masses: O = 16.0, Mg = 24.0)

You must show your working.

(3)

48RAM + 32RAM → 80RAM

0.028× (2Mg + O_2 → 2MgO

1.35g + 0.896g → 2.24g

32 × 0.028 = 0.896

80 × 0.028 = 2.24

mass of magnesium oxide = 2.24 g

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Examiner Comments

This answer is clearly laid out, and is a correct method. Unfortuantely, their factor of 0.028 (1.35/48) has been rounded from 0.028125.

(b) Magnesium burns in excess oxygen to form magnesium oxide.
The balanced equation for this reaction is

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Starting with 1.35 g of magnesium, calculate the maximum mass of magnesium oxide that could be formed in this reaction.
(relative atomic masses: O = 16.0, Mg = 24.0)

You must show your working.

(3)

RFM = 24   MgO = 24+16 = 40

moles = $\frac{mass}{Mr}$ = $\frac{1.35}{24}$ = 0.05625   ratio = 2:2 = 1:1

∴ MgO = 0.05625 moles   Mass = moles × Mr

= 0.05625 × 40 = 2.25g

mass of magnesium oxide = 2.25 g

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Examiner Comments

This is an exemplar of a well laid out answer, clearly stating what is happening at each step.

Question 2 (c)

Many candidates scored full marks here. However, many answers did not include diatomic molecules for hydrogen and chlorine, using H and Cl, and some failed to use the correct formula for HCl (HCl_2 or ClH_2 or H_2Cl_2 were seen). The balancing was generally well carried out, whether or not the constituent parts of the equation were correct (although this is not awarded a mark unless the formulae are correct). Some candidates lost marks by adding extra substances such as oxygen, or by including incorrect charges on the reactants.

(c) Chlorine reacts with hydrogen to form hydrogen chloride.

Write the balanced equation for this reaction.

(3)

~~$2Cl_2 + H_2 \rightarrow 2HCl$~~ $2HCl^-$

~~$Cl_2 + H$~~ $Cl_2 + H_2 \rightarrow 2HCl^-$

Cl^-	H^+
-1	+1

0

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Examiner Comments

The examiners were surprised to see examples such as this with spurious charges.

Question 2 (d)

Most candidates here achieved both marks, but Na^+ = +1 and Cl^- = -1 were seen sometimes.

Question 3 (a) (ii)

This question was well answered – the majority of candidates understood and were able to link the processes/factors to the movement of CO_2 into or out of the atmosphere. Quite a few candidates gave volcanic eruptions and absorption by the oceans as examples in addition to respiration, photosynthesis and burning fossil fuels. Less common answers included carbon capture by mitigation or alternative sources of energy such as solar power as ways of reducing the carbon footprint.

Marks were lost where candidates focussed on the greenhouse effect/ greenhouse gases/ global warming rather than being specific to CO_2 , or were mistakenly comparing the Earth's early atmosphere to today's, rather than what causes variation in today's atmosphere. Some also confused pollution and CO_2 production. There were also a number of candidates stating that methane production by cows increased CO_2.

Candidates had to be clear what process was involved in their explanation. For example, when talking about plants reducing carbon dioxide levels, 'photosynthesis' had to be used in the explanation. Deforestation was a very popular answer but not all candidates explained why it impacts the levels of carbon dioxide. (Some candidates had the misconception that during deforestation 'all the carbon dioxide stored in the tree is released when the tree is cut down'). Similarly, human impacts were also mentioned, such as driving vehicles, but not necessarily giving a reason why this affects carbon dioxide levels.

(ii) The actual percentage of carbon dioxide in the Earth's atmosphere today varies.

Explain **two** factors that cause the percentage of carbon dioxide in today's atmosphere to vary.

(4)

factor 1 Burning fossil fuels releases CO_2 into the atmosphere, This increase the percentage of CO_2 in todays atmosphere.

factor 2 Plants and trees take in CO_2, for photosynthesis, They then release oxygen decreasing the percentage of CO_2.

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Examiner Comments

This answer lays out the chemical processes and clearly states the effect on the amount of carbon dioxide in the atmosphere.

(ii) The actual percentage of carbon dioxide in the Earth's atmosphere today varies.

Explain **two** factors that cause the percentage of carbon dioxide in today's atmosphere to vary.

(4)

factor 1 Transport CO_2 emissions. An increase in transport and industry increases the carbon dioxide uptake in the atmosphere.

factor 2 Increase in sea level means more carbon dioxide is ~~absorbed into the sea~~ condensed into the sea meaning loss in the atmosphere.

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Examiner Comments

This answer is poor, so the 'transport' does not mention why vehicles release carbon dioxide.

Question 3 (b)

There were some very good responses showing that there is some good understanding about intermolecular forces and their bearing upon boiling point. However, there is a lot of confusion between intermolecular forces and covalent bonds, although most knew that the weakness was the key point so that little energy was required. Some answers had 'intermolecular forces between atoms' which suggested that although the correct term was being used it was still not understood. There was interesting reverse logic from some - CO_2 has a low boiling point because it is a gas.

(b) Carbon dioxide is a simple molecular, covalent compound.

It has a low boiling point of –78.5 °C.

Explain why carbon dioxide has a low boiling point.

(2)

Carbon dioxide has a low boiling point because it is a gas which means it has a weak ~~intermolec~~ bonds. ~~therefore it can be boiled all~~

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Examiner Comments

A typical answer confusing intermolecular forces with covalent bonds.

(b) Carbon dioxide is a simple molecular, covalent compound.

It has a low boiling point of –78.5 °C.

Explain why carbon dioxide has a low boiling point.

(2)

Carbon dioxide has a low boiling point because the intermolecular forces between the ~~atoms are~~ molecules are weak. This means less energy (thermal energy) is required to overcome these forces hence the low boiling point

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Examiner Comments

By contrast, this answer clearly links the intermolecular forces to energy.

Question 3 (c)

In Q03c, many candidates did not get the first step correct, and instead of dividing 0.11/44 they multiplied it, or inverted the fraction. Most candidates then were able to recognise that there had to be an involvement of the Avogadro constant and did multiply correctly.

Standard form proved a difficulty for some, with a noticeable number of answers leaving off the $x10^{21}$ from the answer, after a correct calculation. Some candidates did not attempt to round to two significant figures.

(c) Calculate the number of molecules in 0.11 g of carbon dioxide. ✓ break.

Give your answer to two significant figures.

(relative formula mass : $CO_2 = 44$
Avogadro constant $= 6.02 \times 10^{23}$) ✓ multiply by moles

(3)

moles = $\frac{mass}{Ar}$ $0.11 \div 44 = \frac{1}{400}$

$\frac{1}{400} \times (6.02 \times 10^{23}) = 1.505 \times 10^{21}$

number of molecules = 1.5×10^{21}

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The ideal answer, well set out.

Question 4 (b) (ii)

Candidates did recognise the link to the distance of the **outer** electron from the nucleus but did not always state this clearly – just that the 'electrons were further away'. There were a lot of valid references to the number of shells but some not worth credit referring just to the number of electrons in total. Some stated that there were strong bonds (or even intermolecular forces or gravitational attraction orelectromagnetic atrraction) between the electron and the nucleus rather than forces.

Those who made clear the relationship between the electrostatic force of attraction between the outer electron and the nucleus and the distance (or shielding) sometimes gave the answer in terms of potassium being more reactive, which was fully credited.

Most candidates showed some understanding but poor expression got in the way of some – for example, 'more electrons' rather than more shells, or 'more outer shells'.

(ii) The electronic configuration of lithium is 2.1
The electronic configuration of potassium is 2.8.8.1
Lithium is less reactive than potassium.

yo dull in colour

Explain, in terms of their electronic configurations, why lithium is less reactive than potassium.

(3)

Lithium has less electron shells hence the 1 electron on the outer shell is closer to the nucleus so there is stronger electrostatic forces keeping it intact. However, potassium easily looses the 1 electron as it is four shells away from the nucleus hence it is easier to lose due to weaker electrostatic forces holding it together. Therefore, potassium is more reactive than lithium due to the ease of loosing the 1 electron

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A well expressed answer. It would have been even better had it described the ease of losing an electron in energy terms.

Question 4 (c)

This calculation proved more successful for many, with many well set out answers scoring full marks. Mistakes included multiplying both percentages by the same number – either both by 7 or 6, or not dividing by 100 but by one of the other totals/ numbers.

A number of candidates gave answers to more than two decimal places or did not divide by 100 so unfeasibly large numbers appeared in terms of what the question was asking for.

Whilst most candidates scored the marks for 7.59 x 6 and 92.41 x 7, some then added the answers together and divided by 2, showing some confusion about calculating means. Some responses used the proton numbers rather than mass numbers in the calculation. Some candidates did not understand the terminology and thought that the dashes in the question were minus signs.

(c) Lithium has two naturally occurring isotopes, lithium-6 and lithium-7.

A sample of lithium contains
7.59% of lithium-6
92.41% of lithium-7.

Calculate the relative atomic mass of lithium in this sample.

Give your answer to two decimal places.
You must show your working.

(4)

$\frac{(7.59 \times 7) + (92.41 \times 7)}{2} = 350$

$\frac{(7.59 \times 6) + (92.41 \times 7)}{2} = 346.21$

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A misconception of mean demonstrated here, although the candidate did score 3 marks for an answer to two decimal places with only a single error in the calculation.

Question 5 (a)

Whilst the drawing skills of many was questionable, this was not being assessed – just the knowledge of what apparatus to use and how to connect it. Most students included (what they labelled as) a gas syringe or occasionally an upturned measuring cylinder (although not all of these contained water). Gas syringes were occasionally attached directly to the bung with no delivery tube. Where incorrect apparatus as used, it included test tubes, condensers or balloons.

Some lost marks due to not having a flask sealed with a bung/cork (with some having cotton wool). Some delivery tubes were shown as entering an open receiving container where the gas could clearly escape or showing the delivery tube as a single line. Others placed the delivery tube in the reagents in the flask. Quite a few candidates made no response.

5 Calcium carbonate reacts with dilute hydrochloric acid to produce calcium chloride, water and carbon dioxide.

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$$

(a) A student wanted to measure the amount of gas produced in two minutes.

The student suggested that this could be done by counting the number of bubbles formed.
However, the bubbles are produced too quickly to count them.

Figure 3 shows a conical flask in which the calcium carbonate and dilute hydrochloric acid are reacting.

Complete Figure 3 to show the apparatus that could be used to measure accurately the volume of gas given off in two minutes.

(2)

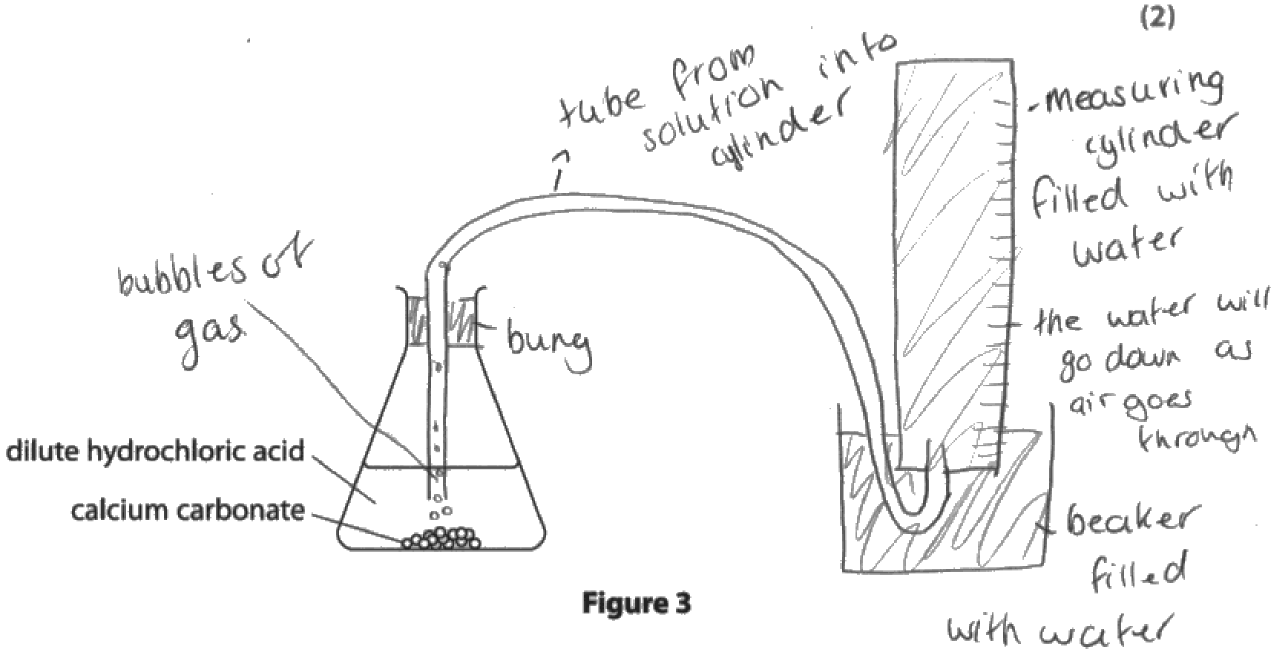

Figure 3

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The candidate has the basic idea, but sadly the delivery tube is in the solution in the flask. This scored 1 mark.

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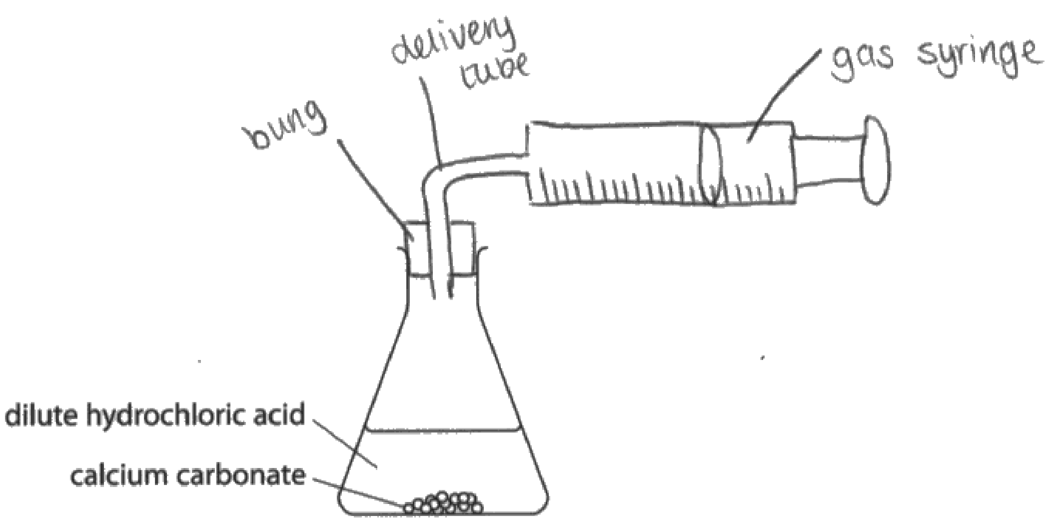

Figure 3

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An example of a 2 mark answer.

Question 5 (b)

This was a question which challenged candidates greatly. Very few candidates were able to state that bond breaking required energy whilst bond making released it. Many had this the other way round, or that making and breaking both required energy.

Whilst candidates did have the idea that energy was given out in an exothermic reaction, there was confusion as to where this energy had come from, mainly saying that it had come from the breaking of the bonds.

Many answers contained contradictory statements and so it was difficult to award marks. Many students wrote the definition of exothermic or gave descriptions of energy level diagrams and did not relate this to bond making and bond breaking.

One examiner suggests “**b**reaking **b**onds **n**eeds energy – e**n**dothermic” (2b's - 2n's).

(b) The reaction between calcium carbonate and dilute hydrochloric acid is exothermic.

Explain, in terms of bond breaking and bond making, why some reactions are exothermic.

(3)

- releases heat and energy. - exothermic reaction
- bond breaking will release heat & energy
- bond making uses energy & ^produces heat doing it.

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Examiner Comments

This was a poorly answered question, and many candidates got this back to front, like this one. The structure of bullet points, however, is helpful.

Question 5 (c)

This question produced a spread of marks over the full range.A significant proportion of candidates gave correct detailed answers, demonstrating a clear understanding of the effects of surface area of $CaCO_3$ and concentration of acid on the volume of gas produced, coupled with a detailed knowledge of collision theory by referring to particles colliding at different rates dependent on the changing factors. Generally, candidates grasped the basic ideas of collision theory and managed to obtain at least a Level 2. Some stated collision theory perfectly, but not all could apply it well to the experimental data. The best answers clearly laid out the response and considered the two factors in turn.

A number of candidates went on to contradict themselves as they wrote and would have benefitted from reading their answer through to check for this. The most common mistake was not referring the volume of gas (ie not really using the results in the table) in their answer. Some candidates gave limited answers, talking about particles without mentioning collisions or collisions without mentioning particles. Learning of the factors affecting rates of reaction led some candidates to assume that all four factors would be present in this reaction, including catalysts and temperature, and it was a pity that in some good answers marks were lost for mentioning energy of the particles being a factor. The best answers talked about the frequency of collisions, not just the number of collisions, and quantified the (rate of) gas production as an estimation of the rate of reaction.

In terms of surface area, a proportion confused this with the larger lumps having a larger surface area. Sometimes this concept was poorly expressed, with smaller lumps having more space to move around rather than having more particles available to react.

In terms of concentration, not all candidates mentioned that in a more concentrated solution of acid there are more particles per unit volume. Some incorrectly stated that higher concentration leads to higher kinetic energy of the particles. Some used the term ‘stronger acid’ when discussing concentration rather than linking to more particles in same volume.

*(c) An investigation was carried out into the rate of reaction of calcium carbonate with dilute hydrochloric acid.

5.0g of small lumps of calcium carbonate were reacted with 50 cm^3 of 0.50 mol dm^{-3} hydrochloric acid.
Another 5.0g of the same sized lumps of calcium carbonate were reacted with 50 cm^3 of 1.0 mol dm^{-3} hydrochloric acid.
The volume of gas collected in two minutes was recorded for each experiment.

The two experiments were then repeated, each using 5.0g of large lumps of calcium carbonate.

Figure 4 shows the results.

concentration of hydrochloric acid in mol dm^{-3}	volume of gas collected in cm^3	
	small lumps of calcium carbonate	large lumps of calcium carbonate
0.50	17.2	3.1
1.0	35.1	5.6

Figure 4

Explain, in terms of collision of particles, how these results show the effect of the size of the lumps of calcium carbonate and the effect of the concentration of the acid on the rate of this reaction.

(6)

The reason the small lumps produced more gas was due to the fact that they had a larger overall surface area, meaning there was more particles able to collide in the same area, meaning more successful collisons and faster, ~~At~~ causing more reations and more gas produced

The reason the higher concentration also produces more gas was because there were more particles able to collide in the same area / space, increasing the chance of collision, meaning more successful collision ~~and~~ and reactions, so more gas produced.

The combination of the small lumps and 1.0 mol made the most gas because ~~they~~ in that solution/reaction there was the highest amount of particles in the same area at one time, meaning the highest chance of successful collisions and reactions, which produce the most gas.

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Level 3 answer explaining both surface area and concentration in terms of a greater 'chance of collsion'.

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Figure 4

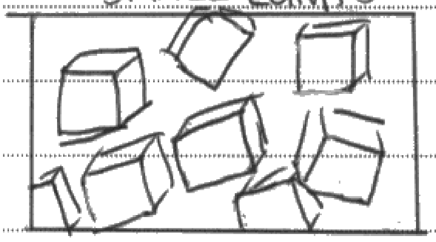
Explain, in terms of collision of particles, how these results show the effect of the size of the lumps of calcium carbonate and the effect of the concentration of the acid on the rate of this reaction.

(6)

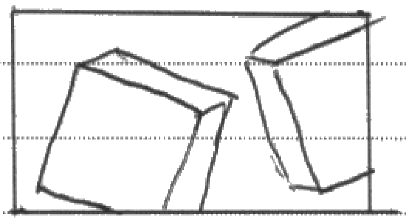
Collision of particles is increased ~~in~~ when a larger surface area is used in the reaction.

A group of small lumps of calcium carbonate has a greater surface area than the same mass of calcium carbonate in large lumps, as they can cover a greater area and have more sides.

SMALL LUMPS



LARGE LUMPS

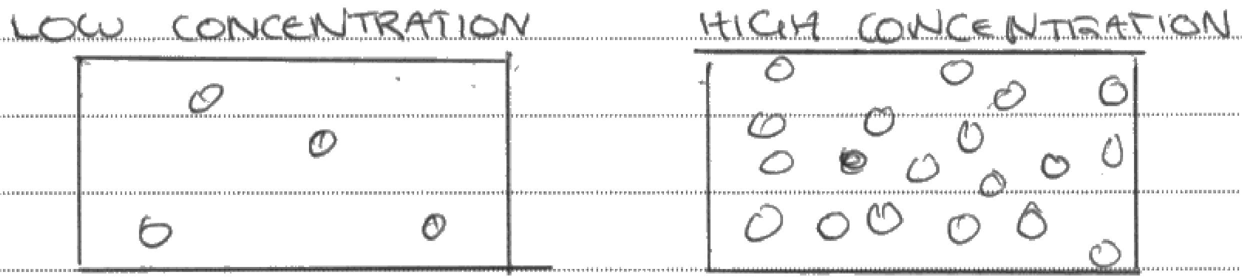


A greater surface area allows for a higher number of collisions of particles to occur.

A greater number of collisions means a faster reaction and so a larger volume of gas is created.

The concentration of HCl also affects the rate of reaction.

A higher concentration of HCl means more particles available to collide with calcium carbonate particles.



Overall, a high concentration of acid and a larger surface area of calcium carbonate lead to more collisions as there are more particles able to collide with each other.

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Another level 3 answer, but talks about 'more collisions' rather than more frequent collisions, which would have been better.

Question 6 (a)

It was pleasing that in q06(a) the majority suggested the use of litmus paper and nearly all of them realised that chlorine bleaches litmus (but a few lost a mark by suggesting that the litmus paper was bleached and then went red).

Unsurprisingly, many other gas tests were seen here, such as limewater turning cloudy, squeaky pops and splints relighting, or even a flame test. Some rather worryingly wanted to smell the chlorine to detect its presence or just said that the gas is green.

Question 6 (b)

Few candidates answered this correctly. The most common Incorrect answer was bromine hydroxide, but others included hydrochloric acid, hydrobromide, bromine oxide, hydrogen bromate, hydrogen bromide. Close to a correct answer was hydrobromine acid or bromic acid, but far from the correct answer was aqueous solution, bromine water or salts.

Question 6 (d)

There were just a few excellent answers here where candidates focussed on 'explain' and linked this to reactivity of the halogens. Some candidates just repeated the information in the table by commenting on the fact that all the solutions ended up brown, but failed to relate **why** this happened. Some candidates did recognise that this equated to a reaction happening but, not what type of reaction was occurring, or not that it was iodine being formed that lead to the brown colour. A significant number suggested that the potassium was more reactive than the halogen and so was displacing the halogen rather than the bromine/chlorine displacing the iodide ion from the solution of the KI. Quite a few stated that 'iodine is the most reactive halogen, so iodine displaced the other halogens, which was why you could see its colour'. Most candidates did score a mark for identifying no reaction in the iodine/ KI reaction. In general, the idea of displacement in halogens was not well understood by many candidates.

(d) Bromine, chlorine and iodine are dissolved in water to make aqueous solutions. Potassium iodide solution is added to each of these solutions.

Figure 5 shows the observations.

halogen	initial colour of aqueous solution	final colour of mixture
bromine	orange	brown
chlorine	pale green	brown
iodine	brown	brown

Figure 5

Explain the observations shown in the table.

(4)

Bromine and chlorine changed from orange and pale green respectively because the iodine in the Potassium iodide solution changed the mixture to brown because it is a more prominant colour. Iodine started off brown so when the potassium iodide solution was added, the iodine didn't react with the iodide resulting in the mixture to remain brown.

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Examiner Comments

This was quite a common misconception showing no understanding of the displacement reaction.

Question 6 (e)

Sadly, many candidates put F for fluorine, but when candidates had fluorine as diatomic they tended to be able to balance the equation. Others had F_3, Fl or Fl_2, Fe_2 , Fe_3 or Fe(III) or had unwanted charges.

(e) Fluorine reacts vigorously with iron to produce iron(III) fluoride, FeF_3.

Write the balanced equation for this reaction.

(2)

$3f + Fe \rightarrow FeF_3$

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Examiner Comments

A common error, giving fluorine as F.

Paper Summary

On the basis of their performance in this paper, candidates should

- Practise giving calculation answers to a given number of significant figures
- Practise mass:mass calculations
- Use correct scientific terminology eg when explaining why plants absorb carbon dioxide, use the term ‘photosynthesis’
- Learn carefully the difference between covalent bonds and intermolecular forces
- In calculations, check that your final answer is feasible, for example, calculating a relative atomic mass must give an answer between the lowest and the highest atomic masses
- Learn why some reactions are exothermic and some are endothermic in terms of bond making and bond breaking
- Learn how to write the formulae of elements in equations
- Understand when energy affects the rate of reaction, and when it does not

Grade Boundaries

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