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Examiners' Report
June 2022

GCSE Combined Science 1SC0 2CH

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June 2022

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Introduction

Paper 1SC0_2CH is the second of two papers that make up the chemistry component of the GCSE Combined Science (Higher tier). Questions 1 and 2 (apart from 2(e)) were common with the foundation tier 2CF, paper and both questions 1 and 2 were common with the 1CH0_2H (Chemistry) higher tier paper. This paper assessed Topics 1, 6, 7 and 8 of the specification.

This was the first time that GCSE Combined Science was taken under normal conditions since June 2019, although candidates and schools had access to the Advance Information which gave information about which topics were and were not being assessed. This Advance Information also listed the core practicals that were also being assessed. Marking took place as usual and grade boundaries were set under the guidance of OFQUAL so the standards would be somewhere between those of 2019 and 2021.

Question 1 (a)(i)

Most candidates gave a suitable piece of equipment that could be used to measure the volume of gas produced. Most of these gave the answer of gas syringe, but some did give the answer of 100 cm^3 measuring cylinder. The second mark was for being able to record the volume to a greater resolution, but about a third of those who scored the first mark either could not give a reason for their choice or made some comment about no gas escaping when using a gas syringe.

Common errors for the first mark included beaker, conical flask, gas jar, pipette; here there was no common pattern for these choices.

(i) Name a piece of apparatus that would be better to measure the volume of gas produced, instead of the 250 cm^3 measuring cylinder.

Give a reason for your answer.

(2)

name of apparatus

Gas syringe

reason ~~less~~ lower chance of gas escaping

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Examiner Comments

This just scored the 1 mark for the gas syringe.

The reason given here turned out to be seen quite frequently.

(i) Name a piece of apparatus that would be better to measure the volume of gas produced, instead of the $250\,cm^3$ measuring cylinder.

Give a reason for your answer.

(2)

name of apparatus

Suringe

reason

the gas will push the suringe back and give a more accurate reading than the cylinder.

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Examiner Comments

This scored 2 marks – 1 for the syringe (spelt incorrectly but recognisable) and 1 for the reason given 'a more accurate reading'.

(i) Name a piece of apparatus that would be better to measure the volume of gas produced, instead of the $250\,cm^3$ measuring cylinder.

Give a reason for your answer.

(2)

name of apparatus

500 cm³ measing cylinder

reason

mesure higher volume of hydrogen if necesary

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Examiner Comments

This scored 0. The use of a larger measuring cylinder would not improve the precision.

Question 1 (a)(ii)

This should be a very straightforward question: read the volume at 90 seconds from the graph, divide that volume by 90. A tolerance on reading the graph meant that volumes of 28, 29 or 30 cm^3 were all acceptable. Some candidates had the correct volume but divided the time, 90 seconds, by the volume. Others used 1.5 minutes in the calculation rather than 90 seconds. In these cases, marks were awarded for the correct volume and the processed result. Marks could also be scored for a correct calculation based on an incorrect volume. Many candidates lost the 3rd mark as a result of incorrect rounding.

Almost a third of the candidates scored 0 on this item, many of whom used incorrect volumes and completely incorrect times and weaker candidates had tried to work out the averages by taking volumes at different times.

(ii) Calculate the mean rate of production of hydrogen over the first 90 seconds, in cm^3 per second.

(3)

28/90 = 0.31 (2dp)

rate = 0.31 cm^3 per second

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Examiner Comments

28 cm^3 was in the accepted range of 28 – 30 as the volume read from the graph. The division by 90 was clearly shown along with the correct answer based on the reading from the graph. This scored all 3 marks.

(ii) Calculate the mean rate of production of hydrogen over the first 90 seconds, in cm^3 per second.

(3)

$90 \div 29 = 3.1034...$

≈ 3.1

rate = 3.1 cm^3 per second

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Examiner Comments

The candidate has correctly read the volume of 29 cm^3. The second marking point for the fraction was not awarded as they have divided time by volume instead of volume by time. The third marking was awarded for the correct evaluation of the fraction.

2 marks awarded

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Examiner Tip

This is an example of a calculation where it was clear how an incorrect process could still be awarded some marks. Had the candidate just given an answer as 3.1 without any working, this would then have scored 0 marks.

Question 1 (a)(iii)

There was a wide variety of ways in which the candidates could offer an acceptable answer, and this was seen in most cases. Many candidates had the idea of no more hydrogen was being produced or the graph plateaued. The most common missed mark was to say the reaction has stopped but sadly failed to explain how they knew it had stopped. In addition, several students referred to the rate becoming constant rather than the volume.

(iii) The student measured the volume of gas for 10 minutes.

State why the measurements could have been stopped at 9 minutes.

(1)

There was no metal pieces left.

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Examiner Comments

1 mark

This was another acceptable answer.

(iii) The student measured the volume of gas for 10 minutes.

State why the measurements could have been stopped at 9 minutes.

(1)

Because the volume stops increasing and stays level after 9 minutes.

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Examiner Comments

This was a correct answer to the question.

1 mark

Question 1 (b)(i)

Most candidates scored the first mark by stating that there were more particles present and less than half of those scored the second mark by saying that there were more frequent collisions.

The most common error for the first marking point was saying there was more acid present, or something similar. By far the most common error on the second marking point was just saying there were more collisions, and not referring to the rate or chance of collisions. Another error often seen was where candidates referred to an increase in kinetic energy of the particles. Weaker answers just said there were more successful collisions and did not comment on frequency. Candidates that didn't score MP1 were also unlikely to score MP2.

(b) The experiment was repeated, but with acid of a higher concentration.

The rate of reaction was faster.

(i) Explain why the rate of reaction increases when the concentration of acid is increased.

(2)

~~more~~ Higher concentration means more acid particles. The ~~high~~ increased surface area means more particles collide, causing more reactions.

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Examiner Comments

This scored 1 mark for more acid particles.

'More particles collide' was insufficient for the second mark as it did not reference the frequency of collisions.

(b) The experiment was repeated, but with acid of a higher concentration.

The rate of reaction was faster.

(i) Explain why the rate of reaction increases when the concentration of acid is increased.

(2)

The higher concentration of acid leads to more particle collisions therefore more / faster reactions.

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The first mark was not given as this answer referred to particle collisions rather than the amount of particles increasing in a given volume. The second was also not given for more collisions as this was not related to time.

0 marks.

(b) The experiment was repeated, but with acid of a higher concentration. same volume

The rate of reaction was faster.

(i) Explain why the rate of reaction increases when the concentration of acid is increased.

(2)

There is more ~~H~~ H^+ ions. This increases the ~~number of~~ frequency of collisions and therefore the frequency of successful collisions.

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This scored 2 marks.

The candidate made mention of more H^+ ions as well as an increase in the frequency of collisions.

Question 2 (c)

Although the majority of the candidates scored at least 1 mark, it was quite surprising to see how many didn't really understand what was going on and tried alternative calculations to determine the mass of carbon dioxide. Often a mark was lost for not giving the mass to 3 significant figures; common incorrect answers included 2.200 and 2.2. A common mistake was to divide 5.000 by 2.800 instead of subtraction. Some candidates attempted calculations involving the M_r of CO_2.

(c) When calcium carbonate is heated it decomposes.

$$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$$

5.000   2.800   2

$\frac{\text{mass}}{\text{moles} \quad \text{mr}}$

When 5.000 g of calcium carbonate is heated, the mass of solid remaining is 2.800 g.

Calculate the mass of carbon dioxide that has been released.

Give your answer to three significant figures.

(2)

Ca CO3

Mr = 40 + 12 x (16x3)
40 + 12 + 48
= 100

moles = 5.000 ÷ 100
= 0.05

Mr of CO2 = 12 + (16x2)
12 + 32
Mr = 44

mass of carbon dioxide = 2.20 g

mass of CO2 = 0.05 x 44 = 2.2

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Examiner Comments

This candidate managed to get to the answer eventually by calculating the number of moles of calcium carbonate, which is the same as the number of carbon dioxide. This was then multiplied by the relative formula mass of carbon dioxide to give the correct answer. There is, of course, a simpler route.

2 marks.

(c) When calcium carbonate is heated it decomposes.

$$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$$

When 5.000 g of calcium carbonate is heated, the mass of solid remaining is 2.800 g.

Calculate the mass of carbon dioxide that has been released.

Give your answer to three significant figures.

(2)

~~40+12+16×3=100~~

~~100~~ $CaCO_3$ = 5g   5g − 2.8g = 2.2g

mass of carbon dioxide = 02.2 g

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Examiner Comments

This scored 1 for the simple subtraction. However nice try for the attempt on 3 significant figures!

Question 2 (d)(i)

Most of the candidates scored the first mark for a full outer shell, but only about half of those scored the second mark about gain/loss/share of electrons.

Candidates need to be careful about referring to electron shells. Atoms only have one outer shell – a common piece of loose description saw candidates mention multiple or more or many outer shells. Some candidates just described the atomic structure (numbers of protons, neutrons, and electrons) and failed to link the full outer shell has no need to gain, lose or share electrons but instead just wrote 'so it doesn't react'.

(d) A diagram of an atom of helium is shown in Figure 3.

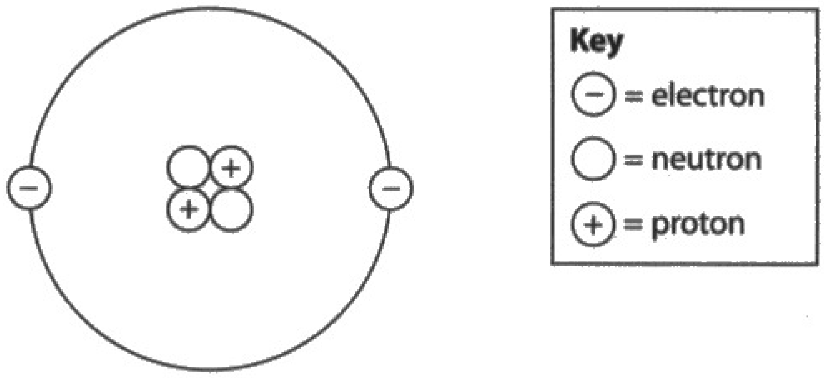

Figure 3

(i) Explain, using Figure 3, why helium is inert.

(2)

it is a gas that has no missing outer electrons

ResultsPlus
Examiner Comments

0 marks

No missing outer electrons is not the same as a 'full outer shell'. In addition there was no mention of electrons lost / gained / shared.

(d) A diagram of an atom of helium is shown in Figure 3.

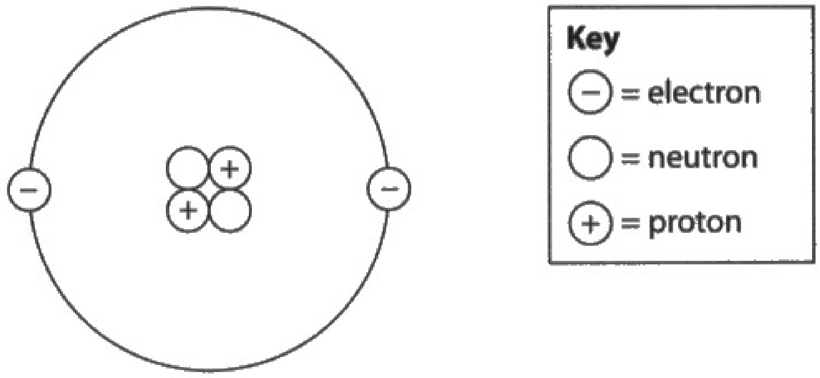

Figure 3

(i) Explain, using Figure 3, why helium is inert.

(2)

It has a full outer electron shell and won't give up the electrons easily

ResultsPlus
Examiner Comments

2 marks

Both points about the full outer electron shell and 'won't give up electrons easily', which implies doesn't lose electrons scored.

Question 2 (d)(ii)

The majority of candidates did not score on this question; this was mostly due to use of incorrect terminology. The most common error seen was candidates saying that helium is lighter than air. Just over a third of candidates gave their answer in terms of low density or less dense than air or less dense than nitrogen. A number of candidates were confused by the idea of density and wrote that helium is denser than air.

Unfortunately, some incorrectly compared its density with oxygen rather than air. Other errors seen included where candidates mentioned non-flammability or that 'it would float' or other irrelevant chemical properties.

(ii) Helium is used to fill balloons.

State one property of helium, apart from it being inert, that makes it suitable for filling balloons.

(1)

~~light, always rises up~~ helium isn't very dense and it is extremely light

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Examiner Comments

This wasn't a particularly well worded answer but was given 1 mark for the idea of low density.

(ii) Helium is used to fill balloons.

State one property of helium, apart from it being inert, that makes it suitable for filling balloons.

(1)

Helium has a low mass allowing balloons to flote

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Examiner Comments

Whilst true helium does have a low mass, it wasn't pointed out that it has a low mass per unit volume – ie a low density. 0 marks. Similar incorrect answers included 'light', 'lightweight', 'floats'.

(ii) Helium is used to fill balloons.

State one property of helium, apart from it being inert, that makes it suitable for filling balloons.

(1)

It won't react with balloons.

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Examiner Comments

This is correct as a property of helium but it did not answer the question. 0 marks.

Question 2 (e)

Candidates struggled to link O_2 as having two atoms for each molecule, very few candidates clearly demonstrated that understanding. Therefore 1 mark was often scored for multiplying the number of moles of oxygen by the Avogadro constant to give 2.107 $\times 10^{24}$. But generally, no second mark could be given showing a lack of understanding of how to extend their answer to work out the correct number of atoms.

Errors seen included where candidates divided moles of oxygen by the Avogadro constant rather than multiplied. Others introduced the relative atomic mass of oxygen into their calculation, which was not given in the question. In these instances, this value was used in a variety of unnecessary ways.

Examiners reported that a significant number of candidates did not attempt this question.

(e) Oxygen gas has the formula O_2.

Calculate the number of oxygen **atoms** in 3.50 mol of oxygen gas.

(Avogadro constant = 6.02×10^{23})

(2)

$3.5 \times 2 = 7 \quad 7 \times 6.02 \times 10^{23} = 4.214 \times 10^{24}$

$4.214 \times 10^{24} \times 2 = 8.428 \times 10^{24}$

number of oxygen atoms = 8.428×10^{24}

ResultsPlus
Examiner Comments

The first line would have scored both marks. Unfortunately the candidate then repeated the second step in the calculation and put this answer on the answer line so only 1 mark could be given.

(e) Oxygen gas has the formula O_2.

Calculate the number of oxygen **atoms** in 3.50 mol of oxygen gas.

(Avogadro constant = 6.02×10^{23})

(2)

mass = moles x Mr   Mr = $\frac{3.50}{6.02 \times 10^{23}}$ = 5.81×10^{-24}

Mr = $\frac{\text{mass}}{\text{moles}}$?

$3.50 \times 6.02 \times 10^{23}$ = 2.167×10^{24}

number of oxygen atoms = 2.167×10^{24}

(Total for Question 2 = 9 marks)

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Examiner Comments

The candidate carried out 2 calculations and decided the second on the lower left was more realistic. However, there was an incorrect copying of the answer from the calculator in 2.167×10^{24}, which should have been 2.107×10^{24}; this simple mistake lost the mark.

(e) Oxygen gas has the formula O_2.

Calculate the number of oxygen **atoms** in 3.50 mol of oxygen gas.

(Avogadro constant = 6.02×10^{23})

(2)

7 x 6.02 x 10^23

number of oxygen atoms = 4.214 x 10^24

ResultsPlus
Examiner Comments

The 7 came from multiplying the number of moles of oxygen molecules O_2 by the number of atoms in 1 molecule to give the number of moles of O atoms. Both steps in the calculation have been carried out correctly in one step so 2 marks were awarded.

Question 3 (a)(i)

A well answered question with the majority gaining two marks. Most candidates identified that there were more nitrogen oxides and more particulates, but some only stated the masses emitted and did not specify a comparison.

Common errors included:

· Stating that unburnt hydrocarbons were more damaging in the diesel engine

· Trying to give explanations instead of just identifying the answer.

· A few candidates just wrote nitrogen instead of nitrogen oxides.

3 (a) Figure 4 shows some information about the composition of pollutant exhaust gases from the engines of two different vehicles.

pollutant	mass of pollutant given out in g per kilometre driven	
	petrol engine	diesel engine
carbon dioxide	210	180
carbon monoxide	1.5	0.10
unburnt hydrocarbons	0.13	0.020
nitrogen oxides	0.36	2.0
particulates	0.0060	0.046
sulfur dioxide	0.0089	0.0037

Figure 4

(i) Give **two** ways in which the data in Figure 4 shows that the diesel engine is **more** damaging to the environment than the petrol engine.

(2)

There is more output of ~~a~~ nitrogen oxides with disel engine than petrol engine. the difference being 1.64. ~~Th~~ Another way is there being more particulates.

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Examiner Comments

Both more nitrogen oxides and more particulates scored here. 2 marks.

(i) Give **two** ways in which the data in Figure 4 shows that the diesel engine is **more** damaging to the environment than the petrol engine.

(2)

It gives out 2.0 nitrogen oxides which is damaging whilst petrol gives out 0.36. It gives out less of the things that aren't so harmful

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This scored 0 as there was no comparison made between the petrol and diesel engine when giving details about the pollutants nitrogen oxides, and the last part of the answer was just too vague to credit.

Question 3 (a)(ii)

The responses of carbon dioxide being less for diesel was given by most candidates, any with global warming, greenhouse effect or climate change as correct environmental comments to match. Those who went for sulfur dioxide correctly linked this to acid rain. When carbon dioxide and sulfur dioxide were chosen, most candidates scored 2 marks. If they didn't, it was due to vague responses such as 'pollutants' or 'harmful to the atmosphere'.

Candidates that opted for other pollutants such as carbon monoxide failed to score. In these instances, it was seen that candidates have clearly understood the health concerns of this compound, but not an environmental concern.

(ii) Explain, using information from Figure 4, **one** way in which the diesel engine is **less** damaging to the environment than the petrol engine.

(2)

Releases less carbon monoxide which leads to death in humans. Releases less sulfur dioxide which leads to acid rain (damaging ecosystems)

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This scored 2 marks for 'Releases less sulfur dioxide' with the linked explanation 'leads to acid rain'. If the candidate had just written 'damages ecosystems' without reference to acid rain this would not have scored the second mark.

Carbon monoxide was ignored as it doesn't cause environmental damage.

(ii) Explain, using information from Figure 4, **one** way in which the diesel engine is **less** damaging to the environment than the petrol engine.

(2)

Diesel engines release 180g of carbon dioxide whereas petrol engines release 210 g of carbon dioxide. Diesel releases 30g less carbon dioxide than Petrol does making it less damaging to the environment.

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This scored just 1 mark for diesel releasing less carbon dioxide than petrol. The linked explanation of 'less damaging to the environment' was not specific enough for the second mark – we were looking for either greenhouse gas/global warming or a specified effect of global warming (eg ice caps melting).

Question 3 (b)(iii)

Disappointingly the majority of candidates failed to score a mark for either the correct formulae of the reactants or even the correct formulae of the products. These candidates often did not recognise that combustion of alkanes means reacting with oxygen to produce carbon dioxide and water.

Where marks could be awarded, it was generally for the correct combustion products; a lack of understanding that combustion requires oxygen as one of the reactants was often seen. When reactants and products were correctly written, often the products balanced correctly but this could not be said for the correct balancing of the reactant oxygen molecules.

Some candidates misread the question and showed equations for cracking rather than complete combustion; often writing H_2 as product. A small, but significant, number of candidates gave a word equation as their answer.

(iii) Write the balanced equation for the complete combustion of octane, C_8H_{18}.

(3)

$C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$

(l) (g) (g) (l)

(Total for Question 3 = 9 marks)

$C_8H_{18} + 12.5O_2 \rightarrow 8CO_2 + 9H_2O$

$C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$

C	8	C	1 × 8			
H	18	~~O 3~~	H	2	× 9	
			O	16	+ 9	
O	2 × 3	~~H 2~~	~~O 3 × 2~~			

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Examiner Comments

2 marks were scored for the left hand side formulae and the right hand side formulae. Unfortunately, the candidate omitted a 2 in front of C_8H_{18} and therefore the mark for balancing could not be scored.

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Examiner Tip

Candidates should practice writing and balancing equations of a variety of reactions.

(iii) Write the balanced equation for the complete combustion of octane, C_8H_{18}.

(3)

~~$C_8H_{18} + 12.5O_2 \rightarrow 8CO_2 + 9H_2O$~~

$C_8H_{18} + 12.5\ O_2 \Rightarrow 8CO_2 + 9H_2O$

(Total for Question 3 = 9 marks)

$C_8H_{18} + 12.5O_2 \rightarrow 8CO_2 + 9H_2O$

Carbon - 8
Hydrogen - 18
Oxygen - 25

Carbon - 8
Hydrogen - 18
Oxygen - 25

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Examiner Comments

3 marks scored for the correct formulae of reactants of products and correct balancing of the equation. '12.5' is permissible in the equation as the equation represents the number of moles of reactants and of products in the reaction.

Question 4 (a)

Just under half the candidates were able to identify bromine as halogen in period 4 of the periodic table. Some candidates gave the answer 'Br' which was not accepted as the name of the element was required. The most common error here was to identify the element as iodine – presumably they ignored hydrogen and helium making up the first period and then started counting from fluorine downwards.

Question 4 (b)

Candidates struggled with this question, with only about half scoring any marks. The most common mark awarded was for stating that chlorine had fewer shells or that atoms of chlorine were smaller than iodine (or the reverse argument in terms of iodine). Many candidates scored 0 for describing the trend in reactivity – chlorine is more reactive than iodine – (and in some cases properties of halogens) rather than explaining them, but did score a mark for saying that it is easier for chlorine to gain an electron.

Examiners reported common errors which included:

· Iodine has more outer shells

· It is easier for chlorine to lose an electron (confusion here with group 1 elements)

· Not linking the force of attraction to the outer shell and the nucleus.

· Many said 'intermolecular forces' instead of force of attraction.

(b) Explain why chlorine is more reactive than iodine.

(3)

• Chlorine is higher up in the halogens and is closer to the nucleus

• chlorine is a yellow dangerous gas

• iodine is far from nucleus, so less dangerous reaction iodine is also a solid which is dark gre

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This candidate did not specify what was closer to the nucleus in chlorine, so nothing here. The rest of the answer did not answer the question.

0 marks.

(b) Explain why chlorine is more reactive than iodine.

(3)

Chlorine is further up the group than Iodine, in group 7 as you go up the table the more reactive the halogen gets. This is because as you go down group 7 the outer electron becomes further away from the nucleus, this weakens the attraction making it less reactive. Chlorine is higher up in the group making it more reactive.

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2 marks.

The first mark was scored because they've mentioned that the outer electron(s) being further away from the nucleus for iodine. The second was scored for describing a weaker attraction (between the outer shell and the nucleus).

Question 4 (c)

Although the majority of candidates identified the substance correctly as sodium chloride, there was a large number of candidates who just gave the answer as ‘salt’ or white solid. Although the correct formula of sodium chloride was an acceptable answer, many gave an incorrect formula such as ‘SCl’ (S=sodium?) or $NaCl_2$.

Question 4 (d)(i)

Candidates found this question to be particularly difficult and less than a quarter of the candidates managed to score marks. The most common mistakes were writing Br instead of Br_2 and $NaBr_2$.

Largely, candidates either got 2 marks or 0 marks. If they could write the correct formulae for both the reactants and the product, they were able to balance it.

Other incorrect answers included adding other formulae into the equation, eg CO_2 or H_2O, writing a word equation, or even writing S for sodium instead of Na.

(d) Sodium also reacts with bromine.

(i) Write the balanced equation for the reaction between sodium and bromine.

(2)

$2Na + 2Br_2 \rightarrow 2NaBr_2$ ~~$+ H_2$~~

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0 marks – although the formulae on the left side were correct, the incorrect formula of the sodium bromide on the right caused the whole equation to be incorrect.

(d) Sodium also reacts with bromine.

(i) Write the balanced equation for the reaction between sodium and bromine.

(2)

$2Na + Br_2 \rightarrow NaBr$

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This was one of the few equations that was seen to be worth just one mark for the correct formulae.

Na + Br →

(d) Sodium also reacts with bromine.

(i) Write the balanced equation for the reaction between sodium and bromine.

(2)

sodium + bromine → sodium bromide

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This candidate didn't appear to understand that a word equation is not a suitable alternative to a balanced equation.

0 marks

Question 4 (d)(ii)

Only a small number of candidates could give an acceptable colour for the solution formed when sodium bromide solution was added to chlorine water.

Common incorrect responses included effervescence / fizzing / bubbling / precipitates / going cloudy / colour change. These seem to be the go-to answers when students are not sure.

Those candidates that did give a colour would most often incorrectly put brown alone or red-brown, some would also put green or pink.

(ii) In another experiment, a student adds colourless sodium bromide solution to chlorine water.

State what you would **see** in this reaction.

(1)

the solution changes colour.

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Candidates need to be more specific about what is seen in a reaction. 'changes colour' is not enough.

0 marks

(ii) In another experiment, a student adds colourless sodium bromide solution to chlorine water.

State what you would **see** in this reaction.

(1)

you will see a colour change. (it would change to orange-brown)

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Brown was not an acceptable colour for the bromine in solution; however, we did accept combinations with brown in this way.

1 mark.

Question 4 (d)(iii)

Few candidates scored both marks for this question. Many candidates managed to gain the allowance 1 mark for saying that bromine is oxidised because it loses electrons. Candidates clearly do not understand the concept that the bromide ion is the species that is oxidised, into the bromine.

Many candidates incorrectly stated the chlorine was oxidised. This tended to be because either (1) they incorrectly thought that oxidation was gained from electrons, leading to the (correct) answer of chlorine, or (2) they thought that going from Cl_2 to Cl^- was the loss of an electron.

(iii) The ionic equation for the reaction between sodium bromide and chlorine is:

$$2Br^- + Cl_2 \rightarrow 2Cl^- + Br_2$$

Explain which species has been oxidised in this reaction.

(2)

The Bromine has faced oxidisation as it has lost ions to chlorine

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0 marks

We were looking for bromide (ions) or Br^- being oxidised, not bromine since bromine appears as a product in the equation. 'lost ions' also did not score as it was the wrong particle being lost.

(iii) The ionic equation for the reaction between sodium bromide and chlorine is:

$$2Br^- + Cl_2 \rightarrow 2Cl^- + Br_2$$

Explain which species has been oxidised in this reaction.

(2)

2Br⁻ was oxidised into Br2 because it lost an electron.

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2 marks scored for the correct species being oxidised (Br^-) and for what was being lost in the process.

Question 5 (a)

This question was fairly well answered with about three-quarters of the candidates scoring at least one mark. Most candidates got MP1 as they'd grasped the idea that plants/trees etc. resulted in the production of oxygen. MP2 wasn't as well answered as, whilst they explained the concept of photosynthesis, they didn't write the term.

Where incorrect answers were present, candidates were including ideas based on volcanoes/the formation of oceans/deforestation.

5 This question is about oxygen.

(a) The percentage of oxygen in today's atmosphere is greater than the percentage of oxygen in the Earth's early atmosphere.

Explain what caused this change to happen.

(2)

Plants had just started to evolve in phase 2. This means that over time they were able to produce more through photosynthesis O_2. ~~The ozone layer also was created by oxygen which caused more complex life.~~

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Examiner Comments

This was a good response here. Plants evolving and producing O_2 through photosynthesis gave this 2 marks.

5 This question is about oxygen.

(a) The percentage of oxygen in today's atmosphere is greater than the percentage of oxygen in the Earth's early atmosphere.

Explain what caused this change to happen.

(2)

Plants photosynthesis decreasea the amount of oxygen in the environment hugely and more emissions of carbon dioxide has decreased it too.

ResultsPlus
Examiner Comments

'Photosynthesis decreases the amount of oxygen' caused this answer to score just 1 mark.

5 This question is about oxygen.

(a) The percentage of oxygen in today's atmosphere is greater than the percentage of oxygen in the Earth's early atmosphere.

Explain what caused this change to happen.

(2)

As water vapour condensed to form oceans, the ~~~~ algae and ~~things~~ primative plants on land and in oceans began to photosynthesise. This released oxygen ~~back~~ into the environment.

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Examiner Comments

2 marks was given for primitive plants began to photosynthesise.

Question 5 (b)

This was a poorly answered question, with most candidates looking for visual proof that the reaction is complete, such as waiting for a white powder to form, or lifting the lid to replenish oxygen.

The more common incorrect response was the test for oxygen. Add a glowing splint and if it doesn't relight, all of the oxygen has been reacted.

Weighing without stating 'until no change in mass' was common. Some candidates were saying 'see if the mass changes' alone. More suggested that they needed to show mass remained constant (MP1) than suggested reheating (MP2). Only a few used the term 'heat to constant mass'.

Explain how the student could check that the magnesium had reacted completely with oxygen.

(2)

Keep re-weighing lid+crucible until mass stops changing/ reducing. This means the reaction has finished ~~the~~ as all the magneisium has been used up.

ResultsPlus Examiner Comments

The candidate suggested re-weighing the crucible until the mass stops changing which scored a mark. They have not said to reheat the crucible and so only 1 mark was given for this answer.

Explain how the student could check that the magnesium had reacted completely with oxygen.

(2)

Once cooled down and ~~to~~ the mass has been found heat it for another 5mins and repeat until the mass stops increasing.

![ResultsPlus Examiner Comments]

ResultsPlus Examiner Comments

This was one of the few good answers seen for this question. Heating further and repeating the mass determination scored 2 marks.

Question 5 (c)

Nearly half the candidates did not score a mark for this question. It seemed as if these candidates had very little experience of determining the empirical formula from reacting masses.

However, for the remaining group of candidates, most marks were awarded for calculating the empirical formula of P_2O_5, but very few candidates went on to relate this to the molecular formula by using the relative formula mass that was given, so limited themselves to 2 marks. There were some candidates who calculated the empirical formula mass, but then having realised that this was half the value of the relative formula mass, gave the final answer as $2P_2O_5$.

Some candidates got confused about rounding in empirical formula when they have the ratio 1:2.5 – many wrote PO_3. Frustratingly, several candidates managed to work out that there were 4 phosphorous atoms and 10 oxygen atoms, then wrote on the answer line: 4 P 10 O, so could not be awarded the 4^{th} mark.

Examiners reported that a number of candidates were using a trial-and-error method of working out how many atoms of each element made up the total for the relative formula mass of the phosphorus oxide and this gave them the correct molecular formula P_4O_{10}.

(c) In another experiment, it was found that 1.24 g of phosphorus reacted completely with 1.60 g of oxygen to form phosphorus oxide.

The relative formula mass of this phosphorus oxide is 284.

Deduce the molecular formula of this phosphorus oxide.

You must show your working.

(relative atomic masses: O = 16, P = 31)

(4)

O	P
$\frac{1.60}{16}$	$\frac{1.24}{31}$
$= \frac{0.1}{0.04}$	$= \frac{0.04}{0.04}$
$= 2.5 \times 2 = 5$	$= 1 \times 2 = 2$

O_5P_2

molecular formula = $O_5 P_2$

ResultsPlus
Examiner Comments

This score 2 marks

Moles of O and P correctly calculated and from this the empirical formula was determined. We accepted the elements in either order for both the empirical and molecular formulae.

(c) In another experiment, it was found that 1.24 g of phosphorus reacted completely with 1.60 g of oxygen to form phosphorus oxide.

The relative formula mass of this phosphorus oxide is 284.

Deduce the molecular formula of this phosphorus oxide.

You must show your working.

(relative atomic masses: O = 16, P = 31)

(4)

$\frac{16}{1.6} = 10$ $\frac{31}{1.24} = 25$

$284 \div 35 = 8.1142\ldots$

10 : 25

~~84~~

2 : 5

P_5O_2

molecular formula = P_5O_2

ResultsPlus
Examiner Comments

There were no marks for the inverted mole calculations: 16/1.6 and 31/1.34. However, the derived ratio and empirical formula was treated as an error carried forward and scored 1 mark.

(c) In another experiment, it was found that 1.24 g of phosphorus reacted completely with 1.60 g of oxygen to form phosphorus oxide.

The relative formula mass of this phosphorus oxide is 284.

Deduce the molecular formula of this phosphorus oxide.

You must show your working.

(relative atomic masses: O = 16, P = 31)

(4)

$16 \times 10 = 160$ $\quad$ $160 + 124 = 284$

$31 \times 4 = 124$ $\quad$ $O_{10} + P_4 = O_{10}P_4$

16		31
16	96	31
32	112	62
48	128	93
64	144	124 → 284
80	160	155

molecular formula = $O_{10}P_4$

ResultsPlus
Examiner Comments

This scored 4 marks.

Unfortunately, the question did not include 'Using these results, deduce the molecular formula ....', so this method of choosing the appropriate number of P and O atoms to add together to make 284 (relative formula mass) had to count and was awarded 4 marks.

(c) In another experiment, it was found that 1.24 g of phosphorus reacted completely with 1.60 g of oxygen to form phosphorus oxide.

The relative formula mass of this phosphorus oxide is 284.

Deduce the molecular formula of this phosphorus oxide.

You must show your working.

(relative atomic masses: O = 16, P = 31)

16 32 48 64 80 96 112 128 144

31 62 93 124

(4)

Phosphorus + oxygen → Phosphorus oxide.

1.60 + 1.24 → 2.84 g

16 31 → 284

moles = mass / mr = 2.84 / 284 = 0.01 moles.

P 237 284

(31 x 4) + (16 x 10) = ~~237~~.

molecular formula = P_4O_{10}

12

ResultsPlus Examiner Comments

4 marks for this answer.

There was nothing stopping candidates from using this method of balancing the number of P and O atoms to arrive at the formula mass of phosphorus oxide.

(c) In another experiment, it was found that 1.24 g of phosphorus reacted completely with 1.60 g of oxygen to form phosphorus oxide.

The relative formula mass of this phosphorus oxide is 284.

Deduce the molecular formula of this phosphorus oxide.

empirical ?

You must show your working.

(relative atomic masses: O = 16, P = 31)

(4)

P	O
$\frac{1.24}{31}$	$\frac{1.60}{16}$
$= \frac{0.04}{0.04}$	$\frac{0.1}{0.04}$
= 1	= 2.5
	= 3

$= PO_3$

molecular formula = PO_3

ResultsPlus
Examiner Comments

This was given just 1 mark.

The candidate had correctly calculated the number of moles of P and O atoms and had obtained a correct whole number ratio. However, they then approximated the 2.5 to 3 and so the resulting formula of PO_3 was then incorrect.

Question 5 (d)(i)

It appears that very few candidates, for this and the following question, had seen a method to determine the percentage of oxygen in the atmosphere.

Common incorrect answers included

- the iron wool drying
- the iron wool falling down the test tube.
- water moving down the tube
- water level increasing or decreasing without saying where.

Where marks were awarded, MP1 was scored for iron would rust or water level in the test tube would rise, but the explanation for MP2 was less frequent.

(d) A student uses the apparatus shown in Figure 6 to investigate the percentage of oxygen in the atmosphere.

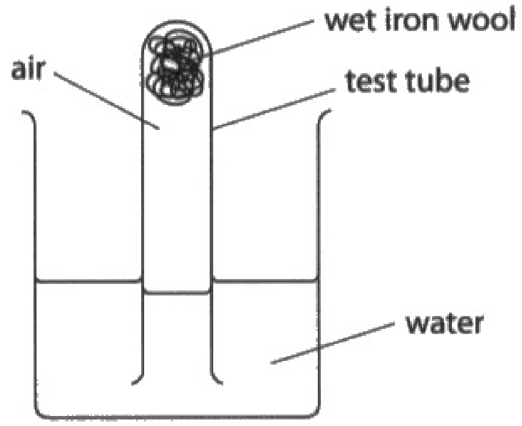

Figure 6

The apparatus was left for a few days.

(i) Explain one change the student would see after a few days.

(2)

The iron will react with oxeygen to form iron oxide.

ResultsPlus Examiner Comments

This scored 1 mark only for the iron reacting with oxygen. The answer does give iron oxide as the substance formed, but this is not an observation.

(d) A student uses the apparatus shown in Figure 6 to investigate the percentage of oxygen in the atmosphere.

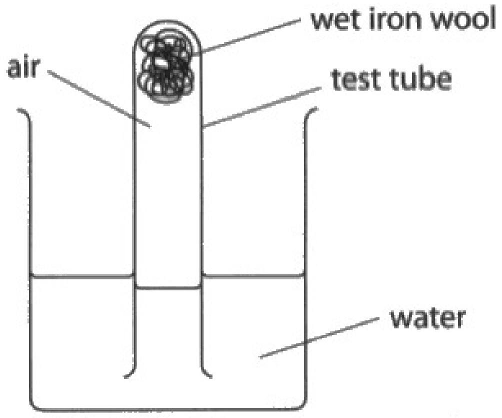

Figure 6

The apparatus was left for a few days.

(i) Explain one change the student would see after a few days.

(2)

The iron would go from Silver in colour to reddy brown due to oxidation.

ResultsPlus
Examiner Comments

2 marks were given for the observation [iron turning reddy brown] and the explanation [due to oxidation].

(d) A student uses the apparatus shown in Figure 6 to investigate the percentage of oxygen in the atmosphere.

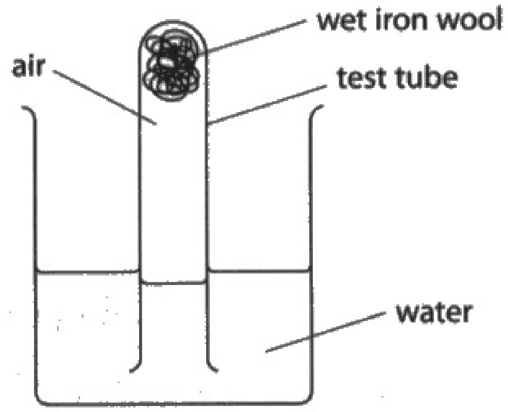

Figure 6

The apparatus was left for a few days.

(i) Explain one change the student would see after a few days.

(2)

There would be more water in the test tube than right now, the volume of oxygen gas will decrease.

ResultsPlus
Examiner Comments

This was another way of answering the question. There would be more water in the test tube as there would be less oxygen in the test tube after a few days.

This scored 2 marks.

Question 5 (d)(ii)

About a quarter of the candidates scored at least one mark by suggesting a piece of apparatus in which they could record the volume changes; most of these candidates opted for a measuring cylinder or a graduated test tube.

However, a number of candidates incorrectly tried to use a gas syringe, or a balance, trying to measure the change in mass, or even 'off the wall' comments such as 'ruler', 'balance', 'thermometer' and even 'pH meter'.

Most candidates who scored MP1 for measuring cylinder didn't score MP2 as they missed the idea of measuring the volume before and after and calculating the change, and would just state that they'd use the measuring cylinder to measure the volume.

A range of incorrect ideas was seen, including ideas regarding the wire wool, the water, alternative ways of measuring oxygen in general, sealing the apparatus, and increasing the size of the apparatus. Some wanted to use a bigger test tube or include extra tubing.

(ii) Explain one change that can be made to the apparatus in Figure 6 to allow the student to calculate the percentage of oxygen in the atmosphere.

(2)

If a gas syringe were used instead of a measuring cylinder to allow the student to measure the ~~gas~~ ~~of~~ volume of ~~oxygen~~ gas produced which can then be used to calculate the percentage of oxygen.

ResultsPlus
Examiner Comments

This answer does not score MP1 for gas syringe. It also doesn't score MP2 – "measure the volume of gas produced, as no gas is produced."

(ii) Explain one change that can be made to the apparatus in Figure 6 to allow the student to calculate the percentage of oxygen in the atmosphere.

(2)

Use a measuring cylinder instead of a test tube ~~be keep b~~ because it allows the student to compare the levels of air before and after. This would allow them to calculate the percentage change of oxygen in the atmosphere.

(Total for Question 5 = 12 marks)

ResultsPlus
Examiner Comments

This answer scored 2 marks for using a measuring cylinder in place of the test tube and for comparing the levels of air before and after, which would show the change in volume of air due to the oxygen reacting with the iron wool.

(ii) Explain one change that can be made to the apparatus in Figure 6 to allow the student to calculate the percentage of oxygen in the atmosphere.

(2)

Include a measuring cylinder which will allow the student to see the difference in water and oxygen.

ResultsPlus
Examiner Comments

One mark was given for the use of the measuring cylinder but the rest of the answer was unclear as to what it meant.

1 mark.

Question 6 (a)(ii)

There were many candidates getting transferred error marks in this question. Answers of ±64 and +32 were quite common due to students mistaking H_2 for 2 lots of H-H bonds, so multiplying that bond energy by 2. Several candidates did not multiply the bond of energy of H-F by 2, so ended up with the answer of ±32. The sign in these cases depended on whether they calculated the overall energy change as 'bonds broken – bonds formed'.

There was a low percentage of full marks due to missing the negative sign or mention of exothermic reaction. Most candidates gave an answer of +530. Here they instinctively take the smaller number away from the bigger number rather than thinking about 'bonds broken – bonds formed'.

Calculate the energy change for this reaction.

(4)

$H_2 + F_2 \rightarrow 2HF$

$2(436 + 158) - 2(562) = 64$

endo thermic reaction

energy change = 64 kJ mol^{-1}

ResultsPlus Examiner Comments

This answer was given 3 marks. The error made here was the doubling of the bond energies of the reactants. This gave a much larger energy value which resulted in the endothermic value of 64 kJ mol^{-1} here.

Calculate the energy change for this reaction.

(4)

436 + 158 = 594

568 × 2 = 1136

1136 − 594 = 550

energy change = 550 kJ mol^{-1}

ResultsPlus
Examiner Comments

This answer was given 3 marks. The error made here was in the subtraction where the candidate used bonds formed – bonds broken and so ends up with the correct numerical answer but with the wrong sign.

It's likely that the candidate just subtracted the smaller number from the larger number rather than thinking about what was actually taking place, in terms of energy required to break bonds and energy released on forming bonds.

Calculate the energy change for this reaction.

(4)

Breaking — reactants

H_2 + F_2

H – H   F – F

+436   +158

+436
+158
+594

Making — products

2HF

–562
× 2
–1124

+594
–1124
–530

total energy change = –530 kJ mol⁻¹

↑ means its an exothermic reaction – energy is being released to the surroundings

energy change = –530 kJ mol^{-1}

ResultsPlus
Examiner Comments

This answer scored 4 marks.

There was the correct addition of the bond energies for the reactants, the correct multiple of bond energy for the product, the correct subtraction of bonds broken – bonds formed: 594 – 1124 = – 530 along with the correct answer and negative sign.

Question 6 (b)

This was a fairly well answered 6-mark question, with good numbers of students accessing all three levels and up to the 6 marks available.

Most were able to give a basic description of a catalyst including its function, with the most common phrases being ‘speeds up a reaction’, ‘lowers the activation energy’ and ‘is not used up’. Several candidates annotated the supplied diagram to help illustrate their answer to a varying degree of help. The idea that catalysts provided an alternative route that requires less energy was less regular but was still seen.

The most common incorrect statements were:

- a catalyst gives the particles more energy
- the activation energy increases
- the frequency of collisions increases
- temperature, concentration and surface area were often referred to as catalysts.

Most candidates were able to explain how the rate of reaction is affected by a catalyst; some backed this up with correct collision theory and used the exothermic energy level diagram to show the lower activation energy, with a catalysed reaction.

The question required knowledge of a catalyst example(s). Many candidates remembered the iron catalyst for the Haber process or gave enzymes as biological catalysts. There were some examples of knowledge of catalytic converters, cracking of large alkanes and other biological examples. The more comprehensive responses had clearly defined paragraphs for the description, function, and examples of catalysts. Frustratingly, some candidates produced excellent descriptions of catalysts but failed to give any examples, thus limiting themselves to level 2.

Unfortunately, there were too many candidates that contradicted themselves and centres should encourage students to proofread their work to reduce this error, as it reduced their overall level of mark available.

Paper Summary

Based on the performance in this examination paper, candidates should:

- practice the various types of calculations met in this paper – empirical formula and molecular formula from reacting masses and relative formula mass, bond energy calculations
- be prepared to interpret experimental descriptions that they may not have met but could still offer sensible suggested answers
- practice writing balanced equations of all degrees of complexity
- know what is expected by the command words ‘describe’ and ‘explain’
- use appropriate terminology in explanations
- avoid giving more points than asked for in any response as this may lose them marks if they include an incorrect point
- reading their responses so that they do not contradict what they are trying to write.

Candidates need to be reminded that in any calculation, all necessary numerical information is given in the question.

Grade boundaries

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

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