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Examiners' Report
June 2019

GCSE Chemistry 1CH0 1H

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June 2019
Publications Code 1CH0_1H_1906_ER

Introduction

This paper followed the usual format of ten questions with two extended response (6 mark) parts. Six questions from this paper formed the paper for Combined Science. Earlier questions in the paper are also found as the latter questions in the Foundation Tier paper.

There were some excellent responses in this paper and the best candidates applied their knowledge very well to unfamilair contexts. There was good evidence of skill in writing equations and performing calculations. Better answers - for example in calculations and the 6-mark answers - were clearly laid out and well structured. In some questions candidates did not properly distinguish between describe and explain. Questions in a practical context were challenging to some, and describing what you 'see' in a reaction did not always yield the expected observations.

Question 1 (a)

Q1(a) was generally answered well with the large majority of candidates knowing or deducing that water was the product, although some formed OH or H_2O_2. There were perhaps more errors in the formulae for hydrogen and oxygen, with some answers including ions or H and/or O. The large majority of equations with correct formulae were correctly balanced.

1 In a hydrogen-oxygen fuel cell, hydrogen and oxygen react at the electrodes.

(a) The overall reaction occurring in this fuel cell is a reaction of hydrogen with oxygen.

Write the balanced equation for this reaction.

(2)

$H_2 + O \rightarrow H_2O$

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Many candidates forget that gaseous elements, excluding group 0, are diatomic.

1 In a hydrogen-oxygen fuel cell, hydrogen and oxygen react at the electrodes.

(a) The overall reaction occurring in this fuel cell is a reaction of hydrogen with oxygen.

Write the balanced equation for this reaction.

(2)

$H_2^{+} + O^{2-} \rightarrow H_2O$

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Candidates should learn that charges should only be included in ionic or half equations.

Question 1 (b) (i)

In Q1(b)(i) most candidates scored with iron rusts/corrodes. The answer had to be specific – for example, "iron is reactive" did not score, but a reference to the reaction with oxygen and/or water or to corrosion/rusting was required. The most common incorrect answer concerned the alleged non-electrical conductivity of iron.

(b) The electrodes of a fuel cell are in contact with water and air.
The electrodes are made of platinum rather than iron.

(i) State why iron is not a suitable metal for the electrodes of the cell.

(1)

Iron will corrode (rust) when in contact with water and air.

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This candidate has succinctly stated the correct answer.

Question 1 (b) (ii)

Q1(b)(ii) was well answered. Where this was incorrect candidates referred to platinum's period or used 'in the middle' or 'between groups 2 and 3' as a description. Others just stated that platinum was a metal. A lot of unnecessary additional information was included for a 'state' type question, where a simple statement of the information, not an explanation, is asked for.

(ii) Platinum acts as a catalyst.

State, in terms of its position in the periodic table, why you would expect platinum to act as a catalyst.

(1)

As it is between group 2 and 3

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This is true, but candidates are expected to know and use correct terminology.

Question 1 (c)

Most candidates thought through this question well, and scored at least one mark, with many getting both marks. The main issue here was being insufficiently exact in the language of the answer. Protection from corrosion was often stated, but others just stated 'protects' but not stating from what, or thought that the electroplating was 'a sacrificial metal'. Others were mixing electroplating with alloying and saying 'to make it stronger'. Many marks were scored with the ideas if improving appearance or by saving cost with a cheaper metal being electroplated, but these answers had to be adequately stated, with vague responses such as 'cheaper' not credited.

Question 2 (a) (i)

Q2(a)(i) was very well answered.

Question 2 (a) (ii)

Q2(a)(ii) was not so well answered, with some candidates giving J and X from period 3.

Question 2 (a) (iii)

Most candidates had the idea that groups 1 and 7 involved gaining/losing one electron, so A, J and unfortunately X were the most common responses.

Question 2 (b) (i)

Most candidates answered this well and recalled definition. When only 1 mark was awarded, this was often because the difference in neutrons but not the same number of protons was given. Candidates are advised in this type of question not to mention electrons which sometimes confused an answer. Some candidates unfortunately mentioned 'different elements with a different number of neutrons'.

(b) Element **E** has an atomic number of 5.
In a sample of **E** there are two isotopes. One isotope has a mass number of 10 and the other isotope has a mass number of 11.

(i) Explain, in terms of subatomic particles, what is meant by the term **isotopes**.

(2)

They are particles that have the same number of protons but different number of neutrons. (~~They~~ They have the same atomic number but different mass number).

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This answer states clearly the standard definition (They are atoms... would have been even better).

Question 2 (c)

Q2(c) was very well done.

Question 2 (d)

It was pleasing to see many carefully set out answers for this part, giving A_2G (or Li_2O). Only 1 mark was awarded for writing down the correct answer but with no working. A common error was to invert the initial fractions, but if this was followed through carefully to get AG_2 examiners could award some of the marks. Some candidates worked all the way through to the simplest ratio, but did not give a final formula.

(d) In an experiment, 3.5 g of element **A** reacted with 4.0 g of element **G** to form a compound.

Calculate the empirical formula of this compound.
(relative atomic masses: **A** = 7, **G** = 16)

You must show your working.

(3)

A + G → x

Mass = 3.5g Mass = 4.0g

Moles = 0.5 mol Moles = 0.25 mol

A_r = 7 A_r = 16

Moles = $\frac{3.5}{7}$ = 0.5 $\frac{4}{16}$ = 0.25

A : G = 0.5 : 0.25

↓ ÷0.25

2 : 1

↓

A_2G

empirical formula of this compound = 2:1 (→ A_2G)

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This answer is not perfect (2:1 should not be on the answer line), but it has been set out so that the working can be vey clearly followed.

(d) In an experiment, 3.5 g of element **A** reacted with 4.0 g of element **G** to form a compound.

Calculate the empirical formula of this compound.
(relative atomic masses: **A** = 7, **G** = 16)

You must show your working.

(3)

moles = $\frac{mass}{mr}$

$\frac{3.5}{7} = 0.5$ $\frac{4}{16} = 0.25$

$\frac{0.5}{0.25} = 2$ $\frac{0.25}{0.25} = 1$

2 : 1

empirical formula of this compound = 2AG

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This answer has calculated the correct ratio of 2:1, but unfortunately has not transferred this to the correct empirical formula.

Question 3 (a) (i)

Q3(a)(i) was answered very well. Candidates who answered this question incorrectly mentioned that the hydrogen was flammable or ignited – which was in the question. Candidates are advised to give the standard answer of 'squeaky pop' as some answers in their own words are insufficiently clear. It was surprising on this paper to see some tests for oxygen, chlorine or carbon dioxide.

3 (a) Water, acidified with sulfuric acid, is decomposed by electrolysis. The water is decomposed to produce hydrogen and oxygen.

(i) A sample of hydrogen is mixed with air and ignited.

State what would happen.

(1)

Combustion, formation of water as hydrogen bonds with oxygen

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Whilst the examiners were expecting 'squeaky pop', the answer is correct - water does form - so this answer was credited.

Question 3 (a) (ii)

Many candidates scored 1 mark here, often recognising the 2:1 ratio, but not always stating the obvious point that the volumes increased with time. Some just quoted data from the table but did not describe how the data for the two gases was linked. A minority neatly said that 'the rate of hydrogen production was double the rate of oxygen production', scoring both marks. Some candidates did not describe the data (as required) but wasted time trying to explain it.

(ii) Throughout the experiment the volume of hydrogen and the volume of oxygen are measured at two-minute intervals.

The results are shown in Figure 2.

time in minutes	volume of hydrogen in cm^3	volume of oxygen in cm^3
0	0	0
2	4	2
4	8	4
6	12	6
8	16	8

Figure 2

Describe, using the data in Figure 2, what the results show about the volumes of hydrogen and of oxygen produced in this experiment.

(2)

Hydrogen is formed quicker than oxygen, and twice as much hydrogen was present as oxygen.

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This is not quite as good as answer as the next one. 'Hydrogen is formed....' is really a rephrase of the information given - it would be better to explicitly say that the volumes are increasing.

Describe, using the data in Figure 2, what the results show about the volumes of hydrogen and of oxygen produced in this experiment.

(2)

The ~~today~~ data illustrates that as hydrogen and oxygen are measured at two minute intervals the volume of hydrogen formed increases at double the rate of oxygen formed.

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This is a good answer because it states that the volume increases over time, and gives the ratio of volumes of the two gases.

Question 3 (c)

Q3(c) was pleasingly well answered with a large majority of students knowing that calcium nitrate is soluble whereas calcium carbonate is not and many explaining the condictivity of the former as being a result of the presence of free moving ions. Sometimes the explanation was in terms of electrons (or even atoms or particles), not ions, being free to move.

(c) Calcium nitrate and calcium carbonate are both ionic compounds.

Calcium nitrate mixed with water behaves as an electrolyte.
Calcium carbonate mixed with water does not behave as an electrolyte.

Explain, in terms of solubility and movement of ions, this difference in behaviour.

(2)

calcium carbonate is insoluble and instead acts as a sedament in water. calcium nitrate can dissolve in water and because it is aqueous it's electrons have energy to move so it becomes an electrolyte

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This answer shows a common error - that electrons are the free particles, rather than ions.

(c) Calcium nitrate and calcium carbonate are both ionic compounds.

Calcium nitrate mixed with water behaves as an electrolyte.
Calcium carbonate mixed with water does not behave as an electrolyte.

Explain, in terms of solubility and movement of ions, this difference in behaviour.

(2)

Calcium nitrate is soluble in water and when it is dissolved in water, its ions are free to carry a charge which is what an electrolyte must do. Calcium carbonate is insoluble in water so remains solid when it is mixed with water. Solid ionic compounds do not conduct electricity because the ions are in fixed position and cannot carry charge. Therefore it cannot be an

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This is a more comprehensive, more clearly written answer than the other example, and correctly refers to ions.

Question 3 (d)

There were a good number of correct answers to this part. Common errors included the reverse reaction, the inclusion of chlorine/chloride, a -2 charge on the electron, forming Zn_2 or subtracting electrons.

(d) When molten zinc chloride is electrolysed, zinc ions, Zn^{2+}, form zinc atoms.

Write the half equation for this reaction.

(2)

$Zn^{2+} - 2e \rightarrow Zn$

(Total for Question 3 = 8 marks)

$Zn^{2+} + 2e \rightarrow Zn$

$Zn^{2+} - 2e \rightarrow Zn$

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Examiner Comments

Whilst the answer on the answer line will be marked, it is advisable to cross out incorrect work. This candiate has unfortunately subtracted electrons, which is a pity as the correct answer is below.

Question 4 (a)

Almost all candidates answered this part correctly, although some subtracted incorrectly or divided their correct answer by two.

Question 4 (b) (i)

This part was generally well answered with lots achieving full marks. Some errors included calculating (5.600-5.450)/5.600 x 100 and inverting the calculation. It was a shame that some mis-entered data into calculators ie their calculation was correctly written, but their answer was incorrect. Candidates are advised to check calculations of they have time at the end. Whilst significant figures were not a marking point here, candidates should get into the habit of considering the correct number of figures to give in an answer, there was a range from 2 to 10 significant figures given.

(b) A second sample of calcium carbonate is strongly heated in a crucible until there is no further loss in mass.
The mass of calcium oxide remaining in the crucible is 5.450 g.

(i) The theoretical yield of calcium oxide in this experiment is 5.600 g.

Calculate the percentage yield of calcium oxide.

(2)

$\frac{\text{actual}}{\text{Theoretical}} \times 100$

$= \frac{5.450}{5.600} \times 100 = 97.32$

percentage yield = 97.32

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Examiners like answers like this: clearly set out so that all of the working can be followed.

Question 4 (c) (i)

Question Q4(c)(i) required an explanation, but many just gave a description. The obvious mark was that mass decreases for calcium carbonate, although some did state the rate is slowing down. Some candidates stated that carbon dioxide was released as the explanation for mass loss, but incorrect explanations for the mass decrease were varied and included calcium carbonate melting and/or evaporating, reacting with oxygen or just 'disappearing'. Very few candidates were able to explain why the rate of reaction decreases as time goes on.

(c) Another sample of calcium carbonate is heated and the mass of solid remaining is measured each minute.

The results are shown in Figure 3.

time in minutes	0	1	2	3	4	5	6	7
mass of solid remaining in g	9.0	8.1	7.2	6.4	6.0	5.6	5.3	5.2

Figure 3

(i) Explain the trend shown by the data in Figure 3.

(2)

As the time went, the mass of solid remaining decreased. This is because ~~the calcium~~ one of the products was carbon dioxide which escapes into the atmosphere and therefore the mass decreased.

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Some candidates just described the pattern in this data. This answer gives a correct explanation as well so scores both marks.

Question 4 (c) (ii)

A considerable number of candidates understood the concept of heating to constant mass, even if they weren't always as good at expressing themselves clearly. Others just stated that the reaction was incomplete but gave no evidence for this idea. Some misunderstood the data completely and thought that it would decrease to zero; others incorrectly thought they needed to know theoretical yield.

Question 4 (d) (i) - (ii)

In Q4(b)(i), candidates, in the vast majority of cases, understood how to use the relative atomic masses of calcium, carbon and oxygen to correctly deduce the relative formula mass of $CaCO_3$ to be 100, although arithmetical errors sometimes cost candidates the second mark, or failing to multiply the A_r of oxygen by 3.

In Q4(b)(ii), however strange it might have seemed dividing by 100 and multiplying by 100 in the same calculation, few candidates were fazed by this and many gave the correct answer. It was noted that most correctly followed instruction that they must show working. A surprising number seemed to think both products were useful and so had an atom economy of 100%.

(d) (i) Calculate the relative formula mass of calcium carbonate, $CaCO_3$.
(relative atomic masses: C = 12, O = 16, Ca = 40)

(2)

12 + 40 + (16 x 3) = 100

relative formula mass = 100

(ii) Calculate the atom economy for the formation of calcium oxide in this reaction.

$$CaCO_3 \rightarrow CaO + CO_2$$

You must show your working.
(relative atomic masses: C = 12, O = 16, Ca = 40;
relative formula mass: calcium oxide = 56)

(2)

Mr desired / Mr all = (40 + 16) / ((40+16) + (12 + (16 x 2)))

56 / 100 = 0.56 x 100 = 56

atom economy = 56 %

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This is an example of a clearly set out correct answer.

Question 5 (a) (i)

Most candidates answered this part well, but there were a few who scored 2 for calculating the % of non-nickel compounds. A few did not take into account that there are 1000g in 1kg.

5 (a) One way to extract metals from land contaminated with metal compounds is phytoextraction.
When plants grow they absorb metal ions through their roots.
The plants are harvested, dried and burned forming an ash.
The ash contains metal compounds.

Plants were grown in a piece of ground contaminated with nickel compounds.

(i) 1 kg of the ash from these plants contained 142.0 g of nickel compounds.

Calculate the percentage by mass of nickel compounds in the ash.

(3)

1kg = 1000g
142.0g of 1kg = 14.2%
100 − 14.2 =

percentage by mass = 85.8%

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The kg to g conversion is clear. Unfortunately, the final answer is the % of non-nickel compounds.

Question 5 (a) (ii)

The benefits of phytoextraction were not well understood. Whilst there were many good answers based on candidates' knowledge and understanding of the process eg high-grade nickel ores being finite or that phytoextraction extracts from low grade ores, a large number referred to higher yield or less cost required for phytoextraction. A minority of answers indicated that less carbon dioxide is produced overall during phytoextraction or that the process is carbon neutral. A significant minority of candidates correctly referred to damage to the landscape or environment caused by mining, including noise pollution or the destruction of habitats, but many gave vague answers such as phytoextraction is better for the environment or causes less pollution.

(ii) Nickel is extracted from nickel compounds.

State an advantage of extracting nickel by phytoextraction rather than from its ore.

(1)

it is cheaper and better for the environment

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Answers such as this with no real scientific content are never likely to score marks.

(ii) Nickel is extracted from nickel compounds.

State an advantage of extracting nickel by phytoextraction rather than from its ore.

(1)

~~Ph~~ Phytoextraction extracts metal ~~nickel~~ compounds from low grade ores, so it is saving the limited resourses of high grade

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This is a much better answer which gives a correct reason.

Question 5 (b) (i)

Many candidates knew the formulae for oxygen and sulfur dioxide and often scored all of the marks. Those who got this question wrong, indicated that oxygen was O (or even O_3) and not O_2 and sulfur dioxide was commonly mistaken as SO_4. Marks were also lost for not using the formulae provided in the question.

(b) Some nickel ores contain nickel sulfide.

(i) In the first stage of extracting nickel from nickel sulfide, the nickel sulfide, NiS, is heated in air to form nickel oxide, NiO, and sulfur dioxide.

Write the balanced equation for this reaction.

(2)

$2 NiS + 5 O_2 \rightarrow 2 NiO + 2 SO_4$

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SO_4 was a surprisingly common formula used for sulfur dioxide.

Question 5 (c)

There was an impressive understanding and description of distillation (or fractional distillation) by candidates with a, significant majority scoring 3. Most had a good appreciation of the key concepts of heating, evaporation and condensing with the idea of a temperature gradient. It was a pity that some did not give the name of the process. Some candidates inappropriately abbreviated answers referring to 'tetracarbonyl'/ 'pentacarbonyl' or 'nickel'/'iron'. Some answers simply stated that nickel tetracarbonyl rose up the column rather than using appropriate terminology such as 'evaporates' and 'condenses'.

(c) In a different method of obtaining nickel, the process produces a mixture of the liquids nickel tetracarbonyl and iron pentacarbonyl.

The boiling point of nickel tetracarbonyl is 43 °C.
The boiling point of iron pentacarbonyl is 103 °C.
These two liquids mix together completely.

Describe the process used to separate these two liquids.

(3)

The process is distillation. You would heat up the mixture (which is in a flask). The flask would be connected to a condensing tube and another empty flask. As the two liquids have different boiling points, they would not evaporate at the same temperature. Therefore, as it has a lower boiling point, the nickel tetracarbonyl would evaporate first and then condense into the other flask. This seperates the mixtures as iron pentacarbonyl is left in the other flask, and the two liquids are seperate.

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This answer:

- gives the name of the process

- gives a brief description of how it works

- explains why the nickel tetracarbonyl is separated

Whilst it is not perfect, it covers the main points and uses the data provided in the question.

Question 6 (a)

This question differentiated between those that understood the concept of a reversible reaction and that of a system in equilibrium. The most common mark was awarded for heating the hydrated salt, although sometimes entirely inappropriate apparatus was used. The other more common marks were for giving correct colour changes, as evidence for the changes, but the least common mark was for stating that water needed to be added to the anhydrous salt. A common error was that candidates thought that cooling down the heated anhydrous copper sulfate (but without adding any water) would cause the reaction to reverse.

Candidates who failed to score high marks tended to describe dynamic equilibria and focus on "closed system" in their responses and experiments relying on the efforts of Monsieur Le Chatelier (raising and lowering temperature, altering pressure), without considering a simple, practical lab experiment. Others did not seem to read the question at all and described making copper sulfate crystals.

Candidates are advised to read a question such as this very carefully but also to think about the observations which would prove the anhydrous and hydrated copper sulfate are present.

6 (a) Hydrated copper sulfate, $CuSO_4.5H_2O$, is a blue solid.
Anhydrous copper sulfate, $CuSO_4$, is a white solid.

Heat energy is needed to convert hydrated copper sulfate to anhydrous copper sulfate. This is a reversible reaction.

$$CuSO_4.5H_2O \rightleftharpoons CuSO_4 + 5H_2O$$

Devise an experiment to show that this is a reversible reaction.

(4)

The copper sulfate is heated with a bunsen burner to make anhydrous copper sulfate, which is white. If the anhydrous copper sulfate is then frozen, ~~the~~ it should return to a blue solid. Change of temperature changes the colour but not the states of matter.

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This response illustrates a misunderstanding that just changing the temperature will reverse this reaction, without the necessary addition of water.

6 (a) Hydrated copper sulfate, $CuSO_4.5H_2O$, is a blue solid.
Anhydrous copper sulfate, $CuSO_4$, is a white solid.

Heat energy is needed to convert hydrated copper sulfate to anhydrous copper sulfate. This is a reversible reaction.

exothermic

$$CuSO_4.5H_2O \rightleftharpoons CuSO_4 + 5H_2O$$

endothermic

Devise an experiment to show that this is a reversible reaction.

(4)

• CuSO4. 5H2O will be heated in a closed system
• Once the reaction ~~[illegible]~~ - requires heat energy meaning ~~[illegible]~~ the forward reaction is ~~[illegible]~~ exothermic
• Once the reaction has taken place completely, decrease the temperature
• This will be in favour of the left hand side reaction as it's endothermic
• Rate of reaction on the right will increase and on the left will decrease and the reaction should be reversed

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This candidate has incorrectly tried to apply principles of equilibria. It is not in any case the description of an experiment - something candidates could carry out in a laboratory.

Question 6 (b)

The responses to this question showed that the difficult concept of a dynamic equilibrium was not well understood. A very large number of candidates ignored the equilibrium, and suggested the reaction of iodine and hydrogen went to completion, resulting in 100% colourless product. Only a few grasped that there would be some iodine remaining, so that the colour would be less purple/ paler / lighter. Some thought that the colour would oscillate between purple and colourless.

(b) Hydrogen reacts with iodine to form hydrogen iodide.
Iodine gas is purple and hydrogen iodide gas is colourless.

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$$

Hydrogen and iodine are placed in a sealed container.
The container is left until equilibrium is reached.

The conditions are changed favouring the forward reaction.

Explain what you would **see**.

(2)

You wouldn't see anything as the gas produced would be hydrogen iodide gas and therefore colourless.

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This illustrates a common misconception about a reaction at equilibrium.

Question 6 (c)

The use of the Avogadro constant was weak. Common incorrect answers here just gave the Avogadro constant or multiplied it by the relative formula mass of copper iodide.

Question 7 (b) (i)

Most candidates scored at least 1 mark for the resistance to corrosion/rusting of stainless steel, but then did not explain specifically that therefore stainless steel rods would not change if used in the experiment so there would be no results. (They did not clearly link their answer to the part of the question '....in **this** experiment'). Some made the correct conclusion that the experiment would be pointless but did not explain why. Some candidates felt that the mixture of elements in stainless steel would interfere with the experiment.

(b) An experiment is carried out to see if magnesium ribbon wrapped around a piece of iron rod has an effect on the rate at which the iron rod rusts.

The apparatus is shown in Figure 4.

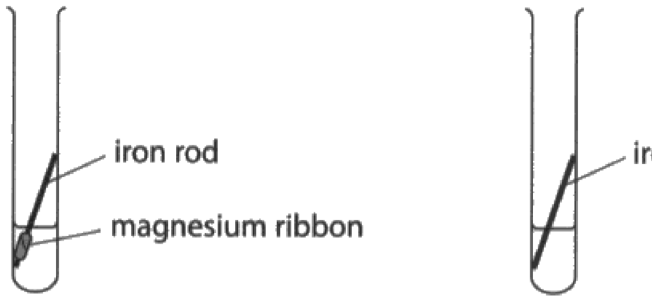

Figure 4

The method used is

- an iron rod, with magnesium ribbon wrapped around it, is placed in a boiling tube labelled **A**
- 10 cm^3 water from a measuring cylinder is poured into this boiling tube
- an identical rod but with no magnesium ribbon wrapped around it is placed in a second boiling tube labelled **B**
- 10 cm^3 water from a measuring cylinder is poured into this boiling tube.

Both boiling tubes are left for a few days.

(i) Explain why iron rod rather than stainless steel rod is used in this experiment.

(2)

~~Stainel~~ Stainless steel does not rust. This would mean that it could not be told if magnesium has an effect on rusting or not because Stainless Steel does not rust. Iron however does rust. The iron with the magnesium ribbon can be compared to the iron without the magnesium ribbon.

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This candidate has fully understood the question, and why the fact that stainless steel will not rust would make this experiment of no use.

Question 7 (b) (ii)

Many candidates got the idea that accuracy wasn't required in this experiment. Some candidates were clearly unaware of a volumetric pipette, mistaking it for a dropping pipette ('pipettes give too small a volume'). A few said that it was because 'a measuring cylinder was used' or that 'a measuring cylinder was more accurate'.

measuring cylinder

(ii) State why it is not necessary to use a pipette to measure out $10\,cm^3$ water in this experiment.

(1)

A pipette couldn't measure $10cm^3$ as it is too small.

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A misunderstading between a dropping pipette and a volumetric pipette.

Question 7 (b) (iii)

The fact that magnesium reacted in tube A very often scored, although many candidates failed to refer to the fact the magnesium was more reactive than iron as an explanation. Some just stated 'sacrificial protection' with no further explanation of what this meant or just said that magnesium 'protected the iron from rusting' without explaining how. Some candidates thought that the magnesium simply blocked that water from getting to the iron nail. These candidates often failed to recognise that the magnesium was reacting. Some got it muddled with a coating of magnesium giving protection, referring to "galvanising".

(iii) After a few days the two boiling tubes were examined.

The results are shown in Figure 5.

boiling tube A	the appearance of the iron rod is unchanged the magnesium has started to disappear
boiling tube B	a small amount of brown deposit has formed around the rod

Figure 5

Explain the results of this experiment.

(2)

The iron rod in boiling tube A hasn't ~~re~~ rusted as the magnesium acted as sacrificial protection (it reacted ~~in place~~ first with the water and air because it's more reactive than iron). Where as the iron rod in B rusted because there was nothing protecting it.

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This candidate has used the term 'sacrificial protection', but importantly has explained what that means in this experiment.

Question 7 (c)

Some really good answers were given here. However, the unfamiliarity of hydrazine caused some candidates difficulty despite the information provided. Some suggested that **water** was used up by hydrazine (therefore there was no rusting) and some thought nitrogen inhibited corrosion (a sort of protective layer). A few wrote about hydrazine corroded instead, perhaps thinking that hydrazine is a metal. The second mark was often lost because the decrease in oxygen amount was not clearly linked to the fact that oxygen was needed for corrosion. Candidates are advised that just reproducing the stem of the question: 'hydrazine reacts with oxygen' or 'hydrazine slows corrosion' will not score without further explanation.

Question 7 (d) (ii)

Most answers here were correct. However, some did not answer the question and talked about yield. A few thought that a catalyst slowed down the rate.

Question 7 (d) (iii)

This question was answered correctly by many candidates with most of the remainder thinking that yield would be increased. Others talked about the rate of attainment of equilibrium.

Question 8 (a)

Many candidates here described the displacement reaction but not what they would see, as required by the question. Many gave no description of either metal (just naming them) even though they understood the reaction. The blue solution turns colourless was most common mark scored. Less successful answers described the solution as clear, described the formation of a blue precipitate or talked about 'bubbles' or 'fizzing'.

8 Pieces of zinc react with copper sulfate solution.
Zinc sulfate solution is colourless.

$$Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$$

(a) Describe what you would **see** when an excess of zinc is added to copper sulfate solution and the mixture left until the reaction is complete.

(2)

the copper sulphate solution would be blue,
but adding zinc would make it go colourless,
and the copper to be released as brown flakes

ResultsPlus
Examiner Comments

This is a good answer because it describes the colour change seen in the solution, and describes the copper formed as 'brown flakes'. In other words, it gives descriptions of what is seen - not just chemical names for the substances.

Question 8 (b)

Many candidates answered this question very well and gaining 4 marks. Others gained 2 marks for correctly assigning oxidation to zinc and reduction to copper ions, but then failed to describe electron loss/gain correctly. OILRIG often appeared and was used well. It was pleasing that there were quite a number of correct half equations.

Common errors included:

- SO_4^{2-}stated to b be gaining and/or losing elections
- Copper sulfate being reduced
- Sulfur itself being cited as giving/receiving electrons
- Cu^{2+} being oxidized to Cu^{3+}
- Zn being reduced
- OILRIG quoted without any elaboration
- Explaining the redox in terms of oxygen gain/loss

Question 8 (c)

Whilst many candidates did achieve full marks, the concept of the mole and molar solutions not fully grasped by many. Most candidates showed full working, therefore increasing the possibility of part marks where an error had occurred. Where candidates scored less than full marks, most managed to calculate the mass of copper sulfate and/or Mr of copper sulfate, therefore scoring 1 or 2 marks for partial completion of the response. Common errors included 159.5/15.95, not dividing the volume by 1000, or dividing 15.95 by 50.

Question 8 (d)

This was mainly worked out correctly but it was disappointing that some candidates lost a mark by failing to give the answer to one decimal place. Another error was to use an Mr of 159.5 rather than 65.

(d) In another experiment, 0.043 mol of copper sulfate, $CuSO_4$, is used.

Calculate, to one decimal place, the minimum mass of zinc that must be added to react with all the copper sulfate.
(relative atomic mass: Zn = 65)

(2)

g / mr | mol   65 × 0.043 = 2.795.

mass = 2.795 g

ResultsPlus
Examiner Comments

The answer is correctly calculated, but has not been rounded to one decimal place.

Question 9 (a) (i)

Most candidates achieved a mark with pH probe/meter, or universal indicator and about even. Some could not give the correct name of the apparatus and gave ‘electronic pH reader’ or similar. A few listed multiple indicators or used litmus paper, phenolphthalein or methyl orange.

Question 9 (b) (i)

This part was answered well by most. Equipment to measure volume was well known. It was a little less common to name a balance for the base, with some incorrect responses mentioning pipette or burette, thinking that the base was a liquid.

Question 9 (b) (ii)

Candidates must learn the colours of indicators - many had not.

Question 9 (b) (iii)

A good number of answers explained the increase in pH being due to more OH^- ions or fewer H^+ ions, but a smaller proportion referred to the H^+ ions reacting (with OH^- ions) or being neutralised. A number said there was an excess of OH^- and gave the impression that there was still the same number of H^+ as at the start but they were outnumbered by the hydroxide ions indication a lack of knowledge that neutralisation was taking place. Some did not use ‘ions’ but referred to hydrogen atoms or particles.

Question 9 (c)

The vast majority of candidates identified with a reason magnesium, usually from its colour, and sodium hydroxide, using from the pH of the solution. However, a very significant number mixed up copper oxide and copper carbonate. Those that answered fully could identify copper oxide because it reacts with sulfuric acid to form blue copper sulfate solution and water, but unlike the carbonate no carbon dioxide is produced, and similarly giving the correct identification of the carbonate using its production of carbon dioxide, when explaining the effervescence in acid.

Other high scoring answers, where candidates were able to identify all four solids, recognised the colour of each substance. Magnesium was often recognised by the formation of bubbles in water and less often through the formation of hydrogen gas in acid when effervescence takes place.

Some candidates failed to read the question properly and did not realise that they had been given the names of the solids.

*(c) Some properties of four solids, **A**, **B**, **C** and **D**, are shown in Figure 6.

The solids, in no particular order, are copper carbonate, copper oxide, magnesium metal and sodium hydroxide.

	A	B	C	D
colour of solid	black	silver	white	green
observation when solid is added to water	black solid remains	a few bubbles appear on surface of solid	solid dissolves and forms colourless solution	green solid remains
pH of mixture of solid added to water	7	8	13	7
observation when solid is added to dilute sulfuric acid	on warming, solid disappears to form blue solution	effervescence solid disappears to form colourless solution	solid disappears to form colourless solution	effervescence solid disappears to form blue solution

Figure 6

Identify the solids **A**, **B**, **C** and **D**, explaining how the information in Figure 6 supports the identification of each solid.

(6)

Magnesium metal is B. This is because it is silver in colour when magnesium is. It also reacts with water and acid when only magnesium and metals above in the reactivity series can do. It reacts with them but only slowly and not violently. Sodium hydroxide is C. This is because it has a very high pH of 13 and all hydroxides are alkali. Sodium metal is also white, metals hydroxides for a salt when reacting with water and they dissolves leaving the solution colourless.

Copper oxide is A. This is because it is black when it is solid and it is insoluble in water as oxides are insoluble. When it reacts with the sulfuric acid it produces blue copper sulfate solution. Copper carbonate is D. As it is always a green solid and it remains solid when with water as nearly all carbonates are insoluble in water. It also forms copper sulfate which is a blue solution. The effervescence for copper oxide is the oxygen being released while for the copper carbonate it is the carbon dioxide being given off.

ResultsPlus

Examiner Comments

There are some errors in this answer, but the candidate has made a good attempt to use the data to identify the four solids. This achieved Level 3.

*(c) Some properties of four solids, **A**, **B**, **C** and **D**, are shown in Figure 6.

The solids, in no particular order, are copper carbonate, copper oxide, magnesium metal and sodium hydroxide.

	A (copper oxide)	B (sodium hydroxide)	C (magnesium)	D (copper carbonate)
colour of solid	black	silver	white	green
observation when solid is added to water	black solid remains	a few bubbles appear on surface of solid	solid dissolves and forms colourless solution	green solid remains
pH of mixture of solid added to water	7	8	13	7
observation when solid is added to dilute sulfuric acid	on warming, solid disappears to form blue solution	effervescence solid disappears to form colourless solution	solid disappears to form colourless solution	effervescence solid disappears to form blue solution

Figure 6

Identify the solids **A**, **B**, **C** and **D**, explaining how the information in Figure 6 supports the identification of each solid.

(6)

Solid C is magnesium ~~as~~ because solid C has the characteristics of a pure metal like magnesium. It dissolves in water and magnesium is a very reactive metal that reacts violently with water. Solid A is copper oxide because it doesn't react with water which is understandable as copper is a metal with low reactivity, which is a bit resistant to oxidation and water. Also it ~~forms blue solution and~~ dissapears in sulfuric acid ~~does~~ and forms a blue solution known as copper sulfate hences it's copper oxide

Solid B is sodium hydroxide because it reacts a bit with water forming bubbles as expected by sodium. and it disappears in sulfuric acid. Solid D is ~~copper~~ copper carbonate as it ~~also~~ unreactive with water as copper is a metal with low reactivity and it dissapears in sulfuric acid to form copper sulfate.

ResultsPlus
Examiner Comments

In this answer, only two of the solids are identiifed. Unfortuantely, the reasons given, which whilst partially correct, are not enough to uniquely identify the substances. [Both copper oxide and copper carbonate react with acid; the answer does not state that only the carbonate effervesces]. This is a Level 1 answer.

Question 10 (a) (i)

Most candidates got this right, but 'redox' was a common incorrect answer.

Question 10 (b)

There was a wide variation in responses on this question, but relatively few scored the full 4 marks. Most candidates were able to show that 2 moles of NO has a mass of 60g and many converted this to 16.67 moles of oxygen and scored at least two marks. Only a minority then went on to multiply this by 24 and then 100/20 to arrive at the correct answer of 2000 dm^3. Others scored the latter two marks after making an initial error that was only penalised once. However a significant number of candidates found this question difficult to understand and often divided by 24 or 5 when they should have used multiplication. Answers that were poorly laid out with little in the way of order or annotation made it difficult to follow candidates' logic and to award part marks where the final answer was incorrect.

(b) In one stage of the production of nitric acid, nitrogen oxide, NO, is reacted with oxygen to make nitrogen dioxide, NO_2.

$$2NO + O_2 \rightarrow 2NO_2$$

Calculate the minimum volume of air, measured at room temperature and pressure, required to react with 1000 g nitrogen oxide to form nitrogen dioxide.

Assume that the air contains 20% oxygen by volume.
(relative atomic masses: N = 14, O = 16
1 mol of gas occupies 24 dm^3 at room temperature and pressure) moles × 24

(4)

$2NO + O_2 \rightarrow 2NO_2$

$\frac{1000g}{60} = 16.\dot{6}$ mol

$\frac{16.\dot{6}}{2} = 8.\dot{3}$ mol oxygen

$8.\dot{3} \times 24 = 200$ dm^3

$\frac{200}{20\%} = 0.2$ $\quad 200 \times 5 = 1000$ dm^3 air

volume of air = 1000 dm^3

ResultsPlus
Examiner Comments

This candidate understands the way through the calculation but unfortunately has incorrectly calulated the moles of NO, so scored 3 marks.

Question 10 (c)

Most candidates attempted this question and discussed at least two factors, with excess air being the most common to leave out of discussion. Marks were generally gained from reference to the effects of pressure and temperature on rate of attainment of equilibrium. The effects of pressure and temperature on yield were given less often and were generally poorer quality responses. Quite a few candidates misidentified that increasing pressure or concentration of reactants 'increases energy of the particles'.

It was surpisingly common to see 10 atm as a decrease in pressure, many candidates seemingly unaware that normal atmospheric pressure is 1 atm. Many candidates just wrote what they had memorised regarding the Haber process. Some candidates compared the conditions in the Haber process to 10 atm pressure and a temperature of 900°C, disregarding the wording of the question.

The least successfully answered section of the question was explaining how excess air affects both rate and equilibrium. Candidates usually understood that extra air would increase yield but were unaware that excess air increased the concentration of oxygen

The poorest answers failed to appreciate that excess air in fact meant excess oxygen, suggested that nitrogen (in the air) was present to be converted into NH_3, NO or HNO_3, or that temperature, excess air and high pressure were 'catalysts'.

Candidates that were most clear structured their work very well, breaking down their answer into paragraphs under 3 headings of air, pressure and temperature, with each explaining rate and separately yield. Those that were not produced answers that were muddled and erratic.

*(c) In another stage in the production of nitric acid, ammonia is reacted with oxygen to form nitrogen oxide and water.

9 exo → 10

$$4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g)$$

← endo

exothermic

Heat energy is given out when ammonia reacts with oxygen.

The conditions chosen for the reaction are

- excess air, rather than just the right amount
- a pressure of 10 atm, rather than atmospheric pressure
- a temperature of 900 °C, rather than room temperature.

Explain the effect of the conditions chosen on the equilibrium yield of nitrogen oxide and on the rate of attainment of equilibrium.

(6)

High pressure (10atm) ~~Pressure~~ causes the equilibrium to move to the ~~fewest~~ side with fewest moles. The left side has 9 moles whilst the right side has 10 moles. This means that the yeild of nitrogen oxide would decrease as the equilibrium shifts to the left. ~~This de~~

Increasing pressure also increases the rate of attainment because the ~~par~~ gas molecules are closer together, and therefore ~~hae~~ have a higher frequency of collisions, so therefore have a higher rate of reaction.

High temperature (900°C) causes the equilibrium to shift to the endothermic side in order to ~~reduce~~ absorb the heat produced. Since "heat energy is given out when ammonia reacts with oxygen", the ~~equilibrium~~ ~~to~~ equilibrium would shift to the left, ~~so~~ as it is endothermic, and ~~there~~ therefore decrease the

yeild of ~~nitrous~~ nitrogen oxide.
Increasing temperature increases the rate of attaintment because the gas particles collide with greater kinetic energy and as a result the chance of successful collisions with ~~the~~ ~~so~~ enough activation energy ~~incr~~ increases, therefore increasing the rate of reaction.

ResultsPlus
Examiner Comments

This is a very well written answer showing excellent understanding. Sadly, it did not address the factor of excess air, so only achieved Level 2. It is essential to answer the whole question.

*(c) In another stage in the production of nitric acid, ammonia is reacted with oxygen to form nitrogen oxide and water.

ammonia + oxygen.

$$4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g)$$

~~nitric acid ammonia~~ ⇌ nitrogen oxide + water.

Heat energy is given out when ammonia reacts with oxygen. — forward reaction is exothermic

The conditions chosen for the reaction are
- excess air, rather than just the right amount
- a pressure of 10 atm, rather than atmospheric pressure
- a temperature of 900 °C, rather than room temperature.

Explain the effect of the conditions chosen on the equilibrium yield of nitrogen oxide and on the rate of attainment of equilibrium.

(6)

Because the reaction is happening at 900°C equilibrium is reached faster because the particles have more energy ~~be~~ due to the thermal energy provided therefore it has the right activation energy to react causing the rate of reaction to be faster and also collide more frequently. However because the forward reaction is exothermic the equilibrium will move to the left to counteract this change as ~~the~~ the backwards reaction is endothermic. Excess air is provided so there are more reactants than products causing the equilibrium to shift more to the right therefore more yield will be produced to use up the excess ~~air~~ oxygen supplied. The pressure of 10 atm ~~means that~~ effects the yield achieved because that means it is a higher pressure but not so much that it would move the equilibrium a more to the left with less particles made, but it would slightly shift in that direction. However an increased pressure means equilibrium will also be attained at a faster rate as the particles have an increase chance of colliding reaching together therefore increasing the rate of reaction so equilibrium is reached sooner.

ResultsPlus
Examiner Comments

A fully comprehensive answer addressing all of the factors for Level 3.

Paper Summary

Based on their performance in this paper, students should:

- Know how to distinguish between 'describe' and 'explain' questions
- Practice using the Avogadro constant
- Learn about the benefits of phytoextraction
- Consider and practice how to describe simple laboratory experiments
- Review their understanding of dynamic equilibria and the species present at equilibrium
- Practise, using past paper questions, describing the observations seen in an experiment
- Learn the acid and alkali colours of indicators

Grade Boundaries

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

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