PEARSON EDEXCEL GCSE CHEMISTRY · 1CH0

CHEMISTRY



MARK SCHEME

TOPIC 5: SEPARATE CHEMISTRY 1 (PACK 2)

SCORE	PERCENTAGE
/207	%

STEMUP

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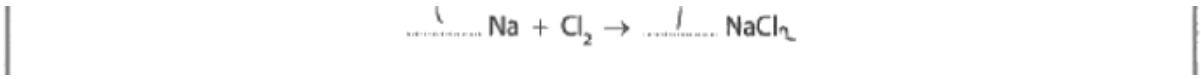
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Q1.

(a)(i)

The majority of candidates were able to balance the equation. A common error was to put 2 in front of Na and 4 in front of NaCl. It was surprising to see some candidates using negative numbers in the equation. A few candidates put formulae or state symbols on the dotted lines instead of balancing numbers. Some candidates changed the formulae to balance the equation.

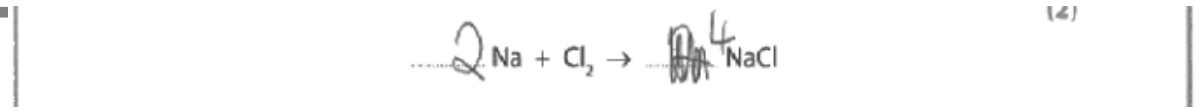


Results Plus: Examiner Comments

This candidate has changed the formula of sodium chloride to $NaCl_2$. If you are given an equation to balance, the formulae will always be correct and you need to balance the equation by putting numbers in front of the formulae in the spaces provided. This answer did not score any marks.

Results Plus: Examiner Tip

Do not change any formulae you are given in a question to balance an equation.

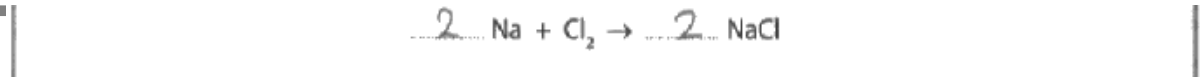


Results Plus: Examiner Comments

This candidate has the first balancing number correct, so scores 1 mark.

Results Plus: Examiner Tip

Count up the number of atoms on the left side of the equation first. There are 2 sodium atoms and 2 chlorine atoms. The number of atoms on the right of the equation must be the same as on the left. The equation is balanced by writing a 2 in front of NaCl.

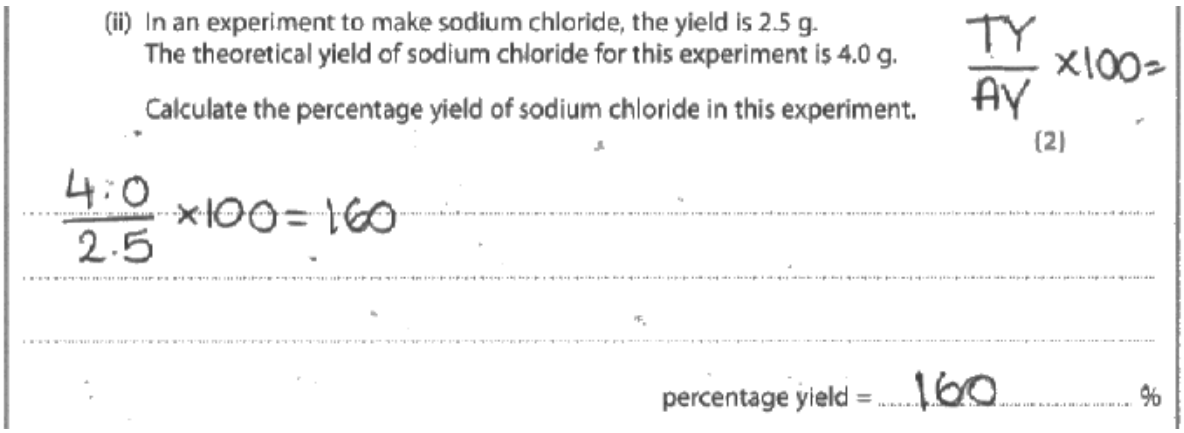


Results Plus: Examiner Comments

This is an example of a correct answer that scored 2 marks.

(a)(ii)

Many candidates were able to calculate the percentage yield. Some candidates divided 4.0 by 2.5 then multiplied by 100 to get a yield of 160%. They should realise that the yield cannot be higher than 100%. Candidates should show their working for calculations so that they have the opportunity to gain a consequential error mark if they have the final answer wrong.


(ii) In an experiment to make sodium chloride, the yield is 2.5 g.
The theoretical yield of sodium chloride for this experiment is 4.0 g.

Calculate the percentage yield of sodium chloride in this experiment.

$\frac{TY}{AY} \times 100 =$

(2)

$\frac{4.0}{2.5} \times 100 = 160$

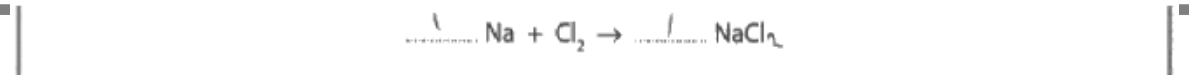
percentage yield = 160 %

Results Plus: Examiner Comments

This answer is incorrect, but it scored 1 mark for some correct working. The first step is wrong as the candidate should have divided 2.5 by 4.0. The candidate has then shown their fraction multiplied by 100 to obtain the percentage and they score a consequential mark.

Results Plus: Examiner Tip

Always show your working for calculations.

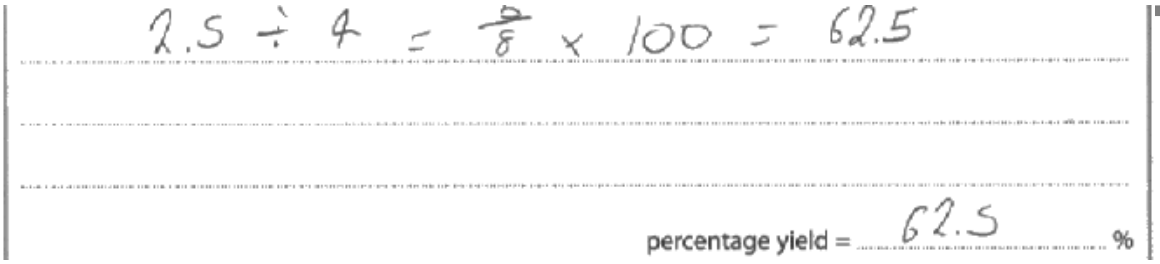

$___ Na + Cl_2 \rightarrow ___ NaCl$

Results Plus: Examiner Comments

This is an incorrect answer and it scored no marks. If some working had been shown, it might have scored 1 mark for correct working, even if the final answer is wrong.

Results Plus: Examiner Tip

Show your working for all calculations.

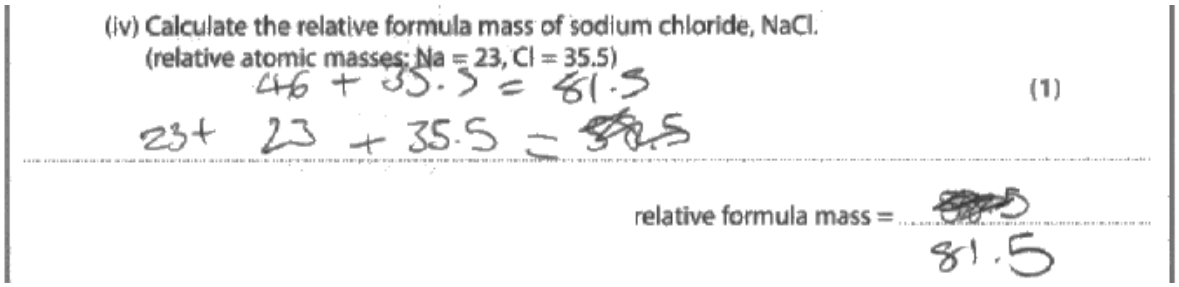


Results Plus: Examiner Comments

This is a very good answer, showing the correct working and answer. This scored 2 marks.

(a)(iv)

The majority of candidates could work out the relative formula mass for sodium chloride. Some candidates multiplied the relative atomic masses and a few subtracted or divided them.



Results Plus: Examiner Comments

This candidate has assumed the formula for sodium chloride is Na_2Cl as they have added the relative atomic mass of two sodium atoms to one chlorine atom. This did not score the mark.

Results Plus: Examiner Tip

Use the formula given in the question. NaCl contains one sodium and one chlorine atom.

23+35.5 = 58.5

relative formula mass = 58.5

Results Plus: Examiner Comments

This is an example of a correct answer, with the working shown. This scores 1 mark.

(b)

Many candidates were able to calculate the percentage of magnesium in magnesium sulfate.

Some candidates tried to calculate the relative formula mass for magnesium sulfate and got a different answer to the value given in the question.

$\frac{16+24+32}{120} \times 100 = 66.66$

percentage of magnesium = 66.66666667 %

Results Plus: Examiner Comments

This candidate has got the first step of the calculation wrong as they should have just divided the mass of magnesium (24) by 120. However, they have then multiplied their fraction by 100, so they score 1 mark.

Results Plus: Examiner Tip

Show your working in calculations.

$\frac{24}{120} \times 100 = 20\%$

percentage of magnesium = 20 %

Results Plus: Examiner Comments

This candidate has given correct working and has the correct answer so was awarded 2 marks.

(c)(i)

Very few candidates understood the term 'empirical formula', so they were unable to score a mark for this question. A common incorrect answer was CH_8.



Results Plus: Examiner Comments

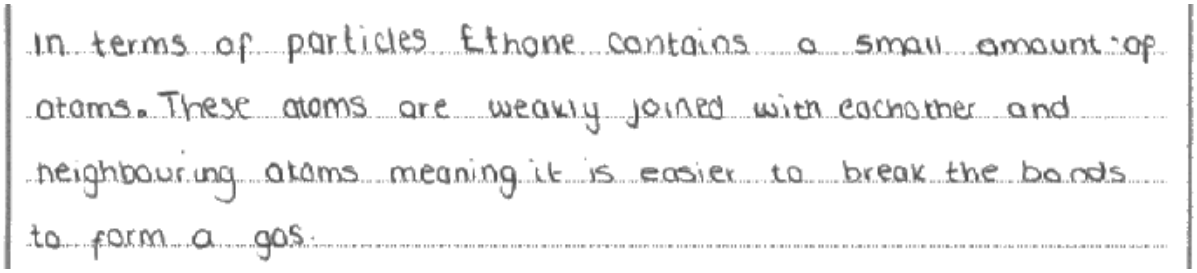
This candidate has correctly worked out that the simplest ratio of carbon to hydrogen is 1:3, but they did not score a mark as the question asked for the empirical formula.

The empirical formula shows the simplest whole number ratio of atoms in the formula. The correct empirical formula for ethane is CH_3.

(c)(ii)

This question was designed to be answered correctly by the candidates working at the top end of the grade range for this paper and it achieved that aim. The concept of weak intermolecular forces between molecules was only given by the more able candidates. Many candidates wrote about the weak bonds between the atoms but a large number did not refer to bonds at all and wrote about few particles that are far apart in a gas.

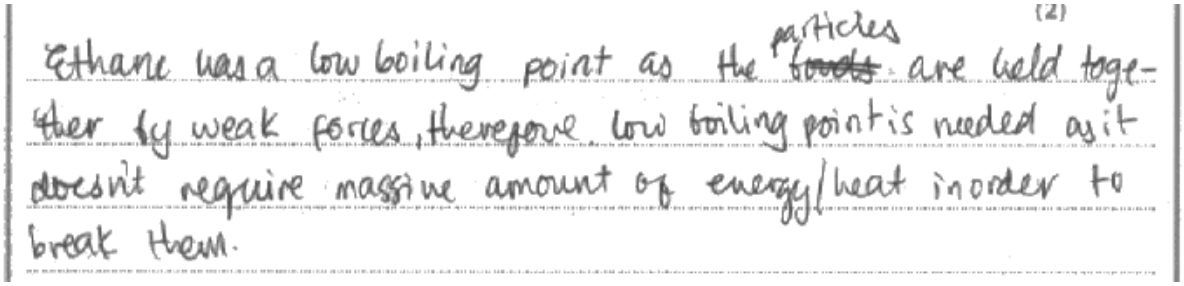
Examiners were surprised to see some candidates writing about hydrogen bonds. There are no hydrogen bonds between ethane molecules and we would not expect candidates to know about specific intermolecular forces at GCSE.



Results Plus: Examiner Comments

This answer did not score a mark as it referred to the bonds between atoms being weak.

The bonds between atoms are strong but the forces between molecules are weak.



Results Plus: Examiner Comments

This is an excellent answer that scored 2 marks.

Results Plus: Examiner Tip

Try to remember that the covalent bonds that hold the atoms together in molecules are strong. There are just weak forces between the molecules.

Q2.

The performance of candidates, in general, for this question was not as good as that for Q08c as the ideas of equilibrium tend to be harder for some to explain. Even so, the number scoring 0 was still quite small, showing that for the overall majority this question was still quite accessible.

Most candidates treated each change of condition in turn to justify why the set of conditions B would be used. Many were able to explain in good depth the effect on the equilibrium yield and the rate of attainment of equilibrium for each condition considered and these answers resulted in a deserved level 3 mark.

For the weaker candidates, some answers could not be credited because of a lack of explanation of correctly quoted changes of condition. There was confusion between the effect of rate and equilibrium position. Many failed to explain the effect of the catalyst effectively, simply stating that it would not be used up. The weaker candidates tended to focus on the cost of producing a temperature of 425 oC instead of 680 oC.

Explain, by considering the effect of changing the conditions on the rate of attainment of equilibrium and on the equilibrium yield of sulfur trioxide, why the manufacturer chooses the set of conditions B rather than the set of conditions A.

(6)

As a manufacturer the person needs to take into account cost when mass producing this chemical. Upholding the temperature in condition A will increase the yield of the sulfur trioxide due to the forward reaction being exothermic. However upholding that temperature is far more costly than the temperature of condition B. A laboratory might use condition A as it doesn't use a catalyst, this is important for accuracy in order to avoid any contamination or by-products. A manufacturer however is more concerned about producing the chemical faster and so will use a catalyst in order to achieve the same yield that it could achieve if they increased the temperature which would be too costly for the manufacturer. B allows the same efficiency as A but at a lower cost.

Results Plus: Examiner Comments

Level 1 - 1 mark
This candidate discussed cost and this was not creditworthy.
It was confused about the effect of higher temperature, incorrectly stating that it will give higher equilibrium yield.
It showed that a catalyst would increase the speed of the reaction and this was creditworthy but they did not appreciate that this would be in both directions and so only 1 mark was awarded.
Had the candidate mentioned the catalyst speeded up the reaction in both directions (only), then this would have been worth 2 marks at the upper end of Level 1.

Explain, by considering the effect of changing the conditions on the rate of attainment of equilibrium and on the equilibrium yield of sulfur trioxide, why the manufacturer chooses the set of conditions B rather than the set of conditions A.

(6)

Set of conditions A has a lower pressure than set B therefore there will be a lower yield because ~~on a higher~~ a higher pressure shifts equilibrium to the ~~least~~ side with fewer molecules (in the direction of the forwards reaction). The temperature used in conditions A is higher than the temperature in conditions B, therefore to counteract the increase in the temperature, equilibrium will shift in the ~~direction~~ endothermic direction - ~~towards the~~ produces more reactants - decreasing yield but increasing the rate of reaction. To compensate for the lower temperature, set of conditions B includes a catalyst, this means that ~~a decrease~~ the rate of reaction will increase without the need to increase temperature and decrease yield, the catalyst will not affect the yield directly. Due to all of this, set of conditions B was chose rather than conditions A because a higher pressure increases rate of reaction and yield and a lower temperature increases the yield but decreases ~~the~~ rate of reaction, however this is counterbalanced by the use of a catalyst which increases the rate of reaction and therefore indirectly increases yield.

Results Plus: Examiner Comments

Level 3 -6 marks
This candidate correctly discussed the effect of pressure, temperature and catalyst on the rate of reaction and the equilibrium yield. Although rate of attainment of equilibrium had not been mentioned, the effect of rate of reaction had been discussed in addition to the effect on (equilibrium) yield for temperature, pressure and catalyst. Overall this was a good answer and fell into the Level 3 category. Note: Not all indicative points need to be included for a Level 3 mark.

Results Plus: Examiner Tip

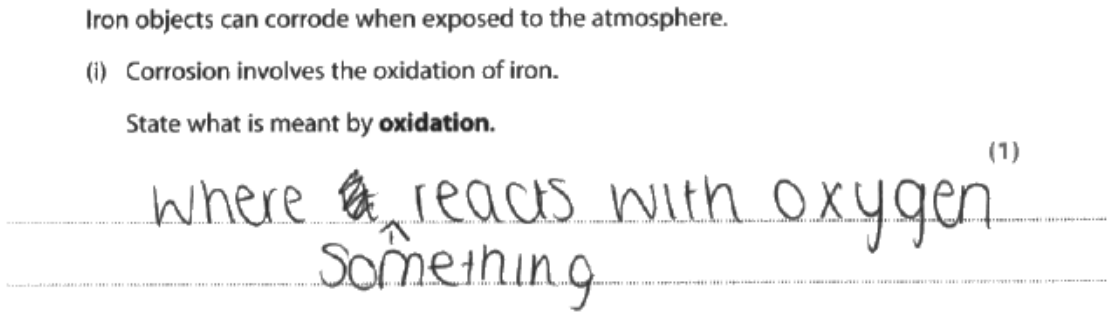
Practice answering these 6-mark answer - there are plenty in the past papers for the previous specification.

Q3.

(i)

Candidates found it quite hard to recall what is meant by the term oxidation.

Where candidates scored the mark was split between those that recalled the simple definition, the gain of oxygen and those that knew that it was the loss of electrons.


Iron objects can corrode when exposed to the atmosphere.

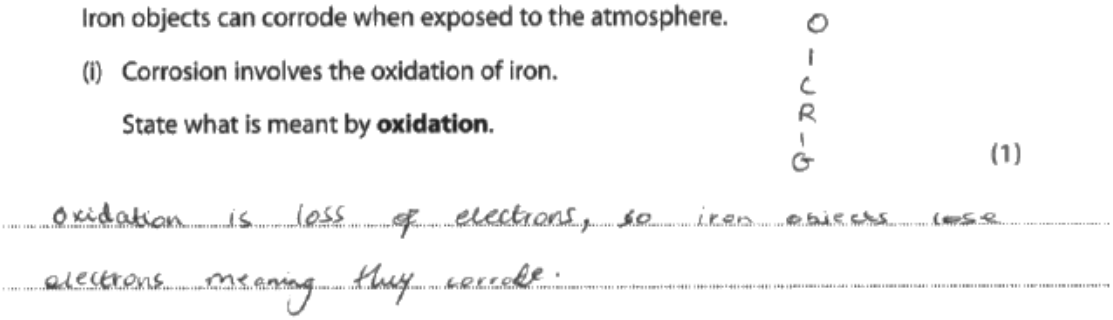
(i) Corrosion involves the oxidation of iron.

State what is meant by **oxidation**. (1)

where ~~it~~ reacts with oxygen something

Results Plus: Examiner Comments

A common answer that did not score was something reacts with oxygen.


Iron objects can corrode when exposed to the atmosphere.

(i) Corrosion involves the oxidation of iron.

State what is meant by **oxidation**. (1)

O I C R I G

oxidation is loss of electrons, so iron atoms lose electrons meaning they corrode.

Results Plus: Examiner Comments

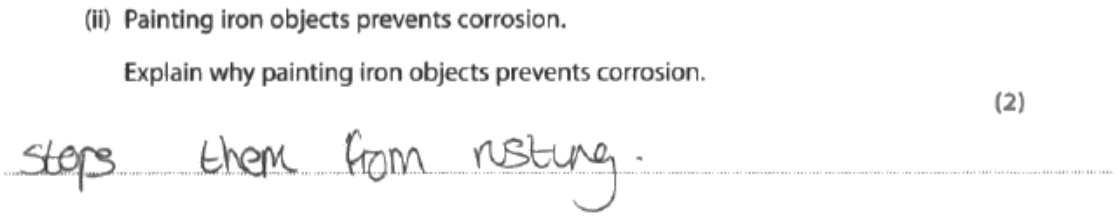
Loss of electrons was a common correct response which was allowed for the mark.

(ii)

Many candidates were able to gain credit on this question as they knew that the paint gives a

protective layer to the iron, many could often explain this this layer excludes air, oxygen or water to help prevent the corrosion.

In some cases, candidates simply restated the stem of the question which did not gain credit.


(ii) Painting iron objects prevents corrosion.

Explain why painting iron objects prevents corrosion.

(2)

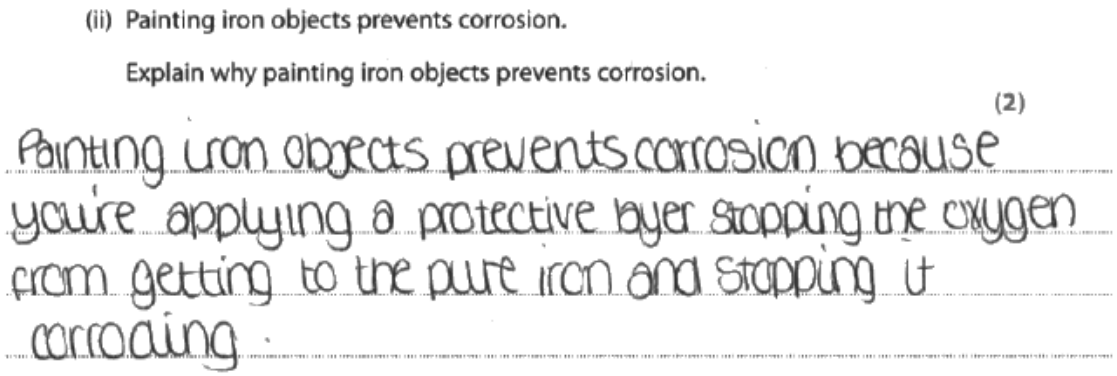
steps them from rusting.

Results Plus: Examiner Comments

Many candidates did not read the question carefully and simply restated that paints stops the objects from rusting rather than answering the question and giving an explaination of why.

Results Plus: Examiner Tip

Candidates should be taught to read the question carefully, taking care to understand what is meant by different command words.


(ii) Painting iron objects prevents corrosion.

Explain why painting iron objects prevents corrosion.

(2)

Painting iron objects prevents corrosion because you're applying a protective layer stopping the oxygen from getting to the pure iron and stopping it corroding.

Results Plus: Examiner Comments

A good answer that scored both marking points.

(iii)

Candidates found stating another way of preventing the corrosion of iron objects difficult. Many restated the stem of the question and stated that the iron should be painted or electroplated. Answers that related to changing the object entirely for example by alloying it were not

accepted.

Those that stated keep the iron out of water or to keep dry did not gain credit.

(iii) Corrosion of iron objects can be prevented by painting them or by electroplating them.

State one **other** way of preventing the corrosion of iron objects.

(1)

Glavnisation

Results Plus: Examiner Comments

A correct answer that scored the mark.

(iii) Corrosion of iron objects can be prevented by painting them or by electroplating them.

State one **other** way of preventing the corrosion of iron objects.

(1)

keeping them dry

Results Plus: Examiner Comments

Those that stated keep the iron out of water or to keep dry did not gain credit.

(iii) Corrosion of iron objects can be prevented by painting them or by electroplating them.

State one **other** way of preventing the corrosion of iron objects.

(1)

moving them into a vacuum where there is no oxygen

Results Plus: Examiner Comments

Impractical methods of stopping rusting were not accepted.

Q4. No Examiner's Report available for this question

Q5.

This extended open-response question showed a wide range in the level of candidate responses seen. Of those responses which scored, invariably they scored only a Level 1 or Level 2, namely 1–4 marks.

This area of the specification, the preparation of crystals of a salt and carrying out a titration, is a frequently tested part of this specification and also of the previous specifications and a Core practical.

Examiners noted that in the majority of the responses seen there was confusion over terminology for key pieces of apparatus, e.g. burette and in the sequencing of steps required. Many candidates simply wrote 'heat the solution with a Bunsen burner' to describe crystallisation. There were a wide range of indicators chosen across the cohort – but in the main they stated the correct colour change for the one they mentioned.

Responses scoring lower level marks, at Level 1, often focused on either the titration or the crystallisation method. In those responses scoring at Level 2, candidates often referred to both the titration and the crystallisation method but not always with complete clarity. In those responses scoring at Level 3, the candidates stated everything required but just missed out repeating without the indicator. This being said, many examiners noted that there were many responses awarded the full 6 marks available – this suggests that they had a clear understanding of the practical procedures involved.

* Ammonia solution and dilute sulfuric acid are used to prepare pure, dry ammonium sulfate crystals.

In an experiment a titration is carried out to determine the volumes of ammonia solution and dilute sulfuric acid that react together.
Then an ammonium sulfate solution is prepared from which the pure, dry crystals are obtained.

Describe in detail, using suitable apparatus, how this experiment should be carried out.

(6)

In order to obtain pure dry crystals you must carry out titration and then crystallisation.

① Make sure you have taken all safety precautions e.g. goggles, hair tied back, gloves etc.

② Using a burette measure out and record the ammonia solution, and add volume entered to beaker along with a few drops of indicator (methyl orange). To

③ Now using a pipette measure how much sulfuric acid you will use.

(4) Using the dial slowly add the Sulpuric acid to the ~~beaker~~ ammonia solution and indicator in the beaker.

(5) Stop when you see a colour change. Methyl orange will turn yellow to red once ammonia solution has been neutralised.

(6) ~~Repeat this pro~~ Record the amount of volume left in pipette.

Ie: Your table should look like this:

Sulphuric acid	Titre 1	Titre 2	Titre 3	Titre 4
Initial vol				
Final vol				
Change in vol				

(7) Repeat the practical at least 3 times.

(8) Once you have all data recorded you must

calculate the mean volume of the ~~a~~ volume of acid added by adding the ~~2 most~~ closest ~~numbers~~ 2 further numbers and dividing by 2. = Mean volume.

(9) Now repeat titration without indicator using mean volume of acid.

(10) Now using crystallisation ~~in~~ filter solution using filter paper then in a petri dish pour mixture of ammonium sulfate and heat until boiling over bunsen burner using tripod, and heat mat and mesh. This will evaporate excess water.

(11) Once brought upto boiling point remove from heat and allow to cool. This is now pure

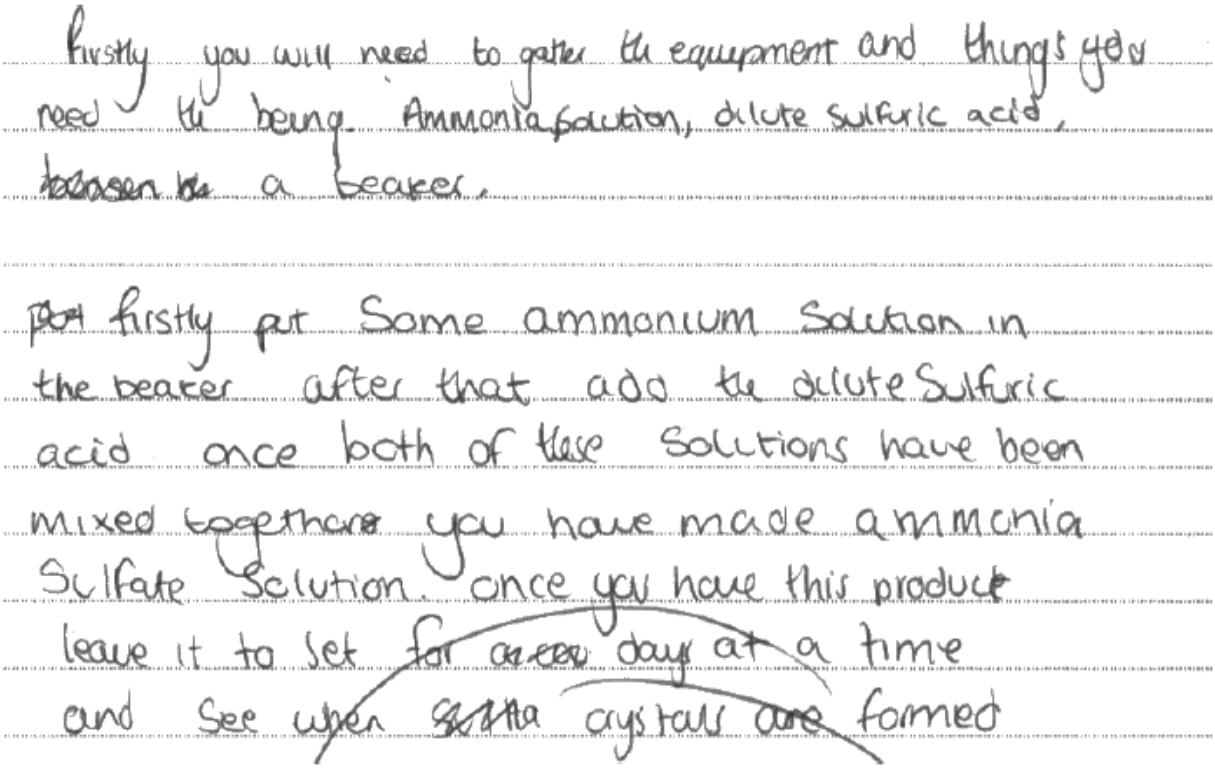
(12) ~~Wash using filter paper. Filter solution~~ Once cooled leave in dry heat e.g: sunlight / oven etc for crystals to form.

Results Plus: Examiner Comments

This response was awarded Level 3 – 6 marks.

The method for the titration is sufficiently developed, although the use of a pipette and a burette are the wrong way round. The method for crystallisation is sufficiently developed. Although filtering is not mentioned, the key process of leaving out the indicator is emphasised. Overall,

this is sufficient for Level 3.


Firstly you will need to gather the equipment and things you need to being Ammonia solution, dilute sulfuric acid, bunsen a beaker.

firstly put Some ammonium Solution in the beaker after that add the dilute Sulfuric acid once both of these Solutions have been mixed together you have made ammonia Sulfate Solution. once you have this product leave it to Set for a few days at a time and See when the crystals are formed

Results Plus: Examiner Comments

This response was awarded Level 1 – 2 marks.

This is a low level response with very little detail, but makes simple statements regarding mixing together the reactants in a beaker and a simple method for crystallisation.

Results Plus: Examiner Tip

This is a frequently asked for procedure. Learn the key steps in the titration and in the production of pure dry crystals.

- Begun by setting up your apparatus consisting of a conical flask, a biruet and a small dish.
- Next put the suggested amount ~~of~~ / volume of ammonia solution into the tube using the biruet. ~~then add the volume of~~ into the conical flask.
- Then wash out the tube with water and add the suggested volume of sulfuric into the tube and stop from flowing into the flask.
- Add small amounts of sulfuric acid to the flask of ammonia solution a bit at a time, then mix.
- There should then be a colour change once the solutions mix.
- pour the mixture into the dish and set up a bunsen burner.
- Heat the mixture until boiling and remove it from the bunsen.

- ~~If~~ Leave the mixture to cool and leave for a few days.
- Finally you should observe ammonium sulfate crystals, the take results.

- When carrying this experiment out, ensure protective clothing and goggles are worn to prevent potential harm.

Results Plus: Examiner Comments

This response was awarded Level 2 – 4 marks.

The method for the titration is described but not well-developed, namely not mentioning the use of the key apparatus or an indicator. There is also a simple description of the crystallisation.

Results Plus: Examiner Tip

This is a frequently asked for procedure. Learn the key steps in a titration, including the apparatus linked to its use, and the key steps in the production of pure dry crystals.

Q6. No Examiner's Report available for this question

Q7. No Examiner's Report available for this question

Q8.

(i) This question was very well answered and almost all candidates scored 2 marks here for stating that the as the percentage of magnesium increased, the strength of the alloy also increased.

(ii) Another well answered question, although again some candidates limited themselves to 1 mark by not reading the question properly and giving the percentage of magnesium from the graph rather than the percentage of aluminium asked for in the question.

Q9.

This question was not well answered on the whole with the majority of responses not scoring the 2 marks available.

Very few candidates scored both marks for two correct observations, namely that 'a colourless solution forms', 'a solid forms' or 'magnesium disappears'.

It was clear that few candidates could recall the observations of commonly asked for displacement reactions.

The most commonly seen responses scoring 1 mark only simply referred to 'turns colourless'.

The most common misconception was that 'fizzing or bubbling' or that 'colour change' would be seen. Many responses recognised that copper would be formed, given in the stem of the question, but did not state 'solid' forms as the observation.

Copper is a transition metal.

Magnesium reacts with copper sulfate solution to form copper and a solution of magnesium sulfate.
Magnesium sulfate solution is colourless.

Describe **two** changes you would **see** during this reaction.

(2)

1 there will be a precipitate forming

2 the magnesium will dissolve

Results Plus: Examiner Comments

This response scored 1 mark only for 'magnesium would dissolve'. Although, the correct observation would be 'disappears', the use of term 'dissolve' was allowed.

The used of the term 'precipitate forming' was not credited since it was not qualified with the correct colour 'red-brown'.

Copper is a transition metal.

Magnesium reacts with copper sulfate solution to form copper and a solution of magnesium sulfate.
Magnesium sulfate solution is colourless.

Describe **two** changes you would **see** during this reaction.

(2)

1 Magnesium loose its colour

2 Copper Sulphate Change colour.

Results Plus: Examiner Comments

This response is typical of those that did not score.

There is an incorrect reference to 'magnesium losing its colour'. Also, the reference made to 'copper sulfate change colour' is not specific enough to be credited.

Results Plus: Examiner Tip

When describing what is seen in a chemical reaction, make sure you give the specific colour changes. It is worthwhile stating both the starting and final colours.

Q10. No Examiner's Report available for this question

Q11.

In this question, the majority of candidates were able to calculate the percentage of gold in the necklace and then go on to use the graph and their answer to determine the purity of the gold.

Q12.

In part (i) candidates found it hard to suggest a reason for using ammonium sulfate and solid ammonium nitrate as fertilisers with many repeating the stem of the question and stating that it would be to increase the yield. Candidates also found it hard to write the balanced equation for the reaction even though the names of all the reactants and products had been given, candidates should be familiar with the formula of common substances referred to in the specification. In (iii), many candidates were able to give a similarity or a difference, but few were able to give both to score both marks available. The most common correct answer seen was the allowable answer that both use the same reactants.

Q13.

Candidates made a good attempt at this question and could explain how alloying changed the pure metals to make the alloys more suitable.

Good answers explained how the structure of the pure metal is changed when alloyed and how this changed the properties of the metal to make it more suitable for the uses given.

* Pure metals are often converted into more useful alloys.
For example, aluminium is converted into an alloy used in aircraft, iron is converted into an alloy used in cutlery and gold alloys are used in jewellery.
These processes of alloying change the structures of the metals.

Some properties of pure aluminium, iron and gold are shown in Figure 12.

	density in g cm^{-3}	malleability	relative strength
aluminium	2.70	easy to bend	low
iron	7.75	easy to bend	low
gold	19.3	easy to bend	low

Figure 12

Explain how alloying changes these pure metals to make the alloys more suitable for the given uses.

An alloy is where atoms of another metal or gas are (6) ~~element~~ are added to another ~~element~~ metal. Pure ~~metal~~ metals only contain one kind of atom, leaving them to have an arranged and neat structure where the atoms can slide. When the atoms can slide this means the metal is weaker and more malleable (as evident in figure 12).

Alloys are made by adding other atom of another element to the pure metal which helps to make it stronger and less malleable. Adding other atoms disrupts the neat and ordered lattice structure of the metal atoms so which decreases the capability for the atoms to slide. By stopping the ~~the~~ layers of atoms to slide, it makes them remain in the same position and overall makes the the metal harder and stronger now it's an alloy.

By alloying aluminium, it will make it more suitable for it's function by being able to withstand the high temperature changes as it's used on aircraft (different altitudes have different temperatures). It would also mean it would be strong but could potentially allow it to be malleable allowing it to be easily fitted. As well as the density could remain low allowing the aircraft to go faster than if the aluminium was more dense.

Making iron into an alloy allows it to have an increased strength, decreased malleability, meaning it can't be bent easily, and the density could be lowered making it more light weight. ~~the~~ This would allow the alloy of iron to be suitable for cutlery as it's light weight but strong and can't bend.

Lastly changing gold into an alloy makes it more durable, have an increased strength and decreased malleability making it less likely to break. It would decrease ~~the~~ the density as well making it more portable and easier to carry around as an accessory. Although it would decrease the value, which makes ~~it~~ it more ~~easy~~ easier for people to buy.

~~Overall~~

Overall showing how alloying these pure metals can help make them more adapted to their functions. or given uses.

Results Plus: Examiner Comments

In this example the candidate starts by explaining how alloying increases the properties of metals. The discussion of alloying in general here is detailed, the candidate then goes onto discuss each metal and its properties and how alloying them improves the properties specific to that use. The discussions are not perfect but do not have to be. There is discussion of the metals and how alloying changes the properties and therefore a mark of 6 in level 3 is awarded.

* Pure metals are often converted into more useful alloys.
For example, aluminium is converted into an alloy used in aircraft, iron is converted into an alloy used in cutlery and gold alloys are used in jewellery.
These processes of alloying change the structures of the metals.

Some properties of pure aluminium, iron and gold are shown in Figure 12.

	density in g cm^{-3}	malleability	relative strength
aluminium	2.70	easy to bend	low
iron	7.75	easy to bend	low
gold	19.3	easy to bend	low

Figure 12

Explain how alloying changes these pure metals to make the alloys more suitable for the given uses.

(6)

All three metals are changed to suit their purposes. Aluminium is used in aircraft meaning it can not be malleable whatsoever. It also needs to be very strong to take the weight of the ~~at~~ passengers etc

Iron is used in ~~cutlet~~ cutlery, therefore it needs to be strong so that it doesn't snap while ~~picking~~ cutting food. It also needs to not be malleable as we would not be able to cut or pick food up with bendy cutlery.

Lastly, Gold. As it is used in jewellery, it needs to ~~be~~ be strong so that it doesn't break. They also need to be less dense or else it would be extremely ~~heavy~~ heavy to carry around. The gold would need to be changed to make it less malleable because nobody wants bendy jewellery.

Results Plus: Examiner Comments

In this example, the candidate has discussed all three metals and why they would not be suitable for their given uses if a pure metal was used. They have not stated how they alloy would make a difference or given any general ideas about alloys. Therefore this was awarded level 2 - 4 marks.

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(6)

- Relative strength become high (so aircraft doesn't fall apart)
- Density ~~is~~ ~~becomes~~ in g cm^{-3} stays the same?
- Malleability goes from easy to bend to hard to bend as the aircraft should be stable.
- ~~It~~ Doesn't conduct ~~energy~~ electricity.
- ~~Conducts~~
- Doesn't dissolve in water?

Results Plus: Examiner Comments

In this example, only one metal has been discussed. There is some correct science. However, there is no discussion of why alloying might change the properties.

Only 1 metal has been discussed and not in great detail, therefore there is not sufficient for level 2. If a very detailed discussion of 1 metal was given, it could be possible to reach level 2.

A mark of 2 in level 1 was awarded.

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Figure 12

Explain how alloying changes these pure metals to make the alloys more suitable for the given uses.

(6)

Gold alloys are suitable ~~from~~ to be used in jewellery because they are ~~een~~ malleable and have a high density. Aluminium is a good alloy to be used in aircraft parts because it has a low density and is easy to bend while gold would not be suitable for aircraft parts because it has a high density. Iron is a good alloy to use for cutlery because it is easy to bend into shapes and has a low relative strength.

A low relative strength is good for cutlery so it isn't to hard to cut things.

Results Plus: Examiner Comments

In this example. the candidate has not understood the question correctly and tried to explain thinking that the data is the data for the alloy not the pure metal, this does not answer the question and therefore 0 marks were awarded.

Q14.

(a)

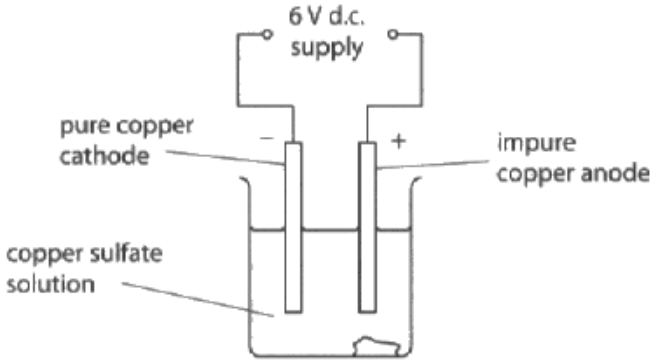
The majority of candidates were able to score the 1 mark available, with references to 'improves resistance to corrosion'. The most common error was to mention 'to prevent rusting' which is clearly only specific to iron and steel. However, this was credited only if the rusting, when mentioned, was specifically linked to iron and steel. Some candidates confused 'corrosive' with 'corrosion'. Several candidates incorrectly referred to 'making the metal stronger' or 'making the metal conduct' or simply repeated the reason already given in stem of the question.

(b)

Although there were some excellent responses seen by examiners, gaining the full 3 marks available, the majority of candidates struggled with interpreting the results for the purification of copper by electrolysis in terms of atoms, ions and the redox processes occurring. Marks were generally awarded for stating 'the movement of copper ions from the anode to the cathode' or for a correct reference to 'the difference in the changes in mass (0.2 g) being down to impurities'.

Many answers referred to the change in mass of the anode or cathode, but did not explain this, or extend this sufficiently to explain the mass difference in terms of impurities. Few responses actually made specific reference to the oxidation/atoms losing electrons or reduction/ions gaining electrons at the anode and cathode respectively. Half equations were rarely given.

(b) Copper sulfate solution was electrolysed using copper electrodes.
The mass of each electrode was determined before it was placed in the solution.



The electrolysis was carried out for a period of time.
The electrodes were removed, washed, dried and their masses redetermined.

The table shows the masses of the electrodes before and after electrolysis.

	mass of electrode before electrolysis / g	mass of electrode after electrolysis / g	change in mass
mass of impure copper anode	40.0	35.0	5.0 g decrease
mass of pure copper cathode	10.0	14.8	4.8 g increase

Explain these results.

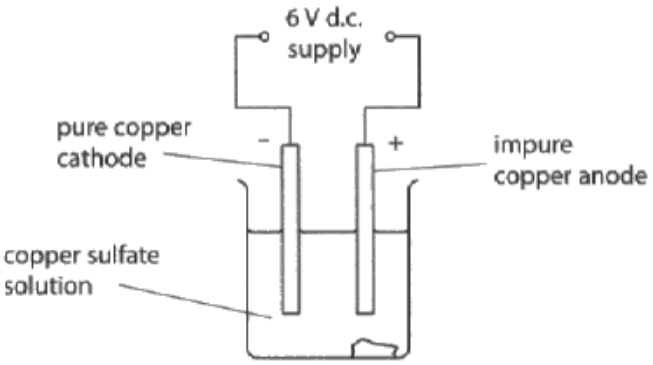
(3)

Because the copper was attracted to the cathode which increased the amount of copper in the cathode while there was a reduction in the anode as the copper migrated to the cathode leaving just the impurities.

Results Plus: Examiner Comments

In this response there is no mention of copper ions or the movement of copper ions, or copper atoms being formed. The impurities are not linked to the 0.2g difference in the mass changes. This response scored 0 marks.

(b) Copper sulfate solution was electrolysed using copper electrodes.
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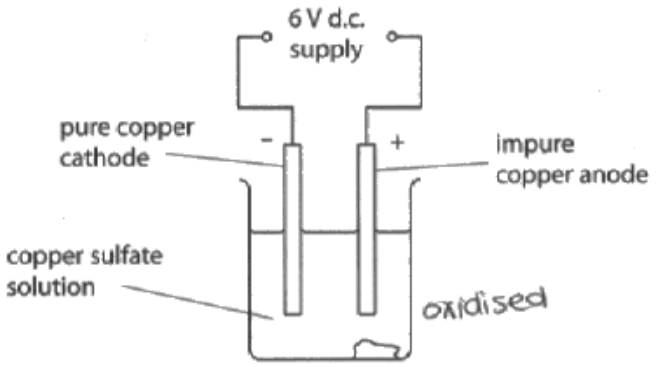
(3)

At the anode, copper atoms are oxidised meaning they lose electrons, forming Cu^{2+} ions that enter into solution. At the cathode, electrons are offered up to reacting Cu^{2+} ion forming copper atom which sticks to the cathode. This means that the anode loses 5 g of mass because copper is stripped off, and the cathode gains 4.8 g because copper is added to it.

Results Plus: Examiner Comments

The processes occurring at the anode and cathode have been discussed in detail. There has been no further discussion of the 0.2g change in mass difference linked to impurities or any mention of movement of ions. This response scored 2 marks.

(b) Copper sulfate solution was electrolysed using copper electrodes.
The mass of each electrode was determined before it was placed in the solution.



The electrolysis was carried out for a period of time.
The electrodes were removed, washed, dried and their masses redetermined.

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mass of pure copper cathode	10.0	14.8	4.8 g increase

Explain these results.

(3)

There was a 4.8g increase on the copper cathode because the copper ~~met~~metal was oxidised at the anode and formed Cu^{2+} ions in solution and then were ~~wi~~reduced at the cathode to form solid copper atoms coating the cathode. This is why The anode decreased in mass by 5g and 0.2g of this was impurities causing a 4.8g increase in cathode mass

Results Plus: Examiner Comments

A typically seen very good response. Three marking points have been mentioned in this response. The formation of copper ions at the anode/oxidation. The reduction of copper ions at the cathode to form copper atoms. The difference in the change in mass has been correctly linked to impurities. This response scored 3 marks.

(c)

This question was very poorly answered by the majority of candidates, with very few candidates scoring the 2 marks available. In cases where 1 mark was scored, it was invariably for showing the correct species on both sides of the equation, but with incorrect balancing, typically for showing only 2 electrons, rather than 4 electrons on the Right Hand Side of the equation. The majority of answers which failed to score, reference to gaining electrons on the Left Hand Side. In some responses this reaction was confused with the oxidation half equation occurring at the

anode during the electrolysis of water.

(c) In an electrolysis experiment, oxide ions, O^{2-}, form oxygen gas, O_2.

Write the balanced half equation for the reaction.

(2)

$O^{2-} \rightarrow O_2 + 2e$

Results Plus: Examiner Comments

A typical 1 mark response for showing the correct species but incorrect balancing, namely the **2** on the LHS is missing and **2**e^- is incorrect on the RHS.

(d)

A significant number of excellent answers were noted by the examiners, gaining the maximum 6 marks, Level 3. There was good recognition of the movement of sodium ions and chloride ions to the correct electrodes and the subsequent reduction and oxidation reactions. The use of half equations for the reduction and oxidation processes was seen occasionally. Very few candidates discussed the fact that two chlorine atoms joined to form a chlorine molecule.

Level 2 responses often showed less detail regarding electron transfer following movement of ions to the electrodes. Often candidates incorrectly referred to chlorine ions instead of chloride ions. Some candidates confused the electrolysis of an aqueous solution of sodium chloride / brine with that of molten sodium chloride in the question, despite some detailed explanations, which often limited the answers to Level 2. In some cases, it was disappointing to see atoms with charges or ions going to the wrong electrodes, or confusing the anode with the cathode.

*(d) Sodium chloride is an ionic compound.
It contains sodium ions, Na^+, and chloride ions, Cl^-. neg pos

When molten sodium chloride is electrolysed, sodium metal and chlorine gas are formed.

Describe how the sodium ions and chloride ions in solid sodium chloride are converted into sodium and chlorine by electrolysis.

(6)

In electrolysis, the sodium ions are attracted towards the cathode as they contain positive ions. which converts it into a sodium metal. The chloride ions are attracted towards the anode as they contain negative ions which forms a chlorine gas.

Sodium goes to the cathode because its a negative electrode and the sodium ions are negative. positive. Chloride ions go to the anode because its a positive electrode and the chloride ions are negative.

This forms sodium and chlorine as they are born attracted to the different electrodes.

Results Plus: Examiner Comments

This response correctly mentions the movement of sodium ions and chloride ions to the cathode and anode respectively. The formation of chlorine gas at the anode and sodium metal at the cathode have been discussed. There have been four relevant points made. This response scored 4 marks – Level 2.

*(d) Sodium chloride is an ionic compound.
It contains sodium ions, Na^+, and chloride ions, Cl^-.

When molten sodium chloride is electrolysed, sodium metal and chlorine gas are formed.

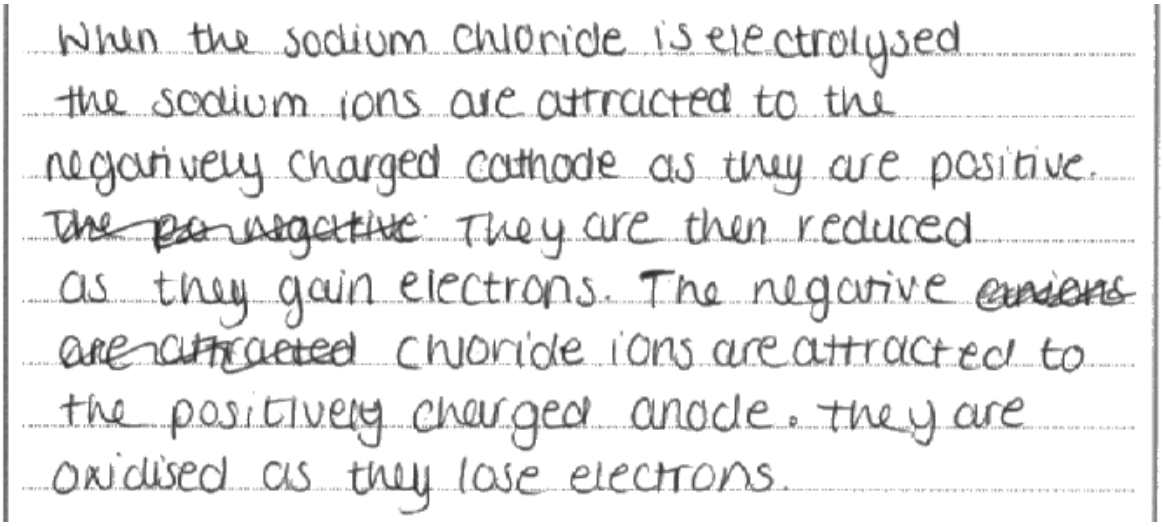
Describe how the sodium ions and chloride ions in solid sodium chloride are converted into sodium and chlorine by electrolysis.

(6)

The sodium ions from the solution are pulled towards the cathode of the electrolysis because opposite charges attract. The chloride ions are pulled towards the anode.

Results Plus: Examiner Comments

Two correct points have been made, namely the movement of sodium ions to the cathode and chloride ions to the anode. This response scored 2 marks – Level 1.


When the sodium chloride is electrolysed the sodium ions are attracted to the negatively charged cathode as they are positive. ~~The positive~~ They are then reduced as they gain electrons. The negative ~~anions are attracted~~ chloride ions are attracted to the positively charged anode. they are oxidised as they lose electrons.

Results Plus: Examiner Comments

The movement of the sodium ions to the cathode and chloride ions to the anode are mentioned. Redox reactions at the electrodes have been discussed, namely chloride ions losing electrons / oxidation and sodium ions gaining electrons / reduction. Overall, although the answer is relatively concise, there are six relevant points regarding both the electrode processes, so this response is sufficient for Level 3 and scored 6 marks.

Two inert electrodes are used, supplied with a current and put into an electrolyte of molten sodium chloride where Na^+ and Cl^- ions are free to move. At the negative cathode Na^+ cations are reduced, and gain electrons, to be deposited as solid sodium atoms. The half equation is: $Na^+_{(l)} + e^- \rightarrow Na_{(s)}$. The sodium is collected and used in street lamps and as a coolant in some nuclear reactors.

Chloride anions are instead attracted to the anode where they are oxidised, and lose electrons to form chlorine gas molecules. The half equation is: $2Cl^-_{(l)} \rightarrow Cl_{2(g)} + 2e^-$. Chlorine is collected at the anode as a toxic green gas and is used to treat water, produce bleach and to make PVC and other polymers.

Results Plus: Examiner Comments

This is an excellent example of typical Level 3 response – 6 marks.

The movement of ions to the respective electrodes has been discussed and the electrode processes at the anode and cathode have been described and explained in detail, coupled with detailed halfequations. There are greater than the minimum valid points required for Level 3.

Q15.

(a)

This question had a very good response, with many candidates able to identify the two anions, namely Cl^- and OH^-, from the choice of four ions. In those few responses which failed to gain credit, candidates incorrectly identified the cations, namely Na^+ and H^+, or gave the formula for sodium chloride, namely NaCl.

(c)

The majority of responses were able to correctly explain oxidation and reduction in terms of the loss and gain of electrons respectively. In a minority of cases, however, despite being asked in

the question to 'explain, in terms of electrons', candidates gave a definition in terms of oxygen and not always stated this correctly. The other commonly seen errors related to responses referring to loss or gain of ions or atoms instead of electrons, or simply getting the redox process the wrong way round, i.e. incorrectly stating that oxidation is the gain and reduction is the loss of electrons (which was credited with 1 mark, as an allowable response in the mark scheme).

(c) During electrolysis, oxidation takes place at the anode and reduction takes place at the cathode.

Explain, in terms of electrons, what is meant by **oxidation** and **reduction**.

(2)

Oxidation means it gains oxygen and reduction means it loses oxygen.

Results Plus: Examiner Comments

This was a typically incorrect response, which did not score. The question specifies 'in terms of electrons', so the definitions stated (although not incorrect) cannot score.

(c) During electrolysis, oxidation takes place at the anode and reduction takes place at the cathode.

Explain, in terms of electrons, what is meant by **oxidation** and **reduction**.

(2)

Reduction is when something is gained, and oxidation is when something is lost.

Results Plus: Examiner Comments

This response did not score. Unfortunately, the key word, namely 'electron(s)' is omitted and 'something' is used by the candidate, which is too vague - insufficient to award any marks.

(c) During electrolysis, oxidation takes place at the anode and reduction takes place at the cathode.

Explain, in terms of electrons, what is meant by **oxidation** and **reduction**.

(2)

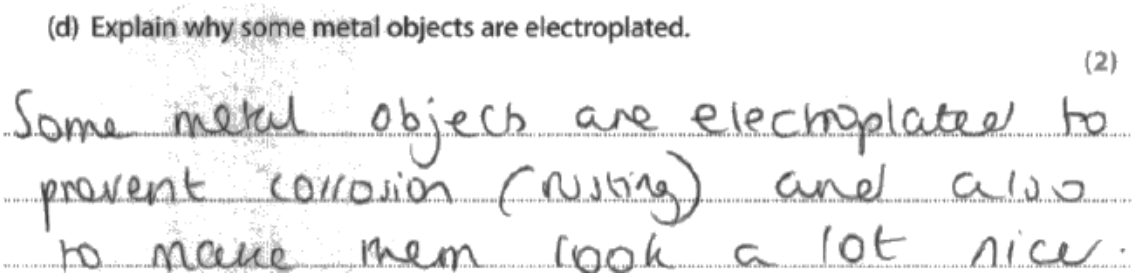
At the anode, oxidation takes place, so the electrons are lost. At the Cathode, reduction takes place, so electrons are gained.

Results Plus: Examiner Comments

A typically seen response and very good answer - fully correct for '(anode) oxidation... electrons are lost' and '(cathode) reduction... electrons are gained'.

(d)

The majority of candidates were able to score at least 1 of the 2 marks available, with references to 'improving the appearance' and/or 'improves resistance to corrosion'. The most common error was to mention 'to prevent rusting' which is clearly only specific to iron and steel. However, this was credited only if rusting, when mentioned, was specifically linked to iron and steel. Several candidates incorrectly referred to 'making the metal stronger'.

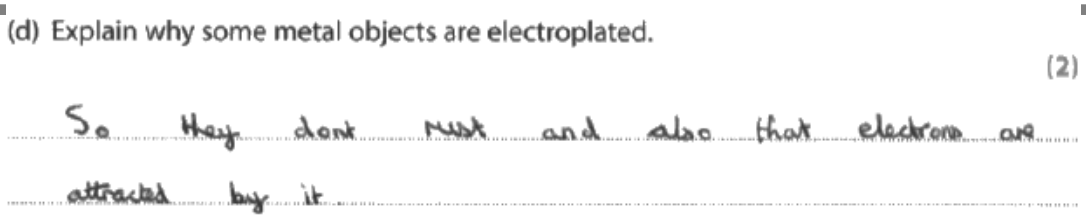

(d) Explain why some metal objects are electroplated.

(2)

Some metal objects are electroplated to prevent corrosion (rusting) and also to make them look a lot nicer.

Results Plus: Examiner Comments

This response was typical of a good answer for 2 marks. 'To make them look a lot nicer' (marking point 2) and 'prevent corrosion' (marking point 3) are credited. Note that had 'rusting' alone been mentioned this last point would not be credited, unless rusting was linked to iron/steel.


(d) Explain why some metal objects are electroplated.

(2)

So they dont rust and also that electrons are attracted by it.

Results Plus: Examiner Comments

This response did not score. 'So they don't rust' is insufficient as it is not linked to iron/steel (so third marking point was not scored).

Q16.

(i)

The majority of candidates were able to state what the anode and cathode would have to be connected to in order to carry out the electroplating. With the majority stating a power pack or

battery. A good proportion were more specific with their answer and stated a DC supply.

The apparatus shown in Figure 13 was used to electroplate a spoon with nickel.

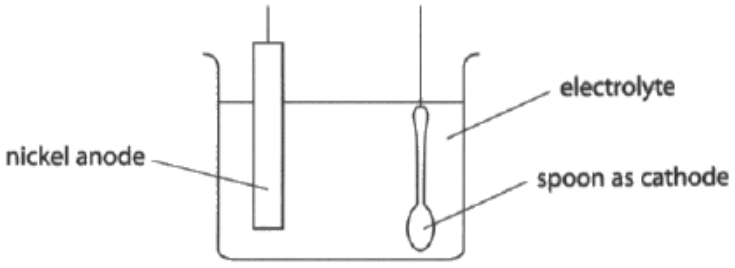


Figure 13

(i) State to what the anode and cathode have to be connected in order to carry out the electroplating.

(1)

A power source.

Results Plus: Examiner Comments

A correct answer that scored the mark.

The apparatus shown in Figure 13 was used to electroplate a spoon with nickel.

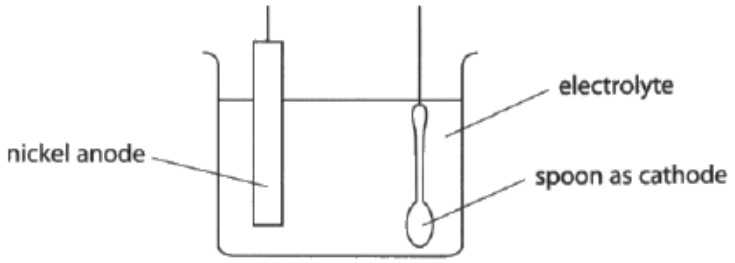


Figure 13

(i) State to what the anode and cathode have to be connected in order to carry out the electroplating.

(1)

electricity.

Results Plus: Examiner Comments

Simply stating electricity was not creditworthy.

(ii)

Very few candidates were able to name a soluble salt of nickel that could be used to form the

electrolyte for the electroplating.

A large proportion of candidates did not read the question carefully and stated that sodium chloride or salt should be used.

(ii) Predict the name of a substance that could be dissolved in water to form the electrolyte for this electroplating.

(1)

nickel sulphate.

Results Plus: Examiner Comments

A correct answer that scored the mark.

(ii) Predict the name of a substance that could be dissolved in water to form the electrolyte for this electroplating.

(1)

Nickel oxide

Results Plus: Examiner Comments

A common incorrect answer that did not score.

(ii) Predict the name of a substance that could be dissolved in water to form the electrolyte for this electroplating.

(1)

Salt

Results Plus: Examiner Comments

A large proportion of candidates simply stated that 'a salt' should be used. This was insufficient and did not gain credit.

Results Plus: Examiner Tip

Candidates should be taught it be specific with their answers.

(ii) Predict the name of a substance that could be dissolved in water to form the electrolyte for this electroplating.

(1)

Sodium chloride

Results Plus: Examiner Comments

A common incorrect answer that did not score.

Q17.

(b)(i)

The majority of candidates knew that argon can be used to put out fires because it is nonflammable.

(b)(ii)

The majority of candidates knew that helium is used in airships because it has a low density.

(c)(i)

It was disappointing that not many candidates knew the appearance of chlorine at room temperature. The appearance of bromine and iodine were given as a colour and a physical state and there were 2 marks for this question, so candidates should also have given the appearance of chlorine as a colour and a physical state. A common incorrect answer was that chlorine is a blue liquid, showing that candidates were probably confused with the use of chlorine in swimming pools. Candidates would benefit from being shown a gas jar of chlorine.

halogen	appearance at room temperature
chlorine	gas
bromine	dark red liquid
iodine	grey solid

Results Plus: Examiner Comments

This candidate scored 1 mark for gas.

Results Plus: Examiner Tip

If you are given some information in a question, try to see if there is a pattern and answer in a similar way. In this question, the appearances of bromine and iodine are described with a colour and a physical state. The appearance of chlorine should also include the colour and physical state.

halogen	appearance at room temperature
chlorine	Green gas
bromine	dark red liquid
iodine	grey solid

Results Plus: Examiner Comments

This is an example of an answer that scored 2 marks as it includes the correct colour and physical state for chlorine.

(c)(ii)

The majority of candidates could write the correct word equation.

Some candidates decided to attempt to write a balanced equation, but credit was only given if this was completely correct. Symbols such as H or Cl should not be used for hydrogen and chlorine gas. Candidates are advised to write word equations when they are asked to do so in a question.

Some candidates also lost marks by writing CL as the symbol for chlorine and others changed the product to hydrochloric acid, hydrochloride or hydrogen chlorine.

Hydrogen + chlorie → hydrogen chlorie

Results Plus: Examiner Comments

This answer scores 1 mark for hydrogen + chlorine. The candidate has written the name of the product as hydrogen chlorine, which is incorrect.

Results Plus: Examiner Tip

Copy the names of chemicals carefully from the question.



Results Plus: Examiner Comments

This candidate tried to write a balanced equation, but the formulae are incorrect so no marks were given.

Results Plus: Examiner Tip

If a question asks for a word equation, do not try to write a balanced equation.



Results Plus: Examiner Comments

This is an example of a correct word equation, scoring 2 marks.

Q18.

Candidates found this extended open response question quite challenging with few scoring a mark in level 3. The first major issue was with the candidates' understanding of what was meant by a chemical cell, with the majority thinking that these contained hydrocarbons which were burnt therefore causing the release of greenhouse gases. Another issue found with this question was with the candidates' understanding of the command word evaluate. If a candidate is asked to evaluate, they should be reviewing the advantages and disadvantages to form a conclusion, few candidates formed a conclusion and this limited their marks. Where candidates scored, it was often for stating that the water produced by the fuel cell could be reused on the spacecraft or for showing an understanding that the hydrogen is flammable and would be difficult to store because it is a gas.

Q19. No Examiner's Report available for this question

Q20. No Examiner's Report available for this question

Q21.

Question (i) discriminated well. Many showed the understanding that increasing the temperature would increase the yield of products to score one mark, the better candidates knew that this was because the equilibrium was shifted to the right. In the same manner a good proportion of learners were able to calculate the number of moles of methane. Of those some knew that they needed to multiply this by four and some knew that they then had to multiply this by 24, only the best performed both of these steps. Other errors included multiplying the number of moles by the formula mass of hydrogen rather than the number of moles.

Q22. No Examiner's Report available for this question

Q23.

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.

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

9 exo → 10

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

exothermic ← endo

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 (100atm)
~~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 ~~a~~ 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 ~~is~~ equilibrium would shift to the left, ~~as~~ as it is endothermic, and ~~the~~ therefore decrease the

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

Results Plus: 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.

* 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.

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.

forward reaction is exothermic

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 ~~it~~ 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~~ affects the yield achieved because that means it is a higher pressure but not so much that it would move the equilibrium 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 reacting together therefore increasing the rate of reaction so equilibrium is reached sooner.

Results Plus: Examiner Comments

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

Q24. No Examiner's Report available for this question

Q25. No Examiner's Report available for this question

Q26.

Candidates generally performed well in this question, with the majority knowing that the 18 carat gold contains atom of different sizes. Of those that knew this many were then able to go on to explain that the 18 carat gold is stronger than 24 carat gold in terms of these different sized atoms disrupting the structure or preventing the layers from sliding. In some cases, candidates did not score as they simply stated that the other metals were stronger.

Q27.

This 6-mark question was not answered very well. Some candidates gave an explanation relating to the equilibrium associated with the Haber Process rather than the one asked about in the question and gave incorrect information about the effect of temperature on equilibrium position because it was learned from the Haber Process rather than applied to this reaction. Level 1 answers correctly determined that a higher temperature would increase the rate of reaction, although this was not usually related to the rate of attaining equilibrium. Most marks scored here related to describing how temperature and catalysts affected the rate of reaction, and there were far fewer answers that discussed the equilibrium.

Q28. No Examiner's Report available for this question

Q29.

There seemed to be some confusion here between the structure of aluminium and alloys compared with bond strength, although many candidates scored 2 or 3 marks for this question.

Q30. No Examiner's Report available for this question

Q31.

(i)

This question was well answered on the whole, with the majority of candidates scoring at least 2 or more of the 3 marks available.

The majority of responses correctly compared the properties of the two substances from the table provided, using correct comparative terms, such as lower, stronger or higher, when comparing density, strength and resistance to corrosion respectively.

In the responses scoring 1 or 2 marks only, candidates often only discussed one or two properties, not all three.

In those responses which did not score, often properties were simply quoted from the table in the stem of the question, with no comparison made between the two substances. In many incorrect responses, the term 'better' was seen when comparing properties – this term is vague and would need qualifying to be of credit.

Magnalium is an alloy of magnesium and aluminium.
It is often used for aircraft parts.

(i) Figure 4 shows information about pure aluminium and magnalium.

substance	density in g cm^{-3}	relative strength	resistance to corrosion
aluminium	2.7	low	high
magnalium	2.0	high	very high

Figure 4

Explain, using the information in Figure 4, why magnalium, rather than pure aluminium, is used for aircraft parts.

(3)

magnalium is used because it has a high & relative strength and a very high resistance to corrasion whereas aluminium has low relative strength and high resistance to corrosion.

Results Plus: Examiner Comments

This is typical of a response which did not score.

Two of the properties from the table have been discussed, namely relative strength and resistance to corrosion. However, the data has been quoted and comparative terms not used, such as higher relative strength and higher resistance to corrosion.

Results Plus: Examiner Tip

With questions requiring a comparison of properties from a table, make sure comparative terms, such as 'stronger', 'higher', are used to compare substances. Avoid simply stating information from the table.

Explain, using the information in Figure 4, why magnalium, rather than pure aluminium, is used for aircraft parts.

(3)

Magalium is chosen over aluminium as Magalium has a higher relative strength and a higher resistance to corrosion meaning it is less likely to get damaged. Magnalium also has a lower density meaning it weighs less than aluminium.

Results Plus: Examiner Comments

A typical example of a fully correct response which scored the 3 marks available.

All three properties, namely relative strength, resistance to corrosion and density, have been correctly compared, using comparative terms.

Results Plus: Examiner Tip

Comparing properties of substances is commonly asked for in chemistry. Remember to use comparative terms, such as higher, lower, when making comparisons.

(ii)

This question was very well answered on the whole, with the majority of responses scoring the 2 marks available, for the answer, 5.0% as the correct percentage of magnesium in the magnalium alloy.

Of those candidates who scored 1 mark only, most incorrectly inverted the fraction in the percentage calculation, arriving at a value of 2000 which was credited as an error carried forward.

Q32. No Examiner's Report available for this question

Q33. No Examiner's Report available for this question

Q34.

Part (i) was less well answered with few candidates being able to explain why a new mixture was evaporated rather than the original mixture from the titration. In part (ii) the majority were able to correctly calculate the percentage yield of potassium chloride to gain both mark points, although only the best candidates were able to suggest a reason why the actual yield was greater than the theoretical yield, with many just giving the opposite of why the yield can be lower rather than thinking through the question and scenarios that might lead to the yield being higher. A good proportion were able to calculate the atom economy in the last part of question 4 to gain the full four marks available. In some cases, candidates scored just 3 marks as they had a misconception of the meaning of decimal place and gave an answer of 80 rather than 80.5.

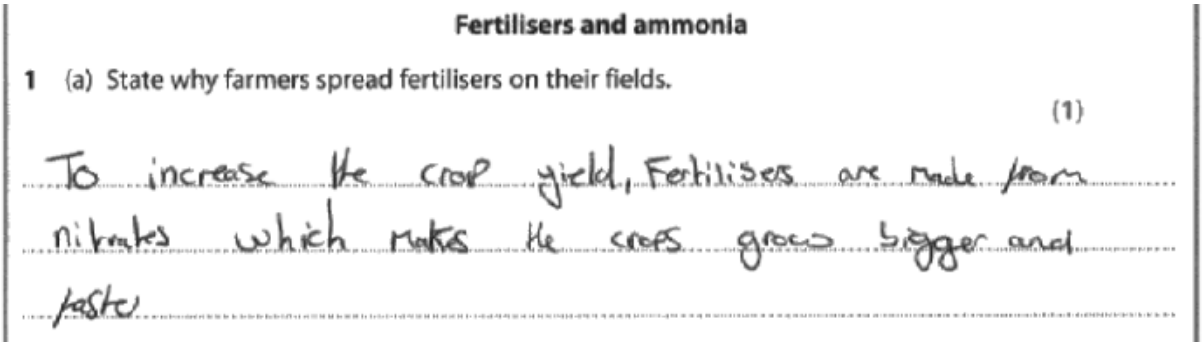
Q35. No Examiner's Report available for this question

Q36.

(a)

This part allowed many candidates to get off to a good start. There was, however, some confusion between fertilisers and pesticides or herbicides. There were a few references to fertilisers being catalysts (not credited) because they speed up the rate of growth (credited). Others suggested that the main function of fertilisers was to neutralise acidic soils.

Some good, detailed descriptions were given.



Fertilisers and ammonia

1 (a) State why farmers spread fertilisers on their fields.

(1)

To increase the crop yield, Fertilisers are made from nitrates which makes the crops grow bigger and faster

Results Plus: Examiner Comments

This answer includes plenty of relevant detail.

Fertilisers and ammonia

1 (a) State why farmers spread fertilisers on their fields.

(1)

Farmers spread fertilisers to help their crops grow quicker and to keep animals away

Results Plus: Examiner Comments

Fertilisers are not used to keep animals away.

Results Plus: Examiner Tip

Learn the difference between fertilisers, pesticides and herbicides.

(b)

This question had a good response with many candidates giving well-explained answers. Most candidates recognised that run-off of fertilisers into water was an issue, and a good number of candidates gained a further mark with answers related to eutrophication, named by some and described by others. However, some candidates thought that fertilisers may kill plants and animals on land, or were unclear what the effect was on water life. Candidates are advised not to be vague, for example "affecting fish" does not tell us whether fish are helped or harmed.

(b) Using too much fertiliser can harm the environment.

Describe how the spreading of too much fertiliser on fields can harm the environment.

(2)

If there is too much, it could be washed into rivers and lakes. It will increase algae and plants to grow on the surface of the lake. This will block sunlight getting in the river so plants can't photosynthesis so die. Fish and animals also die as there is little oxygen. This is eutrophication.

Results Plus: Examiner Comments

This answer is explained very clearly using good, scientific terminology.

(b) Using too much fertiliser can harm the environment.

Describe how the spreading of too much fertiliser on fields can harm the environment.

(2)

The Fertiliser can damage living things that currently live in the area

Results Plus: Examiner Comments

This answer contrasts with the first example, giving little detail.

Results Plus: Examiner Tip

Be clear about what you mean. Fertilisers that are washed into lakes, for example, can lead to the death of fish, but this answer is much too vague.

(c)(i)

Despite being given so much information in the question, i.e. all of the reactants and products, there were a surprising number of blanks or the misuse of ammonia for ammonium and vice versa (which of course had to be penalised in this example). A few candidates unwisely attempted to use formulae; all of those that did were incorrect.

(c) Ammonium nitrate is a fertiliser.

Ammonium nitrate is formed when nitric acid reacts with ammonia.

(i) Write the word equation for this reaction.

(2)

Nitric acid + Ammonia → Ammonia nitrate.

Results Plus: Examiner Comments

Be careful – the product 'ammonium nitrate' was written in the question, and information like this should be carefully transferred.

(c) Ammonium nitrate is a fertiliser.

Ammonium nitrate is formed when nitric acid reacts with ammonia.

(i) Write the word equation for this reaction.

(2)

N_2 + NH_3 → N_3H_3

Results Plus: Examiner Comments

Some candidates give symbol equations when asked for word equations. They have to be completely correct – and rarely are – to score.

(d)(i)

Most responses were given as some spelling of "reversible". Some incorrect responses included "the Haber Process" (an understanding of 'type' is important), "reverse/ reverse reaction", "interchangeable", "vice versa" and "static equilibrium".

(d) In the Haber process, nitrogen and hydrogen react to form ammonia.

nitrogen + hydrogen ⇌ ammonia

(i) The ⇌ symbol in the word equation shows that the reaction goes forwards and backwards at the same time.

Give the name of this type of reaction.

(1)

Two - way reaction.

Results Plus: Examiner Comments

Reversible reaction / equilibrium was required.

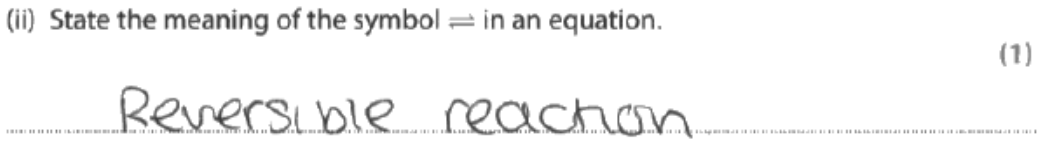
Results Plus: Examiner Tip

You must learn correct scientific terms – why not produce a list of all the key words you learn in each topic?

Q37.

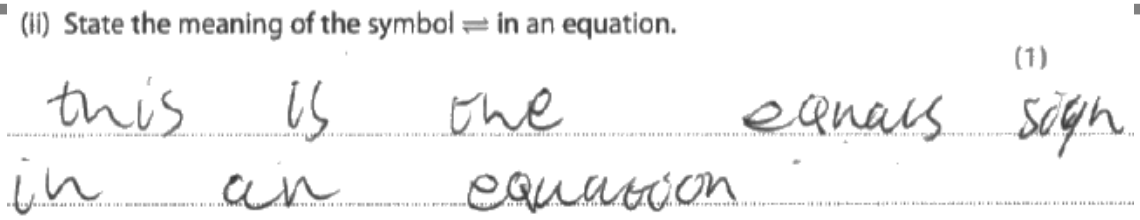
(a) (ii)

Most candidates gained credit for their answers, since they were able to identify the meaning of the symbol for a reversible reaction. It was noted, however, that few candidates appeared to spell reversible correctly.



Results Plus: Examiner Comments

This was the most commonly seen correct answer for the 1 mark available.



Results Plus: Examiner Comments

A typical incorrect answer, where the reversible sign was confused with simply an equal sign, so does not score.

(b) (i)

Very few candidates were able to score both marking points here. Although many were able to identify that urea contained the highest percentage of nitrogen, they did not go on to link it to plant growth. A commonly seen error was that responses stated that urea contained a lot of nitrogen but failed to make a comparative statement. Many responses incorrectly tried to make links to the percentage of nitrogen and oxygen in the atmosphere.

(b) Ammonia is used in the manufacture of some fertilisers.

(i) The table shows information about three fertilisers manufactured from ammonia.

substance	% by mass of nitrogen	% by mass of oxygen
ammonium nitrate	35	60
ammonium sulfate	21	48
urea	47	27

Use the information in the table to explain why urea might be the best fertiliser.

(2)

it has the highest ~~percentage~~ by mass of nitrogen, plants need lots of nitrogen to use as minerals to grow, and it has the lowest percentage of oxygen which plants are able to absorb from the air so is unnecessary in a fertiliser.

Results Plus: Examiner Comments

A good example of a 2 mark response.

(b) (ii)

Most candidates were able to score at least 1 of the 2 marks available, mainly by reference to the first, second and fourth marking points, namely 'fertiliser is washed into rivers', 'increased growth' and 'fish die'. Overall, this question presented many problems to many candidates. Many simply stated eutrophication' as their answer, although they were unable to explain what it meant. Many candidates linked fish death with too much fertiliser, although their explanations were often confused.

(ii) When rivers flow through areas where fertilisers have been spread on the land, plants and animals that live in the rivers can be affected.

Explain how this happens.

(2)

This process is called eurtrophication. Nitrogen speeds up the process of phorosynthesis, so algae on the surface of the water grows more. This blocks out the sunlight, so other Specias of plants can not grow. They die, and bacteria decompose them, and use up the oxygen in the pond in respiration. This means species of animals in the pond have no oxygen and also die.

Results Plus: Examiner Comments

This response scored the 2 marks available. The increased growth of algae, oxygen being used up (by bacteria) when plants decompose and animals (in the pond) dying are correctly mentioned.

(ii) When rivers flow through areas where fertilisers have been spread on the land, plants and animals that live in the rivers can be affected.

Explain how this happens.

(2)

Eutrophacation happens because farmers use to much nitrogen fertilizers. When it rains the excess fertilizer is washed into ponds, lakes and rivers.

Results Plus: Examiner Comments

This response scored 1 mark only for a correct reference to 'excess fertiliser being washed into the river' (the first marking point). The mention of eutrophication, is not required for the specification and this would need to be explained to gain credit.

(ii) When rivers flow through areas where fertilisers have been spread on the land, plants and animals that live in the rivers can be affected.

Explain how this happens.

(2)

The fertiliser can cause the plants to grow which causes them to use more oxygen meaning animals living in rivers may not have enough oxygen.

Results Plus: Examiner Comments

This response did not score. There is no mention of plants (in the river) growing bigger or more quickly (so the second marking point was not scored). The idea of plants using up the oxygen in incorrect, since a reference to decaying/dead plants is necessary. Also, from the response, the effect on animals simply states '...may not have enough oxygen'. This is insufficient, since 'animals dying' is required (so fourth marking point was not scored).

Q38.

(i)

Candidates generally performed well in this question, with many able to complete the word equation for the reaction between ammonia and nitric acid.

Ammonia reacts with nitric acid to form ammonium nitrate.

(i) Complete the word equation for this reaction.

(1)

Ammonia + Nitric acid → ammonium nitrate.

Results Plus: Examiner Comments

The correct answer, that scored the mark.

Ammonia reacts with nitric acid to form ammonium nitrate.

(i) Complete the word equation for this reaction.

(1)

nitric acid + Ammonium → ammonium nitrate

Results Plus: Examiner Comments

Where candidates lost the mark is was often because they stated that ammonium rather ammonia was reacting or that ammonia reacts with nitrate.

Results Plus: Examiner Tip

Candidates should be taught to use the information given in the stem of the question to help them form their answer.

Ammonia reacts with nitric acid to form ammonium nitrate.

(i) Complete the word equation for this reaction.

(1)

NH_3 + NCL → $2NH_3$[redacted]CL

Results Plus: Examiner Comments

In some cases, candidates tried to write the symbol rather than the word equation. To be allowed marks, the symbol equation would have to be entirely correct.

Results Plus: Examiner Tip

Candidates should be taught that if a word equation is asked for, they should not attempt a symbol equation as it is much harder to gain credit.

(iii)

Candidates generally performed well on this question, with most scoring at least 1 mark for showing an understanding that the ammonium nitrate promotes crop growth or yield. Many

knew that it was a fertilizer.

(iii) Explain why farmers spread ammonium nitrate on their fields.

(2)

They increase the efficiency of their crops growing, and acts as a fertiliser.

Results Plus: Examiner Comments

This good answer scored both marks.

(iii) Explain why farmers spread ammonium nitrate on their fields.

(2)

To make the yield of their crops increase and kill any pest.

Results Plus: Examiner Comments

A common misconception seen was that the ammonium nitrate was used as a pesticide.

This example still gained 1 mark for improving crop yield.

Q39.

(b) (i)

This question was generally well answered. Some candidates lost marks as they wrote hydroxide as a product in place of water. Those that tried to use formula generally failed to write the formula correctly and so therefore did not score. Some candidates scored no credit as they wrote the reverse reaction for the decomposition of water.

(b) Hydrogen is used as a fuel in the engines of some vehicles.

In these engines hydrogen reacts with oxygen to form water.

(i) Write the word equation for this reaction.

(2)

hydrogen → oxygen + water

Results Plus: Examiner Comments

The candidate here has put the arrow in the wrong place showing that hydrogen reacts to form oxygen and water which gains no credit.

(b) Hydrogen is used as a fuel in the engines of some vehicles.

In these engines hydrogen reacts with oxygen to form water.

(i) Write the word equation for this reaction.

(2)

Hydrogen + Oxygen → Hydrogen oxide

Results Plus: Examiner Comments

Hydrogen oxide was accepted in place of water. Hydroxide however was not.

(b) Hydrogen is used as a fuel in the engines of some vehicles.

In these engines hydrogen reacts with oxygen to form water.

(i) Write the word equation for this reaction.

(2)

Hydrogen (H) + [redacted] Oxygen (O) = Water (H_2O)

Results Plus: Examiner Comments

This answer scored two marks for the word equation shown. The incorrect formula after the hydrogen and oxygen was ignored.

(b) Hydrogen is used as a fuel in the engines of some vehicles.

In these engines hydrogen reacts with oxygen to form water.

(i) Write the word equation for this reaction.

(2)

H + O → H'O

Results Plus: Examiner Comments

This answer scored zero marks. A word equation has been asked for, the candidate has tried the more difficult task of writing a symbol equation. They have not done this correctly and so therefore cannot score credit.

Results Plus: Examiner Tip

If asked to write a word equation do not attempt to write a symbol equation. To score credit you will need to write the symbol equation fully correct. This is a significantly harder skill than writing a word equation.

(b) (ii)

The majority of candidates performed well on this question to score the 1 mark available for stating that hydrogen only produces water or that it does not produce carbon dioxide. Candidates did not score when they used vague, non-specific terms such as it lasts longer or it is cheaper or environmentally friendly.

(ii) State one advantage of using hydrogen, rather than petrol, as a fuel for vehicles.

(1)

Hydrogen is better for the environment

Results Plus: Examiner Comments

Vague statements such as better for the environment will not score.

Results Plus: Examiner Tip

When answering questions that are looking for advantages or disadvantages of using a specific substance, remember to be specific with your answers. 'Environmentally friendly' is unlikely to gain credit as is 'cheaper'. If you were to state that hydrogen is better for the environment as it does not release carbon dioxide, then this would gain credit.

(iii) Explain one disadvantage of using hydrogen as a fuel for vehicles.

(2)

It is hard to store /transport as it is a gas and must be kept at high pressure.

Results Plus: Examiner Comments

This answer is not sufficient. Hydrogen does put water into the air. If the candidate had stated that it does not put harmful gases into the air then credit would have been awarded.

(ii) State one advantage of using hydrogen, rather than petrol, as a fuel for vehicles.

(1)

It doesn't produce carbon dioxide.

Results Plus: Examiner Comments

An acceptable advantage of using hydrogen rather than petrol is stated in this answer. Some candidates stated that hydrogen produced less carbon dioxide, this is not acceptable as it implies that some carbon dioxde is produced, but just less.

(b) (iii)

Candidates found explaining a disadvantage of hydrogen much more difficult than stating an advantage. Candidates often scored one mark for giving a disadvantage but then found it hard to explain why it was a disadvantage.

(iii) Explain one disadvantage of using hydrogen as a fuel for vehicles.

(2)

Be more expensive

Results Plus: Examiner Comments

Just stating that it would be more expensive was not sufficient for the mark. If the candidate had stated that hydrogen was more expensive to make then credit could have been awarded.

(iii) Explain one disadvantage of using hydrogen as a fuel for vehicles.

(2)

It is hard to store /transport as it is a gas

Results Plus: Examiner Comments

A good answer that explains that it is hard to store the gas because it must be kept at high pressure, this candidate scores 2 marks.

Q40.

Many candidates thought that an alloy has been formed or that iron somehow reacts with zinc. Others ignored the stem of the question and insisted the iron was not exposed, the zinc completely covering the iron. Many candidates recognised that zinc is more reactive than iron, but some said that zinc would rust. Few gave the idea that zinc would corrode easier or in preference to iron. Many just said 'instead of'. Many seemed to have an idea of sacrificial protection. The word 'galvanised' was sometimes seen, but rarely explained.

Iron fences can be galvanised by coating them with a layer of zinc.
When the layer of zinc is scratched exposing the iron to the weather, the iron does not rust.

Explain why the exposed iron does not rust.

(2)

As the rest of the fence is still covered with zinc, the zinc will still rust before the iron as it is more reactive. As it is more reactive it will lose electrons more easily meaning it will prevent the less reactive iron from rusting.

Results Plus: Examiner Comments

Potentially, this was heading to be a good answer, but was let down by the start of the second line. The candidate stated that the zinc is more reactive (than iron) and so scored the second marking point and that was taken a little further with the zinc's ability to lose electrons more easily. Unfortunately 'zinc will still rust' is incorrect and the first marking point was not given, so overall this answer scored 1 mark.

Results Plus: Examiner Tip

'Rust' and 'rusting' are words that are associated with the corrosion of iron and steel only. To that any other metal rusts is incorrect and will not score.

Iron fences can be galvanised by coating them with a layer of zinc.
When the layer of zinc is scratched exposing the iron to the weather, the iron does not rust.

Explain why the exposed iron does not rust.

(2)

Galvansing is an example of sacrificial protection. This is putting a more reactive metal ontop of the iron. The zinc is more reactive ~~than~~ so it will react instead of the iron.

Results Plus: Examiner Comments

A good answer and this scored 2 marks. The candidate clearly understands the the reason why the iron is coated by the zinc as seen by the first line which was then explained in the rest of the answer.

Results Plus: Examiner Tip

Learn all the different ways iron can be prevented from rusting together with an explanation of how that method works.

Q41.

(b)

Many responses scored the full 2 marks available. The majority gained at least 1 mark for correctly calculating the number of moles of zinc used or hydrogen formed, namely 0.2 moles. Many were able to recognise that to calculate the volume of hydrogen, then the number of moles needed to be multiplied by 24, to achieve 4.8 dm^3. Occasionally, after having obtained the correct answer, candidates then incorrectly multiplied this answer by 2, to give a final answer of 9.6, so only scoring 1 mark.

(b) Zinc reacts with dilute hydrochloric acid to form zinc chloride and hydrogen.

$$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$$
$$13g \qquad\qquad\qquad\qquad\qquad ?$$

Calculate the maximum volume of hydrogen formed, at room temperature and pressure, when 13.0 g of zinc reacts completely with excess hydrochloric acid.
(relative atomic mass: Zn = 65.0,
1 mol of any gas occupies 24 dm^3 at room temperature and pressure)

(2)

A_r Zn = 65
65g = 1mole
13g = 0.2mol

1mole Zn → 1mole H_2
0.2mol Zn → 0.2mol H_2
1mol = 24dm3
0.2mol = 4.8dm3

volume of hydrogen = 4.8 dm^3

Results Plus: Examiner Comments

A typical response. This candidate has clearly laid out the working in logical steps to arrive at the correct answer, 4.8 dm^3. This response scored 2 marks.

(c)(ii)

This question was extremely well answered, with most candidates scoring the full 2 marks for 'dynamic equilibrium'. When a 1 mark response was seen occasionally, it was for simply mentioning just 'equilibrium' only or simply mentioning 'reversible reaction'.

(d)

The quality of many of the responses seen by examiners was exemplary. At Level 3, for 6 marks, many candidates were able to explain in detail the conditions used in the Haber process for the manufacture of ammonia, namely the effects of temperature and pressure and the use of a catalyst on yield and rate in equilibrium reactions. The explanations for the effect of increasing pressure were particularly well developed by candidates, but less so for the effects of temperature or the use of a catalyst.

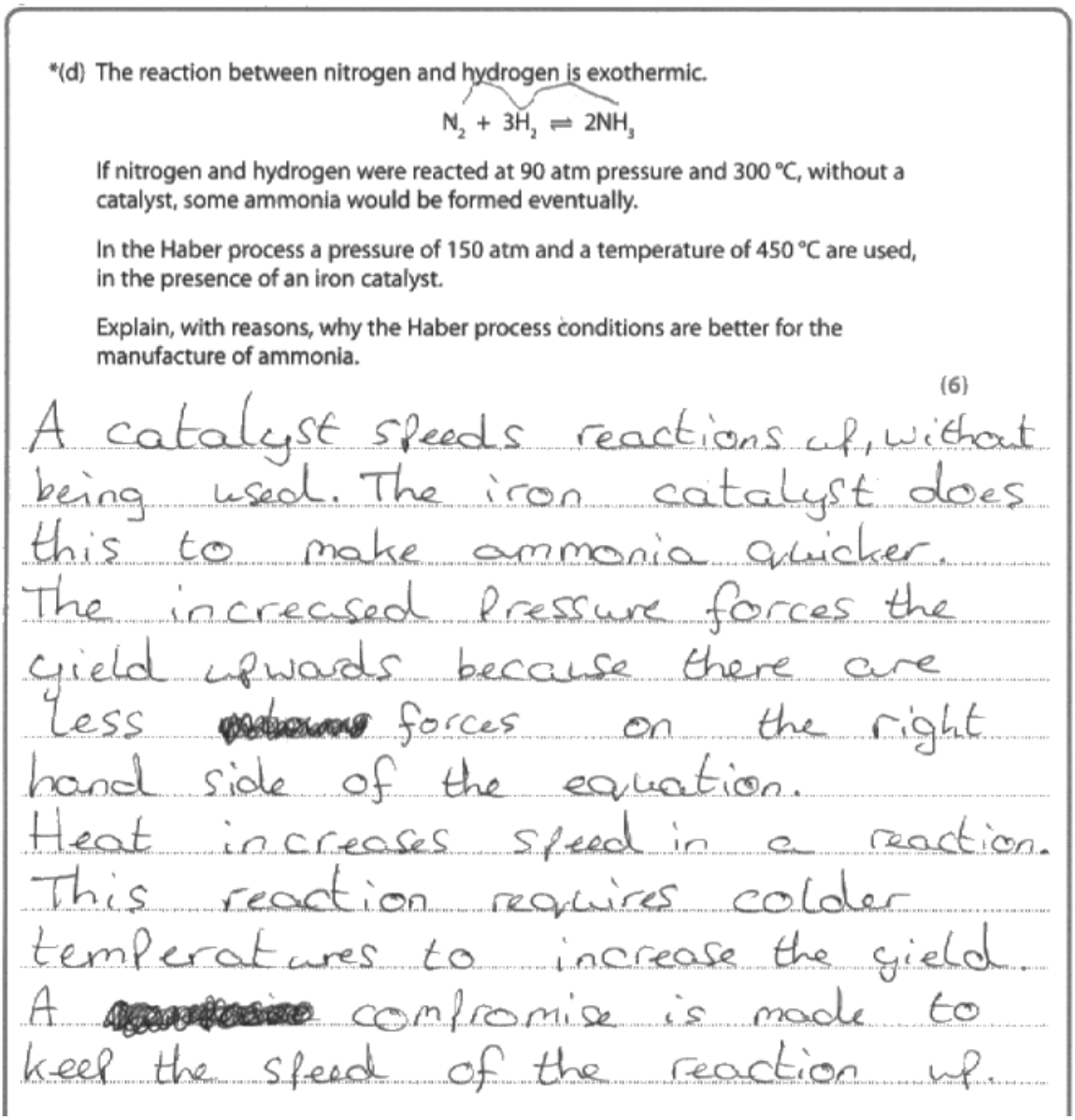
At Level 2, for 4 marks, tended to discuss the effects of changing the conditions on yield and rate of reaction on the Haber process, with no detailed explanation.

Commonly seen areas of weakness or misconceptions included:

- a confusion over the effect of increasing the temperature, many candidates incorrectly thought that this would increase the yield of ammonia;
- a limited knowledge of how a catalyst affects an equilibrium reaction, such that this was often limited to a catalyst speeding up the rate of a reaction;
- explanations for the increasing rate of reaction using collision theory were often not

well-developed.

It is also worthwhile noting that the 'optimum' conditions, for the pressure and temperature used, for the Haber process will vary depending on the sources used, such that those in the question may have not necessarily been the same as those shared with candidates when teaching this topic at centres.



*(d) The reaction between nitrogen and hydrogen is exothermic.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

If nitrogen and hydrogen were reacted at 90 atm pressure and 300 °C, without a catalyst, some ammonia would be formed eventually.

In the Haber process a pressure of 150 atm and a temperature of 450 °C are used, in the presence of an iron catalyst.

Explain, with reasons, why the Haber process conditions are better for the manufacture of ammonia.

(6)

A catalyst speeds reactions up, without being used. The iron catalyst does this to make ammonia quicker. The increased pressure forces the yield upwards because there are less [illegible] forces on the right hand side of the equation. Heat increases speed in a reaction. This reaction requires colder temperatures to increase the yield. A [illegible] compromise is made to keep the speed of the reaction up.

Results Plus: Examiner Comments

An example of a Level 2, 4 marks, response.

Three effects of change have been discussed: a catalyst speeds up the rate of reaction; increasing pressure – increases the yield, but this is not explained correctly; heat increases (equivalent to increased temp, although poorly expressed) – increases speed of reaction and the effect of using of a lower temperature – increases yield (but there is a compromise between speed and yield).

*(d) The reaction between nitrogen and hydrogen is exothermic.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

If nitrogen and hydrogen were reacted at 90 atm pressure and 300 °C, without a catalyst, some ammonia would be formed eventually.

In the Haber process a pressure of 150 atm and a temperature of 450 °C are used, in the presence of an iron catalyst.

Explain, with reasons, why the Haber process conditions are better for the manufacture of ammonia.

(6)

A high temperature means the reaction will be fast but low yeild. A lower temperature means more yeild but more time.

Results Plus: Examiner Comments

An example of a Level 1, 2 marks, response.

Two effects due to temperature have been discussed: increasing temperature – increases speed and lowers yield (of ammonia). The reverse argument is also given.

*(d) The reaction between nitrogen and hydrogen is exothermic.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

If nitrogen and hydrogen were reacted at 90 atm pressure and 300 °C, without a catalyst, some ammonia would be formed eventually.

In the Haber process a pressure of 150 atm and a temperature of 450 °C are used, in the presence of an iron catalyst.

Explain, with reasons, why the Haber process conditions are better for the manufacture of ammonia.

(6)

The higher pressure of 150 atm in the Haber process is better for the manufacture of ammonia as it increases the rate of reaction, as the reactants collide more frequently, and it increases the yield of ammonia as the higher pressure favours the reaction that produces a lower volume of gas, with fewer moles of gas, so the ammonia in this case. The higher temperature decreases the yield of ammonia, as it favours the endothermic reaction to produce hydrogen and nitrogen, using up the excess energy, but it increases the rate of reaction as the reactants collide more frequently. Therefore, much more ammonia can be produced quickly, so it is better for the ~~what~~ industrial manufacture of ammonia. An iron catalyst is better than no catalyst as it lowers the activation energy required for the reactions, so it increases the rate of reaction and allows the reactions to reach equilibrium sooner, so ammonia can be made faster, so this is better than no catalyst. This means that the Haber process conditions manufacture ammonia at a faster rate, so ~~the~~ the manufacturers can get more money quickly.

(Total for Question 6 = 12 marks)

TOTAL FOR PAPER = 60 MARKS

Results Plus: Examiner Comments

A typical example of a very detailed answer, Level 3, 6 marks.

The candidate has described all the valid effects of changing all three conditions, with at least two points of explanation for each change: higher pressure - increases speed and increases yield, with an explanation in terms of decreased number of moles/volume and collision theory; higher temperature – decreases yield and increases speed, with an explanation in terms of favouring the endothermic (back) reaction and collision theory; use of a catalyst – speeds up rate, equilibrium reached faster and lowers activation energy.

Q42. No Examiner's Report available for this question

Q43.

This question was poorly answered on the whole with the majority of responses not scoring the 1 mark available.

Few candidates were able to correctly explain the reason for using brass rather than copper for the pins of an electric plug, namely that pins made from brass do not bend. The most commonly seen incorrect responses referred to the fact that the brass would be 'less likely to break'.

Q44. No Examiner's Report available for this question

Q45. No Examiner's Report available for this question

Q46. No Examiner's Report available for this question

Q47.

The most common answer to this question was related to pollution and suggested that candidates were answering the question as to why hydrogen may be a better fuel than hydrocarbons. There was little understanding shown of chemical cells, or hydrogen-oxygen cells.

Mark Scheme

Q1.

Question Number	Answer	Acceptable answers	Mark
(a)(i)	**2** Na **(1)** + Cl_2 → **2** NaCl (1) Ignore + in front of the 2s	maximum 1 mark if any balancing number is added in front of Cl_2 or if any of the formulae are changed eg 4Na + $2Cl_2$ → 4NaCl or Na + 1/2 Cl_2 → NaCl score (1) do not allow negative signs in front of balancing numbers	**(2)**

Question Number	Answer	Acceptable answers	Mark
(a)(ii)	2.5 / 4.0 (1) their fraction x 100 (1) (=62.5)	0.625 or 5/8 62.5/63 with {no/incorrect} working correct working with {no/wrong}	**(2)**

Question Number	Answer	Acceptable answers	Mark
(a)(iii)	A ionic		**(1)**

Question Number	Answer	Acceptable answers	Mark
(a)(iv)	23 + 35.5 (=58.5) Ignore g	58.5 with {no/incorrect} working 23 + 35.5 with {no/wrong} answer do not allow 58/59 without working	**(1)**

Question Number	Answer	Acceptable answers	Mark
(b)	$\frac{24}{120}$ (1) their fraction x 100 (1) (=20%)	1/5 or 0.2 20 with {no/incorrect} working correct working with {no/wrong} answer	**(2)**

Question Number	Answer	Acceptable answers	Mark
(c)(i)	CH_3	2 CH_3 / C_1H_3 / H_3C do not allow just 1:3	**(1)**

Question Number	Answer	Acceptable answers	Mark
(c)(ii)	An explanation linking any **two** from weak {forces/attractions} (1) between {molecules/particles/them}/ intermolecular (1) little {heat/energy} needed {to separate the molecules/overcome force(s) between molecules} (1)	maximum **1** mark if breaking bonds between atoms/breaking down {molecules/ particles}/breaking covalent bonds specific weak forces eg Van der Waals/London weak bonds do not allow covalent bonds are weak /weak bonds between atoms ignore weak hydrogen bonds weak bonds between {molecules / particles} do not allow intramolecular 'little energy is needed to break the bonds' only if it is clear that {covalent/single} bonds are not being broken	**(2)**

(Total for Question = 11 marks)

Q2.

Question Number	Indicative content	Mark
	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlines in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. • equilibrium reached faster because of higher temperature in set A / equilibrium reached slower because of lower temperature in set B • higher temperature means more frequent collisions because molecules have more energy / ORA for lower temperature in set B • decrease in temperature increases equilibrium yield but system takes longer to reach equilibrium • temperature chosen for optimum conditions • yield lower as forward reaction is exothermic • high temperature favours back reaction which is endothermic • equilibrium reached faster because of higher pressure in set B / equilibrium reached slower because of lower pressure in set A • higher pressure causes molecules to be closer together so more frequent collisions / ORA for lower pressure in set A • yield higher because products occupy smaller volume than reactants for set B • catalyst in set B causes equilibrium to be reached faster • catalyst increases rate of both forward and back reactions • equilibrium position not affected so catalyst does not affect yield • catalyst reduces the need for the higher temperature	**(6)** AO 2 1 AO 3 1a AO 3 1b

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1–2	• Interpretation and evaluation of the information attempted but will be limited with a focus on mainly just one variable. Demonstrates limited synthesis of understanding. (AO3) • The explanation attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question. (AO2)
Level 2	3–4	• Interpretation and evaluation of the information on both variables, synthesising mostly relevant understanding. (AO3) • The explanation is mostly supported through linkage and application of knowledge and understanding of scientific ideas, some logical connections made between elements in the context of the question. (AO2)
Level 3	5–6	• Interpretation and evaluation of the information, demonstrating throughout the skills of synthesising relevant understanding. (AO3) • The explanation is supported throughout by linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of the question. (AO2)

Q3.

Question Number	Answer	Additional guidance	Mark
(i)	gain of oxygen	allow loss of electrons allow addition of oxygen ignore oxygen reacts with metal/substance	(1) AO 1 1

Question Number	Answer	Additional guidance	Mark
(ii)	An explanation linking • the paint {excludes/acts as a barrier/protective layer/shield} (1) • (excludes) air / oxygen / water (1)	 allow rain or moisture for water	(2) AO 2 2

Question Number	Answer	Additional guidance	Mark
(iii)	sacrificial protection	allow coat with plastic / oil / grease allow galvanising allow add a more reactive metal ignore to make an alloy ignore painting ignore electroplating ignore add another metal alone ignore keep away from water/air/oxygen	(1) AO 1 2

Q4.

Question number	Answer	Additional guidance	Mark
(i)	measuring cylinder	allow burette or pipette	(1)

Question number	Answer	Mark
(ii)	(ammonia) + phosphoric acid → ammonium phosphate	(1)

Question number	Answer	Mark
(iii)	An answer that combines the following points of application of knowledge and understanding to provide a logical description: • first heat the solution/leave water to evaporate (1) • and then filter off/dry crystals formed (1)	(2)

Q5.

Question number	Indicative content	Mark
*	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. **AO1 (3 marks) AO2 (3 marks)** • pipette to measure out the ammonia solution (25 cm^3) • into a suitable container, e.g. conical flask • add few drops of methyl orange indicator • put flask on a white tile • fill burette with sulfuric acid solution • read level of liquid in burette • add acid from the burette • swirl flask gently / mix • add drop-wise near end-point • until {indicator just changes colour} • read level on burette • repeat experiment until concordant results owtte • mix the same volumes of sulfuric acid and ammonia solution (determined from the titration experiment) • but leaving out the indicator/methyl orange • pour solution into an evaporating dish • heat the solution to point of crystallisation • leave to cool • filter off crystals • leave to dry	EXP (6)

Level	Mark	Descriptor
	0	• No awardable content
Level 1	1-2	• Demonstrates elements of chemical understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) • The explanation attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question. (AO2)
Level 2	3-4	• Demonstrates chemical understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1) • The explanation is mostly supported through linkage and application of knowledge and understanding of scientific ideas, some logical connections made between elements in the context of the question. (AO2)
Level 3	5-6	• Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) • The explanation is supported throughout by linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of the question. (AO2)

Level	Mark	Additional Guidance	General additional guidance – the decision within levels
			Eg - At each level, as well as content, the scientific coherency of what is stated backed up by planning detail will help place the answer at the top, or the bottom, of that level.
	0	No rewardable material.	
Level 1	1–2	Additional guidance Describes at least two steps of any of the three stages in the preparation of the ammonium sulfate crystals	Possible candidate responses • add sulfuric acid using a burette to ammonium solution • use a pipette to measure out the ammonia solution and fill a burette with sulfuric acid • mix correct volumes of sulfuric acid and ammonia solution together without indicator • heat the ammonium solution until crystals start to form
Level 2	3–4	Additional guidance Describes at least two of the three stages in some detail, at least three steps, OR all three stages but lacking detail	Possible candidate responses • use a pipette to measure out the ammonia solution into a conical flask add few drops of indicator, add acid from a burette to ammonia solution. Crystallise the ammonium sulfate solution. • use a pipette to measure out the ammonia solution. Add sulfuric acid using a burette to ammonia solution. Mix correct volumes of sulfuric acid and ammonia solution together without indicator to produce ammonium sulfate solution. • carry out a titration adding acid to ammonia to find amounts of acid and ammonia solution needed. Mix correct amounts of sulfuric acid and ammonia solution together without indicator. Crystallise the ammonium sulfate solution.
Level 3	5–6	Additional guidance Describes all three stages in the preparation of the ammonium sulfate crystals in some detail to include without use of indicator (6 marks) OR two stages in detail to include repeating without indicator (5 marks)	Possible candidate responses • use a pipette to measure out the ammonia solution into a conical flask. Add a few drops of indicator. Add acid from a burette to ammonia solution, swirling flask, until indicator just changes colour. Mix correct volumes of sulfuric acid and ammonia solution together without indicator to produce ammonium sulfate solution. Heat the ammonium sulfate solution until crystals start to form. Leave to cool and filter off crystals. • use a pipette to measure out the ammonia solution into a conical flask. Add a few drops of indicator. Place flask on white tile. Fill a burette with sulfuric acid and read level on burette. Add acid to ammonia solution, swirling flask, until indicator just changes colour. Read level on burette. Use the results of titration, mixing the correct volumes of sulfuric acid and ammonia leaving out indicator.

Q6.

Question number	Indicative content
	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material that is indicated as relevant. Additional content included in the response must be scientific and relevant. **AO1 (6 marks)** • rinse pipette with alkali and burette with acid • measure alkali using a pipette into suitable container e.g. flask/beaker and place flask on a white tile • add a few drops of indicator/suitable named indicator (eg methyl orange/phenolphthalein) • fill burette with acid and read volume of acid in burette • add acid from burette to the flask slowly swirling the flask until {indicator just changes colour/correct colour change for named indicator (eg methyl orange yellow to peach/orange, phenolphthalein pink to colourless)/solution is neutral} • read volume of acid in burette at end of titration • repeat experiment until concordant results • mix the same volume of alkali with the volume of acid determined from the titration but do not add indicator • pour solution into an evaporating basin then {heat solution/leave the water to evaporate} until pure salt crystals are left • dry crystals using absorbent paper

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1-2	• Demonstrates elements of chemical understanding, some of which is inaccurate. Understanding of scientific, enquiry, techniques and procedures lacks detail. (AO1) • Presents a description which is not logically ordered and with significant gaps. (AO1)
Level 2	3-4	• Demonstrates chemical understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas, enquiry, techniques and procedures is not fully detailed and/or developed. (AO1) • Presents a description of the procedure that has a structure which is mostly clear, coherent and logical with minor steps missing. (AO1)
Level 3	5-6	• Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas, enquiry, techniques and procedures is detailed and fully developed. (AO1) • Presents a description that has a well-developed structure which is clear, coherent and logical. (AO1)

Q7.

Question number	Answer	Additional guidance	Mark
(i)	A description to include • the strength increases (1) AND any one from • as percentage of magnesium (by mass in the alloy) increases (1) • linearly (1) • from 0.1 % to 3.5 % magnesium (1)	MP2 is dependent on MP1	(2) AO3

Question number	Answer	Additional guidance	Mark
(ii)	(from graph) percentage by mass of magnesium = 3.0 % (1) percentage aluminium in alloy = 100 - 3 (1) (= 97 (%))	credit MP1 if written on graph ecf	(2) AO3

Q8.

Question number	Answer	Additional guidance	Mark
(i)	A description to include • the strength increases (1) AND any one from • as percentage of magnesium (by mass in the alloy) increases (1) • linearly (1) • from 0.1 % to 3.5 % magnesium (1)	MP2 is dependent on MP1	(2) AO3

Question number	Answer	Additional guidance	Mark
(ii)	(from graph) percentage by mass of magnesium = 3.0 % (1) percentage aluminium in alloy = 100 - 3 (1) (= 97 (%))	credit MP1 if written on graph ecf	(2) AO3

Q9.

Question number	Answer	Additional guidance	Mark
	A description to include two from • {colour / blue} fades / colourless solution **forms** (1) • (red-brown) solid forms (1) • magnesium disappears (1)	 stays colourless (0) turns colourless (1) ignore wrong starting colour ignore clear allow {red-brown} precipitate/ppt allow dissolves allow magnesium blackens	(2)

Q10.

Question number	Answer	Mark
	A description to include any two from • bright light at start (1) • fades/ gets dimmer (1) • then goes out (1)	**(2)** **AO2**

Q11.

Question number	Answer	Additional guidance	Mark
	final answer of 14 with or without working (3) OR $\frac{2.9}{5.0}$ = 0.58 (1) 0.58 x 100 = 58% (1) 14 (1)	allow ECF allow 13.8-14.0	**(3)**

Q12.

Question number	Answer	Additional guidance	Mark
(i)	both are {soluble/will dissolve} (in water)		(1)

Question number	Answer	Additional guidance	Mark
(ii)	$NH_3 + HNO_3 \rightarrow NH_4NO_3$ LHS (1) RHS (1)	allow multiples	(2)

Question number	Answer		Mark
(iii)	a similarity from : both use sulfuric acid (1) both (are examples of) neutralisation (1) and a difference from : the industrial process is on a much larger scale than the laboratory process / ORA (1) the industrial process involves more stages than the laboratory process / ORA (1) ammonia is a gas in the industrial process but a solution in the laboratory process (1) laboratory preparation uses titration and crystallisation (1)	 ignore both produce ammonium sulfate allow both use same reactants allow both give out heat energy / exothermic (1) allow laboratory preparation is a batch process, industrial preparation is continuous process (1) ignore industrial is more dangerous	(2)

Q13.

Question Number	Indicative content	Mark
	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlines in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. • an alloy is a mixture of metals • because larger/different sized atoms introduced in alloying, • stop layers moving easily over one another • therefore individual alloy is stronger/harder • an aluminium alloy is magnalium • pure aluminium is not suitable for making aircraft as it bends too easily / too weak • aluminium alloy stronger • magnesium atoms lighter than aluminium atoms, • therefore alloy still low density / lower density than aluminum alone • an iron alloy is stainless steel • pure iron is not suitable for cutlery as it bends too easily / too weak • iron corrodes, • corrosion would contaminate food • stainless steel does not corrode • gold alloy harder • therefore more hard wearing • gold alloys less likely to change shape when worn • alloying can change the colour of the gold	**(6)** AO 2 1 AO 3 1a AO 3 1b

Level	Mark	Descriptor
	0	• No awardable content
Level 1	1-2	• The plan attempts to link and apply knowledge and understanding of scientific enquiry, techniques and procedures, flawed or simplistic connections made between elements in the context of the question. (AO2) • Analyses the scientific information but understanding and connections are flawed. An incomplete plan that provides limited synthesis of understanding. (AO3)
Level 2	3-4	• The plan is mostly supported through linkage and application of knowledge and understanding of scientific enquiry, techniques and procedures, some logical connections made between elements in the context of the question. (AO2) • Analyses the scientific information and provides some logical connections between scientific enquiry, techniques and procedures. A partially completed plan that synthesises mostly relevant understanding, but not entirely coherently. (AO3)
Level 3	5-6	• The plan is supported throughout by linkage and application of knowledge and understanding of scientific enquiry, techniques and procedures, logical connections made between elements in the context of the question. (AO2) • Analyses the scientific information and provide logical connections between scientific concepts throughout. A well-developed plan that synthesises relevant understanding coherently. (AO3)

Q14.

Question Number	Answer	Acceptable answers	Mark
(a)	improves resistance to corrosion	ignore rusting	**(1)**

Question Number	Answer	Acceptable answers	Mark
(b)	An explanation to include • anode dissolves / half equation given / atoms lose electrons /copper becomes ions/copper (atoms) oxidised (1) • copper ions moving from anode to cathode (1) • copper plated on cathode / half equation given / ions gain electrons/copper ions reduced/copper ions form atoms (1) • {difference/0.2g} is impurities (1) • would expect same decrease in mass (as increase) (1)	ignore references to mass increase of cathode and mass decrease of anode ignore 'impure copper (ions)' for the second marking point allow difference is metal around it eaten away/ impurities/sludge fallen to bottom of container /under anode (1) (there needs to be a reference to the difference in electrode masses for this point)	**(3)**

Question Number	Answer	Acceptable answers	Mark
(c)	$2O^{2-} \rightarrow O_2 + 4e^{(-)}$ (2) OR $O^{2-} \rightarrow O + 2e^{(-)}$ (1) $2O \rightarrow O_2$ (1)	Unbalanced equation (1)	**(2)**

Question Number		Indicative Content	Mark
QWC	*** (d)**	A description including some of the following points • sodium chloride is melted and ions are free to move at cathode • {sodium / positive} ions move to cathode • (sodium) metal forms at cathode • sodium ions gain electrons ... • to form atoms • this is reduction • $Na^+ + e^- \rightarrow Na$ at anode • {chloride / negative} ions move to anode • (chlorine) gas forms at anode • chloride ions lose electrons ... • to form atoms • this is oxidation • two chlorine atoms combine to form a chlorine molecule / share electrons • $Cl^- \rightarrow Cl + e^-$ / $2Cl^- \rightarrow Cl_2 + 2e^-$ • $2\,Cl \rightarrow Cl_2$	**(6)**
Level	**0**	No rewardable content	
1	**1 - 2**	• a limited description e.g. gives at least one relevant description or explanation • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy	
2	**3 - 4**	• a simple description e.g. for anode or cathode gives at least three descriptions or relevant explanations • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy	
3	**5 - 6**	• a detailed description e.g. for both anode and cathode gives a total of at least five descriptions or relevant explanations • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors	

Q15.

Question Number	Answer	Acceptable answers	Mark
(a)	Cl^- and OH^-	Reject if any other ions given Allow names / chloride and hydroxide	**(1)**

Question Number	Answer	Acceptable answers	Mark
(b)	**D** lead and bromine		**(1)**

Question Number	Answer	Acceptable answers	Mark
(c)	A explanation to include: oxidation is the loss of electrons (1) reduction is the gain of electrons (1)	 oxidation is the gain of electrons **AND** reduction is the loss of electrons (1)	**(2)**

Question Number	Answer	Acceptable answers	Mark
(d)	A explanation to include any two from: to put a layer of one metal onto another metal (1) change / improve the appearance (of metal objects) (1) improve the resistance to corrosion (of metal objects) (1) qualified reference to cost eg thin layer of expensive metal on cheaper metal (1)	 allow to give shiny appearance / look nicer allow prevents corrosion ignore rusting unless linked to iron/steel	**(2)**

Q16.

Question Number	Answer	Additional guidance	Mark
(i)	dc (supply) / direct current / battery	allow power pack allow electrical supply allow power supply allow power source ignore electricity	**(1)** AO 2 1

Question Number	Answer	Additional guidance	Mark
(ii)	nickel sulfate/nickel chloride/nickel nitrate/soluble nickel salt		**(1)** AO 3 3a

Q17.

Question Number	Answer	Acceptable answers	Mark
(a)(i)	D the transition metals		**(1)**

Question Number	Answer	Acceptable answers	Mark
(a)(ii)	D malleable		**(1)**

Question Number	Answer	Acceptable answers	Mark
(b)(i)	non-flammable		**(1)**

Question Number	Answer	Acceptable answers	Mark
(b)(ii)	has a low density		**(1)**

Question Number	Answer	Acceptable answers	Mark
(c)(i)	A description including (yellow-) green (1) gas (1)	 any shade of green do not allow just 'yellow' do not allow green in combination with other colours eg blue-green	 **(2)**

Question Number	Answer	Acceptable answers	Mark
(c)(ii)	hydrogen + chlorine → hydrogen chloride lhs (1) rhs (1) Ignore formulae in addition to all of the names	if formulae are used, do not allow h or CL or superscripts $H_2 + Cl_2$ on lhs 2HCl on rhs reactants in either order do not allow a mixture of words and formulae for both marks eg $H_2 + Cl_2$ → hydrogen chloride scores 1 mark for rhs do not allow hydrochloric acid /hydrochloride/hydrogen chlorine	 **(2)**

(Total for Question = 8 marks)

Q18.

Question number	Indicative content	Mark
	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material that is indicated as relevant. Additional content included in the response must be scientific and relevant. **A01 and A02 (6 marks)** advantages • once set up, fuel cells require no maintenance • chemical cells will need to be replaced / chemical cells have a limited lifetime • fuel cells operate as long as reactants are supplied • voltage drops in chemical cells as reactants are used up • once used chemical cells cannot be used again or need re-charging • used chemical cells take up valuable space on spacecraft • new chemical cells need to be transported to spacecraft • used chemical cells need to be transported back to earth • water produced in the fuel cell is the only product • water can be used on the spacecraft as drinking water disadvantages • hydrogen and oxygen must be supplied • gas tanks need to transported by spacecraft • storage of hydrogen is difficult because it is a gas • hydrogen is flammable • fuel cells are expensive to manufacture conclusion • either cell can be chosen as the preferable one but suitable reasons must be given	**(6)**

Level	Mark	Additional Guidance	General additional guidance Eg - At each level, as well as content, the scientific coherency of what is stated backed up by planning detail will help place the answer at the top, or the bottom, of that level.
	0	No rewardable material.	
Level 1	1–2	Additional guidance Describes an advantage or disadvantage or states two advantages and/or disadvantages	Possible candidate responses • hydrogen is flammable (1) • new chemical cells need to be brought to the spacecraft (1) • water is the (only) product and can be used by astronauts as drinking water (2) • storage of hydrogen is difficult as hydrogen is a gas (2)
Level 2	3–4	Additional guidance Describes two advantages and/or disadvantages	Possible candidate responses • fuel cells are expensive to manufacture and are difficult to repair if they stop working, but fuels cells will continue to work whilst hydrogen and oxygen are supplied (3) • voltage of chemical cells drops as they are used so the energy produced decreases over time. Fuel cells produce water which can be used on the space craft (4)
Level 3	5–6	Additional guidance Describes three advantages and/or disadvantages **and** Evaluates the advantages and disadvantages to form a conclusion	Possible candidate responses • fuel cells are better than chemical cells. This is because water is the only product from the reaction of hydrogen and water. This water can be used on the space craft as drinking water. Chemical cells will become obsolete when reactants have been used up, therefore more chemical cells will be needed and the waste cells will take up valuable space on the space craft (6)

Q19.

Question number	Answer	Additional guidance	Mark
(i)	25 ÷ 1000 × 0.1 = 0.0025 (1) 35 ÷ 1000 × 0.075 = 0.002 625 (1) The acid is in excess (1)	Third mark only awarded as conclusion from calculated data.	(3)

Question number	Answer	Mark
(ii)	$\frac{36.20 + 36.30}{2}$ = 36.25 (1)	(1)

Question number	Answer	Mark
(iii)	D	(1)

Q20.

Question Number	Indicative content
	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. **AO1 (6 marks)** The effect of the temperature rise on the rate of attainment of equilibrium and on the equilibrium yield are considered by: • higher temperature reaches equilibrium faster because molecules move faster • therefore there are more frequent collisions because molecules have more energy • therefore more collisions have required energy but yield will be lower • because higher temperature favours endothermic reaction and so equilibrium shifts to left hand side • which is decomposition of ammonia / ammonia reforms elements • catalyst causes reaction to reach equilibrium faster / catalyst increases rates (of both forward and back reactions) • lowers the activation energy (of both forward and back reactions) but does not affect yield • equilibrium position not affected.

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1-2	• Demonstrates elements of chemical understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) • Presents an explanation with some structure and coherence. (AO1)
Level 2	3-4	• Demonstrates chemical understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1) • Presents an explanation that has a structure which is mostly clear, coherent and logical. (AO1)
Level 3	5-6	• Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) • Presents an explanation that has a well-developed structure which is clear, coherent and logical. (AO1)

Q21.

Question number	Answer	Additional guidance	Mark
(i)	an explanation linking • shift equilibrium to right / in forward direction (1) • increase yield of {product / hydrogen / carbon monoxide} (1)	 allow favours forward/endothermic reaction ignore references to decreasing amounts of reactants. marks are independent	(2)

Question number	Answer	Additional guidance	Mark
(ii)	final answer of 2.4 with or without working (3) OR $\frac{0.4}{16} = 0.025$ (1) 0.025 x 4 = 0.1 (1) 0.1 x 24 = 2.4 (1)		(3)

Q22.

Question number	Answer	Mark
(i)	An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (2 marks): • rate increased/time to reach equilibrium reduced (1) • because gas molecules closer/more concentrated (1) • so increased collision rate/more frequent collisions(1)	(3)

Question number	Answer	Mark
(ii)	A	(1)

Q23.

Question number	Indicative content	Mark
*	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlines in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. **AO1 & AO2 (6 marks)** EXCESS AIR • increases oxygen concentration • so excess air favours right hand side • and gives higher yield • excess air increases concentration of oxygen • equilibrium reached faster PRESSURE • 9 molecules on left and 10 on right • so higher pressure favours left hand side • and gives lower yield • higher pressure increases concentration of gases • more frequent collisions • equilibrium reached faster TEMPERATURE • heat energy given out in forward reaction • higher temperature favours reaction that takes in heat energy • so higher temperature favours left hand side • hence lower yield • molecules move faster at higher temperature • more frequent collisions • therefore more reactions in given time • equilibrium reached faster	(6)

Level	Mark	Descriptor
	0	• No awardable content
Level 1	1-2	• Demonstrates elements of chemical understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) • The explanation attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question. (AO2)
Level 2	3-4	• Demonstrates chemical understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1) • The explanation is mostly supported through linkage and application of knowledge and understanding of scientific ideas, some logical connections made between elements in the context of the question. (AO2)
Level 3	5-6	• Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) • The explanation is supported throughout by linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of the question. (AO2)

Level	**Mark**	**Descriptor**	**Additional guidance**
	0	No rewardable material.	Read whole answer and ignore all incorrect material/ discard any contradictory material then:
Level 1	1–2	Additional guidance **One** factor is discussed with a **statement** of effect on yield **and/or** rate (1) **One** factor is discussed with **explanation** of yield **and/or** rate (2) **Two or three** factors are discussed with **statement** of effect on yield **and/or** rate (2)	Possible candidate responses A higher pressure gives a lower yield because there are more gas molecules on the right hand side. Factor and reason – 2 marks
Level 2	3–4	Additional guidance **One** factor is **fully** discussed with **explanation** of yield **and** rate. (3) **Two** factors are discussed with **explanation** of yield **and/or** rate in one case and just **statement** of yield **and/or** rate in one case(3) **Two** factors are discussed with **explanation** of yield **and/or** rate in each case (4) **Three** factors are discussed with **statement** of effect on yield **and/or** rate with **explanation** for at least one (4)	Possible candidate responses A higher pressure gives a lower yield because there are more gas molecules on the right hand side. A higher temperature gives a lower yield because the forward reaction is exothermic. 2 factors both with reasons – 4 marks
Level 3	5–6	Additional guidance All **three** factors are discussed, with **explanation** of yield **and/or** rate in each case (6) All **three** factors are discussed, with **explanation** of yield **and/or** rate in two cases (5)	Possible candidate responses Excess air gives a higher yield. A higher pressure gives a higher rate because the gas molecules are closer and collide more frequently. A higher temperature gives a higher rate because more molecules have the activation energy. 3 factors, 2 have reasons, 1 statement (air) – 5 marks

Q24.

Question number	Indicative content	Mark
*	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlines in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. **Colour change** • copper is red brown • black colour is copper oxide **Mass increase** • oxygen atoms are added • oxygen atoms have mass • increase in mass due to oxygen atoms • powder heated for longer • powder has more copper atoms exposed • powder reacts more • powder adds more oxygen atoms • powder has larger mass increase **Mass increase less than expected** • copper is unreactive metal • unreactive metals have slow reactions • time not enough for reaction to be complete • copper oxide only forms on surface so less forms on piece than powder • Bunsen flame not hot enough for full reaction • some copper powder may be lost to air • some copper oxide may be lost to air	**(6)** **AO2** **AO3**

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1–2	Interpretation and evaluation of the information attempted but will be limited with a focus on mainly just one variable. Demonstrates limited synthesis of understanding. (AO3) The explanation attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question. (AO2)
Level 2	3–4	Interpretation and evaluation of the information on both variables, synthesising mostly relevant understanding. (AO3) The explanation is mostly supported through linkage and application of knowledge and understanding of scientific ideas, some logical connections made between elements in the context of the question. (AO2)
Level 3	5–6	Interpretation and evaluation of the information demonstrating throughout the skills of synthesising relevant understanding. (AO3) The explanation is supported throughout by linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of the question. (AO2)

Level	Mark	Descriptor	Additional Guidance
	0	No rewardable material.	Read whole answer and ignore all incorrect material/ discard any contradictory material then:
Level 1	1–2	Additional Guidance	Possible candidate response • the longer the heating is the more product is formed (1) • the red-brown copper forms black copper oxide (2) • oxygen is added in heating so the mass increases (2)
Level 2	3–4	Additional Guidance	Possible candidate response • the red-brown copper forms black copper oxide by reacting with oxygen, and the added oxygen causes a mass increase (4)
Level 3	5–6	Additional Guidance Must address all aspects of question to score Level 3	Possible candidate response • the red-brown copper forms black copper oxide by reacting with oxygen, and the added oxygen causes a mass increase. The longer the copper is heated, the more oxygen is gained. However, copper is not very reactive, so it will not all react in the time given to heating even if a powder heated for 10 minutes (6).

Q25.

Question number	Answer	Mark
	An explanation that combines identification via a judgement (1 mark) to reach a conclusion via justification/reasoning (1 mark): • aluminium and copper have different size atoms (1) • and so this prevents the layers of metal atoms from sliding over one another (1)	**(2)**

Q26.

Question number	Answer	Additional guidance	Mark
	An explanation linking • (18 carat gold) contains atoms of different sizes/ORA (1) • disrupts structure of metal / prevents layers from {slipping / sliding /moving} over one another (1)	reject molecules once allow particles/ions for atoms allow particles / atoms / sheets / rows for layers	**(2)**

Q27.

Question number	Indicative content	Mark
*	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material that is indicated as relevant. Additional content included in the response must be scientific and relevant. (effect of using a catalyst) • increases rate of attainment of equilibrium • increasing rate of both forward and back reaction • lowers activation energy • provides an alternative reaction pathway • no effect on equilibrium yield (effects of using a temperature of 220°C rather than lower temperatures) • equilibrium attained in a shorter period of time / faster rate of attainment of equilibrium • because particles move faster/ have higher (kinetic) energy • increased collision frequency and more energetic collisions • equilibrium yield of hydrogen increases with higher temperatures • because heat energy is taken in the forward reaction (endothermic) • increasing the temperature shifts equilibrium further to the right-hand side	**(6)** **AO1**

Level	Mark	Additional Guidance	General additional guidance – the decision within levels Eg - At each level, as well as content, the scientific coherency of what is stated backed up by detail will help place the answer at the top, or the bottom, of that level.
	0	No rewardable material.	
Level 1	1–2	Additional guidance Identifies at least ONE way that use of a catalyst OR temperature affects equilibrium. OR A simple explanation of one way that catalyst or temperature affects equilibrium.	Possible candidate responses • Increasing temperature increases rate of attainment. • Increasing temperature shifts equilibrium to the right. • Using a catalyst has no effect on the equilibrium yield / position of equilibrium • Using a catalyst increases rate of attainment. • Increasing temperature increases the rate of attainment and produces more hydrogen (2) • Using a catalyst lowers activation energy so equilibrium is reached faster (2)
Level 2	3–4	Additional guidance A simple explanation of at least TWO ways that the use of a catalyst OR temperature affects equilibrium. OR A detailed explanation of ONE way that equilibrium is affected	Possible candidate responses • Increasing temperature favours the endothermic reaction so more hydrogen is produced. • A catalyst has no effect on the equilibrium yield but provides an alternative reaction pathway, so the rate of attainment of equilibrium increases. • Increasing temperature means that particles have more kinetic energy, so there are more frequent, successful collisions and the rate of attainment of equilibrium increases.
Level 3	5–6	Additional guidance A detailed explanation of at least TWO ways that the use of a catalyst AND temperature affects equilibrium	Possible candidate responses • Increasing the temperature favours the endothermic reaction and so a higher temperature will produce more hydrogen. A catalyst has no effect on the equilibrium yield as it increases the rate of both the forward and reverse reaction. • Increasing temperature gives the particles more kinetic energy and increases the frequency of collisions, so the rate of attainment of equilibrium increases. Using a catalyst lowers the activation energy, so more particles have the minimum energy required for a successful collision

Level	Mark	Descriptor
	0	No awardable content
Level 1	1-2	• Demonstrates elements of chemical understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) • Presents an explanation with some structure and coherence. (AO1)
Level 2	3-4	• Demonstrates chemical understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1) • Presents an explanation that has a structure which is mostly clear, coherent and logical. (AO1)
Level 3	5-6	• Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) • Presents an explanation that has a well-developed structure which is clear, coherent and logical. (AO1)

Q28.

Question number	Answer	Additional guidance	Mark
	An explanation linking • (in pure aluminium all the atoms are the same (size) whereas) in alloy atoms are different sizes (1) • (in aluminium) {layers/rows/sheets} of atoms easily slide over each other (1) • (in alloy) {layers/rows/sheets} of atoms cannot easily slide over each other (1)	reject the use of 'molecules' once only allow ion/particle in place of atom throughout	(3) AO1

Q29.

Question number	Answer	Additional guidance	Mark
	An explanation linking • (in pure aluminium all the atoms are the same (size) whereas) in alloy atoms are different sizes (1) • (in aluminium) {layers/rows/sheets} of atoms easily slide over each other (1) • (in alloy) {layers/rows/sheets} of atoms cannot easily slide over each other (1)	reject the use of 'molecules' once only allow ion/particle in place of atom throughout	(3) AO1

Q30.

Question number	Answer	Mark
(i)	An explanation including any two from • air/oxygen excluded (1) • water excluded (1) • air/oxygen/water needed for corrosion (1)	(2) AO2

Question number	Answer	Mark
(ii)	An explanation including • zinc is more reactive (than iron) (1) • so reacts instead (1)	(2) AO1

Q31.

Question number	Answer	Additional guidance	Mark
(i)	An explanation to include • magnalium has a **lower** density than aluminium ORA (1) • magnalium is **stronger** than aluminium ORA (1) • magnalium has a **higher** resistance to corrosion than aluminium ORA (1)	 allow magnalium lighter	(3)
(ii)	5.0 with or without working scores 2 3.15 (1) x 100 (1) 63.0 (= 5.0)	allow any sig fig if fraction inverted then x 100 = 2000 allow (1) for 20 allow (1) allow any fraction using data x 100 (1)	(2)

Q32.

Question number	Answer	Mark
(i)	An explanation linking • both {air/oxygen} and water needed for rusting (1) then any two from • tube a – {air/oxygen} and water present (1) • tube b – only dry {air/oxygen} present / no water (1) • tube c – only water present (with nail) / no {air/oxygen} (1)	(3)

Question number	Answer	Additional guidance	Mark
(ii)	No rusting / remains clean / does not corrode	ignore any statements about magnesium	(1)

Question number	Answer	Mark
(iii)	**C** the iron is oxidised **The only correct answer is C** **A** is not correct – hydration is a different reaction **B** is not correct – neutralisation involves an acid **D** is not correct – reduction is loss of oxygen or gain of electrons which does not happen here	(1)

Q33.

Question number	Answer	Additional guidance	Mark
(i)	An explanation linking • solution from titration contains an indicator (1) • therefore second solution used with no indicator / indicator would contaminate salt (1)	MP2 dependent on MP1 allow original mixture was contaminated by indicator so doesn't form a pure salt (2)	(2)

Question number	Answer	Additional guidance	Mark
(ii)	final answer of 120% with or without working (2) OR $\frac{0.84}{0.70}$ (=1.2) (1) $\frac{0.84}{0.70}$ x 100 (=120(%)) (1)	allow any fraction x100 (1)	(2)

Question number	Answer	Additional guidance	Mark
(iii)	{the salt/solid/potassium chloride} was still wet/ not all of the water had been evaporated off		(1)

Question number	Answer	Additional guidance	Mark
(iv)	final answer of 80.5 with or without working (4) OR total mass: 56 + 36.5 (=92.5) / 74.5 + 18 (=92.5) (1) $\frac{74.5}{92.5}$ (= 0.8054) (1) $\frac{74.5}{92.5}$ x 100 (=80.540) (1) = 80.5 (1)	allow ECF throughout 92.5 seen (1) incorrect answer with working to 1 decimal place (1) 50.0/100.0 does not score MP4	**(4)**

Q34.

Question number	Answer	Additional guidance	Mark
(i)	An explanation linking • solution from titration contains an indicator (1) • therefore second solution used with no indicator / indicator would contaminate salt (1)	MP2 dependant on MP1 allow original mixture was contaminated by indicator so doesn't form a pure salt (2)	**(2)**

Question number	Answer	Additional guidance	Mark
(ii)	final answer of 120% with or without working (2) OR $\frac{0.84}{0.70}$ (=1.2) (1) $\frac{0.84}{0.70}$ x 100 (=120(%)) (1)	 allow any fraction x100 (1)	(2)

Question number	Answer	Additional guidance	Mark
(iii)	{the salt/solid/potassium chloride} was still wet/ not all of the water had been evaporated off		(1)

Question number	Answer	Additional guidance	Mark
(iv)	final answer of 80.5 with or without working (4) OR total mass: 56 + 36.5 (=92.5) / 74.5 + 18 (=92.5) (1) $\frac{74.5}{92.5}$ (= 0.8054) (1) $\frac{74.5}{92.5}$ x 100 (=80.540) (1) = 80.5 (1)	allow ECF throughout 92.5 seen (1) incorrect answer with working to 1 decimal place (1) 50.0/100.0 does not score MP4	(4)

Q35.

Question number	Answer	Mark
	An explanation that combines identification – application of knowledge (1 mark) and reasoning/justification – application of understanding (1 mark): • (iron has not rusted because) zinc is more reactive than iron (1) • so zinc corrodes instead of iron (1)	(2)

Q36.

Question Number	Answer	Acceptable answers	Mark
(a)	Increases {plant/ crop} growth/ yield/ size/ growth rate Adds minerals/ specified suitable element eg N, P, K/ nutrients	Allow synonyms for increase eg promote, helps, enhances etc Reject kills pests	**(1)**

Question Number	Answer	Acceptable answers	Mark
(b)	A description linking two of the following • gets washed into water (1) • encourages growth of algae/ weed / algal bloom (1) • algae use up oxygen (1) • algae blocks sunlight (1) • **kills** aquatic life (1) • eutrophication (1) • contaminates drinking water (1)	Allow any sensible water eg river, lake etc but ignore sea Ignore damages, harms etc; allow any specified **water** life eg fish, **water** plants, animals **in water** Ignore effect of fertiliser on field eg on weeds.	**(2)**

Question Number	Answer	Acceptable answers	Mark
(c)(i)	ammonia + nitric acid → ammonium nitrate (2) Spelling must be correct but allow missing one 'm' from ammonia and/or ammonium	LHS (1) R ammonium RHS (1) R ammonia nitrate Allow fully correct balanced equation for 2 Ignore state symbols. If mixed words/symbols, any side with symbols scores 0.	**(2)**

Question Number	Answer	Acceptable answers	Mark
(c)(ii)	**A** corrosive		**(1)**

Question Number	Answer	Acceptable answers	Mark
(d)(i)	(reaction is) **reversible** / (reaches dynamic) **equilibrium**	Allow equilibria R static equilibrium	**(1)**

Question Number	Answer	Acceptable answers	Mark
(d)(ii)	**C** NH_3		**(1)**

Q37.

Question Number	Answer	Acceptable answers	Mark
(a) (i)	**C** $N_2 + 3H_2 \rightleftharpoons 2\ NH_3$		**(1)**

Question Number	Answer	Acceptable answers	Mark
(a) (ii)	reaction is reversible / goes both ways (1)	reaches equilibrium (1)	**(1)**

Question Number	Answer	Acceptable answers	Mark
(b) (i)	A description linking urea contains the highest percentage of nitrogen (1) (this is important because) nitrogen enables plants to grow (1)	 ignore references to oxygen	**(2)**

Question Number	Answer	Acceptable answers	Mark
(b) (ii)	An explanation linking any **two** of the following points (excess) fertiliser is washed into rivers (by rainfall) (1) plants/algae (in the river) grow bigger / more quickly (1) oxygen is used up (by bacteria) when the plants decay/die (1) (this leads to) fish/animals die (due to lack of oxygen) (1)	 allow grow better / increases growth must indicate idea of an increase in growth/faster growth	**(2)**

Q38.

Question Number	Answer	Additional guidance	Mark
(i)	ammonia + nitric acid → ammonium nitrate	accept reactants in either order ignore formula	**(1)** AO 2 1

Question Number	Answer	Mark
(ii)	C NH_4NO_3 **1. The only correct answer is C** ***A*** *is factually incorrect* ***B*** *is factually incorrect* ***D*** *is factually incorrect*	**(1)** AO 2 1

Question Number	Answer	Additional guidance	Mark
(iii)	An explanation linking two from: • as a fertiliser (1) • contains (a high percentage of) nitrogen (1) • help promote plant growth / increases crop yield (1)	allow make crops grow faster ignore use as a pesticide	**(2)** AO 1 1

Q39.

Question Number	Answer	Acceptable answers	Mark
(a)	C produce heat energy when they burn		**(1)**

Question Number	Answer	Acceptable answers	Mark
(b) (i)	hydrogen + oxygen → water LHS (1) RHS (1)	Correct formula Allow hydrogen oxide	**(2)**

Question Number	Answer	Acceptable answers	Mark
(b) (ii)	does not produce harmful {gases / products} /water produced can be used to make more hydrogen/ only produces water/renewable/does not produce carbon dioxide	Answer must imply/refer to hydrogen	**(1)**

Question Number	Answer	Acceptable answers	Mark
(b) (iii)	an explanation linking **EITHER** • escaping/leaked hydrogen (mixes with oxygen or air) • (if ignited), will explode **OR** • hydrogen is a {colourless/odourless} gas • leaks possible / undetectable **OR** • hydrogen expensive to produce • electricity needed / expensive **OR** • hydrogen has to be stored in strong / heavy tanks in the car • heavy tanks cause use of more fuel / are expensive **OR** • fewer hydrogen pumps/stations • difficult to refuel **OR** • high pressure needed • {storage/transport} is difficult/ hydrogen has to be stored in strong / heavy tanks	ignore flammable/dangerous ignore references to cost unless qualified	**(2)**

Q40.

Question Number	Answer	Additional guidance	Mark
	An explanation linking • zinc corrodes {easier than / in preference to / OWTTE} iron / zinc reacts with air and water instead (1) • zinc is more reactive than iron / zinc is sacrificial / zinc has a higher tendency to form ions (1)	reject zinc rusts	**(2)** AO 1 1 AO 2 1

Q41.

Question Number	Answer	Acceptable answers	Mark
(a)	**B** 200 cm^3		**(1)**

Question Number	Answer	Acceptable answers	Mark
(b)	65.0 g Zn produces 24 dm^3 H_2 (1) 13.0 g Zn produces $\frac{13.0}{65.0}$ x 24 (1) (= 4.8 dm^3 H_2)	$\frac{13.0}{65.0}$ mol Zn produces $\frac{13.0}{65.0}$ mol H_2 Vol of H_2 = $\frac{13.0}{65.0}$ x 24 (2) (= 4.8dm^3) 4.8 dm^3 (2) without working allow 65/13 x 24 (1) = 120dm^3 13/65 (1) x (1/24) = 0.00833 dm^3 0.2 anywhere 1 mark x 24 anywhere 1 mark	**(2)**

Question Number	Answer	Acceptable answers	Mark
(c)(i)	**D** natural gas		**(1)**

Question Number	Answer	Acceptable answers	Mark
(c)(ii)	An explanation linking forward and back reactions take place / reversible / dynamic (1) at the same rate / equilibrium (1)	dynamic equilibrium = 2 marks	 **(2)**

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Question Number		Indicative Content	Mark
QWC	*** (d)**	A description including some of the following points Higher pressure: • higher pressure gives increased yield • equilibrium shifts to right hand side • because decrease in number of molecules going from left to right • therefore decrease in volume • favoured by increase in pressure • reaches equilibrium faster • because molecules closer together • so get more frequent collisions Higher temperature • higher temperature reaches equilibrium faster • because molecules move faster • therefore more frequent collisions • molecules have more energy • therefore more collisions have required energy • but yield will be lower • because higher temperature favours endothermic reaction • equilibrium shifts to left hand side • which is decomposition of ammonia / ammonia reforms elements Use of catalyst • catalyst causes reaction to reach equilibrium faster / catalyst increases rates (of both forward and back reactions) • *lowers the activation energy (of both forward and back reactions)* • *reaction follows a new pathway* • does not affect yield • equilibrium position not affected	**(6)**

Level	**0**	No rewardable content
1	**1 - 2**	• a limited description e.g. one valid effect of change OR general comment indicating improved yield or faster rate • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy
2	**3 - 4**	• a simple description e.g. at least two valid effects of change with one point of explanation OR at least three valid effects of change • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy
3	**5 - 6**	• a detailed description e.g. at least three valid effects of change with two points of explanation OR at least two valid effects with three points of explanation (in total) • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors

Q42.

Question number	**Answer**	**Mark**
	reactants are being used up (1)	**(1)**

Q43.

Question number	Answer	Additional guidance	Mark
	pins do not bend (1)	ignore less likely to break allow less malleable	(1)

Q44.

Question number	Answer	Mark
	• improve appearance (1) • help prevent corrosion (1)	(2)

Q45.

Question number	Answer	Mark
	Any **one** advantage from: • reliable composition of fertiliser • produced in large quantities as required • all soluble therefore fertiliser will reach roots as required	(1)

Q46.

Question number	Answer	Mark
	• volumes of solution too large for titration method (1) • large volumes of liquid need to be heated and then allowed to crystallise (1)	(2)

Q47.

Question number	Answer	Additional guidance	Mark
	voltage constant OR chemical cells contain harmful/toxic substances (which need careful disposal after use)	allow produces a voltage as long as hydrogen/oxygen/reactants are supplied fuel cells have longer lifetime does not discharge when left unused	(1) AO1