PEARSON EDEXCEL GCSE CHEMISTRY · 1CH0

CHEMISTRY



MARK SCHEME

TOPIC 4: EXTRACTING METALS AND EQUILIBRIA

SCORE	PERCENTAGE
/158	%

STEMUP

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Q1.

This question was poorly answered. Only a few candidates managed to write in formulae of Al and H_2, and even fewer balance the ionic equation correctly. Probably only the most able candidates scored the two marks here. Some candidates included the chloride ion somehow and overlooked the first sentence of the question or had Al^{3+} on both sides.

Acid solutions contain hydrogen ions. metal + acid → salt + hydrog

Aluminium reacts with dilute hydrochloric acid to form a solution containing aluminium ions, Al^{3+}.

carbonate + acid → salt + water + CO_2

Complete the balanced ionic equation for this reaction.

(2)

$3Al + 3H^+ \rightarrow H Al^{3+} + H_2$

Results Plus: Examiner Comments

Al and H_2 are in the correct places and these score the first mark. Balancing was incorrect and so the second mark was not scored.

Acid solutions contain hydrogen ions.

Aluminium reacts with dilute hydrochloric acid to form a solution containing aluminium ions, Al^{3+}.

Complete the balanced ionic equation for this reaction.

(2)

$2Al_{(s)} + 6H^+_{(aq)} \rightarrow 2Al^{3+}_{(aq)} + 3H_{2(g)}$

Results Plus: Examiner Comments

Correct formulae and balancing, so both marks were awarded.
State symbols were ignored - even if incorrect.
2 marks for this answer

Results Plus: Examiner Tip

State symbols are not needed unless asked for.

Q2.

Candidates found the second of the two extended response (6 mark) questions more difficult.

Vague comments such as 'better for the environment' and 'less pollution' were not awarded credit. However, more specific answers that referred to the ores being finite resources and the fact that recycling conserves them or the fact that less fossils fuel are burned and therefore less carbon dioxide is produced, which in turn reduces the greenhouse effect and global warming did gain credit. Damage to the landscape and habitats due to mining were also credited.

In some cases, there were references to the ozone layer in an evident confusion with the greenhouse effect, this was not awarded credit.

A good proportion of candidates understood energy would be saved with recycling instead of extraction. However only a few went to detail what type of energy would be saved for example electricity in electrolysis and heat in the extraction iron.

Unqualified arguments about cost were not credited. However, if candidates made reference to the cost of electricity in aluminium extraction this was accepted.

* Aluminium is extracted from its ore by electrolysis.
Iron is extracted from its ore by heating with carbon.
Both metals can also be obtained by recycling.

Explain the advantages of recycling aluminium and iron rather than extracting them from their ores.

(6)

One of the main advantages of recycling Aluminium and iron is that it is alot cheaper than extracting it from the ground because both electrolysis and heating with carbon uses up alot of energy which cost alot of money so it is cost effective for companys to recycle then it is to extract new ones from the ground.

Another advantage of recycling Aluminium and iron is that we have dug up and used most of the giant deposit extracts so it is becoming inefficient as you are using alot of energy to get not as much and if we dont recycle then we will run out of these recources.

A final final ~~reason why~~ advantage is that it is better for the environment to ~~recycle~~ recycle as we mentioned it takes up alot of energy which is relaying ~~the~~ green house gasses into the atmosphere which is ~~causing~~ harming the planet through global warming. We are also harming the planet by digging in to it to find ~~some~~ new material in areas we haven't ~~mined~~ mined yet which are places that were occupied by different animals and species which are facing extinction as we destroy there habitats and environments.

Results Plus: Examiner Comments

The candidate has given a good explanation of the advantages of recycling aluminium and iron rather than extraction them from their ores to gain full credit in level 3.

* Aluminium is extracted from its ore by electrolysis.
Iron is extracted from its ore by heating with carbon.
Both metals can also be obtained by recycling.

Explain the advantages of recycling aluminium and iron rather than extracting them from their ores.

(6)

I saves resources and money by using recycled ones. There is no need for the digging and the man power to get the aluminium or Iron. Also alot of time is saved. Once the recycled lot has been used to many times there will still be materials left.

If all the materials are used up at once when we run out there will be no barrow supply. If we recycle there will be plenty left when needed Once we finish recycling the available resources.

It also creates less green ~~hoouf~~ house gases than heating with carbon and is needed alot less. Pollution would decrease which is another advantage.

Results Plus: Examiner Comments

In this example, the candidate states that recycling saves resource... and that there will still be 'materials' left if we recycle them. They go on to state that there is no man power to dig (mining) for the 'aluminium or iron' They re-explain that if we use the ore up there will be no supply, which is the same point about conservation of reserves so there is no further credit here. In the last paragraph they state that less 'green house gases than heating with carbon' which was credited. The answer was therefore placed in level 2 with 4 marks as there is some explanation of conserving resources and statements about less mining and greenhouse gases.

* Aluminium is extracted from its ore by electrolysis.
Iron is extracted from its ore by heating with carbon.
Both metals can also be obtained by recycling.

Explain the advantages of recycling aluminium and iron rather than extracting them from their ores.

(6)

There are many advantages to ~~extracting~~ recycling aluminium and iron rather than extracting them from their ores. One of the advantage is that it saves resources. If you can recycle something rather than get a new one it is the better option as it saves money. Not only does it save money but also means you can reserve and restore both of the materials rather than wasting new bits of each material everytime you use it. It also will not use as much time as you are not needing to ~~recycle~~ carry out the method to remove the ore everytime you require it. By recycling it you are ultimately treating the environment better because you are not extracting as much from the earth.

Results Plus: Examiner Comments

In this example, the candidate understands that recycling saves resources. They say that it saves time and money, but does not justify either of these in any way and is therefore ignored and the answer gained just 1 mark.

* Aluminium is extracted from its ore by electrolysis.
Iron is extracted from its ore by heating with carbon.
Both metals can also be obtained by recycling.

Explain the advantages of recycling aluminium and iron rather than extracting them from their ores.

(6)

- made into other things
- better for the environment
- cheaper
- doesn't need to use a power source

Results Plus: Examiner Comments

It should be noted that full credit can be scored from answers that involved bullet points and tables can score full credit.

However in this case, the content of the bullets is not sufficient.

There is an unqualified comment about cost and a vague statement about recycling being better for the environment. Both of which do not score here.

Stating that recycling doesn't need to use a power source is not correct and does not score.

Q3.

a

Many candidates did well in this question. However, those candidates that did not do well failed to use the information in the table to answer the question and did not make a comparison between the metals and so did not answer the question.

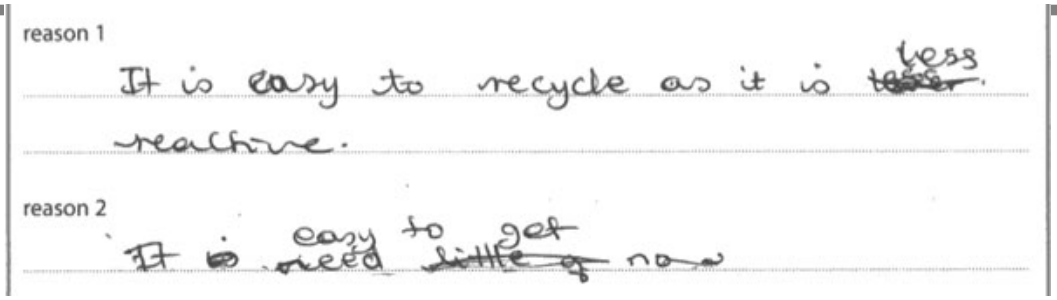
the cost of tin is more ~~expen~~ expensive than aluminium or ~~steel~~ steel.

reason 2

tin is rarer to find than aluminium or steel.

Results Plus: Examiner Comments

A good response which uses the table and compares the materials stated in the table.



Results Plus: Examiner Comments

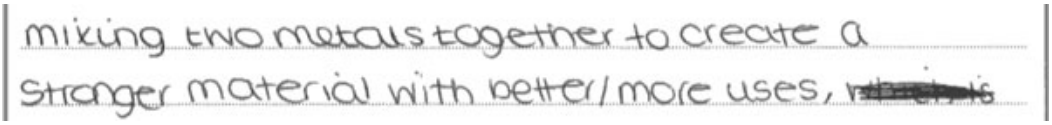
This response has not used information from the table as asked to by the question.

Results Plus: Examiner Tip

When asked to use information from a table, it is important the information is used to help answer the question.

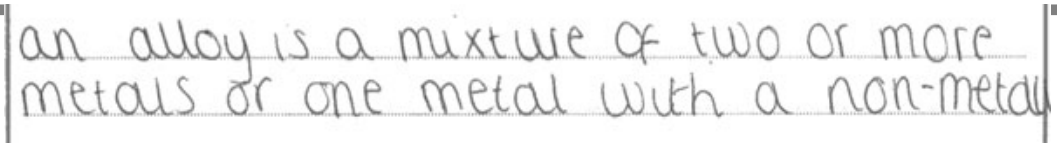
ci

Many candidates knew that an alloy should contain a mixture of atoms rather than a compound, however many also stated that the mixture was of a metals and non-metals.



Results Plus: Examiner Comments

This answer gains full credit as they have the idea of mixing metals.



Results Plus: Examiner Comments

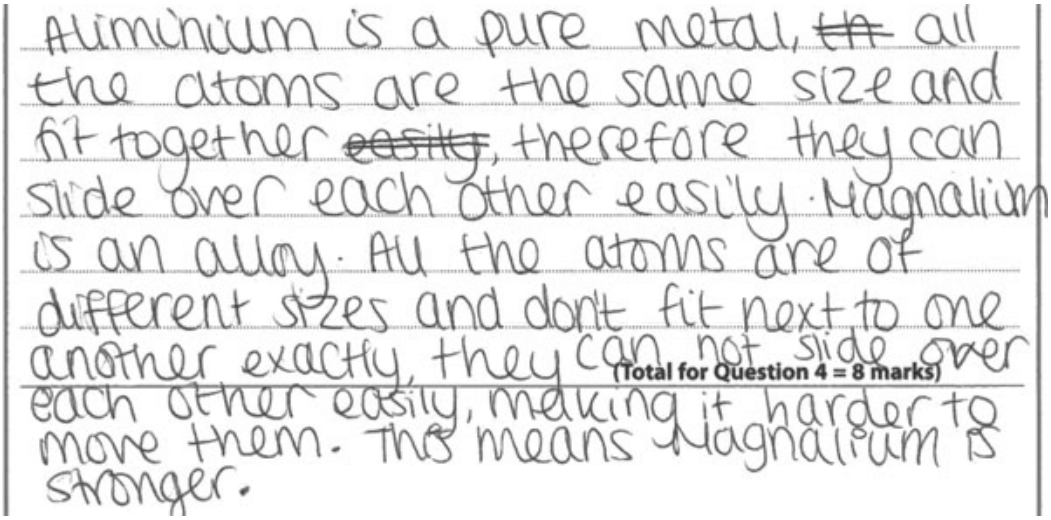
If this response had finished after the word metals, it would have scored 2 marks. However, it then goes on to state 'or one metal with a non-metal' which is not creditworthy.

Results Plus: Examiner Tip

If you are not sure of an answer, never give a right and a wrong answer as the wrong answer will cancel out the right one and you will always get zero marks.

cii

Candidates performed well on this question and could give a concise and detailed account as to why the alloy of magnalium is stronger than pure aluminum.


Aluminium is a pure metal, ~~it~~ all the atoms are the same size and fit together ~~easily~~, therefore they can slide over each other easily. Magnalium is an alloy. All the atoms are of different sizes and don't fit next to one another exactly, they can not slide over each other easily, making it harder to move them. This means Magnalium is stronger.

(Total for Question 4 = 8 marks)

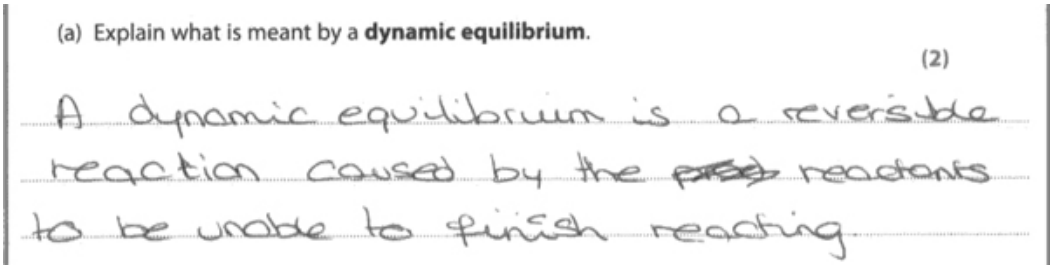
Results Plus: Examiner Comments

A very good answer which scores three marks.

Q4.

(a)

Many candidates scored one mark for knowing the meaning of 'dynamic' but far fewer realised that the concentrations of the reactants and products do not change when the system is in equilibrium. Common errors included: omitting the word 'rate' and stating the forward and reverse reactions are equal, the amounts of reactants and products are equal or cancel out and just describing a reversible reaction.


(a) Explain what is meant by a **dynamic equilibrium**.

(2)

A dynamic equilibrium is a reversible reaction caused by the ~~prod~~ reactants to be unable to finish reacting.

Results Plus: Examiner Comments

This candidate has recognised that a reversible reaction is taking place but has not explained the meaning of the word dynamic or equilibrium, so has not scored a mark.

(a) Explain what is meant by a **dynamic equilibrium**.

(2)

When a reaction is in dynamic equilibrium, the forwards and backwards reactions are still happening, but at the same rate so the amount of product and reactants remains the same

Results Plus: Examiner Comments

This is a very good answer, scoring both marks.

(a) Explain what is meant by a **dynamic equilibrium**.

(2)

Dynamic equilibrium is when the forward and backward reactions react at the same rate.

Results Plus: Examiner Comments

This candidate has explained the meaning of the word 'dynamic' but has not explained 'equilibrium' so has scored 1 mark.

(b) (i)

Many candidates scored one mark for knowing the meaning of 'dynamic' but far fewer realised that the concentrations of the reactants and products do not change when the system is in equilibrium. Common errors included: omitting the word 'rate' and stating the forward and reverse reactions are equal, the amounts of reactants and products are equal or cancel out and just describing a reversible reaction.

(b) In industry, the reaction between nitrogen and hydrogen is affected by the conditions used.

(i) The pressure used is 250 atmospheres.
Explain how the use of a higher pressure would affect the equilibrium yield of ammonia.

(2)

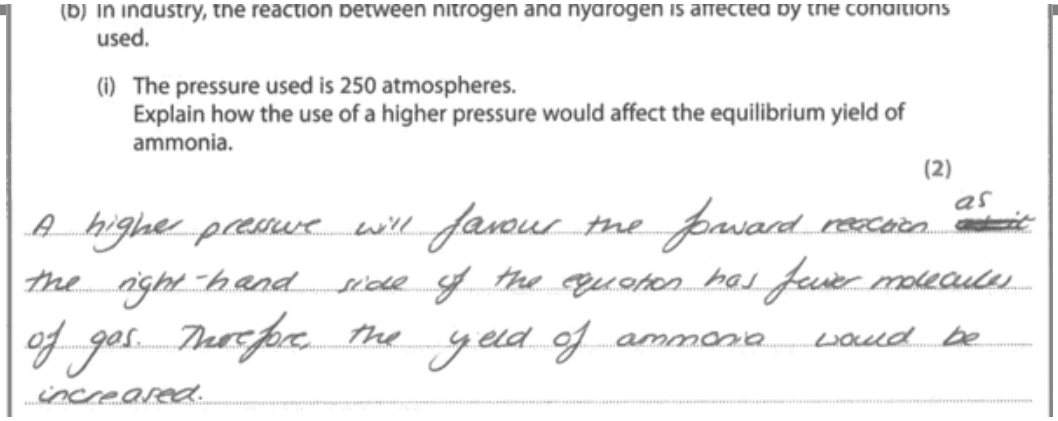
Having a higher pressure would increase the amount of ammonia produced, but it is very expensive.

Results Plus: Examiner Comments

This candidate knows that the yield of ammonia will increase, but has not explained why, so has scored 1 mark.

Results Plus: Examiner Tip

When you are asked for an explanation, try to give a reason in your answer.



(b) In industry, the reaction between nitrogen and hydrogen is affected by the conditions used.

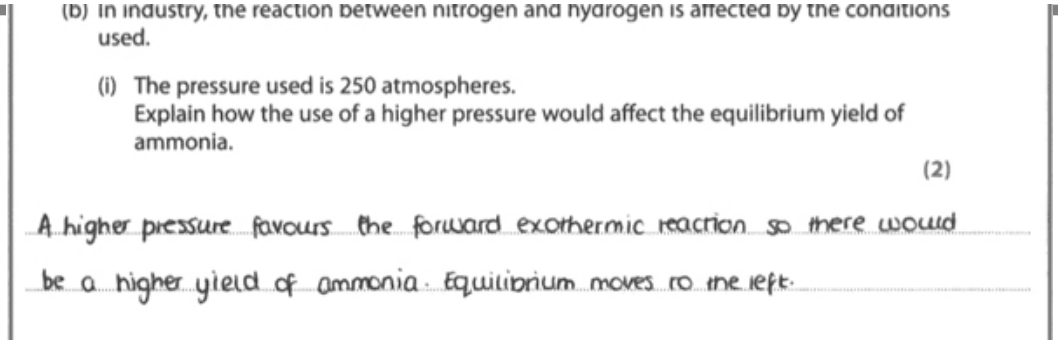
(i) The pressure used is 250 atmospheres.
Explain how the use of a higher pressure would affect the equilibrium yield of ammonia.

(2)

A higher pressure will favour the forward reaction as the right-hand side of the equation has fewer molecules of gas. Therefore the yield of ammonia would be increased.

Results Plus: Examiner Comments

This is an excellent answer, scoring both marks.



(b) In industry, the reaction between nitrogen and hydrogen is affected by the conditions used.

(i) The pressure used is 250 atmospheres.
Explain how the use of a higher pressure would affect the equilibrium yield of ammonia.

(2)

A higher pressure favours the forward exothermic reaction so there would be a higher yield of ammonia. Equilibrium moves to the left.

Results Plus: Examiner Comments

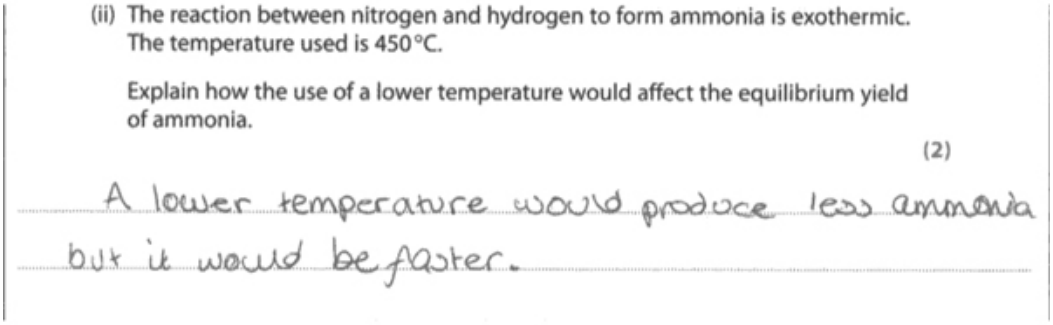
This candidate knows that the forward reaction is favoured and a higher yield of ammonia is formed. Unfortunately, they have then stated that 'equilibrium moves to the left' and this contradicts 'the forward reaction is favoured'. This answer was awarded 1 mark due to the contradiction. Without the last sentence, it would have been given 2 marks.

Results Plus: Examiner Tip

Check your answers carefully to make sure that you have not contradicted yourself.

(b) (ii)

There were some excellent answers to this question although some candidates showed a misunderstanding of the link between the position of the equilibrium and the temperature change. Many candidates discussed the effect of a lower temperature on rate of reaction rather than on the yield of ammonia or stated that as the rate decreases, the yield would also decrease. Contradictions such as 'the equilibrium moves to the right so the yield decreases' were also common.



(ii) The reaction between nitrogen and hydrogen to form ammonia is exothermic. The temperature used is 450 °C.

Explain how the use of a lower temperature would affect the equilibrium yield of ammonia.

(2)

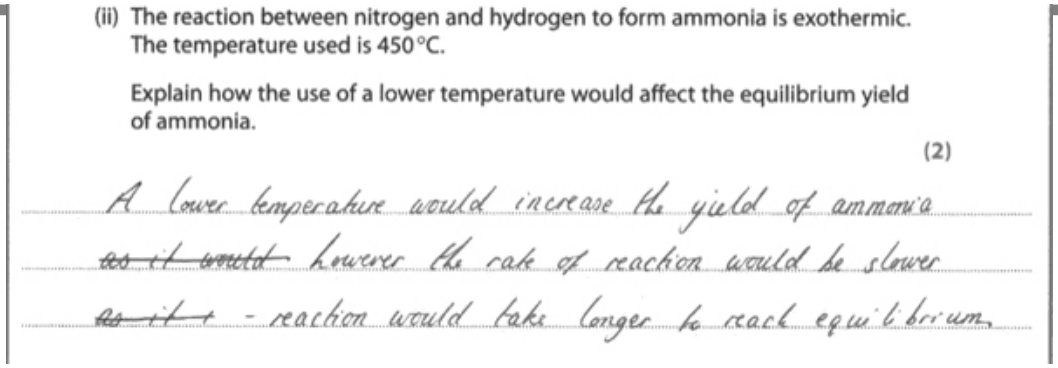
A lower temperature would produce less ammonia but it would be faster.

Results Plus: Examiner Comments

This candidate has not understood the effect of temperature on rate of reaction or equilibrium, so has not scored a mark.

Results Plus: Examiner Tip

Revise the effect of changing temperature on the rate of a reaction and on equilibrium.



(ii) The reaction between nitrogen and hydrogen to form ammonia is exothermic. The temperature used is 450 °C.

Explain how the use of a lower temperature would affect the equilibrium yield of ammonia.

(2)

A lower temperature would increase the yield of ammonia ~~as it would~~ however the rate of reaction would be slower ~~as it~~ - reaction would take longer to reach equilibrium

Results Plus: Examiner Comments

This candidate has scored a mark for the increased yield of ammonia, however, they have not given a reason for why it increases. They have written about the effect of lowering the temperature on the rate of reaction and this is correct. The question does not ask about rate of reaction, so they do not score a mark for that statement.

Results Plus: Examiner Tip

Read the question carefully and make sure you are answering the question that the examiner is asking.

(ii) The reaction between nitrogen and hydrogen to form ammonia is exothermic. The temperature used is 450 °C.

Explain how the use of a lower temperature would affect the equilibrium yield of ammonia.

(2)

A lower temperature would favour the forward ~~backward~~ reaction and move the equilibrium to the right. ~~because~~ The forward reaction is exothermic so this 'adjusts' the system because the forward exothermic reaction releases heat. The yield of ammonia would increase

Results Plus: Examiner Comments

This is a very good answer, scoring both marks because the candidate has stated what happens to the yield and given a reason.

(iii) Even at 450 °C, the reaction is very slow.

State what is used in industry to overcome this problem.

(1)

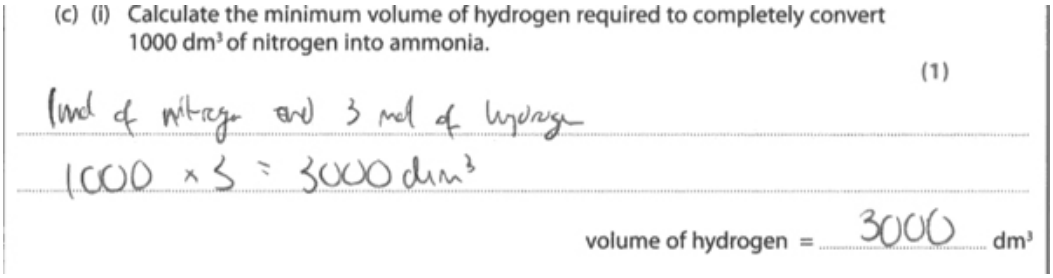
An iron catalyst

Results Plus: Examiner Comments

The majority of candidates knew that a catalyst is used to speed up the reaction and many also knew that an iron catalyst is used. This answer scored 1 mark.

(c) (i)

Although many candidates answered this question correctly, some tried to make it more complicated by using the molar volume of gas to convert the given volume into moles or treated the volume as a mass.


(c) (i) Calculate the minimum volume of hydrogen required to completely convert 1000 dm^3 of nitrogen into ammonia.

(1)

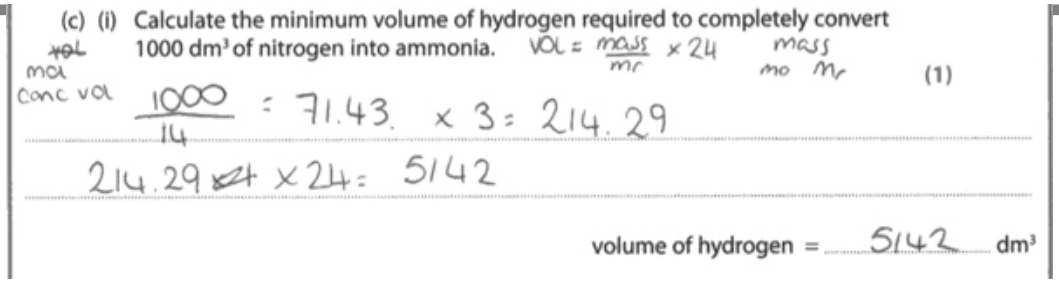
1mol of nitrogen and 3 mol of hydrogen

1000 × 3 = 3000 dm^3

volume of hydrogen = 3000 dm^3

Results Plus: Examiner Comments

This candidate has shown the correct working and answer, so scored the mark.


(c) (i) Calculate the minimum volume of hydrogen required to completely convert 1000 dm^3 of nitrogen into ammonia. VOL = mass/mr × 24 mass no Mr

(1)

mol conc vol 1000/14 = 71.43 × 3 = 214.29

214.29 × 24 = 5142

volume of hydrogen = 5142 dm^3

Results Plus: Examiner Comments

This candidate thought that 1000 g of nitrogen was used and tried to convert it into moles by dividing by the relative atomic mass of nitrogen, so did not score a mark.

Results Plus: Examiner Tip

Read the question carefully. In this question, the volume of nitrogen is given, not its mass.

(c) (ii)

It was encouraging to see a large number of correct answers with clear working. Some candidates did not get the correct final answer but if their working was clear, they could still achieve 2 marks.

(ii) Ammonia is reacted with excess nitric acid, HNO_3, to make ammonium nitrate, NH_4NO_3.



$NH_3 + HNO_3 \rightarrow NH_4NO_3$

Calculate the mass of ammonium nitrate produced by the complete reaction of 34 g of ammonia.

(Relative atomic masses H = 1.0, N = 14, O = 16)

(3)

moles of NH_3 = $14+3=17$ $\frac{34}{17} = 2$

So, 2 moles of NH_4NO_3

RFM of $NH_4NO_3 = 80$

Mass = $80 \times 2 = 160_g$

mass of ammonium nitrate produced = 160 g

Results Plus: Examiner Comments

This is an excellent answer, with clear working, and scored 3 marks.

(3)

r.a.m. of $NH_3 = 17$

$\times 34 = 578$

r.a.m. of $NH_4NO_3 = 80$

$\times 74 = 2720$

mass of ammonium nitrate produced = ... g

Results Plus: Examiner Comments

This answer has scored 2 marks as the candidate has correctly worked out the relative formula masses of ammonia and ammonium nitrate.

Results Plus: Examiner Tip

If you find calculations difficult, you will score some marks if you show your working and calculate the relative formula masses of the relevant substances.

Q5. No Examiner's Report available for this question

Q6.

(ii)

This question was very well answered on the whole with the majority of responses scoring at least 1 of the 2 marks available.

Most commonly correct responses referred to keeping the 'amount or volume of acid' the same and keeping the 'concentration of acid' the same. Often incorrect references to time were made which was ignored by the examiners.

(ii) State **two** variables, apart from the mass of the metals, that should be controlled in this investigation.

(2)

1 how much metal we but in the reactivity.

2 and the time.

Results Plus: Examiner Comments

A typical example of response which did not score.

The amount of metal has been mentioned but, while true, this is repeating the stem of the question, so did not score. The time is ignored.

(ii) State **two** variables, apart from the mass of the metals, that should be controlled in this investigation.

(2)

1 how much of hydrochloric acid is used

2 And the concentration of the hydrochloric acid.

Results Plus: Examiner Comments

A typical example of a fully correct answer.

Keeping the amount and concentration of the acid are the two variables that should be kept the same.

(iii)

This question was well answered on the whole with most responses scoring the 1 mark available.

The majority of correct responses referred to 'copper not reacting' to score the mark.

Often in those responses which did not score, answers incorrectly referred to copper being a 'transition metal' or 'not having enough electrons', showing little understanding of the reactivity series of metals.

(iv)

This question was very well answered on the whole with most responses scoring at least 1 of the 2 marks available.

Most candidates were able to recall the correct state symbols for the two products in the given word equation. Although, lower case symbols are expected, the use of upper case symbols was credited.

Q7. No Examiner's Report available for this question

Q8.

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

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

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

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

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

(3)

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

percentage by mass = 85.8%

Results Plus: Examiner Comments

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

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

(ii) Nickel is extracted from nickel compounds.

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

(1)

it is cheaper and better for the environment

Results Plus: Examiner Comments

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

(ii) Nickel is extracted from nickel compounds.

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

(1)

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

Results Plus: Examiner Comments

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

Q9. No Examiner's Report available for this question

Q10. No Examiner's Report available for this question

Q11. No Examiner's Report available for this question

Q12. No Examiner's Report available for this question

Q13.

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~~ 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

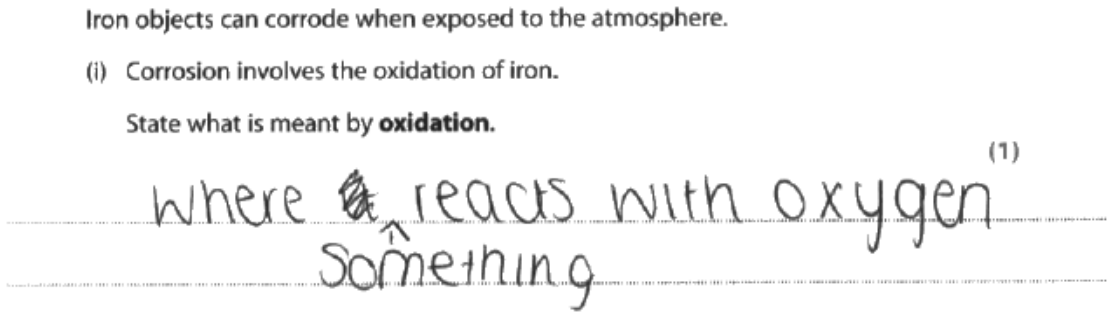
Practice answering these 6-mark answer - there are plenty in the past papers for the previous specification.

Q14.

(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.

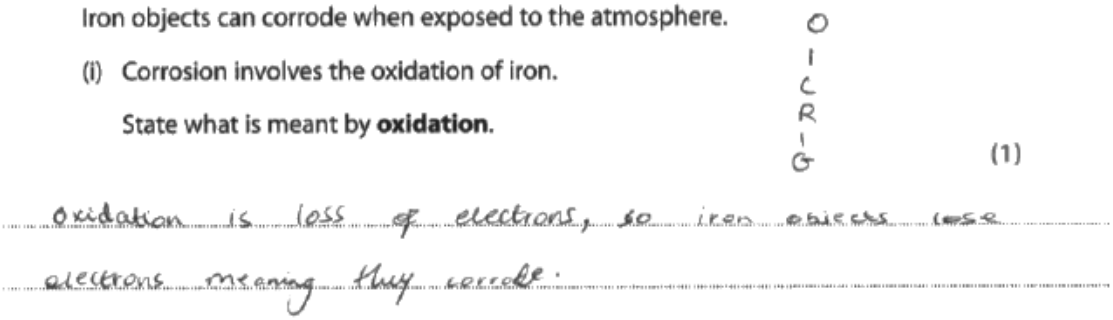
(i) Corrosion involves the oxidation of iron.

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

where something reacts with oxygen

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)

OIL RIG

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

Results Plus: Examiner Comments

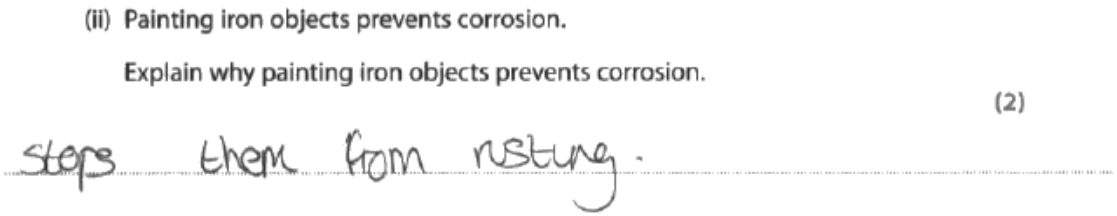
Loss of electrons was a common correct response which was allowed for the mark.

(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)

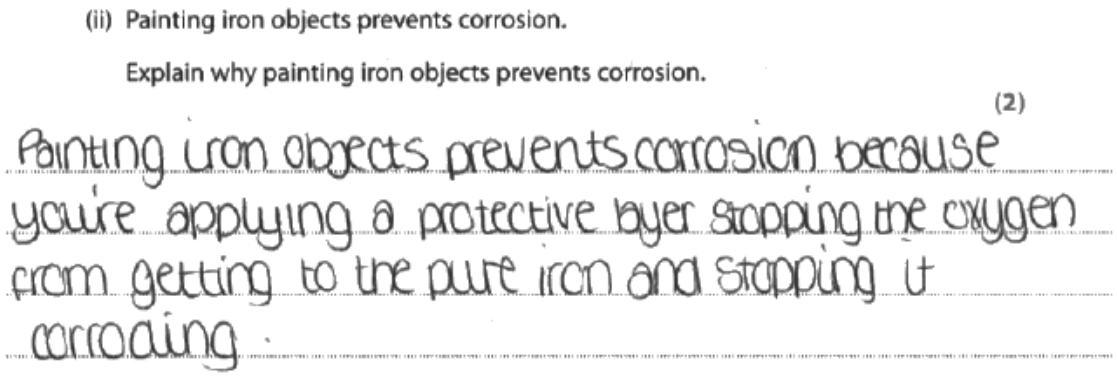
steps them from rusting.

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

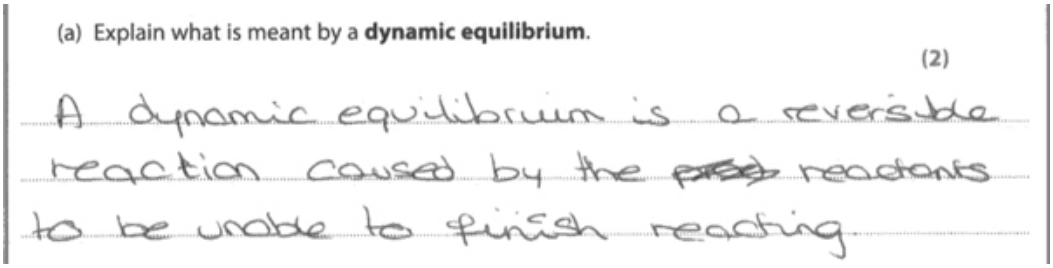
Impractical methods of stopping rusting were not accepted.

Q15.

This was a question about carrying out a practical to determine the order of reactivity of metals. It was very badly answered throughout, with very few candidates mentioning any practical activity at all. Some attempted to explain the order of reactivity but without any reference to practical work, and some used the metals and their sulfate salts interchangeably. Where marks were awarded, they were usually for identifying the mixing of some of the metals with some of the salts. There were very few marks awarded for any observations. Many candidates gave detailed responses about displacement of less reactive metals but did not relate this to the practical activity at all.

Q16.

Many candidates scored one mark for knowing the meaning of 'dynamic' but far fewer realised that the concentrations of the reactants and products do not change when the system is in equilibrium. Common errors included: omitting the word 'rate' and stating the forward and reverse reactions are equal, the amounts of reactants and products are equal or cancel out and just describing a reversible reaction.

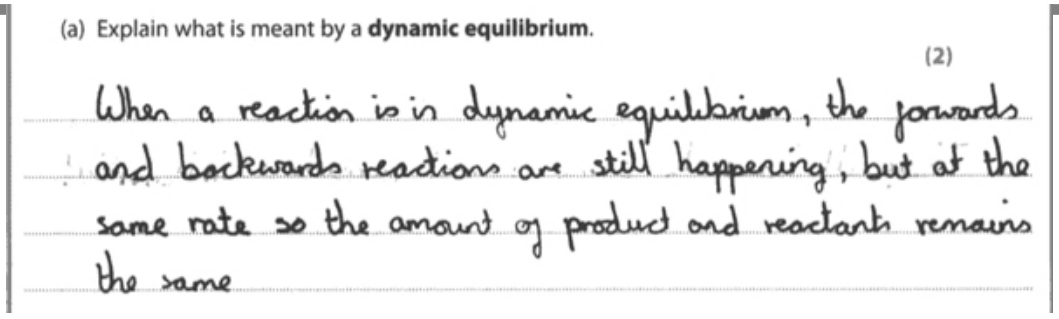

(a) Explain what is meant by a **dynamic equilibrium**.

(2)

A dynamic equilibrium is a reversible reaction caused by the ~~[illegible]~~ reactants to be unable to finish reacting.

Results Plus: Examiner Comments

This candidate has recognised that a reversible reaction is taking place but has not explained the meaning of the word dynamic or equilibrium, so has not scored a mark.


(a) Explain what is meant by a **dynamic equilibrium**.

(2)

When a reaction is in dynamic equilibrium, the forwards and backwards reactions are still happening, but at the same rate so the amount of product and reactants remains the same

Results Plus: Examiner Comments

This is a very good answer, scoring both marks.

(a) Explain what is meant by a **dynamic equilibrium**.

(2)

Dynamic equilibrium is when both of the forward and backward reactions react at the same rate.

Results Plus: Examiner Comments

This candidate has explained the meaning of the word 'dynamic' but has not explained 'equilibrium' so has scored 1 mark.

Q17.

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

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

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

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

(2)

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

Results Plus: Examiner Comments

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

Q18.

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

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

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

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

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

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

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

(4)

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

Results Plus: Examiner Comments

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

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

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

exothermic

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

endothermic

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

(4)

- $CuSO_4.5H_2O$ will be heated in a closed system
- Once the reaction ~~[illegible]~~ ed - requires heat energy meaning ~~it's~~ the forward reaction is ~~endothermic~~ exothermic
- Once the reaction has taken place completely, decrease the temperature
- This will be in favour of the left hand side reaction as it's endothermic
- Rate of reaction on the right will increase and on the left will decrease and the reaction should be reversed

Results Plus: Examiner Comments

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

Q19. No Examiner's Report available for this question

Q20.

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

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

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

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

The conditions are changed favouring the forward reaction.

Explain what you would **see**.

(2)

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

Results Plus: Examiner Comments

This illustrates a common misconception about a reaction at equilibrium.

Q21.

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

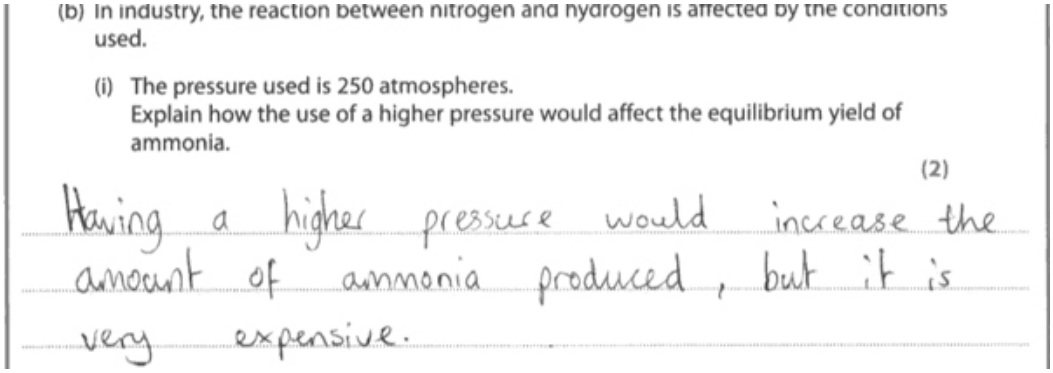
Common errors included:

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

Q22.

(i)

Many candidates scored one mark for knowing the meaning of 'dynamic' but far fewer realised that the concentrations of the reactants and products do not change when the system is in equilibrium. Common errors included: omitting the word 'rate' and stating the forward and reverse reactions are equal, the amounts of reactants and products are equal or cancel out and just describing a reversible reaction.



(b) In industry, the reaction between nitrogen and hydrogen is affected by the conditions used.

(i) The pressure used is 250 atmospheres.
Explain how the use of a higher pressure would affect the equilibrium yield of ammonia.

(2)

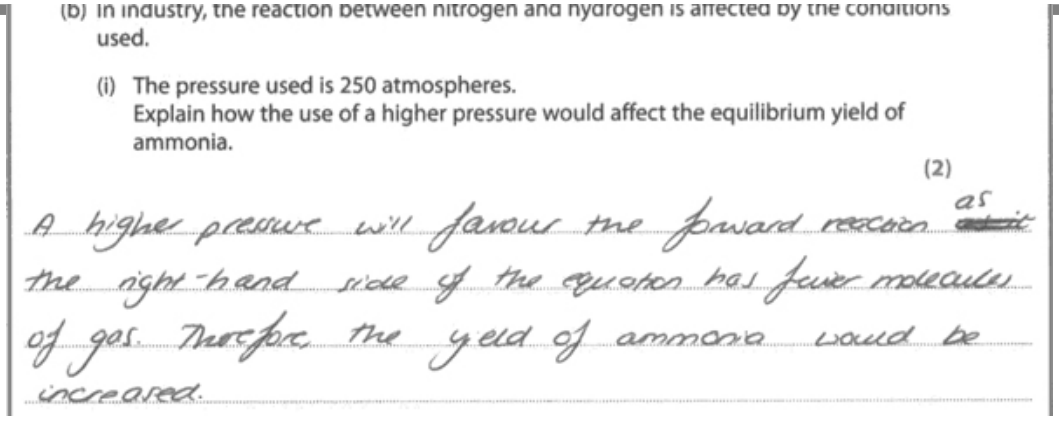
Having a higher pressure would increase the amount of ammonia produced, but it is very expensive.

Results Plus: Examiner Comments

This candidate knows that the yield of ammonia will increase, but has not explained why, so has scored 1 mark.

Results Plus: Examiner Tip

When you are asked for an explanation, try to give a reason in your answer.



(b) In industry, the reaction between nitrogen and hydrogen is affected by the conditions used.

(i) The pressure used is 250 atmospheres.
Explain how the use of a higher pressure would affect the equilibrium yield of ammonia.

(2)

A higher pressure will favour the forward reaction as the right-hand side of the equation has fewer molecules of gas. Therefore the yield of ammonia would be increased.

Results Plus: Examiner Comments

This is an excellent answer, scoring both marks.

(b) In industry, the reaction between nitrogen and hydrogen is affected by the conditions used.

(i) The pressure used is 250 atmospheres.
Explain how the use of a higher pressure would affect the equilibrium yield of ammonia.

(2)

A higher pressure favours the forward exothermic reaction so there would be a higher yield of ammonia. Equilibrium moves to the left.

Results Plus: Examiner Comments

This candidate knows that the forward reaction is favoured and a higher yield of ammonia is formed. Unfortunately, they have then stated that 'equilibrium moves to the left' and this contradicts 'the forward reaction is favoured'. This answer was awarded 1 mark due to the contradiction. Without the last sentence, it would have been given 2 marks.

Results Plus: Examiner Tip

Check your answers carefully to make sure that you have not contradicted yourself.

(ii)

There were some excellent answers to this question although some candidates showed a misunderstanding of the link between the position of the equilibrium and the temperature change. Many candidates discussed the effect of a lower temperature on rate of reaction rather than on the yield of ammonia or stated that as the rate decreases, the yield would also decrease. Contradictions such as 'the equilibrium moves to the right so the yield decreases' were also common.

(ii) The reaction between nitrogen and hydrogen to form ammonia is exothermic.
The temperature used is 450 °C.

Explain how the use of a lower temperature would affect the equilibrium yield of ammonia.

(2)

A lower temperature would produce less ammonia but it would be faster.

Results Plus: Examiner Comments

This candidate has not understood the effect of temperature on rate of reaction or equilibrium, so has not scored a mark.

Results Plus: Examiner Tip

Revise the effect of changing temperature on the rate of a reaction and on equilibrium.

(ii) The reaction between nitrogen and hydrogen to form ammonia is exothermic. The temperature used is 450 °C.

Explain how the use of a lower temperature would affect the equilibrium yield of ammonia.

(2)

A lower temperature would increase the yield of ammonia ~~as it would~~ however the rate of reaction would be slower ~~as it~~ - reaction would take longer to reach equilibrium.

Results Plus: Examiner Comments

This candidate has scored a mark for the increased yield of ammonia, however, they have not given a reason for why it increases. They have written about the effect of lowering the temperature on the rate of reaction and this is correct. The question does not ask about rate of reaction, so they do not score a mark for that statement.

Results Plus: Examiner Tip

Read the question carefully and make sure you are answering the question that the examiner is asking.

(ii) The reaction between nitrogen and hydrogen to form ammonia is exothermic. The temperature used is 450 °C.

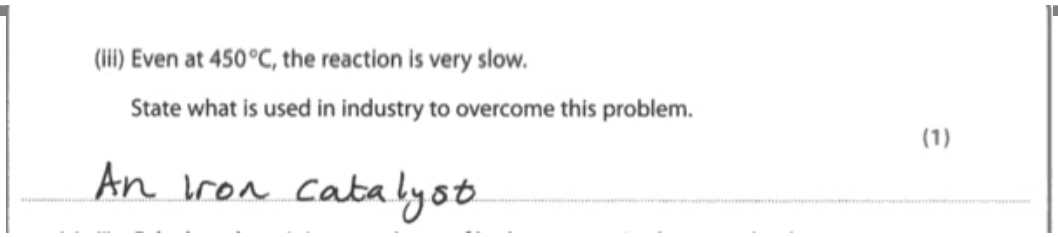
Explain how the use of a lower temperature would affect the equilibrium yield of ammonia.

(2)

A lower temperature would favour the forward ~~backward~~ reaction and move the equilibrium to the right. ~~because~~ The forward reaction is exothermic so it 'adjusts' the system because the forward exothermic reaction releases heat. The yield of ammonia would increase

Results Plus: Examiner Comments

This is a very good answer, scoring both marks because the candidate has stated what happens to the yield and given a reason.


(iii) Even at 450 °C, the reaction is very slow.

State what is used in industry to overcome this problem.

(1)

An iron catalyst

Results Plus: Examiner Comments

The majority of candidates knew that a catalyst is used to speed up the reaction and many also knew that an iron catalyst is used. This answer scored 1 mark.

Q23. No Examiner's Report available for this question

Q24.

Many candidates scored a mark for correctly stating that aluminium is higher than carbon on the reactivity series. There were fewer that then went on to state that carbon cannot displace aluminium or that there would be no reaction between the carbon and aluminium oxide. A number of answers stated that aluminium has strong bonds that require a lot of energy to break – and so not answering the question that was asked.

Q25.

(ii)

In general, foundation tier candidates found calculating the maximum mass of iron produced in the reaction difficult. However, many were able to score at least 1 mark for calculating the formula mass of iron oxide.

A good proportion of candidates were able to calculate the number of moles as 1.5, but this was often then given as a final answer with no further calculation made.

(ii) The formula of the iron oxide is Fe_2O_3.

Calculate the maximum mass of iron that can be obtained from 240 tonnes of iron oxide, Fe_2O_3.

(relative atomic masses: O = 16, Fe = 56)

(3)

56 × 2 = 112 16 × 3 = 48

240 × 160

mass of iron = 38400 tonnes

Results Plus: Examiner Comments

1 mark was awarded here for correctly calculating the relative formula mass of the iron oxide as 160.

(ii) The formula of the iron oxide is Fe_2O_3.

Calculate the maximum mass of iron that can be obtained from 240 tonnes of iron oxide, Fe_2O_3.

(relative atomic masses: O = 16, Fe = 56)

(3)

56 × 2 16 × 3

112 + 48

160

28 12

40

224 96

320

mass of iron = 168 tonnes

Results Plus: Examiner Comments

A fully correct answer that scored all three marks available.

Q26.

Candidates found explaining why aluminium has to be extracted by electrolysis to gain the full two marks available quite difficult. Where candidates scored marks, it was often as they showed the understanding that aluminum is very reactive. Fewer went on to score the second marking point saying that could not be reduced by carbon or alternatively that carbon cannot displace aluminum.

Aluminium cannot be extracted by heating its oxide with carbon.
Aluminium has to be extracted from its oxide by electrolysis.

Explain why.

(2)

because aluminium is more reactive than carbon, its higher in the reactivity series, so will not react properly so has to be done using electricity in electrolysis.

Results Plus: Examiner Comments

This example scored 1 mark. Aluminium is more reactive than carbon gained the first marking point, they then say give the same idea again, that it is higher in the reactivity series. Stating that the aluminium will not react properly, was not sufficient to gain the second mark.

Aluminium cannot be extracted by heating its oxide with carbon.
Aluminium has to be extracted from its oxide by electrolysis.

Explain why.

(2)

Aluminium has a very high melting point so it is not possible to melt it.

Results Plus: Examiner Comments

A common misconception seen was that melting point was too high to be heated with carbon. This scored no marks.

Q27.

Many candidates were content to repeat the information in the question about electrolysis, rather than answer the question. Most said that aluminium was more reactive than carbon and about half made a relevant statement about the carbon not being able to reduce the aluminium oxide.

Aluminium cannot be extracted by heating its oxide with carbon.
Aluminium has to be extracted from its oxide by electrolysis.

Explain why.

(2)

Aluminium is above ~~copper~~ carbon in the reactivity series so it is very reactive and so heating its oxide with carbon would not work.

Results Plus: Examiner Comments

The first part of this response refered to the reactivity of aluminium and scored a mark. The second part of the response is very similar to the stem of the question and did not take the explanation any further. 1 mark was scored overall.

Aluminium cannot be extracted by heating its oxide with carbon.
Aluminium has to be extracted from its oxide by electrolysis.

Explain why.

(2)

Aluminium is more reactive than carbon, hence carbon could not displace it in a reaction, therefore electrolysis is used to extract Aluminium from its ore.

Results Plus: Examiner Comments

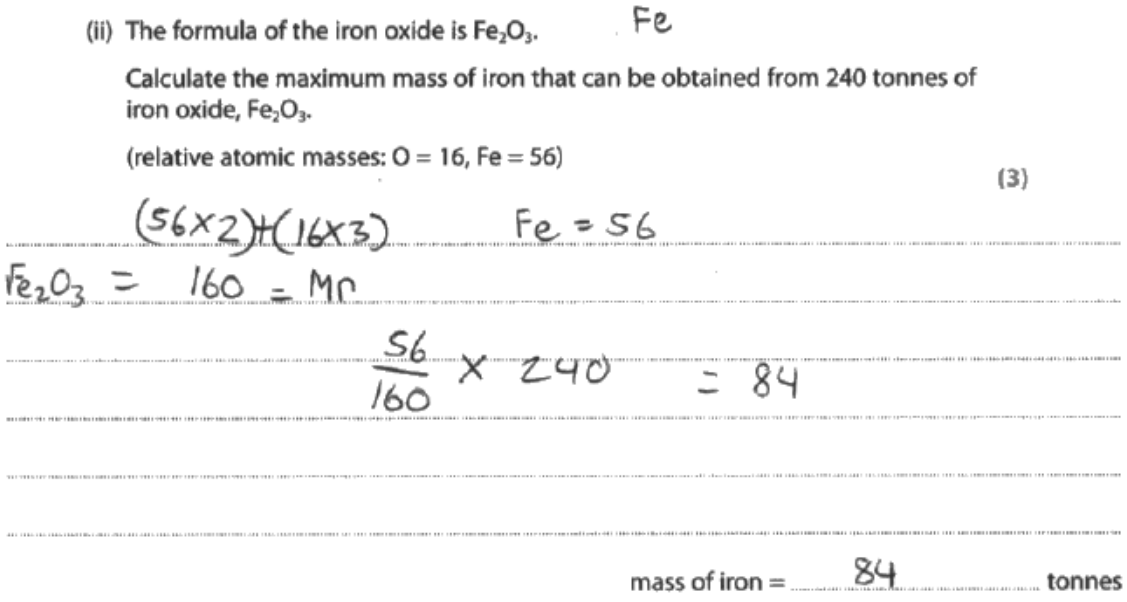
The first line contained a comparison of reactivity scored the 1st mark and the second line contained that it cannot be displaced by carbon which was the 2nd mark.

Q28. No Examiner's Report available for this question

Q29.

(ii)

Many candidates answered this very well and obtained the correct answer for three marks. The major errors arose from an incorrect calculation of the formula mass of iron oxide answered or missing the ratio of 1 mole of iron oxide containing two moles of iron. Those that divided by two rather than multiplied by two scored two marks. Those that only achieved the formula mass of the iron oxide scored the first mark.


(ii) The formula of the iron oxide is Fe_2O_3. Fe

Calculate the maximum mass of iron that can be obtained from 240 tonnes of iron oxide, Fe_2O_3.

(relative atomic masses: O = 16, Fe = 56)

(3)

(56x2)+(16x3) Fe = 56

Fe_2O_3 = 160 = Mr

$\frac{56}{160}$ x 240 = 84

mass of iron = 84 tonnes

Results Plus: Examiner Comments

Calculation of the formula mass of Fe_2O_3 was calculated correctly and scored the 1st marking point. The second step involved the multiplication of the relative atomic mass of iron by 2 and this was missed out. The final step of scaling up to 240 tonnes was consequentially carried out correctly and scored the 3rd mark. So 2 marks for this response.

(ii) The formula of the iron oxide is Fe_2O_3.

Calculate the maximum mass of iron that can be obtained from 240 tonnes of iron oxide, Fe_2O_3.

(relative atomic masses: O = 16, Fe = 56)

(3)

$Fe_2 = 2 \times 56 = 112$

$O_3 = 3 \times 16 = 48$

$\frac{112}{160} \times \frac{240}{1} = 168$ tonnes

mass of iron = 168 tonnes

Results Plus: Examiner Comments

The formula masses and proportions were corrctly calculated (160 & 112). These were then used correctly to give the final answer of 168. 3 marks given for this correct answer.

Results Plus: Examiner Tip

Practice calculations of this type and set out your working in a logical way.

Q30.

This was the most difficult equation on the paper but many candidates scored all 3 marks.

Many scored 2 marks for all the correct formulae but could not balance the equation correctly. Many had the incorrect formula for iron – Fe_2, which then only allowed them to score one mark for the correct reactants.

(c) Iron is extracted from iron oxide, Fe_2O_3.

In the extraction process the iron oxide is heated with carbon to form iron and carbon dioxide.

Write the balanced equation for this reaction.

(3)

$4Fe_2O_3 + 3C_2 \rightarrow 8Fe + 6CO_2$

Results Plus: Examiner Comments

A tricky balanced equation placed here on the last question. Many tried to balance it by using 'C_2' on the reactants side. Only 1 mark here for the correct products.

(c) Iron is extracted from iron oxide, Fe_2O_3.

In the extraction process the iron oxide is heated with carbon to form iron and carbon dioxide.

Write the balanced equation for this reaction.

(3)

$2Fe_2O_3 + 3C \rightarrow Fe_4 + 3CO_2$

Results Plus: Examiner Comments

Some candidates tried balancing the equtaion using Fe_2 on the products side - or Fe_4 as in this case. Only 1 mark for the correct reactants here.

Results Plus: Examiner Tip

Make sure you know the formulae of the compounds used in the course. Also make sure you know which elements exist as molecules.

Q31.

(b)

Out of the three word equations on the paper, this was answered the least successfully although many candidates were able to score 1 mark for correctly writing the reactants. Many lost marks

on the products side of the equation for including water as a product or only giving iron as a product. Carbon oxide was also a common error seen when writing the products.

Q32.

(a)

Many correct answers were seen, but for some it was difficult to decide if they actually knew what was happening due to poor expression e.g. oxygen removed from a metal – did they mean from a metal oxide? Several candidates did answer this in terms of electrons being added which was chemically correct. Some candidates made an attempt at rewriting the question with such answers as 'Reduction is the extraction of a metal from the oxide'.

Metals

6 The list shows some metals in order of reactivity.

most reactive	sodium
	aluminium
	zinc
	iron
	copper
least reactive	gold

(a) Aluminium and iron are extracted by reduction of their oxides.

State what is meant by reduction.

(1)

Reduction means that the oxygen is lost and a ~~loss~~ gain of electrons.

Results Plus: Examiner Comments

Almost a text book answer. Redox in terms of loss and gain of electrons is not in the specification for C1, but is still credited if given as an answer.

6 The list shows some metals in order of reactivity.

most reactive	sodium
	aluminium
	zinc
	iron
	copper
least reactive	gold

(a) Aluminium and iron are extracted by reduction of their oxides.

State what is meant by reduction.

(1)

Reduction is when oxygen is taken out of a metal to form something else.

Results Plus: Examiner Comments

Loss of oxygen from a metal is not correct. Fewer candidates this time gave the common meaning of reduction (eg to make something smaller).

Results Plus: Examiner Tip

Learn the meaning of the chemistry terms used throughout the course.

(b)

Many candidates found this question quite challenging with just a few candidates scoring 2 marks. There were many 1 mark answers in terms of different reactivities but many candidates did not know what to write to get the second mark. They knew that aluminium is more reactive than carbon, but few explained that more energy was needed for the extraction which meant that electrolysis was needed.

(b) Electrolysis and heating with carbon are two methods of reduction.

Explain why aluminium needs to be extracted from its ore by electrolysis, rather than by heating with carbon.

(2)

Aluminium is more reactive than carbon, and forms more stable bonds with its compounds, so carbon cannot displace it from its compound. Electrolysis is a more powerful method of reduction, and is required for metals high up in the reactivity series.

Results Plus: Examiner Comments

A really good answer - but not seen that often in this examination - detailing why aluminium cannot be extracted using carbon and then going on to say why electrolysis is needed.

(b) Electrolysis and heating with carbon are two methods of reduction.

Explain why aluminium needs to be extracted from its ore by electrolysis, rather than by heating with carbon.

(2)

Aluminium needes to be extracted with electrolyses rather than carbon as it is more reactive than carbon.

Results Plus: Examiner Comments

Another example of where rewriting the question does not help the answer. The only creditworthy part is 'as it is more reactive than carbon', so scored just the 1 mark.

Results Plus: Examiner Tip

Rewriting the question does not improve the answer.

Q33.

(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 there 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 encourage 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?

Q34.

(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.

(ii) State the meaning of the symbol ⇌ in an equation.

(1)

Reversible reaction

Results Plus: Examiner Comments

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

(ii) State the meaning of the symbol ⇌ in an equation.

(1)

this is the equals sign in an equation

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).

Q35.

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.

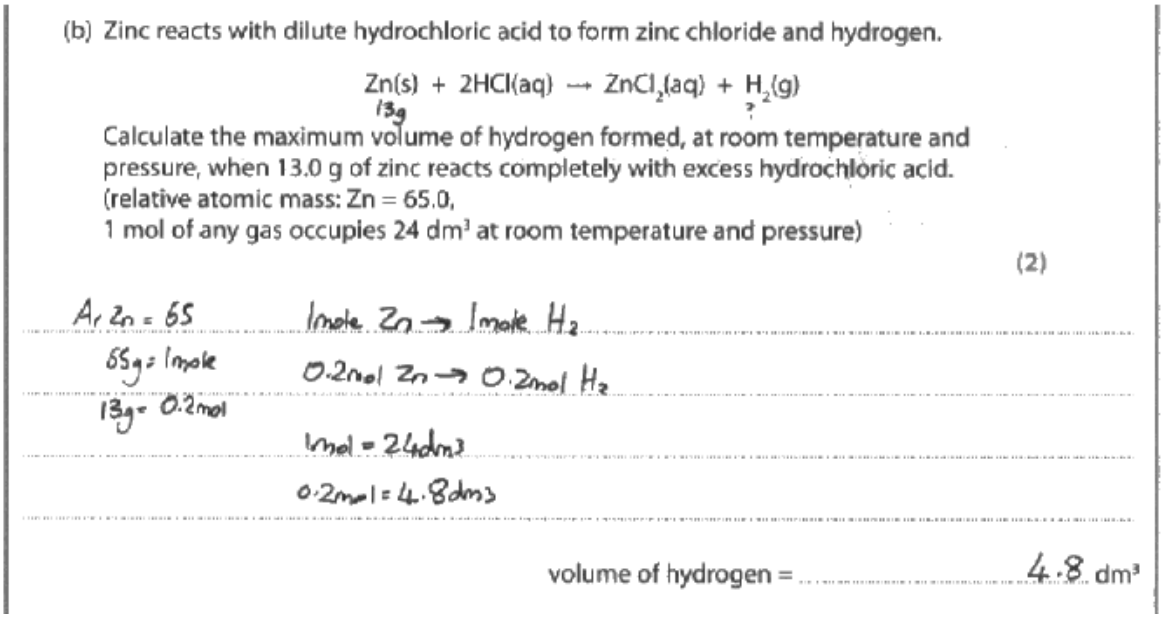
Results Plus: Examiner Tip

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

Q36.

(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 ?

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

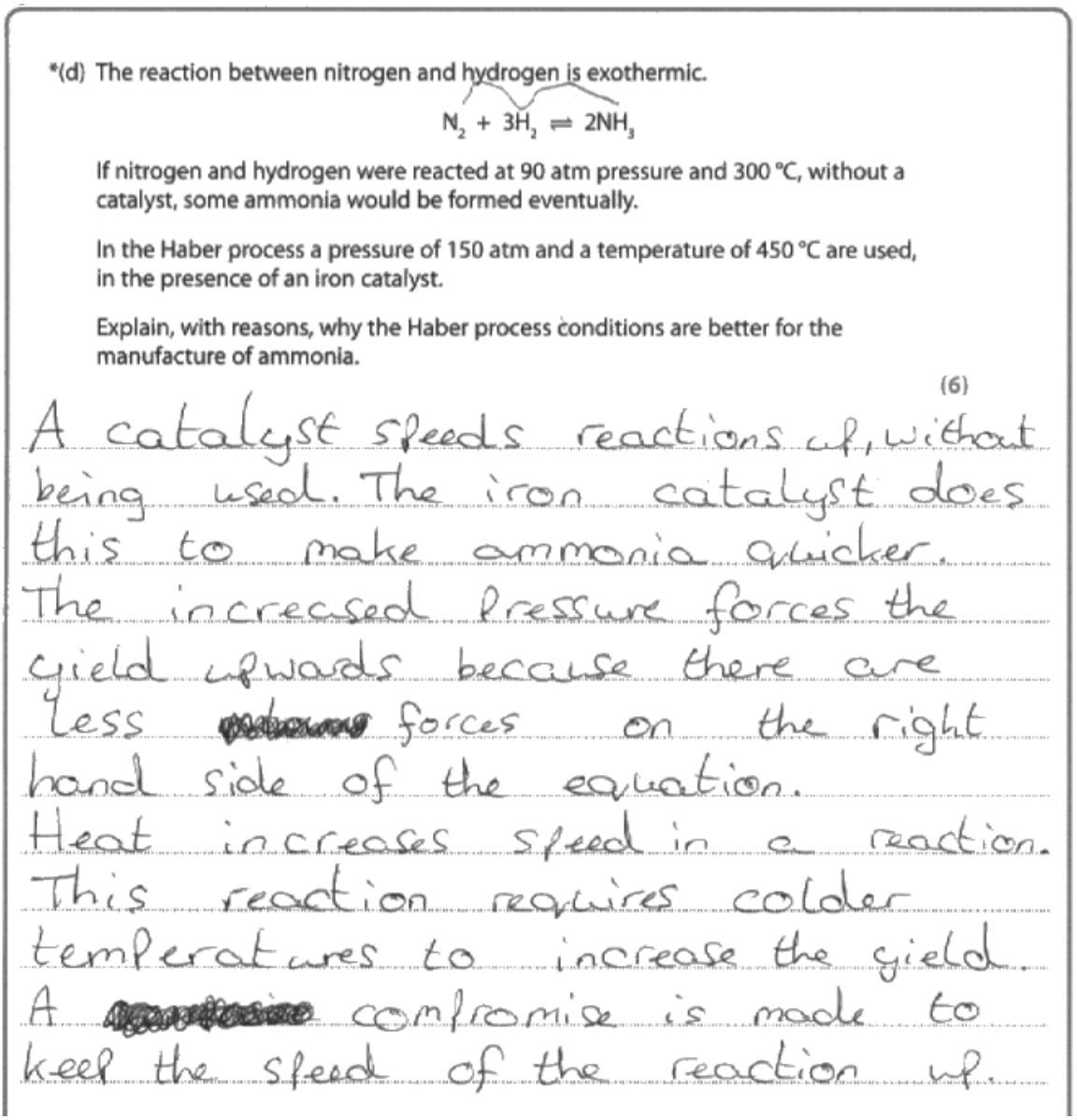
temperature or the use of a catalyst.

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.

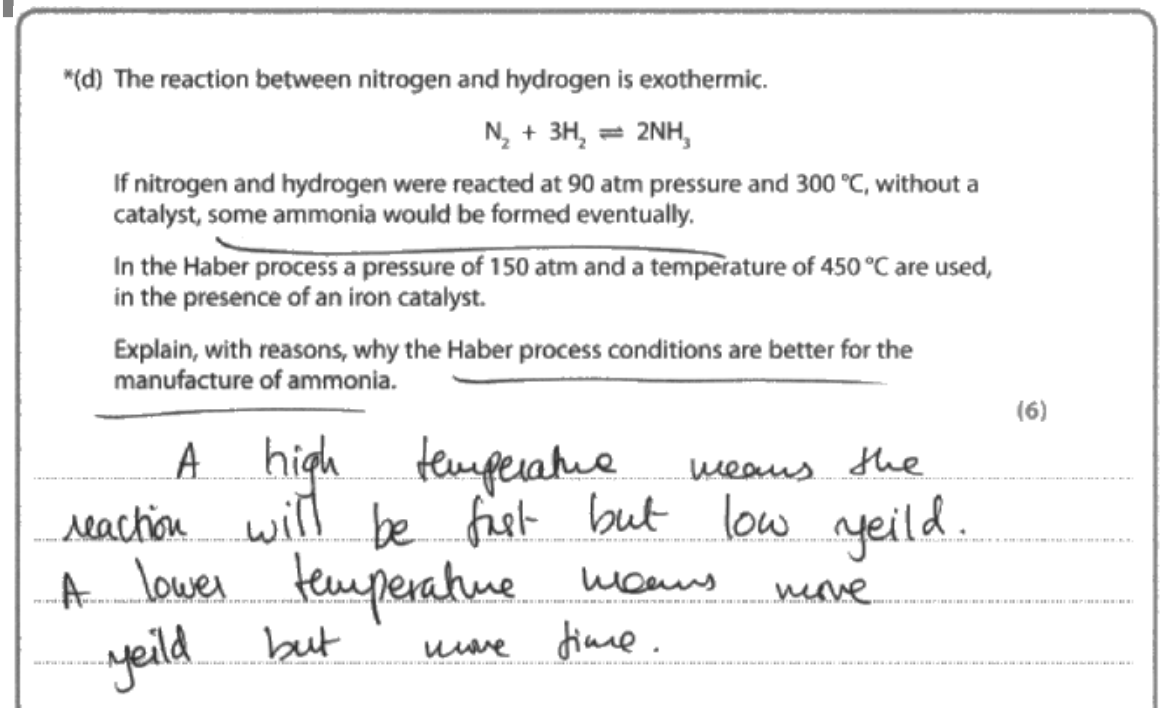
(6)

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 [redacted] 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 [redacted] 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.

Q37.

(i)

This question was very well answered on the whole with most candidates gaining the 1 mark available.

Responses mainly referred to the required specific term 'reversible', and less frequently 'equilibrium' was seen by examiners.

Commonly seen incorrect responses incorrectly stated 'reversed' which is not specific enough to score. In a few cases the incorrect terms 'equal', 'mutual', 'opposite', 'reduction' were seen.

(ii)

This question was very poorly answered with very few correct responses seen for the 1 mark available.

Very few candidates were able to recall the formulae for ammonia, namely NH_3. Often this was left blank by candidates. This was surprising since ammonia and its formation, in relation to the fertilisers, is a frequently tested part of the specification and also in the previous specification.

The most commonly seen errors in those who attempted this question were NH_2 and NH_4.

(iii)

This question was extremely well answered with a significant majority of responses scoring the 1 mark available.

Most candidates were able to state the overall trend in the graph shown, namely that world ammonia increases over time.

The only thing that was highlighted by examiners was that many responses gave a lot more detail than necessary for the 1 mark available.

Q38.

(i)

This question was well answered on the whole with most responses scoring the 1 mark available.

The majority of responses correctly gave the correct number of ions in the formula Al_2O_3, namely five.

In many incorrect responses, 2 was the given number, suggesting that candidates were giving the number of different elements in the formula rather than number of ions.

In a few cases, candidates had misinterpreted the question and had correctly calculated the

formula mass for aluminium oxide.

(ii)

This question was well answered on the whole with most responses scoring at least 1 of the 2 marks available.

Many candidates gave both correct balancing numbers, 4 and 3 respectively, in the spaces of the balanced equation provided. This is an equation commonly seen in this area of the specification and appeared to be well understood by candidates.

Q39. No Examiner's Report available for this question

Q40.

(ii)

There were some strong answers here showing a good understanding of equilibrium. Some candidates said that only ammonia (or sadly 'ammonium') would be present or even gases such as carbon dioxide and oxygen. The explanation was given most often in terms of this being a reversible reaction. It should be noted that 'equilibrium' does not necessarily imply a continuing process and was not credited - but 'dynamic equilibrium' was.

Some candidates did not appreciate the 'explain' and stated the gases correctly without explaining why all three were present.

(ii) The minimum volumes of nitrogen and hydrogen that must react completely to form 5000 dm^3 of ammonia are calculated.

These volumes are mixed and left, under appropriate conditions, until the reaction reaches equilibrium.

Explain which gas or gases will be present when equilibrium is reached.

(2)

Ammonia gas is present, and nitrogen and hydrogen because both reactions are happening at same rate and in both directions

Results Plus: Examiner Comments

A succinctly expressed answer, getting straight to the point.

(iii)

There was a pleasing response to this question with a very good number of candidates predicting a higher yield. Many went on to successfully explain this in terms of a shift of the position of equilibrium to the right, due to a decrease in the number of molecules/ volume. There

were some irrelevant explanations linked to whether the reaction was exothermic or endothermic.

(iii) The Haber process is carried out under a pressure of about 200 atm.

Explain the effect on the **equilibrium yield** of ammonia, if the process is carried out at a pressure higher than 200 atm.

(2)

You will get a higher yield of ammonia as a higher pressure favours the reaction that produces fewer molecules and therefore less volume of gas. The equilibrium will shift to the right as more are fewer molecules of ammonia

Results Plus: Examiner Comments

This answer would have been even better saying 'fewer molecules of ammonia..... than nitrogen and hydrogen' but nevertheless it clearly answers the question.

(iv)

Some excellent responses were seen, although many candidates did not answer the question and talked about the position of equilibrium instead. The phrase 'rate of attainment' was not well appreciated. Those who understood that this was a rates question did not always express themselves well – talking about a greater chance of successful collisions, for example, rather than about the collision frequency.

(iv) Explain the effect on the **rate of attainment of equilibrium**, if the process is carried out at a pressure higher than 200 atm.

(3)

It will increase, this is because the gases will be packed into a smaller space so more collisions will happen per second, therefore more successful collisions will occur, and equilibrium will be attained at a faster rate, because rate of reaction is faster.

Results Plus: Examiner Comments

An example of a well thought-through answer.

Results Plus: Examiner Tip

In questions of this type start with start with a statement such as 'it will increase' and then go on to the explanation.

The candidate very correctly says that the 'collisions per second' (or frequency of collisions) will increase.

Q41.

Question (iii) was well attempted with many candidates scoring. The most common mark awarded was two, this was often scored for showing the understanding that equilibrium yield would increase and that the equilibrium would shift to the right. Only the best candidates were able to explain that the rate of attainment of equilibrium increases and that there is a decrease in number of molecules to score full marks.

Q42. No Examiner's Report available for this question

Q43.

Part (ii) was well answered with many candidates scoring two or three marks. A good proportion of candidates appeared to understand the practical well with many being able to describe lifting the lid from time to time and needing to find the mass after heating. The best candidates correctly described heating to a constant mass.

Q44. No Examiner's Report available for this question

Q45.

This question elicited many muddled responses. A large number either rephrased the question, stating what was reduced and what was oxidised, or rephrased the equation. There were a lot of "the lead has lost the oxide....". To score marks it was essential to refer to **oxygen**. It is important that candidates understand that reduction and oxidation are opposites and that, in chemistry, the word 'reduction' has a particular meaning.

(b) Lead oxide can be converted into lead by heating it with carbon.

The word equation for the reaction is

lead oxide + carbon → lead + carbon dioxide

Explain how this equation shows that lead oxide is reduced and carbon is oxidised.

(2)

NT the lead is no longer with oxygen, but carbon dioxide is formed using the lead oxide's oxygen.

Results Plus: Examiner Comments

This answer shows a clear understanding about the transfer of oxygen.

Q46.

(i)

This question was very well answered on the whole with the majority of responses scoring the 2 marks available.

It was clear to examiners that candidates could clearly recall the correct sequence of stages in a life-cycle assessment.

In the few cases where responses only scored 1 mark, it was for identifying just two correct stages and those stages being adjacent to each other.

(ii)

This question was poorly answered on the whole with most responses not scoring any of the 2 marks available.

Very few responses gave credit worthy responses for advantages of obtaining aluminium by recycling waste rather than by mining the raw material and extraction.

The main issue noted by examiners was the lack of detail or vagueness in the candidates' responses. Commonly seen responses included: 'better for the environment', 'less pollution', 'quicker', 'easier' and 'less waste'. Only in few cases were these qualified, e.g. 'less waste metal goes to landfill' and gained credit.

Again, this area of the specification, commonly examined in both this series and many previous series, was poorly understood by candidates.

(ii) Aluminium can be obtained by recycling aluminium waste.

Give **two** advantages of obtaining aluminium by recycling aluminium waste rather than mining the raw material and extracting aluminium from that raw material.

(2)

1 Cheaper

2 quicker to use

Results Plus: Examiner Comments

A typical example of those responses commonly seen by examiners which did not score.

The terms 'cheaper' and 'quicker to use' are vague and not qualified, so are not credit worthy.

Results Plus: Examiner Tip

Practise examples of questions requiring both advantages and disadvantages, there are plenty of examples in examination papers of the previous specification.

(ii) Aluminium can be obtained by recycling aluminium waste.

Give **two** advantages of obtaining aluminium by recycling aluminium waste rather than mining the raw material and extracting aluminium from that raw material.

(2)

1 Saves money and energy as it takes alot of energy to extract a metal from its ore

2 good environmental impact as, the metal won't be ~~polluting~~ toxic/ landfill waste already affecting the Earth!

Mines won't need to be created thus habitats won't need to be destroyed.

(Total for Question 6 = 11 marks)

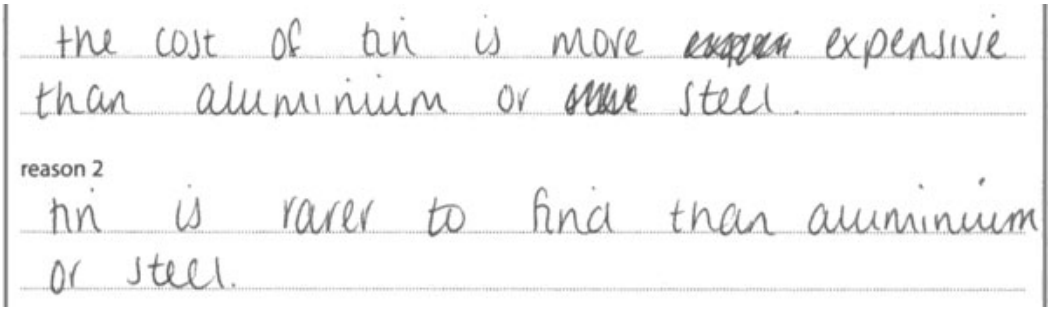
Results Plus: Examiner Comments

This is an example of a response which scored 2 marks.

The correct ideas of less energy required and less damage to habitats have been conveyed.

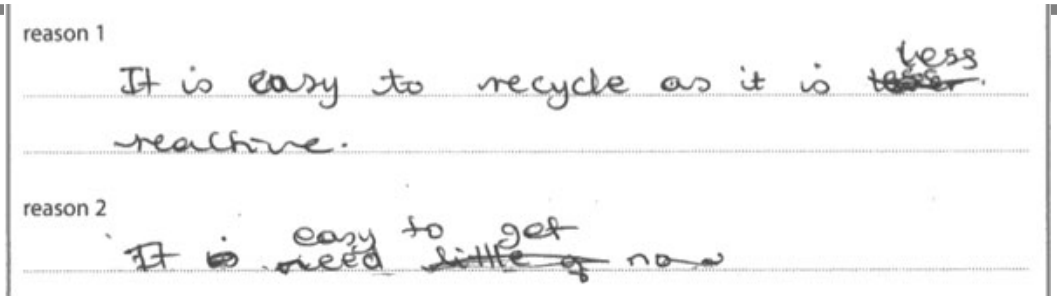
Q47.

Many candidates did well in this question. However, those candidates that did not do well failed to use the information in the table to answer the question and did not make a comparison between the metals and so did not answer the question.



Results Plus: Examiner Comments

A good response which uses the table and compares the materials stated in the table.



Results Plus: Examiner Comments

This response has not used information from the table as asked to by the question.

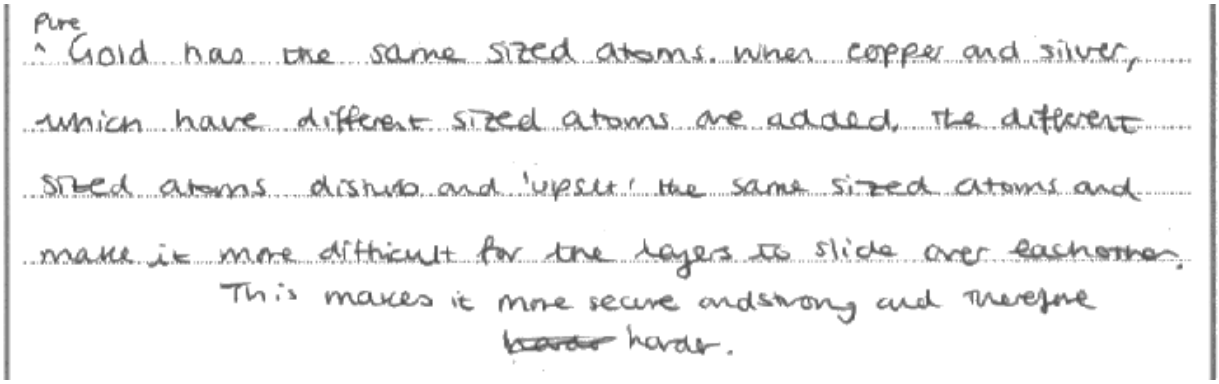
Results Plus: Examiner Tip

When asked to use information from a table, it is important the information is used to help answer the question.

Q48.

(b)(i)

Students demonstrated a good understanding of why a gold alloy is stronger than the pure metal gold. The reference to different sized atoms within an alloy either disrupting the structure/layers or preventing the layers/atoms moving was well understood. Likewise many students showed their understanding that as all the atoms in gold are the same size, this meant that the atoms/layers could slide over each other easily, hence making it softer. A minority referred to 'molecules' instead of 'atoms'. Some candidates made their points clear by drawing diagrams of atoms in the pure metal and the alloy.


Pure
Gold has the same sized atoms. When copper and silver, which have different sized atoms are added, the different sized atoms disrupt and 'upset' the same sized atoms and make it more difficult for the layers to slide over eachother. This makes it more secure and strong and therefore ~~harder~~ harder.

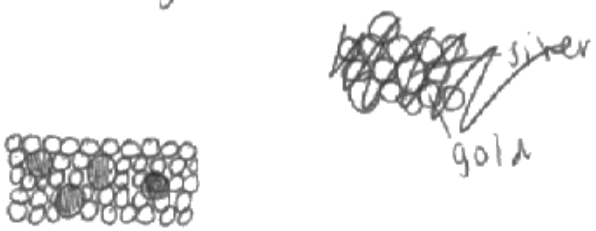
Results Plus: Examiner Comments

A good answer that scored the full 2 marks available.

Results Plus: Examiner Tip

There would be credit for stating that there are different sized atoms in the alloy and for that the atoms cannot slide. However, the candidate has been lax with their use of scientific vocabulary by stating that molecules instead of atoms are different sizes in the first part of the answer so full credit cannot be awarded.

Gold alloys are stronger than pure gold because the copper or silver molecules are different sized to gold molecules so when they are put together the new atoms cannot slide over eachother, making them stronger.

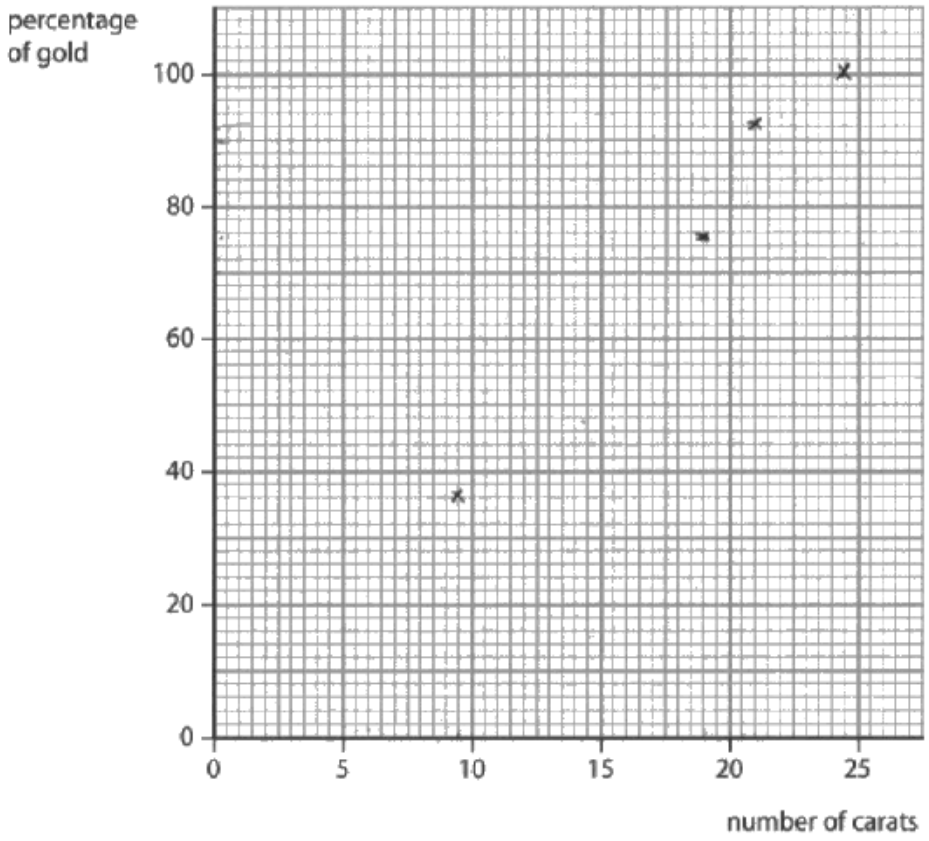


Results Plus: Examiner Comments

It is very important that you use scientific terminology correctly and that terms such as molecules, ions and atoms are used in the correct context, as the use of the wrong term can make your, otherwise correct answer, no longer valid.

(b)(ii-iii)

The majority of candidates were able to plot points accurately, construct a line that best fitted the points drawn and extrapolate to find the percentage of gold in a 14 carat ring. However some students lost marks as they drew a line of best fit from plot to plot or drew a very scruffy line of best fit.



(iii) A gold ring is 14 carat gold.

Use the graph to determine the percentage of gold in the ring.

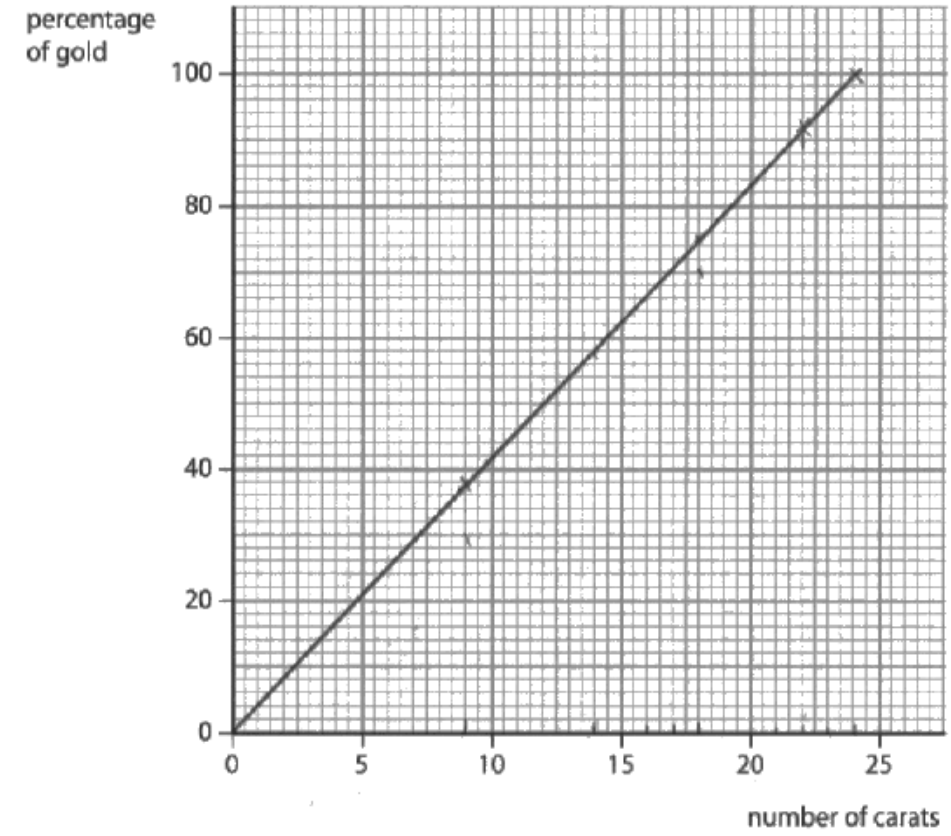
(1)

38%

Results Plus: Examiner Comments

This response scored no marks. There has been an attempt to plot the data. However one of the points was more than 1 small square away from the correct point. No line of best fit has been drawn.

The percentage of gold in the ring is incorrect.



(iii) A gold ring is 14 carat gold.

Use the graph to determine the percentage of gold in the ring.

(1)

58%

Results Plus: Examiner Comments

A good answer that scored full marks for plotting the correct points and drawing a clean line of best fit. The percentage of gold was correctly obtained from the graph.

(c)

Candidates that did well in this question did so as they had a good understanding of the processes involved and the chemistry behind the methods of extraction. They ensured that all areas of the question that had been posed were addressed. Candidates that did less well, either were let down by their weak understanding of the chemistry, for example they were able to state the three methods of extraction but they were not able to relate this to the reactivity of the metals. Or, in some cases, they did not fully address the question and left key areas out. In some cases very generic answers were given and because the detail was lacking marks could not be awarded. Although not required, the best candidates gave very thorough answers, that included correct symbol equations for the reactions taking place.

Gold is the least reactive meaning there is no need for electrolysis because it is already pure, iron is slightly more reactive than gold as it is higher up in the reactivity series. Iron is extracted and heated to be taken from its ore, as aluminum is the most reactive it has to be extracted using electrolysis. meaning it is expensive and will take time to get it. The expense for the process to take place is high meaning lots of money is used.

Results Plus: Examiner Comments

This response gives an explanation of how aluminium and gold are extracted and relates this to their position in the reactivity series. This candidate has also given some explanation in terms of cost for aluminium however they have made no reference to how iron is obtained.

Results Plus: Examiner Tip

Ensure that when you make statements in these six mark questions, you back them up with the chemistry. Once you have written your answer go back and check that you answer fully addresses the question posed.

(6)

If an element is higher than carbon in the series, then it is extracted using electrolysis. these are the most reactive elements, including aluminium. this is because if the element is more ~~attracted to~~ reactive // to carbon, then it wont work. large scale electrolysis is expensive as generating ~~electrolysis~~ electricity requires the burning of fossil fuels or using hydrocarbons. If an element is lower than carbon in the reactivity series, then it is heated with carbon in a blast furnace. this is for example iron to remove the oxygen from the ore by the process of reduction. this method of extraction is also expensive because the powering of a blast furnace requires fuel which will most likely be fossil fuels. However, if the element is on the bottom of the reactivity series, then it doesn't need to be extracted at all. one example is gold. this is because it is naturally found in the earth by itself, as pure metal. this is because it isn't reactive enough to bond with oxygen. Extracting ~~oxygen~~ gold would therefore be very cheap as it does not need to be extracted. An ore is how a metal found in the Earth. It is usually combined with oxygen which is why it's important to extract it to get the pure metal.

(Total for Question 6 = 12 marks)

Results Plus: Examiner Comments

This response gives an explanation of how each metal is extracted. The methods of extraction are then justified in terms of the metals position in the reactivity series. There is also some reference to the cost of each method of extraction, a sound 6 mark answer.

Aluminium does not have to be extracted from it's ore using electrolysis because It is of high reactivity it can be heated with carbon to be extracted whereas iron and gold need to be exoacted using electrolysis because of lower reactivity they're more difficult to extract. It is more expensive to extract iron or gold than it is to extract aluminium.

Results Plus: Examiner Comments

There is no correct indication of how any of the metals can be extracted so therefore no marks can be awarded, even though relative reactivity has been mentioned. The reference to cost is also incorrect.

The reactivity Series determinds whether the metal can be extracted by electrolysis or by heating the ore with carbon. If in the reactivity series it is above carbon, ~~then~~ such as aliminium & gold, then it is extracted using electrolysis, if ~~or~~ it is below carbon such as gold, ~~etc~~ it is extracted via heat. Aliminium is at the top of the reaction series & is also one of the most ~~expensive metals to get~~ cost effective metals to obtain. Gold however, is very expensive as electrolysis is required which is an expensive ~~pro~~ process. This is also why many pieces of gold jewellery are just plated.

Results Plus: Examiner Comments

This response has given a correct method of extraction for aluminium, however it has coupled this with gold which is incorrect. There is no reference to how iron is obtained.

Q49. No Examiner's Report available for this question

Q50.

(i)

This question was well answered on the whole with most responses scoring the 2 marks available.

The majority of responses gave both zinc oxide and carbon as the reactants and also zinc and carbon dioxide as the correct products. The stem of the question gave the candidates all the names of the species involved in the reaction.

Commonly seen errors and omissions included: giving only one product and not both, giving a mixture of names and formulae, giving additional products such as 'water' and 'zinc carbonate', or mixing up reactants and products.

In several responses examiners noted that candidates were unsure of the conventions for writing word equations, namely incorrectly writing the word 'and' between the products or reactants rather than the correct '+' sign.

Zinc can be extracted by heating zinc oxide with carbon.

The products are zinc and carbon dioxide.

(i) Write the word equation for this reaction.

(2)

~~zinc oxide + carbon →~~

zinc oxide + carbon dioxide → zinc carbonate

Results Plus: Examiner Comments

A typical example of a response that did not score.

Although zinc oxide is correctly shown on the reactants side of the equation, carbon dioxide has also been incorrectly included. The 'zinc carbonate' has been incorrectly shown as the only product.

Results Plus: Examiner Tip

Writing word equations is a common feature of the chemistry specification. Use the information, that is to say; the names of the reactants and products, in this case all names are given in the stem, to help you write the word equation.

(ii)

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

The use of the term 'reduction' to describe the type of reaction when an oxide loses oxygen was rarely seen in responses.

Typically incorrect responses included references to 'oxidation' or 'de-oxidisation'.

Q51.

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

Some nickel ores contain nickel sulfide.

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

Write the balanced equation for this reaction.

(2)

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

Results Plus: Examiner Comments

SO_4 was a surprisingly common formula used for sulfur dioxide.

Q52. No Examiner's Report available for this question

Q53. No Examiner's Report available for this question

Q54. No Examiner's Report available for this question

Q55.

Fewer candidates scored in part (i) and (ii) with many giving observations such as fizzing rather than similarities in the products of the reaction in part (i). In part (ii) many candidates thought that calcium was in a different period to potassium and referred to calcium having more shells of electrons.

Q56.

(i)

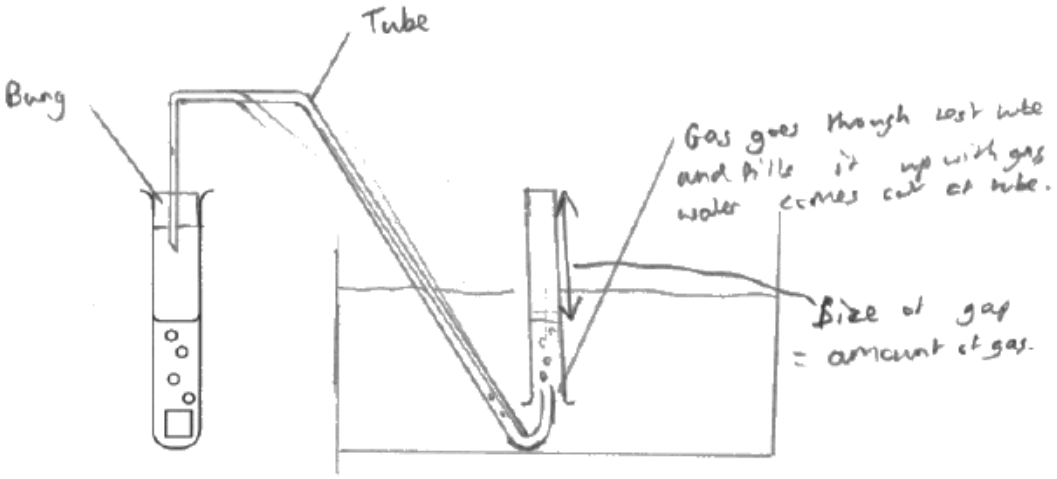
The overwhelming majority managed to put the metals into the correct order of reactivity, with a few scoring 1 mark for having two metals in the correct order and some had the written order in reverse and scored no marks for this.

(ii)

The overall response to this was similar to the other diagram drawing question where there were some very poor diagrams seen, but also many well-constructed labelled diagrams showing how the volume of gas could be measured. We were a little generous with the drawing of a gas syringe. Common mistakes were drawing a test tube to collect the gas with no graduations and missing the bung when connecting the delivery tube to the test-tube shown. Some misread the question and measured mass loss. About a quarter of the candidates did not score.

(ii) Complete the diagram below to show how the student could add to the apparatus to measure the volume of gas produced in the two minutes.

(2)

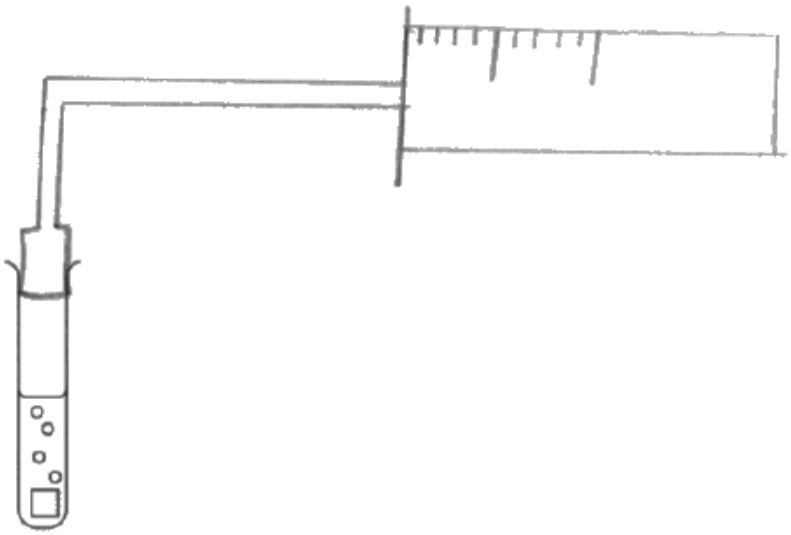


Results Plus: Examiner Comments

1 mark was given for the delivery tube connected to the test-tube. However, the inverted collecting tube is not graduated, and despite the annotation, could not be awarded the second mark. 1 mark only

(ii) Complete the diagram below to show how the student could add to the apparatus to measure the volume of gas produced in the two minutes.

(2)



Results Plus: Examiner Comments

This was not the best of diagrams, but was awarded 2 marks.
The delivery tube was in place and the other apparatus was close enough to represent a gas syringe, including the graduations.

Results Plus: Examiner Tip

The question asked for a labelled diagram. The labels help to inform what the apparatus is, if it's not immediately obvious.

Q57.

(ii)

The marks here were for the formulae of both nitrogen and hydrogen, and for the balancing of the equation. Many candidates scored both marks with slightly more scoring 0 marks for this question. Only a few candidates wrote an unbalanced equation. A common mistake was the formula of nitrogen given as 2N in the equation. Candidates do need to know the formulae of the elements and simple compounds given in the specification.

(ii) Ammonia, NH_3, is made by reacting nitrogen with hydrogen.

Write the balanced equation for this reaction.

(2)

$2N + 3H_2 \rightarrow 2NH_3$

Results Plus: Examiner Comments

Incorrect formula on left hand side (2N) - 0 marks. Balancing was dependent on correct formulae being used. 0 marks.

(ii) Ammonia, NH_3, is made by reacting nitrogen with hydrogen.

Write the balanced equation for this reaction.

(2)

$N_2 + H_2 \longrightarrow NH_3$

Results Plus: Examiner Comments

1 mark for the correct formulae, but no balancing.
1 mark overall.

Results Plus: Examiner Tip

Practice writing and balancing equations from word equations.

Mark Scheme

Q1.

Question Number	Answer	Additional guidance	Mark
	$2Al + 6H^+ \rightarrow 2Al^{3+} + 3H_2$ (2)	Al and H_2 (1) balancing of correct species (1) allow multiples	**(2)** AO 2 1

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. • recycling conserves raw materials/natural resources • less power/energy used • therefore conserves fossil fuels • reduces waste in landfill sites • mining for ores avoided • less damage to habitats/landscape • less energy required to melt and reform metals than to extract them • produces less carbon dioxide than extracting/ reduces carbon footprint • carbon dioxide is a greenhouse gas • greenhouse gases cause global warming • avoids use of large amounts of electricity to extract aluminium from its ore • electricity is expensive • avoids release of carbon dioxide when carbon burns • avoids use of large amounts of heat energy needed to extract iron from its ore IGNORE: • environmentally friendly • cheaper • faster • employment	**(6)** AO 1 1 AO 2 1

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)

Q3.

	Answer	Acceptable answers	Mark
(a)	• tin {more expensive/costs more} (than aluminium/steel) ORA (1) • amount of tin in Earth smaller (than aluminium/steel) ORA (1)	rarer	(2)
(b)	C - reduction		(1)
(c)(i)	an explanation linking the following • a mixture of (1) • metals (1)	reject compound ignore combined/joined specific examples reject reference to non-metals metals melted together (2)	(2)
(c)(ii)	an explanation linking any**three** of • in pure metal /aluminium	ions or particles for atoms reject molecules once only	(3)

	atoms are all same size (1) • in pure metal /aluminium {layers/sheets/atoms} {slide/slip/move} (over one another) easily(1) • magnesium atoms larger (1) • disrupt {layers/structure/arrangement} of aluminium atoms (1) • prevent {layers/sheets/atoms} {slip/slide/move} (1)	different sized particles {lock/hold/jam} layers together	

Q4.

	Answer	Acceptable answers	Mark
(a)	An explanation linking Marking point 1 – one from • forward and back reactions take place (at the same time) (1) • rate of the forward and back reactions is the same (1) Marking point 2 – one from • no (overall) change in the {amount/concentration/mas s/ volume} of each {substance / reactant / product} (1) • no observable change (1)	assume 'both reactions' implies the forward and back reaction allow reversible reaction with the same rate (1) allow reversible reaction in a closed system (1) do not allow the forward reaction equals the reverse reaction allow overall effect is nil (1) allow reactants and products reach a balance (1) ignore forward reaction cancels out back reaction do not allow {amount / concentration /mass/volume} of reactants and products are equal	**(2)**
(b)(i)	An explanation linking two of • higher pressure favours forward reaction/equilibrium shifts to the right (1) • because decrease in {volume / number of molecules}/side with lower volume (1)	ignore answers related to rate/collisions maximum (1) if 3 statements given, but 1 is incorrect	**(2)**

	• yield increases (1)		
(b)(ii)	An explanation linking any two of • lower temperature favours forward reaction/equilibrium shifts to the right (1) • because (forward) reaction is exothermic (1) • yield increases (1)	ignore answers related to rate/collisions if answer refers to increasing temperature, maximum (1) for (forward) reaction is exothermic / reverse reaction is endothermic maximum (1) if 3 statements given, but 1 is incorrect	**(2)**
(b)(iii)	catalyst	iron	**(1)**
(c)(i)	3 × 1000 (1) (= 3000)		**(1)**
(c)(ii)	mark is for the working Method 1 14 + (3 × 1) (1) g of NH_3 makes 14 + (4 × 1) + 14 + (3 × 16) (1) g NH_4NO_3 34 g of NH_3 makes $\frac{(14 + (4 \times 1) + 14 + (3 \times 16)) \times 34}{17}$ or $\frac{80 \times 34}{17}$ 2(14 + (4 × 1) + 14 + (3 × 16)) g NH_4NO_3 (1) = 160 Method 2 moles of NH_3 = $^{34}/_{17}$ (1) = 2 moles of NH_4NO_3 = moles of NH_3 or relative formula mass NH_4NO_3 = 80 (1) mass NH_4NO_3 = 2 x 80 (1) = 160 g	full marks awarded for an answer of 160 g with or without any working allow ecf on incorrect Mr s for either method allow ecf for incorrect moles eg if moles of NH_3 = 0.5 relative formula mass NH_4NO_3 = 80 (1) mass NH_4NO_3 = 0.5 × 80 (1) = 40 g	**(3)**

Q5.

Question Number	Answer	Mark
(i)	**B** a decomposition reaction	**(1)**

Question Number	Answer	Mark
(ii)	An answer that combines the following points to provide a logical description of the experiment • leave the solution (in a warm place) (1) • until crystals form then pat with dry filter paper (1) OR • partially evaporate the water (1) • leave to crystallise and pat dry with filter paper (1)	**(2)**

Q6.

Question number	Answer	Mark
(i)	**A** a balance The only correct answer is **A**. **B** is incorrect because a pipette is used to measure out a volume of liquid and is not used to find the mass of a metal. **C** is incorrect because a stopwatch is used to measure time and is not used to find the mass of a metal. **D** is incorrect because a thermometer is used to measure temperature and is not used to find the mass of a metal.	**(1)**

Question number	Answer	Additional guidance	Mark
(ii)	Any two from the following • (same) volume of acid (1) • (same) concentration of acid (1) • (same) size of metal (pieces) (1) • (same) temperature (1)	 allow amount / mass of acid allow strength / pH allow surface area ignore references to time	**(2)**
(iii)	copper is {not reacting / no reaction / unreactive / low in reactivity series / not reactive enough}	allow less reactive (than hydrogen) ignore inert (alone)	**(1)**
(iv)	$MgCl_2$ (aq) (1) H_2 (g) (1) $Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$	allow AQ allow G	**(2)**

Q7.

Question number	Answer	Mark
	$2Fe_2O_3 + 3C \rightarrow 4Fe + 3CO_2$	(1)

Q8.

Question number	Answer	Additional guidance	Mark
(i)	14(.2) with or without working scores 3 1kg = 1000g (1) $\frac{142}{1000}$ (1) x 100% =14(.2) (1)	If the percentage of non nickel compounds is calculated to give 85.8%/86% score 2 $\frac{142}{1000}$ or 0.142 will score MP1 and MP2 $\frac{142}{1}$ x 100 = 14200 scores (1)	(3)
(ii)	decontaminates ground / conserves {nickel / nickel ores / ores} / allows use of low-grade ore / specified environmental reason: e.g. less noise due to mining / carbon neutral / less carbon dioxide	Ignore any reference to cost/ better for environment etc. / time / energy	(1)

Q9.

Question number	Answer	Additional guidance	Mark
	$\frac{42.5}{5000}$ (1) x 100 (1) (= 0.85)	0.85 alone scores 2	(2)

Q10.

Question number	Answer	Additional guidance	Mark
	20265000 with or without working scores 2 101325 x 200 (1) = 20265000 (Pascals) (1)	allow 20270000 / 20300000 for 2 506.625/ 506.63/ 506.6/ 507 scores 1	**(2)** **AO2**

Q11.

Question number	Answer	Mark
	B turns blue is the only correct answer. **A, C** and **D** are incorrect because the position of equilibrium will shift to the left-hand side	**(1)** **AO2**

Q12.

Question number	Answer	Mark
(i)	hydrogen row: 10 4 -6	**(1)** **AO2**

Question number	Answer	Additional guidance	Mark
(ii)	$N_2 + 3\ H_2 \rightleftharpoons 2\ NH_3$ (2) Formulae of nitrogen **and** hydrogen (1)	balancing mark only if formulae correct	**(2)** **AO2**

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. • 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)

Q14.

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

Q15.

Question number	Answer	Additional guidance	Mark
	A description to include • place separate pieces of each metal into solutions of each of salt (in spotting tray/container) (1) • observe changes in appearance/colour of {metal/solution} (1) • the more reactive metal shows the greater number of reactions (1)	two reactions of different metals in different metal sulfate solutions plus conclusion about reactivity (2) Allow 1 mark for one correctly described reaction between a metal and a different metal sulfate solution	(3) AO2

Q16.

	Answer	Acceptable answers	Mark
	An explanation linking Marking point 1 – one from • forward and back reactions take place (at the same time) (1) • rate of the forward and back reactions is the same (1) Marking point 2 – one from • no (overall) change in the {amount/concentration/mas s/ volume} of each {substance / reactant / product} (1) • no observable change (1)	assume 'both reactions' implies the forward and back reaction allow reversible reaction with the same rate (1) allow reversible reaction in a closed system (1) do not allow the forward reaction equals the reverse reaction allow overall effect is nil (1) allow reactants and products reach a balance (1) ignore forward reaction cancels out back reaction do not allow {amount / concentration /mass/volume} of reactants and products are equal	**(2)**

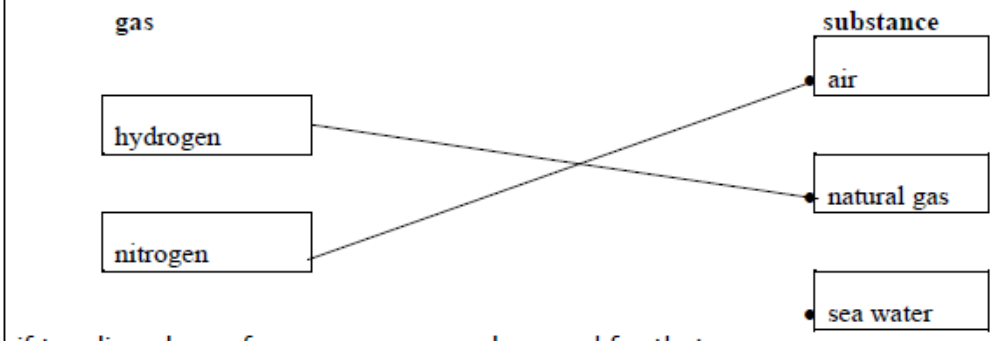
Q17.

Question number	Answer	Additional guidance	Mark
	Any two from: • {(red-)brown / orange / pink} solid formed (1) • (some) {grey/silver} solid remains (1) • (blue solution) becomes colourless (1)	Ignore substance names – descriptions are required allow {grey/silver} solid disappears / reduces / dissolves Answers that include fizzing/ effervescence/ bubbles in addition to correct response have **max** score of 1.	**(2)**

Q18.

Question number	Answer	Additional guidance	Mark
	A description including DECOMPOSITION • **heat** the (hydrated) {crystals / solid} (1) • (solid) goes white/ steam is observed / water produced (1) REVERSE REACTION • add water / water rejoins / water reacts with anhydrous solid (1) • (solid) goes blue (again) / heat is released (1)	ignore anything to do with Le Chatelier etc.. ignore 'closed system' MP4 independent of MP3	**(4)**

Q19.

Question number	Answer	Mark
	 if two lines leave from a gas, no mark scored for that gas	(2) AO1

Q20.

Question number	Answer	Additional guidance	Mark
	An explanation linking • less purple / lighter/ paler / fades (1) • because less iodine (1)	Ignore equilibrium shifts right, forward reaction favoured reject 'goes colourless' for MP1 reject **ALL** iodine reacts to give HI for MP2 (credit **some** iodine reacts / **some** iodine is used up) ignore 'more HI' ignore forwards reaction is favoured	(2)

Q21.

Question number	Answer	Additional guidance	Mark
	An explanation linking • zinc oxidised (1) • because (zinc) lose electrons/ half equation (1) • copper (ions) reduced (1) • because copper (ions) gained electrons/ half equation (1)	ignore copper sulfate is reduced ignore copper sulfate gains electrons marks are independent e.g zinc is reduced because it loses electrons = 1 zinc is oxidised because it gains electrons = 1 If no other mark scored allow one mark for oxidation is the loss of electrons **and** reduction is the gain of electrons	**(4)**

Q22.

	Answer	Acceptable answers	Mark
(i)	An explanation linking two of • higher pressure favours forward reaction/equilibrium shifts to the right (1) • because decrease in {volume / number of molecules}/side with lower volume (1) • yield increases (1)	ignore answers related to rate/collisions maximum (1) if 3 statements given, but 1 is incorrect	**(2)**
(ii)	An explanation linking any two of • lower temperature favours forward reaction/equilibrium shifts to the right (1) • because (forward) reaction is exothermic (1) • yield increases (1)	ignore answers related to rate/collisions if answer refers to increasing temperature, maximum (1) for (forward) reaction is exothermic / reverse reaction is endothermic maximum (1) if 3 statements given, but 1 is incorrect	**(2)**
(iii)	catalyst	iron	**(1)**

Q23.

Question number	Answer	Additional guidance	Mark
	An explanation linking • carbon / C (1) • gained oxygen (to form carbon dioxide) (1)	 reject other elements for MP1 allow oxidation is gain of oxygen / oxidation is loss of electrons (1)	**(2)**

Q24.

Question number	Answer	Additional guidance	Mark
	An explanation linking any two from • aluminium is more reactive than carbon (so electrolysis required) (1) • carbon cannot remove the oxygen / there is no reaction between carbon and aluminium oxide / carbon cannot displace aluminium (1) • electrolysis can be used to reduce aluminium ions (1)	 allow electrolysis is a more powerful method of reduction (1)	**(2)** **AO1**

Q25.

Question Number	Answer	Mark
(i)	**C** iron oxide is reduced **1. The only correct answer is C** ***A*** *is not correct because carbon gains oxygen* ***B*** *is not correct because it is not an acid-base reaction* ***D*** *is not correct because iron oxide loses oxygen*	**(1)** AO 1 1

Question Number	Answer		Mark
(ii)	final answer of 168 (tonnes) with or without working (3) OR relative formula mass Fe_2O_3 = 2x56 + 3x16 (= 160) (1) 160 tonnes Fe_2O_3 produces {2x56 / 112} tonnes Fe (1) 240 tonnes Fe_2O_3 produces $\frac{2x56}{160}$ x 240 (1) = 168 (tonnes) OR relative formula mass Fe_2O_3 = 2x56 + 3x16 (= 160) (1) $\frac{240}{160}$ (1) = 1.5 1.5 x 112 (1) = 168 (tonnes) OR relative formula mass Fe_2O_3 = 2x56 + 3x16 (= 160) (1) $\frac{112}{160}$ (1) = 0.7 0.7 x 240 (1) = 168 (tonnes)	allow ECF throughout M_r $[Fe_2O_3]$= 160 seen without working (1) allow 320 tonnes : 224 tonnes (1) final answer 84 (tonnes) with or without working (2) Note : final answer 1.5 scores 2 overall	**(3)** AO 2 1

Q26.

Question Number	Answer	Additional guidance	Mark
	An explanation linking the following points • aluminium is high in reactivity / aluminium oxide is (very) stable (1) • aluminium (oxide) cannot be reduced by carbon (1)	allow carbon is less reactive than aluminium / ORA / aluminium is very reactive ignore 'aluminium is more reactive' (alone) allow carbon cannot displace aluminium / aluminium **oxide** does not react with carbon ignore aluminium extracted by electrolysis	**(2)** AO 1 1

Q27.

Question Number	Answer	Additional guidance	Mark
	An explanation linking the following points • aluminium is high in reactivity / aluminium oxide is (very) stable (1) • aluminium (oxide) cannot be reduced by carbon (1)	allow carbon is less reactive than aluminium / ORA / aluminium is very reactive ignore 'aluminium is more reactive' (alone) allow carbon cannot displace aluminium / aluminium **oxide** does not react with carbon ignore aluminium extracted by electrolysis	**(2)** AO 1 1

Q28.

	Answer	Acceptable answers	Mark
	C - reduction		(1)

Q29.

Question Number	Answer	Mark
(i)	**C** iron oxide is reduced **The only correct answer is C** ***A*** *is not correct because carbon gains oxygen* ***B*** *is not correct because it is not an acid-base reaction* ***D*** *is not correct because iron oxide loses oxygen*	**(1)** AO 1 1

Question Number	Answer	Additional guidance	Mark
(ii)	final answer of 168 (tonnes) with or without working (3) OR relative formula mass Fe_2O_3 = 2x56 + 3x16 (= 160) (1) 160 tonnes Fe_2O_3 produces {2x56 / 112} tonnes Fe (1) 240 tonnes Fe_2O_3 produces $\frac{2x56}{160}$ x 240 (1) = 168 (tonnes) OR relative formula mass Fe_2O_3 = 2x56 + 3x16 (= 160) (1) $\frac{240}{160}$ (1) = 1.5 1.5 x 112 (1) = 168 (tonnes) OR relative formula mass Fe_2O_3 = 2x56 + 3x16 (= 160) (1) $\frac{112}{160}$ (1) = 0.7 0.7 x 240 (1) = 168 (tonnes)	allow ECF throughout M_r [Fe_2O_3]= 160 seen without working (1) allow 320 tonnes : 224 tonnes (1) final answer 84 (tonnes) with or without working (2) Note : final answer 1.5 scores 2 overall	**(3)** AO 2 1

Q30.

Question Number	Answer	Acceptable answers	Mark
	$2Fe_2O_3 + 3C \rightarrow 4Fe + 3CO_2$ (3) lhs (1) rhs (1) balancing correct formulae (1)		**(3)**

Q31.

Question Number	Answer	Acceptable answers	Mark
(a)	ores (1)	metal ores	**(1)**

Question Number	Answer	Acceptable answers	Mark
(b)	iron oxide + carbon → iron + carbon {dioxide / monoxide} (2) LHS (1) RHS (1)	Correct formula	**(2)**

Q32.

Question Number	Answer	Acceptable answers	Mark
(a)	loss of oxygen	gain of electrons	**(1)**

Question Number	Answer	Acceptable answers	Mark
(b)	An explanation to include • aluminium high in reactivity series / aluminium more reactive than {carbon / iron} (1) • (aluminium reduction) needs more energy / electrolysis is {more / very} powerful (means of reduction) / carbon cannot displace aluminium (from aluminium oxide) (1)	 aluminium compounds are stable aluminium is more reactive ignore just 'very reactive'/highly reactive allow stronger (method of reduction)	**(2)**

Q33.

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** <u>aquatic</u> 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)**

Q34.

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)**

Q35.

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

Q36.

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)**

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

Q37.

Question number	Answer	Additional guidance	Mark
(i)	reversible	allow equilibrium / equilibria /dynamic equilibrium ignore static equilibrium	(1)
(ii)	NH_3	allow H_3N reject NH3, NH^3	(1)
(iii)	world ammonia production increases over time		(1)

Q38.

Question number	Answer	Additional guidance	Mark
(i)	five / 5 (ions)	allow 2 + 3	(1)

Question number	Answer	Mark
(ii)	$2Al_2O_3 \rightarrow 4\ Al + 3\ O_2$	(2)

Q39.

Question number	Answer	Additional guidance	Mark
	Any two from preserves ore reserves / reduces waste / reduces energy needed for metal extraction / preserves {habitats/ landscape / resources}	allow reduces carbon emissions ignore cheaper	(2)

Q40.

Question Number	Answer	Acceptable answers	Mark
(i)	**A** 333 dm^3		**(1)**

Question Number	Answer	Acceptable answers	Mark
(ii)	An explanation linking • all / three gases present/ nitrogen, hydrogen and ammonia (1) • ammonia decomposes/ ammonia turns back to reactants/ reaction goes both ways / reversible (1)	reject ammonium ignore incomplete reaction assume that "both reactions" refer to forward and backward reaction allow **dynamic** equilibrium	**(2)**

Question Number	Answer	Acceptable answers	Mark
(iii)	An explanation linking • increased / high**er** {yield / amount of ammonia} (1) • because fewer (gas) molecules/ moles on RHS/ 4 mole(cule)s on left and 2 on right/ decreased volume on RHS/equilibrium shifts to RHS/ equilibrium shifts in forward direction (1)	mark independently ignore "high yield" reject answers referring to exothermic or endothermic ignore any references to rate	**(2)**

Question Number	Answer	Acceptable answers	Mark
(iv)	An explanation to include • **rate** increased/ time to reach equilibrium reduced (1) • because gas molecules closer / more concentrated (1) • so increased **collision** rate / more **collisions** in a given time / more frequent **collisions**(1)	mark independently ignore any refs to equilibrium ignore 'time is faster'/ allow 'quicker' allow atoms/ particles instead of molecules; allow more molecules present (in same container) do not allow 'more collisions'	**(3)**

Q41.

Question number	Answer	Mark
(i)	**D** increases does not change **A, B, C** are incorrect because catalysts increase rate of attainment of equilibrium and do not change equilibrium yield	**(1)**

Question number	Answer	Mark
(ii)	**C** the amounts of nitrogen, hydrogen and ammonia become constant **A, B, D** are incorrect because when the reaction reaches equilibrium the amount of nitrogen, hydrogen and ammonia remain constant	**(1)**

Question number	Answer	Additional guidance	Mark
(iii)	an explanation linking • equilibrium attained in a shorter period of time / rate of attainment of equilibrium {faster/ increases} (1) • equilibrium yield increases (1) • equilibrium shifts to the {right / forward / to products side} (1) • decrease in number of molecules (1)	allow moves to fewer molecules	**(4)**

Q42.

Question number	Answer	Mark
	B gold The only correct answer is **B**. A, C and D are incorrect because calcium, iron and magnesium respectively, are all found chemically combined to other elements in the Earth's crust.	**(1)**

Q43.

Question number	Answer	Additional guidance	Mark
(i)	**D** oxidation Answers **A** and **B** are physical processes rather than chemical reactions. **C** is wrong because it is not neutralisation.		**(1)**

Question number	Answer	Additional guidance	Mark
(ii)	A description linking any three from: • lift lid from time to time/ leave small gap between crucible and lid (1) • find mass (of crucible, lid and product) (1) • {repeat / heat} to constant mass (1) • final mass – start mass = mass of oxygen (1)	 allow 'weigh' allow find the change in mass	(3)

Q44.

Question number	Answer	Mark
	B gold **A, C, D** – these metals too reactive to exist as uncombined elements	(1)

Q45.

	Answer	Acceptable answers	Mark
	An explanation linking • lead oxide loses **oxygen**(1) • carbon gains **oxygen** (1)	**oxygen** {moved /transferred} from lead to carbon (2) oxide transferred gets no credit	**(2)**

Q46.

Question Number	Answer	Additional guidance	Mark
(i)	C B D A (2) any **two** in the correct order and adjacent to each other max (1)	CB / BD / DA next to each other in this order in any position (1) allow lower case for letters c b d a	(2)
(ii)	Any two from the following • conserves {natural reserves of raw materials/ ore / aluminium (ore)} (1) • less damage to {landscape / habitats} / less {noise /dust} (pollution) (1) • less {energy / electricity} required (to process aluminium waste compared to extracting aluminium from its ore) (1) • less waste metal goes into landfill (1)	{pollution / environment / resources} needs to be qualified less waste needs to be qualified ignore 'less mining (of ore)' which is in stem ignore references to cost / time / fuel	(2)

Q47.

	Answer	Acceptable answers	Mark
	• tin {<u>more</u> expensive/costs <u>more</u>} (than aluminium/steel) ORA (1) • amount of tin in Earth small<u>er</u> (than aluminium/steel) ORA (1)	rarer	(2)

Q48.

Question Number	Answer	Acceptable answers	Mark
(a)	**B** tin oxide is reduced		**(1)**

Question Number	Answer	Acceptable answers	Mark
(b)(i)	An explanation linking two of the following • alloys have different sized atoms • {atoms/layers/sheets/particles} {slide/slip/move} over each other (easily) in pure metal • {structure/layers} disrupted (in alloy) • stop {atoms/layers/sheets/particles} {sliding/slipping/moving} over one another (easily) in	suitable labelled diagrams reject molecules once	**(2)**

Question Number	Answer	Acceptable answers	Mark
(b)(ii)	all points plotted correctly (1) best fit line across 4 plotted points (1)	+/- 1 small square	**(2)**

Question Number	Answer	Acceptable answers	Mark
(b) (iii)	Correct value from their graph +/- one small square (%)		**(1)**

Question Number		Indicative Content	Mark
QWC	* **(c)**	An explanation including some of the following points gold • gold is an unreactive metal/at the bottom of the reactivity series • it does not combine with other elements in the Earth's crust • so is found as uncombined metal • cost of recovery is low iron • iron is a more reactive metal than gold and less reactive than aluminium/middle of reactivity series • found combined with other elements • it is extracted by heating with carbon • electrolysis can be used • but electrolysis is more expensive (than heating with carbon) aluminium • aluminium is a very reactive metal/near to top of the reactivity series • found combined with other elements • it is extracted by electrolysis • because it is very difficult to reduce • electrolysis is a powerful method of reduction • use of electricity makes this method expensive	**(6)**
Level	**0**	No rewardable content	
1	**1 - 2**	• a limited description e.g. a simple justification in terms of reactivity or cost for how one of the metals is extracted OR an indication of how two of the metals are extracted • 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. a simple indication of how all three metals are extracted OR an indication of how two of the metals are extracted with a justification in terms of reactivity or cost for one • 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. indicates how all three metals are extracted with a justification for at least two in terms of reactivity and a reference to cost • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors	

Q49.

Question number	Answer	Mark
(i)	chromium + oxygen → chromium oxide	**(1)** **AO2**

Question number	Answer	Mark
(ii)	**D** oxidation is the only correct answer. **A, B** are incorrect because these are physical changes. **C** is incorrect because there is no acid-base reaction.	**(1)** **AO1**

Question number	Answer	Mark
(iii)	152 with or without working scores 2. (52 x 2) + (16 x 3) (1) = 152 (1)	(2) AO2

Q50.

Question number	Answer	Additional guidance	Mark
(i)	zinc oxide + carbon → zinc + carbon dioxide zinc oxide + carbon → (1) → zinc + carbon dioxide (1)	allow reactants on LHS or products on RHS in either order allow 2 ZnO + C → 2 Zn + CO_2 (2) unbalanced equation (1) ignore state symbols allow = for →	(2)
(ii)	reduction	allow phonetic spellings	(1)

Q51.

Question number	Answer	Additional guidance	Mark
(i)	2NiS + $3O_2$ → 2NiO + $2SO_2$ (2) all four formulae (1) balancing correct formulae only (1)	allow = for → allow multiples if wrong subscript or misuse of capital/small letter e.g. O2, O^2, niO, NIS, allow MP1 but cannot score MP2 if more than 4 formulae, can score MP1 but not MP2 ignore state symbols	(2)

Question number	Answer	Mark
(ii)	**B** the metal produced by electrolysis is very pure is the only correct answer **A** is incorrect because this is a disadvantage **C** is incorrect because electrolysis is expensive **D** is incorrect because heating with carbon can be used	(1)

Q52.

Question number	Answer	Mark
	backward (1) equal (1)	(2) AO1

Q53.

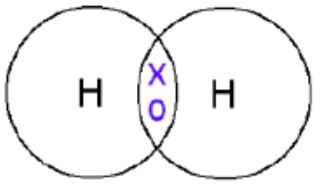
Question number	Answer	Mark
(i)	iron is less reactive (than carbon) ORA	(1) AO2

Question number	Answer	Mark
(ii)	electrolysis is expensive/ more expensive method than heating with carbon/ heating with carbon is cheaper/ electrolysis needs a large amount of electricity	(1) AO2

Q54.

Question number	Answer	Additional guidance	Mark
(i)	sodium + hydrochloric acid (1) → sodium chloride + hydrogen (1)	allow reactants either way round allow products either way round reject 'sodium chlorine' allow $Na + HCl \rightarrow NaCl + H_2$ (1) $2Na + 2HCl \rightarrow 2NaCl + H_2$ (2)	(2)

Question number	Answer	Mark
(ii)	**B** flammable **A** corrosive has a different hazard symbol **C** oxidising has a different hazard symbol **D** toxic has a different hazard symbol	(1)

Question number	Answer	Additional guidance	Mark
(iii)		allow dots or crosses or mixture allow other suitable symbols	(1)

Q55.

Question number	Answer	Additional guidance	Mark
(i)	both form a **hydroxide**	allow formulae ignore observations	(1)

Question number	Answer	Additional guidance	Mark
(ii)	potassium {forms cations / loses (outer) electron} more easily ORA	ignore speed of electron loss / sizes of atoms / number of shells / distance of electrons from nucleus / number of electrons in outer shell	(1)

Q56.

Question Number	Answer	Additional guidance	Mark
(i)	P R Q S (2)	two in correct order (1)	(2) AO 3 2a AO 3 2b

Question Number	Answer		Mark
(ii)	A workable diagram showing a method to measure the volume of the gas • delivery tube between test-tube and (1) • gas syringe / (graduated tube / inverted burette / measuring cylinder) over water bath (1)	if diagram is not workable (eg no bung at top of test tube), max 1 mark allow connection shown as  if collection vessel not labelled, graduations must be shown for the second mark	**(2)** AO 3 3a AO 3 3b

Q57.

Question Number	Answer	Mark
(i)	**B** -78 -33 does not conduct **The only correct answer is B** ***A*** *is not correct because simple molecular, covalent substances do not have high mpt and bpt* ***C*** *is not correct because ammonia is a gas at room temperature and does not conduct* ***D*** *is not correct because simple molecular, covalent substances do not have these properties*	**(1)** AO 2 1

Question Number	Answer	Additional guidance	Mark
(ii)	$N_2 + 3H_2 \rightarrow 2NH_3$ (2) left hand side formulae (1) balancing of correct formulae (1)	accept multiples allow = or ⇌ in place of → ignore state symbols even if incorrect do not allow N2, n2, etc	**(2)** AO 2 1