PEARSON EDEXCEL GCSE CHEMISTRY · 1CH0

CHEMISTRY



MARK SCHEME

TOPIC 5: SEPARATE CHEMISTRY 1 (PACK 1)

SCORE	PERCENTAGE
/146	%

STEMUP

These questions belong to Pearson Edexcel, not to us.

The examination questions, mark schemes and examiner comments in this pack were written and published by Pearson Edexcel. They are past assessment materials, reproduced here so that students can revise from them.

What we do not own

STEMUP is not affiliated with Pearson Edexcel and does not own, and makes no claim to own, any of the question, mark scheme or examiner report material in this pack. Pearson Edexcel has not endorsed, approved or been involved in the production of it. Pearson Edexcel and the qualification titles used here belong to their respective owners and appear for identification only.

Where to find the originals

Pearson Edexcel publishes its past papers, mark schemes and examiner reports. Always check the current specification at qualifications.pearson.com before you revise, because content and wording can change between series.

If you hold the rights to any material in this pack and would like it amended or removed, contact admin@stemup.co.uk and we will act on it.

Q1.

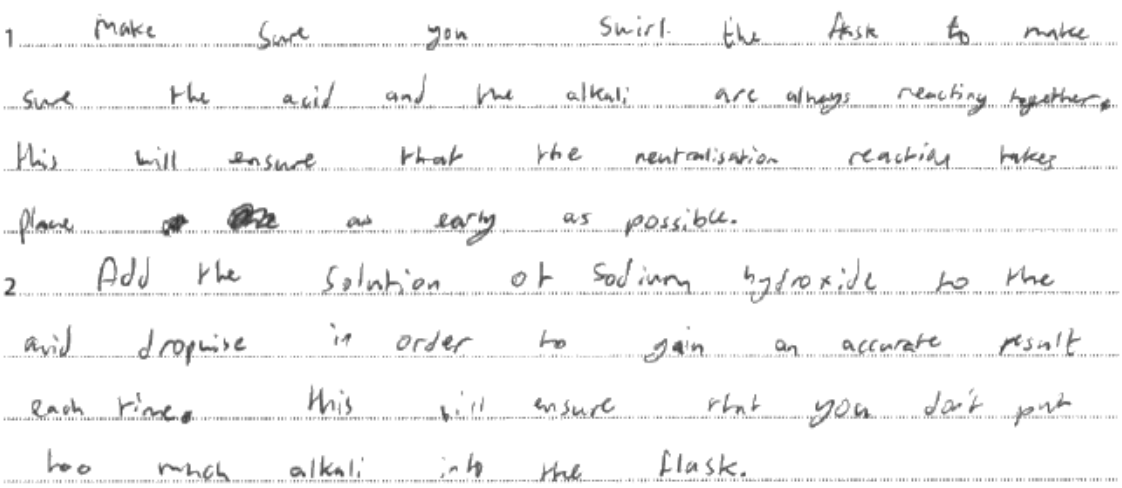
The question was about the details of a titration that would lead to an accurate result being obtained. This was intentionally set as a hard question to test the more able candidates.Marks were given for detail needed (such as use of a white tile) and the explanation (so the indicator colour change can be seen more clearly). Relatively few candidates scored full marks here, however many did offer reasonable details but did not follow the detail with an explanation of how it would lead to a more accurate result, but these did still score marks.

Incorrect ideas included timing the reaction or changing the indicator. Others discussed the idea of fair test or the need to repeat readings. Candidates often confused accuracy for reliability. Concordancy was mentioned frequently.

A brief report of the practical method has been given above.
Further detail can be added to this method to ensure that anyone following the method will obtain an accurate result.

Explain **two** details that could be added to this practical method to ensure an accurate result is obtained.

(4)



Results Plus: Examiner Comments

1st detail : Swirling with the implication that it is to ensure that the chemicals react together scored 2 marks.
2nd detail : Adding sodium hydroxide solution dropwise scored 1 mark as the explanation that the addition would be stopped as colour change would then be seen on the addition of 1 drop of alkali was not given. The explanation here was not sufficient for the mark.
So 3 marks overall.

A brief report of the practical method has been given above.
Further detail can be added to this method to ensure that anyone following the method will obtain an accurate result.

Explain **two** details that could be added to this practical method to ensure an accurate result is obtained.

(4)

1 Perform a rough titration before, in order to find ~~an estimate of the~~ rough values first, and ~~repeat~~ repeat the experiment using this value to slow down the amount of ~~acid~~ Sodium hydroxide being added, as you approach this ~~accurate~~ volume.

2 Read the value of the volume of acid used by looking ~~at~~ at the meniscus at eye level.

Results Plus: Examiner Comments

For the 1st detail, the performing of a rough titration by itself would not lead to an increase in accuracy of a titration result, so was ignored as the rest of the answer was based on knowing this approximate value, then the addition of the sodium hydroxide solution would then be added slowly in an accurate titration when approaching that value.

The reading of the meniscus of any solution would help to improve the accuracy. However, in both cases, no reason was given so this answer only scored 2 marks - 1 for each detail.

Results Plus: Examiner Tip

Revision of all the core practicals will help towards the 15% of marks for testing practical skills and practical work.

Q2. No Examiner's Report available for this question

Q3.

This question was more discriminating than c as it involved more of the higher level content. There were many excellent descriptions of how alloying increases strength. Many included labelled diagrams which helped their answers. A few used incorrect terminology such as 'adding

alloys' or referred to 'molecules' instead of atoms. Some omitted the part on how alloying improves the usefulness of metals or they just referred to increased strength which was in the question. Good candidates gave excellent descriptions of the structures of pure metals and alloys and referred to all the alloys stated in the question, giving improved properties and uses.

The weaker answers often had diagrams that were not identified or labelled. In addition these answers often contained just general statements rather than specific uses for the alloys in the question, such as 'alloys are used for jewellery and bridges'.

The better answers seen for this question used an excellent standard of written communication and used scientific terminology with precision and accuracy.

*(d) Pure metal can be converted into alloys.

In many cases alloys are more useful than pure metals, for example they are stronger. Gold alloys, stainless steel and nitinol are examples of useful alloys.

Describe how alloying improves the usefulness of metals and how strength is increased in terms of structure.

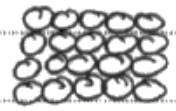
You may use diagrams to help your answer.

(6)

An alloy is much stronger than a pure metal because it is a mixture of 2 or more ~~metal~~ metals with different sized atoms. This means that the alloy does not have a uniform shape.

e.g.  ~~the~~ the atoms are different size so the section cannot slide alongside each other making the alloy stronger.

In pure metals the structure is a uniform shape, the atoms are all the same size so the can slide along each other easily making them malleable.

e.g.  all the atoms are the same size and can slide alongside eachother.

The different sized atoms and the heat alloys are not malleable making them useful because they can be used for a wider range of uses. For example stainless steel is an alloy and is used for cutlery because it is strong. If a pure metal was used the cutlery may bend when being used. Alloys make stronger compounds and have a lot of uses.

Results Plus: Examiner Comments

A very good answer making use of diagrams to help the explanation. The inclusion of how alloying to make stainless steel a more useful metal puts this answer into level 3, scoring 6 marks.

*(d) Pure metal can be converted into alloys.

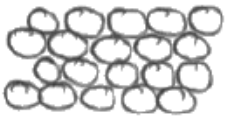
In many cases alloys are more useful than pure metals, for example they are stronger. Gold alloys, stainless steel and nitinol are examples of useful alloys.

Describe how alloying improves the usefulness of metals and how strength is increased in terms of structure.

You may use diagrams to help your answer.

(6)

pure metal



added alloy



~~the~~ Pure metal atoms are all the same size this means they layers of atoms can easily slip over eachother



By adding a different sized alloy it shifts the ~~composition~~ layers which stops ~~these~~ layers from sliding over one another



This is useful because it strengthens the metal and allows them to be (usefully) used for more things. For example, the alloy metals can be used to make cars and other vehicles because they are still malleable, but they are much stronger due

to the addition of the alloy.

The strength of the metal is increased because the alloy distorts the layers of atoms due to the difference in size. This ~~not~~ makes it harder for the atoms to slip over eachother as easily.

Results Plus: Examiner Comments

The question starts well with an explanation about why pure metals are weaker than alloys. However, after that, there is confusion, particularly in the use of the term 'alloy'. There was no use given for a named alloy or how this had improved the usefulness and so this answer was only level 2, scoring 4 marks.

Results Plus: Examiner Tip

Use diagrams to help explain your answers; they can often be more useful than a written explanation.

Q4. No Examiner's Report available for this question

Q5.

(i)

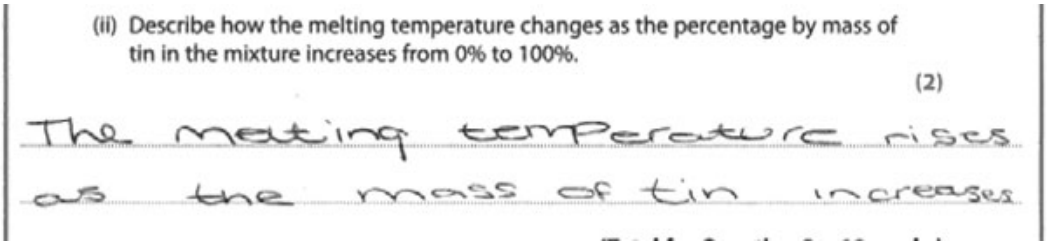
Many answers were correct, although values less than 62.5 or above 63 were commonly seen so the graph had to be read carefully.

Some incorrect answers used the wrong scale - quoting 180 - which makes one wonder what is understood by "180% tin in a mixture".

(ii)

A good number of well worded answers were seen here, although some failed to write about both parts of the trend seen, giving a meaningless answer. Some candidates used wording such as "easier/harder to melt", "melted faster/slower" which didn't really mean lower/ higher melting temperature.

A few wrong answers talked about changes in percentage by mass rather than the melting temperature. Some even mentioned boiling point.

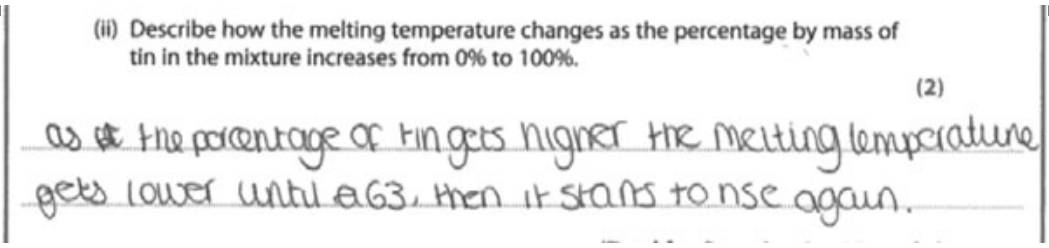

(ii) Describe how the melting temperature changes as the percentage by mass of tin in the mixture increases from 0% to 100%.

(2)

The melting temperature rises as the mass of tin increases

Results Plus: Examiner Comments

This is an example of a meaningless answer - the graph clearly shows that the melting temperature drops then rises.


(ii) Describe how the melting temperature changes as the percentage by mass of tin in the mixture increases from 0% to 100%.

(2)

as the percentage of tin gets higher the melting temperature gets lower until a 63. then it starts to rise again.

Results Plus: Examiner Comments

A clearly described answer.

Results Plus: Examiner Tip

The candidate did well to mention the point where the graph changes gradient (with % would have been even better).

Q6.

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.

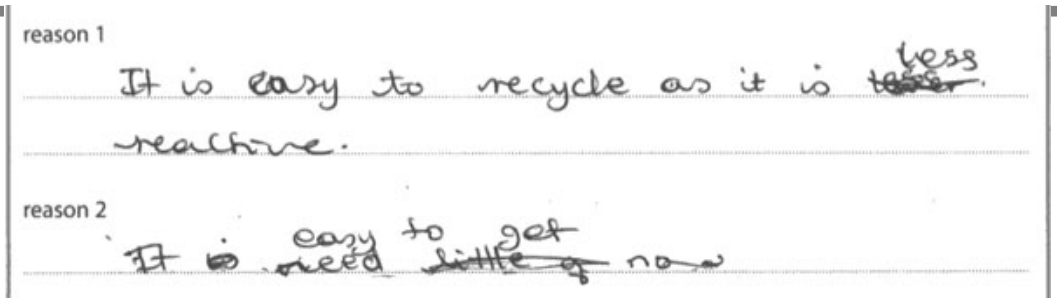
the cost of tin is more ~~expen~~ expensive than aluminium or ~~steel~~ steel.

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

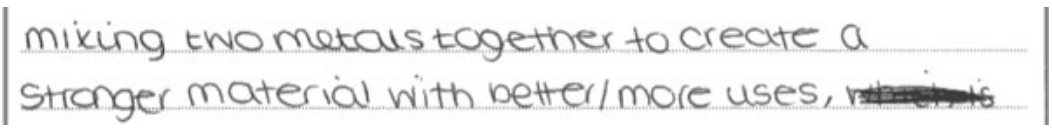
This response has not used information from the table as asked to by the question.

Results Plus: Examiner Tip

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

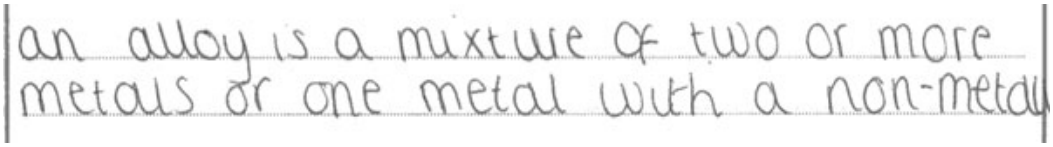
ci

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

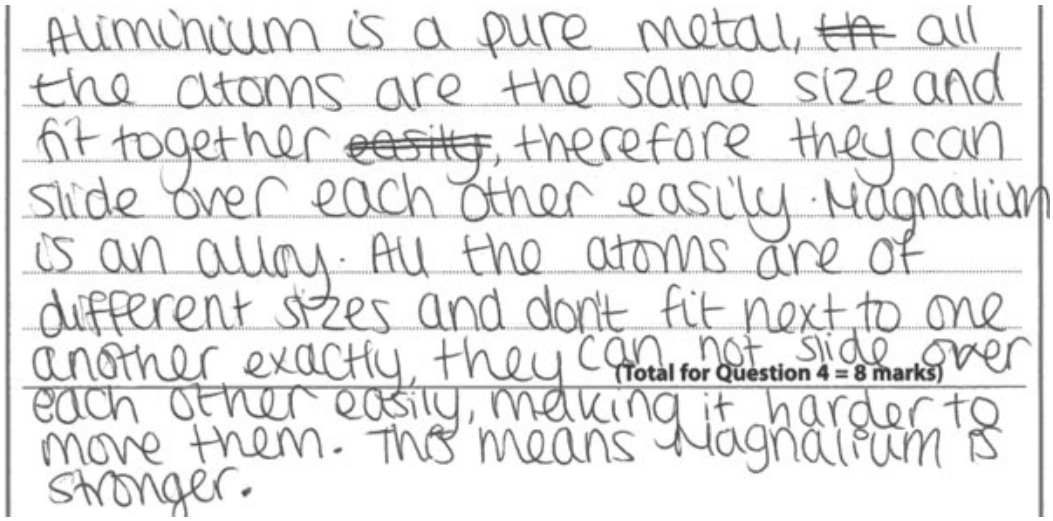
If this response had finished after the word metals, it would have scored 2 marks. However, it then goes on to state 'or one metal with a non-metal' which is not creditworthy.

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.



(Total for Question 4 = 8 marks)

Results Plus: Examiner Comments

A very good answer which scores three marks.

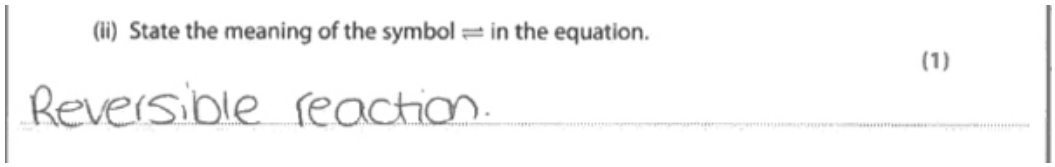
Q7.

(b) (i)

Most candidates gained credit for their answers, scoring the 1 mark available for simply stating 'gas'.

(b) (ii)

Most candidates gained credit for their answers.

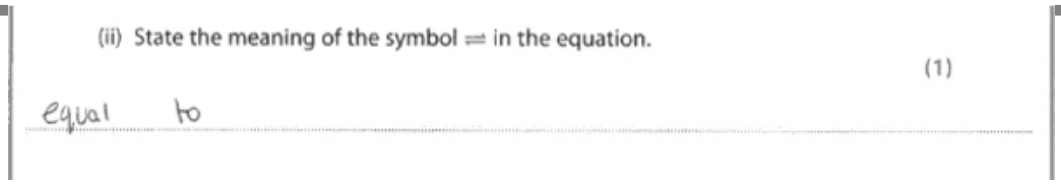

(ii) State the meaning of the symbol ⇌ in the equation.

(1)

Reversible reaction.

Results Plus: Examiner Comments

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


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

(1)

equal to

Results Plus: Examiner Comments

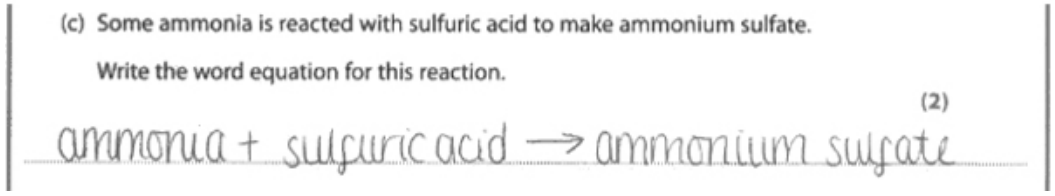
A typical incorrect answer, where the reversible sign was confused with simply an equal sign, so does not score.

(c)

As expected, most candidates gained credit for showing both the correct reactants and products.

Occasionally, extra incorrect products, namely 'carbon dioxide' or 'water' were given, so only 1 mark was scored.

Unfortunately, spelling errors were all too common, especially when the compounds were given in the question.


(c) Some ammonia is reacted with sulfuric acid to make ammonium sulfate.

Write the word equation for this reaction.

(2)

ammonia + sulfuric acid → ammonium sulfate

Results Plus: Examiner Comments

Both the correct reactants and products have been given, so this response was awarded the 2 marks available.

(c) Some ammonia is reacted with sulfuric acid to make ammonium sulfate.

Write the word equation for this reaction.

(2)

Ammonia + Sulfuric acid -> ammonium sulfate + water

Results Plus: Examiner Comments

A typical 1 mark response for showing the correct reactants only. The right hand side is incorrect since 'water' has also been added.

(d)

This question was well answered, with the majority of candidates clearly understanding the role of a fertiliser, to score the 1 mark available.

The most common correct answers referred to increasing the rate of plant growth or the addition of nutrients / mineral salts to the soil.

Where some candidates failed to score, the main misconception was to confuse fertilisers with pesticides or herbicides.

A typically seen correct response for 1 mark.

(d) Ammonium sulfate is used as a fertiliser.

State why farmers use fertilisers on their fields.

(1)

Farmers use fertilisers on their fields to speed up the growing rate of there crops and plants.

Results Plus: Examiner Comments

A typical correct response referring to 'speed up rate of growth', so this was awarded 1 mark.

(d) Ammonium sulfate is used as a fertiliser.

State why farmers use fertilisers on their fields.

(1)

To keep away insects so damage isn't caused to crops.

Results Plus: Examiner Comments

A common misconception, namely to confuse insecticides and fertilisers, so this response did not

score.

(e) (i)

Many candidates were unable to recall 'burette', and simply confused a pipette with a burette.

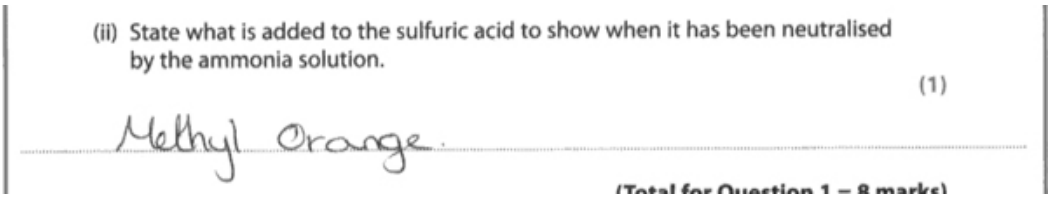
Of those candidates who gained credit for this item, invariably the word was spelled phonetically, this was in most cases sufficient to gain the 1 mark available.

(e) (ii)

Few candidates gained the mark for this question.

Where correct answers were seen, credit was invariably for 'indicator' alone, or 'methyl orange' or 'phenolphthalein' (or a phonetic spelling which was more or less correct).

The most common incorrect answers referred to 'Universal Indicator'. It needs to be stressed to centres that Universal Indicator solution is an inappropriate indicator for titrations.


(ii) State what is added to the sulfuric acid to show when it has been neutralised by the ammonia solution.

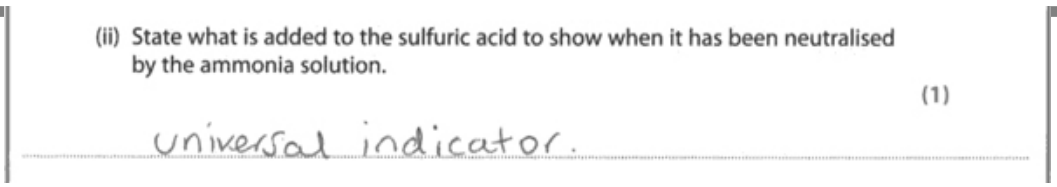
(1)

Methyl Orange.

(Total for Question 1 = 8 marks)

Results Plus: Examiner Comments

A typical 1 mark response for a correctly named indicator, namely 'methyl orange'.


(ii) State what is added to the sulfuric acid to show when it has been neutralised by the ammonia solution.

(1)

universal indicator.

Results Plus: Examiner Comments

A very commonly seen incorrect response. 'Universal indicator' does not score.

Q8.

(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 ~~[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 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.

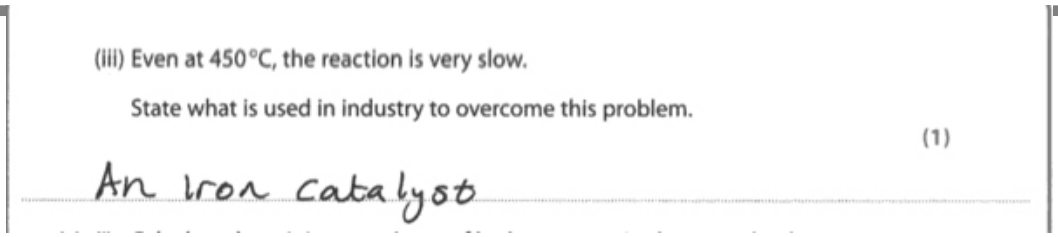
Explain how the use of a lower temperature would affect the equilibrium yield of ammonia.

(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)

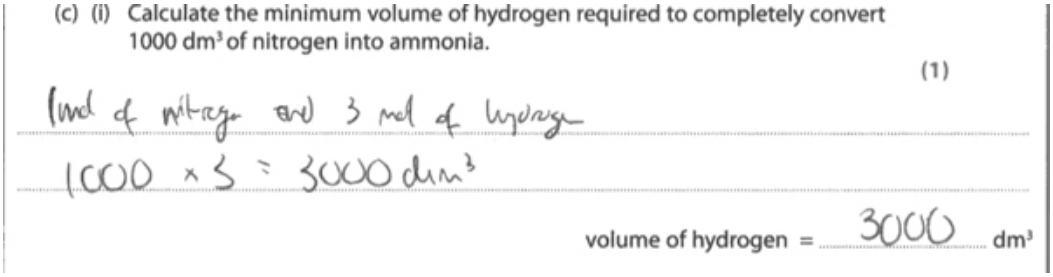
An iron catalyst

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)

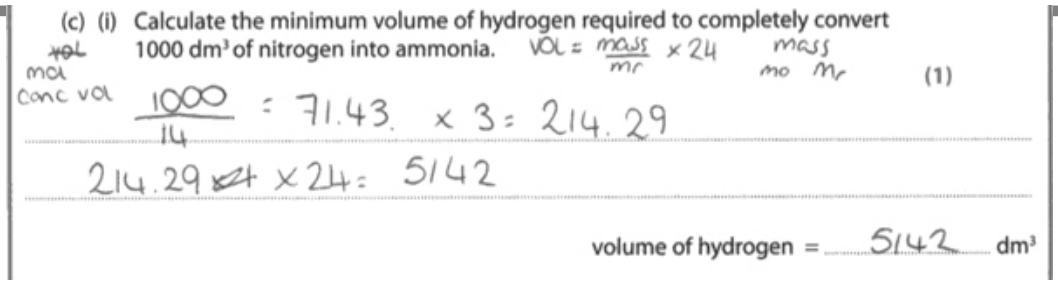
1mol of nitrogen and 3 mol of hydrogen

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

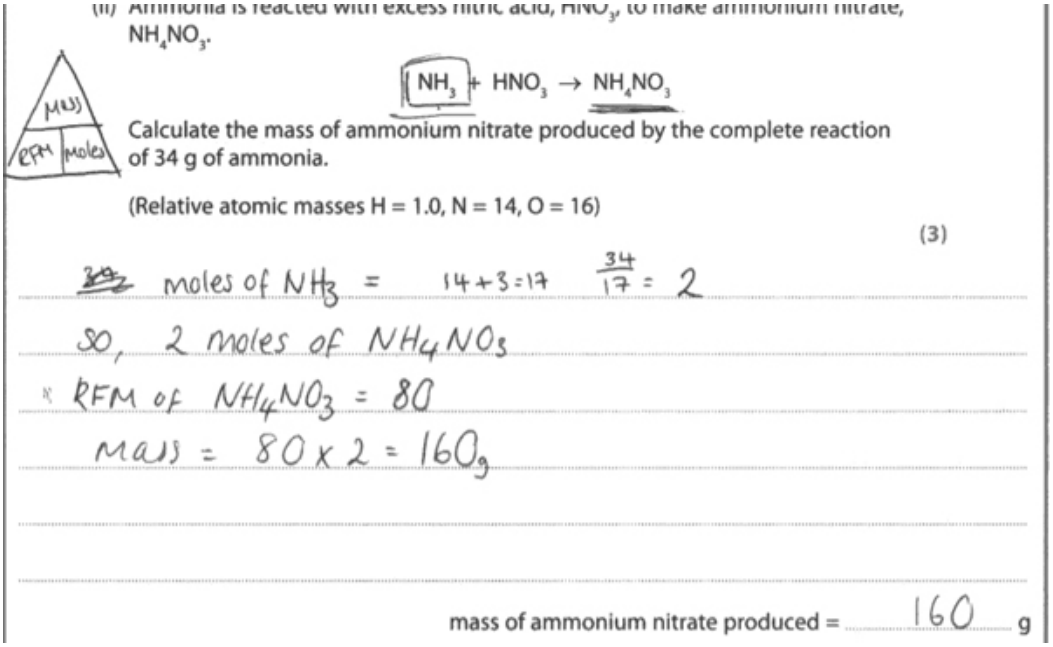
This candidate thought that 1000 g of nitrogen was used and tried to convert it into moles by dividing by the relative atomic mass of nitrogen, so did not score a mark.

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

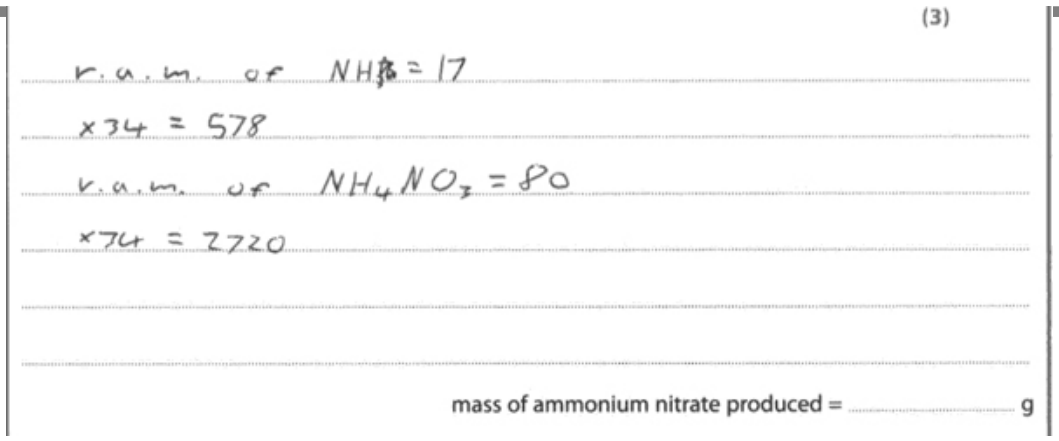
RFM of NH_4NO_3 = 80

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.

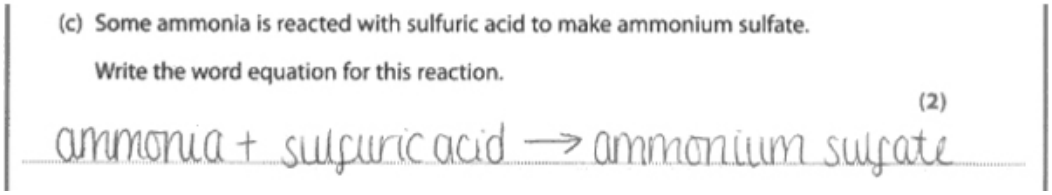
Q9. No Examiner's Report available for this question

Q10.

As expected, most candidates gained credit for showing both the correct reactants and products.

Occasionally, extra incorrect products, namely 'carbon dioxide' or 'water' were given, so only 1 mark was scored.

Unfortunately, spelling errors were all too common, especially when the compounds were given in the question.


(c) Some ammonia is reacted with sulfuric acid to make ammonium sulfate.

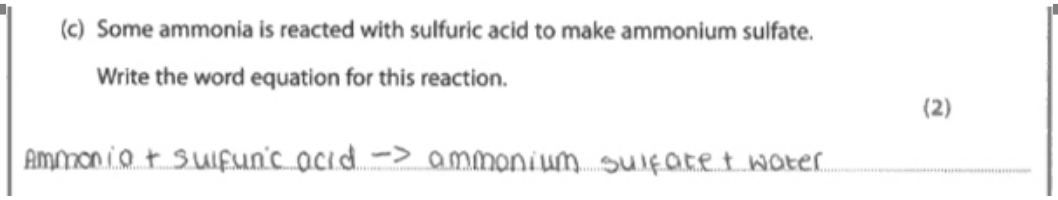
Write the word equation for this reaction.

(2)

ammonia + sulfuric acid → ammonium sulfate

Results Plus: Examiner Comments

Both the correct reactants and products have been given, so this response was awarded the 2 marks available.


(c) Some ammonia is reacted with sulfuric acid to make ammonium sulfate.

Write the word equation for this reaction.

(2)

Ammonia + Sulfuric acid -> ammonium sulfate + water

Results Plus: Examiner Comments

A typical 1 mark response for showing the correct reactants only. The right hand side is incorrect since 'water' has also been added.

Q11. No Examiner's Report available for this question

Q12. No Examiner's Report available for this question

Q13.

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

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

The apparatus is shown in Figure 4.

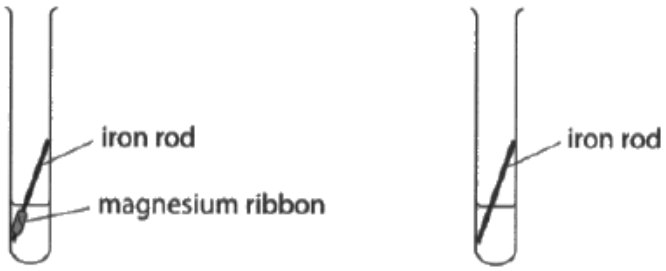


Figure 4

The method used is

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

Both boiling tubes are left for a few days.

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

(2)

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

Results Plus: Examiner Comments

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

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

measuring cylinder

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

(1)

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

Results Plus: Examiner Comments

A misunderstanding between a dropping pipette and a volumetric pipette.

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

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

The results are shown in Figure 5.

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

Figure 5

Explain the results of this experiment.

(2)

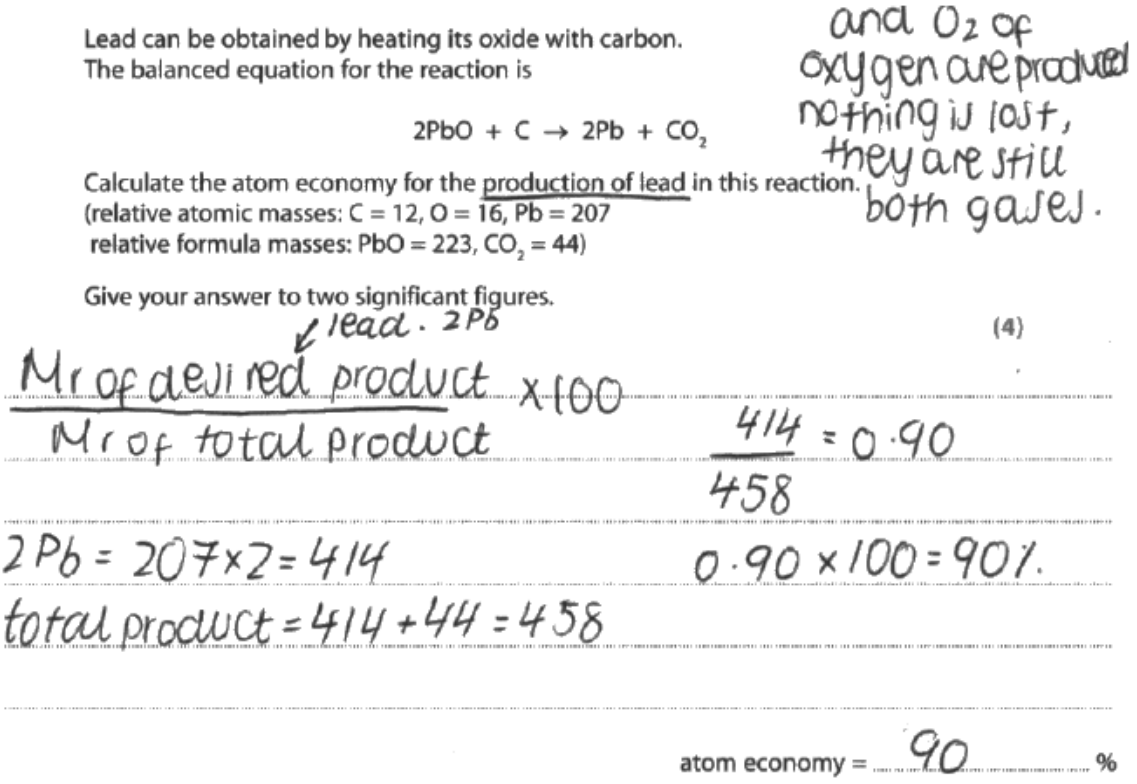
The iron rod in boiling tube A hasn't ~~be~~ rusted as the magnesium acted as sacrificial protection (it reacted first with ~~in place~~ the water and air because it's more reactive than iron). Where as the iron rod in B rusted because there was nothing protecting it.

Results Plus: Examiner Comments

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

Q14.

Whilst candidates did find the question difficult it was pleasing to see a good number of candidates that scored full marks for the correct answer given to two significant figures.



Results Plus: Examiner Comments

The correct answer, with clear working that scored all 4 marks available.

Lead can be obtained by heating its oxide with carbon.
The balanced equation for the reaction is

$$2PbO + C \rightarrow 2Pb + CO_2$$

Calculate the atom economy for the production of lead in this reaction.
(relative atomic masses: C = 12, O = 16, Pb = 207
relative formula masses: PbO = 223, CO_2 = 44)

Give your answer to two significant figures.

(4)

223 x 2 = 446 + 12 = 458

207 x 2 = 414 + 12 = 426 + (16 x 2) = 458

$\frac{414}{458} \times 100 = 90.39$

atom economy = 90.4 %

Results Plus: Examiner Comments

The answer has been calculated correctly but not given to the correct number of significant figures so gained three rather than 4 marks.

Lead can be obtained by heating its oxide with carbon.
The balanced equation for the reaction is

$$2PbO + C \rightarrow 2Pb + CO_2$$

Calculate the atom economy for the production of lead in this reaction.
(relative atomic masses: C = 12, O = 16, Pb = 207
relative formula masses: PbO = 223, CO_2 = 44)

Part reel

Give your answer to two significant figures.

414 446

(4)

$207 \times 2 + 16 \times 2 + 12 = 458$ $\frac{458}{458} \times 100$

$\frac{414 + 44}{458}$

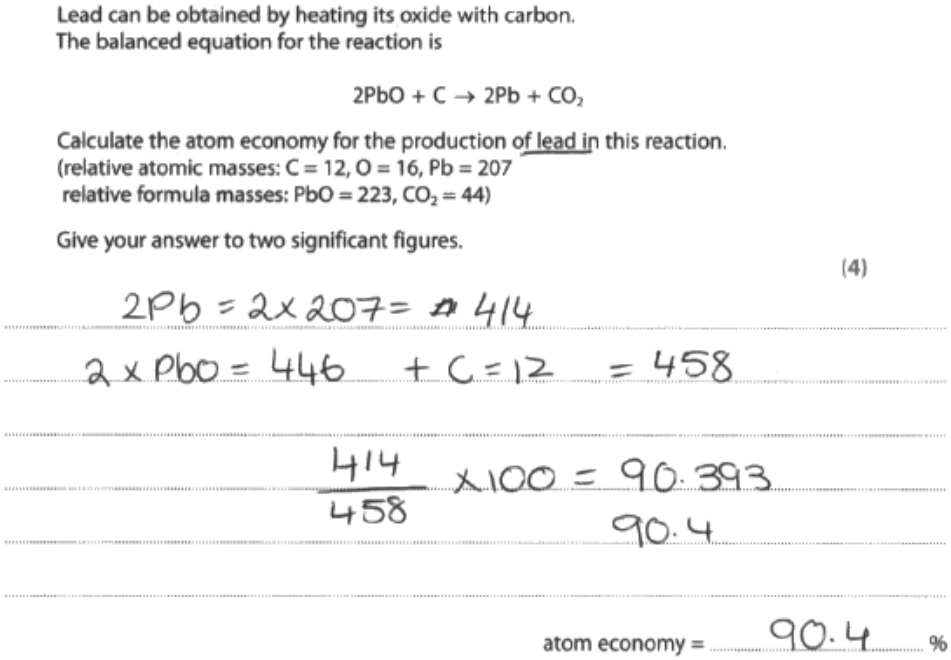
atom economy = 100 %

Results Plus: Examiner Comments

A common error was to divide the masses of all of the products added together, rather than just the mass of theuseful product, by the masses of all of the reactants to come to an answer of 100%. Whilst incorrect, candidates that showed their working did gain some credit. This answer scored 2 marks.

Q15.

Approximately two-thirds of candidates scored at least 2 marks with the rest scoring 4 marks. Several candidates made an error in calculating the sum of the formula masses of either the reactants (2 × 223 + 12) or the products (2 × 212 + 44). Some candidates were trying to calculate the atom economy of something other than lead. Error carried forward was in place, as with other calculations, but here seemed to be applied more often. Unfortunately, many candidates obtained an answer of 90.393% and forgot apply the approximation, as asked, to 2 significant figures.



Lead can be obtained by heating its oxide with carbon.
The balanced equation for the reaction is

$$2PbO + C \rightarrow 2Pb + CO_2$$

Calculate the atom economy for the production of lead in this reaction.
(relative atomic masses: C = 12, O = 16, Pb = 207
relative formula masses: PbO = 223, CO_2 = 44)

Give your answer to two significant figures.

(4)

$2Pb = 2 \times 207 = 414$

$2 \times PbO = 446 \quad + C = 12 \quad = 458$

$\frac{414}{458} \times 100 = 90.393$

90.4

atom economy = 90.4 %

Results Plus: Examiner Comments

A correct calculation which was awarded 3 marks, but an incorrect approximation to THREE significant figures gave the answer of 90.4% which meant the last mark was lost.

Results Plus: Examiner Tip

Ensure you know how to approximate numbers to a given number of significant figures or a given number of decimal places.

Lead can be obtained by heating its oxide with carbon.
The balanced equation for the reaction is

$$2PbO + C \rightarrow 2Pb + CO_2$$

Calculate the atom economy for the production of lead in this reaction.
(relative atomic masses: C = 12, O = 16, Pb = 207
relative formula masses: PbO = 223, CO_2 = 44)

Give your answer to two significant figures.

(4)

$\frac{414}{446+12+44} \times 100 = 82,47dl$

$= 82$

atom economy = 82 %

Results Plus: Examiner Comments

The candidate made an error in calculating the formula masses of the reactants by the addition of the 44. This lost a mark, but with error carried forward, meant that 3 marks could then be awarded.

Q16.

(a)

Nearly half of the candidates could write the correct balanced equation given the information in the question; a further one third scored one mark for a partly correct word equation. It was disappointing to see that so many could not copy the reactants correctly; 'calcium solution' and 'sodium solution' were commonly seen as reactants. Many candidates used just the information and formed the products 'calcium carbonate + salt' or more frequently 'calcium carbonate + another salt'. A small number thought they had to write a balanced equation and invariably failed as they were making up formulae for the substances, e.g. SC for sodium carbonate. Candidates should be advised that where a word equation is asked for, they are not expected to write a balanced equation using chemical formulae.

4 (a) Calcium nitrate solution reacts with sodium carbonate solution.
The products are calcium carbonate and another salt.

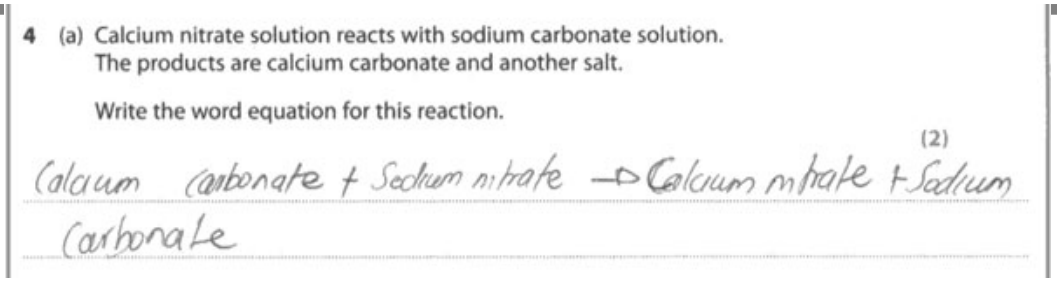
Write the word equation for this reaction.

(2)

Calcium Nitrate + Sodium Carbonate → Calcium Carbonate + Another Salt

Results Plus: Examiner Comments

Quite a common answer. However, 1 mark was score for the correct reactants.


4 (a) Calcium nitrate solution reacts with sodium carbonate solution.
The products are calcium carbonate and another salt.

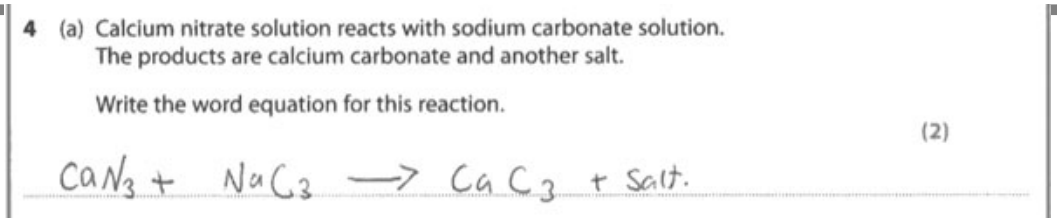
Write the word equation for this reaction.

(2)

Calcium carbonate + Sodium nitrate → Calcium nitrate + Sodium Carbonate

Results Plus: Examiner Comments

All the correct substances, but in the wrong places. This scored 0 marks.


4 (a) Calcium nitrate solution reacts with sodium carbonate solution.
The products are calcium carbonate and another salt.

Write the word equation for this reaction.

(2)

$CaN_3 + NaC_3 \longrightarrow CaC_3 + Salt.$

Results Plus: Examiner Comments

Here is an attempt to write a balanced equation using invented chemical formulae. Answers like this can only be awarded 0 marks.

Results Plus: Examiner Tip

When word equations are asked for, do not attempt to write a balanced equation using chemical formulae. Use the information in the question to help in the construction of the word equation.

(b) (ii)

Only a few candidates scored both marks for describing how to correctly carry out a flame test on a solid. Generally the candidates that scored 1 mark did so for 'putting 'it' into flame' or putting a solid on a rod/loop/splint. Many held the solid OVER or under (?) a flame or just stated 'over a Bunsen'. There were few real attempts to describe the test accurately; the majority described using inappropriate equipment e.g. tongs, spatulas, tweezers, spoons, clamps. Very few mentioned the need to clean the wire loop before carrying the flame test.

(ii) Describe how a flame test is carried out on a solid.

(2)

a bunson burner is used/lit. Then with gloves and tongs you would pickup the solid and hover it over the flame and the colour should appear

Results Plus: Examiner Comments

Incorrect equipment (tongs) as well as 'hover it over the flame' do not attract marks for carrying out the flame test. 0 marks awarded here.

(ii) Describe how a flame test is carried out on a solid.

(2)

you put a chosen solid in the blue flame, and see what colour the flame goes above the solid

Results Plus: Examiner Comments

1 mark was given for putting the solid into a blue (Bunsen) flame.

(ii) Describe how a flame test is carried out on a solid.

(2)

you dip a piece of water into your solid, then place the wire in the hottest part of the Bunsen Burner and watch the COLOUR

Results Plus: Examiner Comments

If only the candidate could re-read their answer! Unfortunately similar errors were often seen in answers to this question.

(ii) Describe how a flame test is carried out on a solid.

(2)

by using a metal flame [redacted] loop. you dip it in acid. You then pick up the solid on the flame loop. You then put the flame loop into the bunsen burner flame and record the colour seen.

Results Plus: Examiner Comments

An answer like this was rarely seen. This was very pleasing to see and 2 marks were given for this answer.

Results Plus: Examiner Tip

The three steps involved in a flame test are:

1. Clean the flame testing rod with hydrochloric acid.

2. Dip the rod into the acid and then into the solid being tested.

3. Put the end of the testing rod into a Bunsen flame with the air hole half open.

Learn the steps involved to carry out a flame test and the colours that are obtained for the ions Na^+, K^+, Ca^{2+} and Cu^{2+}.

(c) (i)

It was clear that most candidates did not know how to calculate the percentage yield as very few candidates obtained the correct answer, however some achieved only one mark because their answer was approximated to 90% from 90.91%. Some had the ratio of mass inverted and obtained an answer of 110% without thinking about the implication. Other incorrect answers were seen using various mathematical processes involving the numbers 40, 44 and 100. The answer of 100 – 40 = 60% was commonly seen.

(c) If calcium carbonate is heated strongly, it decomposes.

$$CaCO_3 \rightarrow CaO + CO_2$$

If 100 g of calcium carbonate is heated a calculation shows that 44 g carbon dioxide should be formed.

(i) In an experiment 100 g of calcium carbonate was heated and only 40 g carbon dioxide was formed.

Calculate the percentage yield of carbon dioxide in this reaction.

(2)

Percentage yield = actual yield / theoretical yield × 100 Ans = 90

100% = 40/44 = 0.909... × 100

percentage yield of carbon dioxide = 90 %

Results Plus: Examiner Comments

A correctly calculated percentage yield. Sadly the candidate then approximated the answer to 90 rather than 91% and so only 1 mark could be given for this.

(c) If calcium carbonate is heated strongly, it decomposes.

$$CaCO_3 \rightarrow CaO + CO_2$$

If 100 g of calcium carbonate is heated a calculation shows that 44 g carbon dioxide should be formed.

(i) In an experiment 100 g of calcium carbonate was heated and only 40 g carbon dioxide was formed.

Calculate the percentage yield of carbon dioxide in this reaction.

(2)

44/40 × 100

actual yield / theoretical yield × 100 44/40 × 100

percentage yield of carbon dioxide = 110 %

Results Plus: Examiner Comments

Candidates who had the ratio inverted didn't stop to think about the consequence of their answer. Here, 1 error had been made - the inverted ratio - so 1 mark was awarded in these instances.

(c) If calcium carbonate is heated strongly, it decomposes.

$$CaCO_3 \rightarrow CaO + CO_2$$

If 100 g of calcium carbonate is heated a calculation shows that 44 g carbon dioxide should be formed.

(i) In an experiment 100 g of calcium carbonate was heated and only 40 g carbon dioxide was formed.

Calculate the percentage yield of carbon dioxide in this reaction.

(2)

100g − 40g = 60g

percentage yield of carbon dioxide = 60 %

Results Plus: Examiner Comments

This answer (or that which showed 100 - 44 = 56) was often seen, showing that the candidate did not understand how to calculated the percentage yield of a product. 0 marks were awarded.

Results Plus: Examiner Tip

Know that percentage yield = (actual yield) x 100 / (theoretical yield), and that this value will always be less than 100%. If you have obtained an answer greater than 100, check your calculation to see where you have made an error.

(c) (ii)

This question was fairly open in terms of the possible responses as shown by the command word 'suggest' in the question. However, to account for a difference between theoretical and actual yields, self-deprecating possibilities such as 'human error', 'spillage', 'anomalies', 'not weighed out accurately', 'wrong equipment' and 'gas escaping' were often cited but would not gain credit and candidates should be advised of this. Some referred to calculation only being a prediction and actual yields were always wrong. Some offered the vague term 'not heated properly'. There was also some confusion with incomplete combustion, as some stated 'there was not enough oxygen being present for a reaction'.

However, almost a quarter of candidates cited a correct reason here and referred to 'not heating it for long enough', 'the reaction not being complete', 'the flame not being hot enough' or 'the calcium carbonate contained impurities'.

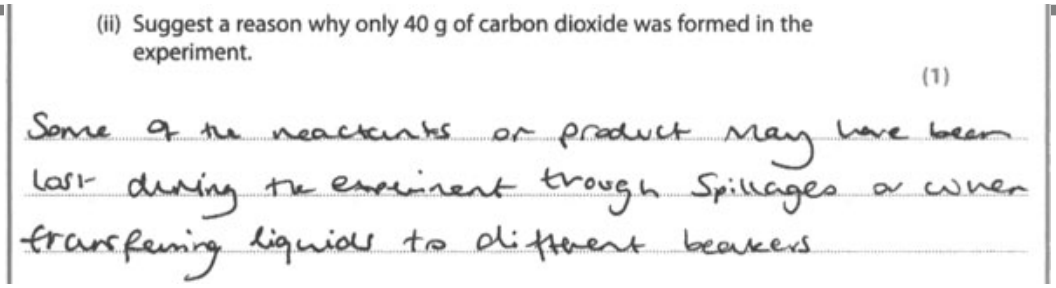
(ii) Suggest a reason why only 40 g of carbon dioxide was formed in the experiment.

(1)

Some of the carbon dioxide could have been lost during the experiment.

Results Plus: Examiner Comments

The candidate had not thought about what was happening during the reaction. All the carbon dioxide was being lost during the reaction. This answer scored 0.



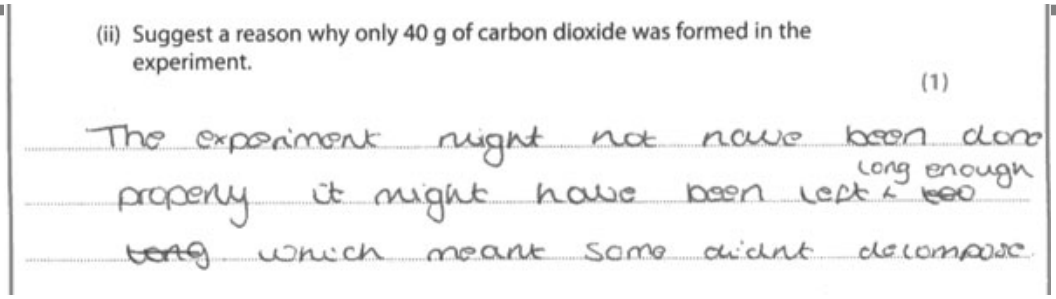
(ii) Suggest a reason why only 40 g of carbon dioxide was formed in the experiment.

(1)

Some of the reactants or product may have been lost during the experiment trough Spillages or when transfering liquids to different beakers

Results Plus: Examiner Comments

The candidate had not thought through the process. A solid was being heated to form another solid with the loss of a gas, so loss of transferring liquids could not possibly happen in this situation. 0 marks given.



(ii) Suggest a reason why only 40 g of carbon dioxide was formed in the experiment.

(1)

The experiment might not have been done properly it might have been left a long enough ~~long~~ which meant some didnt decompose

Results Plus: Examiner Comments

Although not phrased very well to start with, 'might not have been done properly' was ignored and the second part of the answer was very good and scored the 1 mark.

Results Plus: Examiner Tip

To account for yield being less than 100%, there are three main reasons:

a) Incomplete reaction - not all reactants used up.

b) Product lost during the reaction - usually when transferring liquids from one container to another.

c) Other unwanted reactions - usually to make a different product.

Think about the reaction when applying these ideas.

Q17. No Examiner's Report available for this question

Q18. No Examiner's Report available for this question

Q19. No Examiner's Report available for this question

Q20.

The majority of responses to this question scored either 4 marks or 0 marks and there were a significant number of blank responses here. Where candidates attempted the calculation incorrectly there were issues with getting equations the wrong way round (concentration = moles x volume) or putting values for volume where moles should be and attempting to calculate concentration using the two volume values given in the question.

Q21. No Examiner's Report available for this question

Q22. No Examiner's Report available for this question

Q23.

This question was well answered overall, and many candidates scored both marks. The most common 1 mark response was calculating the mass of 2% - presumably due to candidates misreading the question.

Q24.

This question was well answered with the majority of candidates scoring the 1 mark available.

Most candidates were able to correctly subtract the mass of solid remaining from the initial mass of calcium carbonate to arrive at the correct answer 1.787.

Commonly seen errors included: some candidates subtracted incorrectly or divided their correct answer by two.

Q25.

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

Q26. No Examiner's Report available for this question

Q27. No Examiner's Report available for this question

Q28. No Examiner's Report available for this question

Q29.

There was a wide variation in responses on this question, but relatively few scored the full 4 marks. Most candidates were able to show that 2 moles of NO has a mass of 60g and many converted this to 16.67 moles of oxygen and scored at least two marks. Only a minority then went on to multiply this by 24 and then 100/20 to arrive at the correct answer of 2000 dm3. Others scored the latter two marks after making an initial error that was only penalised once. However a significant number of candidates found this question difficult to understand and often divided by 24 or 5 when they should have used multiplication. Answers that were poorly laid out with little in the way of order or annotation made it difficult to follow candidates' logic and to award part marks where the final answer was incorrect.

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

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

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

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

(4)

$2NO + O_2 \rightarrow 2NO_2$

$\frac{1000g}{60} = 16.6 mol$

$\frac{16.6}{2} = 8.3$ mol oxygen

$8.3 \times 24 = 200\ dm^3$

$200 = 0.2$ (20%) $\quad 200 \times 5 = 1000\ dm^3$ air

volume of air = 1000 dm^3

Results Plus: Examiner Comments

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

Q30.

This was low scoring, with more than half of the responses left blank. Whilst this question was challenging, some marks could have been awarded with some straightforward calculations. In this case there was one mark available for converting molar concentration into mass concentration and the relative formula mass was given.

Q31. No Examiner's Report available for this question

Q32.

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

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

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

Calculate the percentage yield of calcium oxide. (2)

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

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

percentage yield = 97.32

Results Plus: Examiner Comments

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

Q33.

(i)

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

In most correct responses, candidates gave their final answer to 2 decimal places.

Commonly seen errors included: (5.600-5.450)/5.600 x 100; inverted fraction, which often was

not multiplied by 100; multiplying the masses, namely 5.4 X 5.6 (= 30.52%).

It was noted by examiners that some responses failed to gain full credit since candidates were attempting to scale their answers rather than multiplying the fraction obtained. This might indicate the lack of a calculator when doing this calculation.

Q34.

Most candidates scored 2 marks for this question. Some lost a mark for incorrectly rounding the answer down to 87% rather than up to 88%.

Q35.

For the first part of the question, part (i), was well answered with the majority scoring the 2 marks available.

Candidates clearly understood how to use the relative atomic masses of calcium, carbon and oxygen to correctly deduce the relative formula mass of $CaCO_3$ to be 100.

A common error which often led to 1 mark only, often arose when failing to multiply the relative atomic mass of oxygen by three, namely arriving at a value of 68.

The second part of the question, part (ii), was very poorly answered with a significant majority of responses not scoring either of the 2 marks available.

Very few candidates clearly understood how to calculate the atom economy.

A common answer was 56, which generally did not score since no working was provided. The most commonly seen incorrect answer was 100 – indicating that a surprising number of candidates seemed to think both products were useful and so had an atom economy of 100%. With the relative formula mass of calcium carbonate being 100 (as calculated in part (i)), the need to both divide by 100 and then multiply by 100 in the same calculation may be a factor that proved most challenging to candidates.

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

(2)

40 + 12 + (16 x 3)

40 + 12 + 48 = 100

relative formula mass = 100

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

$$CaCO_3 \rightarrow CaO + CO_2$$

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

(2)

100 + 100 -> 40 + 16 + 12 + 32

100 -> 100

atom economy = 100 %

Results Plus: Examiner Comments

This response scored 2 marks for part (i).

The relative formula mass for calcium carbonate has been correctly calculated by adding together the relative atomic mass values for all the atoms in its formula.

The response for part (ii) was not credit worthy.

The candidate has not calculated the atom economy but has simply added together all the relative atomic masses for the atoms in the two products in the equation given in the question.

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

(2)

relative formula mass = 100

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

$$CaCO_3 \rightarrow CaO + CO_2$$

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

(2)

$\frac{CaO}{CaCO_3} \times 100 \quad \frac{56}{100} \times 100 =$

atom economy = 56 %

Results Plus: Examiner Comments

This response scored both marks for both parts (i) and (ii).

Although, no working has been shown in part (i), it is the correct value and is credited with the 2 marks.

With part (ii) the correct calculation for the atom economy has been shown, namely (56/100) x 100 =56.

Note that had 56 alone been given, i.e. without working, this would have not been credit worthy.

Results Plus: Examiner Tip

It is sensible with all calculations to show all working. Often where there has been a simple arithmetical error in a candidate's method, examiners are able to award marks in a calculation by error carried forward.

Q36.

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

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

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

(2)

$12 + 40 + (16 \times 3) = 100$

relative formula mass = 100

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

$$CaCO_3 \rightarrow CaO + CO_2$$

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

(2)

Mr desired $40 + 16$

Mr all $(40+16) + (12 + (16 \times 2))$

$\frac{56}{100} = 0.56 \times 100 = 56$

atom economy = 56 %

Results Plus: Examiner Comments

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

Q37.

Candidates made good attempts at this question, and more than half scored 1 of the two available marks. Many would have scored both marks, however it was more common to see the formula mass of oxygen used as 16 rather than the 32 that it is, and then incorrectly calculated the number of moles of oxygen to be 3 rather than the correct value of 1.5.

Other mistakes were with getting calculations mixed up and dividing numbers that should have been multiplied. There were a number of responses of 768, calculated by multiplying the mass by the relative formula mass and therefore using the incorrect formula.

Q38. No Examiner's Report available for this question

Q39. No Examiner's Report available for this question

Q40. No Examiner's Report available for this question

Q41. No Examiner's Report available for this question

Q42.

(i)

The majority of candidates answered this correctly. Many were awarded one mark for showing 10.4/15.0 but were not awarded the second mark as they had not multiplied by 100. The most common error was made by those who got the calculation the wrong way round and divided 15.0 by 10.4. They seemingly failed to realise that 144% was not a sensible answer for a percentage yield.

(ii)

Many students seem to have been well trained in their answers to this question. However a range of non-creditworthy answers were suggested. Some of these involved giving definitions of theoretical yield or referred to the difference between theoretical and actual yield or stated that yield calculations are simply inherently faulty. Others made vague suggestions such as "human error" or errors due to parallax and the need to measure solutions at eye level.

(ii) Suggest **two** reasons why the actual yield was less than the theoretical yield.

(2)

reason 1 The reaction may have been incomplete so not the reactants would made into products

reason 2 Some of the product was lost in preparation, for example when transferring between containers

- Solution of ~~reactants~~ (unwanted reactions could have also occured)

(Total for Question 3 = 10 marks)

Results Plus: Examiner Comments

An answer worth both marks.

(ii) Suggest **two** reasons why the actual yield was less than the theoretical yield.

(2)

reason 1 An incomplete reaction

reason 2 ~~*~~ Some of the reactants made have not been weighed properly.

(Total for Question 3 = 10 marks)

Results Plus: Examiner Comments

The first reason is correct but errors in weighing were not acceptable.

Q43. No Examiner's Report available for this question

Q44.

(i)

Many candidates calculated the correct average of the titration results. However, there were a significant number who took the average of all 3 results, rather than just the two concordant values.

(i) State the volume of hydrochloric acid that must be used to calculate the concentration of sodium hydroxide solution.

(1)

volume of hydrochloric acid = 22.83 cm^3

Results Plus: Examiner Comments

This candidate has included the rough titration result in the average, so has not scored a mark.

Results Plus: Examiner Tip

When you take the average of titration results, only include the results which are concordant (very close readings).

(i) State the volume of hydrochloric acid that must be used to calculate the concentration of sodium hydroxide solution.

(1)

volume of hydrochloric acid = 22.7 cm^3

Results Plus: Examiner Comments

This candidate has scored 1 mark for correctly working out the average of the concordant titration results.

(ii)

Many excellent answers were seen to this calculation, with working clearly explained. Some candidates would benefit from more practice with questions involving concentrations of solutions.

(ii) In a different experiment, 25.0 cm^3 of sodium hydroxide solution reacted with 23.2 cm^3 of 0.100 mol dm^{-3} hydrochloric acid, HCl.

Calculate the concentration of this sodium hydroxide solution, NaOH, in mol dm^{-3}.

mole / conc × vol

(3)

$NaOH + HCl \rightarrow NaCl + H_2O$

$\frac{23.2}{1000} \times 0.1 = 2.32 \times 10^{-3}$ moles

1 mole of NaOH to neutralise 1 mole of HCl.

$\frac{2.32 \times 10^{-3}}{(25 \div 1000)} = 0.0928$ mol dm^{-3}

concentration of sodium hydroxide solution = 0.0928 mol dm^{-3}

Results Plus: Examiner Comments

This is a very good answer, scoring 3 marks.

(ii) In a different experiment, 25.0 cm^3 of sodium hydroxide solution reacted with 23.2 cm^3 of 0.100 mol dm^{-3} hydrochloric acid, HCl.

Calculate the concentration of this sodium hydroxide solution, NaOH, in mol dm^{-3}.

(3)

$NaOH + HCl \rightarrow NaCl + H_2O$

2.32×10^{-3}

Sodium hydroxide - volume = 25.0cm³ conc. = ?

Hydrochloric acid - volume = 23.2cm³ Conc. = 0.100moldm

no. of moles = conc x volume.

$\frac{23.2}{1000} = 0.0232 \times 0.100 = 2.32 \times 10^{-3}$ = moles of HCl

$\text{conc.} = \frac{\text{no. of moles}}{\text{volume}} = \frac{2.32 \times 10^{-3}}{25.0 cm^3}$

concentration of sodium hydroxide solution = ... mol dm^{-3}

Results Plus: Examiner Comments

This candidate has scored 2 marks for the working. They have calculated the number of moles of hydrochloric acid and realised that they need to divide this by the volume of sodium hydroxide. They have just forgotten to multiply by 1000 at the end.

Results Plus: Examiner Tip

Always show your working for a calculation as it might be worth some marks, even if the final answer is wrong.

(ii) In a different experiment, 25.0 cm^3 of sodium hydroxide solution reacted with 23.2 cm^3 of 0.100 mol dm^{-3} hydrochloric acid, HCl.

Calculate the concentration of this sodium hydroxide solution, NaOH, in mol dm^{-3}.

(3)



Vol
mol

$NaOH + HCl \rightarrow NaCl + H_2O$

$\frac{23.2}{0.100} \times \frac{mol}{Vol} = \frac{0.1}{23.2cm^3} = 2.32$

hydrochloric

concentration of sodium hydroxide solution = ... mol dm^{-3}

Results Plus: Examiner Comments

This candidate does not know how to calculate the number of moles from a volume and a concentration, so has not scored any marks.

Results Plus: Examiner Tip

Learn the formulae for calculating amounts in moles for solids, gases and solutions.

Q45.

(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)

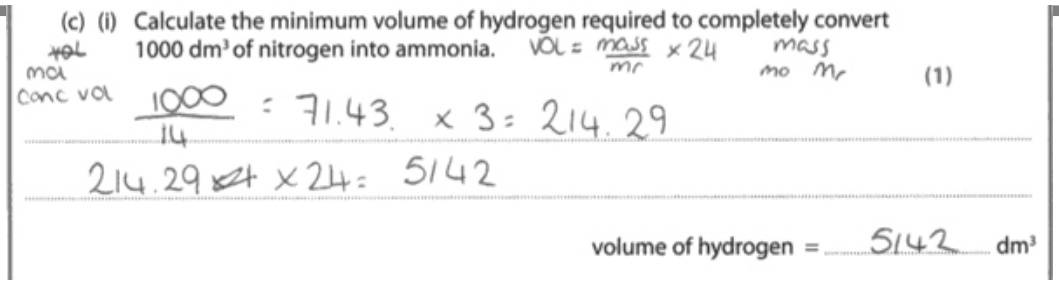
1 mol of nitrogen and 3 mol of hydrogen

$1000 \times 3 = 3000\ dm^3$

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 dm³ of nitrogen into ammonia. (1)

mol conc vol $\frac{1000}{14} = 71.43 \times 3 = 214.29$

$214.29 \times 24 = 5142$

volume of hydrogen = 5142 dm³

Results Plus: Examiner Comments

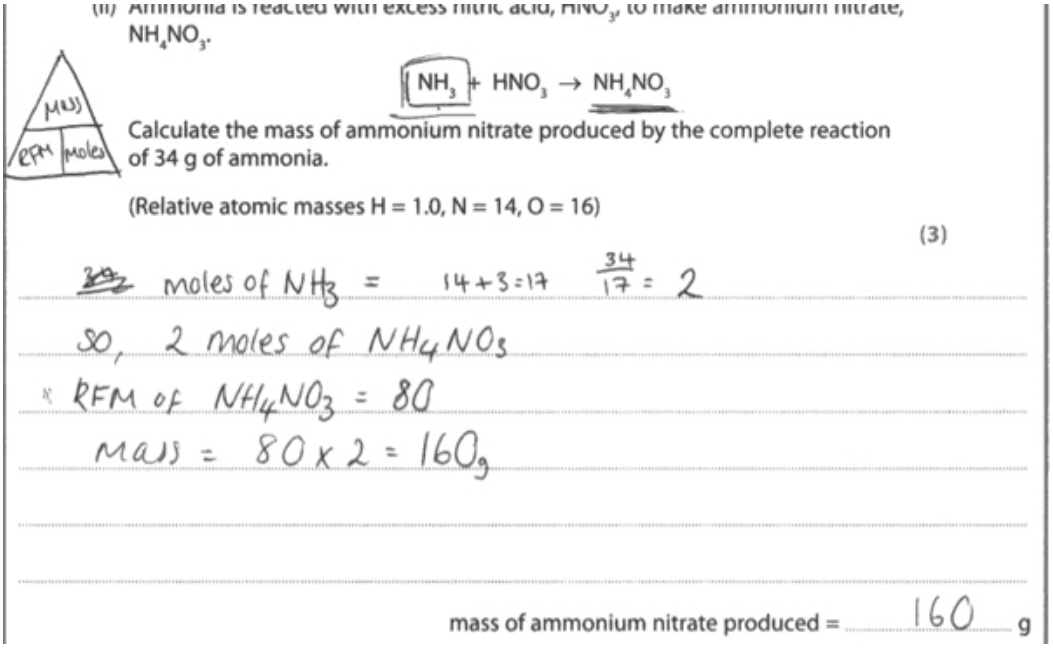
This candidate thought that 1000 g of nitrogen was used and tried to convert it into moles by dividing by the relative atomic mass of nitrogen, so did not score a mark.

Results Plus: Examiner Tip

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

(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

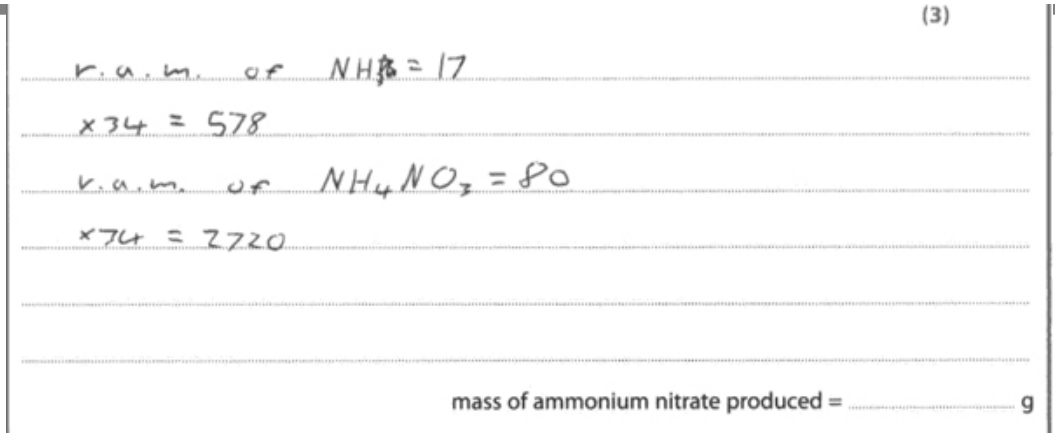
RFM of $NH_4NO_3 = 80$

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.



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.

Q46. No Examiner's Report available for this question

Q47.

About half the candidates had no idea how to calculate the concentration of the sulfuric acid using the information provided. Candidates need to be advised that if relative atomic masses are not given for a particular calculation, then they will not be needed. This was the cause of many candidates going wrong here.

Showing working enabled candidates to score some marks. Several candidates forgot to use the equation to work out the number of moles of acid from the number of moles of alkali, so leading to an answer of 0.194 mol dm^{-3}, so scoring 3 marks. The other misconception frequently seen was the omission of converting from cm^3 to dm^3. It was noticed that there many centres where their candidates knew how to perform this type of calculation with marks of mostly 3 or 4 being awarded.

In the titration, 25.00 cm^3 of dilute sulfuric acid reacted with 24.25 cm^3 of 0.200 mol dm^{-3} sodium hydroxide solution, NaOH.

$$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$$

Calculate the concentration of the dilute sulfuric acid, H_2SO_4, in mol dm^{-3}.

(4)

0.200

0.02425

$24.25 cm^3 = 0.02425 dm^3$

$H_2SO_4 : 2NaOH$

1 : 2

$\frac{1}{2} \times 0.2 \times 0.02425$

$= 4.8 \times 10^{-3}$ mole

$x : 4.8 \times 10^{-3}$

1 : $\frac{1}{2} \times 4.8 \times 10^{-3}$

2.4×10^{-3} moles

$\frac{2.4 \times 10^{-3}}{0.025}$

$25 cm^3 = 0.025 dm^3$

$= 0.096$ mol dm^{-3}

concentration of sulfuric acid = 0.096 mol dm^{-3}

Results Plus: Examiner Comments

The candidate took the result of step one as 0.0048 and not 0.00485, so lost the first mark. The calculation was correct otherwise and scored 3 marks.

Results Plus: Examiner Tip

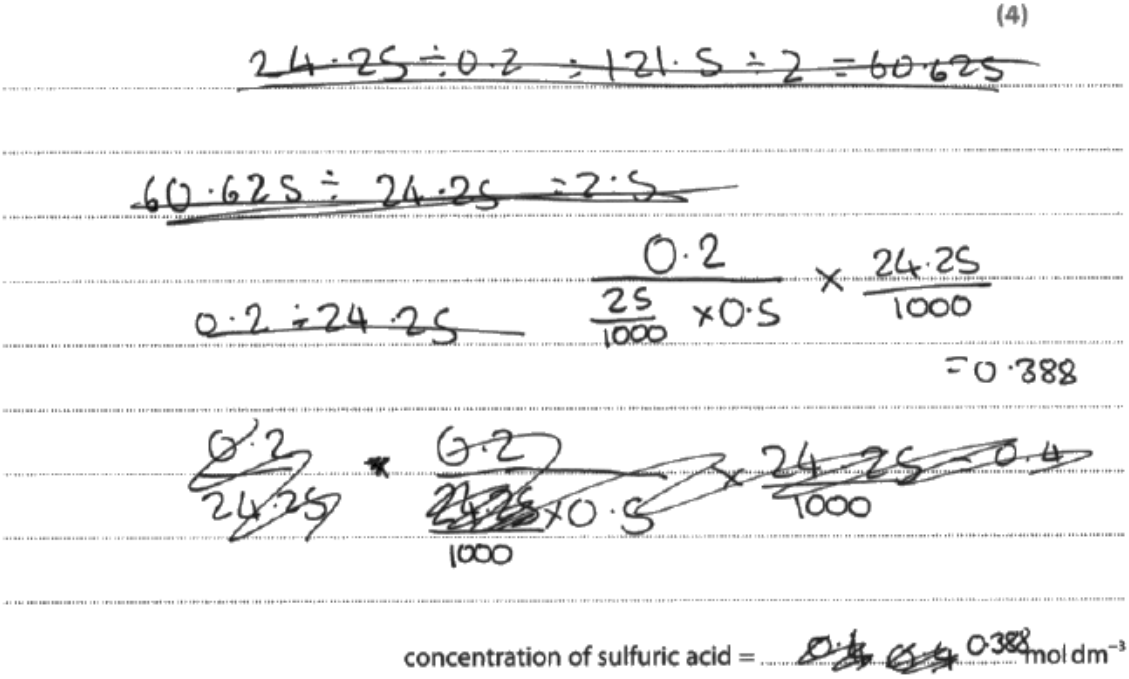
Approximating early on in a calculation will result in an error being made and the loss of a mark.

In the titration, 25.00 cm^3 of dilute sulfuric acid reacted with 24.25 cm^3 of 0.200 mol dm^{-3} sodium hydroxide solution, NaOH.

$$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$$

Calculate the concentration of the dilute sulfuric acid, H_2SO_4, in mol dm^{-3}.

(4)



concentration of sulfuric acid = 0·388 mol dm^{-3}

Results Plus: Examiner Comments

The candidate has divided by 0.5 instead of multiplying by 0.5 so the answer is out by a factor of 4.
Only one mistake was made, so with error carried forward, this scored 3 marks.

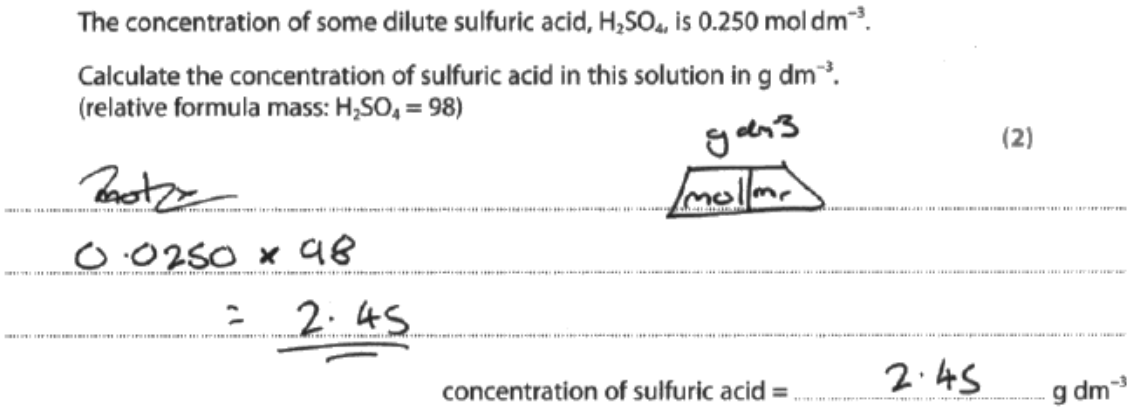
Results Plus: Examiner Tip

As there wil be a minimum of 20% of the marks for testing maths skills on the paper, it is essential that you practice the standard types of calculation.

Q48.

The was answered well by those who attempted the question. A common error was converting the concentration that had just been calculated (24.5) into other units. In these instances, the second mark was lost. In some instances, candidates looked up the relative atomic masses of

hydrogen, sulfur and oxygen and worked out that the formula mass of sulfuric acid was, indeed, 98.


The concentration of some dilute sulfuric acid, H_2SO_4, is 0.250 mol dm^{-3}.

Calculate the concentration of sulfuric acid in this solution in g dm^{-3}.
(relative formula mass: $H_2SO_4 = 98$)

(2)

g dm3

mol | mr

0·0250 × 98

= 2·45

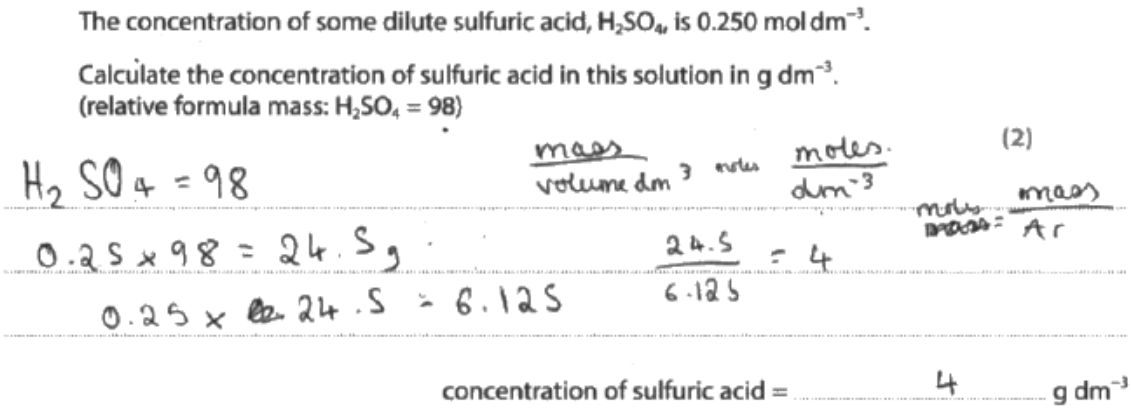
concentration of sulfuric acid = 2·45 g dm^{-3}

Results Plus: Examiner Comments

There's a factor 10 error here probably due misreading the concentration of 0.250 mol dm^{-3} as 0.0250 mol dm^{-3} as used in the calculation. So 1 mark was awarded here.

Results Plus: Examiner Tip

If you get time, always check your calculations for any transcription errors - it could stop you losing a mark or two.


The concentration of some dilute sulfuric acid, H_2SO_4, is 0.250 mol dm^{-3}.

Calculate the concentration of sulfuric acid in this solution in g dm^{-3}.
(relative formula mass: $H_2SO_4 = 98$)

(2)

$H_2SO_4 = 98$

mass / volume dm 3 moles moles / dm^{-3}

moles = mass / Ar

0.25 × 98 = 24.5 g

0.25 × 24.5 = 6.125

24.5 / 6.125 = 4

concentration of sulfuric acid = 4 g dm^{-3}

Results Plus: Examiner Comments

This reponse contains the correct calculation on the left, but two further processing steps were carried out, which were not explained, to give the final answer of 4. These extra steps meant that overall, this scored 0 marks.

Q49.

A difficult calculation but it did differentiate across the ability range. For most, taking the volume of sulfur dioxide and dividing by the molar volume to give the amount of gas was the first step. Some made the error here by diving by the formula mass instead. The other common error was forgetting to convert the units from g to kg.

Calculate the mass, in kilograms, of 750 dm^3 of sulfur dioxide, measured at room temperature and pressure.
(relative formula mass: SO_2 = 64;
1 mol of any gas at room temperature and pressure occupies 24 dm^3)

M
C V

(3)

mass = concentration x volume
mass = 24 x 750 = 18000 g
= 18 kg

mass of sulfur dioxide = 18 kg

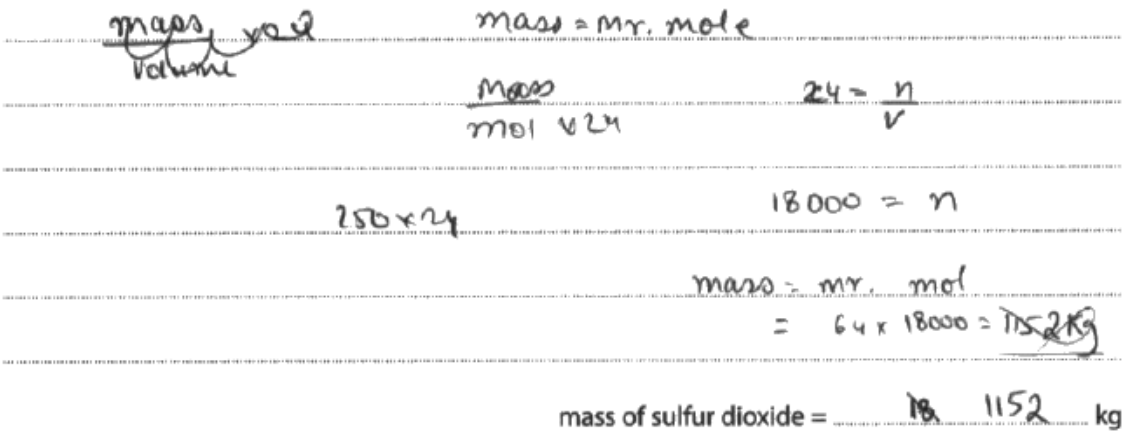
Results Plus: Examiner Comments

The candidate started with the wrong idea of mass = concentration × volume.

The second step of 24 × 750 did not score, but the conversion of g to kg was given a mark. 1 mark overall here.

Calculate the mass, in kilograms, of 750 dm^3 of sulfur dioxide, measured at room temperature and pressure.
(relative formula mass: $SO_2 = 64$;
1 mol of any gas at room temperature and pressure occupies 24 dm^3)

(3)



mass of sulfur dioxide = 1152 kg

Results Plus: Examiner Comments

The first step to calculate the number of moles was incorrect - so no 1st mark. After that moles (wrong) × 64 scores 2nd mp as error carried forward; then the answer is divided by 1000 converting g to kg to get 1152 for the 3rd mp.

2 marks overall

Q50.

Many candidates here did not appreciate the ratio of sulfur dioxide : oxygen in the equation and so gave an answer of 750 dm^3 whereas others used the ratio incorrectly and gave an answer of 1500 dm^3.

Q51.

In general, this question was answered well with many being able to calculate an average.

Figure 3 shows some titration results obtained from an experiment in which an alkali is titrated with an acid.

	titration		
	rough	1	2
final burette reading in cm^3	25.75	49.35	23.70
initial burette reading in cm^3	0.00	25.75	0.00
volume of acid used in cm^3	25.75	23.60	23.70

Figure 3

Calculate the accurate volume of acid reacting with the alkali.

(2)

25.75 + 23.60 + 23.70 = 73.05

$\frac{73.05}{3} = 24.35$

accurate volume of acid reacting 24.35 cm^3

Results Plus: Examiner Comments

A large proportion of candidates knew that they should not include the rough titraton within their average and scored both marks. In some cases candidates did not and so scored just 1 mark. As in this example.

Figure 3 shows some titration results obtained from an experiment in which an alkali is titrated with an acid.

	titration		
	rough	1	2
final burette reading in cm^3	25.75	49.35	23.70
initial burette reading in cm^3	0.00	25.75	0.00
volume of acid used in cm^3	25.75	23.60	23.70

Figure 3

Calculate the accurate volume of acid reacting with the alkali.

(2)

~~49.35 + 23.70 ÷ 2 = 36.525~~

23.60 + 23.70 ÷ 2 = 23.65

accurate volume of acid reacting 23.65 cm^3

Results Plus: Examiner Comments

A correct answer that scored both marks.

Figure 3 shows some titration results obtained from an experiment in which an alkali is titrated with an acid.

	titration		
	rough	1	2
final burette reading in cm^3	25.75	49.35	23.70
initial burette reading in cm^3	0.00	25.75	0.00
volume of acid used in cm^3	25.75	23.60	23.70

Figure 3

Calculate the accurate volume of acid reacting with the alkali.

(2)

.....

.....

accurate volume of acid reacting ..23.70.. cm^3

Results Plus: Examiner Comments

Where learners did not score it was often because they had tried to give a midpoint of the values or simply gave the last value in the table.

Q52.

(i)

It was clear that most candidates did not know how to calculate the percentage yield as very few candidates obtained the correct answer, however some achieved only one mark because their answer was approximated to 90% from 90.91%. Some had the ratio of mass inverted and obtained an answer of 110% without thinking about the implication. Other incorrect answers were seen using various mathematical processes involving the numbers 40, 44 and 100. The answer of 100 – 40 = 60% was commonly seen.

(c) If calcium carbonate is heated strongly, it decomposes.

$$CaCO_3 \rightarrow CaO + CO_2$$

If 100 g of calcium carbonate is heated a calculation shows that 44 g carbon dioxide should be formed.

(i) In an experiment 100 g of calcium carbonate was heated and only 40 g carbon dioxide was formed.

Calculate the percentage yield of carbon dioxide in this reaction.

(2)

Percentage yield = actual yield / theoretical yield × 100 Ans = 90

100% = 40/44 = 0.909... × 100

percentage yield of carbon dioxide = 90 %

Results Plus: Examiner Comments

A correctly calculated percentage yield. Sadly the candidate then approximated the answer to 90 rather than 91% and so only 1 mark could be given for this.

(c) If calcium carbonate is heated strongly, it decomposes.

$$CaCO_3 \rightarrow CaO + CO_2$$

If 100 g of calcium carbonate is heated a calculation shows that 44 g carbon dioxide should be formed.

(i) In an experiment 100 g of calcium carbonate was heated and only 40 g carbon dioxide was formed.

Calculate the percentage yield of carbon dioxide in this reaction.

(2)

44/40 × 100

actual yield / theoretical yield × 100 44/40 × 100

percentage yield of carbon dioxide = 110 %

Results Plus: Examiner Comments

Candidates who had the ratio inverted didn't stop to think about the consequence of their answer. Here, 1 error had been made - the inverted ratio - so 1 mark was awarded in these instances.

(c) If calcium carbonate is heated strongly, it decomposes.

$$CaCO_3 \rightarrow CaO + CO_2$$

If 100 g of calcium carbonate is heated a calculation shows that 44 g carbon dioxide should be formed.

(i) In an experiment 100 g of calcium carbonate was heated and only 40 g carbon dioxide was formed.

Calculate the percentage yield of carbon dioxide in this reaction.

(2)

100g − 40g = 60g

percentage yield of carbon dioxide = 60 %

Results Plus: Examiner Comments

This answer (or that which showed 100 - 44 = 56) was often seen, showing that the candidate did not understand how to calculated the percentage yield of a product. 0 marks were awarded.

Results Plus: Examiner Tip

Know that percentage yield = (actual yield) x 100 / (theoretical yield), and that this value will always be less than 100%. If you have obtained an answer greater than 100, check your calculation to see where you have made an error.

(ii)

This question was fairly open in terms of the possible responses as shown by the command word 'suggest' in the question. However, to account for a difference between theoretical and actual yields, self-deprecating possibilities such as 'human error', 'spillage', 'anomalies', 'not weighed out accurately', 'wrong equipment' and 'gas escaping' were often cited but would not gain credit and candidates should be advised of this. Some referred to calculation only being a prediction and actual yields were always wrong. Some offered the vague term 'not heated properly'. There was also some confusion with incomplete combustion, as some stated 'there was not enough oxygen being present for a reaction'.

However, almost a quarter of candidates cited a correct reason here and referred to 'not heating it for long enough', 'the reaction not being complete', 'the flame not being hot enough' or 'the calcium carbonate contained impurities'.

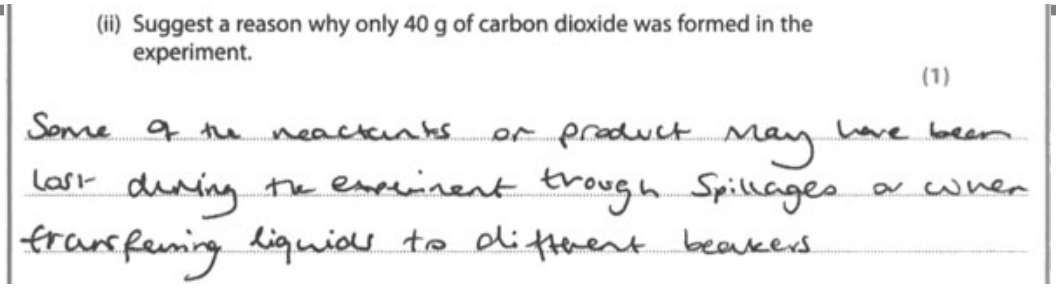
(ii) Suggest a reason why only 40 g of carbon dioxide was formed in the experiment.

(1)

Some of the carbon dioxide could have been lost during the experiment.

Results Plus: Examiner Comments

The candidate had not thought about what was happening during the reaction. All the carbon dioxide was being lost during the reaction. This answer scored 0.



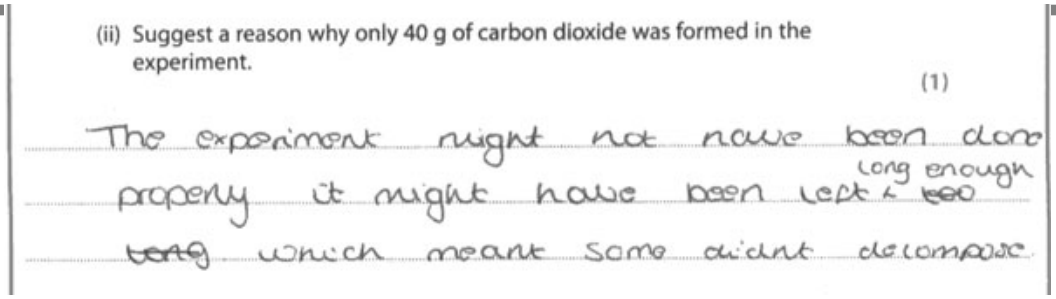
(ii) Suggest a reason why only 40 g of carbon dioxide was formed in the experiment.

(1)

Some of the reactants or product may have been lost during the experiment trough Spillages or when transfering liquids to different beakers

Results Plus: Examiner Comments

The candidate had not thought through the process. A solid was being heated to form another solid with the loss of a gas, so loss of transferring liquids could not possibly happen in this situation. 0 marks given.



(ii) Suggest a reason why only 40 g of carbon dioxide was formed in the experiment.

(1)

The experiment might not have been done properly it might have been left a long enough ~~long~~ which meant some didnt decompose

Results Plus: Examiner Comments

Although not phrased very well to start with, 'might not have been done properly' was ignored and the second part of the answer was very good and scored the 1 mark.

Results Plus: Examiner Tip

To account for yield being less than 100%, there are three main reasons:

a) Incomplete reaction - not all reactants used up.

b) Product lost during the reaction - usually when transferring liquids from one container to another.

c) Other unwanted reactions - usually to make a different product.

Think about the reaction when applying these ideas.

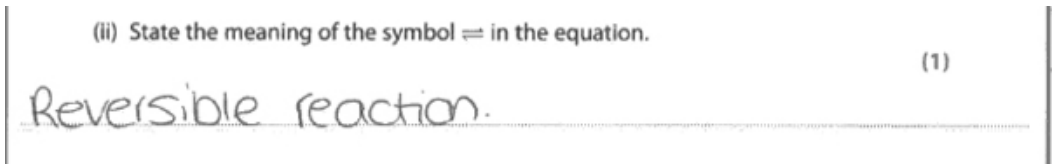
Q53.

(i)

Most candidates gained credit for their answers, scoring the 1 mark available for simply stating 'gas'.

(ii)

Most candidates gained credit for their answers.

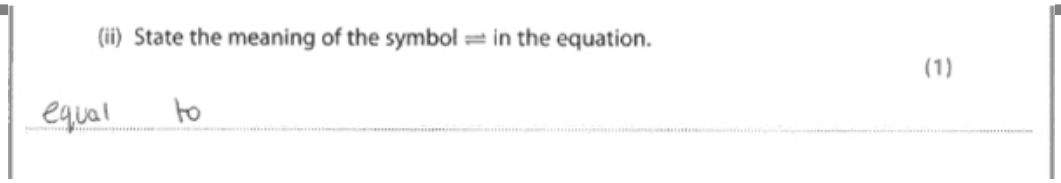

(ii) State the meaning of the symbol ⇌ in the equation.

(1)

Reversible reaction.

Results Plus: Examiner Comments

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


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

(1)

equal to

Results Plus: Examiner Comments

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

Q54. No Examiner's Report available for this question

Q55. No Examiner's Report available for this question

Q56.

The correct colour change for the indicator methyl orange in this situation was correctly given less than half the candidates. A common error was to have the colours but the wrong way round probably resulting from the candidate not reading the question where it said that the acid was in the conical flask to start with. Some gave a colour change for phenolphthalein and the weaker

candidates tended to give random colours.

Q57.

(i)

Candidates appeared to understand what was meant by the term state symbol, however they did not use the information in the table to inform their answer but simply gave the states of the substances at room temperature.

Hydrogen burns in air at a temperature well above 100 °C to form water.

(i) The boiling points of hydrogen and water are shown in Figure 15.

	boiling point in °C
hydrogen	–253
water	100

Figure 15

Use this information to add the missing state symbols to the equation for the reaction taking place as the hydrogen burns.

(2)

$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$

Results Plus: Examiner Comments

A correct answer that scored both marks.

Hydrogen burns in air at a temperature well above 100 °C to form water.

(i) The boiling points of hydrogen and water are shown in Figure 15.

	boiling point in °C
hydrogen	–253
water	100

Figure 15

Use this information to add the missing state symbols to the equation for the reaction taking place as the hydrogen burns.

(2)

$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$

Results Plus: Examiner Comments

For hydrogen this was sufficient and 'g' gained a mark. However for the water those that gave 'l' did not score the mark because in this reaction water would be formed as a gas.

Results Plus: Examiner Tip

Candidates should be taught to use the information in the stem to inform their answer.

Hydrogen burns in air at a temperature well above 100 °C to form water.

(i) The boiling points of hydrogen and water are shown in Figure 15.

	boiling point in °C
hydrogen	–253
water	100

Figure 15

Use this information to add the missing state symbols to the equation for the reaction taking place as the hydrogen burns.

(2)

$2H_2(\text{2}) + O_2(g) \rightarrow 2H_2O(\text{2})$

Results Plus: Examiner Comments

In some cases, it was clear that candidates were not familar with state symbols are tried adding numbers to balance the equation rather than adding state symbols.

(ii)

Candidates found it quite difficult to put into words why the atom economy of the reaction is 100%, many simply stated that the equation is balanced or the same on both sides, whilst this is true, it is not what shows that the atom economy is 100%. Few refered to the useful product.

Where candidates scored the mark, it was usually for saying that there were no waste products.

(ii) The atom economy for the reaction in (i) is 100%.

State how the equation shows that the atom economy is 100%.

(1)

Everything is used up nothing is left

Results Plus: Examiner Comments

Everything is used up did not gain credit.

(ii) The atom economy for the reaction in (i) is 100%.

State how the equation shows that the atom economy is 100%.

(1)



Results Plus: Examiner Comments

A common answer that did not score was that the equation was balanced.

(ii) The atom economy for the reaction in (i) is 100%.

State how the equation shows that the atom economy is 100%.

(1)

there are no exess products of the reaction, all of the reactants made 1 product.

Results Plus: Examiner Comments

This answer gained 1 mark.

Q58.

(i)

Less than a quarter of the candidates scored both marks here. The first state symbol was given correctly by the overwhelming majority, but only about a fifth of the candidates had understood the implication of the first line of the question and had not realised the water formed would be in the gas state. Some candidates showed no knowledge of state symbols.

(ii)

Many candidates assumed that a balanced equation results in 100% atom economy, but just over a half had the idea of one product being formed so no waste.

(ii) The atom economy for the reaction in (i) is 100%.

State how the equation shows that the atom economy is 100%.

(1)

The equation is balanced perfectly

Results Plus: Examiner Comments

Examiners reported seeing this misconception frequently and by this and similar answers. This did not score the mark.

(ii) The atom economy for the reaction in (i) is 100%.

State how the equation shows that the atom economy is 100%.

(1)

Because atom economy = $\frac{\text{desired product mr}}{\text{all products mr}} \times 100 = \frac{36}{36} \times 100 = 100\%$

Results Plus: Examiner Comments

The mathematical expression alone did not score, but with the correct data included as here, scored the mark.

(ii) The atom economy for the reaction in (i) is 100%.

State how the equation shows that the atom economy is 100%.

(1)

The reactants equal the entire wanted product.

Results Plus: Examiner Comments

This was an unusual way of expressing that the reactants went to form just one product. This scored the mark.

Q59.

It was obvious that candidates struggled to produce ionic and half equations and many responses here were either left blank or filled with words or state symbols. Very few candidates scored both marking points although some responses were awarded a mark for including electrons on the left-hand side of the equation.

Q60. No Examiner's Report available for this question

Mark Scheme

Q1.

Question Number	Answer	Mark
	Any two linked explanations Any two suitable precautions to make use of pipette or burette as accurate as possible or to carry out the titration as accurate as possible (1) linked explanation (1) e.g. read bottom of the meniscus on the burette/pipette scale / read burette/pipette at eye-level (1) to obtain accurate volume of sodium hydroxide solution / sulfuric acid added (1) add {solution from burette / alkali} one drop at a time near end point (1) to identify exactly when colour change of indicator takes place (1) use a white tile (1) to make it easier to see exactly when colour change of indicator takes place (1) make sure no air bubbles in burette or pipette when measuring volumes (1) so exact volumes are recorded (1) continually swirl flask (1) to ensure complete mixing of acid with alkali (1) wash inside of conical flask with a little deionised/distilled water (1) to wash reactants into reaction mixture (1) wash burette / pipette with appropriate solution before titration (1) to ensure burette / pipette is not contaminated (1) do not award marks for concordancy / reliability / changes of indicator	**(4)** AO 1 2

Q2.

Question Number	Indicative content	Mark
*	An explanation that combines identification via a judgment (3 marks) to reach a conclusion via justification/reasoning (3 marks) • raw materials: fermentation uses plants which can be regrown / hydration uses crude oil which is finite resource • temperature: fermentation low therefore low energy cost / hydration high therefore high energy cost • atom economy: fermentation lower /hydration of ethene 100% • production rate: fermentation slow / hydration fast • purification: fermentation needs energy for fractional distillation / hydration product pure • carbon dioxide produced by fermentation could be useful product • high pressure needed for hydration means more expensive plant	**(6)**

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1-2	• Deconstructs scientific information but understanding and connections are flawed. An unbalanced or incomplete argument that provides limited synthesis of understanding. • Judgements are supported by limited evidence. (AO3)
Level 2	3-4	• Deconstructs scientific information and provides some logical connections between scientific concepts. An imbalanced argument that synthesises mostly relevant understanding, but not entirely coherently. • Judgements are supported by evidence occasionally. (AO3)
Level 3	5-6	• Deconstructs scientific information and provide logical connections between scientific concepts throughout. A balanced, well-developed argument that synthesises relevant understanding coherently. • Judgements are supported by evidence throughout. (AO3)

Q3.

Question Number		Indicative Content	Mark
QWC	*	A description including some of the following points **Property change (other than increased strength) or use of alloy** • increased hardness • decreased malleability • increased corrosion resistance • shape-memory • gold alloy for jewellery • stainless steel used for cutlery • steel used for construction • nitinol (shape-memory alloy) used for spectacle frames / stents • idea of any use of metal after alloying **Structural change** • pure metal – atoms are all the same size / suitable diagram of pure metal structure • atoms arranged in a regular way / lattice • alloy – atoms are of different sizes / suitable diagram of alloy structure • disrupts arrangement of atoms • atoms in pure metal structure can slide over each (when bent) • alloy – sliding prevented by different sized atoms	**(6)**

Level	**0**	No rewardable content
1	**1 – 2**	• a limited description of how one property changes, one use or one statement related to structure eg iron rusts, stainless steel does not; atoms in a pure metal all the same size • 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 of how two properties change or two uses **or** a simple description of why alloys become stronger or a property/use and a statement about structure eg the atoms in a pure metal have a regular arrangement but in alloys there are different sized atoms • 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 of why alloys become stronger including at least one change in property of an alloy or use eg the atoms in a pure metal have a regular arrangement but in alloys the different sized atoms stops the atoms sliding over each other and how alloys are more useful such as gold alloys used in jewellery • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors

Q4.

Question Number	Answer	Additional guidance	Mark
(i)	mixtures (1)		**(1)**

Question Number	Answer	Additional guidance	Mark
(ii)	brass **AND** magnalium (1)	either order acceptable	**(1)**

Q5.

	Answer	**Acceptable answers**	**Mark**
(i)	62.5 - 63 Allow anywhere in this range		**(1)**
(ii)	A description including • decreases first (1) • then increases (1)	"decreases then increases" scores 2 decreases or increases alone scores 0	**(2)**

Q6.

	Answer	**Acceptable answers**	**Mark**
(a)	• 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)
(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	ions or particles for atoms reject molecules once only	(3)

	• in pure metal /aluminium 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	

Q7.

	Answer	Acceptable answers	Mark
(a)	A – air		**(1)**
(b)(i)	gas	ignore g alone	**(1)**
(b)(ii)	reaction is reversible / reaction goes both ways	reaction is in /reaches equilibrium	**(1)**
(c)	ammonia + sulfuric acid → ammonium sulfate (2) left hand side (1) right hand side (1)	Allow = for →	**(2)**
(d)	improve crop yields / promote plant growth	 crops grow faster adds essential elements / OWTTE	**(1)**
(e)(i)	burette		**(1)**
(e)(ii)	indicator / any named acid-base indicator	ignore Universal indicator	**(1)**

Q8.

	Answer	Acceptable answers	Mark
(a)	An explanation linking	assume 'both reactions' implies the	**(2)**

	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)	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	
(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) • yield increases (1)	ignore answers related to rate/collisions maximum (1) if 3 statements given, but 1 is incorrect	**(2)**
(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	full marks awarded for an answer of 160 g with or without any working allow ecf on incorrect Mr s for either method	**(3)**

34 g of NH_3 makes $\frac{(14 + (4 \times 1) + 14 + (3 \times 16)) \times 34}{17}$ or $\frac{80 \times 34}{17}$ or $2(14 + (4 \times 1) + 14 + (3 \times 16))$ 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		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		

Q9.

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)**

Q10.

	Answer	**Acceptable answers**	**Mark**
	ammonia + sulfuric acid → ammonium sulfate (2)	Allow = for →	**(2)**

	left hand side (1) right hand side (1)		

Q11.

Question number	Answer	Mark
(a)	any **one** precaution from: • wear gloves to prevent contact with skin/safety (1) • spectacles to prevent contact with eyes (1)	**(1)**

Question number	Answer	Additional guidance	Mark
(b)	1000 cm^3 contain $\frac{4.3 \times 1000}{250}$ (1) 1 dm^3 contains 17.1 ($g\,dm^{-3}$) (1)	Award full marks for correct numerical answer without working.	**(2)**

Question number	Answer	Additional guidance	Mark
(c)	$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$ • correct formulae (1) • balancing (1)	Do not award 2 if incorrect balancing added.	**(2)**

Question number	Answer	Mark
(d)	• {titration 1/27 cm^3} should not be used because burette readings {not precise/not accurate/not read to 2 d.p.} (1) • {titration 4/25.80 cm^3} should not be used because volume of used (25.80 cm^3) not concordant with other two (1)	**(2)**

Q12.

Question Number	Indicative content	Mark
*	An analysis that combines identification via a judgment (3 marks) to reach a conclusion via justification/reasoning (3 marks): • tube A has water and air • tube B drying agent absorbs water • tube B has air but no water • tube C oil prevents air being absorbed • tube C has water but no air • red-brown solid is rust • tube A nail has rusted • tube B shows no rusting • tube C shows no rusting • only tube with air and water rusts • water **AND** air are required for rusting	**(6)**

Level	Mark	Descriptor
	0	No awardable 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. • Judgments are supported by limited evidence
Level 2	3-4	• Interpretation and evaluation of the information on both variables, synthesising mostly relevant understanding. • Judgments are supported by evidence occasionally
Level 3	5-6	• Interpretation and evaluation of the information demonstrating through the skills of synthesising relevant understanding. • Judgments are supported by evidence throughout

Q13.

Question number	Answer	Additional guidance	Mark
(i)	An explanation linking • stainless steel resistant to {corrosion/ rusting/ oxidation} / corrosion rate slower / does not react with {air/oxygen} and water • neither rod would rust/ react (in a few days) / there would be no {rusting / reaction}/ no change would occur / it would take a long time for any result (1)	Ignore iron corrodes but ALLOW iron corrodes **faster** than stainless steel / iron rusts but stainless steel does not (1)	(2)
(ii)	measuring cylinder accurate enough / accuracy of pipette not needed / no need to be (more) accurate / the volume of water is not critical	allow exact/ precise for accurate allow pipettes only used for accurate/ precise/ exact volumes	(1)
(iii)	An explanation linking • (A) the magnesium has {corroded/ reacted/ oxidised} / (B) {rusting / corrosion / oxidation} has occurred (1) • because magnesium is more reactive than iron / (magnesium has reacted) instead of the iron (1)	MP1 describes reaction that occurs MP2 reason – ignore 'sacrificial protection' etc.	(2)

Q14.

Question Number	Answer	Additional guidance	Mark
	final answer of 90 with or without working (4) OR total mass : 2x223 + 12 / (2 x 207) + 44 (= 458) (1) mass of useful products : 2 x 207 = 414 414 (1) x 100 (1) (= 90.39) 458 = 90 (1)	allow ECF throughout 458 seen (1) 90.39 / 90.4 for 3 marks 110.628... / 111 (2) 110 (3) correct rounding of an answer with working to 2 sig fig (1)	(4) AO 2 1

Q15.

Question Number	Answer	Additional guidance	Mark
	final answer of 90 with or without working (4) OR total mass : 2x223 + 12 / (2 x 207) + 44 (= 458) (1) mass of useful products : 2 x 207 = 414 414 (1) x 100 (1) (= 90.39) 458 = 90 (1)	allow ECF throughout 458 seen (1) 90.39 / 90.4 for 3 marks 110.628... / 111 (2) 110 (3) correct rounding of an answer with working to 2 sig fig (1)	**(4)** AO 2 1

Q16.

	Answer	Acceptable answers	Mark
(a)	sodium carbonate + calcium nitrate → sodium nitrate + calcium carbonate (2) LHS (1) RHS (1)	ignore solution / state symbols ignore incorrect attempts at balanced equation ignore mixtures of words and formulae	**(2)**
(b)(i)	C orange-red		**(1)**
(b)(ii)	A description including two points from CLEAN • clean (flame test) wire with (hydrochloric) acid (1) SAMPLE • put (wire) into solid (1) TEST • hold (wire) in (Bunsen) flame (1)	• moisten splint • put splint into solid • hold splint in (Bunsen) flame ignore : hold <u>over</u> flame use of tongs / spatula etc for equipment, max 1	**(2)**
(c)(i)	40/44 (1) (= 0.909) (any fraction) x 100 (1) (= 90.9 / 90.91 / 91(%))	correct answer (2) Ignore 90(%)	**(2)**
(c)(ii)	reaction is incomplete / not hot enough / not heated for long enough / use of impure calcium carbonate	ignore {gas escaping / not all collected / incorrect measurement}	**(1)**
(d)	D have high melting points		**(1)**

Q17.

Question number	Answer	Additional guidance	Mark
	• mass values in correct places (1) • multiplication by 100 (1) • correct final answer to two significant figures (1)	$\frac{2.53}{2.85} \times 100 = 88.8\%$ 89% (to 2 s.f.) Award full marks for correct numerical answer without working.	**(3)**

Q18.

Question number	Answer	Additional guidance	Mark
(b)	• mass values in correct places (1) • multiplication by 100 (1) • correct final answer to two significant figures (1)	$\frac{2.53}{2.85} \times 100 = 88.8\%$ 89% (to 2 s.f.) award full marks for correct numerical answer without working	**(3)**

Question number	Answer	Mark
(c)	An explanation that combines identification – improvement of the experimental procedure (maximum 2 marks) and justification/reasoning, which must be linked to the improvement (maximum 2 marks): • add excess sodium sulfate solution rather than a few drops (1) • so more reaction occurs to form more lead sulfate (1) • filter the reaction mixture rather than pour off the liquid (1) • so none of the lead sulfate is lost on separation (1) • wash the lead sulfate (1) • so the impurities are removed (1) • place the lead sulfate in an oven/warm place (1) • so the lead sulfate is dry (1)	**(4)**

Q19.

Question number	Answer	Additional guidance	Mark
	% of tin in alloy = $\frac{15.0}{(15.0+22.5)} \times 100$ (1) = 40.0 (%) (1)	Award full marks for correct numerical answer without working.	(2)

Q20.

Question number	Answer	Additional guidance	Mark
	moles of sulfuric acid = $0.140 \times \frac{12.15}{1000}$ (1) (= 0.001701 mol)	award full marks for correct final answer without working	(4) AO2
	ratio 2 : 1 KOH to H_2SO_4 (1) moles of KOH = 2 x 0.001701 (1) (= 0.003402 mol)	allow ecf from moles of sulfuric acid	
	concentration of KOH = $0.003402 \times \frac{1000}{25.00}$ (1) (= 0.136 mol dm^{-3})	allow ecf from moles of KOH	

Q21.

Question number	Answer	Additional guidance	Mark
	mol of acid = 24.80 ÷ 1000 × 0.200 (= 0.004 96 mol) (1) mol NaOH = 2 × 0.004 96 (= 0.009 92) (1) conc. of NaOH = 0.009 92 ÷ 25.0 × 1000 (1) = 0.3968/0.397 (mol dm^{-3}) (1) or (25.00 × conc NaOH) ÷ 2 = 24.80 × 0.200 (2) conc NaOH = 2 × 24.80 × 0.200 ÷ 25.00 (1) = 0.3968/0.397 (mol dm^{-3}) (1)	Award full marks for correct numerical answer without working. Allow max 3 marks if missing '2 ×' in step 2.	**(4)**

Q22.

Question number	Answer	Additional guidance	Mark
	$\frac{2.00}{100}$ x 695.0 (1) (= 13.9) 695.0 - 13.9 (1) (= 681.1 (g)) OR $\frac{98.00}{100}$ (1) x 695.0 (1) (= 681.1 (g))	award full marks for correct final answer without working allow 2 or more sig.fig.	**(2)** **AO2**

Q23.

Question number	Answer	Additional guidance	Mark
	$\frac{2.00}{100}$ x 695.0 (1) (= 13.9) 695.0 - 13.9 (1) (= 681.1 (g)) OR $\frac{98.00}{100}$ (1) x 695.0 (1) (= 681.1 (g))	award full marks for correct final answer without working allow 2 or more sig.fig.	**(2)** **AO2**

Q24.

Question number	Answer	Additional guidance		Mark
	8.000- 6.213 = (1.787) (g)	allow 1.8, 1.79		(1)

Q25.

Question number	Answer	Additional guidance	Mark
	8.000- 6.213 = (1.787) (g)	allow 1.8, 1.79	**(1)**

Q26.

Question number	Answer	Mark
	1560 with or without working scores 3 78 / 100 (1) 78 / 100 x 2.00 (1) (= 1.56 kg) 1.56 x 1000 (1) (= 1560 g)	**(3)** **AO2**

Q27.

Question number	Answer	Additional guidance	Mark
	proportion gold = 9 ÷ 24 (= 0.375) (1) mass = 0.375 × 12 = 4.5 (g) (1)	Award full marks for correct numerical answer without working.	**(2)**

Q28.

Question number	Answer	Additional guidance	Mark
	Formula mass ammonium chloride = 14.0 + 4.00 + 35.5 = 53.5 moles of ammonium chloride = $\frac{10.0}{53.5}$ = 0.187 (1) volume ammonia = 0.187 × 24 = 4.49 dm^3 (1) or • 2 × 53.5 = 107 g ammonium chloride produces 2 × 24 = 48 dm^3 ammonia (1) • 10.0 g ammonium chloride produces $\frac{10.0}{2\times53.5}\times 2\times 24 = 4.49\ dm^3$ ammonia (1)	Award full marks for correct numerical answer without working.	**(2)**

Q29.

Question number	Answer	Additional guidance	Mark
	2000 dm^3 with or without working scores 4 moles NO = 1000/30 (1) (= 33.3...) moles O_2 = moles NO /2 (1) (= 16.666...) volume O_2 = moles x 24 = 16.666... x 24 (1) (=400 dm^3) volume air = volume O_2 x 100/20 (1) (=2000 dm^3) OR 2 mol NO = 60 g (1) 60 g NO : 24 dm^3 oxygen (1) 1000 g NO reacts with 24 x 1000/60 (1) (=400 dm^3) volume air = volume O_2 x 100/20 (1) (=2000 dm^3)	ecf on all stages **3 marks** all working up to 400 x 20/100 = 80	**(4)**

Q30.

Question number	Answer	Additional guidance	Mark
	0.175 x 56.0 = 9.80 g dm^{-3} (1) mass in 250 cm^3 sample = 0.25 x 9.80 = 2.45 g (1) % pure KOH = 2.45 /2.56 x 100 = 95.7 (%) (1)	award full marks for correct final answer without working	(3) AO2

Q31.

Question number	Answer	Additional guidance	Mark
	100 – 65 – 7 – 3 (1) (= 25)	25 alone scores 1	**(1)**

Q32.

Question number	Answer	Additional guidance	Mark
(i)	97.3(%) with or without working scores 2 $\frac{5.450}{5.600}$ (1) x 100 = 97.3214.... = 97.3(%) (1)	if fraction inverted then x 100 = 102.75... (3 or more sig fig) allow (1) for 0.973 allow (1) MP2 only for correctly x 100 some figure derived from the data given allow any sig fig except 1	**(2)**

Question number	Answer	Mark
(ii)	**A** some solid was lost from the crucible is the only correct answer **B** is incorrect because this would increase mass **C** is incorrect because this would not alter mass **D** is incorrect because this would increase mass	**(1)**

Q33.

Question number	Answer	Additional guidance	Mark
(i)	97.3 (%) with or without working scores 2 5.450 (1) x 100 5.600 = 97.3214... = 97.3 (%) (1)	 if fraction inverted then x 100 = 102.75... (3 or more sig fig) allow (1) for 0.973 allow (1) MP2 only for correctly x 100 some figure derived from the data given *eg* 5.600-5.450 = 15 (%) allow any sig fig except 1	(2)

Question number	Answer	Mark
(ii)	A some solid was lost from the crucible is the only correct answer B is incorrect because this would increase mass C is incorrect because this would not alter mass D is incorrect because this would increase mass	(1)

Q34.

Question number	Answer	Additional guidance	Mark
	1.63 (1) (= 0.876) 1.86 0.876 x 100 (1) (= 87.6 (%))	award full marks for correct final answer without working allow 2 or more sig figs MP2 depends on MP1	(2) AO2

Q35.

Question number	Answer	Additional guidance	Mark
(i)	100 with or without working scores 2 40 + 12 + 3 x 16 (1) =100 (1)	ignore any units ecf for MP2 if using 12,16 and 40, using addition and multiplication only	(2)
(ii)	**56% without working scores 0** $\frac{56}{100}$ (1) (x 100) = 56 (%) (1)	56/answer to 4(d)(i) (1) x 100 (1) MP2 only for correctly x 100 some figure derived from the data given 100% scores 0	(2)

Q36.

Question number	Answer	Additional guidance	Mark
(i)	100 with or without working scores 2 40 + 12 + 3 x 16 (1) =100 (1)	ignore any units ecf for MP2 if using 12, 16 and 40, using addition and multiplication only	(2)
(ii)	**56% without working scores 0** $\frac{56}{100}$ (1) (x 100) = 56 (%) (1)	56/answer to 4(d)(i) (1) x 100 (1) MP2 only for correctly x 100 some figure derived from the data given 100% scores 0	(2)

Q37.

Question number	Answer	Additional guidance	Mark
	moles of oxygen = 48/32 (1) (= 1.5 mol) volume of oxygen = 1.5 x 24.0 dm^3 (= 36 dm^3) (1)	award full marks for correct final answer without working allow ecf on incorrect number of moles	(2) AO2

Q38.

Question Number	Answer	Mark
	amount of sodium hydroxide = $\frac{25.00 \times 0.50}{1000}$ (1) amount of hydrochloric acid = amount of sodium hydroxide (1) $= \frac{25.00 \times 0.50}{1000}$ concentration of hydrochloric acid = $\frac{25.00 \times 0.50 \times 1000}{1000 \times 22.85}$ (1) = 0.547 (mol dm^{-3}) (3 sf) (1) **OR** 25.00 x 0.50 = conc HCl x 22.85 (2) conc HCl = $\frac{25.00 \times 0.50}{22.85}$ (1) = 0.547 (mol dm^{-3}) (3 sf) (1)	**(4)**

Q39.

Question Number	Answer	Mark
(i)	• mass = density x volume(1) • vol = 10^3 = 1000 (cm^3) (1) • mass = 7.87 x 1000 = 7870 (g) (1)	**(3)**

Question Number	Answer	Additional guidance	Mark
(ii)	unchanged appearance of cube (1)	allow cube on bottom of container	**(1)**

Question Number	Answer	Mark
(iii)	• 1.20 kg = 1200 g (1) • 1200/ 1250 = 0.96 (1) • 0.96 x 100% = 96(%) (1)	**(3)**

Q40.

Question Number	Answer	Mark
	• 17.73/24.60 (0.7207) (1) • (17.73/24.60) x 100 (72.07) (1) • = 72.1% (1)	(3)

Q41.

Question Number	Answer	Mark
	• 17.73/24.60 (0.7207) (1) • (17.73/24.60) x 100 (72.07) (1) • = 72.1% (1)	(3)

Q42.

	Answer	Acceptable answers	Mark
(i)	• 10.4/15.0 **(1)** • (10.4/15.0) ×100**(1)** (= 69.3)	69.3 alone worth 2 marks If no/incomplete working shown answer to 2 or more sf scores 2 marks Ignore any units	**(2)**
(ii)	Two suggestions from • reaction incomplete (1) • impure reactants (1) • other unwanted/side reaction(s) occur (1) • product lost during experiment/practical (1)	reversible ignore by-products form could be an example eg some products left in apparatus ignore generic experimental errors eg measuring/weighing errors/human error/spillage	**(2)**

Q43.

Question Number	Answer	Mark
	relative formula mass KOH = 39+16+1 (=56) (1) concentration = 0.625 x 56 (= 35 g dm^{-3}) (1)	(2)

Q44.

	Answer	Acceptable answers	Mark
(i)	$\frac{22.6 + 22.8}{2}$ (1) (= 22.7)		**(1)**
(ii)	marks are for the working no. moles HCl = $\frac{23.2 \times 0.1}{1000}$ (1) (= 2.32×10^{-3}) no. moles NaOH = no. moles HCl (1) no. moles NaOH = no. moles HCl (1) conc NaOH = $\frac{2.32 \times 10^{-3} \times 1000}{25.0}$ (1) (= 0.0928 mol dm^{-3}) mark consequentially OR $\frac{\text{no. moles NaOH reacting}}{\text{no. moles HCl reacting}} = \frac{1}{1}$ (1) $\frac{25.0 \times \text{conc}}{23.2 \times 0.1} = \frac{1}{1}$ (1) conc NaOH = $\frac{0.1 \times 23.2}{25.0}$ (1) (= 0.0928) mol dm^{-3} OR use of $c_1v_1 = c_2v_2$ (1) 0.1 x 23.2 = conc x 25.0 (1) conc NaOH = $\frac{0.1 \times 23.2}{25.0}$ (1) (= 0.0928) mol dm^{-3}	0.0928/0.093 with or without working (3) 0.09 with no working (2) common incorrect answers with working 0.108/0.1077 (2) – used 1:1 ratio but 25x0.1/23.2 0.928 (2) – used 1:1 ratio but missed out 0.1	**(3)**

Q45.

	Answer	Acceptable answers	Mark
(i)	3 × 1000 (1) (= 3000)		**(1)**
(ii)	marks are 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)**

Q46.

Question Number	Answer	Mark
	180 g glucose produces 2 x 24 dm^3 carbon dioxide (1) 75 kg glucose produces 2 x 24 x $\frac{75000}{180}$ dm^3 carbon dioxide (1) = 20000 dm^3 (1)	**(3)**

Q47.

Question Number	Answer	Mark
	0.097 (mol dm^{-3}) with or without working (4) OR moles of NaOH = $\frac{24.25 \times 0.200}{1000}$ (1) (= 4.85×10^{-3}) from reaction equation moles acid = ½ x moles alkali = ½ x 4.85×10^{-3} (1) (= 2.425×10^{-3}) concentration of H_2SO_4 = $\frac{2.425 \times 10^{-3} \times 1000}{25.00}$ (1) = 0.097 (1) (mol dm^{-3}) OR ½ (1) x 24.25 x 0.200 = 25.00 x conc H_2SO_4 (1) conc H_2SO_4 = ½ x $\frac{24.25 \times 0.200}{25.00}$ (1) = 0.097(1) (mol dm^{-3}) on answer line 0.388 / 0.39 (3) [x2 instead of x½] 0.194 / 0.19 (3) [not x½] Ignore sig figs except for 1	**(4)** AO 3 2a AO 3 2b

Q48.

Question Number	Answer	Additional guidance	Mark
	24.5 (g dm^{-3}) with or without working (2) OR concentration = 98 x 0.25 (1) = 24.5 (1) (g dm^{-3})	 allow 2.45 / 24500 (1)	**(2)** AO 2 1

Q49.

Question Number	Answer	Additional guidance	Mark
	final answer of 2 (kg) with or without working (3) OR moles of SO_2 = $\frac{750}{24}$ (1) (= 31.25) mass of SO_2 = $\frac{750}{24}$ x 64 (1) (= 2000) mass of SO_2 = $\frac{2000}{1000}$ (1) (= 2 (kg))	allow ECF throughout 31.25 x 64 (2) allow ECF allow any calculated mass / 1000 (1) final answer 2000 (kg) (2)	**(3)** AO 2 1

Q50.

Question Number	Answer	Additional guidance	Mark
	½ x 750 (1) = 375 (dm^3)	375 alone (1)	**(1)** AO 2 1

Q51.

Question Number	Answer	Additional guidance	Mark
	23.65 with or without working scores 2 OR $\frac{23.60+23.70}{2}$ (1) = 23.65 (1)	 allow 1 mark for all 3 averaged (24.35)	**(2)** AO 3 2a AO 3 2b

Q52.

	Answer	Acceptable answers	Mark

(i)	40/44 (1) (= 0.909) (any fraction) x 100 (1) (= 90.9 / 90.91 / 91(%))	correct answer (2) Ignore 90(%)	**(2)**
(ii)	reaction is incomplete / not hot enough / not heated for long enough / use of impure calcium carbonate	ignore {gas escaping / not all collected / incorrect measurement}	**(1)**

Q53.

	Answer	**Acceptable answers**	**Mark**
(i)	gas	ignore g alone	**(1)**
(ii)	reaction is reversible / reaction goes both ways	reaction is in /reaches equilibrium	**(1)**

Q54.

Question number	**Answer**	**Mark**
	B the element used for rod P is the only correct answer **A, C** and **D** are incorrect because the electrode material must be changed	**(1)** **AO2**

Q55.

Question number	**Answer**	**Mark**
	C hydrogen + oxygen → water is the only correct answer **A, B** and **D** are incorrect as water is the product	**(1)** **AO1**

Q56.

Question Number	Answer	Mark
	from pink / red to orange / yellow	**(1)** AO 1 2

Q57.

Question Number	Answer	Mark
(i)	$2H_2$ (g) + O_2 (g) → $2H_2O$ (g)	**(2)** AO 3 1a AO 3 1b

Question Number	Answer	Additional guidance	Mark
(ii)	all <u>atoms</u> in the reactants are present in the product / only one product is formed	allow no atoms are wasted (in the reaction) / no waste products / nothing is wasted allow total mass of reactants = mass of useful products allow complete calculation to show that atom economy is 100% ignore equation is balanced / same number of atoms on both sides	**(1)** AO 1 1

Q58.

Question Number	Answer	Mark
(i)	$2H_2$ (g) + O_2 (g) → $2H_2O$ (g)	**(2)** AO 3 1a AO 3 1b

Question Number	Answer	Additional guidance	Mark
(ii)	all atoms in the reactants are present in the product / only one product is formed	allow no atoms are wasted (in the reaction) / no waste products / nothing is wasted allow total mass of reactants = mass of useful products allow complete calculation to show that atom economy is 100% ignore equation is balanced / same number of atoms on both sides	**(1)** AO 1 1

Q59.

Question number	Answer	Additional guidance	Mark
	$O_2 + 4H^+ + 4e^{(-)} \rightarrow 2H_2O$ (2) $e^{(-)}$ (on left) (1) balancing (1)	allow equation with e^+ to score MP2 if this is only error allow equation missing electrons but with no extraneous substances to score MP2 if correctly balanced	**(2)** **AO2**

Q60.

Question number	Answer	Mark
	D the metal is oxidised **A** is incorrect because the reaction is with oxygen **B** is incorrect because the reaction is with oxygen **C** is incorrect because the metal does not decompose	**(1)**