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Examiners' Report
June 2013

GCSE Chemistry 5CH3H 01

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Introduction

This is the first Unit C3 paper in the new GCSE specification although it has a similar style to the Unit C1 and C2 papers. Students were assessed on their knowledge and understanding of qualitative analysis, quantitative analysis, electrolysis, equilibria and organic chemistry. There were opportunities for them to demonstrate their knowledge and understanding of writing balanced equations and practical work they have carried out throughout this Unit.

The overall impression of the examiners was that the majority of candidates coped well with this first examination and many excellent answers were seen, particularly to the more challenging questions.

Successful candidates:

- read the questions carefully and answered the questions that were set;
- understood and used correct scientific terminology;
- could write balanced equations;
- could carry out calculations;
- could describe experiments they had carried out.

Some answers were of a lower standard. Less successful candidates:

- did not read the questions carefully and gave answers that were related to the topic being tested, but did not answer the question;
- could not write balanced equations;
- could not carry out calculations;
- had not revised how to test for the ions in the specification.

In future, some candidates need to revise how to write balanced equations, including ionic equations. Some candidates would also benefit from working through more questions involving calculations.

Question 1 (a) (ii)

Many candidates knew that oxidation is loss of electrons. Some candidates were confused between chloride ions and chlorine and it was not unusual to see that some candidates read the half-equation in reverse and they wrote about chlorine gaining electrons. Some candidates wrote that the chloride ions lost their negative charge but this did not score any marks as they needed to refer to electron loss.

(ii) Chlorine is one of the products of the electrolysis.

The half-equation for the production of chlorine is

$$2Cl^- \rightarrow Cl_2 + 2e$$

Explain how the half-equation shows that chloride ions are oxidised.

(2)

This shows that the chloride ions are oxidised because the chlorine is neutral.

ResultsPlus
Examiner Comments

This answer did not score any marks as there was no mention of electrons.

ResultsPlus
Examiner Tip

Use OIL RIG to help you to remember about oxidation and reduction.

Oxidation **I**s **L**oss of electrons.

Reduction **I**s **G**ain of electrons.

(ii) Chlorine is one of the products of the electrolysis.

The half-equation for the production of chlorine is

$$2Cl^- \rightarrow Cl_2 + 2e$$

OIL RIG

Explain how the half-equation shows that chloride ions are oxidised.

(2)

it shows that each chloride ion loses an electron in order to form chlorine

ResultsPlus
Examiner Comments

This is a very good answer, scoring 2 marks.

Question 1 (a) (iii)

A large number of candidates were able to work out that sodium hydroxide solution was left. However, some candidates thought that sodium was left and as it is an alkali metal, the solution would be alkaline. A few candidates thought the solution would be alkaline as acidic chlorine is lost.

(iii) Suggest why the solution remaining at the end of the electrolysis is alkaline. (1)

sodium chloride is an alkaline

ResultsPlus
Examiner Comments

Sodium chloride solution is neutral, so this answer did not score a mark.

ResultsPlus
Examiner Tip

Remember that acids contain H^+ ions and alkalis contain OH^- ions.

(iii) Suggest why the solution remaining at the end of the electrolysis is alkaline. (1)

At the end of the electrolysis the sodium and hydroxide ions that were not electrolysed (as they do not lose their charge as easily as H^+ and Cl^- ions) react together.
(all alkalis contain OH^- ions).

ResultsPlus
Examiner Comments

This is a very good answer and scored 1 mark.

Question 1 (a) (iv)

Surprisingly few candidates knew that molten sodium chloride is used to produce sodium. Quite a large number did not read the question carefully and they suggested changing an electrode to sodium rather than changing the electrolyte, or increasing the voltage.

(iv) The electrolysis of sodium chloride solution does not produce metallic sodium.

State what change you would make to the electrolyte to obtain metallic sodium.

(1)

make the cathode and anode sodium so there is something to react with

ResultsPlus
Examiner Comments

This candidate has suggested a change to the electrodes so has not scored a mark. The question asks for a change to the **electrolyte**.

ResultsPlus
Examiner Tip

Read the question carefully.

(iv) The electrolysis of sodium chloride solution does not produce metallic sodium.

State what change you would make to the electrolyte to obtain metallic sodium.

(1)

The electrolyte would be [redacted] molten sodium chloride

ResultsPlus
Examiner Comments

This is a good answer, scoring 1 mark.

Question 1 (b) (i)

This question was not answered well by many candidates. A lot of candidates thought that there were oxide ions in water or that the oxygen was produced from the sulfate ions. Candidates should be made aware that the ions from water can be discharged at the electrodes during electrolysis of a solution. Some candidates showed an excellent understanding of what was happening and they gave a balanced half-equation for the reaction at the anode.

(b) (i) When copper sulfate solution is electrolysed using inert electrodes, oxygen is formed at the positively charged anode.

Explain how the oxygen is formed from ions in the solution.

(2)

Sulfate ions are lost at the anode
Ions are gained at cathode

ResultsPlus
Examiner Comments

This candidate did not score any marks.

ResultsPlus
Examiner Tip

Ions react at the electrodes by gaining or losing electrons.

(b) (i) When copper sulfate solution is electrolysed using inert electrodes, oxygen is formed at the positively charged anode.

Explain how the oxygen is formed from ions in the solution.

(2)

The Oxygen ions are attracted to the anode, there they lose Two electrons [redacted] so become atoms but then they join to another Oxygen atom to form molecules of Oxygen Gas.

ResultsPlus
Examiner Comments

This candidate thought that there were oxide ions in the solution. However, they do know that the oxygen was formed by loss of electrons at the anode, so scored 1 mark.

ResultsPlus
Examiner Tip

Remember that water contains a few hydrogen ions, H^+, and a few hydroxide ions, OH^-. During electrolysis, these ions can gain or lose electrons to form hydrogen gas or oxygen gas.

(b) (i) When copper sulfate solution is electrolysed using inert electrodes, oxygen is formed at the positively charged anode.

Explain how the oxygen is formed from ions in the solution.

(2)

The hydroxide ions in the solution lose electrons (lose charge) more readily than sulfate ions in the solution, so when the hydroxide is discharged at the cathode, water and oxygen is formed.

ResultsPlus
Examiner Comments

This is a very good answer that identifies the hydroxide ions in the solution and states that they lose electrons to form oxygen. This answer scored both marks.

Question 1 (b) (ii)

This question was answered correctly by a large number of candidates. Just small numbers of candidates multiplied the mass by the relative atomic mass or divided the relative atomic mass by the mass of copper.

(ii) The other product is copper.

1.27 g of copper were produced in an experiment.

Calculate the number of moles of copper, Cu, produced in this experiment.

(Relative atomic mass: Cu = 63.5)

(1)

1.27 ÷ 63.5 = 0.02

amount of copper produced = 0.02 mol

(Total for Question 1 = 8 marks)

ResultsPlus
Examiner Comments

This correct answer scored 1 mark.

(ii) The other product is copper.

1.27 g of copper were produced in an experiment.

Calculate the number of moles of copper, Cu, produced in this experiment.

(Relative atomic mass: Cu = 63.5)

(1)

12.7 ÷ 63.5 = $\frac{1}{5}$ = 0.2

amount of copper produced = 0.2 mol

(Total for Question 1 = 8 marks)

$\frac{12.7}{63.5} = \frac{1}{5} = 0.2$

$\frac{\text{mass}}{\text{Ram} \mid \text{moles}}$

ResultsPlus
Examiner Comments

This candidate has mis-read the question. The mass of copper is 1.27 g not 12.7 g.

ResultsPlus
Examiner Tip

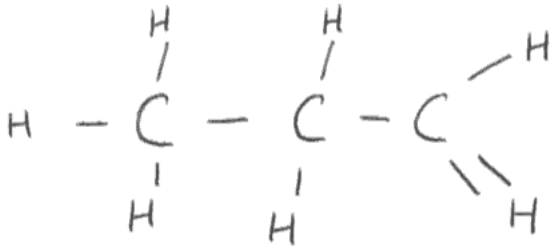
Avoid making careless errors. Read the question carefully.

Question 2 (a) (ii)

Many candidates were able to draw the correct structure for propene. Common errors included: not knowing that there are three carbon atoms in the molecule, drawing two double bonds or none, drawing a double bond between a carbon atom and a hydrogen atom and adding too many hydrogen atoms to the middle carbon atom.

(ii) Draw the structure of a molecule of propene, showing all covalent bonds.

(2)



ResultsPlus
Examiner Comments

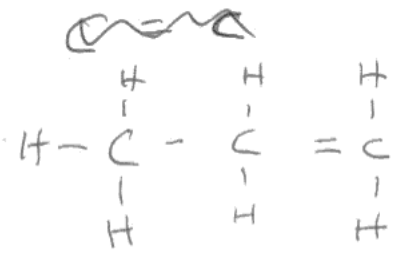
This candidate knew that propene has three carbon atoms and a double dond, but they have shown the double bond between a carbon atom and a hydrogen atom so did not score a mark.

ResultsPlus
Examiner Tip

Remember that hydrogen atoms only form 1 bond.

(ii) Draw the structure of a molecule of propene, showing all covalent bonds.

(2)



ResultsPlus
Examiner Comments

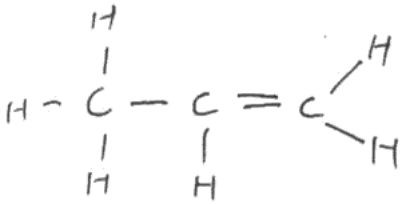
This candidate knew that there should be three carbon atoms and one double bond, so scored 1 mark. However, there are too many hydrogen atoms on the central carbon atom.

ResultsPlus
Examiner Tip

Remember that carbon atoms only form 4 bonds.

(ii) Draw the structure of a molecule of propene, showing all covalent bonds.

(2)



ResultsPlus
Examiner Comments

This was a clear, correct answer scoring two marks.

ResultsPlus
Examiner Tip

Learn that all alkenes contain a double bond between two carbon atoms.

Learn that the prefixes of the names give the number of carbon atoms in the molecules.

meth - shows 1 carbon atom.

eth - shows 2 carbon atoms.

prop - shows 3 carbon atoms.

but - shows 4 carbon atoms.

Question 2 (c) (i)

Many candidates were able to describe one observation for the reaction between sodium carbonate and dilute ethanoic acid, but far fewer could describe two observations. Some candidates stated that carbon dioxide is produced but did not state what they would **see** as a gas is formed.

(c) (i) Describe what you would **see** when solid sodium carbonate is added to dilute ethanoic acid.

(2)

a gas is formed and the Mixture will turn cloudy.

ResultsPlus
Examiner Comments

This candidate knows that a gas is formed but has not stated what they would **see** during the reaction.

ResultsPlus
Examiner Tip

When a gas is formed from a reaction involving a solid and a solution, you will always see the gas as fizzing or effervescence.

(c) (i) Describe what you would **see** when solid sodium carbonate is added to dilute ethanoic acid.

(2)

A reaction taking place and bubbles coming off the Sodium carbonate

ResultsPlus
Examiner Comments

This candidate scored 1 mark for knowing that bubbles would be seen.

ResultsPlus
Examiner Tip

When you see 2 marks for a question, try to include more detail in your answer.

(c) (i) Describe what you would **see** when solid sodium carbonate is added to dilute ethanoic acid.

(2)

There would be fizzing or bubbling as carbon dioxide is produced. The solid ~~or~~ sodium carbonate would dissolve into solution

ResultsPlus
Examiner Comments

This is an excellent answer scoring both marks.

Question 2 (c) (ii)

Although there were some excellent answers to this question, many candidates struggled to write the correct formula for an ester and it was not uncommon to see COO or COOH at the end of the formula. Many candidates did realise that water is formed and gained 1 mark for the formula but some candidates thought that carbon dioxide is produced when a carboxylic acid reacts with an alcohol.

(ii) When ethanoic acid reacts with ethanol, one of the products is the ester, ethyl ethanoate.

Complete the balanced equation for this reaction.

(2)

$CH_3COOH + C_2H_5OH \rightarrow$ $C_2Mg OH$ + CO_2

(Total for Question 2 = 8 marks)

ResultsPlus
Examiner Comments

This candidate has been unable to work out the formula for the ester and has carbon dioxide as the other product, which is incorrect. This answer did not score any marks.

ResultsPlus
Examiner Tip

Remember that a carboxylic acid reacts with an alcohol to produce and ester and water.

(ii) When ethanoic acid reacts with ethanol, one of the products is the ester, ethyl ethanoate.

Complete the balanced equation for this reaction.

(2)

$CH_3COOH + C_2H_5OH \rightarrow$ C_4H_7OOH + H_2O

ResultsPlus
Examiner Comments

This candidate did not know the formula for the ester, but they did know that water is also formed, so scored 1 mark.

ResultsPlus
Examiner Tip

Learn how to write the formula for an ester.

(ii) When ethanoic acid reacts with ethanol, one of the products is the ester, ethyl ethanoate.

Complete the balanced equation for this reaction.

(2)

$CH_3COOH + C_2H_5OH \rightarrow$ $CH_3COOC_2H_5$ + H_2O

ResultsPlus
Examiner Comments

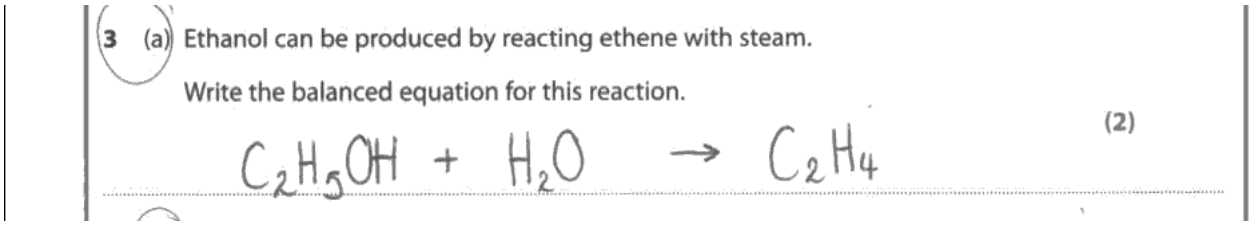
This is an example of a perfect answer, scoring both marks.

ResultsPlus
Examiner Tip

Notice how this candidate has crossed through the end H in the ethanoic acid and the OH in the ethanol. They know that water is formed so were able to combine the remaining parts of the molecules to write the correct formula for the ester.

Question 3 (a)

A large number of candidates could write the correct equation. However, a significant number did not know the formula for ethene.


3 (a) Ethanol can be produced by reacting ethene with steam.

Write the balanced equation for this reaction.

$C_2H_5OH + H_2O \rightarrow C_2H_4$

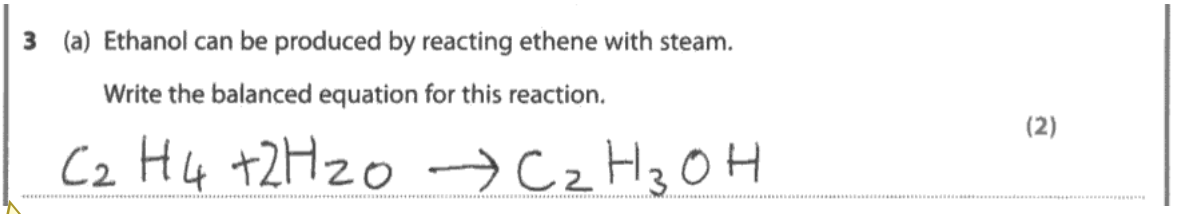
(2)

ResultsPlus
Examiner Comments

This candidate has mis-read the equation and written the equation in reverse, so did not score any marks.

ResultsPlus
Examiner Tip

Read the question carefully and write equations in the correct direction.


3 (a) Ethanol can be produced by reacting ethene with steam.

Write the balanced equation for this reaction.

$C_2H_4 + 2H_2O \rightarrow C_2H_3OH$

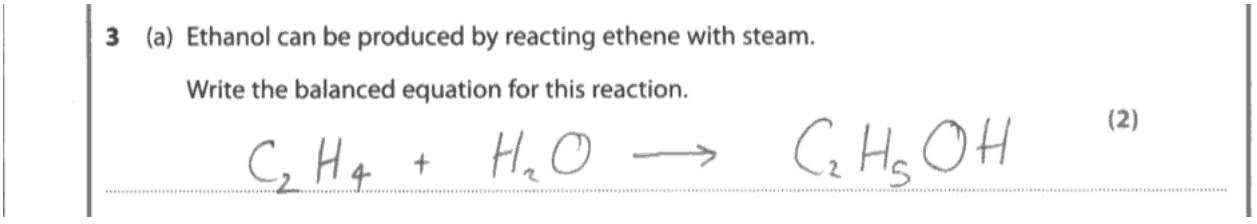
(2)

ResultsPlus
Examiner Comments

This candidate has scored 1 mark for the correct formula for ethene as a reactant. The formula for ethanol is incorrect, even though this was given in part (d) of this question.

ResultsPlus
Examiner Tip

Use the correct formulae given on the examination paper.


3 (a) Ethanol can be produced by reacting ethene with steam.

Write the balanced equation for this reaction.

$C_2H_4 + H_2O \rightarrow C_2H_5OH$

(2)

ResultsPlus
Examiner Comments

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

Question 3 (b)

A number of candidates did not know how to produce ethanol by fermentation, but generally this question was well-answered with the majority of candidates scoring marks for adding yeast, using anaerobic conditions and a correct temperature. Very few candidates mentioned that sugar solution is used, although this was not necessary to score full marks.

(b) Ethanol can also be produced by fermentation.

Describe how ethanol can be produced from sugar by fermentation.

(2)

Ethanol is put in a fermenter and the temperature, pressure and pH levels would be set for optimum yield of ethanol and as ethanol is made, it is removed and the sugar is added at the same rate to keep the pressure and volume uncharged in the fermenter.

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Examiner Comments

This is a vague answer that mentions temperature but does not suggest a suitable value. This answer did not score any marks.

ResultsPlus
Examiner Tip

When you describe an experiment, give specific details.

(b) Ethanol can also be produced by fermentation.

Describe how ethanol can be produced from sugar by fermentation.

(2)

In warm, anaerobic conditions, yeast can break down glucose (sugar) into ethanol, carbon dioxide and energy.
$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$
Yeast has enzymes which do this.

ResultsPlus
Examiner Comments

This is a very good answer, scoring both marks.

Question 3 (c)

The majority of candidates were able to score at least two marks for this question as they could use the information given. A few candidates thought that the land would be useful for growing crops of yeast or for building the fermentation plant. Some candidates did not link the crude oil being used to produce ethene.

(c) A country has large amounts of available fertile land.
It has no reserves of crude oil.
It is not a wealthy country.

Explain why this country produces the ethanol it needs by fermentation rather than from ethene.

(3)

The Because fermintation is the best method to use.

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Examiner Comments

This type of answer did not use the information given in the question so did not score any marks.

ResultsPlus
Examiner Tip

Use the information given in the question.

(c) A country has large amounts of available fertile land.
It has no reserves of crude oil.
It is not a wealthy country.

Explain why this country produces the ethanol it needs by fermentation rather than from ethene.

(3)

The Country produces the ethanol it needs by fermentation due to a it being alot cheaper to do. They have plently of room to do it. And ~~makes~~ it one way a poor Country dont have to spend Money to Make a profit.

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Examiner Comments

This candidate has scored 1 mark for comparing the costs of the processes. They have mentioned 'plenty of room to do it', but this is too vague. If they had mentioned plenty of land to grow the crops needed to produce the sugar for fermentation, they would have scored another mark.

(c) A country has large amounts of available fertile land.
It has no reserves of crude oil.
It is not a wealthy country.

Explain why this country produces the ethanol it needs by fermentation rather than from ethene.

(3)

Fermentation is used to produce ethanol rather than from ethene because the county has fertile land. This land can be used to grow sugar beet or sugar cane to produce glucose for fermentation. The county also has no reserves of crude oil, meaning the crude oil can't be cracked to produce ethene, so no ethene is available in this county. Moreover, it is not wealthy therefore it cannot afford to produce ethanol from ethene as this is expensive (due to ~~cattle~~ crude oil being a non-renewable resource of energy).

ResultsPlus
Examiner Comments

This is a very good answer and scored 3 marks.

Question 3 (d)

Some excellent answers were seen to this question showing a clear understanding of the term 'homologous series'. A few candidates just wrote vague answers such as they all end in -ol or all contain the elements carbon, hydrogen and oxygen and these were not given any credit. A few candidates were also confused between the hydroxyl group and hydroxide ions. Some candidates gave an incorrect general formula, although the formulae for the alcohols were given in the question.

(d) Ethanol is a member of the homologous series of alcohols.
The first three members of the series are

methanol	CH_3OH
ethanol	C_2H_5OH
propanol	C_3H_7OH

Use the formulae of these molecules to explain why these alcohols are members of the same homologous series.

(2)

They have the same general formula ($C_nH_{2n+1}OH$) which is a property of the homologous series. They will also have similar chemical properties but show gradual change in their physical.

ResultsPlus
Examiner Comments

This is an excellent answer, scoring both marks.

They are all members of the same homologous series as they contain the exact same elements, just in different proportions, and as more atoms are added, the higher the boiling point and the more viscous and less volatile it gets

(Total for Question 3 = 9 marks)

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Examiner Comments

This candidate did not score any marks as 'contain the same elements in different proportions' is not the same as 'have the same general formula'.

ResultsPlus
Examiner Tip

Use correct scientific terminology, such as general formula' in your answers.

Question 4 (a)

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

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

(2)

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

ResultsPlus
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 reactant remains the same

ResultsPlus
Examiner Comments

This is a very good answer, scoring both marks.

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

(2)

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

ResultsPlus
Examiner Comments

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

Question 4 (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.

ResultsPlus
Examiner Comments

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

ResultsPlus
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 ~~it~~ the right-hand side of the equation has fewer molecules of gas. Therefore the yeld of ammonia would be increased.

ResultsPlus
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.

ResultsPlus
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.

ResultsPlus
Examiner Tip

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

Question 4 (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.

ResultsPlus
Examiner Comments

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

ResultsPlus
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.

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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.

ResultsPlus
Examiner Tip

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

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

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

(2)

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

ResultsPlus
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.

Question 4 (b) (iii)

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

State what is used in industry to overcome this problem.

(1)

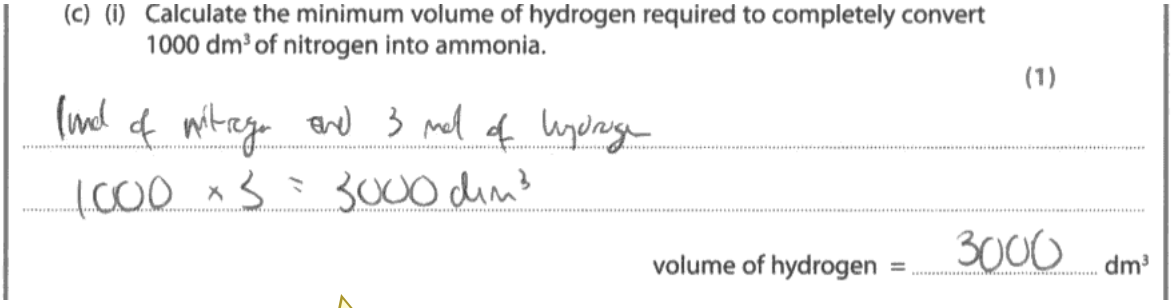
An iron catalyst

ResultsPlus
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.

Question 4 (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)

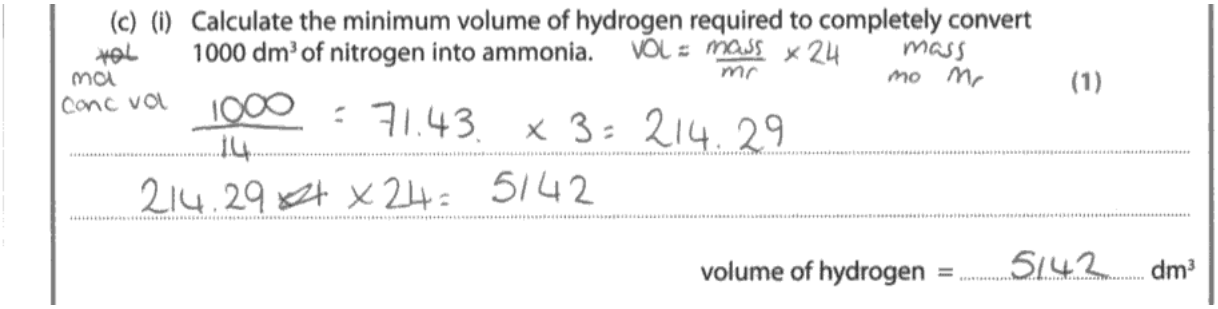
1mol of nitrogen and 3 mol of hydrogen

1000 × 3 = 3000 dm^3

volume of hydrogen = 3000 dm^3

ResultsPlus
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 (1)

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

214.29 × 24 = 5142

volume of hydrogen = 5142 dm^3

ResultsPlus
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.

ResultsPlus
Examiner Tip

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

Question 4 (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)

~~39~~ 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 x 2 = 160g

mass of ammonium nitrate produced = 160 g

ResultsPlus
Examiner Comments

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

(3)

r.a.m. of NH_3 = 17

x34 = 578

r.a.m. of NH_4NO_3 = 80

x74 = 7720

mass of ammonium nitrate produced = g

ResultsPlus
Examiner Comments

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

ResultsPlus
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.

Question 5 (b)

Many vague answers were seen to this question as candidates did not refer to the difficulty of seeing the colour change and instead wrote about the speed of the colour change. A common incorrect answer was that the indicator would contaminate the solution.

(b) Suggest why universal indicator must not be used in titration experiments.

(1)

It wouldn't be accurate enough.

ResultsPlus
Examiner Comments

This is an example of one of the vague answers that were seen and did not score a mark.

ResultsPlus
Examiner Tip

Write specific answers to questions. This question is about titrations and you should know that an indicator is used to find out when the solution is neutral because it changes colour. Universal indicator has a lot of different colours and there is no sharp change in colour at the end point of the titration.

(b) Suggest why universal indicator must not be used in titration experiments.

(1)

As it does not have a sharp colour change, instead it gradually changes colour

ResultsPlus
Examiner Comments

This is a very good answer and scored 1 mark.

Question 5 (c)

Many excellent answers were seen to this question. There were some very clear descriptions of carrying out a titration experiment. Unfortunately, some candidates did not read the whole question and they stopped their description when they had completed the titration. This limited their mark to level 2 as they did not give any description of how to obtain pure, dry crystals of sodium chloride. Some candidates were unfamiliar with the names of the apparatus and referred to 'a tube with a tap at the bottom' instead of a burette. Some candidates used Universal Indicator even though they had been told that it is not suitable in the previous part of the question. Although many candidates mentioned repeating the titration, only a small number explained the importance of concordant results. Many candidates did not mention the need to repeat the titration without the indicator before evaporating the water to obtain crystals. Some candidates thought the crystals were insoluble and used filtration to separate them.

*(c) Sodium chloride solution can be made from dilute hydrochloric acid and sodium hydroxide solution.

Describe a titration experiment to find the exact volume of hydrochloric acid needed to neutralise 25.0 cm^3 of sodium hydroxide solution and how you would use this result to obtain pure, dry crystals of sodium chloride.

(6)

Fill a conical flask with 25 cm^3 sodium hydroxide, and make sure there is a black cross at the bottom of the flask. Set up a burette filled with dilute HCl above the flask. Drop hydrochloric acid into the flask slowly until the solution turns white and cloudy enough so that you can't see the cross anymore. Record how much HCl you have used. To make sodium chloride, add an ~~soluble salt~~ ~~[illegible]~~ and leave overnight, and then you should have the insoluble salt sodium chloride.

ResultsPlus
Examiner Comments

This is an example of a level 1 answer, scoring 2 marks. The candidate has a limited knowledge of a titration experiment but seems to have confused it with using a black cross to time the rate of a reaction when sodium thiosulfate solution reacts with dilute hydrochloric acid.

*(c) Sodium chloride solution can be made from dilute hydrochloric acid and sodium hydroxide solution.

Describe a titration experiment to find the exact volume of hydrochloric acid needed to neutralise 25.0 cm^3 of sodium hydroxide solution and how you would use this result to obtain pure, dry crystals of sodium chloride.

(6)

Put the acid into a burette and the NaOH into a beaker at the ~~beker~~ bottom. Add the acid to the alkali slowly until the indicator turns colourless and then measure ~~how much~~ the ~~%~~ volume of HCl needed to neutralise ~~the~~ ~~ex~~ the NaOH. When the solution is neutralised, it can be heated and the water can be evaporated off. The dry ~~seed~~ NaCl will start to crystallise. ~~Bead~~ Lastly, remove the NaCl from the heat and allow to cool, ~~the~~ ~~crystals will form~~ larger crystals will be formed ~~in the liquid~~ as it cools.

~~Extra~~ $HCl + NaOH \rightarrow NaCl + H_2O$

ResultsPlus
Examiner Comments

This is a level 2 answer, scoring 4 marks. The answer does refer to the titration and how to obtain crystals, but there is not enough detail about how to carry out the titration experiment for it to be level 3.

ResultsPlus
Examiner Tip

Learn all the details of carrying out a titration experiment.

*(c) Sodium chloride solution can be made from dilute hydrochloric acid and sodium hydroxide solution.

Describe a titration experiment to find the exact volume of hydrochloric acid needed to neutralise 25.0 cm^3 of sodium hydroxide solution and how you would use this result to obtain pure, dry crystals of sodium chloride.

(6)

Firstly clean a burette with the acid been used to remove impurities. Then clean the pipette out with the alkali been used. Once clean fill the pipette up with the sodium hydroxide solution. The pipette is very accurate compared to a measuring cyclinder. pour the sodium hydroxide solution into a conical flask. It's important to use a conical flask as it is used to swirl the liquid without it spilling. Next, fill the burette with the hydrochloric acid. Record the volume you start with. Then place a white tile under the burette, put an indicator, like phenolphthalein, into the conical flask so we can see when neutralisation occurs. Place the conical flask under the burette (above the tile) and begin to add the acid whilst swirling the flask. Do a trial before hand so that you know, approximately, when your solution will be neutralised. From that point add the acid drop-by-drop until the pink solution (from the indicator) turns clear. Then record the amount of HCl used.

ResultsPlus
Examiner Comments

This candidate has written an excellent description of carrying out a titration experiment. Unfortunately, they have not mentioned anything about how to obtain crystals from the solution so was given level 2 and 4 marks.

ResultsPlus
Examiner Tip

Read the question carefully and make sure that you have answered all of it.

*(c) Sodium chloride solution can be made from dilute hydrochloric acid and sodium hydroxide solution.

Describe a titration experiment to find the exact volume of hydrochloric acid needed to neutralise 25.0 cm^3 of sodium hydroxide solution and how you would use this result to obtain pure, dry crystals of sodium chloride.

(6)

Firstly, a pipette would be used to accurately measure 25cm^3 of sodium hydroxide, and this would be placed in a conical flask. A burette would be filled with hydrochloric acid. This would need to be a measured amount so that the amount added to the sodium hydroxide solution could be recorded. Next, you would add an indicator to the sodium hydroxide solution (such as phenolphthalin, which dramatically changes colour in an alkali solution to a neutral one). Hydrochloric is slowly added, swirling the conical flask in a controlled way over a white tile, so that a colour change is noticed instantly. Towards the end, the acid should be added drop-by-drop. When the indicater changes colour, note the amount of acid from the burette that was needed to neutralise the sodium hydroxide solution. Repeat the experiment 3 times and find the mean (mean) volume of hydrochloric acid needed. Finally, repeat without adding the indicater, using the mean volume of hydrochloric acid. This solution will contain sodium chloride and water. To obtain just the sodium chloride, the water can be evaporated and the sodium chloride left to dry and crystalise. crystalise.

ResultsPlus
Examiner Comments

This was a very good description of carrying out a titration and obtaining crystals so it was awarded 6 marks.

Question 5 (d) (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

ResultsPlus
Examiner Comments

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

ResultsPlus
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)

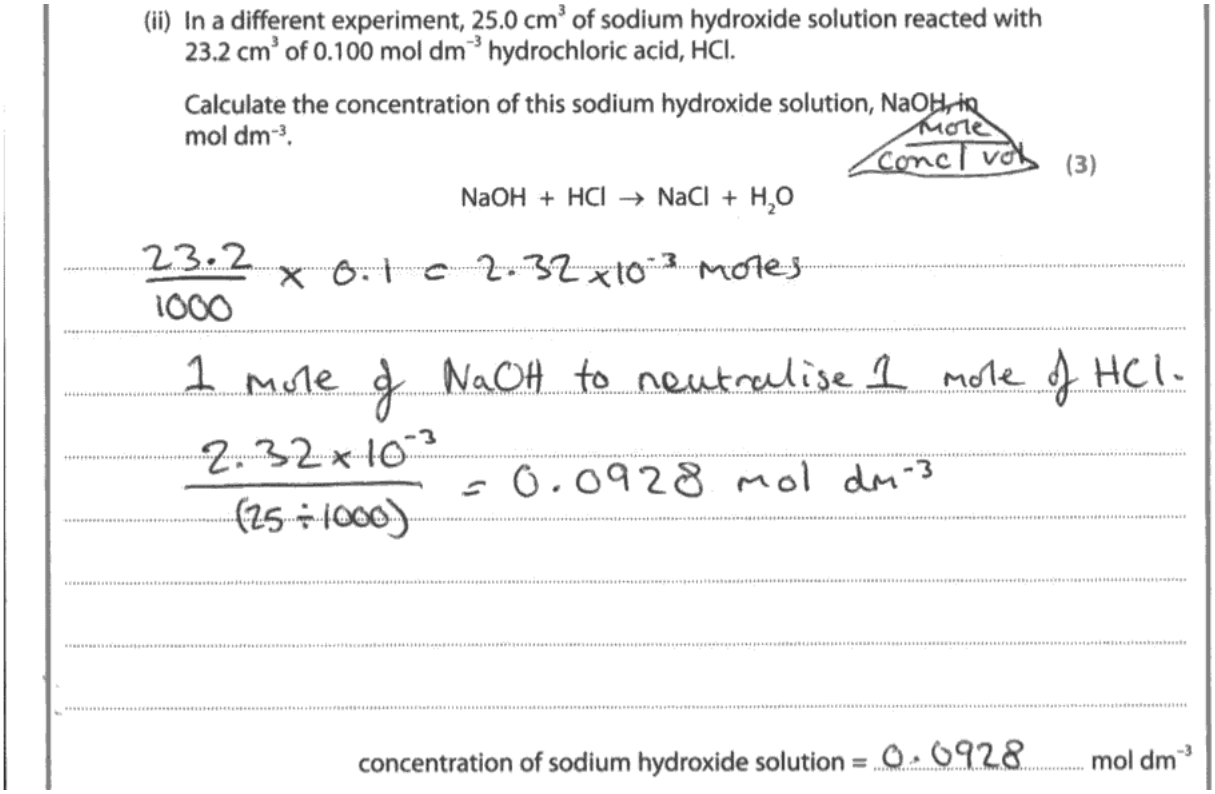
volume of hydrochloric acid = 22.7 cm^3

ResultsPlus
Examiner Comments

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

Question 5 (d) (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}

ResultsPlus
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)

2.32×10^{-3}

$$NaOH + HCl \rightarrow NaCl + H_2O$$

Sodium hydroxide - volume = 25.0cm^3 conc. = ?

Hydrochloric acid - volume = 23.2cm^3 Conc. = 0.100moldm^{-3}

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}

ResultsPlus
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.

ResultsPlus
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)

$NaOH + HCl \rightarrow NaCl + H_2O$

$\frac{23.2}{0.100} \times \frac{1}{1000}$ mol $= \frac{0.1}{\text{Vol}} = \frac{0.1}{23.2\,cm^3} = 2.32$

hydrochloric

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

ResultsPlus
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.

ResultsPlus
Examiner Tip

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

Question 6 (a) (ii)

Although many candidates did know how to test for ammonia, there were many poor descriptions. A significant number omitted to heat the mixture. A surprising number thought that ammonia would turn blue litmus red or even bleach it. A common error was to place red litmus in the solution with sodium hydroxide rather than in the gas.

(ii) Describe how sodium hydroxide solution can be used to show that ammonium ions are present in substance **X**.

(2)

sodium hydroxide solution could be added to substance X. If a white precipitate is formed then ammonium ions are present.

ResultsPlus
Examiner Comments

This candidate has not learnt the test for ammonium ions so has not scored a mark.

ResultsPlus
Examiner Tip

Learn all the tests for the ions that are listed in the specification.

(ii) Describe how sodium hydroxide solution can be used to show that ammonium ions are present in substance **X**.

(2)

Add a few drops of sodium hydroxide solution to substance X and, if aluminium ions are present, a white precipitate should form. To make sure they are aluminium ions and not calcium ions, add more sodium hydroxide solution. The precipitate should redissolve leaving a colourless solution.

ResultsPlus
Examiner Comments

This candidate has described the test for aluminium ions and has not scored any marks as the question asks for ammonium ions.

ResultsPlus
Examiner Tip

Read the questions carefully.

(ii) Describe how sodium hydroxide solution can be used to show that ammonium ions are present in substance **X**.

(2)

Sodium hydroxide solution can be added to substance X, no precipitate will form but it heated, will give off ammonia, this can be tested by the smell and ~~red litm~~ blue litmus paper as it will turn red.

ResultsPlus
Examiner Comments

This candidate knows that the mixture should be heated and has remembered that litmus is used to test for ammonia. However, ammonia is an alkaline gas so the colour change in this description is wrong and the answer scored 1 mark.

ResultsPlus
Examiner Tip

Learn the colour changes for litmus in acidic and alkaline substances.

(ii) Describe how sodium hydroxide solution can be used to show that ammonium ions are present in substance **X**.

(2)

Add sodium hydroxide solution to the substance and boil. A smell of ammonia would be produced and damp red litmus paper would turn blue.

ResultsPlus
Examiner Comments

This is a very good answer, scoring both marks.

ResultsPlus
Examiner Tip

When you are asked to describe a test, always describe how you would carry out the test and the observation that would be made.

Question 6 (b)

A surprising number of candidates were unable to give the correct formula for the hydroxide ion and an even smaller number were able to work out the formula for aluminium hydroxide. However, a significant number of candidates did score 3 marks for this question.

(b) Aluminium ions, Al^{3+}, react with hydroxide ions in solution to give a white precipitate of aluminium hydroxide.

Write the ionic equation for this reaction.

(3)

$Al^{3+} + 3OH^- \rightarrow AlOH_3$

ResultsPlus
Examiner Comments

This candidate has written the correct formula for hydroxide ions so has scored 1 mark. If this candidate had drawn brackets around the OH in the formula for aluminium hydroxide, they would have scored 3 marks.

ResultsPlus
Examiner Tip

Learn how to write formulae for ionic compounds.

(b) Aluminium ions, Al^{3+}, react with hydroxide ions in solution to give a white precipitate of aluminium hydroxide.

Write the ionic equation for this reaction.

(3)

$Al^{3+}_{(aq)} + 3OH^-_{(aq)} \rightarrow Al(OH)_{3(s)}$

ResultsPlus
Examiner Comments

This is an excellent answer, scoring 3 marks. The state symbols were not necessary in this question.

(b) Aluminium ions, Al^{3+}, react with hydroxide ions in solution to give a white precipitate of aluminium hydroxide.

Write the ionic equation for this reaction.

(3)

$Al^{3+} + OH^- \rightarrow Al(OH)_3$

$Al^{3+} + OH^- \rightarrow AL(OH)_3$

ResultsPlus
Examiner Comments

This candidate has written all the correct formulae so has scored 2 marks. If they had balanced the equation, they would have scored an extra mark.

ResultsPlus
Examiner Tip

Remember to balance all equations.

Question 6 (c)

Candidates who had learnt the tests for sodium, potassium, iodide and sulfate ions carefully were able to score full marks for this question. Only a few candidates did not know the correct flame test colours for the cations. More candidates did not know the tests for the anions and made errors such as using dilute hydrochloric acid to acidify the silver nitrate solution to test for iodide ions or stated that a yellow solution would be formed rather than a yellow precipitate.

Explain how, using chemical tests, the technician could find out if the substance left in the beaker was potassium sulfate, potassium iodide, sodium sulfate or sodium iodide.

You may include equations in your answer.

(6)

She would divide the crystals up into four groups for the four different tests she would need to preform. she would need to preform the flame test, silver nitrate test, adding sodium hydroxide solution and the bromide test. The result of these reactions, what precipitates formed, the colours the crystals turned and the ordour they gave off can be used to determine what substance was left in the beake..

ResultsPlus
Examiner Comments

This candidate has given a number of tests that could be carried out, but has not given the results that would be observed from these four salts. This answer was given 1 mark for carrying out a flame test.

ResultsPlus
Examiner Tip

When you are asked for tests to identify substances, describe how you would carry out the test and what you would expect to see.

Explain how, using chemical tests, the technician could find out if the substance left in the beaker was potassium sulfate, potassium iodide, sodium sulfate or sodium iodide.

You may include equations in your answer.

(6)

Firstly, the technician could do a flame test. A flame test would involve ~~heating~~ a ~~sp~~ heating up the substance. A flame test would be able to show if the substance ~~was~~ had potassium or sodium in it. The substance would glow lilac if potassium was present.

Add dilute hydrochloric acid followed by some silver nitrate. ~~Then~~ This test should show the difference between the sulfate and the iodide.

ResultsPlus
Examiner Comments

This is an example of a level 1 answer, scoring 2 marks. The flame test for potassium is correct. However, if you use dilute hydrochloric acid with silver nitrate solution, you will obtaing a precipitate of silver chloride.

ResultsPlus
Examiner Tip

Use dilute nitric acid with silver nitrate solution to test for halides.

Use dilute hydrochloric acid with barium chloride solution to test for sulfates.

Explain how, using chemical tests, the technician could find out if the substance left in the beaker was potassium sulfate, potassium iodide, sodium sulfate or sodium iodide.

You may include equations in your answer.

(6)

- Add dilute Nitric acid to potassium iodide and then a few drops of silver Nitrate. Iodide produces a yellow precipitate. In a flame test the potassium will turn the flame lilac.

In a flame test sodium will produce a red flame.

Add dilute nitric acid to sodium sulphate or sodium iodide then add a few drops on nitric acid. A white precipitate will be formed.

ResultsPlus
Examiner Comments

This is an example of a level 2 answer, scoring 4 marks. The flame test for potassium and the test for iodide are correct. However, sodium does not give a red flame and the test for sulfate is incorrect.

ResultsPlus
Examiner Tip

Learn the tests for all of the ions in the specification.

Explain how, using chemical tests, the technician could find out if the substance left in the beaker was potassium sulfate, potassium iodide, sodium sulfate or sodium iodide.

You may include equations in your answer.

(6)

To identify potassium ions, you can use a flame test. Add the solution to a lit bunsen burner and if the flame turns ~~purple~~ lilac, potassium ions are present. You can also test for sodium ions by a flame test. Again add the solution to a flame and if the flame is yellow/~~orange~~ orange then sodium ions are present. To test for iodide ions, add dilute nitric acid (to get rid of any carbonate ions) and add silver ~~chloride~~ nitrate. If iodine ions are present, a yellow precipitate will form. The equation for this is $Ag^+ + I^- = AgI_{(s)}$. Lastly, to test for sulfate ions, add hydrochloric ~~to~~ acid to the solution followed by barium chloride. If sulfate ions are present, then a precipitate of barium sulfate will form.

ResultsPlus

Examiner Comments

This is a very good level 3 answer, scoring 6 marks. The candidate has written correct identification test for the ions and has even added a correct ionic equation.

Paper Summary

In order to improve their performance, candidates should:

- read all of the information in the question and use it to help them to answer the question;
- practise writing balanced equations, including ionic equations, for the reactions in the specification;
- practise carrying out calculations of the different styles in the specification;
- revise the tests to identify the ions in the specification;
- ensure that they can describe the different experiments that they have carried out in lessons, including titrations.

Grade Boundaries

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