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Examiners' Report
June 2023

GCSE Chemistry 1CH0 1H

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June 2023

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Introduction

1CH0 1H is this first of two papers for GCSE Chemistry Higher Tier.

Some of the earlier questions also appear in the 1F Foundation Tier paper.

The Combined Science paper 1SC0 1CH is composed of six of the ten questions in this paper.

Question 1 (a)

A surprising number of candidates stumbled here, perhaps most commonly in the number of neutrons for isotope A.

1 (a) Figure 1 shows information about two isotopes of hydrogen, **A** and **B**.

Complete the table to show the number of subatomic particles in each isotope.

(2)

	isotope A	isotope B
atomic number	1	1
mass number	1	2
number of protons	1	2
number of electrons	1	1
number of neutrons	1	1

ResultsPlus Examiner Comments

Knowing the meaning of mass number and atomic number is important.

1 (a) Figure 1 shows information about two isotopes of hydrogen, **A** and **B**.

Complete the table to show the number of subatomic particles in each isotope.

(2)

	isotope A	isotope B
atomic number	1	1
mass number	1	2
number of protons	1	1
number of electrons	1	1
number of neutrons	1	~~3~~ 2

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Examiner Comments

Candidates most frequently erred in isotope A's neutron number.

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Examiner Tip

Isotope A does not contain any neutrons.

Question 1 (b)

Most candidates correctly interpreted the graph and identified the constant voltage for 1 hour and then a decrease to 0 V. Some omitted mentioning a specific time reference for the voltage decrease (hence not giving all of the information contained in the graph) and a few candidates quoted voltage values incorrectly. Some candidates lost the second mark for using vague terms, such as "voltage ran out," "voltage stops," or "no more voltage," without explicitly mentioning 0 Volts, whilst others discussed the fuels running out instead of focusing on the voltage reaching zero.

Describe what Figure 2 shows about how the voltage of this fuel cell varies with time.

(2)

The voltage of the fuel cell remains the same for 60 minutes at 1.1V until it begins to rapidly drop to 0V after 60 minutes.

ResultsPlus Examiner Comments

This is a good answer because it describes the graph – constant voltage then dropping – and uses the correct data from the graph.

Describe what Figure 2 shows about how the voltage of this fuel cell varies with time.

(2)

Between 0 and 60 mins the voltage is constant at 1.1V. Then between 60 and ~74 it steadily drops to 0V

ResultsPlus Examiner Comments

Another good answer.

ResultsPlus Examiner Tip

Always use data from a graph when describing it.

Question 1 (c)

Overall, the performance on the sodium part was better than that on the sulfur part. A significant number mentioned that sodium "dissolves" in water instead of more correctly saying it would react. Others did not recognise sodium as a metal. Vague language, such as "interferes in the electrolysis" was used by some candidates, lacking a precise explanation of sodium's reaction with water. Fewer candidates correctly stated that sulfur is a non-metal and/or a poor conductor of electricity. Many mistakenly believed that sulfur is a gas or mentioned toxic gases being produced. Some put the same marking point on both the sodium and sulfur lines, such as labelling both as "very reactive".

(c) A chemical cell is made by placing two electrodes into an aqueous electrolyte.

Figure 3 shows a chemical cell.

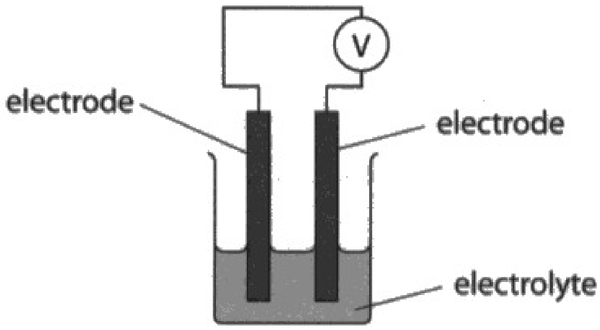

Figure 3

State why sodium and sulfur electrodes are **not** suitable for this experiment.

(2)

sodium

Sodium is reactive and wauld react with the electroyte.

sulfur

Sulfur isn't a metal.

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Examiner Comments

These are both acceptable answers.

(c) A chemical cell is made by placing two electrodes into an aqueous electrolyte.

Figure 3 shows a chemical cell.

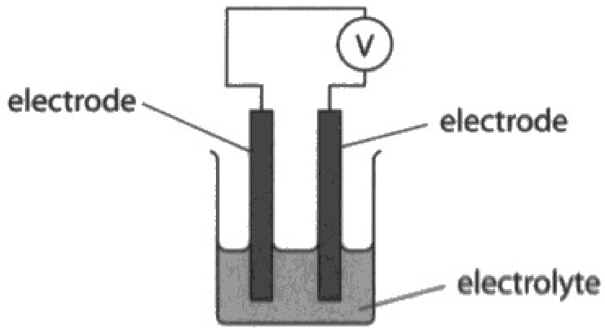

Figure 3

State why sodium and sulfur electrodes are **not** suitable for this experiment.

(2)

sodium

Will react with the electrolyte - not inert.

sulfur

Cannot conduct electricity.

ResultsPlus
Examiner Comments

This answer gives an alternative, correct response for sulfur.

Question 2 (a)

On the whole, the question was reasonably well answered, with a significant number of candidates providing correct answers. However, common wrong answers included suggestions to add excess or weight to a constant mass, add an indicator, or simply wait until there was no more reaction.

2 In an experiment, powdered calcium hydroxide was added to dilute hydrochloric acid and the pH was measured.

The method used was

step 1 measure 200 cm^3 dilute hydrochloric acid into a beaker

step 2 add 0.1 g of powdered calcium hydroxide to the beaker

step 3 find the pH of the mixture

step 4 repeat steps 2 and 3 until the pH stops changing.

(a) State what should be done after **step 2** to make sure that any reaction is complete.

(1)

- add calcium hydroxide in excess

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Examiner Comments

The question needs careful reading – step 2 is adding 0.1g of the solid – so an excess is not correct.

ResultsPlus
Examiner Tip

Carefully look at all of the practicals covered in the course and understand all of the steps involved.

2 In an experiment, powdered calcium hydroxide was added to dilute hydrochloric acid and the pH was measured.

The method used was

step 1 measure 200 cm^3 dilute hydrochloric acid into a beaker

step 2 add 0.1 g of powdered calcium hydroxide to the beaker

step 3 find the pH of the mixture

step 4 repeat steps 2 and 3 until the pH stops changing.

(a) State what should be done after **step 2** to make sure that any reaction is complete.

(1)

See is all the powder disolves

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Examiner Comments

This does not answer the question – to make sure the reaction is complete, the mixture is stirred.

Question 2 (b)

Candidates generally answered this question well and scored both marks for providing the correct products. The most common mistake was "hydrogen" instead of "water" as one of the products. Some offered more than two products, including "calcium hydrochloride" or "calcium chlorate". Some used "salt" instead of specifying the actual name of the salt formed.

(b) Complete the word equation for the reaction.

(2)

calcium hydroxide + hydrochloric acid → calcium chloride + water ~~+ H...~~

ResultsPlus Examiner Comments

The answer scores 2.

(b) Complete the word equation for the reaction.

(2)

CaH + HCl

calcium hydroxide + hydrochloric acid → ~~hydrogen + water~~ Hydrogen chloride

ResultsPlus Examiner Comments

No correct product given.

ResultsPlus Examiner Tip

Learn the general reactions of an acid with a metal, an alkali/base, and with a carbonate.

Question 2 (d)(i)

A straightforward part, well done. Candidates should avoid quoting values to an unwarranted level of precision.

(d) The results of the experiment are shown in Figure 4.

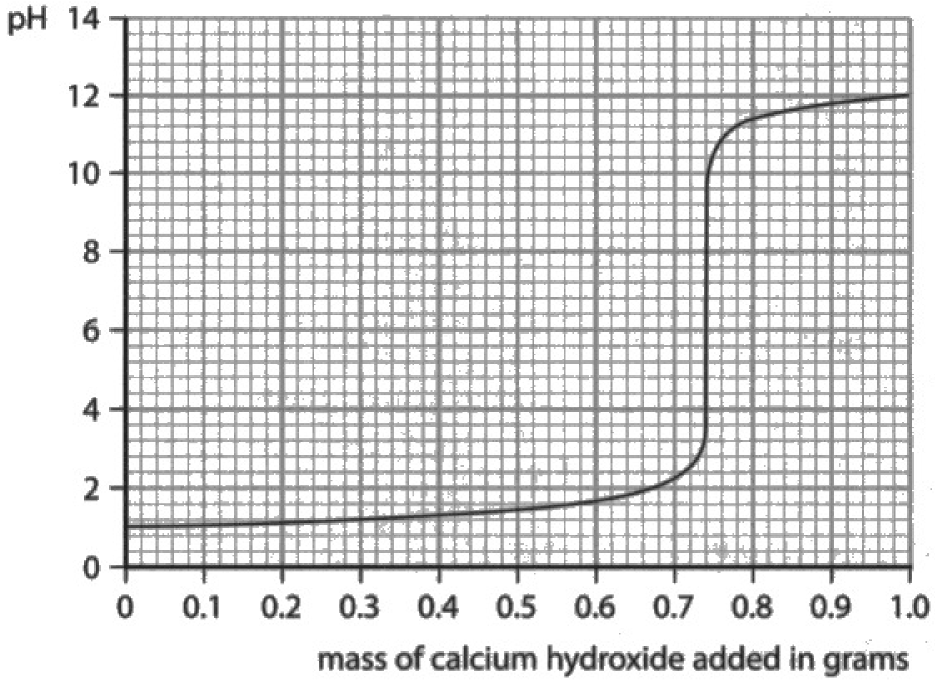

Figure 4

(i) Using Figure 4, give the pH of the acid at the start of the experiment.

(1)

pH = 0.9

ResultsPlus
Examiner Comments

Whilst the expected answer was 1, 0.9 or 1.1 were also allowed but nothing to a higher degree of precision.

Question 2 (d)(ii)

Almost all candidates correctly read the graph.

(ii) Using Figure 4, give the mass of calcium hydroxide required to make a neutral mixture.

(1)

mass of calcium hydroxide = 7.4 g

ResultsPlus
Examiner Comments

The candidate has probably read the scale correctly and incorrectly written down the answer.

ResultsPlus
Examiner Tip

Always check that numerical answers make sense. This answer is more than the total mass added.

(ii) Using Figure 4, give the mass of calcium hydroxide required to make a neutral mixture.

(1)

mass of calcium hydroxide = 0.74 g

ResultsPlus
Examiner Comments

This is the correct answer.

Question 2 (d)(iii)

Most candidates successfully gained the first marking point by identifying that the starting solution was acidic. Many missed out on scoring the second point as they did not mention the neutralisation process taking place. Some mentioned H^+ and OH^- ions, but some got them the wrong way round or did not fully understand their significance in neutralisation. Fewer candidates scored the third marking point by identifying the base or an excess of OH^- ions.

(iii) Explain why the pH starts at a low value and ends at a higher value.

(3)

- At the start there is still a majority H^+ ions, which can't be neutralised, not enough OH^- ions
- At centre all H^+ and OH^- ions ~~re~~ reacted, creating neutral solution
- At end, calcium hydroxide is in excess, more OH^- ions now

(Total for Question 2 = 9 marks)

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Examiner Comments

Whilst 'at the centre' is not an ideal expression, the candidate clearly explains what is happening.

ResultsPlus
Examiner Tip

Using these ions is a good way of explaining pH change.

Question 3 (b)(i)

Most candidates gained both marks here. Where they did not, they were either vague – for example, for magnesium just saying "bubbling" rather than comparing with zinc, or they gave incorrect additional observations.

(b) A student investigates the reactivity of four different metals.

The student adds an equal-sized piece of each metal to separate test tubes containing dilute hydrochloric acid.

The student's observations for zinc and copper are recorded in Figure 6.

metal	observations
magnesium	
zinc	bubbles produced at a steady rate test tube feels slightly warm
iron	
copper	no reaction

(i) Use the information in Figure 5 and in Figure 6 to predict the observations for the reactions of magnesium and of iron with dilute hydrochloric acid.

(2)

magnesium

Bubbles Produced at a fast rate; test tube feels hot.

iron

Bubbles produced at a slow rate.

ResultsPlus
Examiner Comments

This answer is successful because it gives relative bubbling rates of magnesium and zinc compared to the descriptions in the table.

(b) A student investigates the reactivity of four different metals.

The student adds an equal-sized piece of each metal to separate test tubes containing dilute hydrochloric acid.

The student's observations for zinc and copper are recorded in Figure 6.

metal	observations
magnesium	
zinc	bubbles produced at a steady rate test tube feels slightly warm
iron	
copper	no reaction

(i) Use the information in Figure 5 and in Figure 6 to predict the observations for the reactions of magnesium and of iron with dilute hydrochloric acid.

(2)

magnesium

react vigorously, lots of bubbles produced (effervescence)
test tube very hot

iron

bubbles (effervescence) produced at steady rate.
test tube ~~[illegible]~~ slightly warm.

ResultsPlus
Examiner Comments

This answer did not score for iron as the description matches that for zinc.

(b) A student investigates the reactivity of four different metals.

The student adds an equal-sized piece of each metal to separate test tubes containing dilute hydrochloric acid.

The student's observations for zinc and copper are recorded in Figure 6.

metal	observations
magnesium	
zinc	bubbles produced at a steady rate test tube feels slightly warm
iron	
copper	no reaction

(i) Use the information in Figure 5 and in Figure 6 to predict the observations for the reactions of magnesium and of iron with dilute hydrochloric acid.

(2)

magnesium

It will react vigerously with some effervecence

iron

Small amount of bubbles produced with a extremely slow rate

ResultsPlus
Examiner Comments

The answer for magnesium is contradictory.

Question 3 (b)(ii)

Unsurprisingly, the test for hydrogen gas was well answered, with only a few candidates stating the "squeaky pop test" (which does not score) without mentioning a lit splint. A few either mentioned a glowing splint or failed to mention a source of ignition, resulting in the loss of all the marks. A few suggested the test for carbon dioxide using limewater.

(ii) When metals react with acids, hydrogen gas is produced.

Describe the test to show that the gas is hydrogen. Lit ✓

(2)

First, lit a splint so that it produces a flame. Then hold splint in the area of gas and ~~if~~ if a squeaky pop was heard, then hydrogen gas is present.

ResultsPlus
Examiner Comments

An ideal answer – method of test and result.

ResultsPlus
Examiner Tip

Note that "squeaky pop test" is not accepted as either a description of this test or as the result.

(ii) When metals react with acids, hydrogen gas is produced.

Describe the test to show that the gas is hydrogen.

(2)

Light a glowing splint if hydrogen ~~is~~ gas is present a pop sound will occur.

ResultsPlus
Examiner Comments

This answer is unclear because it mentions glowing splint, and does not score.

ResultsPlus
Examiner Tip

Learn all of the gas tests thoroughly – as well as those for ions.

Question 3 (b)(iii)

This equation was well done although 2H was a not uncommon error.

(iii) When magnesium reacts with hydrochloric acid, magnesium chloride and hydrogen are formed.

Complete the balanced equation for the reaction.

(2)

$Mg + 2HCl \rightarrow MgCl_2 + H_2$

ResultsPlus
Examiner Comments

This scores both marks. The candidate has shown a useful method of checking.

(iii) When magnesium reacts with hydrochloric acid, magnesium chloride and hydrogen are formed.

Complete the balanced equation for the reaction.

(2)

$$Mg + \ldots 2 \ldots HCl_2 \rightarrow MgCl_2 + \ldots 2H \ldots$$

ResultsPlus
Examiner Comments

A common error.

ResultsPlus
Examiner Tip

All elements that are gases at room temperature and pressure (except noble gases) are diatomic molecules.

Question 3 (c)(i-ii)

Many candidates correctly answered both parts of the question. Those who did not often put "2x" and then received 1 mark if the error was carried forward giving 2 x 0.005 = 0.01. Others multiplied by 100 or 1000. In the second part, some were dividing instead of multiplying.

(c) An excess of magnesium is added to some dilute hydrochloric acid of pH 2. The mass of hydrogen gas produced is measured.

The experiment is repeated with excess magnesium but with the same volume of dilute hydrochloric acid of pH 1.

(i) State how many times greater the concentration of hydrogen ions is in the acid of pH 1 than in the acid of pH 2.

(1)

10 times greater.

(ii) With the acid of pH 2, the mass of hydrogen gas produced when the reaction is complete is 0.005 g.

Predict the mass of hydrogen gas produced in the reaction with acid of pH 1.

(1)

$\frac{0.005}{10}$

mass = 0.0005 g

ResultsPlus
Examiner Comments

This x 10 is correct, but unfortunately has divided by 10 in the second part.

(c) An excess of magnesium is added to some dilute hydrochloric acid of pH 2.
The mass of hydrogen gas produced is measured.

The experiment is repeated with excess magnesium but with the same volume of dilute hydrochloric acid of pH 1.

(i) State how many times greater the concentration of hydrogen ions is in the acid of pH 1 than in the acid of pH 2.

(1)

2 times greater .

(ii) With the acid of pH 2, the mass of hydrogen gas produced when the reaction is complete is 0.005 g.

Predict the mass of hydrogen gas produced in the reaction with acid of pH 1.

(1)

0 · 005 × 2 = 0 · 01

mass = 0 · 01 g

ResultsPlus
Examiner Comments

This scores 1 for multiplying 0.005g by the factor from the first part.

ResultsPlus
Examiner Tip

Always show working. If one part of the answer is incorrect, some marks can still be gained if the examiner can follow the method used.

Question 4 (a)

The majority of candidates scored very well on the question. Where full marks were not awarded, a mark was often lost for answering to 3 or more significant figures instead of the requested 2. There were still instances where candidates failed to multiply by 100, whilst others were careless in calculating 191.

4 There are several stages to the production of sulfuric acid in industry.

(a) Sulfur dioxide is required for the production of sulfuric acid.

Sulfur dioxide can be obtained by heating copper sulfide, Cu_2S, in excess air.

$$Cu_2S + O_2 \rightarrow 2Cu + SO_2$$

Calculate the atom economy for the production of sulfur dioxide, SO_2, in this reaction.

(relative atomic mass: Cu = 63.5
relative formula masses: O_2 = 32.0, Cu_2S = 159.0, SO_2 = 64.0)

Give your answer to two significant figures.

(4)

$\frac{\text{product}}{\text{reactants}} \times 100$ $\left(\frac{64}{(159+32)}\right) \times 100$

$\left(\frac{64}{191}\right) \times 100 \rightarrow 0.335... \times 100$

atom economy = 34 %

ResultsPlus
Examiner Comments

The answer is clearly laid out and correctly rounded.

4 There are several stages to the production of sulfuric acid in industry.

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relative formula masses: O_2 = 32.0, Cu_2S = 159.0, SO_2 = 64.0)

Give your answer to two significant figures.

(4)

~~63.39 (63.5 × 2) +~~ 159 + 32 = 191

(63.5 × 2) + 64 = 191

atom economy = 100 %

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Examiner Comments

Scores 1 for mass of products.

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Examiner Tip

Look at past papers to see standard calculations like this one and learn how to do them.

Question 4 (c)(i)

Overall, responses were excellent, and very many scored both marks. Those who scored 1 mark generally gained it for the calculation of 400/80. A few lacked an understanding of the underlying chemistry and simply played with the numbers, adding 80 and 98 or even subtracting 80 from 98. Some were confused by the term "tonnes" and tried and failed to convert units.

(c) The equation shows a reaction forming sulfuric acid.

$$SO_3 + H_2O \rightarrow H_2SO_4$$

400 tonnes = 400,000

(i) Calculate the maximum mass of sulfuric acid that could be produced from 400 tonnes of sulfur trioxide, SO_3.

(relative formula masses: SO_3 = 80, H_2SO_4 = 98)

(2)

moles = mass / mr   400 / 80 = 5moles

1 : 1   mass = moles x mr   5 x 98 = 490

maximum mass of sulfuric acid = 490 tonnes

ResultsPlus
Examiner Comments

Very well laid out answer.

(c) The equation shows a reaction forming sulfuric acid.

$$SO_3 + H_2O \rightarrow H_2SO_4$$

(i) Calculate the maximum mass of sulfuric acid that could be produced from 400 tonnes of sulfur trioxide, SO_3.

(relative formula masses: $SO_3 = 80$, $H_2SO_4 = 98$)

(2)

~~98/80 x 400 = 490~~ $\frac{80}{98} \times 400 = 326.5$

maximum mass of sulfuric acid = ~~490~~ 326.5 tonnes

ResultsPlus
Examiner Comments

The fraction has been inverted, but nevertheless scores 1 for x 100 and correctly evaluating.

Question 4 (c)(ii)

In a straightforward calculation, excellent responses were observed, with nearly all scoring these marks.

(ii) Using a different amount of sulfur trioxide, it was calculated that 700 tonnes of sulfuric acid could be made.

The actual mass produced was 672 tonnes.

Calculate the percentage yield of sulfuric acid.

(2)

700 − 672 = 28

$\frac{28}{700}$ = 0.04 x100 = 4

percentage yield = 4

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Examiner Comments

Some candidates worked out the 'loss of yield'.

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Examiner Tip

Check that numerical answers make sense. If nearly all the product was formed, the yield cannot be so low.

Question 4 (c)(iii)

Nearly all candidates provided two suggestions here. Some confused yield with atom economy ("there are waste products"). Other confusion involved the yield not being accurately measured or mentioned the loss of energy/heat. Most candidates suggested unwanted side reactions or incomplete reactions as reasons for discrepancies. Some candidates tried to use the previous question to help them and mentioned general statements about actual yield always being less than theoretical yield or not ever achieving 100% yield. It should be noted that 'human error' ("some was spilt") was not credited.

(iii) State **two** reasons why the percentage yield is less than 100%.

(2)

1 Some energy was lost during the reaction

2 Some products are damaged or ~~don't~~ not all reaction / collide to form products.

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Examiner Comments

The second reason may have scored if it was less muddled and better expressed in terms of an incomplete reaction.

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Examiner Tip

Energy changes do not cause changes in yield.

Question 5 (a)(i)

Overall, the performance was not particularly good for what should be a familiar equation. The biggest error was that candidates did not appreciate the diatomic nature of hydrogen and nitrogen (especially nitrogen, given as 2N). The majority picked up the mark for including the equilibrium symbol. Some provided imaginative oxides for nitrogen in the equation.

5 (a) Ammonia is manufactured in the Haber process by the reversible reaction between nitrogen and hydrogen.

(i) Write the balanced equation for the reversible reaction between nitrogen and hydrogen to make ammonia, NH_3.

(3)

$N_{2(g)} + 3H_{2(g)} \longrightarrow 2NH_{3(g)}$

ResultsPlus
Examiner Comments

Balanced, but missing the equilibrium sign.

5 (a) Ammonia is manufactured in the Haber process by the reversible reaction between nitrogen and hydrogen.

(i) Write the balanced equation for the reversible reaction between nitrogen and hydrogen to make ammonia, NH_3.

(3)

$2N + 3H_2 \rightleftharpoons 2NH_3$

ResultsPlus
Examiner Comments

A common error, thinking that nitrogen was not diatomic.

Question 5 (a)(iii)

The vast majority of candidates provided the correct answer of "catalyst." The most common error was suggesting that iron was a sacrificial metal or reacting with oxygen or “stabilising”.

(iii) In the Haber process, iron is added to the vessel where the nitrogen and hydrogen react.

State the purpose of the iron.

(1)

Speed up reaction (its used as a catalyst)

ResultsPlus
Examiner Comments

Both parts of the sentence would have scored.

Question 5 (a)(iv)

The movement of the position of equilibrium is a challenging topic, and some candidates struggled with interpreting in which direction the equilibrium would shift. It was pleasing that most realised that the exothermic reaction was significant. Some understood that the reaction would shift to oppose the temperature change. However, some misconceptions arose, such as thinking that endothermic reactions would take in heat and so raise the temperature. The main mistake was stating that the reaction shifted in the endothermic direction or to the left. Some confused the discussion with rates of reaction instead of focusing on the effect on the position of equilibrium. Some failed to score a second mark as they simply stated that the equilibrium would oppose the change in temperature without explaining how or why.

(iv) The reaction between nitrogen and hydrogen to make ammonia can reach dynamic equilibrium.

The reaction gives out heat. - exothermic

Explain how the position of equilibrium changes if the temperature is decreased.

(2)

If the temperature is lowered, the equilibrium moves to raise it. This would mean the equilibrium would move to the ~~left han~~ products (right hand side), as the reaction is exothermic (gives off heat)

ResultsPlus
Examiner Comments

A well-expressed answer.

ResultsPlus
Examiner Tip

In questions like this, you are advised to give the general answer (position of equilibrium moves to opposes the change in conditions), then to apply to the variable (to give out heat), then to apply to reaction (which is forward direction as it is exothermic).

Question 5 (b)

Generally, the question was well done, with most candidates scoring marks for the process of heating and cooling the sealed tube. The third mark was more problematic, with some omitting to consider or appropriately mention possible observations or providing vague comments like "note observations" or "record the position of equilibrium." The most able commented on possible colour changes and indicated uncertainty about which might be correct, as they did not know if the forward reaction was exothermic. A few suggested putting the tube in the kettle to boil, or thought there were 2 tubes (A and B), or added ice/ hot water into the tube.

(b) Compound **A** is a dark brown gas.

Compound **B** is a colourless gas.

Two molecules of **A** combine to form one molecule of **B** in a reversible reaction.

You are given

- a sealed glass tube containing an equilibrium mixture of **A** and **B**
- a beaker
- a kettle
- some ice

$A_2 \rightleftharpoons B$

At room temperature, the equilibrium mixture is a pale brown colour.

Devise an experiment to show how the position of equilibrium of this reaction is affected by temperature.

The sealed tube must **not** be opened.

(3)

boil some water using the kettle and pour into beaker and place the sealed glass tube into it. depending on wether the gas observed is colourless or wether its closer to dark brown shows wether the reaction is favoured to the left or right. If it is darker brown it favours the left side and if it favours the right side the gas will be a light brown or nearly colourless.

(Total for Question 5 = 10 marks)

take some water in a beaker with some ice and place the sealed test tube into it. and you would observe the opposite from the one that was in the boiling water.

ResultsPlus Examiner Comments

A very full answer (although the analysis of possible colour changes was not required).

(b) Compound **A** is a dark brown gas.

Compound **B** is a colourless gas.

Two molecules of **A** combine to form one molecule of **B** in a reversible reaction.

You are given

- a sealed glass tube containing an equilibrium mixture of **A** and **B**
- a beaker
- a kettle
- some ice

At room temperature, the equilibrium mixture is a pale brown colour.

Devise an experiment to show how the position of equilibrium of this reaction is affected by temperature.

The sealed tube must **not** be opened.

(3)

~~put~~ heat kettle to the desired tempeture you want then pour kettle water into beaker and place glass tube in and if change ~~bottom~~ colour the rate of equilibrium changes also do wait with ice so after experiment done ~~pt~~ clean equipment and do the test again but instead of kettle water use ice. ~~and~~

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Examiner Comments

This answer has some errors. The remark 'also do with ice' is not clear enough to score the mark.

Question 6 (b)(i)

The vast majority of candidates gained the first marking point, demonstrating a general understanding of the trend (although a few just repeated the data from the table). However, very many fewer achieved further marks as there was a lack of a clear explanation or vagueness in response. Errors included: ions have more energy to move at a higher current, using "voltage" instead of "current", talking about a faster rate of reaction. Few mentioned electrons or what happens when cations reach the cathode which was critical to an explanation.

(b) The student investigated the change in the mass of copper formed when the current was altered.

The results are shown in Figure 7.

current in A	mass of copper formed in g
0.0	0.000
0.2	0.040
0.4	0.080
0.6	0.118
0.8	0.158
1.0	0.196

Figure 7

(i) State and explain the trend shown in these results.

(3)

as current increases, the mass of copper formed also increases. This is because there is a better and higher flow of electrons so the copper is attracted to the cathode more, and it is deionised at a quicker rate so more copper will form.

ResultsPlus
Examiner Comments

Unfortunately, "deionised" is not the correct term. Otherwise, this answer shows understanding.

ResultsPlus
Examiner Tip

Learn the correct terminology – in this case, the copper ions are reduced.

(b) The student investigated the change in the mass of copper formed when the current was altered.

The results are shown in Figure 7.

current in A	mass of copper formed in g
0.0	0.000
0.2	0.040
0.4	0.080
0.6	0.118
0.8	0.158
1.0	0.196

0.120
0.160
0.200

(i) State and explain the trend shown in these results.

(3)

- increasing the current increases the mass of copper formed in g.

- increasing the current in A by 0.2 each time increases the mass of copper by about 0.040 each time.

ResultsPlus
Examiner Comments

This scores 1 for the trend.

ResultsPlus
Examiner Tip

Read command words. "State and explain" requires the trend (1 mark) and an explanation (2 marks) – this answer has no explanation as to why a higher current causes more mass of copper to form.

Question 6 (b)(ii)

Most candidates managed to gain the second marking point by identifying the need to measure the mass of the cathode after the experiment (although some simply stated to "measure" the cathode without explicitly referring to measuring its mass). Some incorrectly mentioned scraping off the copper from the electrode, which is a poor method to measure the mass. Few remembered the crucial step of drying the electrode before measuring its mass. Others suggested that the copper appears at the bottom of the beaker and needs to be filtered out as a precipitate of the reaction.

(ii) **Describe how, after the power supply has been switched off, the mass of copper formed can be measured.**

(2)

~~Remore the cathod~~ Measure initial mass of cathode before electrolysis. Remore cathode with copper and dry it. Measure final mass of cathode. Final - initial mass of cathode = mass of copper formed.

ResultsPlus
Examiner Comments

A clearly expressed answer, including the need to dry the electrode.

Question 6 (c)

Many candidates struggled to gain the first marking point, which involved converting milligrams to grams. Some were multiplying by 10 or 100 instead of dividing by 1000, but many left this step out. Candidates generally showed confidence in using standard form and multiplying by Avogadro's constant to attempt to calculate the number of atoms. Some candidates who had the correct calculations in their working still didn't obtain the right answer because they made errors when inputting values into their calculators (checking is highly recommended) whilst others omitted the power when writing the final answer.

(c) In another experiment, 74 mg of copper is formed.

Calculate the number of copper atoms in 74 mg of copper.

(relative atomic mass Cu = 63.5; Avogadro constant = 6.02×10^{23})

(3)

74 mg = 0.074 g

No. of particles = moles X (6.02×10^{23}) = 7.015×10^{20} (3 d.p.)

moles = 0.074 g ÷ 63.5 = 0.001165...

number of atoms = 7.015×10^{23} (3 d.p.)

ResultsPlus
Examiner Comments

This candidate has calculated the correct answer but unfortunately written down the wrong index on the answer line, so loses 1 mark.

(c) In another experiment, 74 mg of copper is formed.

Calculate the number of copper atoms in 74 mg of copper.

(relative atomic mass Cu = 63.5; Avogadro constant = 6.02×10^{23})

(3)

$\frac{74\text{mg}}{63.5}$ = 1.7 moles = 1.165354331   1.7 moles x (6.02×10^{23}) = 1.0234×10^{24}

number of atoms = 1.0234×10^{24}

ResultsPlus
Examiner Comments

The candidate has calculated 1.165... moles, but unfortunately has incorrectly rounded it to 1.7 moles.

Question 7 (a)(i)

The most common errors here were mixing up ammonia and ammonium.

7 Titration is used to carry out some neutralisation reactions.

(a) Ammonium nitrate can be made by neutralisation.

(i) State the name of the two reactants that are neutralised to make the salt ammonium nitrate.

(2)

ammonia and nitrogen .

ResultsPlus
Examiner Comments

Some candidates did not pick up the word 'neutralised' in the question.

ResultsPlus
Examiner Tip

For neutralisation, an acid and a base are required.

Question 7 (b)(i)

Many candidates struggled with reading the burette accurately. Common errors included not reading from the bottom of the meniscus and not being able to read to 0.05 cm^3 precision, or reading burette scale "upside-down". In the final answer, it was common not to provide the second decimal place.

(b) Titrations involve aqueous solutions and the use of burettes.

(i) Figure 8 shows readings on part of a burette at the start and at the end of a titration.

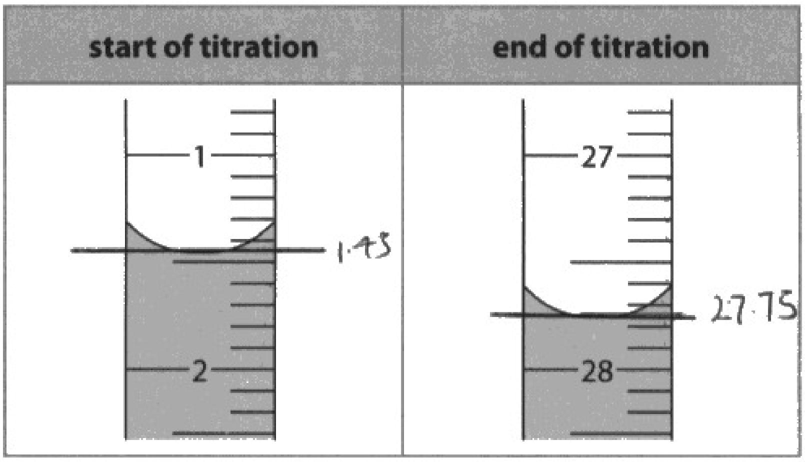

Figure 8

Calculate the volume of solution added from this burette.

Give your answer to a suitable number of decimal places.

(2)

27.75 - 1.45 = 26.3

volume = 26.3 cm^3

ResultsPlus
Examiner Comments

Correct reading, but second decimal place lost in answer.

(b) Titrations involve aqueous solutions and the use of burettes.

(i) Figure 8 shows readings on part of a burette at the start and at the end of a titration.

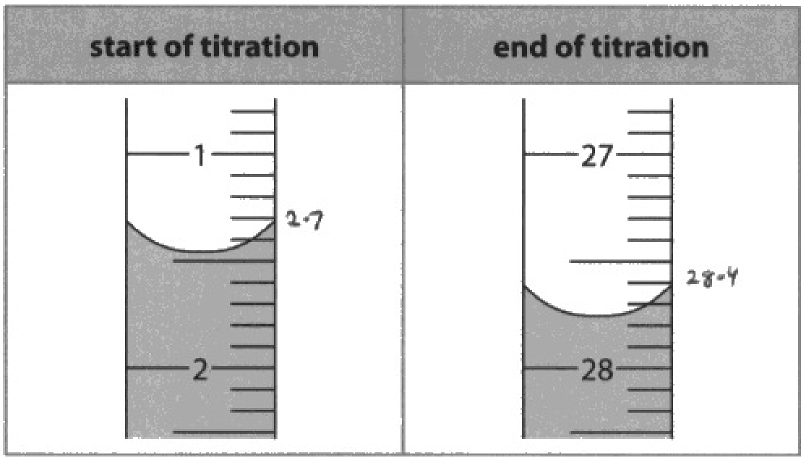

Figure 8

Calculate the volume of solution added from this burette.

Give your answer to a suitable number of decimal places.

(2)

28·4 – 2·7 = 25·7

volume = 25·7 cm^3

ResultsPlus
Examiner Comments

This candidate has read from top of meniscus and using scale backwards.

(b) Titrations involve aqueous solutions and the use of burettes.

(i) Figure 8 shows readings on part of a burette at the start and at the end of a titration.

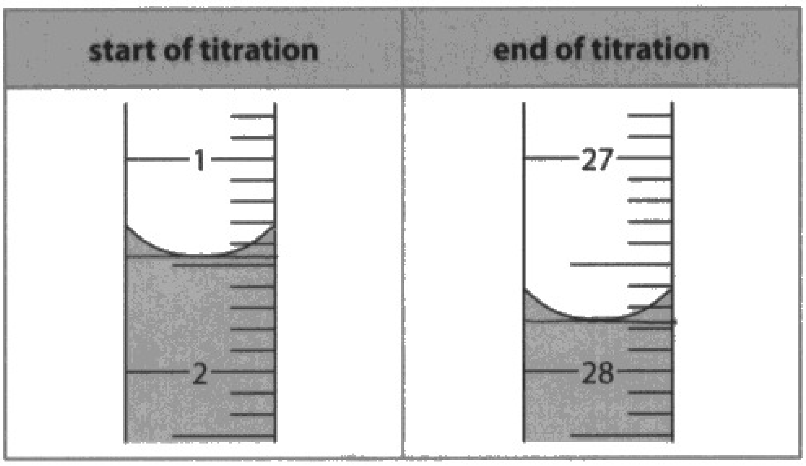

Figure 8

Calculate the volume of solution added from this burette.

Give your answer to a suitable number of decimal places.

(2)

volume of solution = 27.78 − 1.46

= 26.32

volume = 26.32 cm^3

ResultsPlus
Examiner Comments

This candidate is reading the scale with too much precision.

ResultsPlus
Examiner Tip

The 2nd decimal place is always 0 or 5.

Question 7 (b)(ii)

Only some candidates understood that concordant volumes are used to calculate a mean. The most common error was omitting only the rough titration from the mean.

(ii) A student carries out a titration four times.

The volumes from the student's results table are shown in Figure 9.

	rough	titration 1	titration 2	titration 3
volume in cm^3	25.90	24.90	24.60	25.00
used to calculate mean volume		✓	✓	✓

Figure 9

Tick the volumes that should be used to calculate the mean volume.

ResultsPlus
Examiner Comments

Only concordant results should be used to calculate the mean.

Question 7 (b)(iii)

It seems that there was a mix of confusion and misunderstanding among the candidates regarding the use of burettes. Many candidates failed to understand the specific requirements of the question and instead provided general improvements for a titration rather than focusing on improvements for the burette itself. Cleaning or rinsing the burette was the most frequently mentioned practice. Incorrect suggestions mentioned reading from the bottom of the meniscus, swirling the flask, not storing the burette in a cupboard, and filling the burette with a measuring cylinder or pipette. Candidates struggled with using the correct terminology to describe different parts of the burette, such as referring to the jet, graduation marks or tap inaccurately. It was clear that candidates did not pay attention to the diagram, and rarely addressed the specific points there, such as not filling the burette over 0 cm^3.

The student wrote a description of how they used the burette.

> I took the burette from the cupboard. I closed the tap and filled the burette with the correct solution. I added the solution from the burette drop by drop to the flask until the indicator changed colour.

Give **three** improvements to the way that the student used the **burette**.

(3)

1 use a white tile for easier spotting of colour change.

2 Fill the burette while its on the floor to remove risks of spillage.

3 rinse the burette before use to remove dust an inside.

ResultsPlus Examiner Comments

The candidate has not picked up information from the diagram. Additional points are given about the method of titration, but not use of the burette as required.

Question 7 (c)

Many candidates provided incorrect combinations of colours for the indicators used in the reaction. Some candidates mixed in incorrect colours or failed to mention the correct colours altogether. There were instances where candidates incorrectly stated a single colour change, such as pink to colourless, instead of considering both indicators.

(c) In a titration a student placed alkali in the flask.

By mistake a few drops of litmus **and** a few drops of phenolphthalein were added to the flask. blue → red pink → colourless

The student added acid to the flask until the mixture was acidic.

Predict the colour change that would be seen.

(1)

from .... purple .... to .... pink ....

ResultsPlus
Examiner Comments

It was not uncommon to give pink as the final colour.

(c) In a titration a student placed alkali in the flask.

By mistake a few drops of litmus **and** a few drops of phenolphthalein were added to the flask.

The student added acid to the flask until the mixture was acidic.

Predict the colour change that would be seen.

(1)

from .... pink .... to .... cla colourless. ....

ResultsPlus
Examiner Comments

This is the colour change for phenolphthalein, but has not considered the litmus.

Question 7 (d)

Some candidates believed that the addition of water would increase the titre volume, most likely stemming from the idea that water is being added, which would increase the overall volume of the solution in the flask. Others thought it would decrease the volume, because adding water would make the solution in the flask weaker. Some candidates recognised that distilled water has a pH of 7, which means it does not affect the required volume. Some even said that the neutral water would neutralise the liquid in the flask.

Question 8 (a)

Some candidates gave "salt" as a response here, and others "hydrogen". Some unwisely gave two products.

8 Crystals of copper sulfate are prepared by reacting copper oxide, a base, with dilute sulfuric acid.

(a) Name the other product of this reaction.

(1)

hydrogen

ResultsPlus
Examiner Comments

Not all candidates know the standard reactions of acids.

Question 8 (b)

Most candidates realised that some copper oxide would remain. Some provided incorrect descriptions of the observations, such as "fizzing stops". Some candidates suggested carrying out a pH test to determine if the solution is neutral, indicating a misunderstanding of the reaction. Many, however, did not indicate that the copper oxide sinking to the bottom of the beaker was due to the excess copper oxide present. They also often failed to state that the acid had reacted completely or had been neutralised.

(b) During the experiment, a spatula measure of copper oxide, a black powder, is added to warm, dilute sulfuric acid in a beaker.

When the mixture is stirred, the black powder disappears and the mixture turns pale blue.

The student then adds more copper oxide until the maximum amount of copper sulfate is formed without wasting copper oxide.

Explain how the student knows when to stop adding copper oxide.

(3)

When the copper oxide no longer reacts and just sinks to the bottom of the ~~flask~~ beaker. This indicates it is no longer reacting with the acid as all of the acid has reacted.

ResultsPlus
Examiner Comments

A reasonable answer not just saying that copper oxide is in excess – an 'explain' question requires a scientific explanation, not just description.

(b) During the experiment, a spatula measure of copper oxide, a black powder, is added to warm, dilute sulfuric acid in a beaker.

When the mixture is stirred, the black powder disappears and the mixture turns pale blue.

The student then adds more copper oxide until the maximum amount of copper sulfate is formed without wasting copper oxide.

Explain how the student knows when to stop adding copper oxide.

(3)

~~When they add~~ They will keep adding the copper oxide until the black solid appears at the bottom of the beaker. This is because copper oxide is in excess and has reacted completely with the ~~sul~~ sulfuric acid. This is when the student can stop adding copper oxide.

ResultsPlus
Examiner Comments

An answer scoring all 3 marks.

Question 8 (d)

This was generally well answered with candidates able to state that ions in a solution were able to move and occasionally that they did so randomly. They were also aware that ions in a solid don't move about or merely vibrate and/or are in a regular or lattice arrangement. Some forgot to discuss the solution.

(d) When some water is removed from the aqueous solution of copper sulfate, crystals of copper sulfate are made.

Describe how the arrangement and movement of the particles change as crystals are formed from a solution.

(3)

The particles in ~~the~~ aqueous solution are in random arrangement, they are ~~in~~ no fixed arrangement, however as crystals formed, the forces of attraction between the particles increase until the particles are in a regular lattice arrangement and only vibrate around a fixed point

ResultsPlus
Examiner Comments

This scores full marks as 3 of the 4 marking points have been stated.

ResultsPlus
Examiner Tip

The question asks for a description of arrangement AND movement. This answer omits the movement of the particles in solution. Make sure you cover all points.

Question 8 (e)

Many candidates did not recognise that there was no change in the oxidation state of copper in the reaction. Candidates should be encouraged to explain that oxidation and reduction involve the transfer of electrons as some still referred to oxidation in terms of the gain of oxygen or reduction in terms of the loss of oxygen in this question. A few candidates invented an additional option and stated that copper had been oxidised and then reduced, showing a misunderstanding of the concepts.

(e) In this reaction, copper oxide, CuO, forms copper sulfate, $CuSO_4$.

Explain, in terms of electrons, whether the copper in copper oxide has been oxidised, has been reduced, or has not been oxidised or reduced.

(2)

It was not been oxidised or reduced as it hasn't gained or lost electrons.

ResultsPlus
Examiner Comments

A well expressed, succinct answer.

Question 8 (f)

Most candidates were able to answer the question correctly. Some candidates lost marks due to incorrect rounding. For example, rounding the answer to 11.9. The most common incorrect answer was 39.875 divided by 0.3 resulting in 132.9. It is worth emphasising the importance of critically evaluating whether the obtained answer is realistic and consistent with the problem.

Question 9 (a)(i)

Careful counting was required, which most candidates managed. It was surprising that some did not put the atoms into a formula format (for example, giving 6C 2N.....)

9 (a) Figure 11 shows the structure of a molecule of compound **S**.

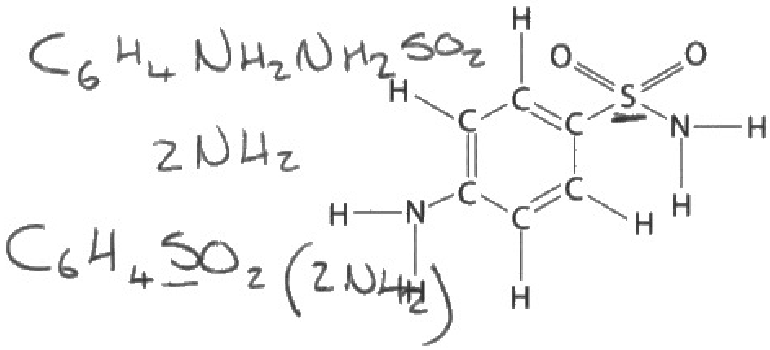

Figure 11

(i) Use Figure 11 to deduce the empirical formula of compound **S**.

(1)

$C_6H_4SO_2(2NH_2)$

ResultsPlus
Examiner Comments

Empirical formulae do not contain brackets.

Question 9 (a)(ii)

In general, candidates demonstrated a good understanding of the concept that purity of substances can be indicated by their melting points. However, some candidates lost marks by stating that impure substances have two different melting points instead of recognising a range of melting points due to impurities. Some candidates mixed up the letters A, B, and C, either missing one or writing one twice in their answers. Some candidates repeated data from the table without providing specific explanations or reasoning, or were writing about boiling points instead of melting points. Candidates attempted to explain the range of melting points by referring to different elements present in the substances. However, the question specifically mentioned substance S as a compound, which some candidates missed.

(ii) The melting points of three samples of **S** are shown in Figure 12.

sample	melting point in °C
A	160–164
B	166
C	163–165

Figure 12

State whether each of these samples, **A**, **B** and **C**, is pure or impure and justify your answers using the information in Figure 12.

(3)

B is pure as it only contains one element. A and C are impure as they contain more than one element with different melting points and characteristics.

ResultsPlus
Examiner Comments

The purity information for A, B and C is correct but the explanation is not.

Question 9 (b)

The majority of candidates performed well in this question. Those who did not, rearranged the expression incorrectly when calculating the Rf value. Some divided 2.4 by 0.22 instead of multiplying to calculate the distance.

Question 9 (c)

It was encouraging to see that a large number of candidates attempted the question well and achieved good scores. However, many misconceptions were seen. Some candidates incorrectly stated that NaCl had covalent bonds or strong intermolecular forces, while water had weak covalent bonds. While most identified distillation as the correct method for separating the mixture, many provided unfeasible setups or mentioned filtration, evaporation, or crystallisation instead or in addition to distillation. Some did not clearly express themselves or used ambiguous language when discussing bonding and separation methods.

*(c) A solution of sodium chloride in water needs to be separated to obtain a sample of pure, dry sodium chloride and a sample of pure water.

Figure 13 shows the boiling points of sodium chloride and water.

substance	boiling point in °C
sodium chloride	1465
water	100

Figure 13

Explain this difference in boiling points in terms of the structure and bonding of sodium chloride and water and how this difference is used to choose a method to separate sodium chloride solution into pure, dry sodium chloride and pure water.

(6)

Sodium chloride has a higher boiling point because it has more bonds and elements to break down than water. Water has less, weaker bonds in its solution.

ResultsPlus
Examiner Comments

This answer is of no merit. Note that it does not mention structure at all and does not specify a separation technique.

*(c) A solution of sodium chloride in water needs to be separated to obtain a sample of pure, dry sodium chloride and a sample of pure water.

Figure 13 shows the boiling points of sodium chloride and water.

substance	boiling point in °C
sodium chloride	1465
water	100

Figure 13

Explain this difference in boiling points in terms of the structure and bonding of sodium chloride and water and how this difference is used to choose a method to separate sodium chloride solution into pure, dry sodium chloride and pure water.

(6)

The sodium chloride is ~~covalently~~ Ionicly bonded together causing more ~~intermolecular~~ intermolecular forces to keep the sodium Chloride together. This attributes to the high boiling point as a larger amount of energy is required to overcome the bonds.

The water is covelantly bonded as it has a more simple Structure with less bonds holding the hydrogen and oxygen together, so the boiling point is quite low.

The large difference in boiling points helps to chose the method of Seperation as fractional distilation would be best to seperate them.

Once separated the sodium chloride would have to

be heated by a bunsen burner to remove excess
Solution and to dry it.

ResultsPlus
Examiner Comments

This answer has some correct information, but the description of the bonding and structure is not fully correct and complete. The separation technique is accepted, but there is no additional detail.

*(c) A solution of sodium chloride in water needs to be separated to obtain a sample of pure, dry sodium chloride and a sample of pure water.

Figure 13 shows the boiling points of sodium chloride and water.

substance	boiling point in °C
sodium chloride	1465
water	100

Explain this difference in boiling points in terms of the structure and bonding of sodium chloride and water and how this difference is used to choose a method to separate sodium chloride solution into pure, dry sodium chloride and pure water.

(6)

Sodium chloride is an ionic lattice with strong electrostatic gorces og attraction that require a lot og energy and heat to break so they have a high boiling point. Water is a liquid with simple covalent bonds but has weak molecular gorces og attraction which can be more easily overcome so it has a lower boiling point. This diggerence allows the use og distillation as the solution can be heated to 100°C where the water will evaporate into water vapour and be condensed and collected in another beaker and the sodium chloride is legt behind in the original beaker

ResultsPlus
Examiner Comments

A succinctly written response covering all aspects of the question, scoring full marks.

Question 10 (a)(i)

Reinforcing the idea that metals undergo oxidation reactions when exposed to oxygen and water would help with this part. Some candidates used imprecise terminology such as a metal "being eaten away" or "broken down", or worse, a metal being "corrosive".

10 (a) Buildings sometimes have water sprinklers to put out fires.

The pipes in some water sprinklers are filled with nitrogen gas to prevent corrosion when the system is not in use.

(i) State what is meant by the term **corrosion**.

(2)

it is irritation to the skin by a liquid like bleach, dangerous

ResultsPlus
Examiner Comments

Mixing up corrosion with corrosive.

Question 10 (a)(ii)

Some candidates performed very well in this part, and others – if they laid out their working clearly – could score part marks. Many struggled with converting between dm^3 and cm^3. Some attempted to find the moles of nitrogen using the mass of nitrogen (71g), which was credited if it followed through correctly. Others inverted or ignored the molar ratio in the equation. It is worth reminding candidates to maintain an excess of significant figures during calculations and only rounding the final answer.

(ii) Nitrogen can be made from sodium azide, NaN_3.

2 : 5

$$2NaN_3 \rightarrow 2Na + 3N_2$$

2 : 2 : 3

Calculate the maximum volume, in cm^3, of nitrogen produced from 110 g of sodium azide.

(relative formula mass: NaN_3 = 65;

1 mol of gas occupies 24 dm^3 in the conditions used)

(4)

mol = mass / Mr

1.7 = 110 / 65

1.7 × 24

40.8 dm³

×1000 = 40800 cm³

÷2 ×3 61200 cm³

dm³ → cm³

×1000

volume = 61200 cm^3

ResultsPlus
Examiner Comments

The candidate has rounded the number of moles correctly to 1.7. As the working is clearly set out, all the steps can be followed and full marks are awarded.

Question 10 (b)

Candidates generally understood the differences between alloys and pure metals, particularly in terms of strength and structure related to different sizes of atoms/ ions. However, there were several areas where candidates encountered difficulties. One key error was not covering all aspects of the question and failing to identify or explain a similarity between alloys and pure metals. Most that did chose electrical conductivity, although a common misconception was that alloys do not conduct electricity, overlooking the presence of delocalised electrons. Some candidates used incorrect terminology, such as referring to covalent bonding in metals or intermolecular forces in metallic bonding. While many mentioned properties and uses, some provided insufficient examples or did not sufficiently relate properties to uses.

*(b) Compare and contrast the properties and uses of pure aluminium and pure copper with the alloys of aluminium and the alloys of copper.

Include in your answer an **explanation** of the similarities and the differences in the properties and the uses of a pure metal and its alloy.

(6)

Pure aluminium has a regular lattice of positive aluminium ions surronded by a sea of delocalised electrons. Aluminium is very malleable because the regular structure allows layers to easily slide past each other when a force is added. This means that Al can be useful to make thin sheets of Al as a covering / foil. Al can also conduct electricity due to delocalised electrons that can flow

An alloy of aluminium is Magnalium which is a mixture of Aluminium and Magnesium atoms. The atoms are different sizes & so they make a disrupted structure / irregular. This makes it harder for layers to slide past each other so it is more stronger and less malleable. Can be used for ~~flat~~ uses such as aircrafts and to make strong structures. Magnalium has a sea of delocalised electrons that can flow so they can also conduct electricity.

Pure copper

Regular positive lattice of Cu^{2+} ions surrounded by a sea of delocalised electrons which can flow and carry charge → so they are a good conductive material.

Copper is ~~est~~ very malleable due to the regular structure so layers can easily slide past each other.

Uses for copper → electrical wiring

An alloy for copper is Brass made of copper and tin atoms. Layer s are distorted so it is harder for layers to slide past each other → they are less malleable.

Uses of Brass → piping, because of their strong properties and ~~statues~~ statues.

→ due to the different sized atoms.

ResultsPlus
Examiner Comments

This answer covers all aspects of the question – has explained a difference (strength) and a similarity (conductivity) and has given examples of uses. Full marks.

*(b) Compare and contrast the properties and uses of pure aluminium and pure copper with the alloys of aluminium and the alloys of copper.

Include in your answer an **explanation** of the similarities and the differences in the properties and the uses of a pure metal and its alloy.

(6)

Both aluminium and copper are strong metals.
They can both be found in the transition metals part of the periodic table.
~~Bo~~ Copper is very malleable, meaning it can easily be changed shape, making it suitable for things such as pipes.
However aluminium is not very malleable, so isn't suitable to be used for pipes.
Aluminium is more reactive than copper, which means it can not be used in some places involving acids.
The alloys of aluminium and copper are less stable than pure aluminium and copper, meaning they have much less uses.
They are different, as alloys have a lower melting point, and are not as shiny or as hard. This makes them look worse than the pure versions

and also act worse as they can be
melted much easier.

ResultsPlus
Examiner Comments

This answer only reached Level 1 because it gives a scattering of correct information only with no explanations of any similarities or differences.

Paper Summary

Based on their performance in this paper, candidates should:

- Write as clearly as they can as legibility was an issue raised by some examiners. Candidates should use precise and accurate language when describing scientific phenomena. Vague terms often lead to a loss of marks. It is important to explicitly mention key concepts and avoid generalisations.
- Learn how to accurately and fully describe the pattern in a graph using precise values.
- When performing calculations, candidates should pay attention to units, significant figures, and careful laying out of the working. Careless errors or incorrect rounding cost marks. Candidates should double-check their calculations and ensure consistency with the question's requirements.
- Particularly in 6-mark questions, candidates should ensure that they answer all aspects of the question.
- Pay careful attention to practical methods, including titration.
- Understand the energy changes involved in bond making and bond breaking.

Grade boundaries

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