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GCSE Combined Science 1SC0 1CH

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Introduction

Paper 1CH is the first of two Chemistry papers in the suite of six papers for Combined Science. The six questions in this paper are six of the ten questions in GCSE Chemistry Higher Tier Paper 1. The first two questions in this paper are also found towards the end of the equivalent Foundation Tier papers. There was no advanced information this session. Overall, candidates that did well this series attempted all the questions on this paper. They had a good understanding of the core practicals in the specification and were able to explain why specific parts of the method are carried out. They were able to apply their knowledge to unfamiliar situations and clearly explain themselves in their responses using the correct scientific language.

Question 1 (a)

The first question on the paper was based on a practical where calcium hydroxide was added to dilute hydrochloric acid. Candidates were asked what should be done after step 2 of the method given to make sure that any reaction is complete. A good proportion of candidates realised that the mixture should be mixed or stirred to gain the mark. Unfortunately, many candidates did not read the question carefully and thought that the calcium hydroxide should be left in excess, not appreciating that the steps 2 and 3 were repeated until the pH stops changing. Common incorrect answers that were not accepted were to wait for a set period of time or to add universal indicator.

1 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)

wait a few seconds or minutes for the powder to react.

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Examiner Comments

A common answer that did not gain credit.

1 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)

Mix the Solution together.

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Examiner Comments

Mix or stir the solution gained the mark.

Question 1 (b)

In question 1(b), a good proportion of candidates were able to give the products of the reaction between calcium hydroxide and hydrochloric acid as calcium chloride and water.

In some cases, candidates gave a more generic answer and stated salt and water, therefore scoring just one of the two marks available for water.

It was pleasing to see that of those that knew calcium chloride was the product, only a small proportion lost the mark for stating calcium chlorine rather than calcium chloride.

(b) Complete the word equation for the reaction.

(2)

calcium hydroxide + hydrochloric acid → Salt + water

ResultsPlus
Examiner Comments

This generic answer scored 1 mark for water.

(b) Complete the word equation for the reaction.

(2)

calcium hydroxide + hydrochloric acid → ~~[crossed out]~~ calcium chloride + hydrogen

ResultsPlus
Examiner Comments

A common error was to give hydrogen as a product rather than water. This answer therefore scored just 1 mark for calcium chloride.

(b) Complete the word equation for the reaction.

(2)

calcium hydroxide + hydrochloric acid → calcium chloride + water

ResultsPlus
Examiner Comments

A good answer that scored both marks.

Question 1 (d)(i)

The vast majority of candidates were able to read from the graph to give the pH of the acid at the start of the experiment.

Question 1 (d)(ii)

Despite the reading for the mass of calcium hydroxide being directly on a grid line, a noticeable percentage of candidates gave values other than 0.74 and so lost the mark.

Question 1 (d)(iii)

Candidates found explaining why the pH starts a low value and ends at a higher value moderately challenging with a small percentage gaining the full three marks available.

Those that did score the full three marks gave a comprehensive explanation that linked the rise to an increase in hydroxide ions. Many candidates scored for giving the allowable response that calcium hydroxide is an alkali.

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

(3)

PH starts at a low value because before adding the calcium hydroxide it was an acid with a strong acidic PH of 1. After adding the calcium hydroxide it made the PH increase because the calcium hydroxide turned the acid into a alkali.

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Examiner Comments

Many candidates repeated the stem of the question in their answer, which gains no credit. This example did score credit for stating that the acid has a pH of 1. There is no mention of neutralisation in the answer and adding the calcium hydroxide to acid alone was not considered sufficient to score as there needed be some reference to the acid reacting with the hydroxide or neutralisation for the second mark.

ResultsPlus
Examiner Tip

Candidates should be taught not to copy the stem of the question as part of their answer as no credit will be awarded and it wastes time in the exam and space for the rest of their answer.

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

(3)

As at the beginning the solution had a high concentration of H^+ ions, but as more OH^- ions were added, the solution started to become neutralised, thus making the pH ~~higher~~ neutral, after pH 7 there are more OH^- ions, making the pH higher than 7.

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Examiner Comments

This is a good answer that gained the full three marks for stating that there was a high concentration of H+ ions, that the solution was neutralised and that after pH 7 there were more OH – ions.

Question 2 (b)(i)

Question 2(b)(i) was generally well answered with many candidates scoring both marks for predicting the observations of the reactions of magnesium and iron with dilute hydrochloric acid.

Where candidates lost marks, it was often because they gave an incorrect observation for magnesium, stating that it would explode or there would be sparks or a flame.

In other cases where marks were lost it was often as candidates commented on the reactivity of the metal and did not give the 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 3.

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

Figure 3

(i) Use the information in Figure 2 and in Figure 3 to predict the observations for the reactions of magnesium and of iron with dilute hydrochloric acid.

(2)

magnesium

The magnesium lights + produces a glowing light and bubbles

iron

Bubbles are formed ~~stead~~ ~~and~~ at a steady rate

ResultsPlus
Examiner Comments

This example scored no marks. The inclusion of the incorrect observation for magnesium meant that the first mark point would not be scored. The observation of bubbles being formed at a steady rate matches the description for the reaction with zinc which is a more reactive metal and so no credit was awarded.

(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 3.

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

Figure 3

(i) Use the information in Figure 2 and in Figure 3 to predict the observations for the reactions of magnesium and of iron with dilute hydrochloric acid.

(2)

magnesium

vigerous bubbling at a rapid rate.
test tube feels hot.

iron

slight bubbling at an inconsistant rate.
test tube feels a little bit warm.

ResultsPlus
Examiner Comments

A good example that scored both marks. Either the test tube feels hot or vigorous bubbles would have scored for magnesium and the reference to slight bubbling gains the mark as this comparative description indicates less bubbling than the reaction with zinc.

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Examiner Tip

Candidates should be taught to read the question carefully, possibly highlighting or underlining key terms if it helps, to ensure they address what is asked for in the stem of the question. In this case, observations rather than stating if the metal is more or less reactive.

Question 2 (b)(ii)

In question 2(b)(ii), candidates were asked to describe the test for hydrogen. In general, candidates performed well in this question with the majority gaining both marks for stating that a lit splint would cause a squeaky pop. Where candidates did not score, it was often because they referred to a glowing splint rather than a lit splint or they simply referred to the squeaky pop test rather than describing the test.

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

Describe the test to show that the gas is hydrogen.

(2)

You place a lit splint into a test tube and if there is hydrogen present you will hear a squeaky pop.

ResultsPlus
Examiner Comments

A good answer that gained both marks.

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

Describe the test to show that the gas is hydrogen.

(2)

a glowing split makes squeaky pop.

ResultsPlus
Examiner Comments

Use of a glowing splint gains no marks.

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

Describe the test to show that the gas is hydrogen.

(2)

Squeaky pop.

ResultsPlus Examiner Comments

Stating squeaky pop alone does not score.

ResultsPlus Examiner Tip

When asked to describe a test, do not simply name the test. You should give the reagent or method for the test and the expected positive result of the test.

Question 2 (b)(iii)

Candidates performed well in this question, with a good proportion scoring both marks for balancing and adding the formula of hydrogen. Where candidates lost a mark, it was often as they gave the formula of hydrogen as 2H rather than H_2.

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

Complete the balanced equation for the reaction.

(2)

$Mg + 2HCl \rightarrow MgCl_2 + H_2$

mg -> 1
HCL = 2

mg -> 1
Cl -> 2

ResultsPlus
Examiner Comments

A good answer that scored both marks.

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

Complete the balanced equation for the reaction.

(2)

Mg + ...2..........HCl → $MgCl_2$ + ..2..H...........

ResultsPlus
Examiner Comments

A common answer that scored 1 mark for the balancing. 2H did not score.

ResultsPlus
Examiner Tip

Candidates should be familiar with the formula of the common compounds in the specification. They should also be familiar with the formula of the diatomic elements.

Question 2 (c)(i-ii)

Candidates performed well in these two questions about pH. A good proportion of candidates understood that an acid of pH 1 would have a concentration of hydrogen ions ten times greater than pH 2. The majority of those that scored the mark for part (i) often went on to score the mark in part (ii) also for correctly predicting the mass of hydrogen gas produced in the reaction with an acid of pH 1 as 0.05.

A common misconception in part (i) was that the concentration would be two times higher. Where candidates stated an incorrect value for part (i), error carried forwards was allowed and an answer of 0.01 scored the mark in part (ii)

(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 tiés 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 x10 = 0.005

mass = 0.005 g

ResultsPlus
Examiner Comments

In this example, the candidate scores the mark in part (i). In part (ii), although the calculation is correct, the evaluation is incorrect and so the mark is not awarded.

more

(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)

x10

(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 x 10 = 0.05

mass = 0.05 g

ResultsPlus
Examiner Comments

A good answer that scored both marks.

Question 3 (a)(i)

Candidates found writing the balanced equation for the reversible reaction challenging.

Candidates used the formula for ammonia given in the question, but often gave the formula for hydrogen as 3H or H_3. This meant two marks were lost as the balancing mark could only be awarded if the formulae of all three molecules was correct.

A large proportion of candidates were able to pick up at least one mark for the equilibrium sign which was marked independently.

3 (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)

$1N(g) + 3H(g) \rightleftharpoons 1NH_3$

ResultsPlus
Examiner Comments

This answer scored 1 mark only for the equilibrium sign.

3 (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

Although the candidate has the formula for hydrogen and ammonia correct, because the formula of nitrogen is incorrect the mark for the formula and the mark for the balancing could not be awarded. 1 mark was awarded for the equilibrium sign.

3 (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)

$N_2 + 3H_2 \rightleftharpoons 2NH_3$

ResultsPlus
Examiner Comments

A good answer that scored the full 3 marks available.

Question 3 (a)(iii)

Candidates found stating the purpose of iron in the Haber process quite challenging. Just under half of all candidates knew that it was there to act as a catalyst or to speed up the reaction, with many giving ideas about rusting, neutralisation or stabilising the reaction.

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

State the purpose of the iron.

(1)

To neutralize the reaction

ResultsPlus Examiner Comments

A common answer that did not score.

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

State the purpose of the iron.

(1)

To be used as a catalyst to speed up the rate of reaction

ResultsPlus Examiner Comments

Speed up the reaction or catalyst are both creditworthy responses and the answer scored 1 mark.

Question 3 (a)(iv)

Candidates found it challenging to explain how the position of equilibrium changes in the reaction between nitrogen and hydrogen if the temperature increases, with few scoring full marks.

Many candidates confused equilibrium conditions with Collison theory and rates of reaction, stating that the equilibrium would decrease or would be achieved slower or that equilibrium would not be achieved at all. This was often linked to collision of particles.

Where candidates did score, it was often for stating that the equilibrium moves to the exothermic direction.

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

The reaction gives out heat.

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

(2)

If temperature is decreased the [illegible] it will take more time for the reaction to reach dynamic equilibrium because temperature speeds up the rate of reaction.

ResultsPlus
Examiner Comments

A common answer that scored no marks.

(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 decreaced, the exothermic side is favoured, because the reaction will try to increase the temperature again, so that equilibrium is reached.

ResultsPlus
Examiner Comments

A good example of a response that scored two marks.

Question 3 (b)

Question 3(b) gave candidates an unfamiliar context and asked them to devise an experiment to show how the position of equilibrium of the reaction is affected by temperature.

Candidates were able to access the question well and many were able to describe a practical procedure using the equipment given in the question to achieve two marks. A small proportion also stated how they would know that the position of equilibrium had changed.

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

Compound **B** is a colourless gas. hydrogen?

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)

Place the glass tube inside a beaker that has some ice in it. This decrease in temperature will cause the equilibrium to shift and the mixture will become darker as the equilibrium has shifted to reactants, ~~where bonds are being~~ to create exothermic. Take out test tube and leave it until it returns to a pale brown colour at room temperature. After taking ice out of beaker, pour boiling water from kettle into the beaker. Place test tube back in beaker and temperature of mixture will increase. Equilibrium will shift ~~to~~ to products as it is trying to become endothermic, turning the mixture very pale brown or colourless. Note that at room temperature, the mixture is a pale brown.

(Total for Question 3 = 10 marks)

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Examiner Comments

A good answer, that scored 3 marks, that describes placing the glass tube in cold conditions and then in hot conditions and describes looking for the colour change in each condition.

(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)

Using kettle ~~[illegible]~~ boil up the water and place in beaker. Then get that and put the glass tube in and then pour ice in to show variation in temprature. Make sure to check temprature before and after adding ice in.

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Examiner Comments

In this example response, the candidate has described how to put the tube into hot and cold conditions. They have not, however, described how they would know if the position of equilibrium has changed and so scored 2 marks.

Question 4 (b)(i)

Candidates found Question 4(b)(i) difficult. Whilst the majority were able interpret the data in the table to state that as the current increases the mass increases, few were then able to give an explanation for the trend. For the explanation, many just repeated part of the trend again and stated that this was because more copper was formed, again some candidates tried to explain in terms of rate of reaction and more collisions.

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

The results are shown in Figure 4.

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 4

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

(3)

The trend in these results is that as the current increases the mass of copper formed also increases. This is because the increased current allows for more collisions to occur and therefore more copper can be formed.

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Examiner Comments

This response gained 1 mark for the trend.

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

The results are shown in Figure 4.

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 4

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

(3)

As the current increases so does the mass of copper formed. This is because the copper ions were moving faster and so where the electrons so the copper ions are gain electrons at a faster rate and the reduction reaction is occuring more frequently increasing the amount of copper forming

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Examiner Comments

In this example, the candidate scored the full 3 marks for stating the trend and then showing an understanding that the copper ions gain electrons at a faster rate gaining the second and third marking points in one.

Question 4 (b)(ii)

Candidates also found describing how the mass of copper formed in an electrolysis experiment difficult. Those that knew that the mass of the electrode should be measured very rarely knew that the electrode should be dried first.

A common misconception was that the copper would collect at the bottom of the beaker and so could therefore be filtered out.

Many candidates discussed scraping the copper off of the electrode. This scored no marks.

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

(2)

The mass of copper formed can be mesured through first using filtration to seperate the copper from the mixture. The copper can then be weighed which will tell us the total mass.

ResultsPlus
Examiner Comments

Filtering off the copper gained no marks. Although the candidate states that the copper should be weighed, as there is no reference to weighing the electrode this did not score.

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

(2)

Weigh the mass of both electrolytes to see how much one has lost and the other has gained.

ResultsPlus
Examiner Comments

This response gained no marks. Whilst there is reference to measuring the mass, unfortunately the candidate has stated to measure the mass of the electrolytes rather than the electrode.

Candidates should take care with the use of key terms, especially in subjects such as electrolysis where different terms which are very similar refer to different aspects of the topic area or practical, for example electrolysis, electrode, electrolyte and electrode.

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

(2)

measure the mass of the anode before, then after, the change will be the mass of copper.

ResultsPlus
Examiner Comments

Although the candidate refers to measuring the mass of the anode this was still allowed and one mark awarded for measuring the mass before and after.

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

(2)

By taking out the Copper electrodes and drying them to remove ~~water~~ any liquid. Then ~~using weighing scales~~ use weighing scales to weigh them and record the mass.

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Examiner Comments

A good answer that scored both marks.

Centres should ensure that candidates are carrying out core practicals in class and candidates should ensure that they are familiar with the methods and be able to explain, in terms of the chemistry, why different steps in the methods are carried out.

Question 4 (c)

Part (c) of question 4 asked candidate to calculate the number of copper atoms in 74mg of copper. Few candidates released that they needed to convert the mg to g and so few gained the full 3 marks.

A good proportion scored 2 marks for amount of copper and then multiplying by the Avogadro constant.

Where candidates scored just 1 mark, it was often because they calculated the number of moles then divided by the Avogadro constant rather than multiplying.

(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)

(M) = Mass / Relative atomic mass

= 74 / 63.5 = 1.16535 x (6.02 x 10^23)

= 7.015407 x 10^23

number of atoms = 7

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Examiner Comments

In this example, the candidate scored just 1 mark. They have not converted mg to g so do not gain the first marking point.

With error carried forward, the second mark for finding the amount of copper was awarded.

Unfortunately, the last mark could not be awarded, although the candidate has correctly multiplied by Avogadro's constant and evaluated it correctly, they have then given 7 on the answer line rather than 7 x 1023 and so have given two contradicting answers.

(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)

~~mass =~~

~~$0.074 \times 63.5 \times 6.02 \times 10^{23}$~~

$\frac{6.02 \times 10^{23}}{63.5}$ = 9 $\frac{0.074}{63.5}$ = 0.00116534 × 6.02×10^{23}.

74 mg → grams ÷1000 = 0.074 grams.

number of atoms = 7.02×10^{20}.

ResultsPlus
Examiner Comments

A good answer that scored all three marks.

(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)

$(74 \div 63.5) \times 6.02 \times 10^{23}$

$= 7.02 \times 10^{23}$.

number of atoms = 7.02×10^{23}.

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Examiner Comments

This example gained two marks. The candidate has missed the first mark only for not converting the amount of copper.

(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)

$74 \times 63.5 = 4699$

$4699 \times 6.02 \times 10^{23} = 2.828798 \times 10^{27}$

number of atoms = 2.828798×10^{27}

ResultsPlus
Examiner Comments

In this example, the candidate scored 1 mark. They have not converted the mass of copper to g and so did not gain the first marking point. They then multiplied the mass by the relative atomic mass rather than divided so did not gain the second marking point. With error carried forward, the last mark was scored for multiplying their answer by the Avogadro constant to gain the last marking point.

Question 5 (a)

Candidates found it hard to name the other product of the reaction between copper oxide and dilute sulfuric acid with a small proportion of the cohort gaining the mark for water.

In some cases, candidates did not read the question carefully and either gave the product as copper sulfate rather than the other product, water, or gave one of the reactants.

5 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)

water.

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Examiner Comments

This example scored the mark.

5 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)

copper oxide

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Examiner Comments

This example scored no marks as the candidate has given a reactant rather than a product.

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Examiner Tip

Take care that you read the question carefully and, if you have time, check through your answer to check that your answer makes sense with the question set.

Question 5 (b)

In another practical scenario, candidates found it hard to explain how the student would know when to stop adding copper oxide when making copper sulfate crystals with the minority scoring full marks.

Many candidates thought that the reaction would produce a gas and so therefore stated that they would stop adding the copper oxide when the fizzing stopped.

(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)

• the black powder is stirred into the mixture and dissolves
• more coppe oxide is added and the black powder stays at the bottom of the beake so all of the sulfuric acid has been reacted and coppe oxide is in excess so stops adding

ResultsPlus
Examiner Comments

This example gained all three marks. The candidate has a clear understanding of the practical stating that the copper oxide will stay at the bottom of the beaker and explains that this is because all the sulfuric acid has been used up because the copper oxide is in excess.

(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 it stops turning pale blue

ResultsPlus
Examiner Comments

A common answer that did not score was that the solution will no longer turn pale blue.

(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)

The copper oxide will no longer be dissolved. this is because there is no room in the mixture for more copper oxide to dissolve.

ResultsPlus
Examiner Comments

Some candidates stated that the copper oxide would no longer 'dissolve'. This was allowed and one mark awarded.

ResultsPlus
Examiner Tip

Centres should ensure that candidates are carrying out core practicals in class and candidates should ensure that they are familiar with the methods and be able to explain, in terms of the chemistry, why different steps in the methods are carried out.

Question 5 (d)

Candidates were generally able to describe how the arrangement and movements of the particles changes as crystals are formed from a solution. However, some candidates tended to focus on the arrangement and movement of the particles in the solid but not the solution therefore limiting their mark to two out of the three available marks. A noticeable number of candidates went on to talk about evaporation and the arrangement and movement of particles in a gas as well. This did not contradict any marks already awarded, but did mean that time was lost on this part as it was not necessary to answer the question.

(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 ageuos solution has liquid like structure so the particles can flow on one another and are arranged in a random order. However when the crystal is formed, the particles are arranged in order and a lattice structure of rows. These particles vibrate on a fixed point.

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Examiner Comments

This good answer scored three marks. The candidate states that the particles are arranged in a random order when in solution and that, when the crystal forms, the particles are lattice or rows, either of which could have scored, and they vibrate around a fixed point.

Question 5 (e)

Candidates found it challenging to explain if the copper oxide had been oxidised or not with very few scoring full marks. Candidates found it hard to comprehend that the copper would be neither oxidised or reduced with many stating that the copper had been oxidised and had lost electrons.

A number of candidates seemed to think that the fact that there is only one oxygen in CuO, but four in CuSO4, indicated oxidation had occurred. In other cases, there seemed to be a belief that the Cu2+ ion was only formed when the CuSO4 formed and hence electrons were lost during the reaction. For those candidates scoring both marks the idea of no loss or gain of electrons was given much more often than the idea that the charge or the copper ion had not changed.

Many identified the OILRIG pneumonic; few were able to correctly apply it.

(e) In this rection, 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.

Cu– share 5   Cu(s) share 2

(2)

Copper oxide form copper sulfate which is a reduction which means it gains electrons from the sulfer

Ox is Loss Red is gain

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Examiner Comments

This answer scored no marks.

(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)

The copper oxide has been Oxidized, it has lost an electron.

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This answer scored no marks.

(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 has neither Oxidised or reduced because it was an ionic compound before the reaction (CuO) and after the reaction ($CuSO_4$) So no electrons have been lost or gained.

ResultsPlus Examiner Comments

A good answer that scored both marks.

(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 has not been oxidised or reduced, as it hasnt lost or gained oxygen. Reduction is gain of electrons and oxidation is loss of electrons.

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Examiner Comments

This example scored 1 mark. The candidate states that copper has not been oxidised or reduced to gain the first mark. They go on to state that the copper has not lost or gained oxygen – the question asks for the explanation in terms of electrons and this was ignored. The candidate then gives the definitions of reduction and oxidation in terms of electrons, but doesn't actually state that copper has not lost or gained electrons, so the second mark was not awarded.

Question 5 (f)

In the last part of question 5, candidates were asked to calculate the mass of copper sulfate that was dissolved in a solution. A good proportion were able to calculate this correctly. Where candidates lost the mark, it was generally because they divided rather than multiplied the concentration by the volume.

(f) In another experiment, a copper sulfate solution with a concentration of 39.875 g dm^{-3} is used.

Calculate the mass of copper sulfate dissolved in 0.300 dm^3 of this solution.

(1)

39.875/0.300 = 132.92 166667

= 132.92

mass = 132.92 g

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Examiner Comments

The candidate has divided the concentration by the volume rather than multiply and so scored no marks.

(f) In another experiment, a copper sulfate solution with a concentration of 39.875 g dm^{-3} is used.

Calculate the mass of copper sulfate dissolved in 0.300 dm^3 of this solution.

(1)

$\frac{0.3}{39.875}$ = 0.00752...

= 0.008

~~$\frac{39.875}{0.300}$ = 132.916~~

~~= 132.92g~~

mass = 0.008 g

ResultsPlus
Examiner Comments

The candidate has divided the volume by the concentration rather than multiply and so scored no marks.

(f) In another experiment, a copper sulfate solution with a concentration of 39.875 g dm^{-3} is used.

Calculate the mass of copper sulfate dissolved in 0.300 dm^3 of this solution.

(1)

39.875 x 0.300 = 11.9625

mass = 11.9625 g

ResultsPlus
Examiner Comments

A good answer which scored the mark.

Question 6 (a)(i)

Candidates found it challenging to give the empirical formula of the molecule shown, with many simply listing elements and giving the numbers of atoms present rather than giving their answer as an empirical formula.

6 (a) Figure 5 shows the structure of a molecule of compound **S**.

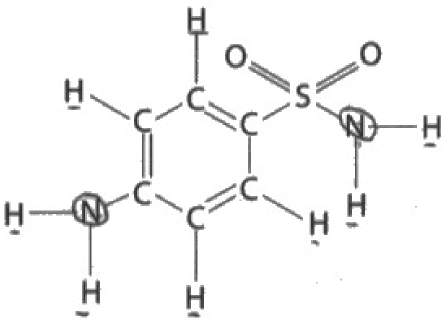

Figure 5

(i) Use Figure 5 to deduce the empirical formula of compound **S**.

(1)

$C_6H_8N_2SO_2$

ResultsPlus
Examiner Comments

A good answer which gave the answer as an empirical formula to gain the mark.

6 (a) Figure 5 shows the structure of a molecule of compound **S**.

2 O = 32
2 N = 28
6 C = 72 + = 140
8 H = 8

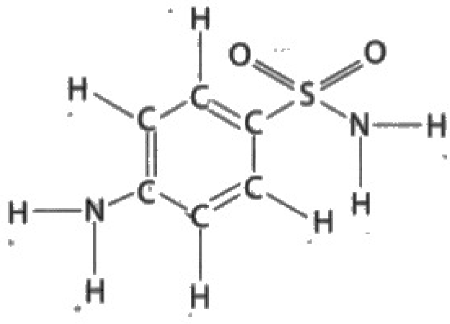

Figure 5

(i) Use Figure 5 to deduce the empirical formula of compound **S**.

(1)

140 ....

ResultsPlus
Examiner Comments

Some candidates were clearly unsure what empirical formula meant and added up the numbers rather than giving a formula, as in this example which scored no marks.

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Examiner Tip

It is important that candidates know the different types of formula that they could be presented within an exam and what is meant by each.

6 (a) Figure 5 shows the structure of a molecule of compound **S**.

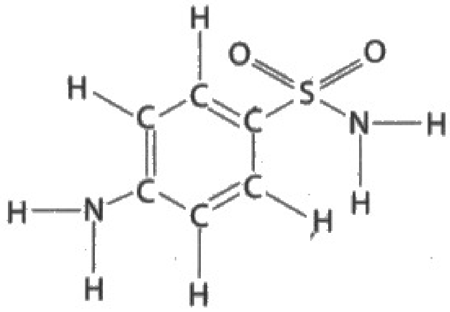

Figure 5

(i) Use Figure 5 to deduce the empirical formula of compound **S**.

(1)

$SC_6H_8N_2O_2$

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Examiner Comments

Symbols for elements were allowed in any order, as in this example which scored the mark.

6 (a) Figure 5 shows the structure of a molecule of compound **S**.

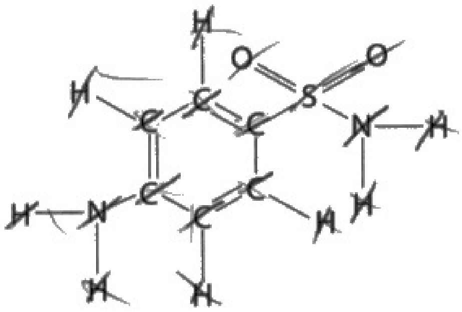

Figure 5

Carbon
Hydrogen
Nitrogen
oxygen
sulfur

(i) Use Figure 5 to deduce the empirical formula of compound **S**.

(1)

6carbon, 8Hydrogen 2Nitrogen 2Oxygen, sulfur

ResultsPlus
Examiner Comments

Candidates who simply listed the elements and numbers present did not score as this is not an empirical formula.

Question 6 (a)(ii)

Candidates found it fairly straightforward to state which of the three substances were pure or impure. Most candidates were then able to show an understanding that pure substances have a fixed melting point and impure substances melt over a range of temperatures.

Some candidates had problems articulating this final point and it was often not clear if they thought impure substances have multiple melting points as opposed to melting over a range.

In some cases, candidates were not clear with their justifications describing the melting points as ‘accurate’ or ‘precise’, these terms were ignored.

Another common error was where candidates wrote correctly about ‘B’ and then in next sentence wrote ‘A and B’ instead of ‘A and C’ – a clear example of rushing and not reading their own answer.

(ii) The melting points of three samples of **S** are shown in Figure 6.

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

Figure 6

State whether each of these samples, **A**, **B** and **C**, is pure or impure and justify your answers using the information in Figure 6.

(3)

A → impure, has a range of melting points and so must contain ~~[illegible]~~. a mixture of elements.
B → pure, has a fixed melting point, only contains one element.
C → impure, range of melting points, can be seperated by chemical processes because its a mixture, does not have a fixed composition.

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Examiner Comments

A good, well-presented answer, that scored the full 3 marks.

Question 6 (b)

Part (b) of question 6 was generally well answered with a good proportion of candidates being able to calculate the distance the spot of compound s moves as 0.528.

A common incorrect answer was 10.9, where candidates had divided the distance moved by the solvent front by the Rf value. Candidates should have thought twice about this answer as it is more than 1.

(b) A scientist uses chromatography in an investigation of compound **S**.

In the conditions used, compound **S** has an R_f value of 0.22.

Calculate the distance the spot of compound **S** moves if the solvent front has moved by 2.4 cm.

(2)

R_f value = $\frac{\text{distance moved by dye}}{\text{distance moved by solvent front}}$

$0.22 = \frac{\text{dye}}{2.4}$

$0.22 \times 2.4 =$ d by dye

$= 0.528$

distance = 0.528 cm

ResultsPlus
Examiner Comments

A good answer that scored both marks.

(b) A scientist uses chromatography in an investigation of compound **S**.

In the conditions used, compound **S** has an R_f value of 0.22.

Calculate the distance the spot of compound **S** moves if the solvent front has moved by 2.4 cm.

(2)

$\frac{0.22}{2.4}$ = 0.091666

↳ 0.092 = 0.09

distance = 0.09 cm

ResultsPlus
Examiner Comments

The candidate has divided the Rf value by the distance the solvent front had moved and so scored no marks.

(b) A scientist uses chromatography in an investigation of compound **S**.

In the conditions used, compound **S** has an R_f value of 0.22.

Calculate the distance the spot of compound **S** moves if the solvent front has moved by 2.4 cm.

(2)

2.4 ÷ 0.22 = 10.9

distance = 10.9 cm

ResultsPlus
Examiner Comments

This answer scored no marks as they have divided the distance moved by the solvent front by the Rf value.

ResultsPlus
Examiner Tip

Candidates should be aware that the Rf value must be less than one as the spot cannot move further than the solvent.

Question 6 (c)

The last question on the paper was a 6-mark question with a levels-based mark scheme. Candidates were asked to explain the difference in boiling points of sodium chloride and water and to choose a method to separate the sodium chloride solution into pure, dry sodium chloride and pure water.

It was pleasing to see that the vast majority were able to access the question well and make a good attempt at an answer.

When discussing the difference in boiling points, many candidates referred to NaCl having stronger bonds than water or water having weaker covalent bonds than NaCl's Ionic bonds. However, the covalent bonding and intermolecular forces were frequently seen when describing sodium chloride also.

The most successful candidates clearly linked the correct bond type to the energy needed to break the correct bonds/forces.

The underlying principles behind the separation technique and the ability to articulate this was an issue for many candidates. Candidates that knew that Distillation could be used to separate the sodium chloride and water often lacked knowledge of the names of apparatus used in the process.

Many candidates failed to address that both pure water and pure, dry sodium chloride were wanted at the end of the process, so evaporation and crystallisation were often seen instead of distillation.

In some cases, instead of separating the saltwater mixture, some candidates attempted to separate the elements of sodium chloride and then hydrogen and oxygen from water.

*(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 7 shows the boiling points of sodium chloride and water.

substance	boiling point in °C
sodium chloride	1465
water	100

Figure 7

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 formed by an ionic bond. Ionic bonds are bonds form by the loss and gain of ~~electrons~~ ions between a metal atom and a non-metal atom. These bonds are held together by strong electro-static forces which is the attraction of two ~~negat~~ oppositely charged ions. These bonds form a regular arrangement or pattern of ions which forms a structure called the lattice structure. Ionic compounds have very strong electrostatic forces keeping the ions bonded, these forces are very strong and hard to overcome, they require huge amounts of heat and energy. Hence, having a high melting and boiling point. This is why sodium chloride has a boiling point of 1465.

Water is formed by covalent bonds between hydrogen and oxygen atoms. Covalent compounds are formed by the sharing of pair of electrons between atoms. Covalent atoms are also strong bonds formed by the attraction of negatively charged electrons and the atom's nucleus. However, between the molecules of covalent compounds, there are weak intermolecular bonds holding the molecules together. These

Forces are discrete and weak. They require less energy to overcome their bonds. Hence, they have low melting and boiling points. This is why water has a

ResultsPlus
Examiner Comments

In this example response, the candidate has given a very good explanation of the difference in boiling points between sodium chloride and water.

However, they have not explained how you could separate a mixture of the two and so cannot move into Level 3.

*(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 7 shows the boiling points of sodium chloride and water.

substance	boiling point in °C
sodium chloride	1465
water	100

Figure 7

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 covelent bonds in water are easily broken down when heated up, this means it has a ~~low~~ low boiling point. The boiling point of sodium chloride is high due to it having strong intermolecular forces of attraction. Sodium chloride has a giant lattice structure so is hard to break down. ~~It~~ They can be seperated using crystalisation. A method where the water is extracted from the solution, leaving behind pure, dry crystals of sodium chloride.

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Examiner Comments

In this example response, the candidate stated that the bonds in water are covalent.

They go on to say that sodium chloride is high because it has strong intermolecular forces of attraction and that it has a strong lattice structure – the lattice part is true, and can be credited.

They state that they can be separated using crystallisation which is incorrect and ignored.

The answer therefore scores 2 marks for two basic facts about the two substances.

*(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 7 shows the boiling points of sodium chloride and water.

electrostatic – ionic —

covalent – weak intermolecular forces.

substance	boiling point in °C
sodium chloride	1465
water	100

Figure 7

Explain this [redacted] terms of the s[redacted] sodium chloride and water and how this difference is used to c[redacted]o separate sodium chloride solution into pure, dry sodium chloride and pure water.

(6)

Sodium chloride has a high boiling point as it is an ionic bond. An ionic bond is a bond between a metal and a non-metal. The bonds are held by electrostatic forces ~~tt~~ and are extremely strong so need high temperatures to break them. Water is a covalent bond made up of weak intermolecular forces which can be easily broken. This is why the boiling point is 100°c. ~~To seperate sodium chloride, simple distillation can be used~~, A covalent bond is when non-metals share pairs of electrons. To seperate sodium chloride, simple distillation can be used, making sure to heat the solution ~~[illegible]~~ until the temperature reaches 100°c. This will evaporate the water ~~and~~ ~~t~~ passing through a condenser which will turn it back into liquid. That will be pure water. The sodium chloride ~~[illegible] to cool to dry.~~ is now pure as the water has been removed. It can now be left to ~~dry~~ cool and dry.

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Examiner Comments

In this example response, the candidate has given an explanation of the boiling points of sodium chloride and water and how to separate the two using distillation.

Full credit in Level 3 was awarded.

Paper Summary

Based on their performance on this paper, candidates should:

- Ensure that they are familiar with formula of common elements and compounds in the specification and know which elements are diatomic.
- Ensure that they are familiar with the core practicals in the specification.
- Ensure that they are familiar with common laboratory equipment names and uses and equipment specific to core practicals.
- Try to use a methodological approach when asked for description of a practical or part of an experiment.
- Take care with key terms such as electrolysis, electrode, electrolyte and electrode.
- Learn to use information from the stem of the question to inf orm answers.
- When working through calculation questions, try to use a logical approach when setting out working.
- When calculations are required, ensure that working is shown so that intermediate marks and error carried forward can be applied where necessary.

Grade boundaries

Grade boundaries for this, and all other papers, can be found on the website on this link:

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