Qualification Accredited

Oxford Cambridge and RSA

GCSE (9-1)

Examiners' report

TWENTY FIRST CENTURY SCIENCE COMBINED SCIENCE B

J260

For first teaching in 2016

J260/06 Summer 2024 series

Version 1

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Contents

Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates.

The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. A selection of candidate answers is also provided. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report.

A full copy of the question paper and the mark scheme can be downloaded from OCR.

Paper 6 series overview

J260/06 is the higher tier paper for the chemistry unit for the GCSE (9-1) Combined Science B (Twenty First Century Science). The paper covers all of the chemistry content of the specification.

To do well on this paper candidates need to have a good all-round knowledge and to be able to apply it in a structured and logical sequence.

They need to have experienced a range of practical techniques and be able to both recall them and to apply them to unfamiliar experiments.

They need to have a range of basic mathematical skills and the ability to follow a logical sequence in multi-step calculations.

Candidates were well prepared and most were able to complete all the questions, showing that all topics had been covered. Candidates often struggled to express themselves in longer written responses.

Most candidates were able to complete all the questions and there was no evidence of issues with time management.

More candidates showed their working in calculations although some need more encouragement to structure this a bit more.

Assessment for learning

Candidates should be helped to understand why each stage of a practical is carried out as this will help them to remember the stages and adapt them as necessary to answer a specific question. The use of videos of practicals are useful to reinforce learning but should be used in addition to hands-on practical work and expert demonstrations.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• used a logical sequence to complete multi step calculations. **Questions 1 (c), 2 (f), 9 (a) (iii)** • had a good understanding of practical techniques and the ability to adapt them to less familiar experiments. **Question 2 (a)** (measuring techniques), **6 (a)** (titration), **9 (b) (i)** (collection of gases) • were able to plan responses to longer questions in order to meet key points. **Question 6 (b)** (titration LoR), **7 (b) (ii)** (rates of reaction • could construct equations and half equations from given information. **Question 4 (c) (i)** (ionic equations), **7 (c)** (balanced symbol equations, **9 (b) (iv)** (half equations).	• did not successfully distinguish between ions and atoms etc. **Question 9 (a) (ii)** (redox) • had little understanding of practical techniques • manipulated data for a response but without addressing the needs of the question **Questions 1 (c), 2 (f), 9 (a) (iii)** • struggled with the use of standard form **Questions 1 (a) (i), 1 (a) (ii), 3 (b).**

Question 1 (a) (i)

1

(a) **Table 1.1** shows the diameters of some particles.

Table 1.1

Particle	Diameter (m)
Carbon atom	1.54×10^{-10}
Fullerene molecule	1.10×10^{-9}
Silver atom	2.88×10^{-10}
Platinum nanoparticle	1.00×10^{-8}

(i) Which **two** particles have diameters with the same order of magnitude?

.... and .... **[1]**

For this question, most candidates understood that the particles with same order of magnitude are those with diameters to the same power of 10 and so chose carbon and silver.

Question 1 (a) (ii)

(ii) Write down the particles in order of diameter.

Smallest ....

↓ ....

↓ ....

Largest ....

[2]

Again, in this question, candidates were able to give the particles in order of increasing size. Some gave them in the reverse order and some had carbon and silver the wrong way round.

Question 1 (b)

(b) Nanoparticles make effective catalysts because they have a high surface area to volume ratio.

Table 1.2 shows the surface area to volume ratio of some different sized particles.

Table 1.2

	Nanoparticle	**Particle of Fine Powder**	**Particle of Coarse Powder**
Size of Particle (nm)	60	600	6000
Surface Area to Volume Ratio	0.1	0.01	0.001

Describe the relationship between the size of a particle and its surface area to volume ratio.

....

....

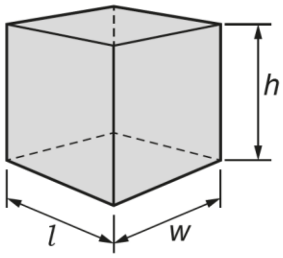
....

.... **[2]**

Most candidates understood that as particle size increased, the surface to volume ratio decreased with some going on to quantify the change as increasing and decreasing by a factor of ten. Some quoted numbers from the table without commenting on their significance.

Question 1 (c)

(c) The nanoparticle shown is a cube. This nanoparticle has a volume of 1000 nm^3.



NOT TO SCALE

Calculate the surface area of the nanoparticle.

Use the formula: surface area = 6 × (h × w)

Surface area = ... nm^2 **[3]**

Those candidates who used the given volume of the cube to calculate the height, width, and depth as being 10nm were usually successful in calculating the surface area as 600nm^2. Some candidates thought that the 6 quoted in the formula for surface area was the length and so used 6 for width and height also.

Question 2 (a)

2 A student is investigating the reaction between calcium hydroxide and hydrochloric acid.

$Ca(OH)_2(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + 2H_2O(l)$

(a) They want to find the temperature change during the reaction.

1 g masses of solid calcium hydroxide are added one by one to 50 cm^3 of dilute hydrochloric acid in a plastic cup.

Describe **two** measurements the student needs to make **and** the apparatus needed to make the measurements.

1. ....

....

2. ....

....

[2]

In this question candidates were expected to use their practical knowledge to identify measurements needed in this unfamiliar experiment. Measurements needed were temperatures (before and after additions of solid), the mass of the solid and the volume of the acid, all of these could be taken from the method given. Some answers did not make it clear what was being measured, for example, the amount or concentration of the acid rather than the volume. A few chose measurements not needed in this experiment, such as time.

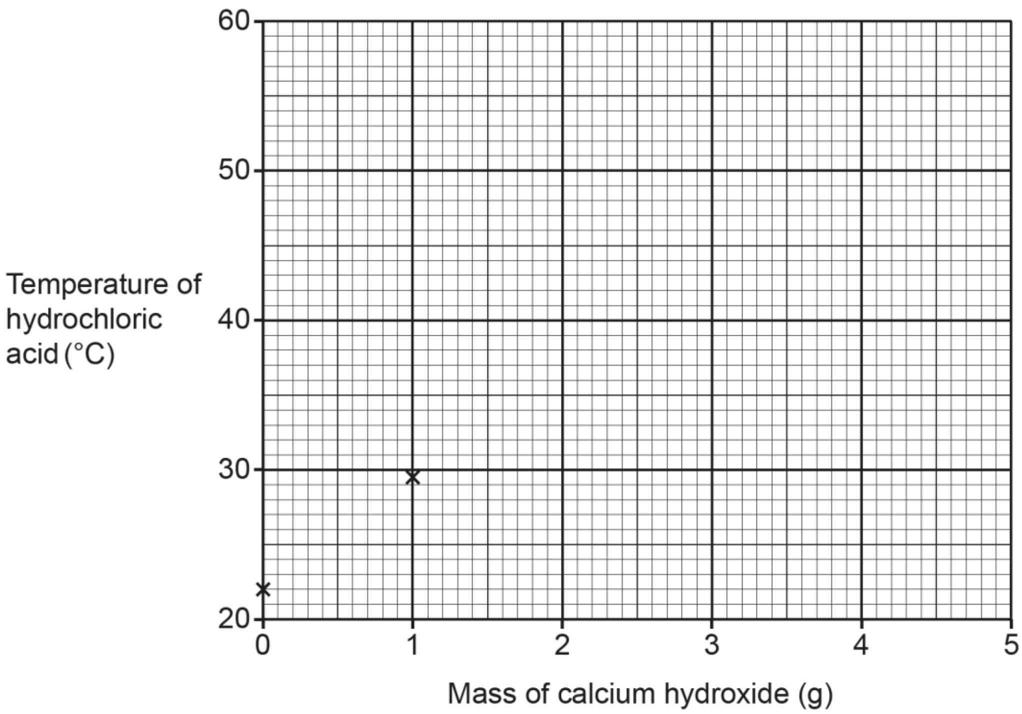
Question 2 (b), (c) and (d)

(b) The table shows the student's results:

Mass of calcium hydroxide (g)	Temperature of hydrochloric acid (°C)
0	22.0
1	29.5
2	37.0
3	44.5
4	52.0
5	59.5

Plot the results from the table on the graph.

Two points have already been plotted. **[2]**



(c) Draw a line of best fit. **[1]**

(d) Which relationship describes the graph?

Put a (ring) around the correct option.

y = mx **$y = mx^2$** **y = mx + c** **y = mx – c** **[1]**

Almost all candidates plotted the points correctly for Question 2 (b) and most went on to plot a good line of best fit for Question 2 (c). Most lines were well drawn using a pencil and ruler. The most common error in drawing the line of best fit was to draw it from the point 20,0 instead of 22,0. In Question 2 (d), most candidates correctly identified y = mx + c as the relationship describing the graph, the most common error was to choose y = mx.

Question 2 (e)

(e) Calculate the **change** in temperature if 3.8 g of calcium hydroxide is added to the hydrochloric acid.

Use the graph.

Temperature change = ... °C **[2]**

Candidates were expected to understand that it was the change in temperature that was required for this question. Most candidates were able to use the graph to find the temperature after the addition of 3.8g of solid and some went on to subtract the initial temperature to find the temperature change.

Question 2 (f)

(f) Calculate the change in thermal energy when 3.8 g of calcium hydroxide is added to 50 cm^3 of hydrochloric acid.

Use the formula:

Change in thermal energy (J) = 4.2 × temperature change (°C) × mass of hydrochloric acid (g)

1 cm^3 hydrochloric acid = 1.02 g

Change in thermal energy = ...J **[3]**

Candidates could successfully substitute their value for temperature change into the formula given. The most common error was to use 50g as the mass of hydrochloric acid instead of 51g obtained by calculating it from the given density.

Question 3 (a)

3 Atoms are made up of a small nucleus containing protons and neutrons. The rest of the space contains electrons.

(a) Complete the table to show the relative masses and charges of the three particles in the atom.

Particle	**Relative Mass**	**Relative Charge**
Proton	....	....
Neutron	....	....
Electron	....	....

[3]

Most candidates knew some of the relative masses and charges of the atomic particles with some good answers recalling them all. Some answers for relative charges were incomplete, showing just + for protons and – for electrons. A common error in the relative masses was to show neutrons as 0 and/or electrons as 1.

Question 3 (b)

(b) A student builds a model of an atom.

They use a tennis ball with a diameter of 6.7 cm to represent the nucleus in the model.

The diameter of an atom is 1×10^5 times bigger than the diameter of its nucleus.

Calculate the diameter of the model of the atom.

Give your answer in **m**.

Diameter of model = ...m **[2]**

The strongest candidates converted the diameter of the ball from cm to m and then multiplied by the number of times that an atom is bigger than its nucleus. Some either did not do the conversion or multiplied by 10 to get m rather than dividing. Others divided by the number of times that an atom is bigger than its nucleus instead of multiplying.

Question 3 (c)

(c) The number of protons, neutrons and electrons in an atom or an ion can be calculated using the atomic number and relative atomic mass of the element.

Complete the table to show the number of each particle present in a phosphorus atom and a sodium ion.

Use the Data Sheet.

	Phosphorus atom, P	**Sodium ion, Na^+**
Number of **Protons**	....	....
Number of **Neutrons**	....	....
Number of **Electrons**	....	....

[3]

The use of atomic number and relative atomic mass to calculate the number of atomic particles in atoms was well known. Calculating the number of electrons in a positive ion was less well known with some assuming it was the same as for an atom and some that the positive ion had an extra electron. A few thought that the number of neutrons was the same as the relative atomic mass instead of the difference between the relative atomic mass and the atomic number.

Question 3 (d)

(d) The properties of elements depend on the electron arrangements of their atoms.

The electron arrangement of magnesium is 2.8.2.
The electron arrangement of fluorine is 2.7.

Explain why magnesium is a metal and fluorine is a non-metal.

....

....

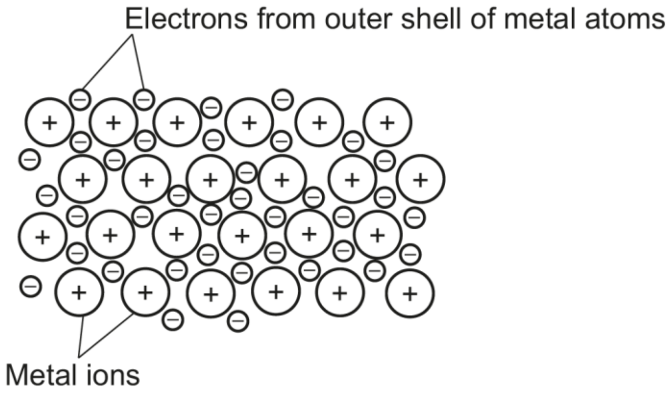
....

.... **[2]**

There were some detailed answers explaining that magnesium is a metal because it reacts by losing electrons and that it has a small number of electrons in its outer shell, while fluorine is a non-metal because its outer shell of electrons is almost full. Many answers identified the loss or gain of electrons without going on to explain why. Some said that metals were on the left of the Periodic Table and non-metals on the right without using the electron arrangements to explain why.

Question 4 (a)

4 The diagram shows the structure of a metal.



(a) Explain why metals are good electrical conductors, malleable, and have high melting points.

Good electrical conductors ....

....

Malleable ....

....

High melting points ....

....

[3]

There were some excellent responses which used the structure given to explain the properties of metals. These identified the particles present in metals and the way they behave as the reason for these properties, i.e. good electrical conductivity due to the presence of moving electrons, malleability due to the sliding of layers/ions and high melting points due to attraction between ions and electrons, with electrical conductivity being the most well-known. Some did not know what malleability was and discussed bending or strength. Many knew that high melting points meant strong forces of attraction but did not go on to relate this to the structure of metals.

Misconception

Many candidates continue to use the term intermolecular forces when discussing attractions between particles even when there are no molecules present.

Question 4 (b)

(b) A student does some experiments to find the reactivities of some metals.

In one experiment, they add a piece of magnesium to a blue aqueous solution of copper ions.

They see a reddish metal formed and the blue solution fades to colourless.

$Mg(s) + Cu^{2+}(aq) \rightarrow Cu(s) + Mg^{2+}(aq)$

Explain how this reaction shows that magnesium is more reactive than copper.

....

....

....

.... **[2]**

The best responses linked reactivity of metals with ease of loss of electrons and explained that the equation showed that magnesium lost electrons more readily than copper. Some referred to magnesium gaining electrons and copper losing them. Many did not refer to electrons at all, only referring to displacement with no indication how this explained the difference in reactivity.

Question 4 (c) (i)

(c) The table shows the student's results from the other experiments:

	$Cu^{2+}(aq)$	$Fe^{2+}(aq)$	$Mg^{2+}(aq)$	$Ag^{+}(aq)$
Cu(s)		No change	No change	Change
Fe(s)	Change		No change	Change
Mg(s)	Change	Change		Change
Ag(s)	No change	No change	No change	

(i) Write a **balanced ionic equation** for the reaction between solid copper and aqueous silver ions.

.... **[2]**

Good responses used the information in the table to identify the correct symbols, including charges, for the relevant atoms and ions and went on to put these into a balanced equation. Many just guessed the charges on the ions, often just giving a single positive charge on both ions. A few thought that the symbol for silver was Fe.

Question 4 (c) (ii)

(ii) Write down the metals in order of reactivity.

Most reactive ....

....

....

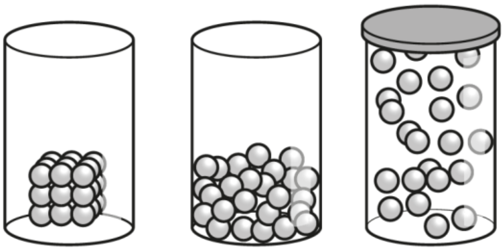
Least reactive ....

[2]

Most candidates placed the metals in a correct order of reactivity. Some had them in the opposite order and a few used ions instead of the elements.

Question 5 (a)

5 The particle models for the different states of matter are shown.



Solid Liquid Gas

(a) State **two** limitations of the particle model.

1. ....

....

2. ....

....

[2]

A wide range of limitations of the particle model were accepted here. Some weaker responses were too vague e.g. does not show what the particles actually look like. Others described what the models did show rather than what they did not.

Question 5 (b)

(b) The table gives some information about the movement and arrangement of particles for the different states of matter.

Complete the table.

	Movement of Particles	**Arrangement of Particles**
Solid	....	1 Regular 2 Close together
Liquid	....	1 Random 2 ....
Gas	Move in all directions	1 .... 2 ....

[4]

The best responses used the information given to describe the information required. Some lost marks for incomplete information, e.g. solids are fixed or do not move, with no reference to vibration. Many thought that liquid particles are far apart.

Question 5 (c)

(c) Explain why heating a solid causes it to change state.

....

....

....

.... **[2]**

Candidates were expected to understand what changes to the particles occurred during a change of state and explain this either by increased kinetic energy of the particles leading to more movement or by energy supplied causing bonds to break leading to greater separation of particles. Some described the change in movement or separation of the particles without explaining why this happened.

Question 5 (d)

(d) Sulfur dioxide has a melting point of –73 °C and a boiling point of –10 °C.

What is the state of sulfur dioxide at 20 °C?

.... **[1]**

Most candidates correctly identified that state of sulfur dioxide at 20 °C as being a gas. A small number thought it was a solid.

Question 6 (a)*

6 A student wants to find the concentration of a sodium hydroxide solution. They do a titration using sodium hydroxide solution and 0.010 mol / dm^3 dilute hydrochloric acid.

(a)* Describe how the student can **accurately** find the concentration of the sodium hydroxide solution, using these solutions.

Include an explanation of **how** this method gives high quality data.

....

....

....

....

....

.... **[6]**

Many candidates understood the basic idea of a titration and described adding one solution to a fixed volume of the other until an 'end point' was reached and then reading the volume added, although some did not include the addition of an indicator. Better responses included extra details such as the names of suitable apparatus, swirling the mixture during additions, standing flask on a white tile and the use of a rough reading and repeats. To achieve the higher levels there needed to be some explanation as to how the method gives high quality data and many candidates did not attempt this part of the question. The most common points made by those who attempted it were swirling to ensure mixing, use of a white tile to help identify colour change, adding drop by drop to avoid missing end point and the use of repeats.

Some candidates had no knowledge of a titration method, with a few writing about an entirely different practical such as chromatography.

Assessment for learning

Candidates can only achieve the higher levels in Level of Response questions if they cover all the items required in the question. They should be encouraged to do a rough plan of important things to cover before they start writing

Exemplar 1

To accurately find the concentration of the sodium hydroxide solution, the student would have to use the equipment with the closest increments. The student should then add the acid ~~8th~~ drop by drop and use an indicator such as methyl orange. As soon as the indicator changes colour, the student should stop dripping the acid. Repeat the experiment 5 times and record a mean to make the results as accurate as possible. **[6]**

Although this candidate has not covered all the possible details of the titration method, this response is enough to fully achieve a Level 2, 4 marks. If they had gone on to explain some reasons why the method gives good quality data, then it would have been a Level 3 response.

Question 6 (b) (i)

(b) The table shows the student's results.

Titration	**1**	**2**	**3**	**4**	**5**
Volume of Acid Added (cm^3)	**27.2**	**25.4**	**25.3**	**25.2**	**25.2**

(i) Why is the first reading much higher than the others?

....

.... **[1]**

Most candidates knew that the first reading was a rough reading, although why this would give a much higher reading was less well known. The best answers referred to the idea that subsequent readings would have a rough idea when to stop and so could add the acid more slowly when nearly there. Answers saying that the student had gone past the colour change were also acceptable.

Question 6 (b) (ii)

(ii) Calculate the mean volume of acid which reacts with the sodium hydroxide solution.

Give your answer to **1** decimal place.

Mean volume of acid = ... cm^3 **[3]**

There were some good answers where the candidate understood that they should take the mean of only the four readings that were close together. Many used all five, often even when they had identified the first reading as being a rough reading. A few candidates did not round their answer to one decimal place.

Question 6 (b) (iii)

(iii) The student's teacher states that the volume of the hydrochloric acid needed to react with the sodium hydroxide should be **25.8** cm^3.

Explain what the student's results show about the accuracy and precision of their experiment.

Accuracy ....

....

Precision ....

.... **[2]**

The difference between accuracy and precision was not well understood with answers often being reversed. Some responses included a suitable comparison but omitted to say whether this meant accuracy/precision was good or bad.

Exemplar 2

Accuracy The students results are fairly accurate. They are 0.1 cm^3 out. This is because of their first titration.

Precision The students results are precise as they are all within 0.2 cm^3 of each other, other than titration 1 which is not precise or accurate. **[2]**

This response shows that the candidate has understood the difference between accuracy and precision. They have compared the student's mean value with the stated actual volume and related that to accuracy. They have gone on to compare the values of the different readings and showed they understood that close values indicate a good precision. This response received 2 marks.

Question 7 (a) (i)

7 Ammonia is made from nitrogen and hydrogen.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

(a)
(i) Define this symbol $\rightleftharpoons$.

.... **[1]**

Most candidates recognised the symbol as representing a reversible reaction. A few thought that it was an equilibrium.

Question 7 (a) (ii)

(ii) Explain why reactions like this **never** give a 100% yield.

....

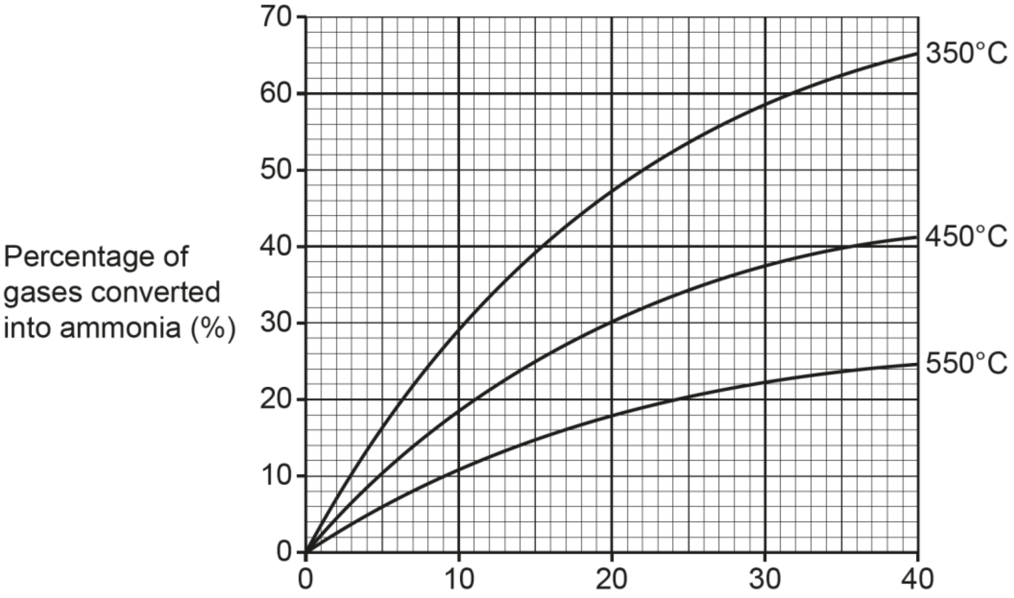
.... **[1]**

Many candidates understood that a reversible reaction never achieves a 100% yield because products will be reacting to go back to reactants, although some struggled to explain this. A common error was to say that gases were lost to the atmosphere.

Question 7 (b) (i)

(b) The conditions of the reaction are carefully chosen to produce the best yield as quickly as possible.

The graph shows the effect of temperature and pressure on the yield of ammonia.



(i) Complete the table to show the effect of changing the conditions on yield and rate of reaction.

Use words from the list.

Increase	**Decrease**	**No Effect**

	Effect on yield	**Effect on rate of reaction**
Increasing the Temperature	....	Increase
Increasing the Pressure	....	Increase
Using a Catalyst	....	....

[4]

Most candidates knew that catalysts increase the rate of reaction and many were able to use the graph to predict the effect of temperature and pressure on the yield of this reaction.

Question 7 (b) (ii)

(ii) Explain why the rate of reaction increases when the temperature and pressure are increased.

Temperature ....

....

....

....

Pressure ....

....

....

.... **[4]**

Most candidates explained that increasing the temperature led to an increase in the kinetic energy or speed of the particles. While some went on to explain that this increased the successful collisions, others just referred to the frequency of collisions.

Many candidates understood that increasing the pressure led to more particles in a given volume or that the particles would be closer together but some just wrote that there would be more particles. Good responses went on to relate this to increased frequency of collisions but many just wrote that there would be more collisions. A few thought that increasing the pressure would affect the energy or speed of the particles.

Question 7 (c)

(c) Ammonium sulfate, $(NH_4)_2SO_4$, is used by farmers as a fertiliser.

Ammonia gas is bubbled into dilute sulfuric acid, H_2SO_4, to form an aqueous solution of ammonium sulfate.

Write a **balanced symbol equation** for the reaction.

Include **state symbols**.

.... **[2]**

Many candidates did not know the formula for ammonia and so were unable to produce a suitable equation. Responses including incorrect formula for sulfuric acid and ammonium sulfate were common, in spite of them being given in the question.

Assessment for learning

When writing equations, candidates should be encouraged to start by using those formulae given in the question to form part of the equation and then to complete it either from their knowledge or by looking earlier in the question. Once all the correct formulae are in place, then they can access marks for balancing and/or state symbols. Again, with state symbols, they should look for clues given in the questions such as references to aqueous solutions or gases.

Question 8 (a) (i)

8 Acids react with some metal compounds to form salts.

(a) **Table 8.1** shows the reactants and products of some of these reactions.

Table 8.1

Acid	Metal Compound	Salt Formed
Hydrochloric acid	Sodium hydroxide	Sodium chloride
Sulfuric acid	Copper oxide	....
....	Calcium carbonate	Calcium nitrate

(i) Complete the table. **[2]**

Most candidates were able to name the acid and the salt formed from the given substances. Copper sulfide instead of copper sulfate was seen frequently and some thought nitric acid was nitrate acid.

Question 8 (a) (ii)

(ii) Complete the **word equation** for the reaction between hydrochloric acid and sodium hydroxide.

Hydrochloric acid + sodium hydroxide → sodium chloride + ...

[1]

The production of water in the reaction between acids and alkalis was not well known with many candidates choosing hydrogen as the second product.

Assessment for learning

When attempting to answer this type of question by recall, candidates often confuse the products of acids reacting with alkalis and acids reacting with metals. They should be encouraged to use information given to help with this, and the acronym M.A.S.H (metal + acid, salt + hydrogen) may also be helpful. In this case seeing what is left from the acid and the alkali when the salt forms should help them to realise that it cannot be hydrogen as there is some oxygen from the alkali.

Question 8 (b) (i)

(b) **Table 8.2** shows the H^+ concentration and pH of different concentrations of dilute hydrochloric acid.

Table 8.2

Concentration of $HCl(aq)$ (mol/dm^3)	Concentration of $H^+(aq)$ (mol/dm^3)	pH
0.1	1×10^{-1}	1
0.01	1×10^{-2}	2
0.001	1×10^{-3}	3

(i) Describe the relationship between H^+ concentration and pH shown in **Table 8.2**.

....

....

....

.... **[2]**

Most responses described how the pH increases as the hydrogen ion concentration decreases. Some went on to add detail by adding that as the hydrogen ion concentration decreases by a tenth, the pH goes up by one unit.

Assessment for learning

Candidates need practice in looking for extra detail when analysing data, using the number of marks available in the question as a guide.

Question 8 (b) (ii)

(ii) What is the pH of 0.0001 mol/dm^3 dilute hydrochloric acid?

.... **[1]**

The link between pH and acid concentration was well known with most correctly giving 4 as the pH for 0.0001mol/dm^3 hydrochloric acid.

Question 8 (c) (i)

(c) A student does an experiment to find the pH of different concentrations of dilute ethanoic acid, CH_3COOH.

Universal Indicator paper is dipped into a test-tube of each of the solutions.

(i) Describe how the student finds the pH using this test.

....

.... **[1]**

There were some good descriptions of the use of a colour chart to find pH using Universal Indicator. Many showed that they understood how the indicator worked by linking colour to pH but then did not go on to say how the colour could be matched to a specific pH.

Question 8 (c) (ii)

(ii) The results of the experiment are shown in **Table 8.3**.

Table 8.3

Concentration of CH_3COOH(aq) (mol/dm^3)	**pH**
0.1	3
0.01	3
0.001	4

Describe how the student can change their method to get pH measurements correct to **1** decimal place.

....

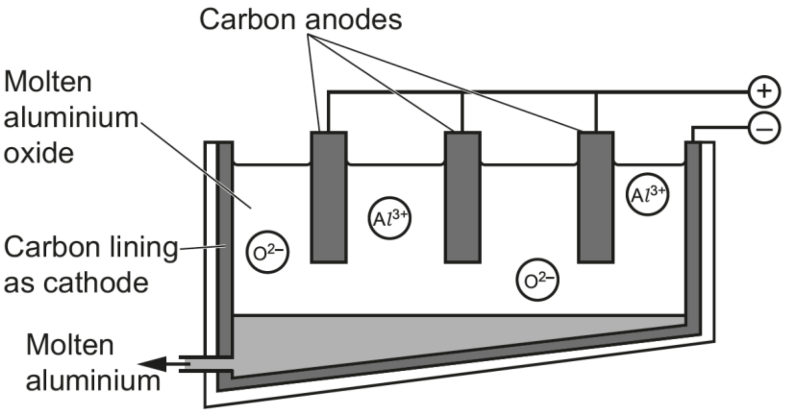
.... **[1]**

Candidates were expected to identify a pH meter/probe as the way to increase the number of decimal places that the pH can be measured to. Many decided to change the concentration of the acid.

Question 9 (a) (i)

9 Electrolysis is the decomposition of ionic compounds using electricity.

(a) Aluminium is extracted from molten aluminium oxide by electrolysis.



(i) Explain why the electrolysis must use **molten** aluminium oxide, and **not** solid aluminium oxide.

.... **[1]**

Most candidates understood that the reason that molten aluminium oxide is needed for electrolysis was to do with electrical conductivity although many did not explain why molten aluminium oxide is a better conductor than as a solid . There were some good responses saying that the ions could only move in liquids. Some only explained that the ions in liquid can move without comparison with a solid ; a few discussed movement of electrons instead of ions.

Question 9 (a) (ii)

(ii) The **half equations** show the reactions at the electrodes.

$Al^{3+} + 3e^{-} \rightarrow Al$

$2O^{2-} \rightarrow O_2 + 4e^{-}$

What is oxidised and what is reduced during the electrolysis of aluminium oxide?

Explain your answer.

Oxidised ....

Reduced ....

Explanation ....

....

[3]

Most candidates understood that oxidation is loss of electrons and reduction is gain and so correctly deduced which half equation involved which type of change. Most were not specific enough about what is actually changing and answers of aluminium instead of aluminium ions for oxidation and oxygen instead of oxide ions were seen frequently.

Misconception

? This confusion about identifying a species undergoing a change is very common. Candidates should be aware that they need to be clear whether the species they are identifying is an ion or not.

Question 9 (a) (iii)

(iii) This is the balanced symbol equation for the decomposition of aluminium oxide by electrolysis:

$$2Al_2O_3 \rightarrow 4Al + 3O_2$$

Calculate the mass of aluminium that will be produced when 100 g of aluminium oxide is used.

Give your answer to **3** significant figures.

Relative atomic masses: Al = 27.0 O = 16.0.

Mass of aluminium produced = ... g **[4]**

There were some very well explained and successful calculations where candidates clearly used the formula masses of aluminium and aluminium oxide in order to find the mass of aluminium produced. Some used the ratio of reacting masses while others used moles. Others clearly understood what they needed to do but made errors with ratios from the equation. Most candidates showed some working but with some this was just a jumble of numbers with no sequence of stages shown. Also, most candidates showed they understood significant figures.

Assessment for learning

Now that candidates are usually showing some working, they would find it more helpful to add a few words to remind them what they have found e.g. 'M_r =' or 'mass of ….='. This will help them to decide on the next stage of the calculation.

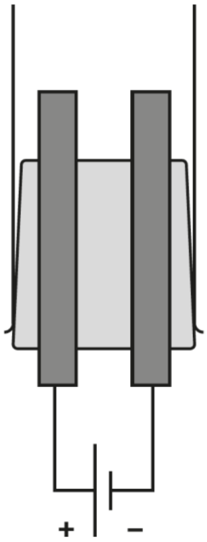
Candidates should also be encouraged to look at the question again after they have finished a calculation to check whether or not specific numbers of significant figures/decimal places are required.

Question 9 (b) (i)

(b) When aqueous sodium sulfate is electrolysed the products are hydrogen gas and oxygen gas.

(i) Complete the diagram to show how the gases can be collected by electrolysis of aqueous sodium sulfate.

Include labels.



[3]

Many candidates misinterpreted the diagram, assuming that the bung shown was the electrolyte and credit was given for understanding that the electrodes need to be dipping in the electrolyte for electrolysis, providing that it was clearly labelled. A few candidates understood that gases should be collected by inverted test tubes of water, either from having seen this process or from their knowledge of methods of collecting gas. Some used their knowledge to suggest the use of a gas syringe although it wasn't always clear how it would be attached to the apparatus.

Question 9 (b) (ii)

(ii) The ions present in aqueous sodium sulfate are Na^+, SO_4^{2-}, H^+ and OH^-.

State where the H^+ **ions** and OH^- **ions** come from.

.... **[1]**

Some candidates understood that the hydrogen and hydroxide ions come from the water of the aqueous solution. Some did not relate this to the solution given and said that hydrogen ions come from acid and hydroxide ions from alkali. A few suggested they came from the electrodes.

Question 9 (b) (iii)

(iii) Explain why hydrogen is formed instead of sodium.

....

.... **[1]**

The best answers clearly understood that the more reactive the element, the less likely it was for its ions to gain electrons and turn to the element and so explained that hydrogen is less reactive than sodium. Some did not consider which ions would produce elemental sodium or hydrogen and so tried to explain using incorrect ions.

Question 9 (b) (iv)

(iv) Complete the table to show where hydrogen gas and oxygen gas are formed **and** the **half equations** for the reactions occurring at each electrode.

Electrode	Product	Half Equation
Anode (+)		
Cathode (–)		

[3]

Candidates who read the question carefully understood that the choice of products was oxygen and hydrogen gases only and most got these the correct way round. Many quoted ions as the products formed at the electrodes with hydrogen ions and hydroxide ions being most frequent. Candidates do find writing half equations challenging but a few good answers were seen.

Assessment for learning

Writing half equations is a challenging skill. Candidates should be encouraged to break the answer down in stages. For example for the production of hydrogen, write down the reactant as H^+ and the product as H_2, balancing and adding electrons should then seem much less daunting.

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