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Examiners' report

GCSE

COMBINED SCIENCE A (GATEWAY SCIENCE)

OCR Level 1/Level 2 GCSE (9-1) in Combined Science A (Gateway Science)

J250

For first teaching in 2016

J250/09 Summer 2025 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 responses 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 Teach Cambridge.

Paper 9 series overview

Candidates performed well on this paper, generally scoring higher than in the previous session of examinations. Improvements were seen in many areas, demonstrating good subject knowledge and exam technique.

The multiple choice questions were generally well scoring with very few common errors across the range of questions.

The Level of Response question was very well answered with a significant number of candidates giving well-structured answers, scoring highly.

Intermolecular forces remains an area where candidates find it challenging to use simple language to express their ideas, often confusing overcoming forces with breaking bonds.

Candidates have made improvements on describing trends in data, balancing equations and calculating bond energies in comparison to previous series.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• understood indicators and their purpose • could identify the correct separation technique to use in different situations • described trends in data effectively • had a good understanding of atomic structure • could balance symbol equations • could explain exothermic reactions • could calculate bond energies • could explain the process of electrolysis • could calculate reacting masses.	• struggled to correctly draw the particle arrangement of a liquid • had difficulty determining the structure of a material based on its properties • made errors in drawing correctly positioned electrons in a dot and cross diagram, particularly ensuring the correct number of electrons in each shell of a covalently bonded molecule • were unable to clearly explain boiling points using ideas about structure and bonding, particularly intermolecular forces • were unable to clearly explain how formulae are constructed to have a molecule with no overall charge • were unclear about the role of the anode and cathode in attracting anions and cations, as well as the reactions taking place at each electrode

Section A overview

The multiple choice section was well answered with only a few questions giving incorrect answers. There were only a small number of noticeable patterns to the incorrect responses. This section scored better than in previous sessions. Students gave the appropriate time to the questions and working out or calculations were common practice across the papers for the questions that required it. This was pleasing to see.

Question 1

1 Which statement describes a **pure** substance?

A A mixture of substances which melts at a single temperature.

B A mixture of substances which melts over a range of temperatures.

C One substance which melts at a single temperature.

D One substance which melts over a range of temperatures.

Your answer ☐ **[1]**

Almost all candidates scored this mark.

Question 2

2 Which row describes the **nucleus** of an atom?

	Charge	Mass
A	positive	contains little of the mass of the atom
B	positive	contains most of the mass of the atom
C	negative	contains little of the mass of the atom
D	neutral	contains most of the mass of the atom

Your answer ☐ **[1]**

Where incorrect answers were given, D was the common choice showing a misunderstanding of the charge of the nucleus.

Question 3

3 Which substance is made from rings of carbon atoms?

A Carbon monoxide

B Copper carbonate

C Graphene

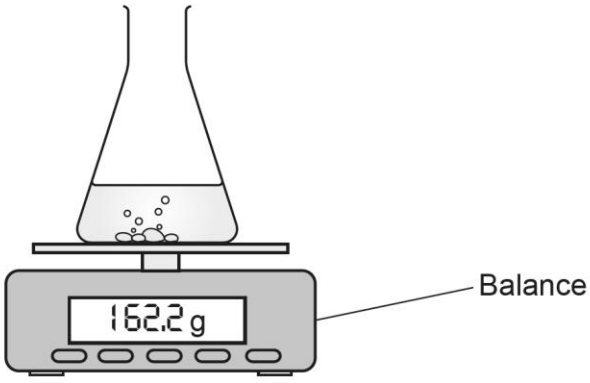
D Poly(ethene)

Your answer ☐ **[1]**

Generally well answered

Question 4

4 The diagram shows a chemical reaction.



During the reaction the mass on the balance **decreases**.

Which state symbol describes the **product** that causes the mass to decrease?

A aq

B g

C l

D s

Your answer ☐ **[1]**

Generally well answered

Question 5

5 Which statement about how Mendeleev arranged his version of the Periodic Table is **incorrect**?

A He arranged elements in order of atomic number.

B He arranged elements with similar properties in groups.

C He left gaps for undiscovered elements.

D He swapped the order of pairs of some elements.

Your answer ☐ **[1]**

Generally well answered, but when an incorrect answer was given, D was the answer usually chosen.

Question 6

6 Which of these is a **cation**?

A Cl^-

B He

C I_2

D Na^+

Your answer ☐ **[1]**

Generally well answered

Question 7

7 A student performs a chromatography experiment on a mixture of dyes.

The solvent moves 8.0 cm up the chromatography paper.

The R_f value for one dye is 0.60.

What distance does this dye move up the chromatography paper?

A 4.0 cm

B 4.8 cm

C 6.0 cm

D 7.2 cm

Your answer ☐ **[1]**

Generally well answered

Question 8

8 The reaction of iron, Fe, with copper ions, Cu^{2+}, can be written as two half equations.

$Fe \longrightarrow Fe^{2+} + 2e^-$

$Cu^{2+} + 2e^- \longrightarrow Cu$

Which species is **oxidised**?

A Cu

B Fe

C Cu^{2+}

D Fe^{2+}

Your answer ☐ **[1]**

Generally well answered

Question 9

9 The particle model is used to describe changes of state.

Which statement about the particle model is **correct**?

A It takes into account the forces between particles.

B It takes into account the size of the particles.

C It takes into account the space between the particles.

D It represents the particles as inelastic spheres.

Your answer ☐ **[1]**

Where incorrect answers were given, C was usually the chosen response.

Question 10

10 How many grams of NaOH are found in 50 cm^3 of a 4 g/dm^3 solution of NaOH(aq)?

A 0.08 g

B 0.2 g

C 2 g

D 80 g

Your answer ☐ **[1]**

This question was well answered by the majority, but with A as the more common incorrect response.

Section B overview

It was pleasing to see improved exam technique and greater understanding of scientific principles in this section. Candidate responses demonstrated understanding of some difficult concepts and generally good explanations were given across this section of questions. Candidates seemed well prepared, and the number of omissions were significantly reduced. Even the higher demand questions were well attempted and candidates were rewarded for their stamina in completing the whole examination paper.

Question 11 (a) (i)

11 A student investigates the reaction of magnesium carbonate and dilute sulfuric acid.

(a) The student wants to measure the pH of the dilute sulfuric acid.

(i) Suggest the pH of dilute sulfuric acid.

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

Almost all candidates could give the pH of dilute sulphuric acid. This seems well embedded across all candidates.

Question 11 (a) (ii)

(ii) Name an indicator that the student could use to measure the pH of dilute sulfuric acid.

State the colour of the indicator after it has been added to the dilute sulfuric acid.

Name of indicator .....

Colour .....

[2]

A small number of candidates chose litmus as their indicator of choice for finding the pH, with red as their positive colour. As the colour was marked independently candidates could still score at least one of the two marks available.

Question 11 (a) (iii)

(iii) Name a piece of equipment the student could use to measure the pH more accurately.

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

Only a limited number of candidates could identify a pH probe or pH meter as a device to measure the pH of a substance more accurately.

Question 11 (b)

(b) When magnesium carbonate reacts with dilute sulfuric acid, it forms a salt, water and carbon dioxide.

What is the name of the salt?

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

This is a process that most candidates seem to have improved on over the past few series of examinations and there was a significant number of candidates that were successful in naming this compound.

Question 11 (c)

(c) The student adds an **excess** of magnesium carbonate to dilute sulfuric acid until **no more of it reacts**.

magnesium carbonate(s) + sulfuric acid(aq) → salt(aq) + water(l) + carbon dioxide(g)

Magnesium carbonate is a white powder that is insoluble in water.

A colourless solution of the salt is formed.

Describe **two** observations the student would see as the reaction is happening.

1 .....

.....

2 .....

.....

[2]

Bubbling, fizzing and effervescence were all regularly seen responses that were given marks. The problem came with what happened with the insoluble white powder. Many candidates tried to describe changes in temperature. This is not something the students were expected to discuss as this is not something you would **see** as part of the reaction. As the reaction progressed the insoluble solid would react, forming a solution and hence the solid would 'disappear' from the vessel.

Question 11 (d)

(d) The student separates the salt from the solution formed at the end of the reaction.

Step 1: They remove the excess magnesium carbonate. **Step 2:** They remove the water from the salt solution.

State the names of the separation techniques used in Step 1 and Step 2.

Step 1 .....

Step 2 .....

[2]

This question was well answered, with only a small number of candidates suggesting 'fractional distillation' instead of 'simple distillation'.

Question 11 (e) (i)

(e) The student measures the mass of the salt obtained when different masses of magnesium carbonate are added to the same volume of dilute sulfuric acid.

The table shows their results.

Mass of magnesium carbonate (g)	Mass of the salt (g)
1.0	1.4
2.0	2.9
3.0	4.3
4.0	5.7
5.0	7.1
6.0	7.1
7.0	7.1

(i) Describe the relationship between the mass of magnesium carbonate and the mass of the salt.

.....

.....

.....

..... **[2]**

Most candidates could effectively describe the relationship between the mass of magnesium carbonate and the mass of salt. Fewer could articulate the nuance of the plateaued section at 5 grams of magnesium carbonate.

Question 11 (e) (ii)

(ii) A student thinks that when 6.0 g of magnesium carbonate has been added it is in excess.

Explain why the student is **correct**.

.....

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

A large number of candidates could not articulate their ideas in a clear way to allow them to be given credit for their responses. The word 'excess' was often repeated as a reason for the lack of a change in mass.

Question 12 (a)

12 Atoms are made from the sub-atomic particles protons, neutrons and electrons.

(a) **Table 12.1** shows the relative mass and relative charge of the three sub-atomic particles.

Complete **Table 12.1** by writing the name of a sub-atomic particle in each space.

Table 12.1

Sub-Atomic particle	Relative mass	Relative charge
.....	0.0005	–1
.....	1	0
.....	1	+1

[2]

Almost all candidates scored these marks. Candidates are not used to being asked questions about atomic structure in this way but they had sufficient confidence to be able to identify each sub-atomic particle.

Question 12 (b)

(b) An atom of phosphorus has an atomic number of 15 and a mass number of 31.

Calculate the number of protons, neutrons and electrons in this atom of phosphorus.

Number of protons = ...

Number of neutrons = ...

Number of electrons = ...

[2]

Errors more often surrounded the number of neutrons in the first instance, followed by the use of mass numbers rather than atomic numbers for the calculations.

Question 12 (c) (i)

(c) Phosphorus reacts with oxygen to form an oxide called phosphorus trioxide.

Phosphorus trioxide has the molecular formula P_4O_6.

(i) What is the empirical formula of phosphorus trioxide?

Tick (✓) **one** box.

PO ☐

P_2O_3 ☐

P_4O_6 ☐

[1]

A very large number of candidates scored this mark. There was no pattern in the incorrect responses.

Question 12 (c) (ii)

(ii) Complete the **balanced symbol** equation for the reaction of phosphorus trioxide with water.

$$P_4O_6 + \text{.....}H_2O \rightarrow \text{.....}H_3PO_3$$

[2]

It was pleasing to see a massive improvement in the number of candidates successfully balancing this equation. The common error was in 3 water molecules and 2 phosphoric acid molecules where candidates had not realised the number of phosphorus atoms also needed to be balanced and not just the hydrogen.

Question 12 (c) (iii)

(iii) **Table 12.2** shows the melting point and boiling point of phosphorus trioxide.

Table 12.2

Melting point (°C)	Boiling point (°C)
24	173

In the box draw the particle arrangement for phosphorus trioxide at 100 °C.

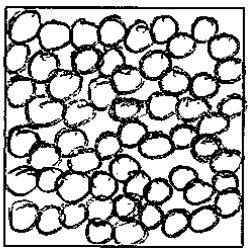
Use ◯ to represent each particle.

[1]

Some candidates could identify liquid as the correct state but the quality of the particle diagrams was poor. Candidates were expected to draw a full box of the correct sized particles, where each particle was touching another but in an irregular or random pattern, reflecting the arrangement in a liquid. Gases were often drawn.

Exemplar 1

Use ◯ to represent each particle.



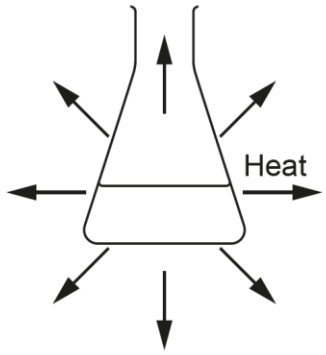
[1]

As you can see from the exemplar, the box is full of circles that are touching each other and are randomly arranged. The candidate has made this harder for themselves by drawing smaller circles than was expected. This is a suitable arrangement and scores the mark.

Question 13*

13* The boxes show three pieces of information about a reaction.

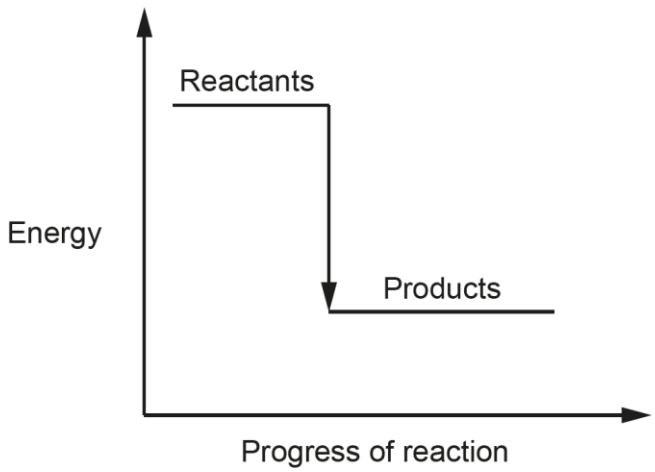
1



2

Temperature at start of reaction (°C)	Final temperature of reaction (°C)
20	42

3



State whether the reaction is exothermic or endothermic.

Explain your answer using information from each box.

.....

.....

.....

.....

.....

..... **[6]**

This was a very well answered Level of Response question, with the whole range of responses seen. Some candidates gave good descriptions of the information in the boxes but explained the reaction was endothermic rather than exothermic.

Some candidates also had not realised that the three boxes related to the same experiment as they changed their decision about the type of reaction taking place from box 1 to box 2 and then again to box 3.

For those candidates that understood the question fully, there were several routes to achieving 6 marks. Most candidates that were awarded 6 marks explained that heat was given out by the reaction mixture, as seen by the outward arrows in box 1, there was an increase in temperature shown in the information in box 2 and the energy level diagram in box 3 showed the reactants had more energy than the products and so the overall energy decreased, indicating an exothermic reaction.

Exemplar 2

The reaction is exothermic. In box number 1, the heat of the reaction is exiting, so it is exothermic as the surroundings are getting warmer. In box number 2, the final temperature has more than doubled which means the ~~reactio~~ reaction that took place is exothermic. In box number 3, the graph for an exothermic reaction is shown. it is clear that it is exothermic as the products is lower than reactants.

This is a common response of a candidate who has logically explained each box in turn, as well as giving an overall decision of an exothermic reaction. This is a Level 3 response and scored 6 marks without using up all of the writing space, proving it is possible to be concise and achieve all of the marks.

Question 14 (a)

14 The properties of materials depend on their structure and bonding.

(a) The table shows some information about four materials.

Material	Appearance at room temperature	Melting point (°C)	Does it dissolve in water?	Does it conduct heat?	Does it conduct electricity?	Does it react with acids?
A	a grey-black solid	3600	no	yes	yes	no
B	a flexible white solid	166	no	no	no	no
C	a silver-grey solid	1538	no	yes	yes	yes
D	a white solid	770	yes	no	when molten	no

Draw **four** lines to connect each **material** with its correct **structure**.

Material

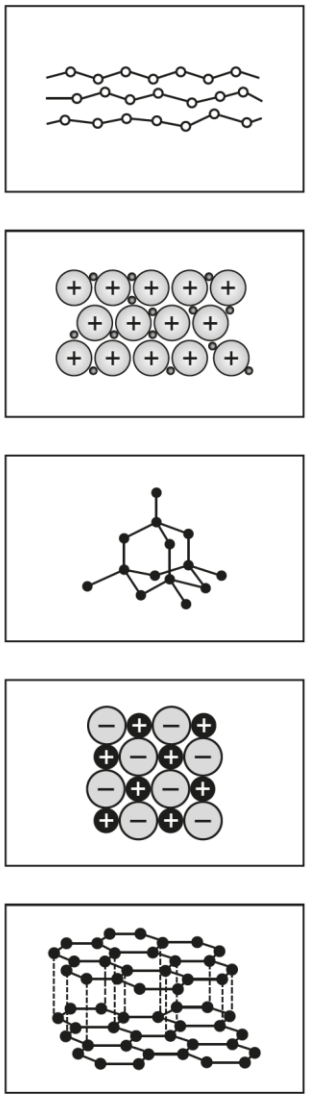
A

B

C

D

Structure

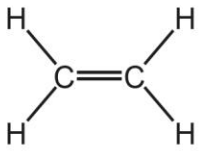


[4]

A limited number of candidates scored 4 marks on this question. Where candidates scored only 2 marks the most common combination of correct responses was for identifying A as a structure that could conduct electricity and B as the flexible white solid. C and D were the most confused responses, with candidates frequently mixing the two diagrams up.

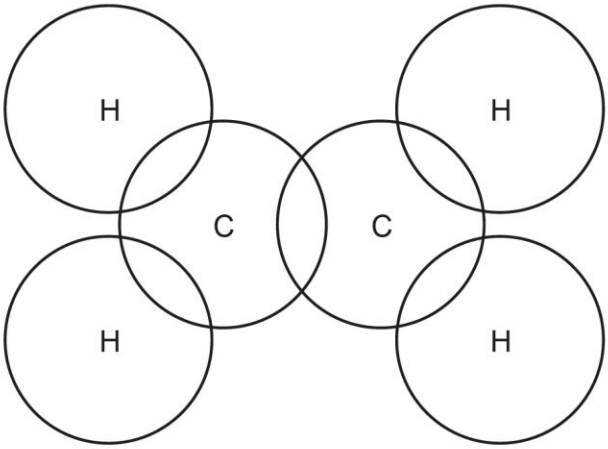
Question 14 (b) (i)

(b) Ethene, C_2H_4, has this structure.



(i) Complete the dot and cross diagram for a molecule of ethene.

Only show the outer shell electrons.



[2]

Almost all candidates had understood what to do in drawing the 'dot and cross diagram' by drawing in the overlap sections. Many candidates could accurately draw a total number of 4 electrons between the 2 carbon atoms and 2 electrons in each overlap between the carbon and hydrogen atoms. Errors came about when candidates drew extra electrons outside of the overlap areas, adding to the total number of electrons in the diagram. The two overlap types were marked separately and independently, but where the total number of electrons on the diagram exceeded the total number of outer electrons in the compound a mark was lost. All symbols and shapes used for electrons were considered to be correct, but most candidates did use dots and crosses, showing a pleasing amount of preparation had gone into their revision.

Question 14 (b) (ii)

(ii) Explain why ethene has a low boiling point.

Use ideas about structure and bonding.

.....

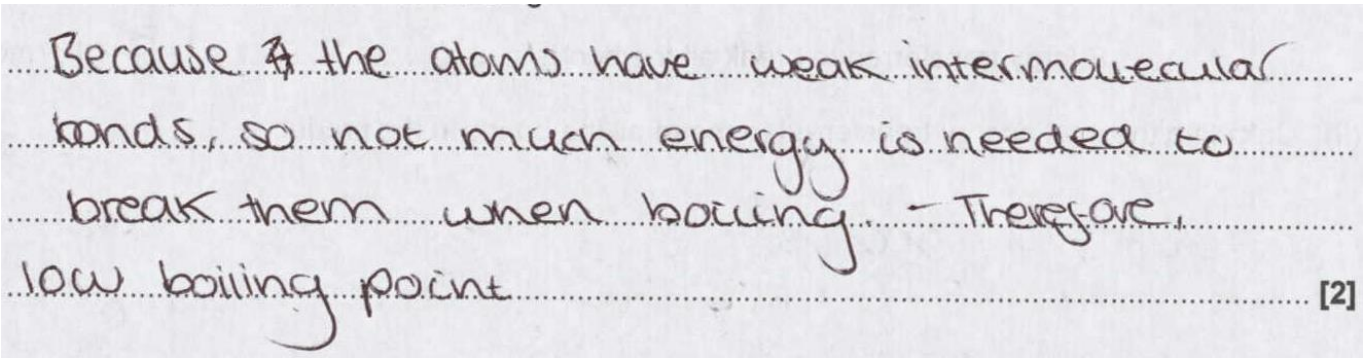
.....

.....

..... **[2]**

As in previous years, this is an area where candidates struggled to articulate their ideas. They often mix up ideas about intermolecular forces, electrostatic forces and covalent bonding. Teachers need to identify alternative methods to simplify this concept to make sure candidates can engage with the question.

Exemplar 3



This exemplar shows one of the common errors candidates make when attempting to explain intermolecular forces. They have referred to intermolecular 'bonds' rather than forces.

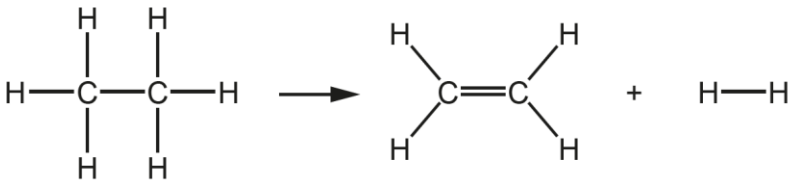
Misconception

Candidates mix up simple covalent molecules and intermolecular forces. The misconceptions are that intermolecular forces are **bonds** rather than **forces**, that covalent bonds are broken for melting to occur and that these bonds are weak. Candidates have little understanding that the covalent bonds within molecules are strong and these are not broken during melting. Instead weak intermolecular forces that hold the molecules close together are overcome during melting.

There are a number of resources available to support teachers and students with these conceptually challenging topic areas, including this: Decision tree: what type of bonding from RSC.

Question 14 (c) (i)

(c) The equation shows how ethene can be produced.



The table shows some bond energies.

Bond	Bond energy (kJ/mol)
C–C	347
C–H	413
C=C	612
H–H	436

(i) Calculate the total energy transferred to **break** all the bonds in the reactant.

Energy transferred to break all the bonds = ... kJ/mol **[1]**

Candidates could generally calculate the energy transferred to break all of the bonds. Where mistakes were made, it was usually miscounting the C-to-H bond or missing the C-to-C bond completely.

Question 14 (c) (ii)

(ii) Calculate the total energy transferred to **make** all the bonds in the products.

Energy transferred when all the bonds are made = ... kJ / mol **[1]**

Candidates could generally calculate the energy transferred when all the bonds are made, however when mistakes were made it was usually due to missing the H-to-H bond or not accounting for the C-to-C double bond.

Question 14 (c) (iii)

(iii) Use your answers to parts **(i)** and **(ii)** to calculate the energy change for the reaction.

Energy change = ... kJ / mol **[1]**

Candidates often subtracted the two previous values the wrong way around (energy transferred from bonds formed minus energy transferred when bonds are broken) rather than the correct method of energy transferred from bonds broken minus energy transferred from bonds made. Several candidates added an incorrect sign to their answer if they made a mistake in their calculations rather than simply subtracting the two incorrect values.

Question 15 (a)

15 Sodium hydroxide, NaOH, and calcium hydroxide, $Ca(OH)_2$, are ionic compounds that dissolve in water to form alkaline solutions.

(a) Why are solutions of sodium hydroxide and calcium hydroxide called alkalis?

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

Only a limited number of candidates could state that an alkali contains an OH^- ion. Many opted for a comment about their pH.

Question 15 (b)

(b) Explain why the formula of sodium hydroxide is NaOH but the formula of calcium hydroxide is $Ca(OH)_2$.

.....

.....

.....

.....

.....

..... **[3]**

Candidates found it difficult to articulate their ideas in answers to Questions 15 (b). The idea that only 1 Na^+ ion is needed to react with 1 OH^- ion to produce a neutral compound whereas Ca^{2+} required 2 OH^- ions to cancel out the charge, seemed a difficult concept for many candidates. Discussions often talked about number of electrons in the outer shell and how many electrons would need to be lost or gained to form a full outer shell, rather than the understanding that it is simply a balance of the positive and negative charges to make a neutral compound.

Question 15 (c)

(c) The electrolysis of a sodium hydroxide solution produces hydrogen at the cathode rather than sodium.

Explain why.

.....

.....

.....

.....

.....

..... **[3]**

Many candidates could explain that sodium is more reactive than hydrogen, however fewer could explain why hydrogen is released at the cathode instead of sodium. Several candidates confused the charges of the anode and the cathode as well as the direction of movement of the ions present in the solution.

Question 15 (d) (i)

(d) When carbon dioxide is bubbled through a calcium hydroxide solution it turns cloudy white.

This is the equation for the reaction.

$$Ca(OH)_2(aq) + CO_2(g) \longrightarrow CaCO_3(s) + H_2O(l)$$

(i) Which chemical in the equation turns the solution cloudy white?

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

Most candidates incorrectly suggested that carbon dioxide was responsible for the cloudy white colour seen, rather than the formation of the solid white calcium carbonate. The carbon dioxide reacting with the calcium hydroxide does form the white solid but the product of calcium carbonate is the chemical which gives the reaction a white solid.

Question 15 (d) (ii)

(ii) What is the alternative name for the calcium hydroxide solution?

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

A large number of candidates could identify calcium hydroxide as limewater. Most incorrect answers just repeated the stem of the question or picked another substance from the equation.

Question 15 (d) (iii)

(iii) The calcium hydroxide solution contains 0.038 g of calcium hydroxide.

Calculate the maximum mass of carbon dioxide that can react with the calcium hydroxide solution.

Give your answer to **2** significant figures.

Relative atomic mass (A_r): H = 1.0 C = 12.0 O = 16.0 Ca = 40.1

Mass of carbon dioxide = ... g **[4]**

Most candidates could calculate the relative formula mass of calcium hydroxide of 74.1. Where mistakes were made, it was usually the loss of the number after the decimal. Carbon dioxide calculations had no issue, where a number was given it was usually 44.

There were errors made in the rearrangement or recollection of the formula used - the wrong things were multiplied together or divided. However a more consistent number of candidates could correctly calculate the mass of carbon dioxide, showing good preparation for this type of question.

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