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GCSE (9-1)

Examiners' report

GATEWAY SCIENCE CHEMISTRY A

J248
For first teaching in 2016

J248/01 Summer 2018 series

Version 1

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. 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 examination paper can be downloaded from OCR.

Paper J248/01 series overview

J248/01 is the first of two foundation tier papers for Gateway Science Chemistry A. This component assesses topics C1, C2, C3 and C7 and is worth 50% of the total GCSE. To do well on this paper, candidates need to demonstrate knowledge and understanding of scientific ideas, techniques and procedures across all four topics. They need to be able to apply their knowledge and understanding to unfamiliar contexts as well as displaying the ability to analyse information. Candidates also need to be familiar with a range of experimental procedures.

J248/01 has an equal emphasis on knowledge and understanding of the assessment outcomes from the specification and application of this knowledge.

Section A overview

Very few candidates omitted any of these multiple choice questions.

Questions on pH (1), the periodic table (4), groups of the periodic table (11) and intermolecular forces (15) were particularly well answered.

Questions on scientists who developed the atomic model (3), formulae (6), products of a chemical reaction (12) and nanoparticles (14) proved to be the most difficult for candidates.

Question 1

1 Which of these pH values shows the pH of a strong acid?

A 1

B 5

C 7

D 10

Your answer ☐ **[1]**

A small minority of candidates gave C or D as their response.

Question 2

2 Which of these general properties correctly describes a metal?

A Ductile and good conductor of heat

B High density and forms negative ions

C Malleable and low density

D Shiny and brittle

Your answer ☐ **[1]**

All answers were seen; B was the most popular incorrect response.

Question 3

3 A number of scientists contributed to the development of the atomic model.

Which of these scientists discovered the electron?

A Bohr

B Dalton

C Rutherford

D Thomson

Your answer ☐ **[1]**

Candidates found this difficult; B was the most popular incorrect response.

Question 5

5 What is the typical size of the radius of an atom?

A 10^{-2} m

B 10^{-5} m

C 10^{-10} m

D 10^{-20} m

Your answer ☐ **[1]**

A significant number of candidates thought the atom to be larger than it is, selecting either A or B as their answer.

Question 6

6 Lead nitrate contains lead ions, Pb^{2+}, and nitrate ions, NO_3^-.

What is the formula for lead nitrate?

A $PbNO_3$

B $Pb(NO_3)_2$

C Pb_2NO_3

D $Pb_2(NO_3)_2$

Your answer ☐ **[1]**

All answers were seen but C was the most common incorrect response.

Question 7

7 Look at the equation.

$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$

Which substance is **oxidised** in this reaction?

A CH_4

B CO_2

C H_2O

D O_2

Your answer ☐ **[1]**

All answers were seen but B was the most common incorrect response.

Question 8

8 Look at the equation.

$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$

Which substance is the **oxidising agent** in this reaction?

A CH_4

B CO_2

C H_2O

D O_2

Your answer ☐ **[1]**

A and C were both often seen.

Question 9

9 Which statement about **covalent** bonding is true?

A Electrons are transferred from one atom to another.

B Electrons are delocalised.

C Electrons are shared between atoms.

D Ions are formed.

Your answer ☐ **[1]**

Candidates found this difficult, with many choosing A or B.

Question 10

10 The electronic structure of an atom of an element is 2.8.8.2.

In which **period** of the Periodic Table is this element found?

A 1

B 2

C 4

D 8

Your answer ☐ **[1]**

Many candidates confused period with group.

Question 11

11 The electronic structure of an atom of an element is 2.8.8.2.

In which **group** of the Periodic Table is this element found?

A 1

B 2

C 4

D 8

Your answer ☐ **[1]**

Some candidates confused group with period.

Question 12

12 What is the name of the gas made when zinc carbonate reacts with hydrochloric acid?

A Carbon dioxide

B Chlorine

C Hydrogen

D Oxygen

Your answer ☐ **[1]**

Many candidates thought the gas given off to be hydrogen.

Question 13

13 Which equation represents **neutralisation**?

A $2H^+ \longrightarrow H_2$

B $H_2O \longrightarrow H^+ + OH^-$

C $H^+ + OH^- \longrightarrow H_2O$

D $2OH^- \longrightarrow O_2 + H_2$

Your answer ☐ **[1]**

Candidates found this difficult with all responses seen.

Question 14

14 Which of these statements about nanoparticulate materials is correct?

A Nanoparticles are much smaller than atoms.

B Nanoparticulate materials can be used as catalysts.

C Nanoparticulate materials have a very small surface area to volume ratio.

D There are no risks when using nanoparticulate materials.

Your answer ☐ **[1]**

Candidates found this very difficult, usually opting for A or C.

Section B overview

Candidate performance

Candidates who did well on this paper generally did the following:

- Discussed the properties of materials and their structure: 21(a) and (b).
- Applied knowledge of melting points to a set context: 18(c)(ii).
- Applied the particulate theory of matter to properties of solids, liquids and gases: 25.
- Constructed and balanced symbol equations: 25(b), 26(b).
- Produced a clear, concise and well-structured answer for the Level of Response question: 24.
- Sequenced the processes involved in a salt preparation: 26(a).
- Applied knowledge and understanding to questions set in a novel context.

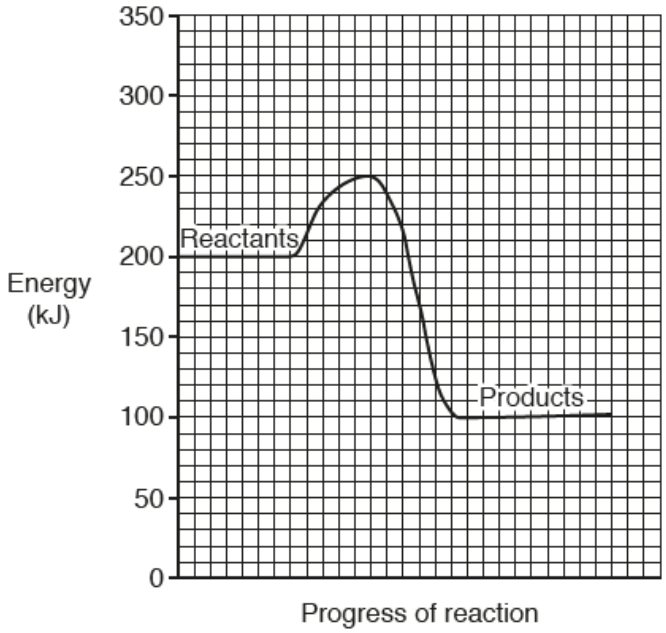
Candidates who did not do well on this paper generally did the following:

- Found it difficult to apply what they had learnt to unfamiliar situations.
- Tended to repeat the question stem as their answer to a question.
- Found it difficult to analyse data, draw conclusions in relation to the data and explain their conclusions e.g. 24, 18(c)(ii).
- Found it difficult to explain experimental procedures and sequence an experiment. Showed imprecise use of scientific terminology.

There was no evidence that candidates did not have enough time to complete the paper.

Question 16(c)(i)

(c) Look at the reaction profile for reaction **A**.



(i) Calculate the energy change in this reaction.

Answer = ... kJ **[1]**

Candidates found this difficult. Common incorrect responses included: the height of the profile (250 kJ) and the difference between the height of the profile and the products (150 kJ).

Question 16(c)(ii)

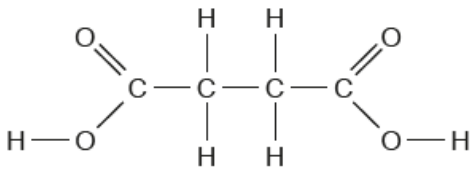
(ii) Calculate the activation energy.

Answer = ... kJ **[1]**

Candidates found this difficult. Common incorrect responses included: the height of the profile (250 kJ), the difference between the height of the profile and the products (150 kJ), or the level of the products (100 kJ).

Question 17(a)

17 Look at the diagram. It shows the displayed formula of succinic acid.



(a) Complete the table to show the number of atoms of each element in this displayed formula.

Element	Number of atoms
C	.....
H	.....
O	.....

[2]

Most candidates had the correct number for carbon but then had 4 for hydrogen and / or 6 for oxygen.

Question 17(b)

(b) What is the **empirical formula** of succinic acid?

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

The majority of candidates gave the molecular formula taken from their answer in (a). Some put + between the elements, CHO, or a ratio of numbers (usually 4:6:4).

Question 17(c)

(c) Succinic acid has a melting point of 184 °C and a boiling point of 235 °C.

What is the state of succinic acid at 25 °C?

Explain your answer.

.....

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

Many candidates appreciated that succinic acid would be solid and higher ability candidates could explain why. Lower ability candidates tended to repeat the data in the question with no interpretation, or thought it to be a liquid.

Question 18(a)

18 A student is separating some mixtures. She wants to make pure water from a solution of salt water. She filters the mixture.

Her method does not work.

(a) Explain why her method does not work and describe the method she should use.

.....

.....

.....

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

Many candidates discussed a mixture of salt and water with no implication that the salt was dissolved or that the salt particles were small enough to fit through the filter paper. Many candidates referred to salt molecules. Most candidates thought that it was the salt that was required rather than the water and so crystallisation and evaporation of water were common non-creditworthy responses.

Question 18(b)

(b) The student wants to separate a mixture of two liquids.

The liquids are:

Liquid	Boiling point (°C)
Water	100
Ethanol	78

Which separation technique should she use?

Explain how the method works.

.....

.....

.....

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

Many candidates thought simple distillation would separate the two liquids and went on to discuss the ethanol evaporating at 78 °C. Higher ability candidates appreciated that separation would occur due to the different boiling points with lower ability candidates copying data without providing additional interpretation.

Question 18(c)(i)

(c) The student separates two solid substances **A** and **B**. She wants to check that they are **pure**.

(i) What is meant by a **pure solid**?

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

Common responses from lower ability candidates included references to the solid containing no impurities, or containing no other solid or only one mixture.

Question 18(c)(ii)

(ii) The student measures the melting points of four samples of solid **A**.

Look at her results.

Sample	Melting point (°C)
1	115
2	119
3	114–118
4	120–122

She knows that a pure sample of solid **A** has a melting point of 120 °C.

She concludes that sample 4 is the purest sample of solid **A**.

Do the results support her conclusion?

Explain your answer using evidence from the table.

.....

.....

.....

.....

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

All candidates found this very difficult. The vast majority thought Sample 4 would be the purest since it contained 120 °C in the range or because it had the highest melting temperature. Some chose Sample 1 because of the single or lowest melting temperature. The few that chose Sample 2 found it difficult to explain their choice. Candidates needed to appreciate that a pure sample has a single melting temperature and that adding an impurity to a substance lowers its melting temperature. Sample 4 cannot be pure since the melting happens over a range of temperatures and because the temperature is higher than the pure sample. Sample 3 cannot be pure as the melting happens over a range of temperatures. The melting temperature for Sample 1 is a defined value but the value is much lower than that for Pure A and so is unlikely to be A. Sample 2 has a defined value and is within experimental error of the correct value and so is most likely to be the purest sample of Solid A.

Question 19(a)

19 Two students heat some calcium carbonate, $CaCO_3$.

Look at the equation for the reaction.

$$CaCO_3\mathbf{(s)} \longrightarrow CaO\mathbf{(s)} + CO_2(g)$$

Calcium carbonate $\longrightarrow$ Calcium oxide + Carbon dioxide

(a) What is the meaning of **(s)** in the equation?

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

Lower ability candidates gave 'solution' as their answer.

Question 19(c)

(c) Student **A** states:

'If I heat 20 g of calcium carbonate, I will make 8.8 g of calcium oxide and 11.2 g of carbon dioxide.'

Is student **A** correct?

Explain your answer.

.....

.....

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

Many candidates agreed with the statement because the masses added to 20 g. Higher ability candidates appreciated that the masses were reversed.

Question 19(d)(i)

(d) Student **B** investigates another reaction.

Look at the equations.

$2Mg(s) + O_2(g) \longrightarrow 2MgO(s)$

magnesium + oxygen ⟶ magnesium oxide

(i) Calculate the relative formula mass of magnesium oxide.

Answer = ... **[1]**

Candidates found this very difficult. Many doubled the relative formula mass and a significant number used atomic numbers rather than relative atomic masses.

Question 19(d)(ii)

(ii) Use the relative formula mass of magnesium oxide and the relative atomic masses of magnesium and oxygen to show if mass is conserved during this reaction.

.....

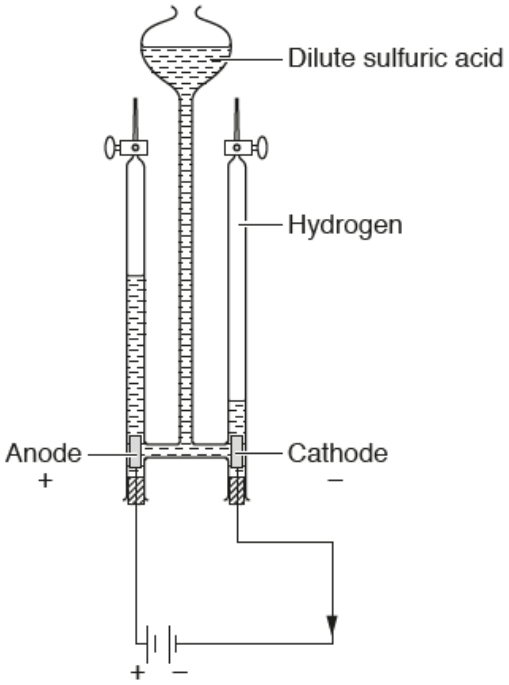
.....

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

A significant number of candidates omitted this question part or simply wrote 'yes' or 'no' with no further explanation. Many candidates looked at the number of atoms involved rather than at the masses. Those that did use masses usually confused relative formula mass with the mass of the reagent in the equation.

Question 20(a)

20 A student electrolyses dilute sulfuric acid.



Hydrogen gas is made at the cathode.

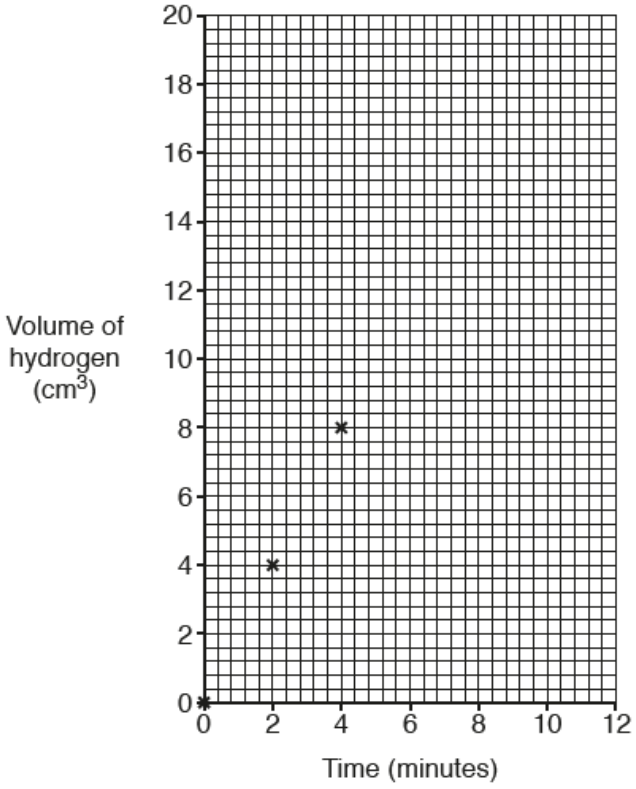
The student measures the volume of hydrogen made at the cathode every 2 minutes for 10 minutes.

Look at his results.

Time (minutes)	Volume of hydrogen (cm^3)
0	0.0
2	4.0
4	8.0
6	14.0
8	16.0
10	20.0

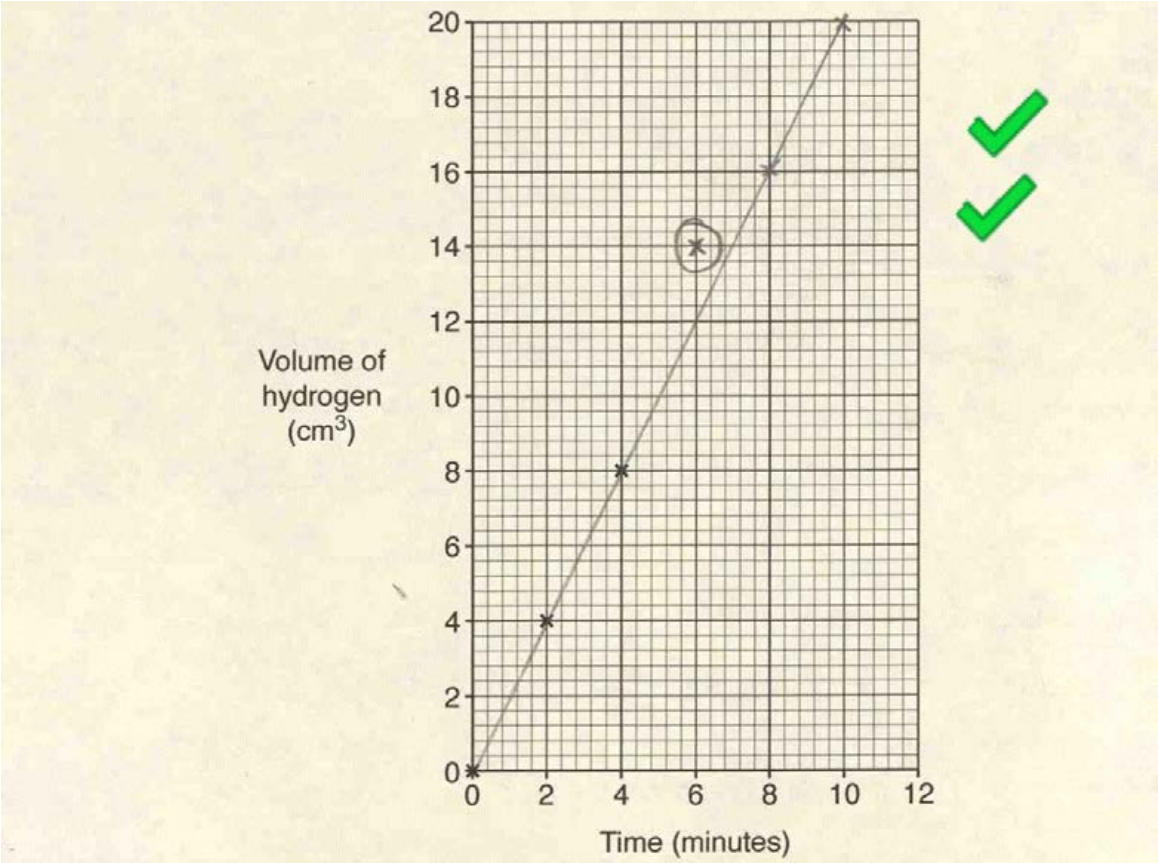
(a) Plot the results on the grid. The first 3 points have been done for you.

Draw a line of best fit. **[2]**



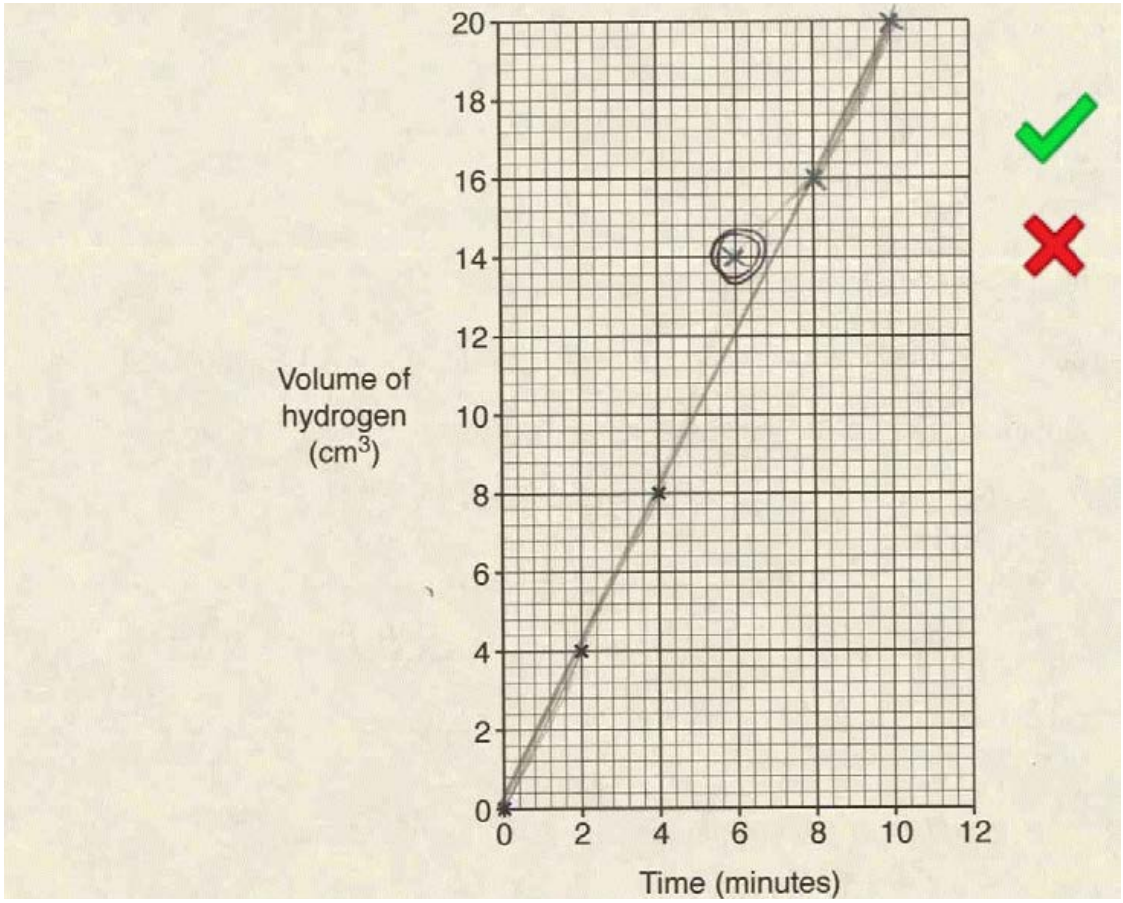
The majority of candidates plotted the points correctly but a significant number did not gain credit for the line. Often more than one line was drawn. Some lines included the anomalous point or ignored the point at (0,0).

Exemplar 1



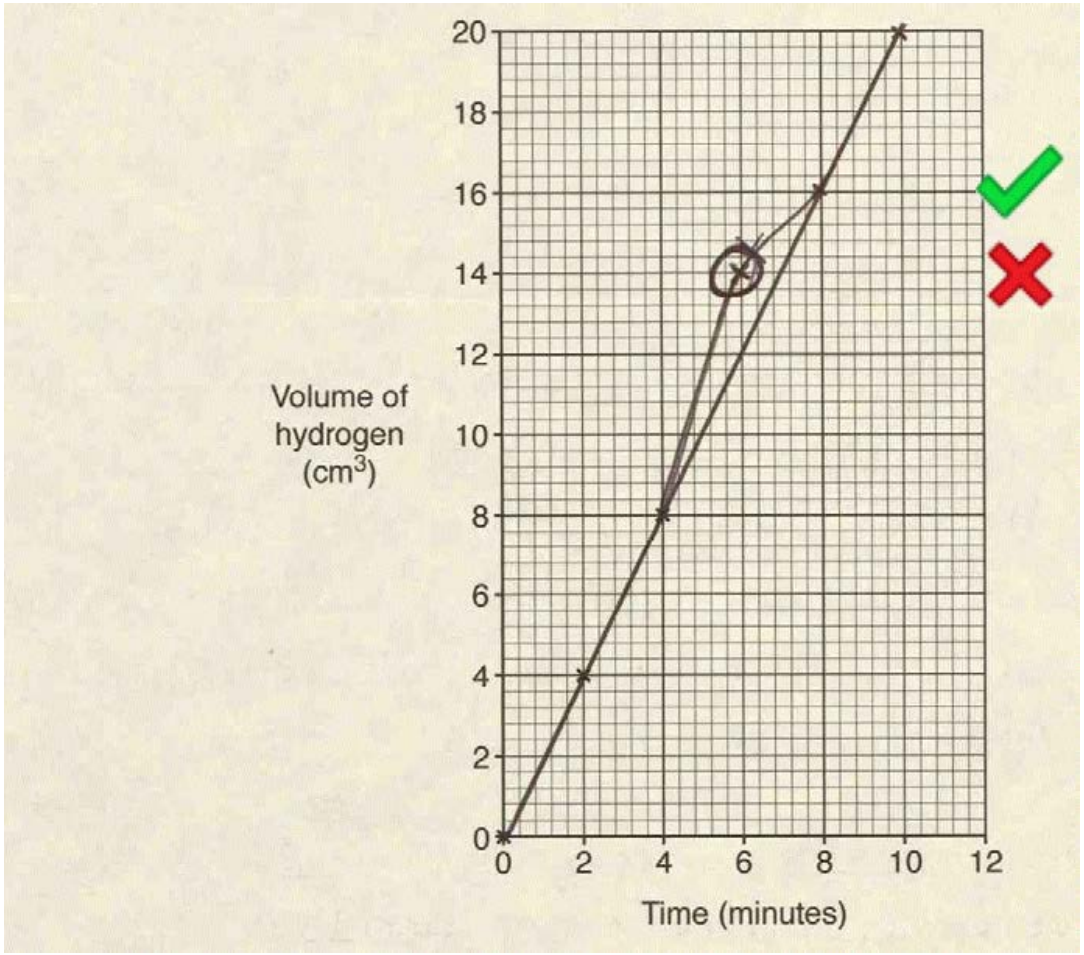
The points are plotted correctly. The line is a single best-fit straight line taking into account all of the points except the anomalous point and so gains credit.

Exemplar 2



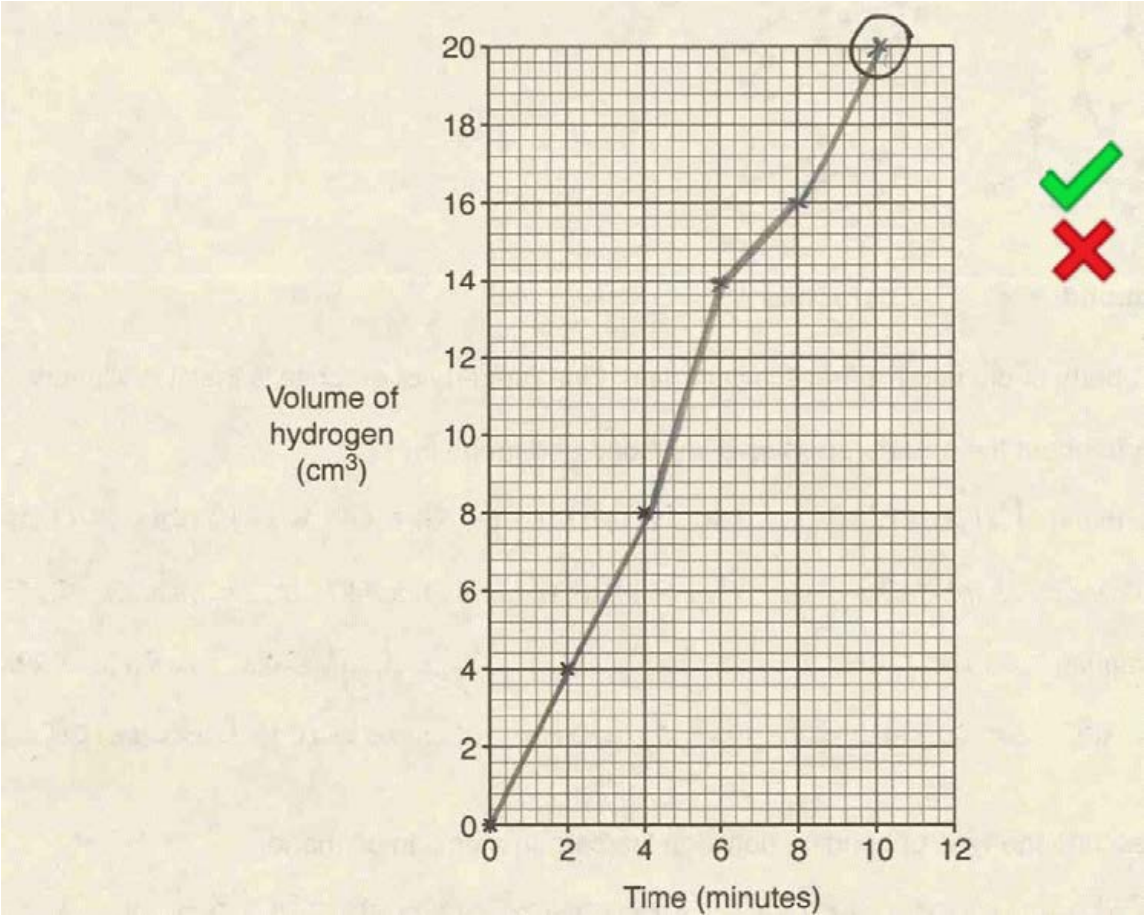
The points are plotted correctly. The line contains two sections which are very thick and does not gain credit.

Exemplar 3



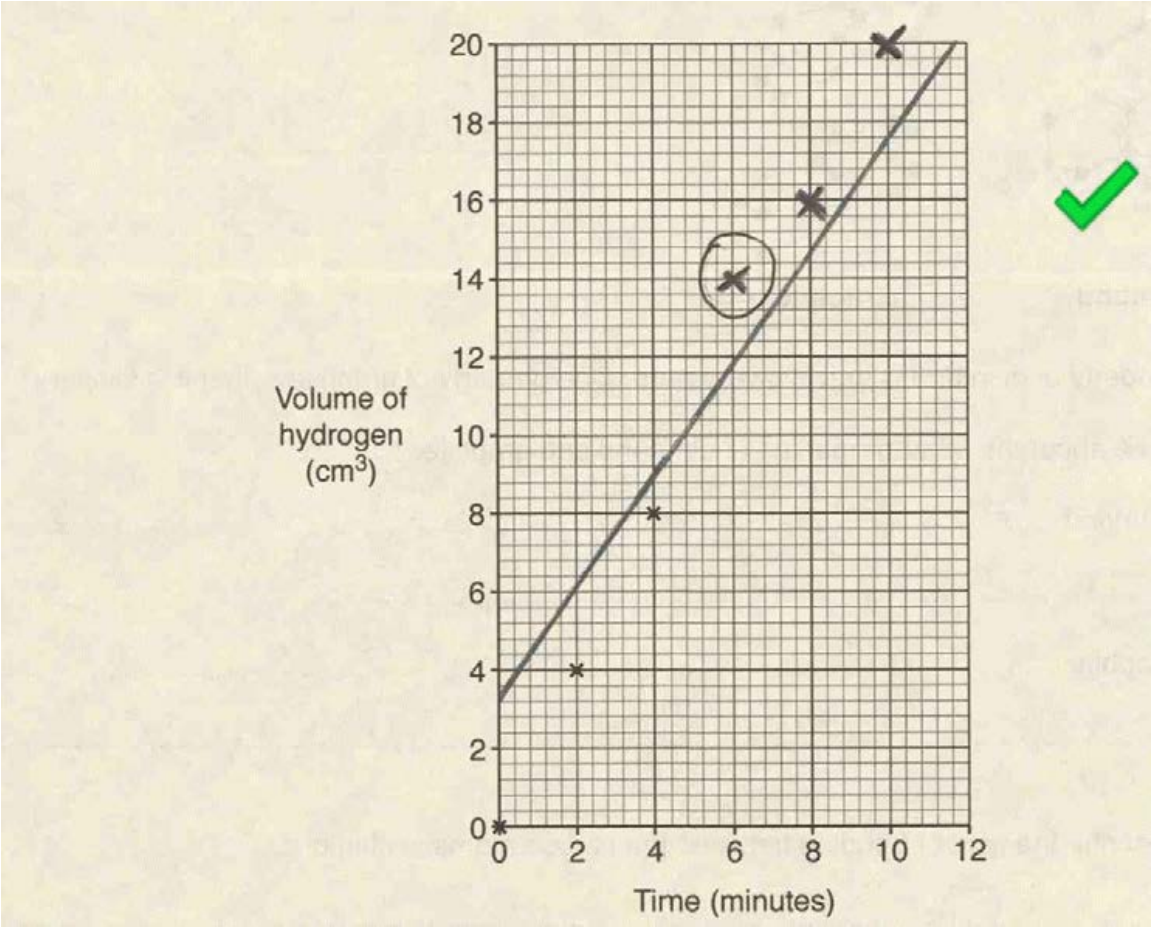
The points are plotted correctly. The candidate has drawn two lines, one taking into account the anomalous point and one not, this does not gain credit.

Exemplar 4



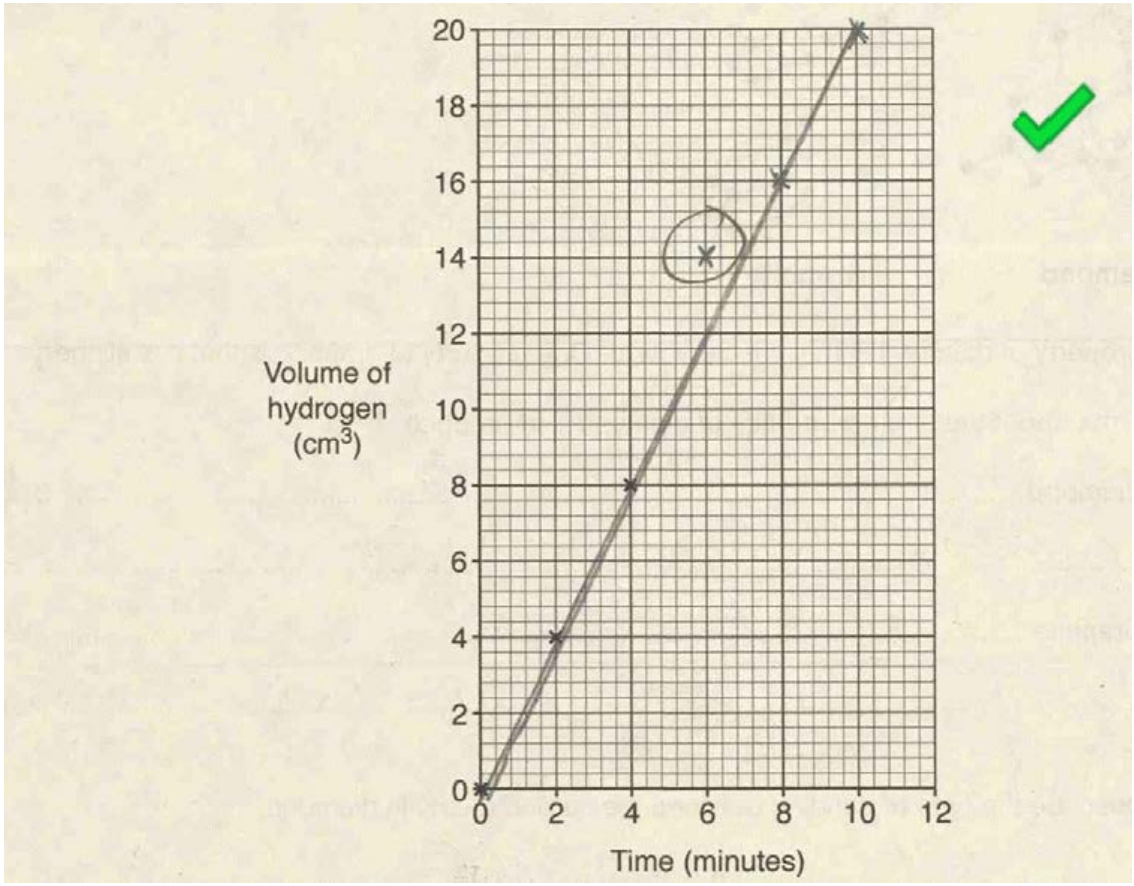
The points are plotted correctly. The candidate's line takes into account the anomalous point and so does not gain credit.

Exemplar 5



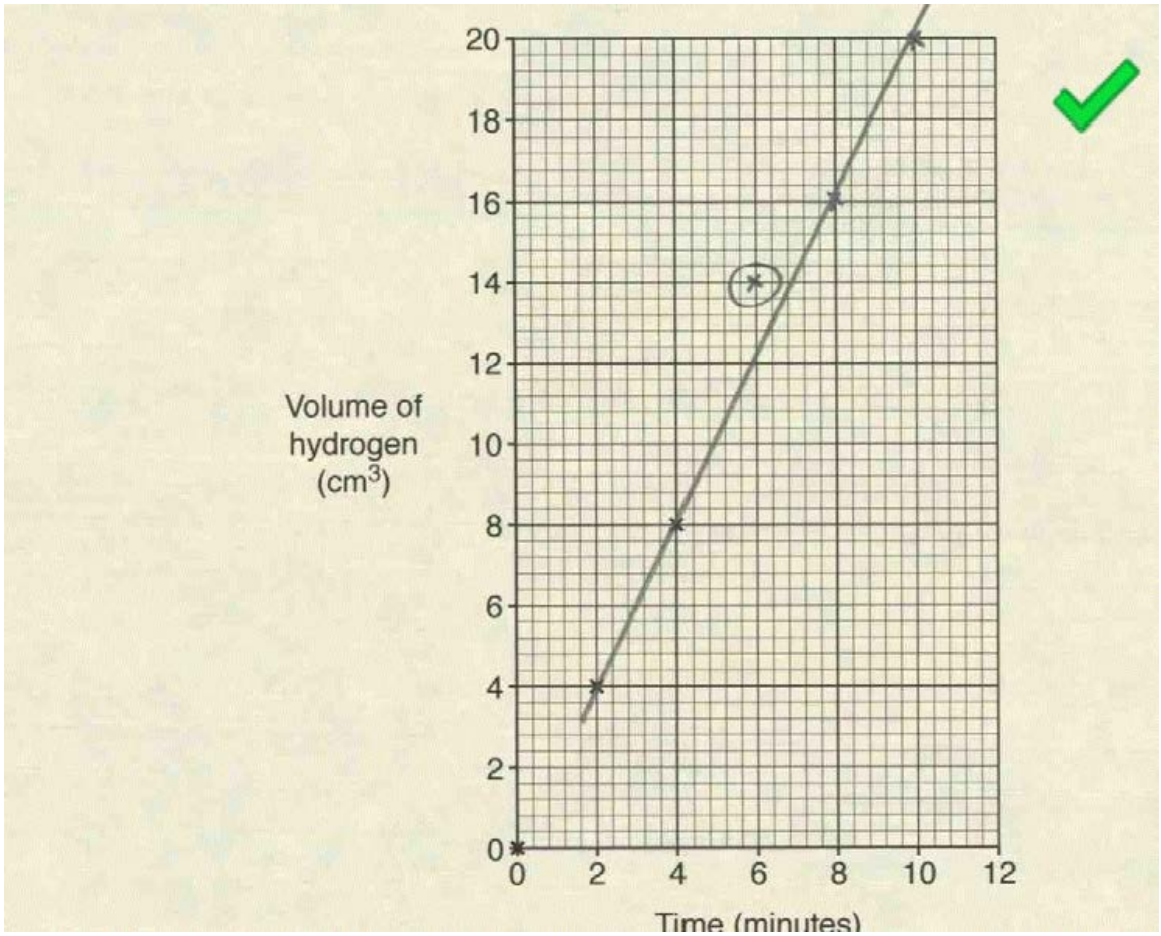
The points are plotted correctly. The line is not the best-fit line and so does not gain credit.

Exemplar 6



The points are plotted correctly. There are multiple lines in the lower sections and so the line does not gain credit.

Exemplar 7



The points are plotted correctly. The ln does not cover the whole range of the points and so does not gain credit.

Question 20(c)

(c) Sulfuric acid contains these particles.

H^+ OH^- H_2O SO_4^{2-}

Which particles are attracted to the **anode**?

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

Many candidates appreciated that the anions would be attracted to the anode but only identified one, often OH^-. A large number of candidates gave H^+ as their answer.

Question 20(d)

(d) The student also investigates the electrolysis of some molten (liquid) salts.

Complete the table.

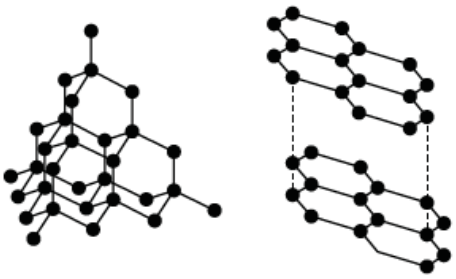
Molten salt	Formula	Product at cathode	Product at anode
Potassium chloride	KC*l*	Potassium	.....
Lead iodide	PbI_2	.....	Iodine

[2]

Many candidates gained full credit but chloride was seen often in place of chlorine.

Question 21(a)

21 The diagrams show the structures of diamond and graphite.



Diamond **Graphite**

One property of diamond is that it is very hard. One property of graphite is that it is slippery.

(a) Write about the other properties of diamond and graphite.

Diamond .....

.....

Graphite .....

..... **[4]**

Candidates found this difficult with many only repeating the information given in the question. 'Shiny' and 'dull' were common responses, as was discussion of intermolecular forces. Of those who stated 'high melting or boiling point' for diamond, many thought that those of graphite would be low. The electrical conductivity of graphite was well known.

Question 21(b)

(b) Describe the type of bonding between the carbon atoms in diamond.

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

'Strong' and 'ionic' were seen often, with some candidates giving 'metallic'.

Question 21(c)

(c) Graphite is slippery.

Use the structure of graphite to explain why.

.....

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

Higher ability candidates correctly described the layered structure of graphite and many also discussed intermolecular forces. A small number discussed weak covalent bonds.

Question 22(c)

(c) Most of the mass of an atom is in the nucleus.

Explain why.

.....

.....

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

Higher ability candidates recalled the relative masses of protons, neutrons and electrons. Lower ability candidates discussed the larger number of particles in the nucleus with no reference to mass, or stated that the nucleus contained the protons and neutrons. A small number of candidates discussed the role of the nucleus in a cell.

Question 22(d)

(d) Look at these two atoms of chlorine.

$^{35}_{17}Cl$ $^{37}_{17}Cl$

What is the relationship between these two atoms of chlorine?

Explain your answer.

.....

.....

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

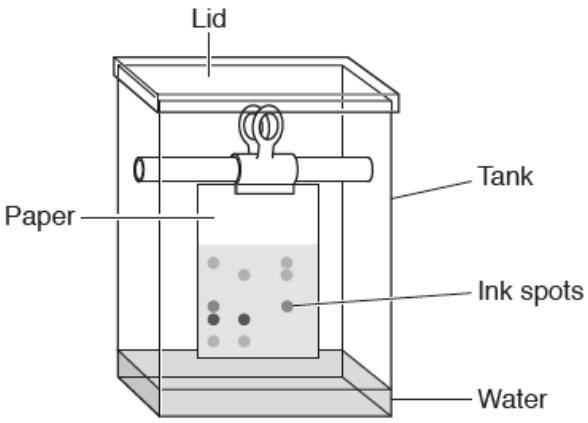
Many candidates discussed relative atomic mass, or reversed atomic number and mass number. A small number thought one to be an atom and the other an ion. A small number used the term isotope.

Question 23(a)

23 A forensic scientist is investigating the ink that has been used to forge the signature on a cheque.

She separates the colours in some inks using paper chromatography.

Look at the diagram of her apparatus.



(a) What is the **mobile phase** in this experiment?

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

Many candidates gave ink spots as the mobile phase.

Question 23(b)

(b) Explain how paper chromatography separates the colours in ink.

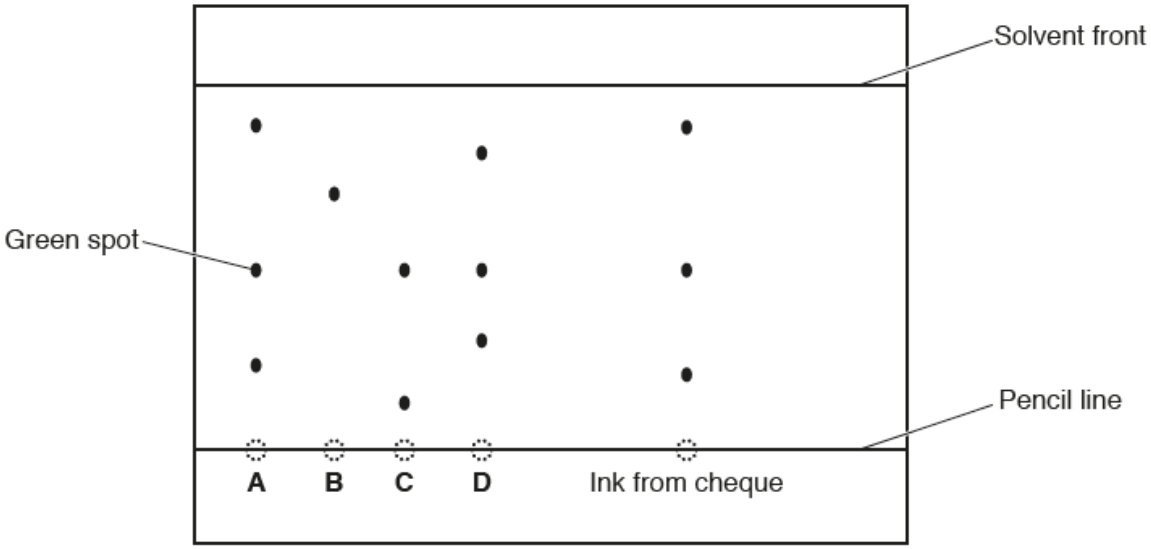
.....

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

Only a very small number of candidates gained credit. The majority said that the water separated or smudged the colours.

Question 23(c)(i)

(c) Look at the results of the scientist's experiment.



(i) Look at the green spot for ink **A**.

Calculate the R_f value for the green spot.

Answer = ... **[2]**

Very few candidates measured both distances correctly and, of those that did, many inverted the division and so calculated a number greater than 1. Many candidates omitted the question or quoted an incorrect number with no working.

Question 23(c)(ii)

(ii) Which ink was used to forge the signature on the cheque?

Explain how you can tell.

.....

.....

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

The majority of candidates chose A with many explaining their choice. A small number of candidates chose Sample B and suggested that none of the spots aligned with the ink from the cheque.

Question 24

24* Look at the data about some substances.

Substance	Melting point (°C)	Boiling point (°C)	Does it conduct Electricity?	Density (g/cm^3)
A	0	100	No	1.0
B	1085	2562	Good conductor	9.0
C	801	1413	Solid does not conduct but conducts when melted or when dissolved in water	2.2

What is the type of **bonding** present in each of substances **A**, **B** and **C**?

Explain how you can tell.

.....

.....

.....

.....

.....

.....

.....

.....

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.....

.....

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

Candidates found this question very difficult. Many repeated the properties listed in the table without naming the type of bonding. Others discussed bonding being strong or weak without applying the argument to the properties or to the type of bonding. Some candidates reversed A and C and explained that ionic substances do not conduct electricity but covalent ones do. Some reversed B and C and explained that metals conduct when molten but ionic substances conduct all of the time. Higher ability candidates gained full credit.

Question 25(a)(i)

25 Magnesium is an element. It is solid at room temperature.

(a) (i) **Solid** magnesium cannot be compressed.

Why?

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

Candidates found this very difficult. Many repeated the stem of the question or listed the properties of a solid such as hardness or fixed shape, or discussed the bonds being strong. Few discussed the particles making up the solid.

Question 25(a)(ii)

(ii) **Solid** magnesium **cannot** flow, but **liquid** magnesium **can** flow.

Explain why.

.....

.....

.....

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

Higher ability candidates considered the particles in the solid and liquid and their relative movements. Most candidates found this very challenging with many repeating the stem of the question as their answer. Some listed the properties of a solid and a liquid in terms of fixed shape and taking the shape of the container.

Question 25(a)(iii)

(iii) Magnesium **gas** completely fills any container it is put in.

Explain why.

.....

.....

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

More candidates discussed particles in this part of the question. The relative movement of the particles was quite well known, although descriptions of 'expanding particles' were quite common. Some candidates repeated the stem of the question as their answer. Some discussed the general properties of a gas including filling any space.

Question 25(b)

(b) Magnesium reacts with water. Magnesium hydroxide, $Mg(OH)_2$, and hydrogen, H_2, are made.

Write a balanced symbol equation for this reaction.

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

Many candidates were able to write an equation with the correct formulae and higher ability candidates balanced their equation. Lower ability candidates gave only the right hand side of the equation. Mg^{2+}, $Mg(OH_2)_2$ and Mg_2 were seen frequently.

Question 25(c)

(c) Magnesium nitrate has the formula $Mg(NO_3)_2$.

Calculate the relative formula mass of magnesium nitrate.

Answer = ... **[1]**

Higher ability candidates gained credit but many found this difficult. Some omitted the question or quoted a number with no working. Common errors included finding the relative formula mass of MgNO, MgN_3O_3 or $MgNO_3$.

Question 26(a)

26 A student has a solution of hydrochloric acid, HC*l*, and a solution of sodium hydroxide, NaOH.

He wants to make a pure, dry sample of sodium chloride.

(a) Describe how he can do this.

Include the apparatus he should use and his method.

.....

.....

.....

.....

.....

.....

.....

..... **[4]**

Higher ability candidates appreciated that the acid and alkali needed to be mixed and the resulting solution crystallised. A very small number appreciated that the mixing should be done by titration. Many candidates suggested 'splitting the two solutions into ions or atoms', either by heating or electrolysing, and then reacting the sodium with the chlorine or chloride they thought they had made. Many thought that the two solutions should be separated by fractional distillation or that the hydrochloric acid should be heated to produce sodium chloride. A significant number omitted the question.

Question 26(b)

(b) Write a **balanced symbol** equation for the reaction.

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

Higher ability candidates gave a correct equation. Common incorrect responses included: no H_2O; H_2 instead of H_2O; $NaCl_2$; $Na(OH)_2$; Na_2OH; or just giving one side of the equation.

Question 26(c)

(c) The student also investigates other reactions.

The table shows the salts he can make from different starting materials.

Complete the table.

Acid used	Other starting material	Salt made
Sulfuric acid	Copper oxide	.....
.....	Zinc carbonate	Zinc nitrate
Hydrochloric acid	.....	Magnesium chloride

[3]

Higher ability candidates gained full credit. Common incorrect responses included nitrate acid, nitrogen oxide, nitric oxide and nitrogen in place of nitric acid, and sulfur oxide and copper sulfide in place of copper sulfate.

Question 26(d)

(d) What **type** of reaction happens when sulfuric acid reacts with copper oxide?

.....

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

'Exothermic' was the most popular answer. Redox, oxidation, displacement and reversible were all common responses. Higher ability candidates gained credit.

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