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Examiners' report

GCSE

GATEWAY SCIENCE CHEMISTRY A

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

J248

For first teaching in 2016

J248/03 Summer 2025 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. 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 3 series overview

This paper is designed to assess content from Topics C1, C2 and C3 and is 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 three topics. They need to be able to apply their knowledge and understanding to unfamiliar contexts as well as analysing information. The practical skills specified in section C7 of the specification are also assessed so candidates therefore need to be familiar with a range of experimental procedures and be able to think about how an experimental method could be improved. The first two questions in Section B overlap with the foundation tier paper.

There was no evidence to suggest that candidates were short of time in answering the paper. All candidates answered all the multiple choice questions. In Section B, examiners noted that the majority of candidates answered all questions with very few 'no responses' to questions.

There were several questions where candidates needed to carry out a numerical calculation, for example Questions 16 (c), 17 (c) and (d), 19 (e), 22 (e) and 23 (a) and (b). Where an equation needs to be recalled, candidates should be encouraged to write the equation down as a first step. Previous examiners' reports have noted that candidates should practise setting out their working clearly so that, if they make an error, the examiner can follow their working out and award marks for an error carried forward. Examiners noted that the majority of candidates showed their working clearly and logically in a format which was easy to interpret.

When candidates are required to plot a graph, they should be reminded to do so using a pencil so that if they make a mistake, it can easily be corrected. This is much more difficult if they have plotted their graph in pen.

In Question 18 (a) candidates had the opportunity to draw a labelled diagram to support their answer. Candidates should be encouraged to make use of suitably labelled diagrams, especially when describing an experiment, as examiners noted that candidates were able to score a high proportion of marks from clear, labelled diagrams.

Question 20 is the 6-mark Level of Response question where candidates had the opportunity to demonstrate their knowledge and understanding of chemistry by constructing their own answer. It is important that candidates answer all parts of the question set; in this case identifying the type of structure and bonding and then explaining the properties in the table in terms of this.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• described an experiment to investigate the temperature change when magnesium is added to copper sulfate solution, clearly describing the apparatus to use and the measurements to take (Questions 18 (a)) • appreciated that, having recalled the typical radius of an atom, they needed to multiply by 2 to calculate the diameter of an atom. This allowed them to estimate the number of atoms that would fit across a sample of lithium (Questions 19 (e)) • used knowledge of the structure and bonding in graphite to explain properties of graphite (Questions 16 (b) (i) and (ii)) • recalled the relationship between hydrogen ion concentration and pH to calculate one variable from the other (Question 22 (f)) • recognised the 1:2 mole ratio of Cr_2O_3:Cr in the equation and used this correctly to calculate the mass of Cr_2O_3 needed to make 1 mole of Cr (Question 23 (a)) • recalled that the mass of 1 atom can be calculated by dividing the A_r by the Avogadro constant (Question 23 (b)) • recalled that in electrolysis oxidation occurs at the anode and reduction occurs at the cathode in order to write balanced half equations for the reactions at each electrode (Question 23 (c)).	• were unable to recall the relative mass and relative charge of subatomic particles (Question 19 (a)) • recalled the numerical value for the typical radius of an atom but did not give any units (m or nm) for their value (Question 19 (e)) • drew a dot and cross diagram for lithium fluoride showing the sharing of outer shell electrons (Question 19 (d)) • made errors with state symbols when writing the balanced symbol equation for a reaction, usually by using (l) instead of (aq) (Question 22 (a)) • could not draw a curve of best fit having correctly plotted results on a graph (Question 22 (b) (ii)) • did not use the experimental data given when explaining which experiment had the higher concentration of acid, usually just saying that the reaction was faster without saying why they knew it was faster (Question 22 (c)).

Section A overview

Section A is 15 Multiple Choice Questions (MCQs) which assess AO1 (recall of knowledge and understanding) and AO2 (application of knowledge and understanding). Candidates were able to successfully demonstrate their knowledge and understanding on the multiple-choice questions, with a very high percentage of candidates answering all 15 questions correctly. Mistakes most commonly occurred on Questions 12 and 13. All of the MCQs in Section A were attempted by all candidates.

Many candidates continue to demonstrate good practice and use the 'white' space around the question to write down working and/or equations (to assist with answering the question and to help them to check their answer at the end of the examination) and eliminate incorrect options as they read through the question. Other good practice seen included underlining key words and working through distractors, crossing out those perceived to be most obviously incorrect.

Centres should encourage candidates to take care to write their answer letter clearly as B and D can be confused if writing is unclear. If a candidate changes their mind about an answer, they should cross out their original answer and write their new answer clearly to the right of the answer box, rather than overwriting their original answer. Marks cannot be awarded if the answer is not clear.

Question 12

12 Ethene reacts with bromine to form dibromoethane.

What is the energy change for the reaction?

Energy required to break bonds (kJ/mol)	Energy released from forming bonds (kJ/mol)
2453	2548

A –48 kJ/mol

B –95 kJ/mol

C 95 kJ/mol

D 190 kJ/mol

Your answer [1]

Selecting option C was a common misconception in this question as candidates often think they must subtract the smaller number from the larger value rather than recalling

$$energy\ change = energy\ required\ to\ break\ bonds - energy\ released\ from\ making\ bonds.$$

Question 13

13 Which of the following reactions does **not** show a neutralisation reaction?

A Magnesium + hydrochloric acid → magnesium chloride + hydrogen

B Magnesium carbonate + hydrochloric acid → magnesium chloride + water + carbon dioxide

C Magnesium hydroxide + hydrochloric acid → magnesium chloride + water

D Magnesium oxide + hydrochloric acid → magnesium chloride + water

Your answer ☐ **[1]**

Only the higher attaining candidates recognised that magnesium is a metal and not a base, therefore reaction A is not a neutralisation reaction. B was a common incorrect answer.

Assessment for learning

It is often helpful to relate neutralisation reactions to the ionic equation of neutralisation. Hydrogen ions from the acid react with hydroxide ions from the alkali forming water. This can help candidates to identify a neutralisation reaction.

Section B overview

This section includes short (1 mark) questions as well as questions requiring longer answers. There is also one Level of Response question; Question 20. Questions 16 and 17 overlap with the foundation tier paper. This section covers all the assessment objectives, AO1, AO2 and AO3 (analysing information and ideas). Very few questions were omitted in Section B which was very pleasing to see. In calculation questions examiners noted an improvement in the clarity with which candidates set out their calculations. This really does help when a candidate's final answer is incorrect, and examiners are looking to award error carried forward marks. The use of bullet points, particularly in the Level of Response question, enables candidates to structure their answer logically and with clarity and should be encouraged by teachers.

Question 16 (a)

16 Scientists are developing the use and application of nanoparticles.

(a) The table shows the diameters of four different particles.

Particle	Diameter (nm)
A	97
B	2100
C	11
D	0.73

Which **two** particles are nanoparticles?

.... and ....

Explain your answer.

....

....

[2]

Most candidates correctly identified A and C as nanoparticles. A common misconception was C and D because they had the smallest diameters or that nanoparticles have diameters between 10 and 100 nm.

Question 16 (b) (i)

(b)
(i) One use of nanoparticles is in medicines.

State **one other** use of nanoparticles.

Explain why they can be used for that purpose.

Use ....

Explanation ....

....

....
[2]

The most common correct uses of nanoparticles were as suncream or catalysts. Lower attaining candidates tended to give a use which was not sufficiently specific, e.g. a computer, rather than electric or electronic circuits. The mark scheme required that the explanation matched the use, with many candidates not scoring the explanation mark as they gave 'large surface area to volume ratio' as an explanation regardless of whether it matched the use.

Question 16 (b) (ii)

(ii) Some scientists are worried about the risks of using nanoparticles.

Which statements are risks to humans of using nanoparticles?

Tick (✓) **two** boxes.

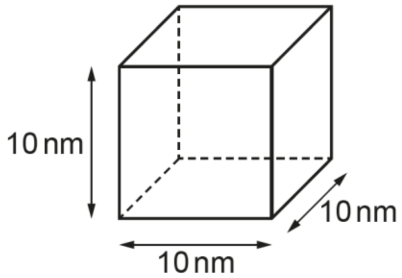
They can block ultraviolet light.	☐
They can catalyse harmful reactions in the body.	☐
They can have antibacterial properties.	☐
They can have toxic effects on the body.	☐
They have a high surface area to volume ratio.	☐

[2]

Most candidates correctly ticked the second and fourth boxes.

Question 16 (c)

(c) A cube-shaped nanoparticle has sides of length 10 nm.



Calculate the surface area to volume ratio of the cube.

Use the equation:

$$\text{Surface area to volume ratio} = \frac{\text{surface area}}{\text{volume}}$$

Surface area to volume ratio = ...**[3]**

Most candidates correctly calculated both the surface area and the volume of the cube and were then able to use the equation to calculate the surface area to volume ratio. Lower attaining candidates divided the volume by the surface area despite the equation being given in the question.

Question 17 (a)

17 This question is about separation techniques.

(a) What is meant by a **pure** substance?

....

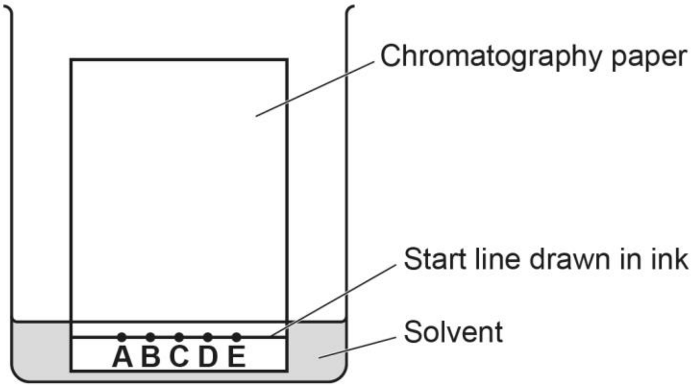
.... **[1]**

Most candidates were able to correctly define a pure substance. Answers which did not score the mark often described pure substances as having a fixed melting point, rather than melting over a range of temperatures. This is a property of a pure substance rather than what is meant by a pure substance.

Question 17 (b) (i)

(b)
(i) A student does a chromatography experiment to separate some dyes.

The diagram shows how they set up their equipment.



The student's experiment will **not** work to separate the dyes.

Suggest **two** changes the student can make so that the experiment will work.

1 ....

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

Most candidates scored 2 marks for recognising that the start line needs to be drawn in pencil and the solvent needs to be below it. Many wrote about not submerging the start line. A common misconception was suggesting the solvent needed to be at the start line rather than below it. Few candidates wrote about the dyes needing to be more spread out on the line. Candidates need to be encouraged to read the question carefully, as some candidates simply commented what was wrong with the experiment rather than specifying what needs to be changed so that the experiment will work.

Question 17 (b) (ii)

(ii) The student calculates that a dye has an R_f value of 0.67.

The table shows the R_f value of different dyes.

Colour of dye	**R_f value**
Blue	0.15–0.20
Red	0.35–0.40
Pink	0.40–0.80
Yellow	0.75–0.80

Which dye did they use in their experiment?

Explain your answer.

Dye ....

Explanation ....

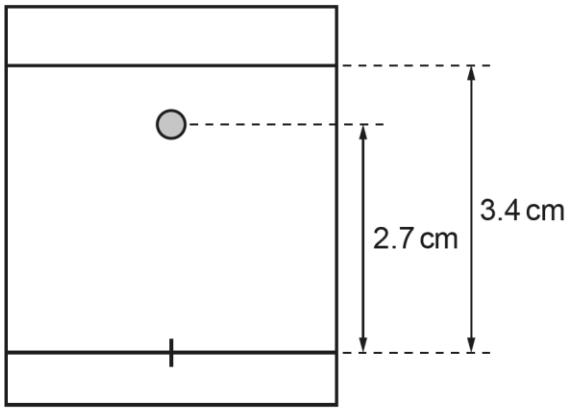
....

[2]

Most candidates correctly explained that the pink dye was used because the R_f value of 0.67 is within the range 0.40-0.80.

Question 17 (c)

(c) The diagram shows a chromatogram for another dye.



Calculate the R_f value of the dye.

Use the equation: $R_f = \dfrac{\text{distance travelled by the substance}}{\text{distance travelled by the solvent}}$

R_f value = ... **[2]**

Most candidates correctly substituted the values from the diagram into the equation to calculate the R_f as 0.79. The most common error was 3.4 ÷ 2.7.

Question 17 (d)

(d) A student separates substance **S** from a mixture of substances **S** and **T**.

The starting mass of the mixture is 9.7 g and they obtain 5.1 g of pure substance **S**.

Calculate the mass of pure substance **S** that could be separated from 15.0 g of the mixture.

Mass of pure substance **S** = ... g **[2]**

The most common error in this question was the use of 9.1, 5.1 and 15.0 in a subtraction calculation, e.g. 9.4 – 5.1 = 4.6, then 15.0 – 4.6 = 10.4g

Question 18 (a)

18 A group of students are investigating chemical reactions.

They add magnesium powder to copper sulfate solution.

They predict this will cause an increase in temperature, as they believe the reaction is exothermic.

(a) The students collect the apparatus needed to test their theory.

Describe an experiment the students can do to measure the increase in temperature.

You can include a labelled diagram in your answer.

Optional diagram:

....

....

....

....

.... **[4]**

This question discriminated well. Most candidates had the correct idea about which experiment they needed to write about. Some described the use of a polystyrene cup or an insulated beaker, but many selected a piece of glassware, usually a beaker, test tube or conical flask. While these pieces of apparatus were allowed by the mark scheme, they are not the best choice to minimise heat loss to the surroundings. Very few candidates chose to use a lid or to stir the mixture. A common error noted by examiners was that the starting temperature should be measured after the magnesium is added to the copper sulfate solution. Many candidates wrote about timing the reaction and measuring the temperature at certain time intervals but did not suggest that the highest temperature/final temperature should be recorded. Candidates were able to score marks from clear, labelled diagrams.

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Our Purposeful Practical resource and the integrated instructions are a great way of developing students' practical skills.

Question 18 (b)

(b) The students do the experiment five times.

The table shows the students' results.

Experiment	Temperature increase (°C)
1	37
2	39
3	53
4	22
5	48

The students' results show that their experiment is **not** repeatable.

Explain why.

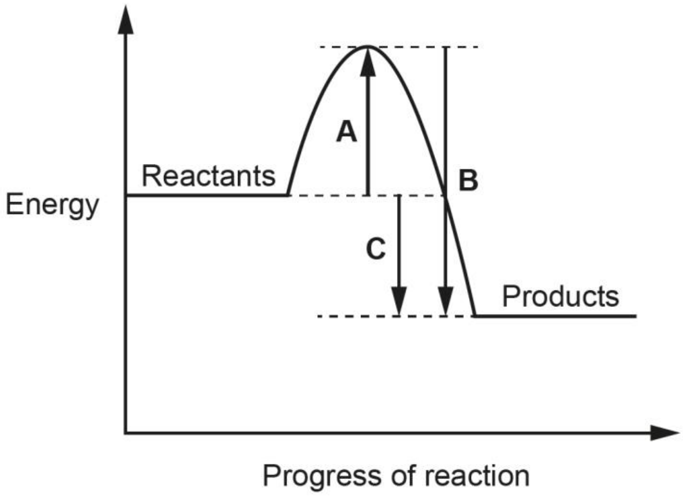
....

.... **[1]**

Most candidates showed clear understanding of repeatability and explained that the results were not similar or covered a range of temperatures. Responses which did not gain marks tended to describe reasons why the data was not repeatable or described the fact that there was no pattern/trend to the results as the temperatures did not gradually increase or decrease.

Question 18 (c) (i)

(c) The students draw a reaction profile for the reaction.



(i) Which part of the reaction profile shows the activation energy?

Tick (✓) **one** box.

A ☐

B ☐

C ☐

[1]

Most candidates correctly identified A as the activation energy.

Question 18 (c) (ii)

(ii) Which part of the reaction profile shows the energy change?

Tick (✓) **one** box.

A ☐

B ☐

C ☐

[1]

B was a common misconception in this question.

Question 19 (a)

19 Atoms contain three subatomic particles: protons, neutrons and electrons.

(a) The table shows some information about the subatomic particles.

Subatomic particle	Relative mass	Relative charge
Electron	....	....
Neutron	1	....
Proton	1	+1

Complete the table to show the relative mass and relative charge of each subatomic particle. **[3]**

Many candidates gained 3 marks with most being able to state the relative charges for an electron and neutron correctly. The relative mass of an electron was where candidates tended to lose a mark because they incorrectly stated 0 mass or wrote 0.005 instead of 0.0005. Some candidates also contradicted themselves by writing 'or 0' next to a correct answer for the relative mass of an electron.

Question 19 (b)

(b) Describe how a lithium atom forms a lithium ion.

....

.... **[1]**

Most candidates described the loss of an electron by a lithium atom. Some candidates contradicted themselves by writing that the atom needs to lose or gain an electron to become an ion, possibly talking about atoms in general rather than lithium in particular.

Question 19 (c)

(c) Lithium exists as two isotopes.

Complete the sentence about isotopes.

Use words from the list.

atom	**electrons**	**element**	**ion**	**neutrons**	**protons**

Isotopes are atoms of the same .... with the same number of ....

but different numbers of ....

[3]

Most candidates gained all 3 marks. The most common error was stating that isotopes have the same number of electrons; while this is true it is not the definition of an isotope.

Question 19 (d)

(d) Lithium can bond with fluorine to form lithium fluoride.

Draw the dot and cross diagram to show the bonding in lithium fluoride.

You only need to show the outer shell electrons.

[2]

Many excellent dot and cross diagrams were seen by examiners. Common mistakes were showing a lithium ion with a full shell of 8 electrons or omitting the charges on the ions.

Misconception

The most common misconception was that lithium and fluorine bond covalently by sharing electrons.

Question 19 (e)

(e) A sample of lithium is 11.5 cm wide.

Estimate how many lithium atoms would fit across the width of the sample.

Use your knowledge of the typical radius of atoms in your calculation.

Estimated number of lithium atoms = ... **[3]**

All but the highest attaining candidates found this question challenging. The typical radius of an atom (quoted in Section 1.2c of the specification as 10^{-10} m) was not well known or when it was recalled the correct units were not given (e.g. 1 x 10^{-10} cm) or no units were given. Candidates who were able to recall the radius of an atom in m often then did not make sure that the values for atomic radius and the width of magnesium metal were in the same units before proceeding with the next part of the calculation. Of those that gained the first 2 marks the most common error was then not recognising that the atomic radius needed to be doubled to calculate the number of ions to fit the width of the sample of lithium.

Question 20*

20* This question is about structure and bonding.

The table shows some information about three different substances.

Substance	Melting point (°C)	Boiling point (°C)	Conducts electricity?
J	734	1435	yes, when molten or in solution
K	–182	–162	no
L	3422	5930	yes

It is also known that substance **L** is malleable.

Identify the type of structure and bonding in each substance.

Explain the properties shown in the table for each substance in terms of the type of structure and bonding.

[6]

This 6-mark Level of Response question assessed AO1 and AO3. At Level 3 (5 – 6 marks) candidates needed to demonstrate detailed knowledge and understanding of the structure and bonding in all three structures and accurately apply this knowledge to explain the properties of each substance. All candidates attempted the question which generated a wide range of responses and differentiated well. Some candidates had clearly thought about and planned their answer by writing annotations and notes next to the table of data.

Substance L was often mistaken for a giant covalent structure (usually graphite) because candidates had either missed the sentence about L being malleable or not understood its meaning; some candidates described the malleability of graphite.

Substance K was often described as being as gas, due to the low melting and boiling points, without identifying it as a simple molecule or making any reference to weak intermolecular forces. Substance K was also often identified as a polymer.

Misconception

Many candidates wrote about intermolecular forces in relation to all 3 substances, even when correctly identifying J as ionic and L as metallic, demonstrating a lack of understanding of what an intermolecular force is and when they occur.

Exemplar 1

Substance	Melting point (°C)	Boiling point (°C)	Conducts electricity?
J	734	1435	yes, when molten or in solution
K	–182	–162	no
L	3422	5930	yes

→ giant ionic lattice
→ simple covalent
→ metallic

It is also known that substance **L** is malleable.

Identify the type of structure and bonding in each substance.

Explain the properties shown in the table for each substance in terms of the type of structure and bonding.

Substance J has high boiling and melting points due to strong electrostatic forces of attraction between oppositely charged ions that require a lot of energy to overcome. It also conducts electricity as when in solution or molten, it's ions are free to move and carry a charge. Substance J is therefore a giant ionic lattice. Substance K has low melting and boiling points due to weak intermolecular forces that are easily overcome. K cannot conduct electricity as there are no free ions or electrons. Therefore, K has a simple covalent structure. Substance L has very high melting and boiling points due to strong electrostatic forces of **[6]** attraction between positive metal ions and delocalised electrons. Because L has delocalised electrons, it can also conduct electricity. Therefore, L has a giant metallic lattice structure.

This is a Level 3 (6 mark) response.

The candidate has accurately applied their knowledge and understanding to explain the melting & boiling points and electrical conductivity of each substance. They then correctly use these properties to identify the structure and bonding in each of substances J, K and L.

The response is clear, detailed, and succinct, and represents some of the planning that has been previously recommended in examiner reports.

Exemplar 2

Substance	Melting point (°C)	Boiling point (°C)	Conducts electricity?	
J	734	1435	yes, when molten or in solution	ionic
K	–182	–162	no	simple covalent
L	3422	5930	yes	metal

It is also known that substance **L** is malleable.

Identify the type of structure and bonding in each substance.

Explain the properties shown in the table for each substance in terms of the type of structure and bonding.

J is an ionic bond. Ionic bonds have a high melting and boiling point and only conduct electricity when molten or in solution because the electrons only then are delocalised. K is a simple covalent bond. Simple covalent bonds have a low boiling and melting point due to weak intermolecular forces between the molecules. They ~~d~~ have fixed electrons so they do not conduct electricity.
L is a metalic bond. Metalic bonds have a high melting and boiling point due to the strong metal bonds between the metals. They conduct electricity because they have a sea of delocalised electrons. **[6]**

back of paper

20* Furthermore ionic bonds have strong ionic forces between the ions.

This is a Level 2 (4 mark) response.

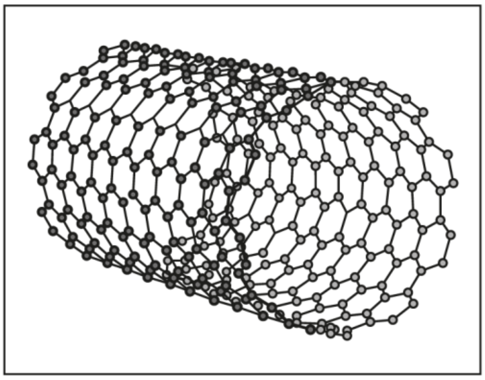
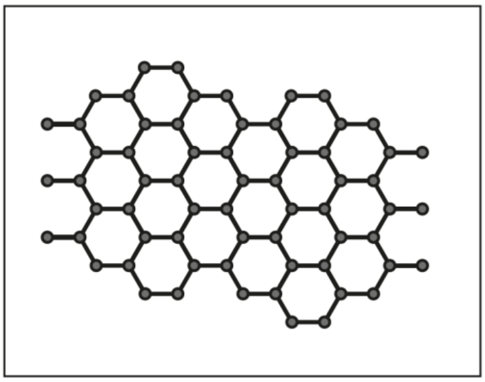
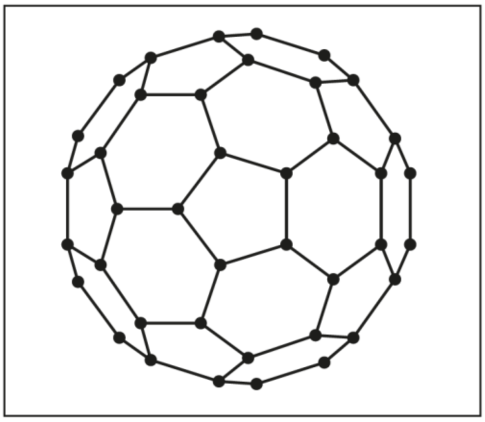
The candidate has demonstrated clear knowledge and understanding to identify the bonding in J as ionic, in K as simple covalent and in L as metallic.

They have given an incorrect explanation of the electrical conductivity of substance J and have not offered any explanation for substance J's melting and boiling points. The properties of substance K (both electrical conductivity and melting & boiling points) are explained clearly, but not in detail. There is a clear, but not detailed explanation of the electrical conductivity of L.

Question 21 (a)

21 This question is about allotropes of carbon.

(a) Draw lines to connect each **allotrope structure** with its correct **name**.

Allotrope structure	**Name**
	Buckminsterfullerene
	Graphene
	Nanotube

[2]

Most candidates correctly named all three allotrope structures.

Question 21 (b) (i)

(b) Graphite is used to make electrodes because it conducts electricity and has a high melting point.

(i) Explain why graphite conducts electricity.

....

....

.... **[2]**

Most candidates described that graphite conducts electricity because of delocalised electrons. However, some did not gain both marks because they did not then expand their answer to describe that the electrons can move, or they wrote about electrons carrying electricity or current, rather than charge.

Question 21 (b) (ii)

(ii) Explain why graphite has a high melting point.

Use ideas about structure and bonding in your answer.

....

....

.... **[2]**

Many candidates only gained one mark for this question as they omitted to describe graphite as having <u>many</u> strong covalent bonds, although most understood that the high melting point was related to the large amount of energy needed to break the bonds. This was another question, like question 20, where a significant number of candidates incorrectly referred to (strong) intermolecular forces needing to be broken, often contradicting what they had correctly written about strong covalent bonds being present.

Question 22 (a)

22 A student reacts solid calcium carbonate, $CaCO_3$, with nitric acid, HNO_3.

Calcium nitrate, $Ca(NO_3)_2$, carbon dioxide and water are made.

Calcium nitrate is soluble in water.

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

Include state symbols.

.... **[3]**

A significant number of candidates did not score 3 marks because they wrote (*l*) as the state symbol for HNO_3 and/or $Ca(NO_3)_2$. Very few errors were seen in the formulae for the reactants and products, and most candidates were able to balance the equation correctly. Other errors noted by examiners were $Ca(NO_3)_2$ as (s) despite the clue in the Question that it is soluble in water, and H_2O as (aq). State symbols were sometimes omitted altogether.

Question 22 (b) (i)

(b) The student measures the volume of carbon dioxide every 10 seconds.

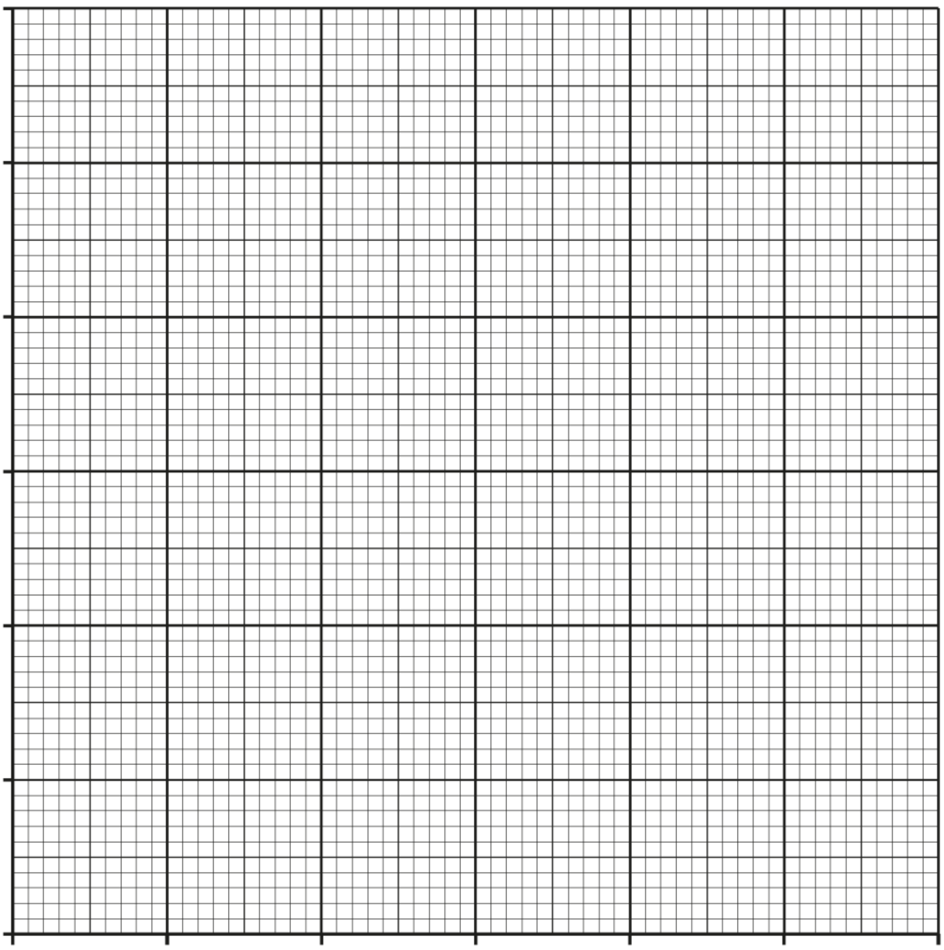
Table 22.1 shows the student's results.

Table 22.1

Time (s)	Volume of carbon dioxide (cm^3)
0	0
10	15
20	31
30	
40	45
50	47
60	47

(i) Plot the results on the graph.

Volume of carbon dioxide (cm^3)



Time (s)

[3]

Most candidates were able to draw linear scales on both axes and plot all points correctly for 3 marks. Many did omit plotting the point at (0,0) but were still credited if their best fit curve started from the origin.

Question 22 (b) (ii)

(ii) Draw a curve of best fit. **[1]**

The curve of best fit was usually drawn well with a sharp smooth line; some candidates needed to take more care to make sure the curve went through all the points, and did not rise above horizontal between 50 and 60s.

Assessment for learning

Candidates should be encouraged to draw graphs in pencil, not pen, so that any errors made can be corrected easily using an eraser. This is much more difficult of they have plotted their graph in pen.

Question 22 (b) (iii)

(iii) Use the graph to estimate the volume of carbon dioxide that has been made after 30 seconds.

Volume of carbon dioxide after 30 seconds = ... cm^3 **[1]**

Most candidates correctly used the graph to estimate the volume of carbon dioxide after 30 seconds.

Question 22 (c)

(c) The student repeats the experiment with a different concentration of nitric acid.

Table 22.2 shows the results of both experiments.

Table 22.2

Time (s)	Volume of carbon dioxide (cm^3)	
	Experiment 1	Experiment 2
0	0	0
10	15	21
20	31	39
30		41
40	45	47
50	47	47
60	47	47

Which experiment had the **higher** concentration of acid?

Explain your answer.

Experiment ....

Explanation ....

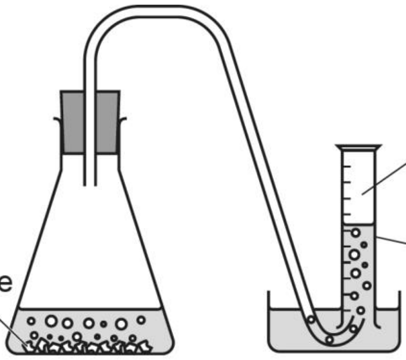
....

[2]

Most candidates recognised that Experiment 2 had the higher concentration of acid. The explanation needed to show use of the results to justify their answer, but some candidates just stated that the reaction in Experiment 2 was faster without further detail, or that more CO_2 was formed without including the concept of time.

Question 22 (d)

(d) The diagram shows the apparatus the student uses.



Suggest another piece of equipment that could be used to measure the volume of carbon dioxide.

.... **[1]**

Most candidates correctly suggested the use of a (gas) syringe.

Question 22 (e)

(e) Calcium nitrate, $Ca(NO_3)_2$, can also be made in the reaction between calcium and nitric acid.

$Ca + 2HNO_3 \rightarrow Ca(NO_3)_2 + H_2$

60 g of calcium reacts with excess nitric acid.

Calculate the mass of calcium nitrate made.

Relative atomic mass (A_r): Ca = 40.1 N = 14.0 O = 16.0

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

Mass of calcium nitrate made = ... g **[4]**

Many candidates correctly calculated the mass of $Ca(NO_3)_2$ made, to 3 significant figures, as 246. Some candidates did not gain marks due to rounding errors during their calculation and/or making a mistake when calculating the formula mass of $Ca(NO_3)_2$, but generally understood the steps needed to calculate the mass of $Ca(NO_3)_2$ made. Most candidates used the method of calculating the number of moles of calcium first and then using the 1:1 ratio to calculate mass of $Ca(NO_3)_2$. Some candidates incorrectly used the formula mass of HNO_3 rather than $Ca(NO_3)_2$ in their calculation.

Exemplar 3

Calculate the mass of calcium nitrate made.

Relative atomic mass (A_r): Ca = 40.1 N = 14.0 O = 16.0

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

40.1 +
14
16
16
16
16
16
16

	Ca +	$2HNO_3$ →	$Ca(NO_3)_2$	+ H_2
Mass	60g		? 245.	536…
Mr	40.1		164.1	
Mole	1.496…		1.496259352	
Ratio	1		1	

Mass of calcium nitrate made = ~~[illegible]~~ 246 g **[4]**

This candidate has clearly tabulated the data for Ca and $Ca(NO_3)_2$. They understand that 1 mol of Ca reacts with 1 mol $Ca(NO_3)_2$. They have calculated the formula mass of $CaNO_3$ and hence the mass of $Ca(NO_3)_2$ made. Their answer is then correctly quoted to 3 significant figures. Had the candidate made an error, their working out is set out very clearly which would have enabled the examiner to give marks for error carried forward. It is also worth noting the good practice by the candidate of underlining the requirement of the question to 'Give your answer to **3** significant figures.'

Question 22 (f)

(f) **Table 22.3** shows the hydrogen ion concentration and the pH for two different acids.

Table 22.3

Acid	Hydrogen ion concentration (mol/dm^3)	pH
Hydrochloric acid	1.0×10^{-1}	1.0
	....	2.0
Sulfuric acid	2.0×10^{-1}	....
	2.0×10^{-3}	2.7

Complete **Table 22.3**. **[2]**

Higher attaining candidates were able to correctly calculate the hydrogen ion concentration and pH. A common incorrect answer was a pH of 4.7. From the working out seen by examiners, candidates had first calculated that 2.0×10^{-1} was 100 x bigger than 2.0×10^{-3}. From the value 2.7 given in the table they had then incorrectly increased the pH by 2 (rather than decreased) to give the answer 4.7. A common incorrect answer for the concentration of hydrogen ions was 2×10^{-2}.

Question 23 (a)

23 Chromium is a shiny transition metal.

(a) The equation shows the displacement reaction between aluminium and chromium oxide.

$2Al(s) + Cr_2O_3(s) \rightarrow Al_2O_3(s) + 2Cr(s)$

Calculate the mass of chromium oxide needed to make 1 mol of chromium.

Relative atomic mass (A_r): Cr = 52.0 O = 16.0

Mass of chromium oxide = ... g **[3]**

This was another calculation which many candidates completed successfully. Lower attaining candidates correctly calculated the formula mass of chromium oxide as 152 and gave this as their final answer. 304 was a common incorrect answer when candidates used the mole ratio the wrong way round.

Question 23 (b)

(b) Calculate the mass of **one** atom of chromium.

Relative atomic mass (A_r): Cr = 52.0

Avogadro constant = 6.02×10^{23}

Mass of one atom of chromium = ... g **[2]**

The most common error in this question was for candidates to divide the Avogadro constant by 52.0.

Question 23 (c)

(c) Chromium is used for electroplating.

Chromium atoms lose electrons at the anode.

Chromium ions, Cr^{3+}, gain electrons at the cathode.

Write **balanced** half equations to show the reactions at each electrode.

Anode ....

Cathode ....

[4]

High attaining candidates gained all 4 marks for this question demonstrating their knowledge that oxidation occurs at the anode and reduction at the cathode. If full marks were not gained, candidates tended to most commonly gain marks from the cathode half equation. The anode equation proved to be more challenging for many with candidates unsure how to represent the loss of electrons in the equation. Chromium ions were sometimes shown with incorrect charges, and chromium atoms often shown as Cr_2. Some candidates wrote half equations for aluminium or oxygen/oxide, possibly because they were reactants in the original displacement equation at the start of question.

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