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GCSE (9–1)

Examiners' report

GATEWAY SCIENCE CHEMISTRY A

J248

For first teaching in 2016

J248/03 Summer 2023 series

Version 1

ocr.org.uk/science

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 3 series overview

J248/03 is the first of two examination units for candidates entered for the Higher Tier of the GCSE examination for Gateway Science Chemistry A. This unit assesses teaching 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 displaying the ability to analyse information. The practical skills specified in section C7 of the specification form the basis of 15% of the marks on the paper. 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.

J248/03 has an equal emphasis on knowledge and understanding of the assessment outcomes from the specification and application of this knowledge. There are fewer questions which assess analysis of information and ideas.

There was no evidence to suggest that candidates were short of time in answering the paper. The majority of candidates answered all of the multiple-choice questions. In Section B, there was a very low question omission rate.

Section A of the paper has 15 multiple-choice questions, each worth 1 mark. Candidates should be given the opportunity to practise these types of questions under timed conditions. In particular, candidates should be encouraged not to spend too long on any question but also to read the whole question including all the possible responses. Other helpful tips include using 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 response at the end of the examination) and eliminating incorrect options as they read through the question.

Several questions required candidates to analyse information and ideas. Candidates should be encouraged to practise interpreting data both qualitatively and quantitatively from different sources. In particular, candidates need to use numerical data to identify trends and patterns rather than just restating the data given in a question.

There were several questions where candidates needed to carry out a numerical calculation. Where an equation needs to be recalled, candidates should be encouraged to write the equation down as a first step. Candidates should practice setting out their working clearly so that, if they make an error, the examiner can follow their working out and give marks for an error carried forward. Most candidates showed their working out, but this was often random and difficult to interpret. Candidates should also be encouraged to pay careful attention to whether a question requires an answer to a particular number of significant figures or decimal places.

Where a question suggests that candidates can include a labelled diagram in their response, centres should encourage candidates to do so. For example, in Question 20 (a) candidates who drew a clear, labelled diagram were able to gain full marks from their diagram and a short description.

Question 19 (a) 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 the question set in a logical way with clear explanations, and many candidates were able to do this.

There were a number of questions where an explanation was required. Candidates should be encouraged to use the number of answer lines and the marks for the sub-part as a guide to the length of their responses. Candidates should also make sure that they use appropriate chemistry terminology correctly in their answers.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• constructed and balanced symbol and half equations for familiar and unfamiliar reactions: Question 16 (b) (ii), 19 (c), 22 (c) (ii) • performed standard and novel calculations following the required rubric (e.g. clear working, units and, where needed, significant figures) calculating mean mass of product: Question 16 (b) (i), relative formula mass: Question 20 (c) (ii), mass of product: Question 22 (a) (i), number of molecules: Question 22 (a) (ii) • produced a clear, concise and well-structured answer for the Level of Response question, Question 19 (a) • applied knowledge and understanding to questions set in a novel context.	• found it difficult to apply what they had learnt to unfamiliar situations • found it difficult to construct and balance ionic and half equations reactions: Questions 16 (b) (ii), 19 (c), 22 (c) (ii) • found it difficult to analyse data and then make a judgement, or draw a conclusion, in relation to the data, e.g. Questions 17 (b) (ii),18 (d) (ii), 21 (a), 21 (c) • found it difficult to analyse information to describe experimental procedures, e.g. Question 20 (a) • showed imprecise use of scientific terminology, e.g. Questions 18 (d) (i), 20 (c) (iv), 21 (b).

Section A overview

Candidates were able to successfully demonstrate their knowledge and understanding on the multiple-choice questions, with a high percentage of candidates answering all 15 questions correctly. Mistakes most commonly occurred on Questions 4, 9 and 13. All of the multiple-choice questions in Section A were attempted by all candidates.

Question 3

3 A carbon nanotube is 1.4×10^{-9} m wide. A human hair is 1.4×10^{-4} m wide.

How many times wider is the hair compared to the nanotube?

A 100

B 1000

C 10 000

D 100 000

Your answer ☐ **[1]**

Misconception

B was a common misconception in this question, possibly because candidates saw 10^{-4} in relation to the human hair and made a link to an answer with four zeros.

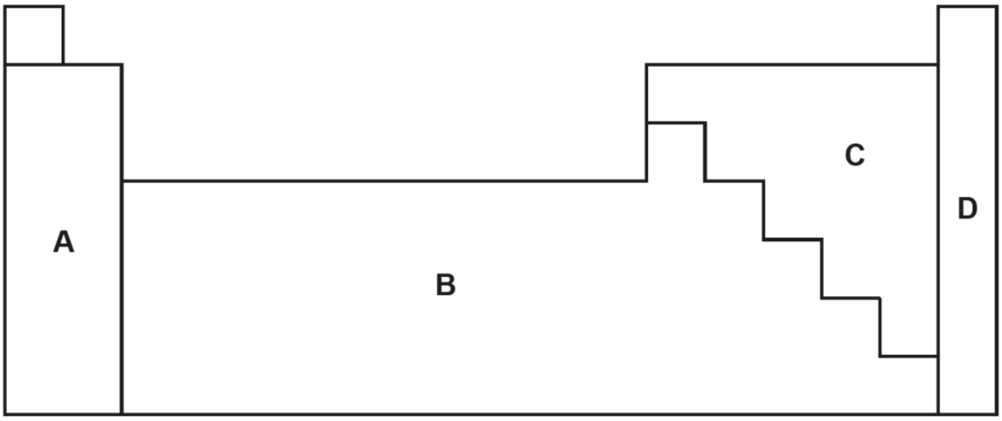
OCR support

The Mathematical Skills Handbook provides both teachers and students support on the use of mathematical skills in GCSE Science, including the use of standard form. It can also be used in conjunction with the Mathematical skills check in to assess student skills.

Question 4

4 An element reacts with oxygen to form an **acidic oxide**.

Which area of the Periodic Table is the element from?



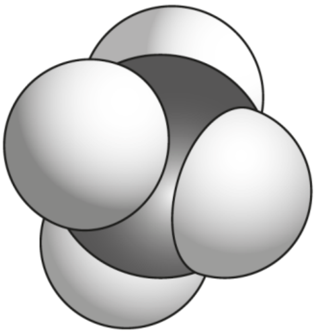
Your answer [1]

Misconception

A was a common misconception in this question, with candidates identifying the Group 1, 2 and 3 metals rather than knowing that non-metals form acidic oxides.

Question 5

5 The diagram shows a 3D space filling model of methane.



What are the limitations of showing methane as a 3D space filling model?

A It does not show how close together the atoms are.

B It does not show how many electrons are in a bond.

C It does not show the relative size of the atoms.

D It does not show the relative volume that the atoms take up.

Your answer ☐ **[1]**

Misconception

C was a common misconception in this question. Candidates often thought that a 3D space filling model does not show the relative size of the atoms, which is actually an advantage of representing a molecule using a 3D space filling model.

Question 9

9 Which statement about an oxidising agent is correct?

A It gains oxygen in a reaction.

B It is oxidised in a reaction.

C It is reduced in a reaction.

D It loses electrons in a reaction.

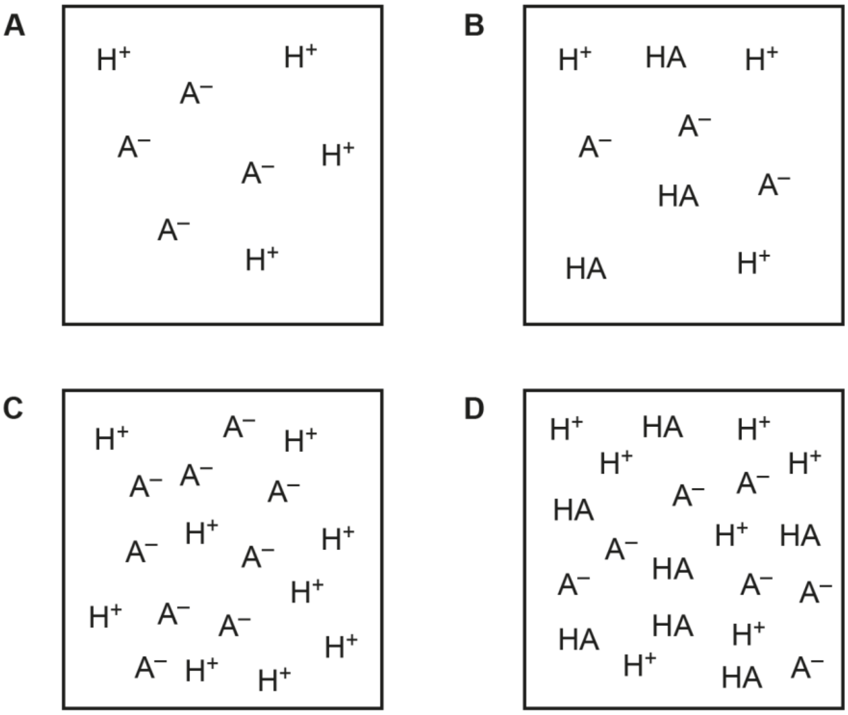
Your answer ☐ **[1]**

Misconception

? D was a common misconception in this question. Candidates had clearly made the link between oxidation and loss of electrons, whereas the question related to an oxidising agent which is reduced (so gains electrons) in a reaction.

Question 13

13 Which diagram represents a **strong**, **dilute** acid?



Your answer [ ] **[1]**

Misconception

C and D were common misconceptions in this question. Candidates frequently confused the terms strong and concentrated, which led them to choose the diagrams which showed concentrated solutions.

Question 14

14 What is the correct balanced equation for the combustion of hexane, C_6H_{14}?

A $C_6H_{14} + 13O_2 \rightarrow 6CO_2 + 7H_2O$

B $C_6H_{14} + 6O_2 \rightarrow 6CO_2 + 7H_2O$

C $2C_6H_{14} + 19O_2 \rightarrow 12CO_2 + 14H_2O$

D $2C_6H_{14} + 26O_2 \rightarrow 12CO_2 + 14H_2O$

Your answer ☐ **[1]**

All possible incorrect responses were seen in this question.

Section B

Question 16 (a)

16 A scientist is studying acids and alkalis.

(a) Which statement about acids and alkalis is **correct**?

Tick (✓) **one** box.

A reaction between an acid and an alkali is neutralisation. ☐

Acids form OH^- ions in solution. ☐

Alkalis have a pH of less than 7. ☐

Sodium hydroxide, NaOH, is an example of an acid. ☐

[1]

Most candidates were able to identify the correct statement. The most common incorrect response was that alkalis have a pH of less than 7.

Question 16 (b) (i)

(b) The scientist reacts sulfuric acid with insoluble magnesium carbonate, $MgCO_3$.

They repeat the experiment two more times.

The table shows their results.

	Experiment 1	**Experiment 2**	**Experiment 3**
Mass of magnesium sulfate, $MgSO_4$, produced (g)	4.37	4.31	4.38
Mass of magnesium carbonate, $MgCO_3$, remaining (g)	1.33	1.38	1.32

(i) Calculate the mean mass of magnesium sulfate, $MgSO_4$, made.

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

Mean mass of magnesium sulfate = ... g **[3]**

4.31 was often picked out as an anomaly and not included in the mean calculation. However, where this occurred, candidates overall went on to successfully score 2 marks for error carried forward for correctly processing the other two numbers. Candidates need to be made aware that tiny differences in measurements of mass (in this case 0.06 g) are not a large enough difference to be considered an anomaly.

Question 16 (b) (ii)

(ii) Complete the **balanced symbol** equation for the reaction.

Include state symbols.

H_2SO_4 (aq) + $MgCO_3$(s) → $MgSO_4$(aq) + ... (......) + ... (......)

[2]

Many candidates correctly completed the equation by writing H_2O(l) and CO_2(g). However, some candidates who correctly wrote H_2O and CO_2 then incorrectly gave the state symbol for water as (aq). Common incorrect responses were CO_3 and H_2 as the products.

Question 16 (b) (iii)

(iii) How does the scientist remove the unreacted solid magnesium carbonate, $MgCO_3$(s)?

.... **[1]**

Most candidates knew that the unreacted magnesium carbonate is removed by filtration.

Question 16 (b) (iv)

(iv) How does the scientist obtain **pure dry** magnesium sulfate crystals from magnesium sulfate solution?

.... **[1]**

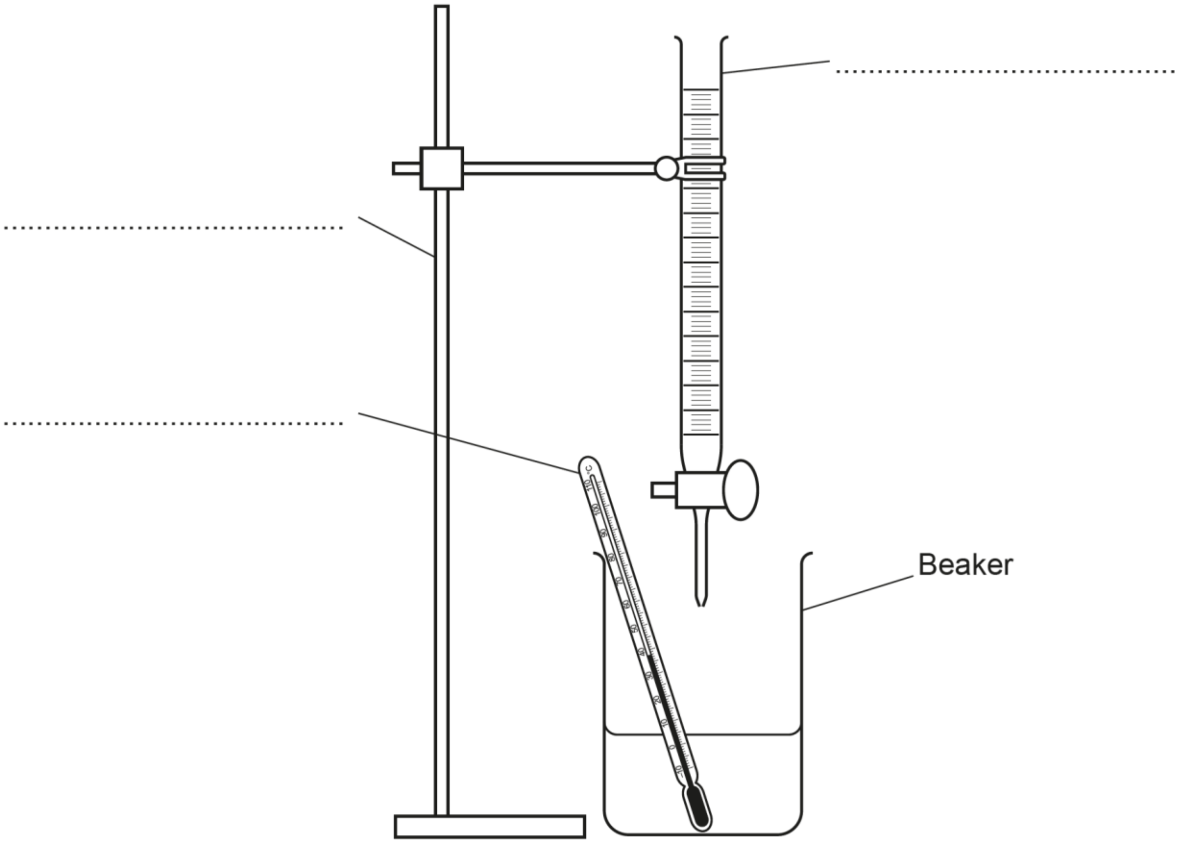
Most candidates knew that pure dry magnesium carbonate is obtained by crystallisation or evaporation of the solvent.

Question 17 (a) (i)

17 (a) A student does an experiment to find out the temperature change of the reaction between an acid and an alkali.

The diagram shows the student's experiment.

(i) Label the equipment in the diagram.



[3]

Most candidates correctly labelled the thermometer and clamp stand but there were a significant number who could not label the burette. Incorrect responses included pipette, measuring tube and dripping tube. Some candidates labelled the stand as a clamp.

OCR support

The Practical support guide has suggestions for alternative practicals to support the delivery of each practical activity group. Giving students as many opportunities as possible to gain confidence with apparatus remains an important part of GCSE Chemistry. The Supplement Student booklet may also prove helpful for students to interact with multiple contexts for practical techniques.

Question 17 (a) (ii)

(ii) Suggest **one** change the student can make so that the temperature change is measured more accurately. Use the diagram.

....

.... **[1]**

Insulating the beaker or using an electronic thermometer were common correct responses. Less successful responses saw candidates write about repeating the experiment to calculate an average or standing the thermometer up to a vertical position to improve accuracy.

Question 17 (b) (i)

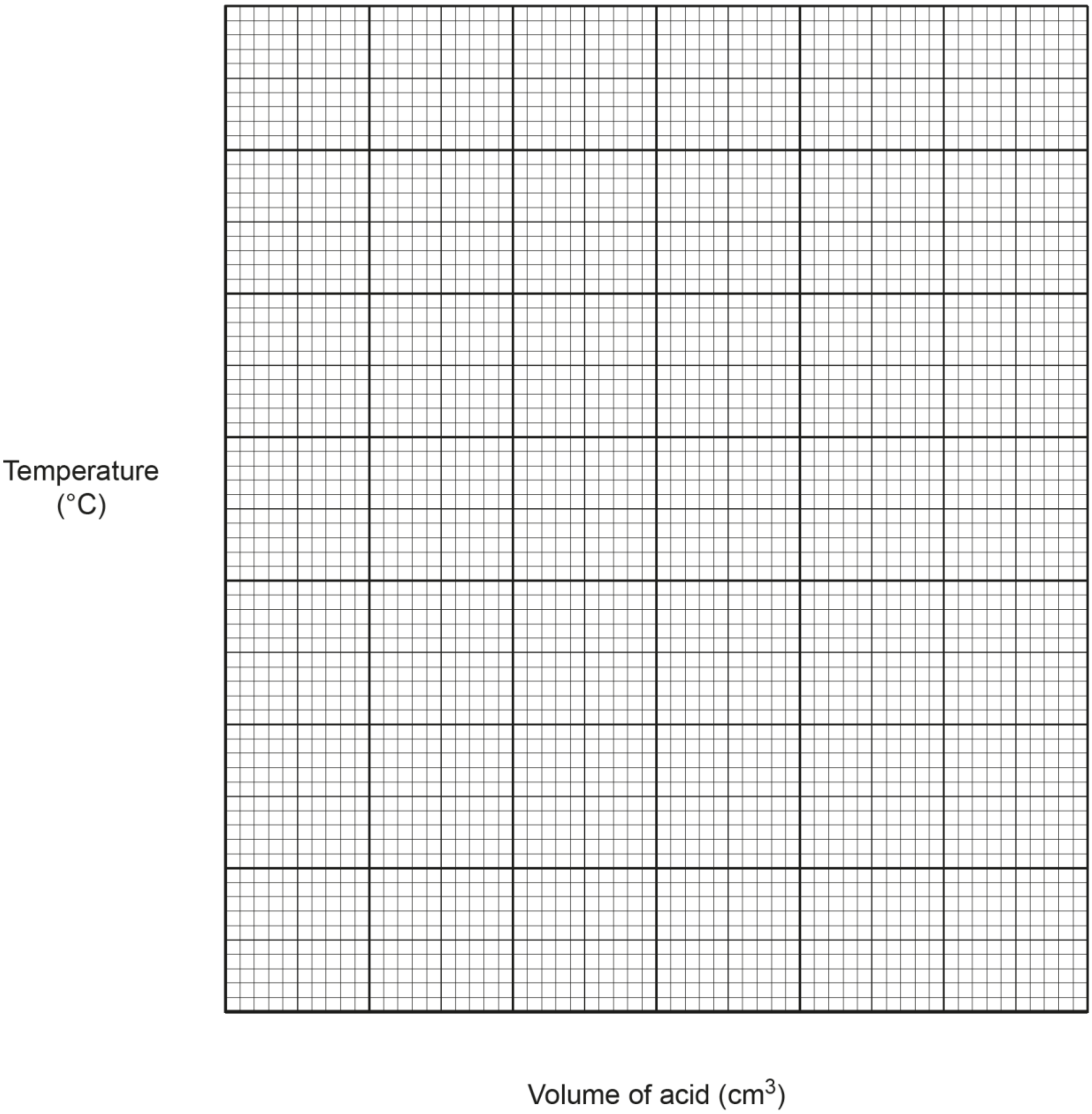
(b) The student adds the acid, 5 cm^3 at a time, to the alkali in the beaker.

The student records the temperature of the solution after each addition of acid.

The table shows their results.

Volume of acid (cm^3)	**Temperature (°C)**
0	18
5	20
10	23
15	26
20	27
25	26
30	24

(i) Plot the results from the table on the grid.



[2]

Most candidates were able to successfully draw and plot the graph. The mark for the linear scale on both axes tended to be lost where candidates had gone from 0 to 15/16/17 on the y-axis without the use of a broken axis. Incorrect plots were rare.

Question 17 (b) (ii)

(ii) Describe what happens to the temperature measured as the acid is added.

....

....

.... **[2]**

Most candidates correctly analysed the data to conclude that the temperature initially increased, before decreasing after 20 cm^3 of acid is added. Less successful responses included only the first statement.

Question 17 (b) (iii)

(iii) The reaction is exothermic.

Explain how you can tell this from the student's results.

....

.... **[1]**

Successful responses to this question stated that the temperature increased in the student's experiment. Many candidates gave the definition of an exothermic reaction, i.e. a reaction that gives out energy. This did not answer the question, which asked candidates to refer to the student's results.

Misconception

? Some candidates stated that the temperature decreases in an exothermic reaction. This comes from a misconception that energy being given out during a reaction results in the temperature falling.

Question 17 (c)

(c) The activation energy for the student's reaction is 132 kJ / mol.

Complete the sentence to state the meaning of activation energy.

Activation energy is the minimum ....

.... **[1]**

Most candidates correctly stated the meaning of activation energy.

Question 18 (a)

18 (a) The model of the atom has developed over time.

Describe the experiment **and** results that Rutherford, Geiger, and Marsden used to determine that an atom has a nucleus.

....

....

....

....

.... **[3]**

This experiment was well known by candidates, with most scoring 2 or 3 marks. Some candidates wrote about expected results, e.g. Rutherford, Geiger, and Marsden expected most/all of the particles to pass through the gold foil, rather than stating that this was what they actually observed. Other candidates did not mention that most of the alpha particles passed straight through the gold foil.

Question 18 (b)

(b) Which statements about atoms are **correct**?

Tick (✓) **two** boxes.

A proton has a positive charge and a relative mass of 1.	☐
An atomic radius is approximately 1×10^{-12} m.	☐
An electron has a negative charge and a relative mass of 1.	☐
Most of the mass of the atom is in the nucleus.	☐
The radius of an atom is much smaller than the radius of a nucleus.	☐

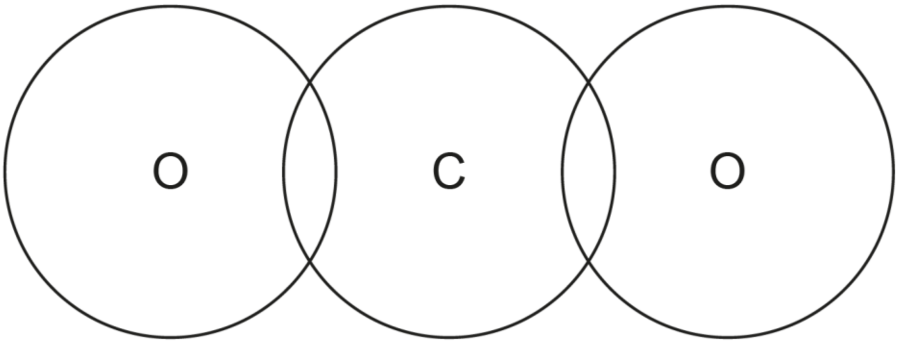
[2]

Most candidates identified the two correct statements.

Question 18 (c)

(c) Complete the dot and cross diagram to show the bonding in carbon dioxide, CO_2.

You only need to show the outer shell electrons.



[2]

This question required candidates to draw a correct 'dot and cross' diagram. Many excellent diagrams were seen by examiners. Less successful candidates tended to include diagrams showing only one shared pair of electrons between the carbon and oxygen atoms.

Question 18 (d) (i)

(d) (i) At –78 °C, and 0.1 MPa pressure, carbon dioxide changes state from a solid to a gas.

Changing state from a solid to a gas is called **subliming**.

Describe what happens to the **movement** and **arrangement** of the particles when a solid turns into a gas. Use the particle model.

....

....

....

....

.... **[3]**

Many candidates, even higher attaining candidates, did not gain marks on this question usually because they did not give direct comparisons, choosing instead to make general statements, e.g. stating that particles are arranged regularly in a solid but then not stating their arrangement in a gas. Less successful responses saw candidates write about bulk properties of solids and gases such as referring to gas particles being able to take the shape of the container.

Exemplar 1

they move from a closely packed, fixed position in a solid to a far apart position in a gas moving in all directions. This is because the particles gain kinetic energy so move further apart and move faster.

This exemplar illustrates a clear response to this question in which the candidate has described what happens to the movement and arrangement of the particles when a solid changes to a gas. The answer is comparative, as required by the question.

Question 18 (d) (ii)

(ii) Carbon dioxide can be a liquid at different pressures and temperatures.

Pressure (MPa)	Melting point (°C)	Boiling point (°C)	Sublimation point (°C)
0.1			–78
1.0	–56	–40	

State a temperature and a pressure at which carbon dioxide is a **liquid**.

Explain your answer.

Temperature .... °C Pressure .... MPa

Reason ....

....

....

[3]

Most candidates correctly selected a temperature and pressure at which carbon dioxide is a liquid, although a common misconception was that carbon dioxide is a liquid at its melting point of -56°C. Fewer candidates scored the marks for the explanation with many attempting to wrap up the other 2 marks in a single sentence, hence not answering either condition in the detail required. Very few scored the mark for explanation of their choice of pressure.

Question 19 (a)*

19 A scientist wants to make copper using electrolysis.
They consider two different electrolysis experiments using inert electrodes as shown in the table.

	Experiment 1	**Experiment 2**
Electrolyte	molten copper chloride	copper sulfate solution
Electrode the scientist collects product from	anode	cathode

(a)* Predict and explain what will be made at the electrode the scientist collects the product from in each experiment.

Determine which experiment the scientist should use to make copper.

....

....

....

....

....

.... **[6]**

This 6 mark Level of Response question assessed AO2 and AO3. At Level 3 (5 – 6 marks) candidates needed to accurately apply their knowledge and understanding to give a detailed explanation of the product made at each electrode in each experiment and determine that the scientist should use Experiment 2. All candidates attempted the question which generated a wide range of responses and discriminated well. High attaining candidates demonstrated an excellent level of understanding relating to the electrolysis of copper sulfate solution, with many writing about the presence of hydrogen ions and how the reactivity series determines which product is discharged at the cathode, although some did not explain where the hydrogen ions had come from. These candidates also tended to support their answers with correct half equations. Some candidates stated the rules they had learnt for what is produced in a solution during electrolysis, for example, oxygen is produced if no halogen present, which didn't demonstrate a complete understanding. A common incorrect response seen was that sulfur would be produced at the anode. Many candidates did not explicitly discuss the charges on the ions and electrodes but were able to identify the correct products and the use of Experiment 2 to collect copper to achieve Level 2 and 4 marks.

Exemplar 2

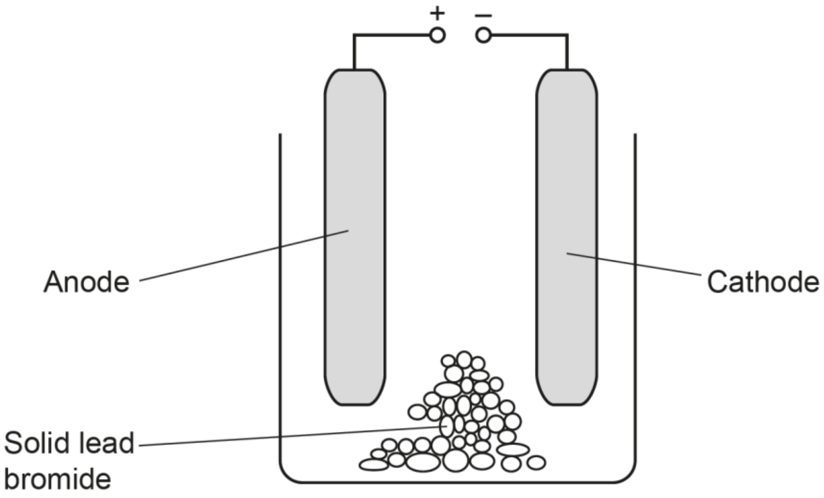
As both experiments have inert electrodes it means the electrodes won't reactive with the electrolyte. In experiment 1 molten copper chloride is used meaning ~~factors~~ two ions are present Cu^{2+} and Cl^- (copper and chloride ions) this means as copper is positive the Cu^{2+} goes to the ~~cathode~~ ~~(negative~~ cathode / negative electrode where the Cu^{2+} is reduced and Cu is produced. In comparison in Experiment 2 there are 4 ions present Cu^{2+}, SO_4^{2-}, H^+, OH^- as its a solution. And still as ~~copper~~ Cu^{2+} is positive and ~~hydrogen~~ H^+ is positive it both gets attracted to the cathode where ~~hydrogen gas~~ copper will be produced at the electrodye and ~~copper~~ H^+ will stay in the solution because hydrogen is more reactive. In experiment 1 scientist collects from anode **[6]** not cathode meaning copper wont be taken by scientist but instead chlorine gas will be produced at anode and thats what will be collected by the scientist. The scientist should use experiment 2 because then copper is retrievable through cathode where scientist is collecting product from but also doesn't produce toxic substance like chlorine which is seen in experement 1

This is a Level 3 response which correctly determined that the scientist should use Experiment 2. The candidate has accurately applied their knowledge and understanding of electrolysis to explain the product made at each electrode in the experiment. This response was given 6 marks.

Question 19 (b)

(b) Another scientist investigates the electrolysis of lead bromide.

The diagram shows their experiment.



The experiment does **not** make any lead.

State **two** changes the scientist should make so that lead is made.

1 ....

....

2 ....

.... **[2]**

Successful responses to this question stated that the lead bromide needed to be molten for electrolysis to occur, but fewer candidates appreciated that the electrodes need to touch the electrolyte. Common incorrect answers included switching the electrodes around, making the lead bromide a solution, connecting the circuit together because they misunderstood the +/- symbol at the top of the diagram, adding a power supply, using inert electrodes, and adding an electrolyte to the beaker.

Misconception

The difference between molten and aqueous liquids was a common misconception. Some candidates wrote about molten solutions. Most were unaware that lead bromide is insoluble.

Question 19 (c)

(c) Complete the **balanced half** equation for the production of bromine from bromide ions.

$$2Br^{-} - \text{.............} \longrightarrow \text{.............}$$

[2]

Most candidates correctly completed the half equation. The main error was not knowing that bromine is a diatomic molecule.

Question 20 (a)

20 (a) A scientist has a sample of seawater. The sample contains sand, water and salt.

The scientist wants to collect **pure** samples of:

- sand
- water
- salt.

Describe a method the scientist could use to separate and collect the sand, water and salt.

You can include labelled diagrams in your answer.

....

....

....

....

....

....

.... **[4]**

Most candidates were able to describe the separation of sand, water and salt using filtration, distillation, and crystallisation. Less successful candidates missed out the distillation step and wrote about filtration followed by crystallisation.

Assessment for learning

Candidates should be encouraged to include **labelled** diagrams in questions that ask them to describe an experimental method. Many candidates scored the majority, if not all, of the marks in this question from labelled diagrams.

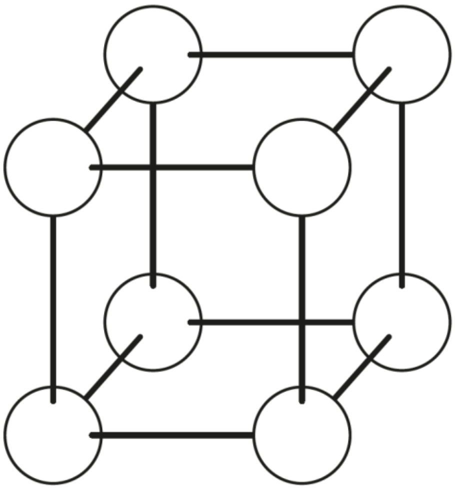
OCR support

Our Candidate Exemplars show how this can be used to good effect and is a great way of showing students how to make the most of this skill.

Question 20 (b)

(b) The salt collected is sodium chloride.

Complete the ball and stick model by labelling the sodium ions and the chloride ions.



[2]

Some candidates omitted this question, and many candidates labelled the circles as Na and C*l* rather than Na^+ and Cl^-. S/S^+ instead of Na/Na^+ was a common error. Some candidates who correctly labelled the ions did not appreciate that the ions alternate in the lattice structure.

Question 20 (c) (i)

(c) Seawater can contain isotopes of sulfur.

(i) Draw **three** lines to connect each **isotope** with its correct **description**.

Isotope	Description
16 **S** 32	This isotope contains 17 neutrons.
16 **S** 33	This isotope has a full outer shell of electrons.
16 **S** 34	This isotope has more protons than neutrons.
	This isotope has the highest mass number.
	This isotope has the same number of neutrons and protons.

[2]

Most candidates correctly matched the three isotopes to their descriptions.

Question 20 (c) (ii)

(ii) Some of this sulfur in seawater is in the form of magnesium sulfate, $MgSO_4$.

What is the relative formula mass of a sample of magnesium sulfate, $MgSO_4$, where all of the sulfur atoms are the isotope sulfur-33?

Sulfur-33 is

16
S
33

Relative atomic mass (A_r): O = 16.0 Mg = 24.3

Relative formula mass = ... **[2]**

Most candidates correctly calculated the relative formula mass of magnesium sulfate. The most common incorrect response was 24.3 + 33 + 16 = 73.3.

Question 20 (c) (iii)

(iii) A scientist wants to separate magnesium sulfate from other compounds using thin layer chromatography.

The spot does **not** move from the start line on the chromatogram.

State what the scientist should change so that magnesium sulfate is separated from the other compounds.

.... **[1]**

Many candidates correctly stated the need to change the solvent.

The most common incorrect responses were:

- use gas chromatography
- melt the magnesium sulfate
- increase the concentration of the solvent or use more solvent
- change the stationary phase
- add water.

Question 20 (c) (iv)

(iv) Explain why magnesium sulfate has a high melting point.

....

....

.... **[2]**

Successful responses to this question described the strong electrostatic attraction between oppositely charged ions, which needs lots of energy to overcome. Less successful responses referred to intermolecular forces, even after identifying the bonding in magnesium sulfate as ionic.

Assessment for learning

Candidates should be encouraged to use correct terminology. Many candidates attempted to explain the high melting point of magnesium sulfate in terms of covalent bonds or intermolecular forces. The term intermolecular forces appeared to be used by candidates without understanding of what they are or what type of structure possesses them.

Question 21 (a)

21 **Table 21.1** shows information about four different substances.

Table 21.1

Substance	Melting point (°C)	Appearance	Electrical conductor?
1	1085	shiny solid	yes
2	770	white crystals	yes when dissolved in water
3	120	flexible solid	no
4	78	white crystals	no

(a) Which of the substances is a polymer?

Explain your answer.

Substance ....

Reason ....

....

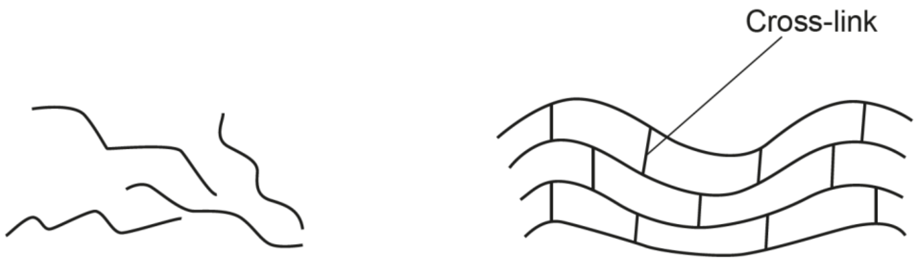
.... **[3]**

Many candidates correctly identified Substance 3 and were able to give two correct reasons for their choice. Some candidates, despite correctly selecting Substance 3 as the polymer, wrote about its melting point of 120°C being high. The most common incorrect choice was Substance 1 with the reasoning being that polymers have high melting points.

Question 21 (b)

(b) **Fig. 21.1** shows two different polymer structures.

Fig. 21.1



Explain why polymers without cross-links can stretch more than polymers with cross-links.

....

....

.... **[2]**

The chemistry of polymer structures was not well known by candidates, with very few candidates referencing chains of polymers. Most candidates just wrote about layers being able to slide over each other. Some candidates did score 1 mark for recognising that the cross-links were covalent bonds. Many talked about the layers not being attached together so the polymer could easily be stretched.

Exemplar 3

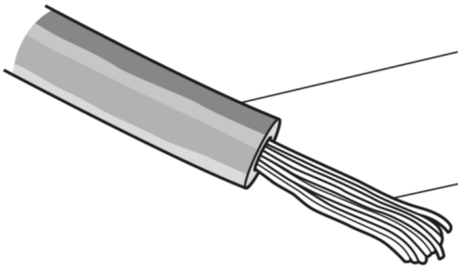
Cross links are really strong covalent bonds meaning the polymer structure is rigid. The other polymer has weak forces between chains so layers can slide over each other **[2]**

This response illustrates a correct, 2 mark response. The candidate has identified that cross-links are covalent bonds and realised that polymer chains without cross-links can slide over each other.

Question 21 (c)

(c) **Fig. 21.2** shows an electrical cable.

Fig. 21.2



Which substance from **Table 21.1** would be best to use to make each part of the electrical cable?

Explain your answers.

Part A ....

Reason ....

Part B ....

Reason ....
[3]

Most candidates selected the correct substances from the table and explained their answers. Some candidates selected Substance 1 for Part A and Substance 3 for Part B. Candidates should be encouraged to read questions carefully as a common error was not selecting substances from Table 21.1 but instead naming materials, e.g., rubber/plastic for Part A and copper/metal for Part B.

Question 22 (a) (i)

22 Magnesium nitrate decomposes when heated to form magnesium oxide.

$$2Mg(NO_3)_2 \rightarrow 2MgO + 4NO_2 + O_2$$

(a) (i) Calculate the **mass** of oxygen made when 0.45 moles of magnesium nitrate decomposes.

Relative atomic mass (A_r): O = 16.0.

Mass of oxygen = ... g **[3]**

Many candidates correctly calculated the mass of oxygen as 7.2g. The most common incorrect response was 14.4g because while candidates had correctly calculated the formula mass of oxygen as 32, they hadn't used the mole ratio to determine that the number of moles would be 0.225. Some candidates calculated the M_r of O_2 as 64 because they multiplied 16 x 6.

Question 22 (a) (ii)

(ii) Calculate how many **molecules** of nitrogen dioxide, NO_2, are produced from 0.45 moles of magnesium nitrate.

The Avogadro constant is 6.02×10^{23}.

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

Number of molecules of NO_2 = ... **[3]**

The most common error was the incorrect calculation of moles of NO_2, but many candidates went on to multiply their value by Avogadro's number for error carried forward marks. Higher attaining candidates showed a good understanding of 3 significant figures. The most common incorrect answer was 2.71 x 10^{23} from multiplying the 2 numbers given in the question together. Some candidates incorrectly divided Avogadro's number by the number of moles of NO_2.

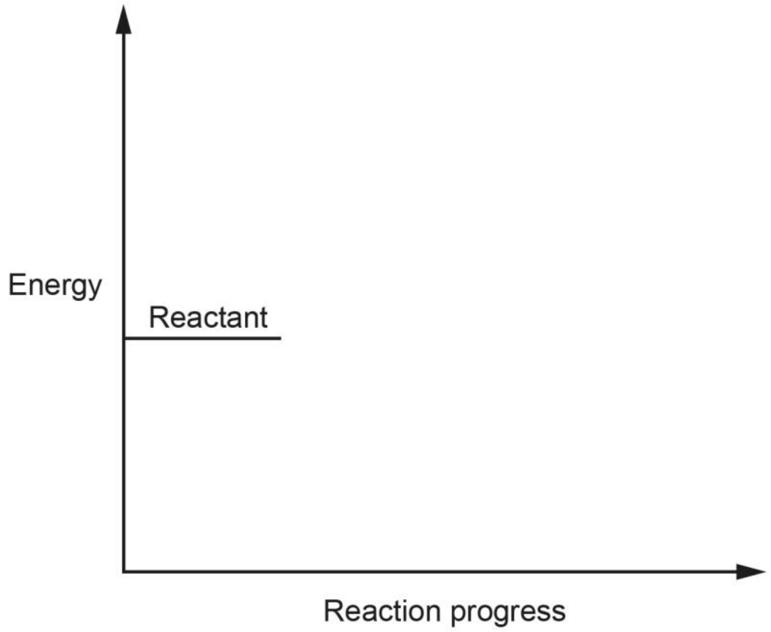
Question 22 (b)

(b) The decomposition of magnesium nitrate is an **endothermic** reaction.

Complete the reaction profile for an endothermic reaction.

Include the labels:

- products
- activation energy
- energy change of reaction.



[4]

Most candidates drew the correct profile for an endothermic reaction. However, double headed arrows were commonly seen which indicates a lack of understanding of what the diagram shows. The GCSE Science Exam Hints for students highlighted that energy profile diagram arrows are single headed, show direction of energy change and extend to the limits of the change.

Question 22 (c) (i)

(c) Magnesium nitrate is an ionic compound.

(i) Explain why magnesium forms Mg^{2+} ions.

....

.... **[1]**

Many candidates did not give enough detail in their responses, for example stating that magnesium has 2 electrons on its outer shell but failing to explain that it loses them to become the 2+ion. Statements that magnesium loses two electrons were also seen, with no reference to the electrons being lost from the outer shell, or to allow the magnesium atom to become stable.

Question 22 (c) (ii)

(ii) A solution containing magnesium ions reacts with a solution containing hydroxide ions.

Solid magnesium hydroxide is made.

Write the **balanced ionic** equation for this reaction.

.... **[2]**

The formula for magnesium hydroxide was frequently incorrect despite many candidates correctly using Mg^{2+} and OH^- ions in the reactant side of their equations. Common errors were MgOH and $MgOH_2$. The GCSE Science Exam Hints for students highlighted that when writing the chemical formula of an ionic compound, candidates need to remember the charges have to balance in ionic formulas.

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