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OCR
Oxford Cambridge and RSA

GCSE (9–1)

Examiners' report

GATEWAY SCIENCE CHEMISTRY A

J248

For first teaching in 2016

J248/03 Summer 2024 series

Version 1

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Contents

Introduction

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

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

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

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

Paper 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, the majority of candidates attempted all of the questions.

Several questions (for example 18 (c) (ii), 20 (b) and 22 (a)) required candidates to analyse information and ideas, including data in graphical form. 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, for example 16 (a), 16 (b) (ii), 18 (b), 19 (b) (iv) and 22 (c) (ii). Where an equation needs to be recalled, candidates should be encouraged to write the equation down as a first step. Last year's examiners' report 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 although the vast majority of candidates showed their working out this was still sometimes not set out clearly and therefore difficult to interpret.

Question 21 (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 are a number of questions where an explanation is 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 answers. Candidates should also make sure that they use appropriate chemistry terminology correctly in their answers. Use of incorrect terminology was a common reason for candidates not gaining marks e.g. in Question 21 (b) (i).

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• used bond energy data to calculate the energy change for a reaction, including recalling that the energy change is equal to energy transferred when bonds break – energy transferred when bonds form **(Questions 18 (b) (i) & (ii)**) • described how Rutherford's atomic model was an improvement on Thompson's "plum pudding" atomic model (**Question 19 (a)**) • recalled the typical radius of an atom and used this to calculate the number of Mg^{2+} ions that would fit across a sample of Mg metal (**Question 19 (b) (iv)**) • used a knowledge of acidity and pH to describe how to make a solution with a lower pH (**Question 19 (c) (ii)**) • produced a clear, concise, and well-structured answer for the Level of Response question explaining, using correct terminology, why the melting point of diamond is higher than that of poly(ethene) or chlorine (**Question 21 (a)**) • explained in terms of ions why ionic compounds conduct electricity when dissolved in water but not when solid (**Question 21 (b) (i)**) • calculated the theoretical mass of a reactant using mole ratio, and then calculated the mass used from the data given (**Question 22 (c) (ii)**).	• did not appreciate the advantage of using a polystyrene cup, rather than a beaker, when investigating energy changes in reactions (**Question 18 (c) (i)**) • were unable to draw particle model diagrams for a solid and a liquid (**Question 20 (a) (i)**) • could not explain the limitations of the particle model (**Question 20 (a) (iii)**) • confused ideas about covalent bonds and intermolecular forces in the Level of Response question (**Question 21 (a)**) • drew a dot and cross diagram for magnesium chloride showing sharing of electrons (**Question 21 (b) (ii)**) • calculated the theoretical mass of a reactant using mole ratio, but then incorrectly calculated the mass used from the data given (**Question 22 (c) (ii)**).

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 high percentage of candidates answering all 15 questions correctly. Mistakes most commonly occurred on Questions 7, 8, 9, 10 and 11. Questions 8 and 9 were the most challenging in this section. All of the MCQs in Section A were attempted by all candidates.

Many candidates had taken on board advice from last year's examiners' report to 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 7

7 Which products are formed in the electrolysis of sodium chloride solution?

	Anode	**Cathode**
A	chlorine	hydrogen
B	chlorine	sodium
C	oxygen	hydrogen
D	oxygen	sodium

Your answer [ ] **[1]**

Selecting option B was a common misconception in this question, being the products formed in the electrolysis of molten sodium chloride. Candidates should be encouraged to read the question carefully and to underline key words, e.g. 'solution' in this case.

Question 8

8 How did Mendeleev group elements together to develop his Periodic Table?

A Based on chemical properties and left gaps

B Based on mass number and atomic number

C Based on physical properties and atomic number

D Based on physical properties and left gaps

Your answer [ ] **[1]**

Only the higher attaining candidates recalled that Mendeleev grouped elements based on chemical properties and left gaps with D being a common incorrect answer.

Question 9

9 What is the mass of one atom of beryllium, Be?

Relative atomic mass (A_r): Be = 9.0.

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

A 6.64×10^{-24} g

B 1.50×10^{-23} g

C 2.41×10^{24} g

D 5.42×10^{24} g

Your answer [ ] **[1]**

Selecting option D was a common misconception with candidates multiplying the relative atomic mass of beryllium by the Avogadro constant rather than dividing by the Avogadro constant.

Question 10

10 Zinc reacts with iron chloride to form zinc chloride and iron.

$Zn + FeCl_2 \rightarrow ZnCl_2 + Fe$

What is the **balanced ionic equation** for this reaction?

A $Zn + Fe^{+} \rightarrow Zn^{+} + Fe$

B $Zn + Fe^{2+} \rightarrow Zn^{2+} + Fe$

C $Zn + 2Fe^{+} \rightarrow Zn^{2+} + 2Fe$

D $2Zn + Fe^{2+} \rightarrow 2Zn^{+} + Fe$

Your answer ☐ **[1]**

The charges on the zinc ion and the iron ion were not well known, with examiners seeing all possible incorrect responses. Candidates could be encouraged to use the 'criss-cross/crossover' rule to work out the charges on the ions in an ionic compound from the formula.

Question 11

11 Molten aluminium oxide, Al_2O_3, is electrolysed.

Which row of the table shows the reactions at the electrodes?

	Cathode	Anode
A	$Al^{3+} + 3e^{-} \rightarrow Al$	$O^{2-} \rightarrow O_2 + 2e^{-}$
B	$Al^{3+} \rightarrow Al + 3e^{-}$	$O^{2-} + 2e^{-} \rightarrow O_2$
C	$Al^{3+} + 3e^{-} \rightarrow Al$	$2O^{2-} \rightarrow O_2 + 4e^{-}$
D	$Al^{3+} \rightarrow Al + 3e^{-}$	$2O^{2-} + 4e^{-} \rightarrow O_2$

Your answer ☐ **[1]**

Selecting option D was a common misconception in this question indicating that candidates did not recall that reduction occurs at the cathode and oxidation occurs at the anode.

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 21(a). 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, too, which was very pleasing to see. In some of the longer answer questions, a large proportion of the candidates re-stated the same point in several different ways; this gained no extra marks but often resulted in candidates writing below the answer lines and trying to squash an answer in which then became very difficult to read. Candidates should be encouraged to use the number of lines within a question as a guide to the length of answer required.

Question 16 (a) (i)

16

(a) A scientist investigates dissolving four different tablets in water.

Each tablet has a different surface area.

They add each tablet to 20 cm^3 of water and time how long it takes for the tablet to dissolve.

The table shows their results.

Tablet	Surface area of tablet (cm^2)	Volume of tablet (cm^3)	Surface area to volume ratio	Time taken to dissolve (seconds)
A	2.8	0.3	9.33 : 1	43
B	2.5	0.2	12.5 : 1	27
C	1.5	0.2		62
D	3.0	0.2	15.0 : 1	

(i) Calculate the surface area to volume ratio of tablet C.

Surface area to volume ratio = ... **[2]**

Most candidates correctly calculated the surface area to volume ratio as 7.5 : 1. Some candidates correctly divided 1.5 by 0.2 and gave an answer of just 7.5, which gained 1 mark only.

Question 16 (a) (ii)

(ii) Complete the sentence to describe the relationship between the surface area to volume ratio and the time taken to dissolve.

As the surface area to volume ratio .... ,

the tablet will take .... time to dissolve. **[1]**

Most candidates correctly analysed the data in the table to state that as the surface area to volume ratio increases the tablet will take less time to dissolve.

Question 16 (a) (iii)

(iii) The scientist thinks that tablet D will dissolve **slowest** in 20 cm^3 of water.

Explain why the scientist is **incorrect**.

....

....

.... **[2]**

Most candidates appreciated that tablet D has the largest surface area to volume ratio and would therefore dissolve the fastest or take the least time to dissolve. A lack of comparison between tablet D and the other tablets resulted in some candidates not gaining marks.

Misconception

?

A significant number of candidates stated that tablet D will dissolve in the fastest time, which did not gain the second mark. Candidates should be encouraged to use correct scientific terminology, i.e. shortest time/fastest rate.

Question 16 (b) (i)

(b) The scientist performs thin layer chromatography on solutions of each of the tablets.

(i) The spots on the chromatogram are **colourless**.

State what the scientist could use to see the spots.

.... **[1]**

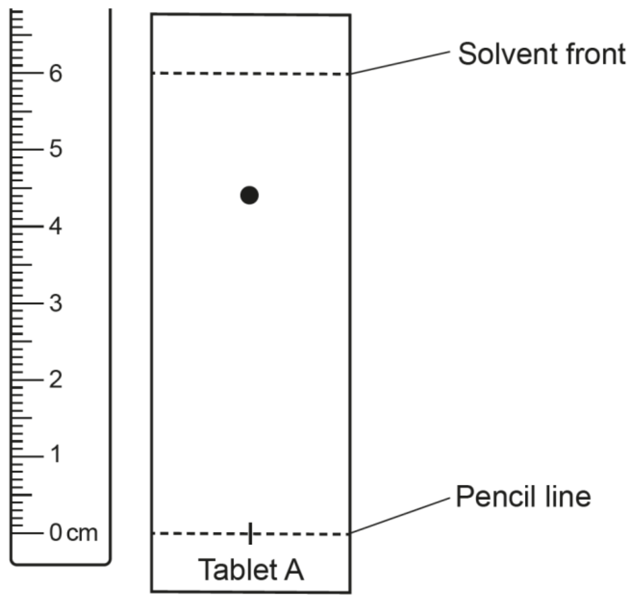
Many candidates, even higher attaining candidates, were not aware of the use of locating agents, stains, or UV light in chromatography. 'Indicator' was a common incorrect response.

OCR support

Activity 2: Chromatography of leaf chloroplasts, available on Teach Cambridge, has extension questions about locating agents. It also includes an exemplar chromatogram gram to practise calculating R_f values and should be used to reinforce learning following a class practical.

Question 16 (b) (ii)

(ii) After the scientist uses a method to see the spots, the chromatogram for Tablet A is shown.



Calculate the R_f value for the spot seen from tablet A.

R_f value = ... **[3]**

Most candidates understood how to determine the R_f value from the chromatogram by taking measurements, writing the formula, and showing their working out. A frequent error was the spot measurement given as 4.5 cm because candidates had measured from the top rather than the centre of the spot which resulted in an R_f value of 0.75 rather than 0.73. When candidates had shown their working out, examiners gave 2 marks allowing error carried forward.

Question 17 (a)

17 A student wants to separate a mixture of compounds.

Different separation methods are used depending on the mixture.

(a) Draw lines to connect each **separation method** to the correct **mixture**.

Separation method	Mixture
Crystallisation	Insoluble solid and liquid
Filtration	Solution containing a soluble solid dissolved in a liquid
Fractional distillation	Three liquids with different boiling points

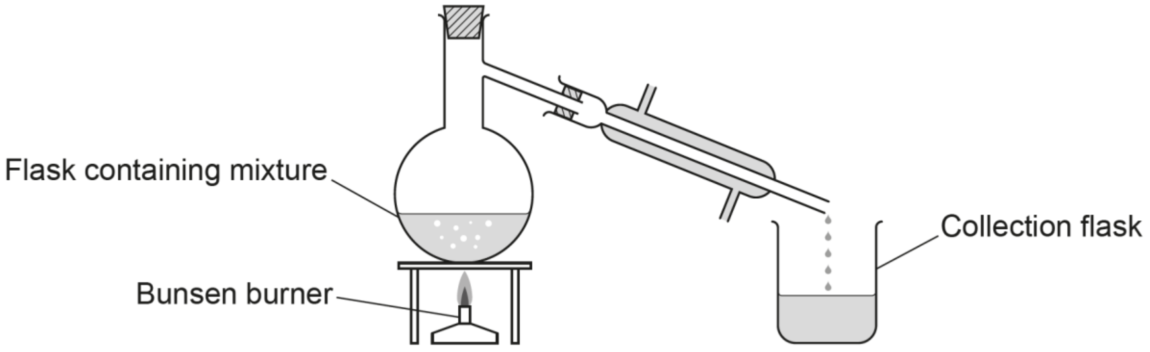
[2]

Almost all candidates gained 2 marks for this question. When candidates did not it tended to be because they had crystallisation and filtration the wrong way round.

Question 17 (b) (i)

(b) The student decides to use simple distillation to separate a mixture.

They set up the apparatus shown in the diagram.



(i) A liquid in the mixture is **flammable**.

Suggest a change the student could make to the apparatus to make the distillation safer.

....

.... **[1]**

Most candidates recognised the hazard being posed by the Bunsen flame and were able to correctly suggest the use of a water bath or electric heater. The most common incorrect answers included moving the flask higher above the Bunsen burner, placing a heat proof mat under the equipment, or putting a gauze between the flask and tripod.

Question 17 (b) (ii)

(ii) The student wants to record the boiling point of the pure liquid that is collected in the collection flask.

Suggest an improvement the student could make to the apparatus so that they can record the boiling point.

....

.... **[1]**

Most candidates identified that a thermometer would enable the boiling point to be measured but there were many who stated incorrectly that it should be put into the collection flask.

Question 17 (c)

(c) The pure liquid collected has the molecular formula $(C_2H_5)_2O$ and a boiling point of 35 °C.

Which statements about the pure liquid are **correct**?

Tick (✓) **two** boxes.

The empirical formula is CH_2.	☐
The melting point is lower than 35 °C.	☐
The pure liquid contains two compounds.	☐
The pure liquid is an element.	☐
The pure liquid will be a gas at above 35 °C.	☐

[2]

Most candidates were able to interpret the data about the pure liquid and correctly ticked the second and fifth boxes. It is worth centres highlighting to candidates that they should note how many boxes they are required to tick in questions of this type. Some candidates only ticked one box.

Question 17 (d)

(d) Calculate the relative formula mass of a $(C_2H_5)_2O$ molecule.

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

Relative formula mass = ... **[3]**

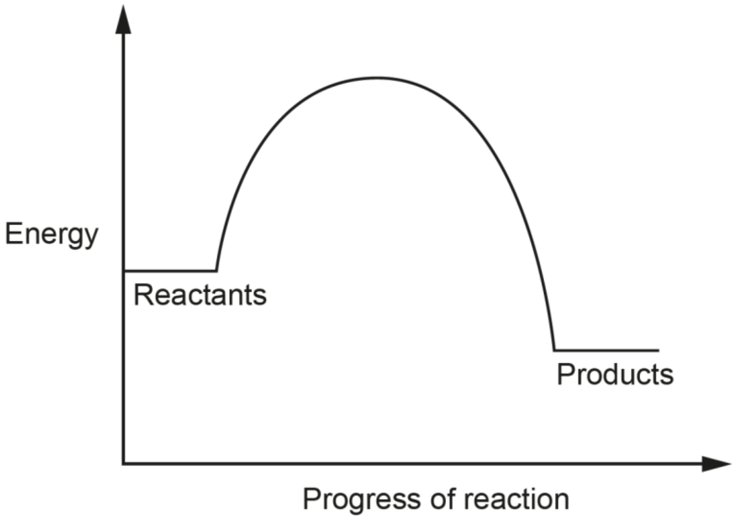
Virtually all candidates correctly calculated the relative formula mass as 74.

Question 18 (a) (i)

18 A scientist is studying two chemical reactions.

One reaction is exothermic, and one reaction is endothermic.

(a) The reaction profile for the exothermic reaction is shown.



(i) Explain how you can tell the reaction profile is for an **exothermic** reaction.

....

.... **[1]**

Many high quality responses to this question were seen with candidates recognising that they needed to refer to the reaction profile diagram. However, there were many references to bond breaking/making or energy being lost, which examiners ignored.

Question 18 (a) (ii)

(ii) Describe **one** difference and **one** similarity the scientist will see in the reaction profile for the endothermic reaction.

Difference ....

....

Similarity ....

....

[2]

This question differentiated between candidates well. When marks were not gained it tended to be because responses were not detailed enough or because candidates wrote about energy being absorbed or released without reference to how they knew that from the energy profile.

Most candidates referred to seeing activation energy on the diagrams as a similarity. Some wrote about both diagrams having a curve but did not refer to it being the same shape. Other common responses, which lacked sufficient detail to gain marks, were statements that both diagrams show reactants and products or an energy change (without stating that the energy will increase then decrease between the reactants and the products).

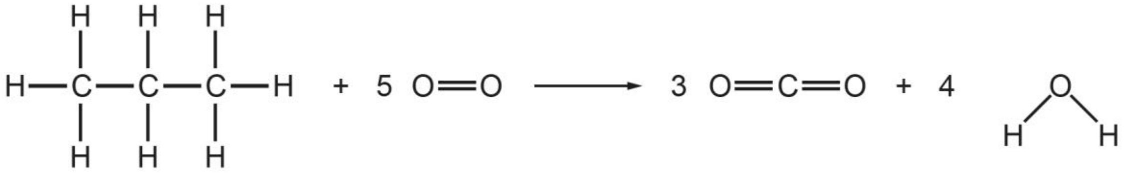
Question 18 (b) (i)

(b) One of the reactions the scientist is studying is the combustion of propane.

This is the balanced symbol equation for the reaction.

$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

The equation can be written using the following formulas.



The table shows the bond energies.

Bond	C–C	C–H	O=O	C=O	O–H
Bond energy (kJ/mol)	347	412	498	799	465

(i) Calculate the energy transferred when all the bonds form in the products.

Energy transferred = ... kJ/mol **[3]**

This question was well answered in many cases, with candidates setting out their working clearly. However, candidates do need to ensure they read the question carefully as many included calculations involving the reactants as well. Occasionally candidates calculated the overall energy change for the reaction which resulting in them only gaining 2 of the 3 marks available.

Question 18 (b) (ii)

(ii) The energy transferred when all the bonds break in the reactants is 6480 kJ / mol.

Use your answer to part **(b)(i)** to calculate the energy change for this reaction.

Energy change = ... kJ / mol **[2]**

Candidates who had correctly answered Question 18 (b) (i) tended to gain 2 marks for this question as well. The most common incorrect answer was +2034 kJ/mol due to subtracting the energy transferred when all the bonds break in the reactants from their answer to part (b) (i).

Question 18 (c) (i)

(c) A student studies a different reaction.

They want to find out if it is exothermic or endothermic.

(i) Some possible steps for a method are given in the list.

Write **five** steps from the list in the correct order to describe the method the student should use.

A	Add the solid to the solution.
B	Cover the top of the reaction with a lid.
C	Cover the top of the reaction with cotton wool.
D	Put on safety goggles.
E	Put the solution into a beaker and use a thermometer to record the temperature before the reaction starts.
F	Put the solution into a polystyrene cup and use a thermometer to record the temperature before the reaction starts.
G	Use a thermometer to record the temperature as the reaction progresses.

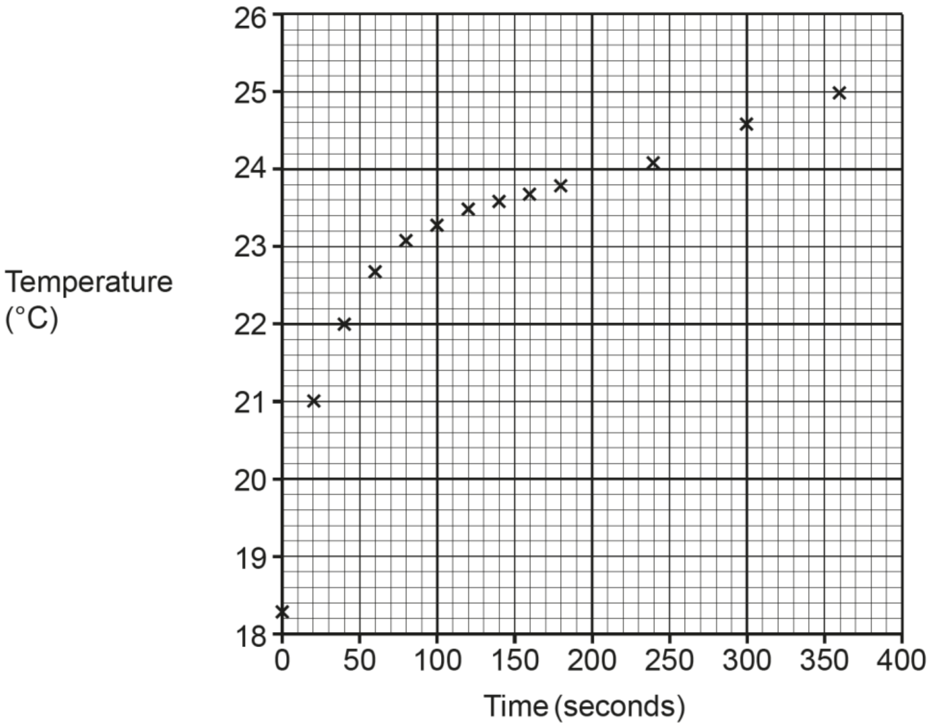
Step 1	Step 2	Step 3	Step 4	Step 5

[3]

Many candidates were able to select the correct steps and place them in order. However, where a mark was dropped it tended to be when candidates selected the use of a beaker (E) rather than a polystyrene cup (F) for step 2. This implies that many candidates lack the knowledge of the benefits of polystyrene as an insulator compared to glass and its use to study exothermic reactions.

Question 18 (c) (ii)

(ii) The student plots their results on a graph.



The student concludes that the reaction is **exothermic**.

Explain why the student is **correct**.

....

....

....

.... **[2]**

Good responses to this question stated that the temperature increased in the student's experiment, explaining that this was due to energy being released to the surroundings. However, there were many candidates who wrote about energy being lost.

Question 19 (a)

19 Many scientists were involved in the development of the atomic model.

(a) Describe **two** ways Rutherford's atomic model was an improvement on Thomson's "plum pudding" atomic model.

1 ....

....

2 ....

.... **[2]**

This question discriminated well. Responses from less successful candidates lacked clarity and often did not refer to the nucleus. Some candidates described the gold leaf experiment without detailing what it proved while others wrote about electrons orbiting the atom rather than the nucleus. References to neutrons being in Rutherford's model was also quite common.

Exemplar 1

1 Rutherfords model ~~cente~~ included a nucleus at the centre which contained most of the atoms mass

2 Rutherfords model proved most of the atom was empty space whereas Thompsons had particles across the atom

This response clearly describes two differences between Rutherford's atomic model and Thomson's "plum pudding" model. The first statement is clear that it is the <u>nucleus</u> at the centre of the atom which contains most of the atom's mass. Lower attaining candidates tended to just say that most of the mass is in the centre.

The second statement is clear that most of the atom is empty space.

Question 19 (b) (i)

(b) Atoms are either oxidised or reduced to form ions.

(i) Complete the sentences about how atoms form ions.

Atoms are .... to form positive ions. Atoms ....

electrons to form positive ions.

Atoms are .... to form negative ions. Atoms ....

electrons to form negative ions.

[2]

Most candidates gained both marks for this question. Those who gained only 1 mark usually knew that atoms lose electrons to form positive ions and gain electrons to form negative ions but confused oxidation and reduction.

Question 19 (b) (ii)

(ii) The table shows information about three different ions.

Complete the table.

Ion	Number of protons	Number of neutrons	Number of electrons	Mass number
Mg^{2+}	12	....	10	24
F^{-}	9	10	....	19
Li^{+}	3	4	2	....

[2]

Most candidates were able to complete the table correctly. The most common error was that the F^{-} ion has 9 electrons, but also a mass number of 6.9 was seen for Li^{+} indicating that some candidates are unclear about the difference between mass number and relative atomic mass.

Question 19 (b) (iii)

(iii) The element lithium exists as isotopes.

State one difference and one similarity between the Li^{+} ions formed from different isotopes of lithium.

Difference ....

....

Similarity ....

.... **[2]**

Good responses to this question stated that isotopes have a different number of neutrons and the same number of protons. The most common incorrect response was that isotopes have a different number of electrons, presumably because candidates had focused on Li^{+} in the question rather than the ions formed from different isotopes.

Question 19 (b) (iv)

(iv) A sample of magnesium metal is 5.2 cm wide.

Estimate how many Mg^{2+} ions would fit across the width of the sample of magnesium metal.

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

Estimated number of Mg^{2+} ions = ... **[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. Candidates who were able to recall the radius of an atom in m often then did not ensure 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 magnesium metal sample.

Question 19 (c) (i)

(c) Ions are also formed when acids and alkalis dissolve in water.

(i) Which statements about acid solutions are **correct**?

Tick (✓) **two** boxes.

A dilute solution has a low ratio of acid to volume of solution.	☐
A dilute solution of acid contains more acid than a concentrated solution.	☐
A strong acid can be made into a concentrated solution or a dilute solution.	☐
A strong acid partially ionises in solution.	☐
A weak acid can only be made into a dilute solution.	☐

[2]

Most candidates correctly ticked the first and third boxes.

Question 19 (c) (ii)

(ii) A student makes an acid solution with a pH of 3.

Describe two things the student could do to make a solution with a lower pH.

1 ....

....

2 ....

....

[2]

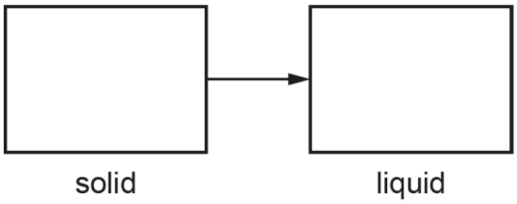
This question demonstrated a wide range of understanding around acid strength and concentration, and it tended to be the higher attaining candidates who performed well. Of those that gained 2 marks, most wrote about increasing concentration or adding more acid. Many talked about using a strong acid rather than a stronger one. The idea of using less water or using a higher ratio of acid to water was not seen so often in candidates' responses. Some candidates incorrectly suggested evaporating the solution to remove water (without linking to increasing H^+ concentrations) or to remove OH^- ions.

Question 20 (a) (i)

20

(a) The particle model can be used to show changes of state.

(i) Complete the diagram to show what happens to the particles as a solid changes to a liquid.



[2]

The solid diagram was generally drawn well but candidates were often unable to represent the differences between particles in a solid and a liquid in a convincing way. Many of the liquid diagrams represented particles in a more random order but often the particles were not touching.

Question 20 (a) (ii)

(ii) Which statements about changes of state are **correct**?

Tick (✓) **two** boxes.

Boiling describes a gas turning into a liquid. ☐

Freezing is a chemical change. ☐

Melting is a physical change. ☐

The amount of energy needed to melt a substance depends on the strength of the forces between particles. ☐

The arrangement of particles becomes more random during condensing. ☐

[2]

Most candidates correctly ticked the third and fourth boxes.

Question 20 (a) (iii)

(iii) The particle model has limitations when showing changes of state.

Explain **two** limitations of the particle model.

1 ....

....

2 ....

....

[2]

Many good responses to this question were seen from higher attaining candidates who were able to write about the limitations of the particle model, usually with regards to the shape and size of the particles. Very few referred to particles being inelastic. Common incorrect answers included the model not showing space between particles or movement of particles.

Misconception

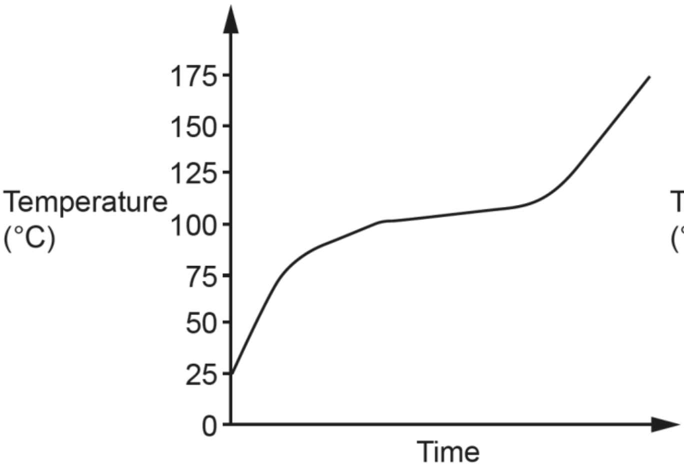
A common misconception was reference to bonds between particles rather than the fact that the model does not take into account the forces of attraction between the particles.

Question 20 (b)

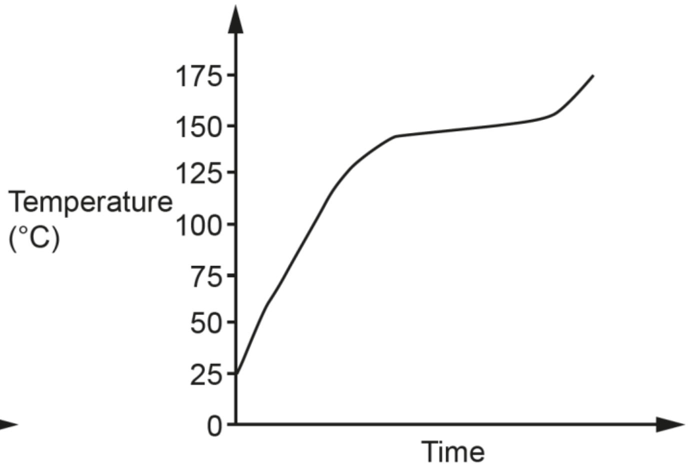
(b) A scientist needs to choose a **solid** formulation that will be used at **high** temperatures.

The graphs show how the temperature changes as three different formulations, **A**, **B** and **C**, are heated.

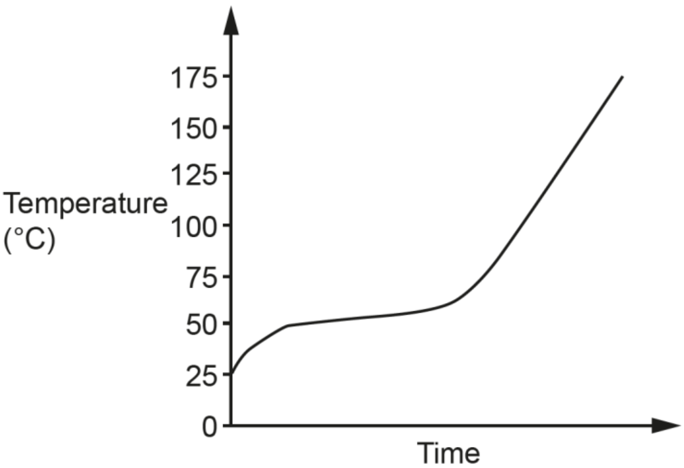
Formulation **A**



Formulation **B**



Formulation **C**



Which formulation should the scientist choose?

Explain your answer.

Formulation ....

Explanation ....

....

....

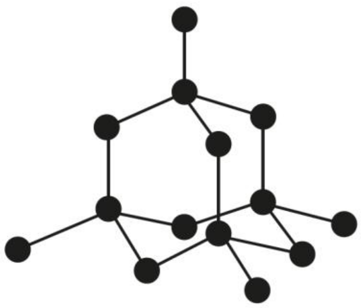
....

[2]

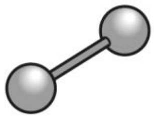
Most candidates correctly selected formulation B, with many then able to explain their choice in terms of melting point to gain 2 marks. Lower attaining candidates focused their answers on comparing the shapes of the graphs, for example the steepness of the lines or the times taken for the lines to plateau, without understanding that this represented the solid melting.

Question 21 (a)*

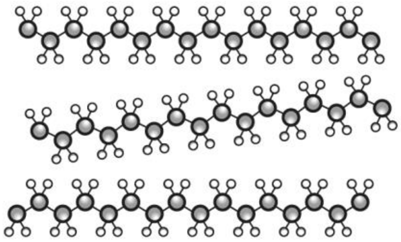
21
(a)* The structures of diamond, chlorine, Cl_2, and poly(ethene) are shown.



Diamond



Chlorine, Cl_2



Poly(ethene)

All the substances contain covalent bonds between the atoms.

Explain which substance has the highest melting point.

Use your knowledge of structure and bonding.

....

....

....

....

....

.... **[6]**

This 6 mark Level of Response question assessed AO1 and AO2. 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 why diamond has the highest melting point. All candidates attempted the question which generated a wide range of responses and differentiated well between those who had a detailed level of knowledge and understanding of the three types of structure and bonding and those who had limited understanding. Most candidates correctly identified diamond as having the highest melting point and there were some excellent answers describing it as a giant covalent structure requiring large amounts of energy to break the many strong covalent bonds.

However, there were a significant proportion of candidates who went on to write about diamond also having intermolecular forces.

Many candidates were able to identify chlorine as a simple covalent molecule and poly(ethene) as a polymer but only those who expanded their answers to include correct reference to intermolecular forces for both achieved Level 3 marks. Many candidates ranked chlorine and poly(ethene) by the number of covalent bonds needing to be broken or wrote about poly(ethene) having crosslinks rather than intermolecular forces.

Exemplar 2

Chlorine has the lowest melting point because it is only a diatomic molecule (the smallest). This means that intermolecular forces are weak and the most easily overcome here. Polyethene has a greater melting point, as it is made up of long chains, which have much stronger intermolecular forces between them as a result of their size. These are only overcome with more energy ~~easily~~, so polyethene has a higher melting point. Finally, diamond is found in the form of giant covalent structures. Due to their size and strong shape, the intermolecular forces in diamond are the strongest ~~stronger~~, so the most ~~more~~ energy is required to overcome them, so ~~it~~ diamond has the highest melting point.

This is a Level 2, (3 mark) response.

Chlorine is identified as having the lowest melting point with weak intermolecular forces, which are most easily overcome. The candidate has also identified chlorine as a simple covalent molecule. Poly(ethene) is identified as a polymer, with stronger intermolecular forces than chlorine. Although the candidate appreciates that diamond is a giant covalent structure, its melting point is then discussed in terms of its intermolecular forces.

This response has demonstrated clear knowledge and understanding of the structure and bonding in some of the structures but has not applied this to explain why diamond has the highest melting point.

Question 21 (b) (i)

(b)
(i) Magnesium chloride is an ionic compound.

Explain why ionic compounds can conduct electricity when dissolved in water, but **not** when solid.

....

....

....

....

.... **[3]**

Good responses to this question described that ionic compounds contain ions. In a solid the ions are held in fixed positions whereas when ionic compounds are dissolved the ions are free to move.

Misconception

A key misconception in this question was that electrical conductivity in ionic compounds is the result of the movement of electrons rather than ions. This led to many candidates gaining no marks for this question.

Question 21 (b) (ii)

(ii) Construct the dot and cross diagram for the ions in magnesium chloride, $MgCl_2$.

Show the outer electron shells only.

Dot and cross diagram:

[2]

Many excellent dot and cross diagrams were seen by examiners. The most common mistake was showing 6 dots and 2 crosses (or vice versa) in the outer shell of a chloride ion or omitting the charges on the ions. There were however a significant proportion of candidates who drew diagrams showing sharing of electrons/covalent bonding.

Question 22 (a)

22 A student is making a sample of magnesium carbonate, $MgCO_3$.

The table gives information about four different methods the student could use.

Method	Cost of starting materials (£)	Mass of $MgCO_3$ produced (g)	Is the $MgCO_3$ pure?
1	12.11	6.24	yes
2	11.37	16.90	no
3	15.23	15.34	yes
4	20.50	10.86	no

(a) Which method should the student use to make their sample?

Explain your answer.

Method ....

Reason..

....

....

.... **[3]**

Most candidates scored 2 marks for identifying method 3 due to the $MgCO_3$ being pure. Less went on to score the third mark because they did not explain why method 3 was a better choice than method 1.

Question 22 (b)

(b) A teacher shows the student how to purify magnesium carbonate.

If the student knows how to purify magnesium carbonate, should they use the **same** method as they used in part **(a)**?

Explain your answer.

....

.... **[1]**

Candidates could respond yes or no to this question, provided they gave a reasonable justification for their answer. The most common answer was no, method 2 should be used because it is cheaper or produced a greater mass of magnesium carbonate. Of those candidates who answered yes that method 3 should still be used, very few scored the mark because they didn't justify it with a valid reason.

Question 22 (c) (i)

(c) The student reacts the magnesium carbonate they have made with hydrochloric acid.

(i) Complete the **balanced equation**.

Include state symbols.

$MgCO_3$(s) + 2HC*l*(aq) → ....(........) + H_2O(l) + ...(........) **[2]**

A common error was writing the state symbol for $MgCl_2$ as (s) but most correctly identified CO_2(g) as the other product. The most common incorrect formula given was MgC*l*.

Question 22 (c) (ii)

(ii) The student uses 0.2 mol of hydrochloric acid in the reaction. The hydrochloric acid is the **limiting reagent**.

At the end of the reaction, 0.82 g of magnesium carbonate is left unreacted.

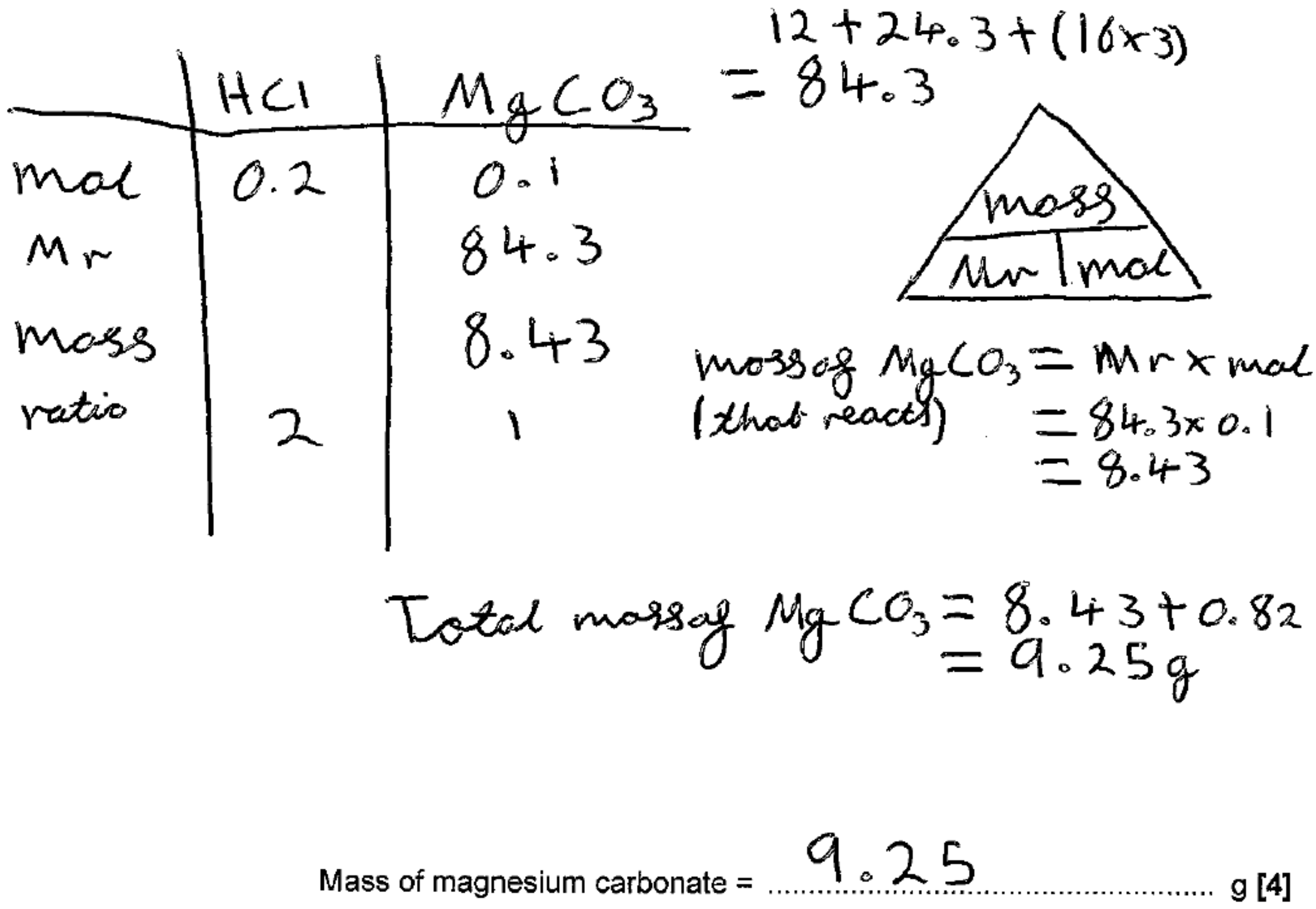
Calculate the mass of magnesium carbonate that the student uses in the reaction.

Relative atomic mass (A_r): C = 12.0 Mg = 24.3 O = 16.0

Mass of magnesium carbonate = ... g **[4]**

Only the highest attaining candidates gained 4 marks, with most not appreciating the idea of a reagent being in excess and that its value should have been added to 8.43g. Common errors included subtracting the excess from 8.43 to give an answer of 7.61g, or not recognising that there was a 2:1 ratio of acid to carbonate. Many candidates set out their calculations in a table showing formula mass, number of moles (or mole ratio) and mass, which was extremely helpful to examiners when looking to give marks for error carried forward.

Exemplar 3



This candidate has clearly tabulated the data for HCl and $MgCO_3$. They understood that 0.2 mol of HCl react with 0.1 mol $MgCO_3$. They have calculated the M_r of $MgCO_3$ and hence the mass of $MgCO_3$ that reacted. Finally, the mass of $MgCO_3$ used in the reaction is calculated by adding the mass of $MgCO_3$ that reacted to the mass left unreacted to obtain the correct answer of 9.25g. They achieved all 4 marks for this response. 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.

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