

GCSE (9-1)

Examiners' report

***GATEWAY SCIENCE COMBINED
SCIENCE A***

J250

For first teaching in 2017

J250/10 Summer 2018 series

Version 1

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Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates. The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report. A full copy of the question paper can be downloaded from OCR.

3-3 grade

Like all exam boards, we have awarded a 'safety net' grade of 3-3 for higher tier GCSE Combined Science candidates in 2018 where appropriate so that they are not disadvantaged by being the first to sit a new GCSE. To help teachers making difficult decisions about higher versus foundation tiers in 2019, OCR will be providing further guidance and extra webinars during the Autumn term.

Paper J250/10 series overview

J250/10 is the second of two higher papers assessing chemistry in the Combined Science A suite. The other four papers in the suite assess biology and physics. This paper assesses content from topics C4–C6 and CS7, with assumed knowledge of C1–C3. This is the first time this qualification has been assessed. To do well on this paper, candidates need to be comfortable applying their knowledge and understanding to unfamiliar contexts and be familiar with a range of practical techniques. There is also an emphasis on knowledge and understanding of the assessment outcomes from the specification.

In questions with 2 marks (e.g. 11d, 14aii, 18a b & c) many candidates did not gain both marks - they do not seem to realise that if there are 2 marks, then 2 reasons/points are required. Exam practice is essential so that candidates understand the requirements of a paper such as 2 points for 2 marks.

Candidate performance overview

Candidates who did well on this paper generally

- Read the question carefully and used all information given.
- Knew basic scientific principles and terminology and used them correctly.
- Were able to interpret data from tables and graphs.
- Had carried out relevant practicals.
- Were able to analyse information and evaluate plans.
- Were able to balance equations correctly.
- Were able to use data correctly to perform calculations and show working, including giving answers to correct decimal places or significant figures.
- Understood the factors that affect rate and equilibrium.

Candidates who did less well on this paper generally

- Did not read the questions carefully and did not use all the information provided.
- Did not use correct terminology e.g. Q15a use of rays rather than radiation and bounce/reflect rather than emit.
- Could not write correct balanced equations.
- Could not evaluate a plan.
- Struggled to interpret data from tables and graphs.
- Did not know the correct unit for time.
- Did not follow instructions in calculations to give correct number of decimal places or significant figures.
- Could not explain the factors that affect rate or equilibrium.

Most candidates had sufficient space to write their answers, with few using the additional answer space. There was no evidence that candidates did not have time to finish the examination.

Section A

Question 1

- 1 Iron can be extracted from its ore by heating it with carbon.

Which statement is the correct explanation for this?

- A Iron is above carbon in the reactivity series.
- B Iron is above copper in the reactivity series.
- C Iron is below carbon in the reactivity series.
- D Iron is below sodium in the reactivity series.

Your answer

[1]

Most candidates correctly gave C as an answer. Some misread the answer for B and gave this instead. Candidates must ensure they take the time to read all the information carefully.

Question 2

- 2 Look at the table.

	Nitrogen	Oxygen	Carbon dioxide	Argon
A	21%	78%	0.04%	0.1%
B	80%	15%	4.5%	0.5%
C	70%	20%	9%	1.0%
D	78%	21%	0.04%	0.9%

Which row in the table shows the percentages of gases in the present day atmosphere?

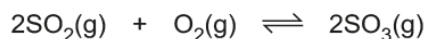
Your answer

[1]

This question was answered well. Again it requires candidates to read all the information carefully.

Question 3

- 3 Look at the equation for the reaction between sulfur dioxide and oxygen to make sulfur trioxide.



The reaction forms a **dynamic equilibrium**.

Which of the following describes dynamic equilibrium?

- A All the reactants and products are gases.
- B The rate of the backward reaction is greater than the rate of the forward reaction.
- C The rate of the forward and backward reactions are equal.
- D The rate of the forward reaction is greater than the rate of the backward reaction.

Your answer

[1]

Almost all candidates gained a mark here. It is important to understand basic principles and definitions.

Question 4

- 4 Fluorine is the most reactive element in Group 7 (Group 17).

Why?

- A Fluorine atoms gain an electron more readily than the other Group 7 elements.
- B Fluorine is a gas.
- C Fluorine exists as diatomic molecules.
- D Fluorine atoms lose electrons more readily than the other Group 7 elements.

Your answer

[1]

Most candidates answered this correctly.

Question 5

- 5 Which statement about the fractional distillation of crude oil is correct?

- A Diesel leaves the fractionating column at the bottom.
- B Petrol leaves the fractionating column at the top.
- C The fractionating column is hottest at the top.
- D The hydrocarbons in crude oil can be separated because they have different boiling temperatures.

Your answer

[1]

Almost all candidates answered this correctly.

Question 6

6 Magnesium is a more reactive metal than copper.

Why?

- A Copper forms positive ions more readily than magnesium.
- B Copper is higher in the reactivity series than magnesium.
- C Magnesium gains electrons more readily than copper.
- D Magnesium loses its outer electrons more easily than copper.

Your answer

[1]

Most candidates answered this correctly.

Question 7

7 Which of these solutions will react with each other?

- A Sodium bromide and iodine
- B Sodium chloride and bromine
- C Sodium chloride and iodine
- D Sodium iodide and bromine

Your answer

[1]

Only the more able answered this question correctly. Candidates need to apply their knowledge here.

Question 8

8 Which statement about the halogens (Group 7 elements) is correct?

- A Astatine is the most reactive halogen.
- B Chlorine has the electronic structure 2.8.7.
- C Fluorine is the element with the darkest colour.
- D The halogens have the molecular formula X_3 .

Your answer

[1]

Almost all candidates answered this correctly.

Question 9

- 9 Why does a catalyst speed up a chemical reaction?
- A It causes the reactants to collide less frequently.
 - B It decreases the overall energy change of the reaction.
 - C It lowers the activation energy of the reaction.
 - D It makes more product.

Your answer

[1]

Most candidates answered this correctly.

Question 10

- 10 Which statement about extracting copper by phytoextraction is correct?
- A Bacteria in the soil absorb the copper ions.
 - B Plant ash is equivalent to a high grade ore.
 - C Plant roots absorb copper metal from the soil.
 - D The plants are crushed to extract the copper ions.

Your answer

[1]

Only the most able candidates answered this correctly. It is new to chemistry specifications and so it may not have been covered in the correct depth. Many candidates incorrectly chose C as they did not understand it was copper ions that are absorbed,

Section B

Question 11(a)

11 A company wants to make a glass to hold a cold drink. They are considering materials **A** and **B**.

Look at the life cycle assessments for a glass made out of materials **A** and **B**.

Process	Material A		Material B	
	Energy used (MJ)	Greenhouse gases made (g of CO ₂)	Energy used (MJ)	Greenhouse gases made (g of CO ₂)
Extracting the raw materials	5.0	2.2	3.8	1.4
Manufacturing of the glass from the raw materials	0.4	0.3	0.4	0.1
Transporting the glasses to the shops	1.5	1.0	3.1	2.2
Process W	2.0	0.6	5.0	1.7
Total

(a) Complete the table to show the totals for each column. [2]

Candidates did well here. Almost all were able to total the columns correctly.

Question 11(b)

(b) Write down the name of process **W**.

..... [1]

Many candidates discussed selling or using the glass. This is not part of the life cycle assessment and so was not creditworthy.

Question 11(c)

(c) It costs more to transport glasses made from material **B**.

Suggest a reason why.

..... [1]

Here candidates had to apply their own knowledge in an unfamiliar context. Most candidates gave reasonable suggestions.

Question 11(d)

(d) Which material should the company choose?

Justify your answer.

.....

.....

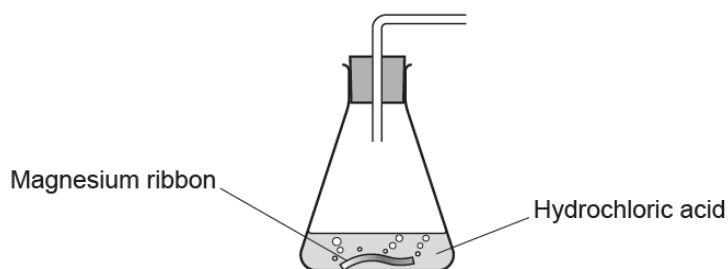
.....

..... [2]

The candidates had to use the totals they calculated to answer this question. Those who made an error in (a) were not penalised and could still gain full marks here if they used their totals correctly. Many did very well here. A few used the figures for extraction and therefore chose B and not A. They were still able to gain a compensatory mark if they explained, showing they had used extraction figures.

Question 12

- 12 A student investigates the rate of reaction between magnesium and hydrochloric acid. The reaction gives off hydrogen gas.



The student wants to investigate how changing the **concentration** of the hydrochloric acid affects the rate of reaction.

Look at her plan.

First experiment

I will put 0.5g of magnesium ribbon into the flask.

I will add 50 cm³ of hydrochloric acid.

I will measure how fast the gas is given off.

Second experiment

I will put another 0.5g of magnesium ribbon into the flask.

I will add 100 cm³ of the same hydrochloric acid.

I will measure how fast the gas is given off.

Another student thinks that the plan will not work and he does not understand exactly what he has to do.

Suggest how the plan for this investigation can be improved.

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.....

.....

..... [4]

This question requires candidates to evaluate the plan and make suggestions for improvements. No marks were credited for repeating the experiment as this does not improve the plan. This question was not generally done well. It is important that candidates are given the chance to evaluate plans when carrying out practical work. They will have to apply this skill to unfamiliar contexts such as this one. Many candidates were able to suggest a suitable way to measure how fast the gas was given off. Some just stated they needed to measure the gas given off and this was insufficient for a mark. Many suggested using a gas syringe or counting bubbles which are both creditworthy. Few understood that changing the volume did not change the concentration. A few were able to give control variables. Some candidates suggested using a balance to measure change in mass. This is a reasonable suggestion based on their knowledge. It is unlikely to work as hydrogen is given off. The hydrogen lost would make little

measurable difference to the mass. This knowledge was not was being tested. So the idea of using a balance was credited.

Candidates who do not gain many marks misunderstood the point of the question and gave answers to do with the writing of the plan, e.g. use bullet points or list apparatus. Some candidates suggested the mass of magnesium needed altering showing a complete lack of understanding of the investigation altogether.

Question 13(a)

13 The table shows some hydrocarbons from crude oil.

Name	Formula
Methane	CH ₄
Propane	C ₃ H ₈
Butane	C ₄ H ₁₀

(a) Nonane is another hydrocarbon from crude oil.

It contains 9 carbon atoms.

Predict the formula of nonane.

..... [1]

Candidates could answer this question by recalling the general formula for alkanes or by using information in the table to work out the formula. This question was fairly well answered.

Question 13(b)

(b) Write down the name of this homologous series of hydrocarbons.

..... [1]

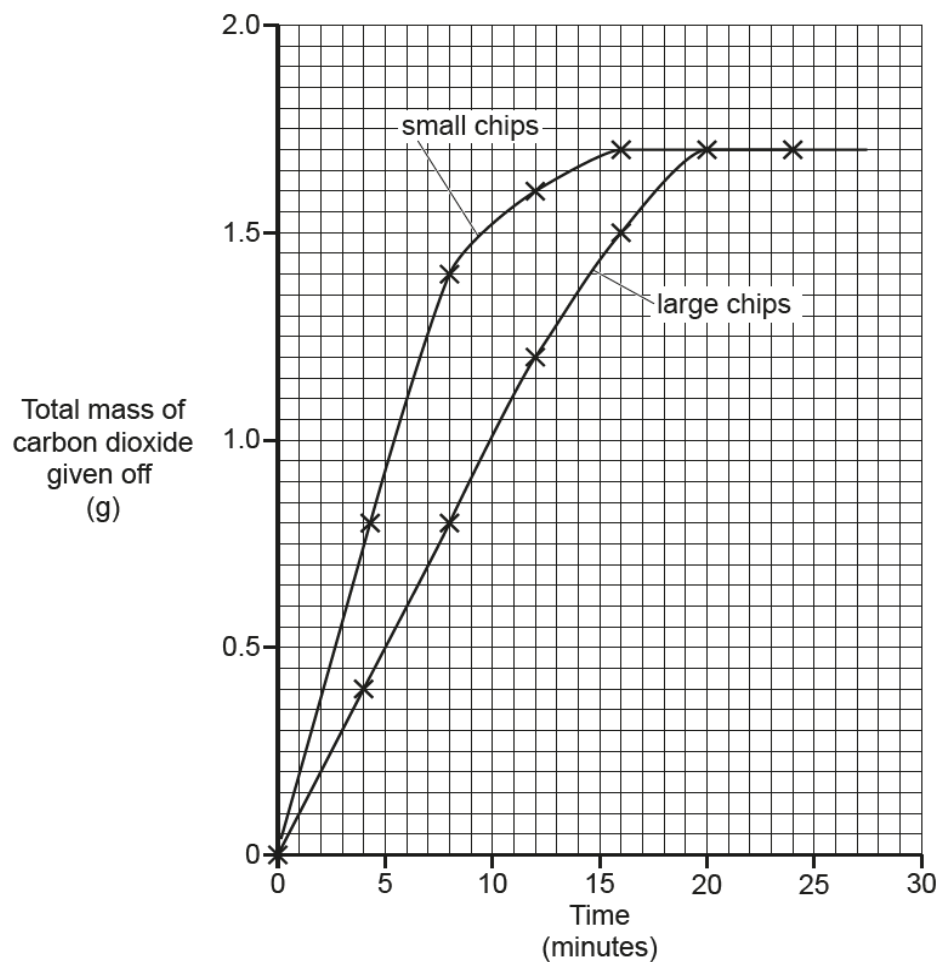
Relatively few candidates gave the term alkane. Common incorrect answers were "hydrocarbon chain" (or similar), "ethane" (and other named alkanes) and "alkenes", "crude oil". A few answered "reactivity series". Many candidates did not understand what is meant by a homologous series.

Question 14(a)(i)

14 A student investigates the rate of reaction between marble chips and hydrochloric acid.

He measures the total mass of carbon dioxide given off for different sizes of marble chips.

Look at a graph of his results.



- (a) (i) Calculate the rate of reaction **during the first 8 minutes** for the small marble chips and the large marble chips.

Include the units.

Give your answers to **2 decimal places**.

Small marble chips	Large marble chips
Answer = Unit =	Answer = Unit =

[3]

This question requires candidates to read information off the graph. They need to use these figures to calculate rate. They also have to give their answer to 2 decimal places. Most candidates correctly read the figures from the graph. A common error was converting the minutes to seconds. This was not asked for and made the calculation difficult. It also gave answers that could not reasonably be given as 2 decimal places. Another common error was not giving the answers to 2 decimal places. The answer for large chips was 0.1 and many candidates did not write this as 0.10 and so lost a mark. Many candidates did not know the units and gave g/m for an answer. This was not credited as m is a unit of distance not time.

Question 14(a)(ii)

- (ii) Which reaction is faster?

Explain how you can tell using data from the graph.

.....

.....

..... [2]

This question required candidates to interpret the graph. Many got a mark for the small chip line being steeper. A few understood that more gas was made in 8 minutes. It was important that they stated 'in 8 minutes' or 'over same period of time' as by the end of the practical both gave off the same amount of gas. Only a few mentioned that the line levels off first.

Question 14(b)

(b) Explain why changing the size of the marble chips changes the rate of the reaction.

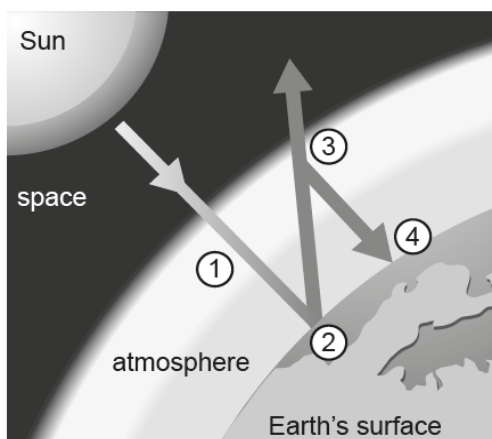
.....
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.....
.....
..... [3]

Candidates lost marks here because they did not say which size chips had the greatest surface area. Some were confused and thought big chips have bigger surface area. Very few wrote about surface area: volume ratio. Other answers which lacked understanding/detail were the ideas of just “more collisions”, “faster collisions” and reference to increasing amounts of energy when using smaller marble chips. The collision mark can only be credited for more frequent or more successful collisions. Carrying out practicals in the specification will help candidates understand the science involved.

Question 15(a)

15 Look at the diagram.

It shows four processes (1 – 4) which happen in the Earth's atmosphere and on its surface.



(a) Describe the four processes and how the greenhouse effect occurs.

.....

.....

.....

.....

.....

.....

..... [4]

Candidates had to explain the greenhouse effect. This meant that they needed to mention greenhouse gases at least once in order to be credited full 4 marks. Most candidates lost marks because they did not use the correct terminology or showed a lack of understanding of what was happening to the radiation. Many used the term 'rays' which was ignored. Many also described radiation as 'bouncing' or being 'reflected' off the Earth. This was also ignored. It is important that candidates show understanding of scientific processes by using the correct terminology. Radiation absorbed and emitted is not the same as radiation being bounced off.



Misconceptions

- Radiation (or heat/energy/light) reflects off the Earth's surface should be is absorbed and emitted.
- Ozone layer is involved in some way (often described as trapping the heat). It is greenhouse gases such as carbon dioxide that cause some heat to be reflected back to the Earth's surface.
- The arrows represented movement of the greenhouse gases, bouncing off the Earth's surface and moving in/out of space. Whereas, the arrows actually represent the passage of infrared radiation.

Exemplar 1

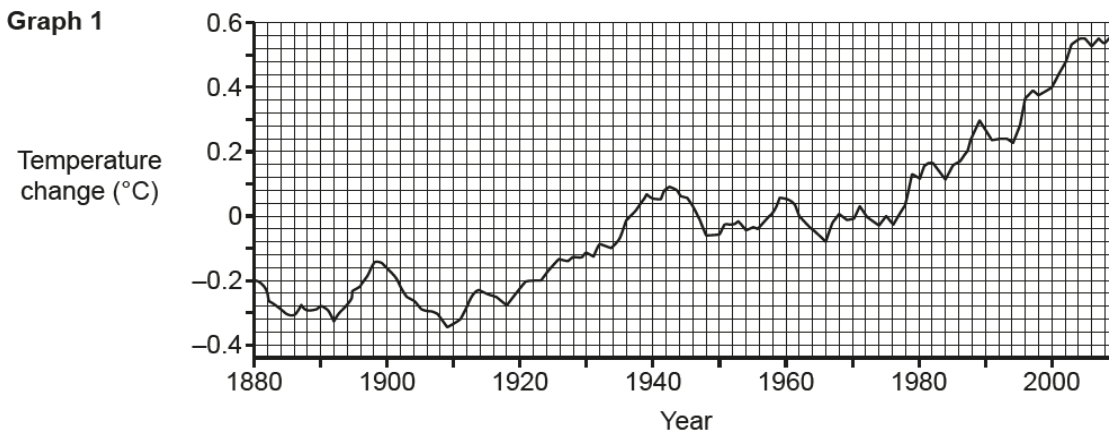
At 1, the sun generates heat radiation to Earth and at 2 ~~the~~ earth absorbs the heat and infrared. The radiation radiates off of Earth but at 3, some escapes out to space through the ozone layer. Some of the heat and infrared radiation reflects back down from the ozone to, 4, (Earth)

This candidate was able to gain 3 marks. They used the correct terminology; 'radiation', 'absorbs' and 'radiates'. Although they correctly stated that the radiation 'escapes out to space' they did not gain this mark. They had already been credited with 3 marks. The mark scheme states that there must be at least one mark about the role of greenhouse gases in order to fully answer the question. This candidate does not mention greenhouse gases. They incorrectly state radiation 'reflects back down from the ozone'. The candidate has shown they do not know the difference between the ozone and greenhouse gases. This is a common misconception and cannot be credited marks.

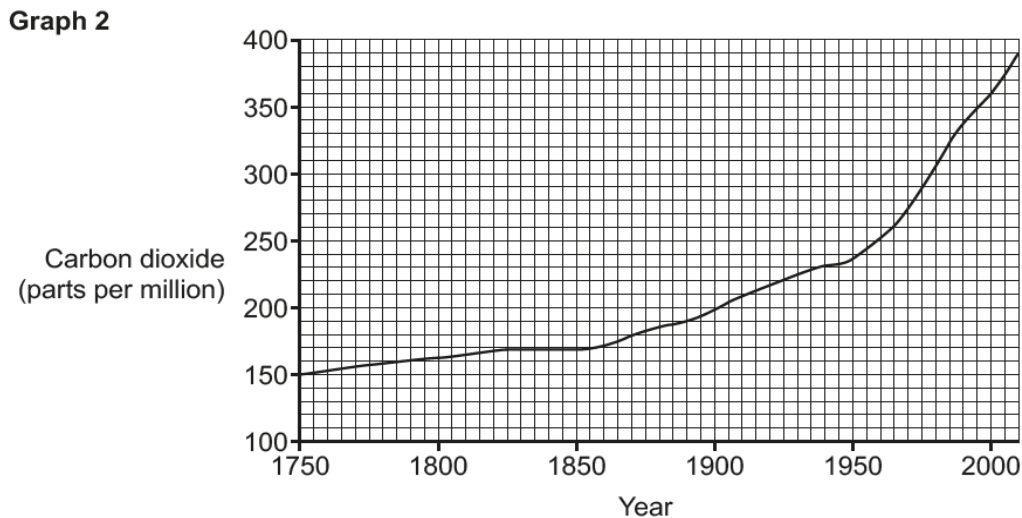
Question 15(b)

(b) Look at the graphs.

Graph 1 shows how the Earth's temperature has changed between 1880 and 2010.



Graph 2 shows how the amount of carbon dioxide in the air has changed between 1750 and 2010.



Some scientists believe that **graph 1** and **graph 2** show that increased levels of carbon dioxide have increased the Earth's temperature.

Other scientists believe that it is just a natural cycle of change.

Quote data from the graph which supports **both** of these arguments.

Evidence to support increased temperature of Earth

.....

.....

.....

Evidence to support a natural cycle

.....

.....

..... [2]

Candidates need to interpret both graphs for each part of this question. They must mention graph 1 and graph 2 in each part. Many candidates mentioned both graphs for the first part but only mentioned graph 1 for the second part. Each part of the question requires a comparison. This is not possible without describing both graphs.

Question 16(a)*

16 Look at the information about three elements X, Y and Z in the Periodic Table.

Element	X	Y	Z
Atomic number	Less than 11	11	More than 11
Melting point (°C)	181	98	63
Density (g/cm ³)	0.53	0.97	0.86
Reaction with water	Reacts quickly making hydrogen	Reacts vigorously making hydrogen	Reacts explosively making hydrogen
Energy needed to remove 1 electron from an atom (kJ/mol)	520	496	419
Atomic radius (nm)	0.134	0.154	0.196
Formula of chloride	XC _l	YC _l	ZC _l
Action of heat on carbonates	Breaks down and makes carbon dioxide	No reaction	No reaction

(a)* Student A thinks that elements X, Y and Z are in the same Group of the Periodic Table.

Student B thinks they are in different Groups of the Periodic Table.

Analyse and explain the information in the table that supports **both** Student A's and Student B's conclusions.

Who do you think is correct?

..... [6]

This is a levels of response question. Candidates are not assessed by the number of correct points they have given. They are assessed by how well they address the question. The question asks that they 'Analyse and explain the information in the table that supports both Student A's and Student B's conclusions' This means to gain full marks they must discuss how each could be correct. They must all choose which is correct and give valid reasons for this. Less able candidates were able to take information from the table and state which conclusion it supports. They did not explain how it supports the conclusion. Candidates gaining level 2 marks interpreted the information e.g. 'there is a trend in how the elements reacted with water as they got more reactive and elements in a group show trends'. Candidates gaining level 3 marks were able to do this for both A and B and could also give valid reasons for both, e.g. 'most of the evidence supports A and sodium is group 1' or 'not all the evidence shows they are in the same group so it must be B'.

Candidates were pretty good at explaining two of the pieces of evidence for candidate A, and linking the information to group 1 elements. Many focused heavily on the atomic number and that different atomic numbers meant that they could not all be in the same group. Often trends were overlooked and comments were made about melting points/densities/energies/radii being similar to support candidate A, or different to support candidate B. Many recognised that the different action of heat on carbonates supported candidate B but too often this was only a statement rather than an explanation. There were few level 3 answers mainly because candidates did not explain both pieces of evidence for candidate B. Many realised that element Y was sodium and so Y could be in group 1. In the better answers there was talk of trends within groups, especially when looking at the reaction of the elements with water but trends were not often recognised in the atomic radius or melting points.

Most candidates did make a choice but did not explain why they made the choice. The most common 'valid reason' was that they were in group 1, the other 'valid reasons' were rarely seen.



Misconception If elements were in the same group the physical data should all be similar, rather than it showing a trend.

Exemplar 2

I believe that student A can be right as the reaction with water shows that they all create hydrogen as a product. This clearly shows that all x, y and z are in group 1 as all group 1 elements have a product of hydrogen. However student B could be right as they have very different boiling points. This could infer that they are all different elements from different groups.

This candidate has shown that they know the elements are in group 1. This is a valid reason to choose A. They have explained that elements in a group would behave the same way with water. This is an explanation of information from the table. They have mentioned B but the science is incorrect so can be ignored. This is a level 2 answer.

Question 16(b)

(b) Write a **balanced symbol equation** for the reaction of element **Y** with water.

Use 'Y' to represent element Y.

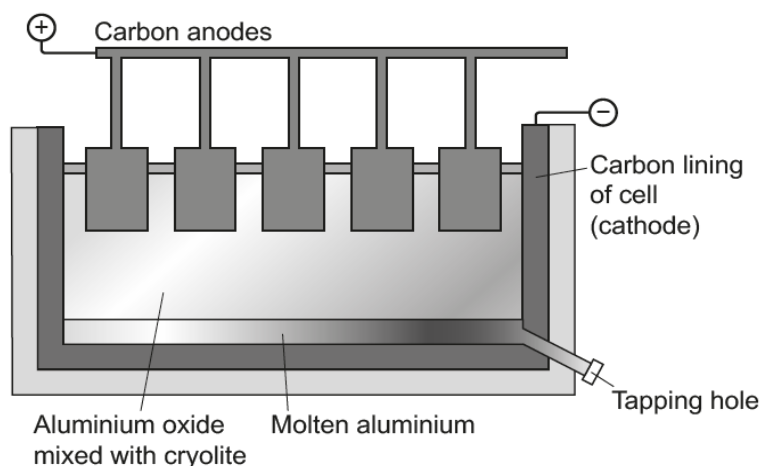
..... [2]

Candidates are required to write a balanced equation here. This was not well answered and it is suggested that candidates are given the opportunity to practice writing balanced equations in preparation for this paper. Hydrogen was often given the symbol H (instead of H₂) and many had an oxide rather than a hydroxide formed. It was rare to be credited only one mark. If candidates got the formulae right they could usually balance the equation correctly.

Question 17(a)

17 Aluminium is extracted from its ore by electrolysis.

This is an electrolysis cell.



(a) Aluminium **cannot** be extracted by heating aluminium oxide with carbon.

Explain why.

..... [1]

Most candidates knew this was about relative reactivity. Candidates should be encouraged to compare the reactivity of the two elements. Stating aluminium is reactive does not fully answer the question.

Question 17(b)

- (b) Aluminium oxide is mixed with cryolite in the electrolysis cell.

Explain why cryolite is used.

..... [1]

Few candidates knew this. The most common incorrect answers were that cryolite behaves as a catalyst/ lowers the activation energy/ speeds up the electrolysis. There were some candidates who wrote about it lowering the melting point of aluminium rather than aluminium oxide. This did not gain a mark.

Question 17(c)

- (c) Aluminium is made at the negative electrode (cathode) from aluminium ions, Al^{3+} .

Write a **half equation** for this reaction. Use e^- to represent an electron.

..... [1]

A balanced half equation is required here. The electrons should be represented as $3e^-$. Most candidates attempted this but were unclear about how to write a half equation.

Question 17(d)

- (d) Oxygen, O_2 , is made at the positive electrode (anode).

The anodes in the cell have to be replaced every few weeks.

Suggest why.

.....
 [2]

Candidates have to apply their knowledge of the extraction of aluminium process as well as the reactions of oxygen. Few candidates gained marks here. Many suggested the anode corroded or rusted. Some suggested the anode became coated in oxygen.

Question 17(e)

- (e) Write the overall **balanced symbol** equation for the electrolytic breakdown of aluminium oxide, Al_2O_3 .

..... [2]

Most candidates did not realise the reactant was the aluminium oxide. Many tried to write an equation to produce aluminium oxide. Many also tried to write another half equation. A few gave the formula of aluminium as Al_2 . Candidates need to practice writing balanced equations.

Question 18(a)

- 18 Look at the equation for the equilibrium reaction between sulfur dioxide, SO_2 , oxygen and sulfur trioxide, SO_3 , in a closed system.



- (a) Predict the effect of adding **more oxygen** to the equilibrium mixture.

Explain your answer.

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

Many candidates said that equilibrium would move right for 1 mark. Very few got the mark for the removal of oxygen. A number tried to explain it by writing that there were less moles of gas on the right hand side.

Question 18(b)

- (b) Predict the effect of increasing the **total pressure** in the equilibrium mixture.

Explain your answer.

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

Few candidates really seem to understand equilibria properly. e.g. references to what happens if you raise the pressure on the LHS as opposed to raising the pressure on the RHS as if the 'sides' are 2 separate entities. Most of the 1 mark answers had equilibrium moving to the right. Many candidates tried to link this to fewer molecules on the RHS of the equation (but not always successfully).

A significant number of candidates did not refer to equilibrium at all but focused more on the idea of an increased rate of reaction with more frequent collisions. More frequent collisions gained a mark. A mark for increased rate was only credited if they stated that equilibrium was reached faster. This was rarely seen.

Candidates could either gain marks for discussing position of equilibrium or for discussing the rate to reach equilibrium.

Question 18(c)

- (c) Predict the effect of increasing the **temperature** of the equilibrium mixture.

Explain your answer.

.....

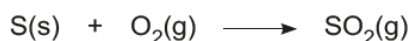
.....

..... [2]

Many candidates focused on the increased rate of reaction rather than the position of equilibrium changing. Several candidates did however correctly state that the reaction would need to move in the endothermic direction but then did not correctly identify whether this would be left or right from the information given. Too many candidates were not precise and opted for 'left' or 'right' preferring to sit on the fence and just state 'it would affect the equilibrium'.

Question 18(d)

- (d) Sulfur dioxide for this reaction is made by burning sulfur.



Calculate the mass of sulfur needed to make 48 tonnes of sulfur dioxide.

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

The relative atomic mass, A_r , of S is 32.1 and of O is 16.0.

Answer = tonnes [3]

Candidates struggled with this calculation. Most did know how to convert the answer they got to 2 significant figures. If a mistake was made early in the calculation they could still gain some marks. It must be clear from their working which steps are correct. Some candidates wrote several attempts at different calculations and then left it to the examiner to choose which their answer was. This is seen as a list and so cannot be credited.

Those that were confident with mole calculations answered well but it appeared that many did not attempt to calculate the number of moles of SO_2 in 48 tonne. Many made no attempt whilst others made use of 32.1, 16 & 64.1 in random ways. The use of 'tonne' rather than 'gram' seemed to confuse the average candidate.

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Section B, Q15a

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Section B, Q15b

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Section B, Q17

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