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GCSE (9-1)

Examiners' report

GATEWAY SCIENCE COMBINED SCIENCE A

J250
For first teaching in 2017

J250/04 Summer 2018 series

Version 1

Contents

Introduction

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

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

Paper J250/04 series overview

J250/04 is the fourth of six foundation tier papers for Gateway Combined Science A. This component assesses Topics C4, C5 and C6, with assumed knowledge of Topics C1, C2, C3 and Topic CS7 (PAGs C1-C5), and is worth 16.7% 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. Candidates also need to be familiar with a range of experimental procedures.

J250/04 has an equal emphasis on knowledge and understanding of the assessment outcomes from the specification, application of this knowledge and analysis of information and ideas.

Section A overview

Very few candidates omitted any of these multiple choice questions.

Questions on catalysts (2), boiling point trend in Group VII (8), reading a value from a graph (9) and interpreting a graph (10) were well answered.

Questions on water treatment (1), chlorine (3) and composition of the air (5) proved to be the most difficult for candidates.

Question 1

1 Large scale desalination is used to make drinking water from seawater in hot countries.

What is the name of the technique used to remove the dissolved salts from seawater to get drinking water?

A Chromatography

B Evaporation

C Filtration

D Simple distillation

Your answer ☐ **[1]**

Candidates found this difficult. Both B and C were common incorrect responses. Only about a quarter of candidates chose the correct response.

Question 2

2 Which statement about catalysts is correct?

A A catalyst decreases the rate of many different reactions.

B A catalyst for one reaction will be the catalyst for many different reactions.

C A catalyst has no effect on the rate of the reaction.

D A catalyst usually increases the rate of a reaction.

Your answer ☐ **[1]**

A small number of candidates gave A or B as their response. This question was answered well with three quarters of candidates selecting the correct response.

Question 3

3 Look at the table.

	State at room temperature	Electronic structure
A	Gas	2.7
B	Gas	2.8.7
C	Liquid	2.8.7
D	Solid	2.7

Which row in the table has the correct information about chlorine?

Your answer ☐ **[1]**

A large number of candidates thought chlorine to be a liquid, incorrectly selecting C as their response.

Question 4

4 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]**

A was the most common incorrect response. Over half the candidates selected the correct response.

Question 5

5 Look at the table.

	Nitrogen	Oxygen	Carbon dioxide
A	21%	78%	0.04%
B	80%	15%	5%
C	70%	20%	10%
D	78%	21%	0.04%

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

Your answer ☐ **[1]**

Candidates found this difficult. All responses were seen with A and C being the most common incorrect responses. Only about a quarter of candidates chose the correct response.

Question 6

6 Look at the equation for the reaction between nitrogen and hydrogen to make ammonia.

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

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]**

All responses were seen for this question with about half the candidates selecting the correct response.

Question 7

7 The Group 0 elements are unreactive.

Why are they unreactive?

A They all exist as single atoms.

B They are all gases.

C They have a full outer electron shell.

D They need one electron to gain a full outer electron shell.

Your answer ☐ **[1]**

B and D were popular incorrect responses. Less than half of candidates chose the correct response.

Question 8

8 Look at the boiling points of some Group 7 elements.

Element	Boiling point in °C
Fluorine	−188
Chlorine	−34
Bromine	59

What is the most likely boiling point of iodine?

A −20 °C

B 50 °C

C 184 °C

D 350 °C

Your answer ☐ **[1]**

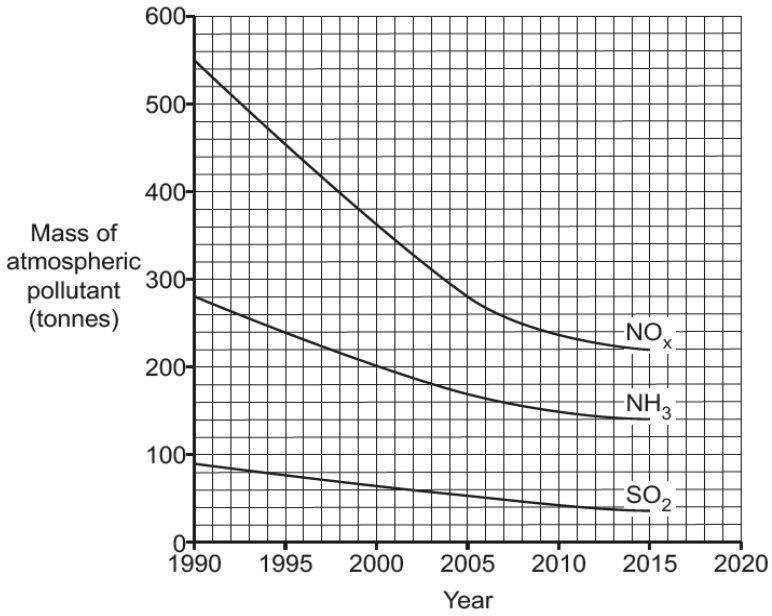
B was a popular incorrect response. About two thirds of candidates answered this question well selecting the correct response.

Question 9

9 The graph shows how the masses of three atmospheric pollutants have changed in one city since 1990.

The atmospheric pollutants are:

- Oxides of nitrogen, NO_x
- Ammonia, NH_3
- Sulfur dioxide, SO_2



In which year was 280 tonnes of **oxides of nitrogen** present in the atmosphere?

A 1990

B 2000

C 2005

D 2010

Your answer ☐ **[1]**

A was the most popular incorrect response. This question was well answered with about two thirds of candidates choosing the correct response.

Question 10

10 Look at the graph in question 9.

Which statement is true based on the data on the graph?

A In 2015 the level of oxides of nitrogen was higher than the levels of sulfur dioxide or ammonia.

B The levels of all three pollutants fell by the same amount between 1990 and 2015.

C The level of ammonia fell the most between 1990 and 2015.

D The level of sulfur dioxide decreased by more than half between 2000 and 2015.

Your answer ☐ **[1]**

B and D were popular incorrect choices. This question was well answered with about two thirds of candidates choosing the correct response.

Section B overview

Candidate performance

Candidates who did well on this section generally were able to do the following:

- Draw a single curve of best fit: 11(a)(ii).
- Read data from a graph: 11(b)(ii), 15(a) and 15(b).
- Recall how the Earth's atmosphere has evolved: 13.
- Interpret experimental results to place metals in order of their reactivity and explain their choice: 14(a).
- Calculate outcomes using data in a table: 17(a).
- Draw conclusions from simple data: 17(d).
- Apply knowledge and understanding to questions set in a novel context.

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

- Apply what they had learnt to unfamiliar situations.
- Analyse data, draw conclusions in relation to the data and explain their conclusions e.g. 11(c) and 15(c).
- Explain experimental procedures and name control and dependent variables: 18.
- Explain data in terms of molecules and the forces between them: 12(c)(i), 12(c)(ii).
- Write word equations: 14(b).
- Recall organic chemistry: 12(a), 12(b), 19(a), 19(b).

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

Question 11

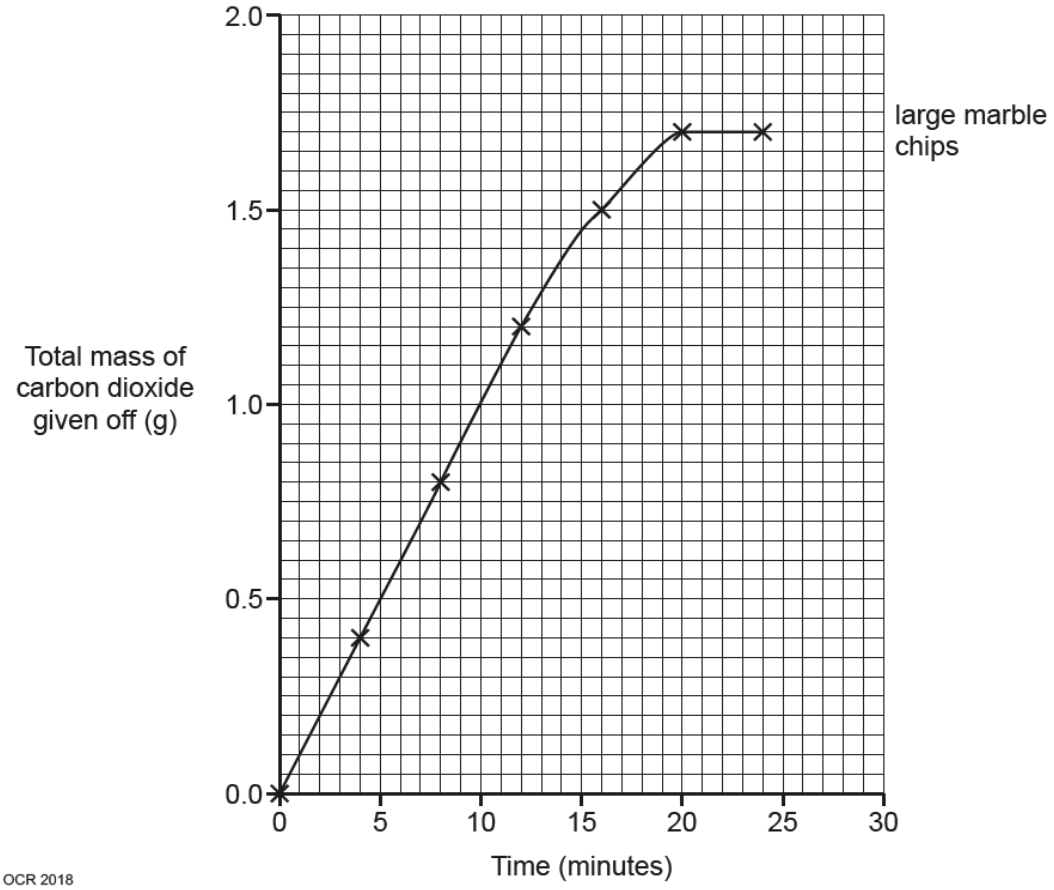
11 A student investigates the rate of reaction between marble chips and hydrochloric acid.

Both experiments use 50 cm^3 of hydrochloric acid and an excess of marble chips.

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

Look at his results.

Time (minutes)	Total mass of carbon dioxide given off (g)	
	Large marble chips	Small marble chips
0	0.0	0.0
4	0.4	0.8
8	0.8	1.4
12	1.2	1.6
16	1.5	1.7
20	1.7	1.7
24	1.7	1.7



Question 11(a)(i)

(a) The student has plotted his results for the large marble chips on the graph.

(i) Plot the results for the **small** marble chips. **[2]**

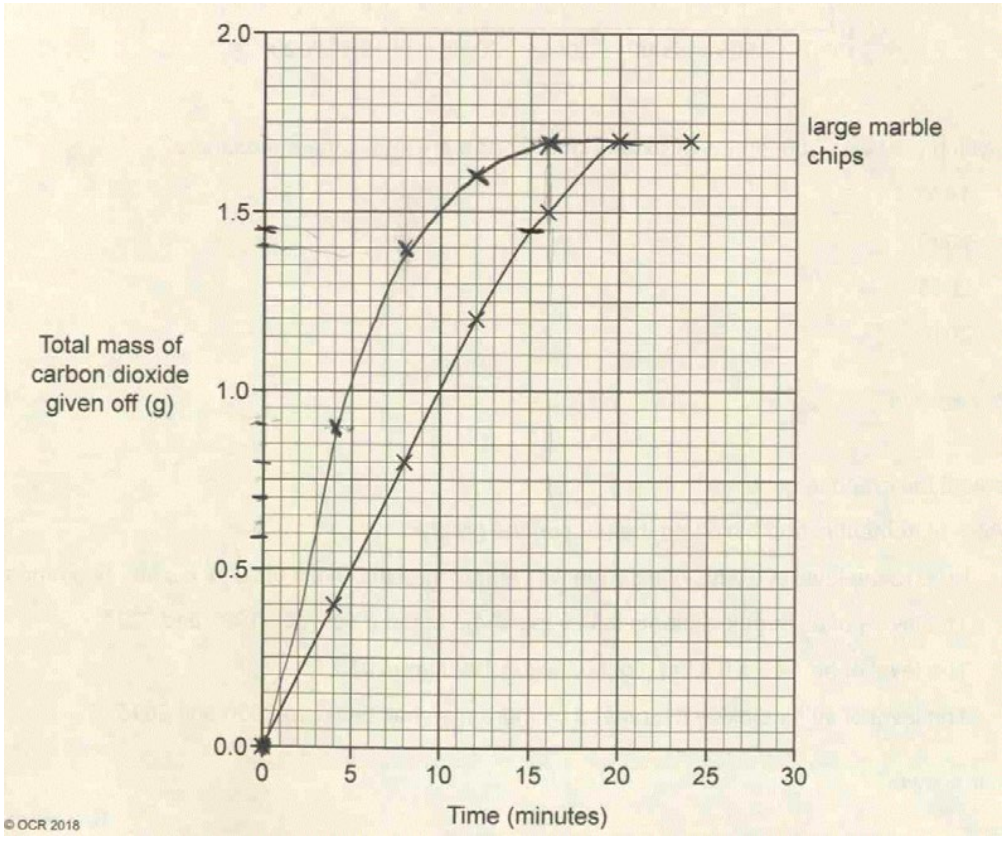
Many candidates found the scale on the y-axis challenging, 4 minutes was often plotted at 0.65 and 16 minutes at 1.60.

Question 11(a)(ii)

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

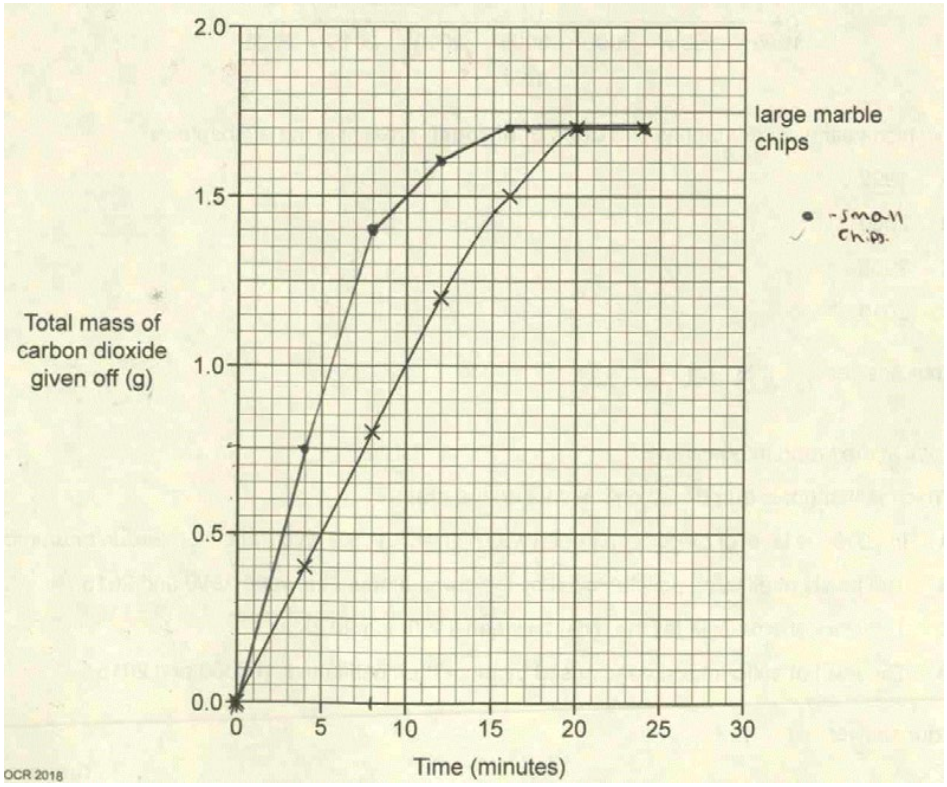
Candidates found the line challenging. Many candidates drew thick or feathery lines, joined the points with a ruler drew multiple lines or drew a curve and a straight line.

Exemplar 1



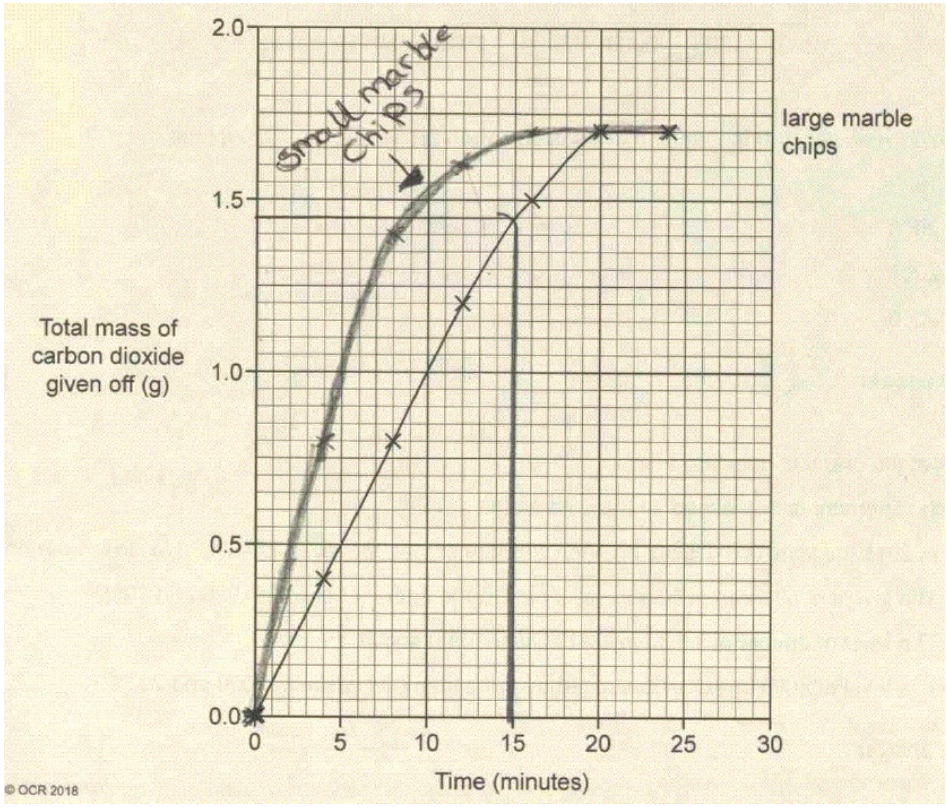
This is an example of a good line of best fit.

Exemplar 2



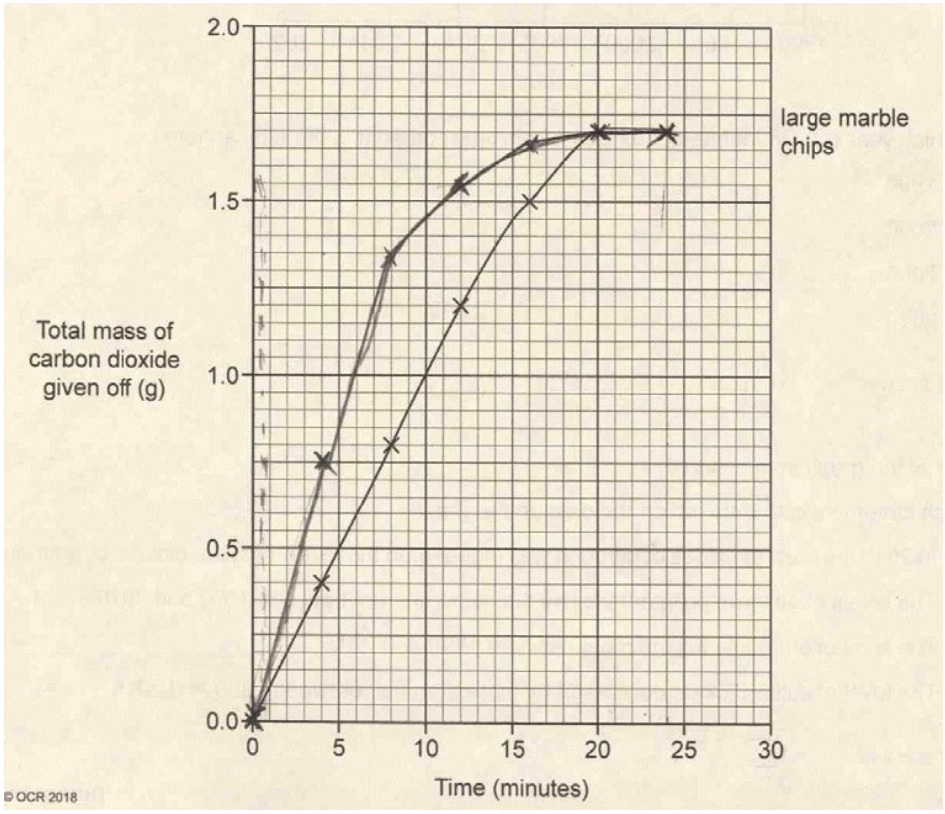
Many candidates joined the points with straight lines drawn with a ruler.

Exemplar 3



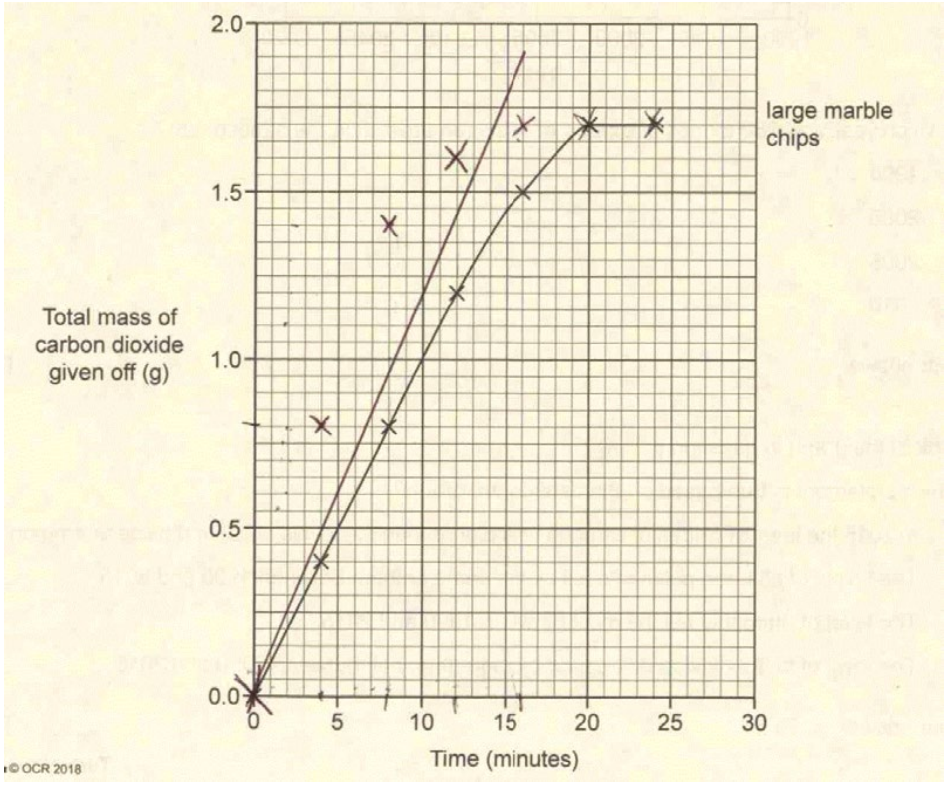
Some candidates drew thick or feathery lines.

Exemplar 4



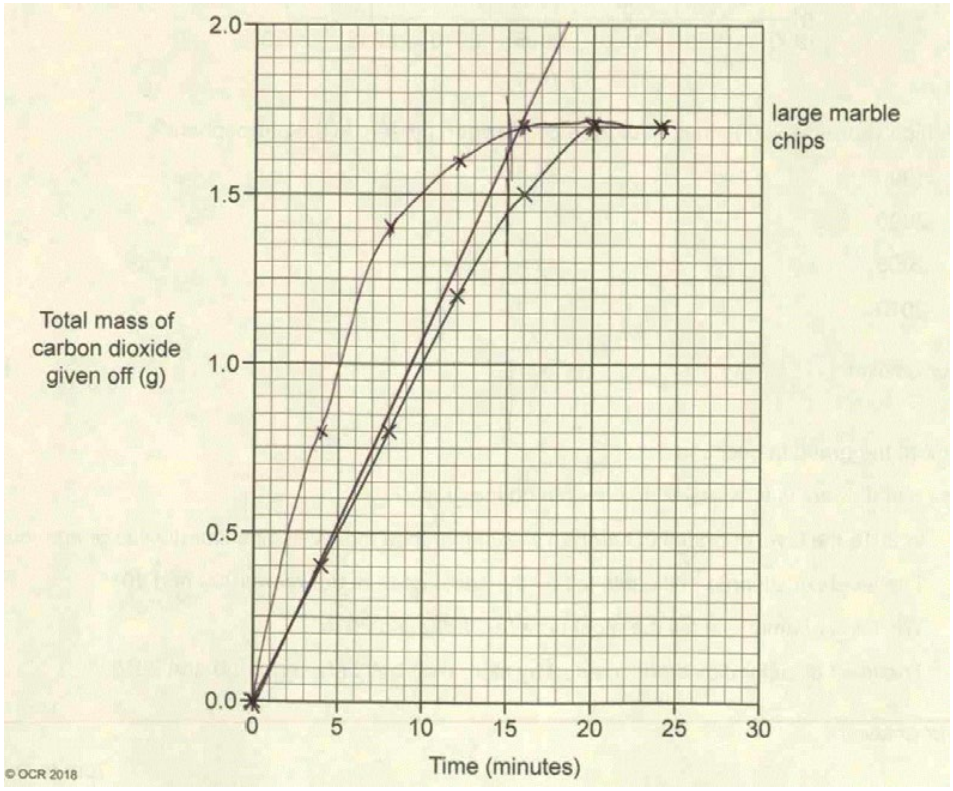
Some candidates drew multiple lines.

Exemplar 5



Some candidates drew one straight line.

Exemplar 6



Some candidates drew a best fit curve and a straight line.

Question 11(b)(i)

(b) Look at the line for the **large** marble chips.

(i) How long does it take for the reaction to finish?

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

Many candidates gave 24 minutes which is the time of the last reading rather than when the graph stopped rising at 20 minutes

Question 11(b)(ii)

(ii) What mass of carbon dioxide is given off after 15 minutes?

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

Some candidates misread the scale and 1.7 was a popular incorrect response.

Question 11(c)

(c) The reaction is faster with small marble chips.

Write down **two** ways that the graph shows this is correct.

1 .....

.....

2 .....

.....

[2]

Many candidates rewrote the stem of the question or answered in terms of the reaction rather than the graphs. Many discussed the points being closer together or further apart or thought that more gas was evolved by the small marble chips. Steepness of the line was the more common correct response and higher ability candidates gained full credit.

Question 11(d)

(d) Both small and large marble chips give off the same mass of carbon dioxide at the end of the experiments.

Suggest why.

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

Candidates found this very challenging. Many discussed either the amount of marble chips or the amount of carbon dioxide being the same or that the timing of the reaction was the same.

Question 11(e)

(e) A balance was used to measure the amount of carbon dioxide given off.

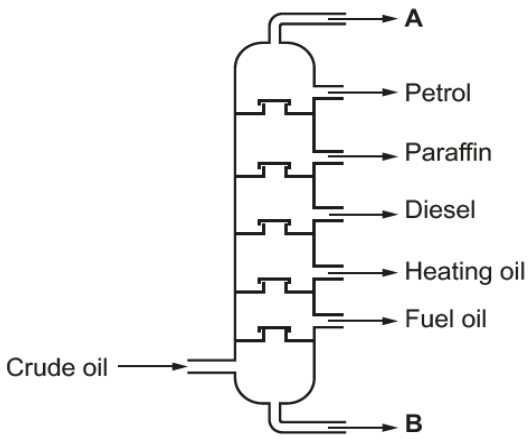
Write down the name of a different piece of equipment that could be used to measure the amount of carbon dioxide produced.

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

Candidates found this very difficult. Common responses included: 'gas meter', 'carbon dioxide meter' and 'scales'.

Question 12(a)

12 Crude oil can be separated into useful substances called fractions.



(a) Write down the name of the process that separates crude oil into fractions.

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

Candidates found this difficult and a significant number omitted the question. Distillation, electrolysis, filtration, cracking, fracking and chromatography were common responses.

Question 12(b)

(b) Name the fractions **A** and **B**.

A .....

B .....

[2]

Few candidates gained credit. The most common incorrect response was input or in for A and output or out or exit for B. Carbon dioxide, gas and hot were also common for A and waste, oxygen and cold for B.

Question 12(c)(i)

(c) Here are the boiling ranges for petrol and diesel.

Fraction	Approximate boiling range (°C)	Number of carbons
Petrol	30–80	5–10
Diesel	205–290	13–17

(i) How do the sizes of molecules in petrol and diesel differ?

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

Candidates found this difficult. Many repeated the stem of the question either saying the sizes were different or that one was larger than the other without specifying which one. Many thought that diesel had more molecules.

Question 12(c)(ii)

(ii) Explain why the boiling range for petrol is different from the boiling range for diesel.

.....

.....

.....

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

A very small minority of candidates answered in terms of intermolecular forces. Many linked the sizes of the molecules to boiling faster or slower or discussed the number of molecules or discussed ease of boiling or ease of burning. A small number compared the boiling points.

Question 12(d)

(d) Not enough petrol is made from crude oil to meet world demand.

Oil refineries make more petrol using a process called **cracking**.

Describe how cracking makes more petrol from other hydrocarbons.

Include the conditions needed.

.....

.....

.....

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

Candidates did not understand cracking and many described the process of fracking and its environmental consequences. Others repeated the stem of the question and conditions were rarely mentioned. A significant number omitted the question.

Question 13

13 Complete the sentences about how the Earth's atmosphere has evolved.

Choose words from the list.

argon	**condensed**
melted	**nitrogen**
oxygen	**sunlight**
thunderstorms	**volcanoes**

The earliest atmosphere was made up of ammonia, carbon dioxide and water vapour.

These gases were released by ..... .

The water vapour ..... to form the oceans.

Ammonia was converted by bacteria in the soil to make ..... .

The earliest plants photosynthesised.

They absorbed carbon dioxide and released ..... gas.

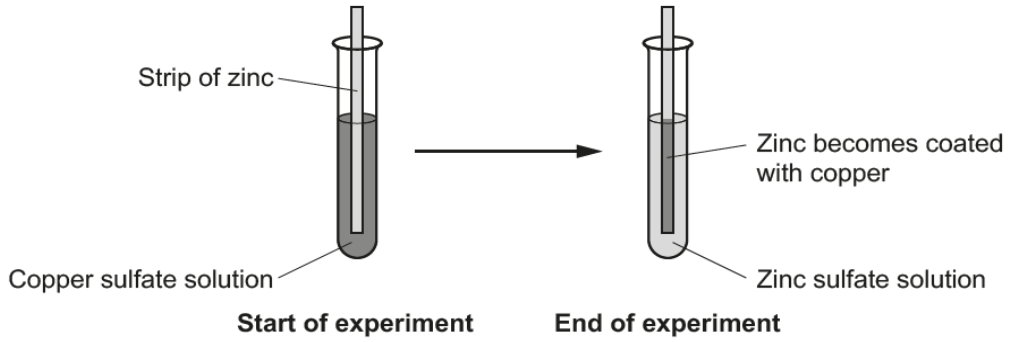
[4]

Higher ability candidates gained full credit with the majority of candidates gaining at least partial credit. Condensed, the answer for the second sentence was where candidate most often gained credit. . Thunderstorms and sunshine were common incorrect responses for the first sentence. Nitrogen and oxygen were often reversed and quite often argon replaced one of them.

Question 14

14 A student investigates the reactivity of some metals with metal salts.

The diagram shows one of the experiments that he does.



He repeats the experiment using other metals and solutions.

Look at his results.

Solution	Metal added				
	Silver	Zinc	Magnesium	Copper	Iron
Copper sulfate	✗	✓	✓		✓
Zinc sulfate	✗		✓	✗	✗
Silver nitrate		✓	✓	✓	✓
Magnesium sulfate	✗	✗		✗	✗
Iron sulfate	✗	✓	✓	✗	

✓ = Metal reacts
✗ = Metal does not react

Question 14(a)

(a) Use the results to place the metals in order of reactivity.

Most reactive metal .....

.....

.....

.....

Least reactive metal .....

Explain your reasoning.

.....

.....

.....

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

Candidates who put metals into the list usually put them into the correct order but a significant number put the solutions into the list. The explanation proved challenging and lower ability candidates could not explain why they had chosen the order they had written.

Question 14(b)

(b) Write a **word equation** for the reaction between copper and silver nitrate solution.

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

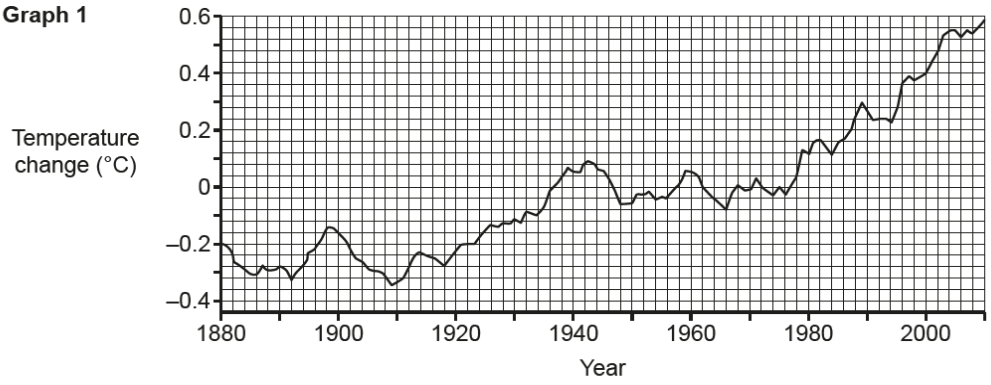
Candidates found this difficult and some omitted the question. Of those that gave word equations many omitted the silver from the right hand side or turned the silver into sulfate. Many attempted symbol equations but did not give the correct formulae for the compounds or the correct symbols for the metals.

Question 15(a)

15 Look at the graphs.

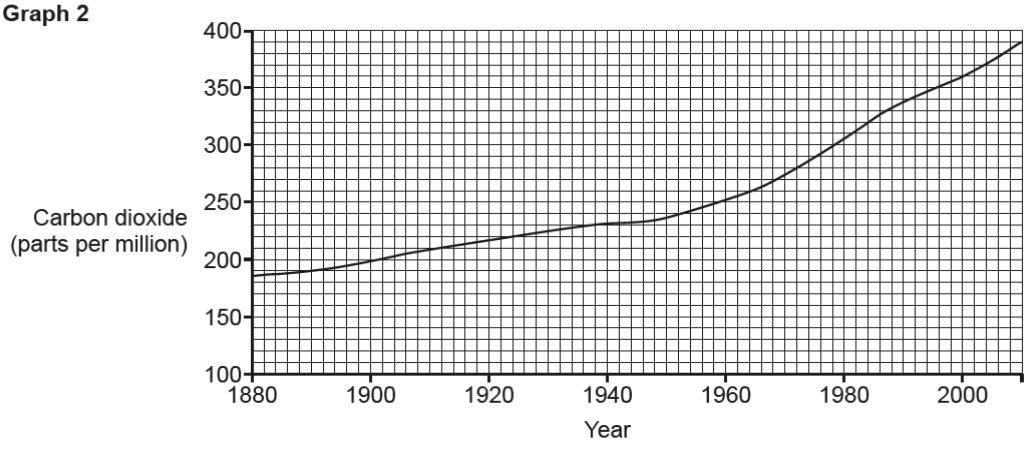
Graph 1 shows how the Earth's temperature has changed between 1880 and 2010.

Graph 1



Graph 2 shows how the amount of carbon dioxide in the air has changed between 1880 and 2010.

Graph 2



(a) In **graph 1**, how much has the Earth's temperature increased between 1880 and 2000?

Answer = ... °C **[1]**

Many candidates gave the value 0.8 possibly for the value at 2010 rather than the value for 2000. Other common responses included 6 and 8, showing that candidates had misread the scale on the y-axis.

Question 15(b)

(b) In **graph 2**, what is the difference between the amount of carbon dioxide in the air between 1880 and 2000?

Answer = ... parts per million **[1]**

Candidates found the scales difficult to read. 200, 205, 225, 270 and 290 were all seen frequently.

Question 15(c)

(c) 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 graphs which support **both** of these arguments.

Evidence to support increased temperature of Earth .....

.....

.....

.....

Evidence to support a natural cycle .....

.....

.....

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

Higher ability candidates linked the rise in temperature and rise in carbon dioxide in the first part of the questions. Many candidates only discussed the change in temperature. Some only mentioned the levels in one particular year.

Whilst higher ability candidates appreciated the up and down nature of the temperature, few of them also linked this to the rise in carbon dioxide. Most candidates discussed cycles or seasons on Earth being natural or discussed other features of the Earth and the solar system. Deforestation and burning fuels were both seen quite often.

Question 16*

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	64
Number of electrons in outer shell	1	1	1
Density (g/cm^3)	0.53	0.97	0.89
Reaction with water	Reacts quickly making hydrogen	Reacts vigorously making hydrogen	Reacts explosively making hydrogen
Action of heat on the carbonates of X, Y and Z	Breaks down and makes carbon dioxide	No reaction	No reaction
Formula of chloride	X*Cl*	Y*Cl*	Z*Cl*
Melting point of chloride (°C)	614	801	773

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]**

Many candidates appreciated that candidate A could be correct as all three elements had 1 electron in their outer shell. Many thought this was sufficient evidence and so did not undertake any further discussion of information in the table or Student B. Those that used the reaction with water as evidence for Student A often just had the elements reacting with water rather than reacting similarly. Some named the elements from their atomic numbers but many thought that the different atomic numbers supported Student B.

Many thought the reactions with water were different and so supported Student B. Some candidates discussed the different reactions of heat on the carbonates to be evidence in support of Student B. Many thought that different melting points and densities supported Student B rather than considering trends in these properties. Very few considered the chlorides either in terms of melting point or formula.

A significant number omitted the question.

Exemplar 1

I think Student A is correct because all the graph tells us that all the elements have 1 electron in their outer shell; this means they are in the same group. More evidence from the graph is the melting points having a small range which indicates they are in the same group. Also all the elements react with water in a way to produce hydrogen meaning their reactivity is similar. Lastly the formulas the elements have to use to make chlorine are similar all this information leads me to think Student A is correct. L2 [6]

The candidate has chosen Student A as being correct and has cited several pieces of evidence from the table to support this choice. (The evidence cited: all have 1 electron in their outer shell, all react with water to produce hydrogen and the formulae of the chlorides are all similar.)

This answer fulfils Level 2 in the OR statement of the mark scheme. There is a choice of conclusions, there is sufficient supporting evidence within a structured line of reasoning.

The question asks the candidate to analyse and explain the information that supports both Student A's and Student B's conclusions and decide who they think is correct.

In order for this answer to move into Level 3, the candidate needs to consider the evidence which could support Student B e.g. there is no clear trend in melting point or density or the reaction of heat on the carbonates are different.

Question 17(a)

17 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]**

Question 17(b)

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

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

Candidates found this difficult and many opted for a word beginning with w including waste, weighing and water. Many also discussed the next step in terms of use rather than life cycle assessment and so selling, shopping, delivering and storing were all common incorrect responses.

Question 17(c)

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

Suggest a reason why.

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

Many candidates answered in terms of fragility of the glass or packaging and some in terms of greenhouse gases.

Question 17(d)

(d) Which material should the company choose?

Justify your answer.

.....

.....

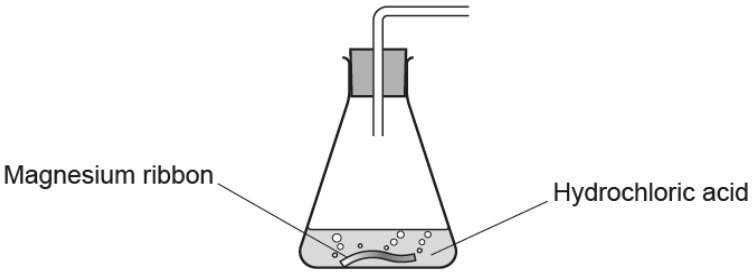
.....

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

Many candidates chose material A and could give at least one correct reason for their choice with many giving two. Some referred to making energy and using greenhouse gases. Some chose material B because it must be better quality if it costs more or thought that higher energy requirements and higher greenhouse gas emissions were beneficial. The rest of the answers in support of material B were too vague to be creditworthy.

Question 18

18 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 0.5 g of magnesium ribbon into the flask.

I will add 50 cm^3 of hydrochloric acid.

I will measure how fast the gas is given off.

Second experiment

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

I will add 100 cm^3 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.

.....

.....

.....

.....

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

Candidates found this very challenging. Most said that the method needed to contain more detail, be written down correctly or be in steps that a candidate could follow. Many mentioned repeating or stopwatch but did not consider the variables to be controlled or varied or how the gas would be collected or how the stopwatch would be used. Many increased the amount of magnesium to be in line with the increased amount of acid. A significant number omitted the question.

Question 19(a)

19 The table shows some hydrocarbons from crude oil.

Name	Formula
Methane	CH_4
Propane	C_3H_8
Butane	C_4H_{10}

(a) Nonane is another hydrocarbon from crude oil.

It contains 9 carbon atoms.

Predict the formula of nonane.

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

Very few candidates gained credit. Higher ability candidates appreciated that nonane would contain C_9 but C_9H_{16}, C_9H_{21}, and C_9H, were common incorrect responses from these candidates. C_5H_{12} was also a common response. A significant number omitted the question.

Question 19(b)

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

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

Few candidates gained credit and many omitted the question. Some named specific alkanes, homologous series and halogens were common responses.

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