OCR
Oxford Cambridge and RSA

Accredited

GCSE (9–1) Chemistry B (Twenty First Century Science) F

J258/02 Depth in chemistry (Foundation Tier)

Sample Question Paper

Date – Morning/Afternoon

Version 2.3

Time allowed: 1 hour 45 minutes

You must have:
- a ruler (cm/mm)
- the Data Sheet

You may use:
- a scientific or graphical calculator

First name									
Last name									
Centre number						Candidate number				

INSTRUCTIONS
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Complete the boxes above with your name, centre number and candidate number.
- Answer **all** the questions.
- Write your answer to each question in the space provided.
- Additional paper may be used if required but you must clearly show your candidate number, centre number and question number(s).
- Do **not** write in the bar codes.

INFORMATION
- The total mark for this paper is **90**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended responses will be assessed in questions marked with an asterisk (*****).
- This document consists of **24** pages.

Answer **all** the questions.

1 Extreme Weather Events

Extreme weather events make big news all over the world. Floods and storms have killed and injured many people around the world and caused massive damage to populated cities in recent years.

Fig. 1.1 shows the trend in extreme weather events.

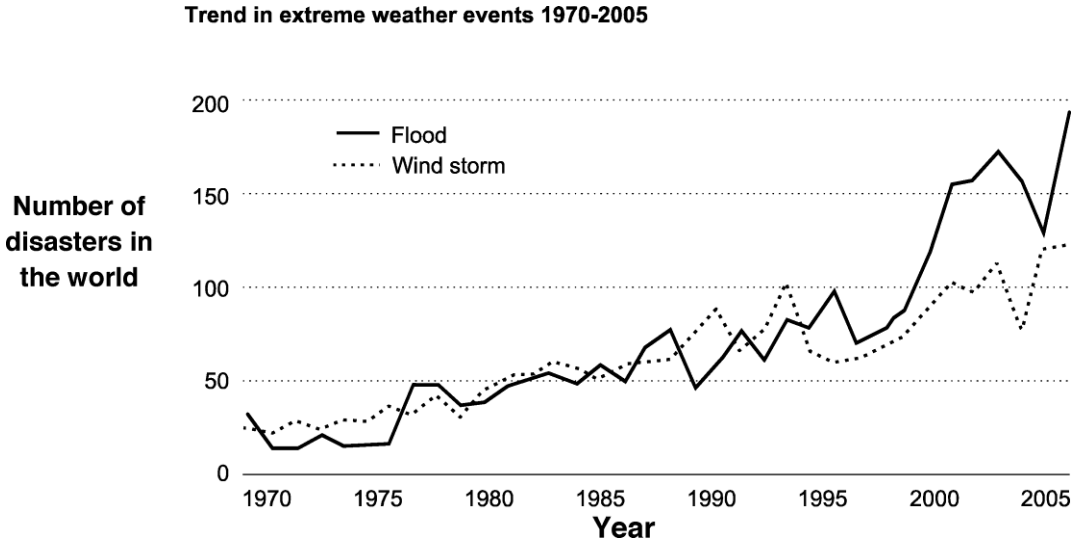

Fig. 1.1

Fossil fuels are burned for energy in power stations and for transport.

Fig. 1.2 shows how carbon emissions for the whole world have changed since 1800.

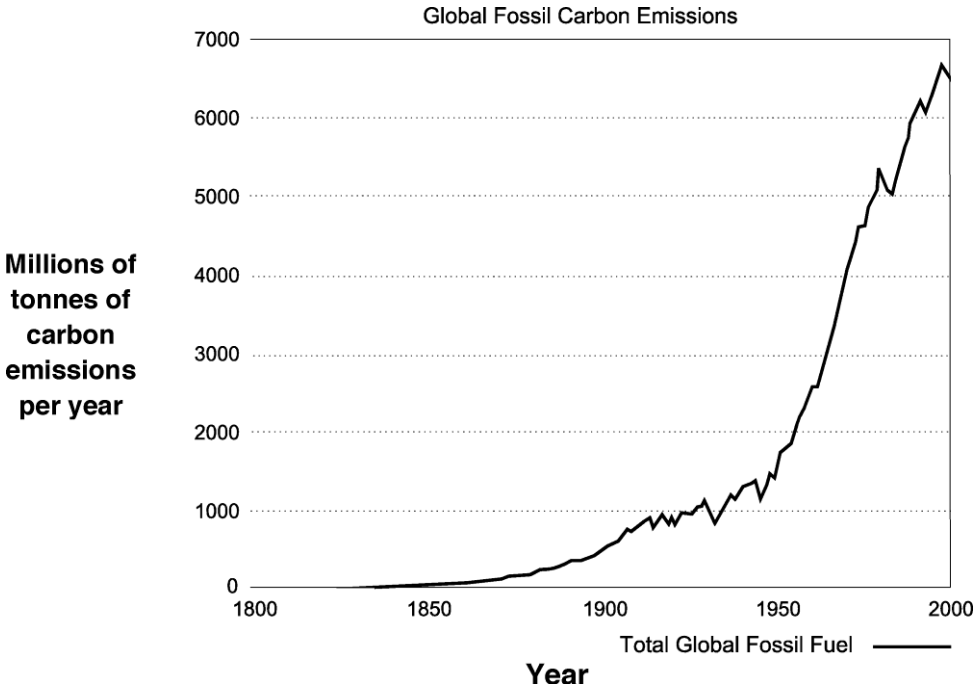

Fig. 1.2

Scientists believe that there is a correlation between the numbers of different types of extreme weather events and the levels of global carbon emissions from burning fossil fuels.

(a) Describe the correlation between the number of floods and storms (**Fig. 1.1**) and global carbon emissions (**Fig. 1.2**).

Use data from the graphs in your answer.

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

(b) **Fig. 1.1** shows data from 1970 onwards. It is very difficult to gather data about the numbers of floods and storms in the past.

Since 1970, the number of floods and storms has increased by more than 100%, although the rise in global temperature over the same time is relatively small.

(i) Give reasons why it is difficult to gather reliable data about the number of floods and storms that have happened in the past.

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

(ii) The table shows some data about the total number of floods and storms.

Period of time	1971–1980	2001–2010
Total number of floods and storms	750	3000

Use a calculation to show that the percentage increase in floods and storms between these two periods is 400%.

[2]

(c) Floods and storms (**Fig. 1.2**) affect only some parts of the world and do **not** happen every day.

Scientists think that there is a correlation between carbon emissions (**Fig. 1.2**) and global temperatures **(Fig. 1.3)**.

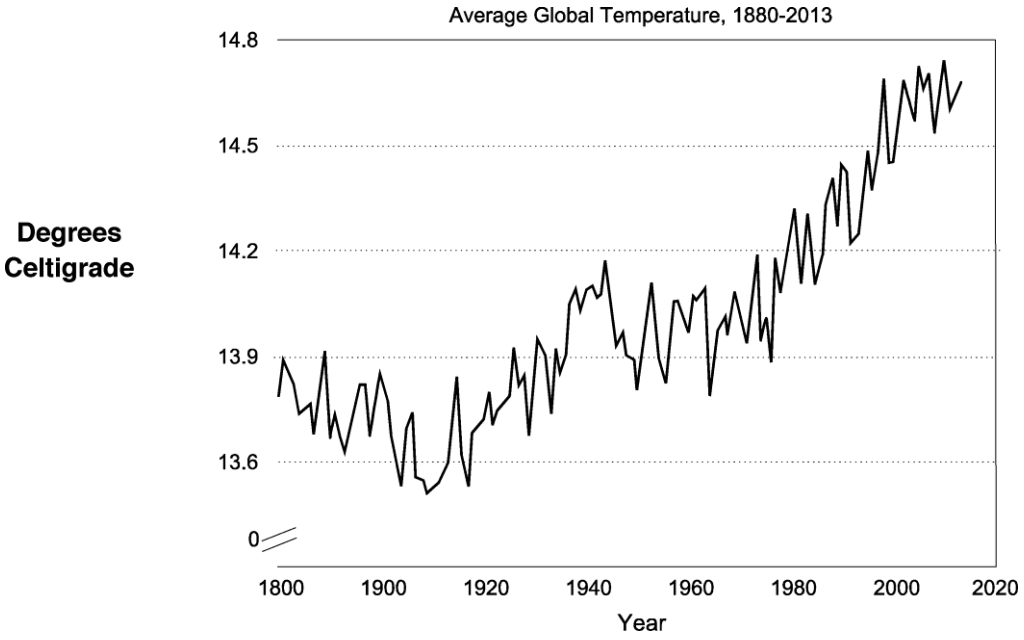
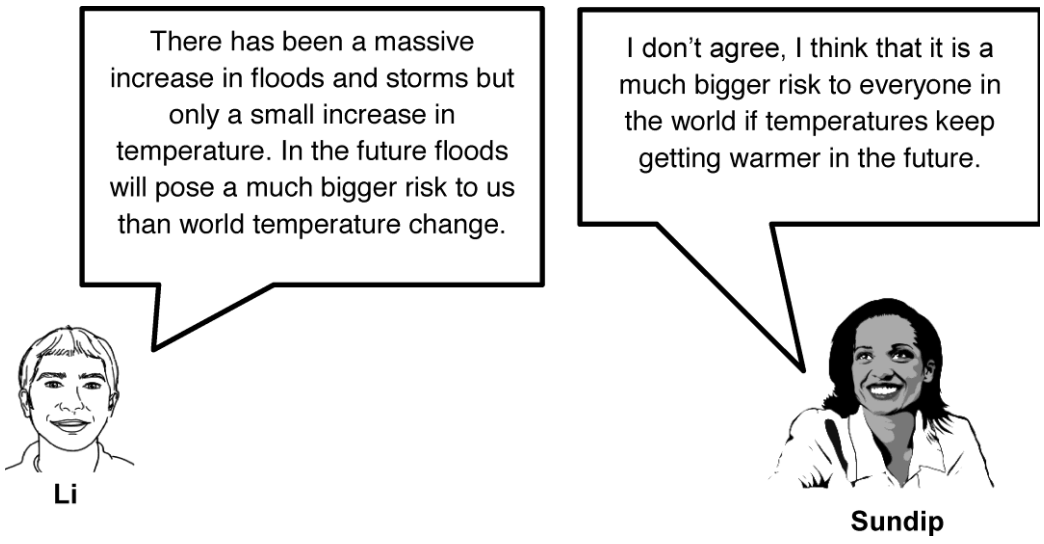


Fig 1.3

Li and Sundip talk about extreme weather and global temperature data.



Who do you think is right?

Explain your answer.

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

(d) Read the information about a new way to reduce the problems caused by carbon emissions.

Carbon storage schemes ‘capture’ carbon emissions from power stations before they are released into the air. One method stores the gas permanently on a very large scale in oil wells. The gas helps to increase the pressure on the oil so that more oil can be extracted from the well.

Now, scientists in Poland have developed a new method of making a carbon storage material from old CDs.

Now that consumers download music and store it electronically, more and more CDs will be thrown away and can be recycled to make this new material. Scientists hope to be able to use the same methods to use other waste plastics.

Compare the benefits and drawbacks of using oil wells or old plastics for carbon emissions.

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

2 Lithium is an element in Group 1 of the Periodic Table.

Lithium reacts with fluorine gas to form lithium fluoride.

(a) (i) Complete the word and symbol equation for the reaction.

lithium	+	fluorine	→	.....
2	+	F_2	→	2 LiF

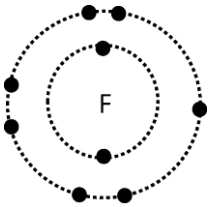
[2]

(ii) Draw lines to join each **substance** to its correct **description**.

Substance	Description
lithium	non-metal
fluorine	compound
lithium fluoride	metal

[2]

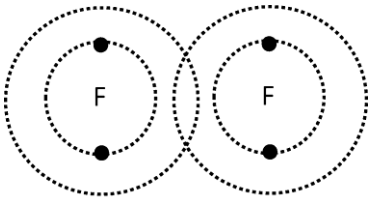
(b) (i) The diagram shows the arrangement of electrons in a fluorine atom.



fluorine atom

A fluorine molecule contains two atoms held together by a single covalent bond.

Complete the diagram to show the arrangement of electrons in a fluorine molecule.

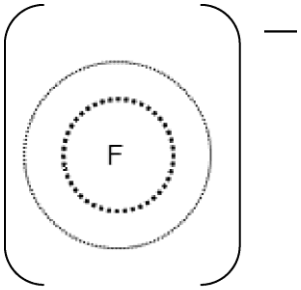


fluorine molecule

[2]

(ii) In the reaction with lithium, each fluorine atom gains an electron to form a fluoride ion, F^-.

Complete the diagram to show the arrangement of electrons in a fluoride ion.



fluoride ion

[2]

(c) The table shows some information about fluorine and lithium fluoride.

Substance	Structure	Melting point (ºC)
fluorine	simple covalent	–220
lithium fluoride	giant ionic	845

Why are the melting points of fluorine and lithium fluoride different?

Put ticks (✔) in the boxes next to the **two** correct answers.

Simple covalent substances have lower melting points than giant ionic substances. ☐

Ions do **not** attract to each other. ☐

There are weak forces between simple covalent molecules. ☐

Ionic substances dissolve easily. ☐

[2]

3 Sarah is a geologist. She takes samples of minerals from a range of rocks and tests them.

The table shows her results.

Mineral	Melting point	Electrical conductivity		
		when solid	when molten	when dissolved in water
A	high	good	good	does not dissolve in water
B	high	does not conduct	does not conduct	does not dissolve in water
C	high	does not conduct	good	good

(a) How does the data show that all of the minerals are solids at room temperature?

.....

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

(b) Sarah thinks that the mineral samples contain a metal, an ionic compound and a covalent compound.

Explain the conclusions you can draw from Sarah's results about the bonding in the minerals.

(i) Mineral **A**

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

(ii) Mineral **B**

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

(iii) Mineral **C**

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

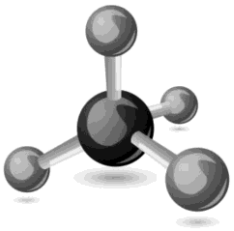
4 The table shows information about some alkanes.

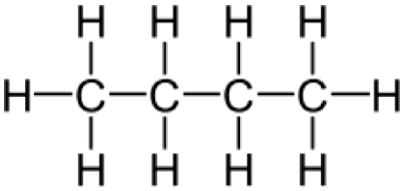
Name of alkane	Number of carbon atoms	Molecular formula
methane	1	CH_4
ethane	2	C_2H_6
propane	3	C_3H_8
butane	4	C_4H_{10}
pentane	5	,,,,,,,,,,,,,,,,,,,,

(a) Complete the table to show the molecular formula for pentane. **[1]**

(b) The diagrams show a ball and stick model for one alkane and a displayed formula of another.

Complete the diagrams by filling in the missing names.





Name of alkane: ..... Name of alkane: .....

[2]

(c) The alkanes have the general formula $C_nH_{(2n+2)}$.

What is the molecular formula of an alkane with 8 carbon atoms?

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

(d) Which statements about alkanes are true?

Put ticks (✔) in the boxes next to the **two** correct answers.

All alkanes are hydrocarbons. ☐

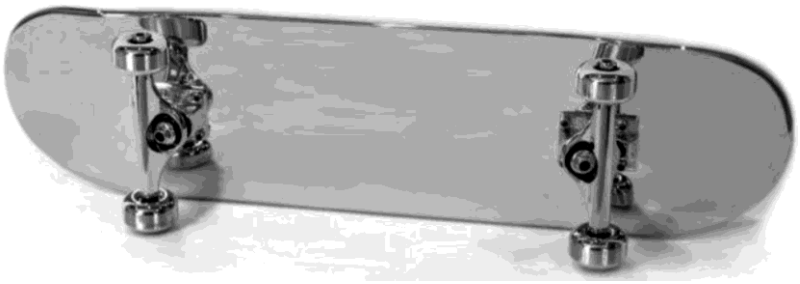
Alkanes have double bonds between their carbon atoms. ☐

The alkanes are a homologous series. ☐

Alkanes are all solids at room temperature. ☐

[2]

5 Alex works for a company that makes skateboards.



Customers complain that their skateboards lose performance when they get wet.

Skateboards have bearings in **each** wheel to help the wheels rotate smoothly and freely.

Skateboard wheel bearing

The bearings in the wheels contain smaller steel ball bearings.

These rust if they get wet.

The word equation for rusting is:

iron + water + oxygen → rust (hydrated iron(III)oxide)

(a) Balance the symbol equation for the formation of rust.

.....Fe(s) + 6H_2O(l) +..... O_2(g) → 2 Fe_2O_3.3H_2O(s) **[2]**

(b) Alex thinks that the mass increase caused by the ball bearings rusting will be very small and will **not** affect the performance of the skateboard.

(i) Calculate the percentage by mass of iron in rust.

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

- Relative formula mass of rust = 213.6

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

(ii) Each bearing contains seven smaller ball bearings.

Calculate the increase in mass of the skateboard. if 2 g of the iron in each ball bearing turns to rust.

Give your answer to the nearest gram.

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

(c) Sam thinks that the rust itself is the problem.

Suggest, with an explanation, how Alex could solve the problem of the rusting ball bearings.

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

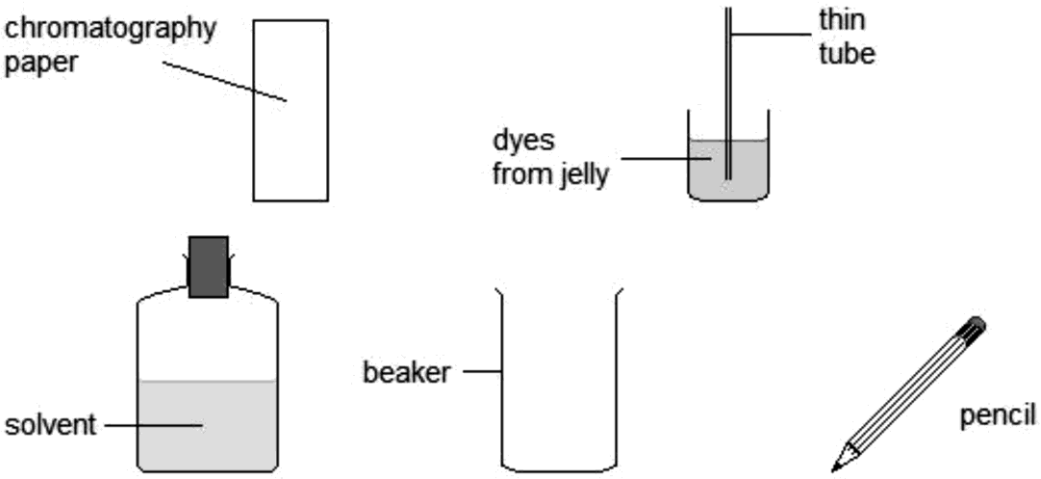
6 Eve works in a laboratory where food dyes are tested.

Some dyes are banned because they are known to be harmful.

Eve is going to test a jelly that will be exported to the USA.

(a) Eve prepares a chromatogram of the jelly.

The diagrams show some apparatus she uses.



(i) 0.2% of the mass of the solvent is sodium chloride.

Calculate how much sodium chloride she needs to use to make 250 cm^3 of the solvent.

Assume 1 cm^3 of solvent has a mass of 1 g.

amount of sodium chloride = ...g **[2]**

(ii) Describe how Eve should set up her chromatogram of the jelly.

You may use a diagram in your answer.

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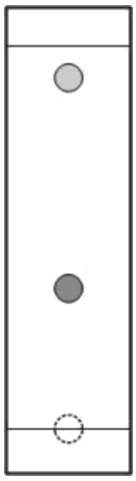
..... **[4]**

(b)* Eve's finished chromatogram is shown below.



The table shows R_f values of food dyes banned in the USA.

Food dye	Rf **value in 0.2% sodium chloride solution**
Yellow 5	0.71
Blue 2	0.37
Yellow 6	0.52
Red 3	0.10

Explain the conclusions Eve can make about the jelly

Include what she could do to increase the confidence in her conclusions.

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..... **[6]**

7 Fertilisers are used to help to grow food.

The first stage of making fertilisers uses hydrogen to make ammonia.

Very large amounts of hydrogen are needed.

The table shows some information about one large scale process for making hydrogen.

Raw materials	• methane gas from refining crude oil • steam
Temperature of process (ºC)	700 – 1100
Waste gases	• carbon dioxide, • carbon monoxide, • unreacted methane
Atom economy (%)	< 20

(a) The waste gases are collected to make sure that they do not harm the workers.

Which waste gas is directly harmful to people? What are its effects?

Gas: .....

Effect on people: .....

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

(b) Jack thinks that this process is **not** sustainable in the long term.

Explain why Jack thinks this.

Use the information in the table to help you to explain your reasoning.

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

(c) The equation for the process is:

methane + steam ⇌ hydrogen + carbon dioxide

$CH_4 + 2H_2O \rightleftharpoons 4H_2 + CO_2$

In this reaction, the methane is never used up there is always some left over.

(i) How does the equation show that the methane can never be all used up?

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

(ii) The leftover methane is recycled back into the start of the process.

Explain why this makes the process more sustainable.

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

(d) **(i)** Jack uses this equation to calculate the atom economy of the process.

$$\text{Atom economy} = \frac{\text{Total mass of hydrogen molecules made}}{\text{Total mass of molecules used}} \times 100\%$$

Equation: $CH_4 + 2H_2O \rightleftharpoons 4H_2 + CO_2$

Calculate the atom economy for this process.

atom economy = ...% **[3]**

(ii) The information says that the atom economy is < 20 %.

Does the value you have calculated agree with this?

Explain your reasoning.

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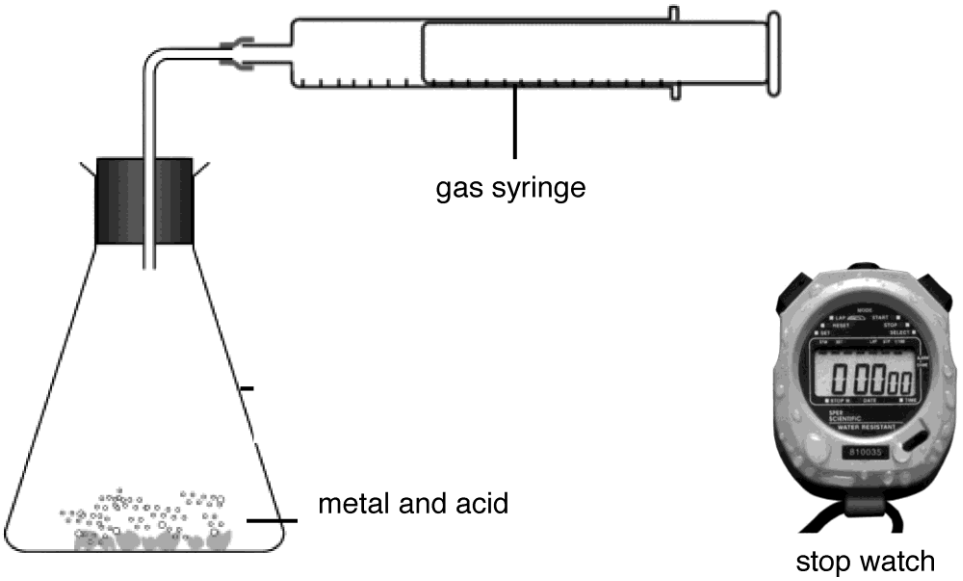
..... **[2]**

8 Kai investigates the rate of reaction between a metal and an acid.

He uses this apparatus.



(a) Kai investigates how changing the concentration of the acid affects the volume of gas collected in 10 s.

What factors should Joe control to make sure that his results are repeatable?

Justify your answer.

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..... **[5]**

(b) Kai repeats his experiment three times for four different concentrations of acid.

The table shows his results.

Concentration of acid (mol/dm^3)	**Volume of gas collected after 10 seconds** (cm^3)			**Mean volume of gas (cm^3)**
	Repeat 1	**Repeat 2**	**Repeat 3**	
0.50	3	2	4	3
1.00	4	5	4	4
1.50	5	6	6	
2.00	6	7	6	

Kai makes this comment on his results.

If I show the mean volumes for the last two concentrations to one significant figure, they are the same.

I need to show the mean volumes to at least two significant figures to see a difference.

(i) Use calculations to show that Kai is right.

[3]

(ii)* Evaluate Kai's results and explain how he could change his method to improve the quality of his results.

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..... **[6]**

9 Mendeleev organised the elements into the first Periodic Table.

The diagram shows some elements from Groups 2 and 3 in Mendeleev's Periodic Table.

Group 2
Be
Mg
Cd
Zn

Group 3
B
Al
(gap)
(gap)

(a) Mendeleev left gaps in his table.

Two gaps are shown in Group 3.

Explain why these gaps were so important.

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

(b) Two of the elements in Mendeleev's Group 2 are **not** in Group 2 of the modern Periodic Table.

Identify the elements and state where they are found in the modern Periodic Table.

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

END OF QUESTION PAPER

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OCR
Oxford Cambridge and RSA

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…day June 20XX – Morning/Afternoon

GCSE (9–1) Chemistry B (Twenty First Century Science)
J258/02 Depth in chemistry (Foundation Tier)

SAMPLE MARK SCHEME

Duration: 1 hour 45 minutes

MAXIMUM MARK 90

This document consists of 20 pages

MARKING INSTRUCTIONS

PREPARATION FOR MARKING

SCORIS

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: *scoris assessor Online Training*; *OCR Essential Guide to Marking*.

2. Make sure that you have read and understood the mark scheme and the question paper for this unit. These are posted on the RM Cambridge Assessment Support Portal http://www.rm.com/support/ca

3. Log-in to scoris and mark the **required number** of practice responses ("scripts") and the **required number** of standardisation responses.

   YOU MUST MARK 10 PRACTICE AND 10 STANDARDISATION RESPONSES BEFORE YOU CAN BE APPROVED TO MARK LIVE SCRIPTS.

MARKING

1. Mark strictly to the mark scheme.

2. Marks awarded must relate directly to the marking criteria.

3. The schedule of dates is very important. It is essential that you meet the scoris 50% and 100% (traditional 50% Batch 1 and 100% Batch 2) deadlines. If you experience problems, you must contact your Team Leader (Supervisor) without delay.

4. If you are in any doubt about applying the mark scheme, consult your Team Leader by telephone, email or via the scoris messaging system.

5. Work crossed out:
   a. where a candidate crosses out an answer and provides an alternative response, the crossed out response is not marked and gains no marks
   b. if a candidate crosses out an answer to a whole question and makes no second attempt, and if the inclusion of the answer does not cause a rubric infringement, the assessor should attempt to mark the crossed out answer and award marks appropriately.

6. Always check the pages (and additional objects if present) at the end of the response in case any answers have been continued there. If the candidate has continued an answer there then add a tick to confirm that the work has been seen.

7. There is a NR (No Response) option. Award NR (No Response)
   - if there is nothing written at all in the answer space
   - OR if there is a comment which does not in any way relate to the question (e.g. 'can't do', 'don't know')
   - OR if there is a mark (e.g. a dash, a question mark) which isn't an attempt at the question.

   Note: Award 0 marks – for an attempt that earns no credit (including copying out the question).

8. The scoris **comments box** is used by your Team Leader to explain the marking of the practice responses. Please refer to these comments when checking your practice responses. **Do not use the comments box for any other reason.**
   If you have any questions or comments for your Team Leader, use the phone, the scoris messaging system, or email.

9. Assistant Examiners will send a brief report on the performance of candidates to their Team Leader (Supervisor) via email by the end of the marking period. The report should contain notes on particular strengths displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.

10. For answers marked by levels of response:

Read through the whole answer from start to finish, using the Level descriptors to help you decide whether it is a strong or weak answer. The indicative scientific content in the Guidance column indicates the expected parameters for candidates' answers, but be prepared to recognise and credit unexpected approaches where they show relevance. Using a 'best-fit' approach based on the skills and science content evidenced within the answer, first decide which set of level descriptors, Level 1, Level 2 or Level 3, best describes the overall quality of the answer. Once the level is located, award the higher or lower mark:

The higher mark should be awarded where the level descriptor has been evidenced and all aspects of the communication statement (in italics) have been met.
The lower mark should be awarded where the level descriptor has been evidenced but aspects of the communication statement (in italics) are missing.

In summary:

The skills and science content determines the level.
The communication statement determines the mark within a level.

Level of response questions on this paper are **6(c)** and **8(b)(ii)**.

11. **Annotations**

Annotation	Meaning
DO NOT ALLOW	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
( )	Words which are not essential to gain credit
__	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

12. **Subject-specific Marking Instructions**

INTRODUCTION

Your first task as an Examiner is to become thoroughly familiar with the material on which the examination depends. This material includes:

- the specification, especially the assessment objectives
- the question paper
- the mark scheme.

You should ensure that you have copies of these materials.

You should ensure also that you are familiar with the administrative procedures related to the marking process. These are set out in the OCR booklet **Instructions for Examiners**. If you are examining for the first time, please read carefully **Appendix 5 Introduction to Script Marking: Notes for New Examiners**.

Please ask for help or guidance whenever you need it. Your first point of contact is your Team Leader.

The breakdown of Assessment Objectives for GCSE (9–1) in Chemistry B:

	Assessment Objective
AO1	**Demonstrate knowledge and understanding of scientific ideas and scientific techniques and procedures.**
AO1.1	Demonstrate knowledge and understanding of scientific ideas.
AO1.2	Demonstrate knowledge and understanding of scientific techniques and procedures.
AO2	**Apply knowledge and understanding of scientific ideas and scientific enquiry, techniques and procedures.**
AO2.1	Apply knowledge and understanding of scientific ideas.
AO2.2	Apply knowledge and understanding of scientific enquiry, techniques and procedures.
AO3	**Analyse information and ideas to interpret and evaluate, make judgements and draw conclusions and develop and improve experimental procedures.**
AO3.1	Analyse information and ideas to interpret and evaluate.
AO3.1a	Analyse information and ideas to interpret.
AO3.1b	Analyse information and ideas to evaluate.
AO3.2	Analyse information and ideas to make judgements and draw conclusions.
AO3.2a	Analyse information and ideas to make judgements.
AO3.2b	Analyse information and ideas to draw conclusions.
AO3.3	Analyse information and ideas to develop and improve experimental procedures.
AO3.3a	Analyse information and ideas to develop experimental procedures.
AO3.3b	Analyse information and ideas to improve experimental procedures.

Question			Answer	Marks	AO element	Guidance
1	(a)		floods increase / storms increase (over time) / correct use of figures from the graphs to illustrate a correlation for storms ✓ global carbon emissions increase (over time) / correct use of figures from the graphs to illustrate a correlation for carbon emissions ✓ increases follow a similar pattern ✓	3	2.1	Correct use of figures from the graphs to illustrate a correlation for storms.
	(b)	(i)	data not available / no data collected / can't go back ✓ data may be of lower quality / records not kept accurately / not systematic / different methods of collecting data / instrumentation make comparing data difficult ✓	2	2.2	
		(ii)	3000 ÷ 750 x 100 ✓ = 400 % ✓	2	2.1	

Question			Answer	Marks	AO element	Guidance
	(c)		<Sundip because> global temperatures pose threat to more people / worldwide idea ✓ gives examples of effects of increase in global temperatures: more flooding, ice caps melting, climate change, crops failure / desertification ✓ floods give threat to local area idea / relatively few people ✓ number of floods and storms still (relatively) small / do not happen every day ✓	4	3.1a 3.1a 3.2a 3.2a	If decision is not given, then maximum (2) marks.
	(d)		gives advantage of either method: using CDs/old plastics uses waste / old oil wells are not useful ✓ (makes comparison): Oil wells are bigger scale / can store large amounts of carbon dioxide / not enough CDs idea/a lot of plastic will need to be stored somewhere idea ✓ (makes comparison): Using oil wells has other benefits / more oil is needed for fuels and making chemicals / helps to get (more) oil from oil well / oil is running out so using all reserves is beneficial ✓	3	3.1a 3.2b 3.2b	

Question			Answer	Marks	AO element	Guidance
2	(a)	(i)	lithium + fluorine → lithium fluoride ✓ 2Li ✓ + F_2 → 2LiF	2	1.1	
		(ii)	✓ lithium → metal ✓ fluorine → non-metal ✓ lithium fluoride → ionic compound	2	1.1 1.2	All three correct = (2) One or two correct = (1)
	(b)	(i)	shows 2 shared electrons between fluorine atoms ✓ shows correct number of other electrons for each atom (6) ✓	2	1.1 2.2	Accept dots or crosses or a mixture of both.
		(ii)	shows a total of 10 electrons ✓ in configuration 2,8 ✓	2	1.1 2.2	
	(c)		simple covalent substances have lower melting points than giant ionic substances ✓ there are weak forces between simple covalent molecules ✓	2	1.1	

Question			Answer	Marks	AO element	Guidance
3	(a)		they all have high melting points ✓	1	2.2	
	(b)	(i)	**A** is a metal/has metallic bonding✓ because it conduct electricity when solid and molten✓	2	2.1 3.2b	
		(ii)	**B** is a covalent compound✓ because it does not conduct when solid or molten✓	2	2.1 3.2b	
		(iii)	**C** is an ionic compound✓ because it does not conduct when solid but does conduct when molten✓	2	2.1 3.2b	
4	(a)		C_5H_{12} ✓	1	2.2	
	(b)		methane ✓ butane ✓	2	1.2	
	(c)		C_8H_{18} ✓	1	2.2	
	(d)		✓ all alkanes are hydrocarbons. ✓ the alkanes are a homologous series.	2	1.1	

Question			Answer	Marks	AO element	Guidance
5	(a)		**$4Fe(s)$✓$+6H_2O(l) + 3O_2(g)$ ✓ ⟶ $2Fe_2O_3.3H_2O(s)$**	**2**	**1.1**	
	(b)	**(i)**	**FIRST CHECK THE ANSWER ON THE ANSWER LINE** **If answer = 52.25 (%) award 2 marks** 2 iron atoms in a rust atom RAM iron = 55.8 therefore $\frac{2 \times 55.8}{213.6} \times 100$ ✓ = 52.247 = 52.25 (%) to 2dp ✓	**2**	**2.2**	
		(ii)	**FIRST CHECK THE ANSWER ON THE ANSWER LINE** **If answer = 51 (g) award 3 marks** mass of iron turned to rust = 2 x 7 x 4 = 56 g✓ mass of rust = $\frac{\text{mass of iron}}{0.5225} = \frac{56}{0.5225}$ = 107.177✓ increase in mass of skate board = 107.177 – 56 = 51.177 = 51 (g) to the nearest gram ✓	**3**	**2.2**	**ALLOW ECF** from **(b)(i)**

Question			Answer	Marks	AO element	Guidance
	(c)		coat/galvanise/grease ball bearings ✓ to form barrier to keep the water and oxygen from the steel ✓ or use another material ✓ with the same desirable properties but that does not rust ✓ or suggestion of an alternative material such as ceramic ✓ and why ✓	2	1.1	Any two linked answers
6	(a)	(i)	**FIRST CHECK THE ANSWER ON THE ANSWER LINE** **If answer = 0.5 (g) award 2 marks** mass of solvent = 1 x 250 =250 ✓ mass of NaCl = 250 x 0.2 ÷ 100 = 0.5 (g) ✓	2	2.2	
		(ii)	draw start line with pencil ✓ put a dot of dye on start line ✓ add sodium chloride/solvent to beaker / put paper into solvent ✓ make sure solvent is below level of dot ✓	4	1.2	all points may be scored from a clearly labelled diagram

Question	Answer	Marks	AO element	Guidance
(b)*	Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. **Level 3 (5–6 marks)** *Shows correct understanding of output of the chromatogram and calculates correctly the Rf of some of the spots, including linking the Rf values to the table of food dyes.* **And** *makes correct conclusions about the jelly* **And** *Suggests improvements to increase confidence in the result.* *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated* **Level 2 (3–4 marks)** *Shows correct understanding of output of the chromatogram and calculates correctly the Rf of some of the spots, including linking the Rf values to the table of food dyes.* **And** *makes some conclusions about the jelly or suggests improvements.*	**6**	**2 x 1.2 2 x 2.2 3.2b 3.3b**	**Indicative scientific points may include** **AO3.2b: making conclusions about the dye dyes by comparing results with table of Rf values** For example • one spot possibly a safe dye • one spot banned dye • cannot be exported to USA **AO2.2: directly linking spots Rf values** For example • calculates the Rf of dyes: 0.37 / 0.92 • compares spots with table **AO1.2: understanding of the output from a chromatogram** For example • jelly contains 2 dyes • shows how to calculate RF value **AO3.3b: making improvement to increase confidence** For example • use a different solvent • suggest a different method • look at a more extensive Rf table to identify other dye and check for safety

Question			Answer	Marks	AO element	Guidance
			There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence. **Level 1 (1–2 marks)** *Shows correct understanding of output of the chromatogram and attempts to calculate the Rf of a spot but incorrectly (shows knowledge of the formula)* *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 marks** No response or no response worthy of credit.			

Question			Answer	Marks	AO element	Guidance
7	(a)		carbon monoxide ✓ toxic / reduces oxygen content of blood ✓	2	2.1 1.1	
	(b)		(links judgment to main reasons why non-sustainable) methane is non-renewable/finite/will run out/comes from fossil fuels ✓ carbon dioxide is a waste product which causes climate change ✓ makes another point 'against' the process: high temperature uses energy / large energy input / atom economy is low / large amount of waste products idea ✓	3	 3.2a 3.2a 3.1a	.
	(c)	(i)	reversible reaction / explanation of reversible reaction ✓ idea that reaction never reaches 100% yield / all reactants do not react / reaction does not go to completion ✓	2	2.1	
		(ii)	does not waste raw materials / use less methane / methane is non-renewable ✓ less waste given out / less waste to dispose of ✓	2	2.1	

Question			Answer	Marks	AO element	Guidance
	(d)	(i)	**FIRST CHECK THE ANSWER ON THE ANSWER LINE** **If answer = 15.38 (%) award 3 marks** Total mass of H_2 molecules = 4 x 2 = 8 ✓ Total mass of molecules used = (2 x 18) + (1 x 16) = 52 ✓ atom economy = 8 ÷ 52 x 100 = 15.38 (%) ✓	**3**	 **2.1** **2.1** **2.2**	 **ALLOW** total mass of molecules used = (4 x 2) + 44 = 52 **ALLOW** 2 or more sig figs, correctly rounded.
		(ii)	idea that < means 'less than' ✓ (yes because) 15.38 is <u>less than</u> 20 ✓	**2**	**2.1** **2.2**	**ALLOW ECF** on incorrect value from (d)(i)
8	**(a)**		volume of acid✓ temperature of acid ✓ mass of magnesium✓ surface area of magnesium ✓ Correct link between increase in rate of reaction and factor (e.g. if surface area is greater, rate increase) ✓	**5**	**1.2**	
	(b)	**(i)**	(1.50) 5+6+6 /3=5.7(to two sig figs) ✓ (2.00) 6+7+6 /3 =6.3 (to two sig figs) ✓ both values round to 6 (to one sig fig) ✓	**3**	**2.2**	**ALLOW** 5.67 etc if correctly rounded (last number must be 7)

Question			Answer	Marks	AO element	Guidance
	(b)	(ii)*	Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. **Level 3 (5–6 marks)** *Correctly evaluates the quality of the data as being poor with valid reasons.* **And** *Makes several correct suggestions for the development of the method with correct explanation of how the data will be improved.* *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated* **Level 2 (3–4 marks)** *Correctly evaluates the quality of the data as being poor with valid reasons.* **And** *Makes several correct suggestions for the development of the method or makes one suggestion with a correct explanation of how the data will be improved.* *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.*	**6**	**2 x 3.1b** **2 x 3.3a** **2 x 3.3b**	**Indicative scientific points may include** **AO3.1b evaluation of the quality of Joe's results.** For example • no spread of data • results too close together • volumes measured very small **AO3.3a suggestions for the development of Joe's method** For example • Increase time before volume measured • Increased volume of acid • Increased surface area of magnesium • more magnesium **AO3.3b explanation of how the data will be improved** For example • Volume of gas will be greater • more precise measurement of volume • Larger spread of data • Less overlap of ranges

Question			Answer	Marks	AO element	Guidance
			Level 1 (1–2 marks) *Correctly evaluates the quality of the data as being poor with a valid reason.* **And** *makes one suggestion for the development of the method with no explanation.* *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 marks** No response or no response worthy of credit.			
9	**(a)**		gaps are for undiscovered elements ✓ he predicted properties / new elements matched his predictions / new elements had the properties he predicted ✓	**2**	**1.1**	
	(b)		Cd and Zn / cadmium and zinc ✓ transition metals ✓	**2**	**2.1**	Both elements required for 1 mark

Summary of updates

Date	Version	Details
May 2018	2	We've reviewed the look and feel of our papers through text, tone, language, images and formatting. For more information please see our assessment principles in our "Exploring our question papers" brochures on our website
November 2019	2.1	Inconsistency of names amended in Question 1c.
October 2021	2.2	Updated copyright acknowledgements.
September 2024	2.3	Updated the font of oxidation numbers.