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GCSE (9–1) Chemistry B (Twenty First Century Science)
J258/04 Depth in chemistry (Higher Tier)
Sample Question Paper

Date – Morning/Afternoon

Version 2.1

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 **20** pages.

Turn over

Answer **all** the questions.

1   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
A*l*
(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]**

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

He uses this apparatus.

gas syringe

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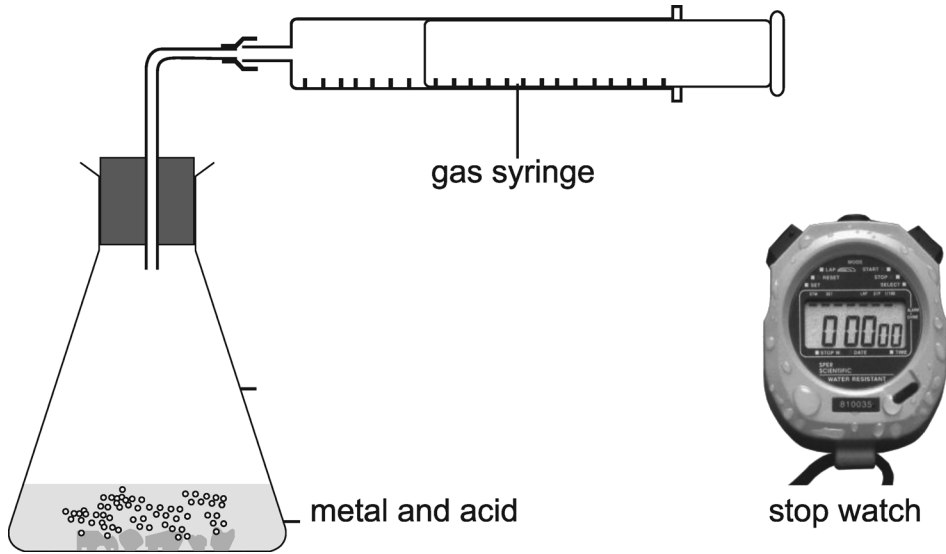
(a) Kai investigates how changing the concentration of the acid affects the volume of gas collected in 10 s.

What factors should Kai 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/dm³)	Volume of gas collected after 10 seconds (cm³)			Mean volume of gas (cm³)
	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.

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[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]**

3   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 popluated cities in recent years. People are looking to try to explain these events and to predict what will happen in the future.

Scientists have collected data about changes to our climate and our weather and about global carbon emissions. They use data such as this to identify correlations about factors that may affect our climate and to predict likely changes in the future.

Trend in extreme weather events 1970-2005

Average Global Temperature, 1880-2013

Global Fossil Carbon Emissions
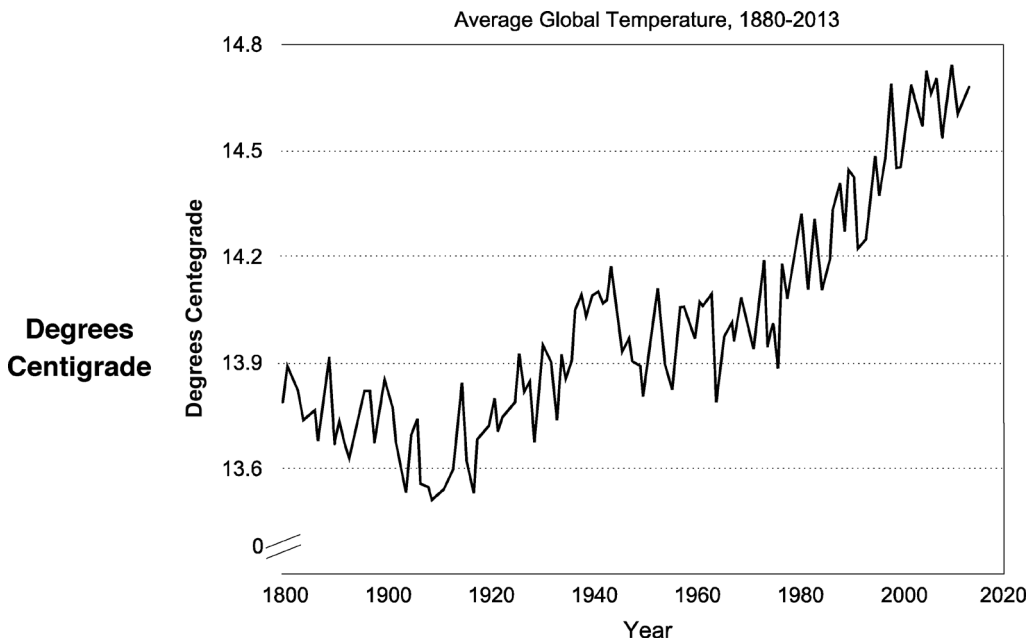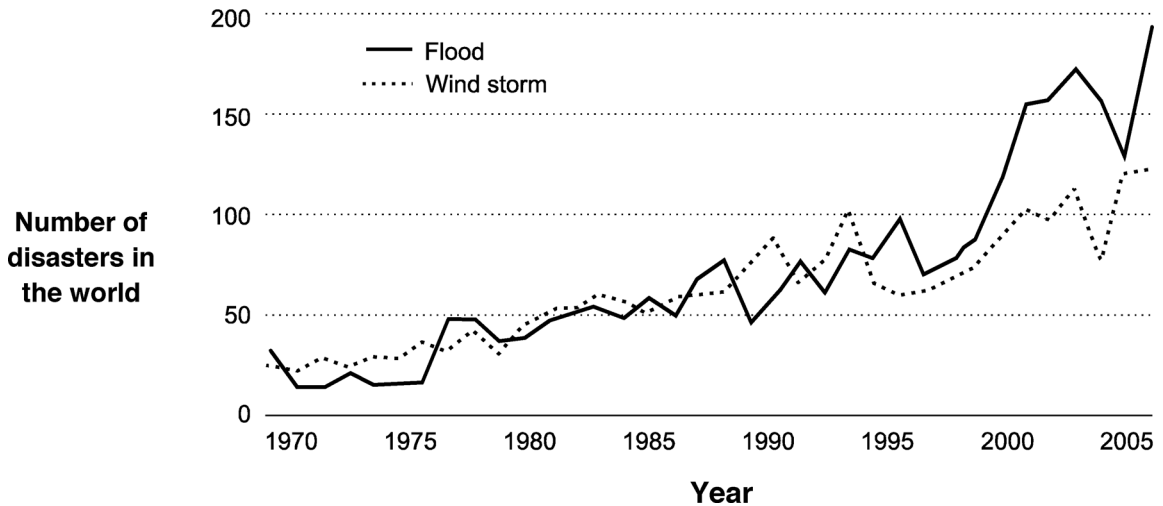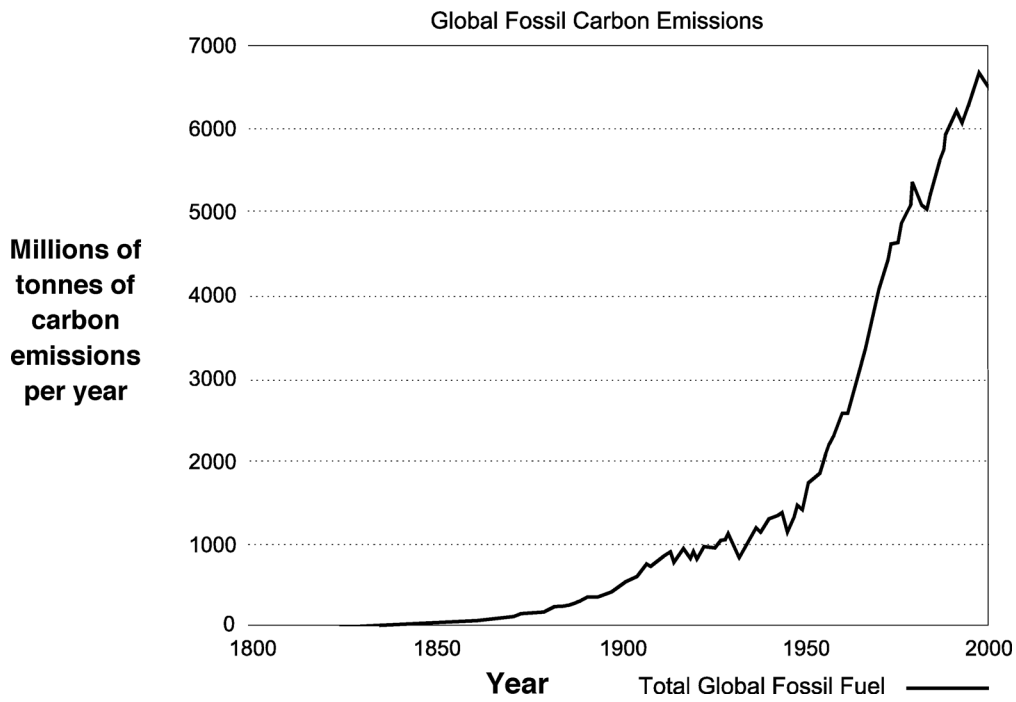
Computer simulations have been developed to predict how our weather and climate may change in the future. These simulations give very accurate predictions about temperature, but they rely on using known values of global carbon emissions. However, scientists say that it is very difficult to make reliable long term predictions for the future.

(a) Scientists have identified correlations about factors which may affect our climate.

Describe the correlations that the graphs show.

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.... **[3]**

(b) Explain why it is difficult to make reliable predictions about changes to global temperatures in the future.

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.... **[2]**

(c) Ben looks at the graphs and makes this comment:

'**There is a much greater percentage increase in the number of floods than in the global temperatures.**

The future risks from floods will get bigger and bigger. In the future, people will be at much greater risks from floods than the risks from rising temperatures.'

(i) Ben says there is a much greater percentage increase in the number of floods than in the global temperature.

Explain why Ben thinks this.

Use values from the graphs to support your answer.

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.... **[3]**

(ii) Ben thinks that in the future, people will be at much greater risks from floods than the risks from rising temperatures.

Explain why Ben may not be right.

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.... **[3]**

 Turn over

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

> Scientists in Poland have developed a new method of making old CDs into a material that can absorb carbon dioxide. Carbon dioxide can be 'captured' from the air and stored in the material. 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.
>
> Toxic gases from industrial processes can also be stored in the material.
>
> Scientists hope to be able to make the same material from other waste plastics. However, further development of these ideas will have a high cost. To raise the necessary funding, scientists will need to show that this new idea will have a significant impact on the problems caused by fossil fuels.

Do you think benefits of this process are likely to outweigh the costs in the long term?

Explain your reasoning.

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.... **[4]**

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

Lithium reacts with fluorine gas to form lithium fluoride.

Lithium fluoride is an ionic compound.

(a) Write a balanced symbol equation for this reaction.

Include state symbols in your answer.

.... **[3]**

(b) Lithium atoms react with fluorine atoms to form lithium ions and fluoride ions.

Draw dot and cross diagrams to show the arrangement of electrons and charge for a lithium ion and a fluoride ion.

[3]

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

Substance	Structure	Melting point (in °C)	Boiling point (in °C)
fluorine	simple covalent	−220	−188
lithium fluoride	giant ionic	845	1680

Explain why the melting point and boiling point of fluorine and lithium fluoride are different.

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.... **[3]**

5 Sundip is a geologist. She takes samples of minerals from a range of rocks.

She tests their melting points and electrical conductivity so that she can work out the bonding and structure of each mineral.

The table shows her results.

Mineral	Melting point (in °C)	Electrical conductivity		
		when solid	when molten	when dissolved in water
A	1083	good	good	insoluble
B	1600	does not conduct	does not conduct	insoluble
C	801	does not conduct	good	good
D	373	conduct	good	does not conduct

(a) Sundip thinks minerals **C** and **D** are both ionic compounds with a giant structure.

Explain why Sundip thinks this.

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.... **[2]**

(b) Compare minerals **A** and **B**.

What type of structure and bonding do minerals **A** and **B** have?

Explain your answer.

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.... **[4]**

6 The table shows information about some alkanes.

Alkane	Number of carbon atoms	Molecular formula
methane	1	CH_4
ethane	2	C_2H_6
pentane	5	C_5H_{12}
heptane	7	C_7H_{16}

(a) What is the name of the alkane in the table which has the empirical formula CH_3?

Explain your reasoning.

Name: ....

Reason: ....

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.... **[2]**

(b) The diagram shows a ball and stick model of a hydrocarbon.
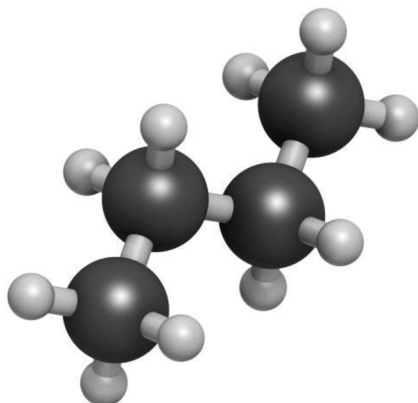
Give the molecular formula and the name of this hydrocarbon.

Molecular formula: ....

Name:... **[2]**

(c) An alkane in petrol contains 8 carbon atoms.

Draw a fully displayed formula for this alkane.

[2]

7   Li works for a company that makes skateboards.
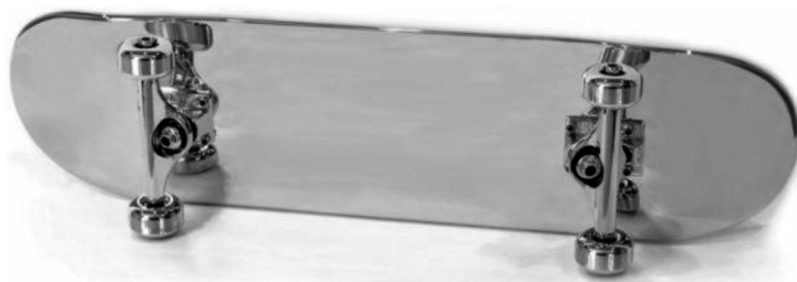
Customers complain that their skateboards lose performance when they get wet.

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

(b) (i) Li tests the skateboard after it has been in wet conditions.

Each ball bearing has a mass of 5 g.

- There are seven ball bearings in each bearing.

- The steel is an alloy of iron and carbon. It contains 0.5% carbon.

- Half of the iron in each ball bearing rusts away.

Calculate the mass of rust (hydrated iron(III) oxide) produced per bearing.

Give your answer to the nearest gram.

Mass of rust = ... g **[5]**

(ii) The mass of the skateboard when new is 3 kg.

Calculate the percentage increase in the mass of the skateboard caused by the rust.

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

Percentage mass increase = ... % **[3]**

(c) Li notices that this skateboard does **not** perform as well as when new.

Suggest, with an explanation, a reason for this and how the problem could be solved.

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.... **[2]**

8 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.

The table shows R_f values of some food dyes. The first four dyes are banned in the USA.

Food dye	R_f value in 1.755 g/dm^3 sodium chloride solution
Yellow 5	0.71
Blue 2	0.22
Yellow 6	0.52
Red 3	0.10
Red 40	0.25
Blue 1	0.88

(a) Eve prepares a chromatogram of the jelly.

(i) Calculate what concentration of sodium chloride in mol/dm^3 she needs to use.

Concentration of sodium chloride = ... mol/dm^3 **[2]**

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

You may use a diagram in your answer.

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.... **[4]**

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

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]**

9 Hydrogen is used on an industrial scale to make fertilisers.

One reaction pathway for making hydrogen is from methane gas reacting with steam.

This is a two stage process.

Stage 1: $CH_4 + H_2O \rightleftharpoons CO + 3H_2$

Stage 2: $CO + H_2O \rightleftharpoons CO_2 + H_2$
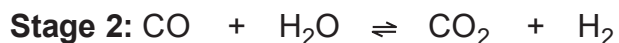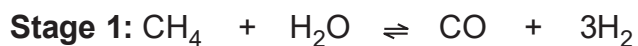
(a) The overall equation for the reaction is:

$CH_4 + 2H_2O \rightleftharpoons 4H_2 + CO_2$
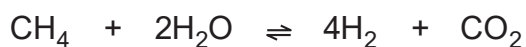
Jack and Nina discuss the process.

Jack: This is an efficient process for making hydrogen. The volume of hydrogen made is four times the volume of the waste

Jack

Nina: I don't agree with you. The atom economy for the reaction is well below 20%.

Nina

(i) What is the waste product of this process?

.... **[1]**

(ii) Use a calculation to show that the volume of hydrogen made is four times the volume of the waste product.

- One mole of gas has a volume of 24 dm^3 at room temperature and pressure.

[2]

(iii) Use the overall equation for the reaction to calculate the atom economy.

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

(iv) Explain why the atom economy for the process is low even though the volume of hydrogen made is high.

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.... **[2]**

(b) Nina also says that she thinks that this method of making hydrogen is not sustainable in the long term.

Explain why Nina may think this.

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.... **[4]**

END OF QUESTION PAPER

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