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

J258/02 Depth in Chemistry (Foundation Tier)

Wednesday 13 June 2018 – Morning

Time allowed: 1 hour 45 minutes

7030105065

You must have:
- a ruler (cm/mm)
- the Data Sheet (for GCSE Chemistry B (inserted))

You may use:
- a scientific or graphical calculator
- an HB pencil

J258/02

First name	
Last name	
Centre number	Candidate number

INSTRUCTIONS
- The Data Sheet will be found inside this document.
- Use black ink. You may use an HB pencil for graphs and diagrams.
- 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. If additional space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the barcodes.

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 **28** pages.

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Answer **all** the questions.

1 **Table 1.1** shows some information about diamond, graphite and carbon dioxide.

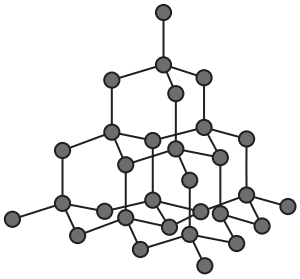
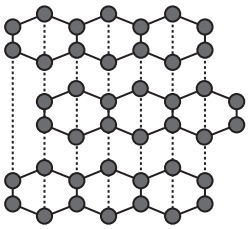
	Diamond	**Graphite**	**Carbon dioxide**
Diagram of structure			
Formula	C(s)	C(s)	$CO_2(g)$
Element or compound?	element	element	compound
State at room temperature and pressure	solid	.....	.....
Structure and bonding	giant covalent	giant covalent	simple covalent

Table 1.1

(a) Complete **Table 1.1** by filling in the **state** for graphite and carbon dioxide. **[2]**

(b) Explain why diamond and graphite are elements, but carbon dioxide is a compound.

.....

.....

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

(c) Diamond and graphite have giant covalent structures.
Carbon dioxide has a simple covalent structure.

Explain how the diagrams of their structures show that these statements are true.

.....

.....

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

2 Nitrogen oxides are pollutant gases that are produced when coal burns in a power station.

(a) (i) Nitrogen monoxide is one type of nitrogen oxide that is formed in a power station.

The reaction that forms nitrogen oxide can be shown in an equation.

Complete the word and balanced symbol equation by filling in the boxes.

nitrogen + ... → nitrogen monoxide

..... + O_2 → 2NO

[2]

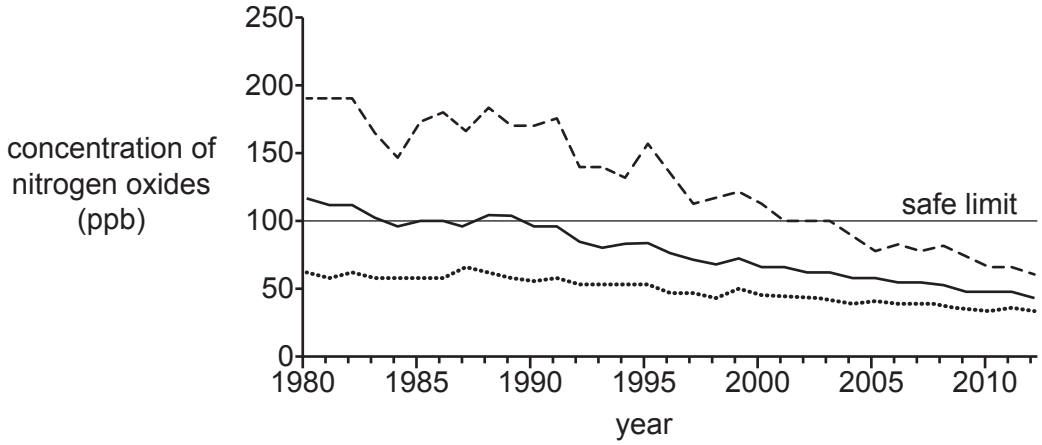
(ii) Which statements about nitrogen oxides are **true** and which are **false**?

Put a tick (✓) in one box in each row.

	True	**False**
Nitrogen oxides are also produced in car engines.		
Nitrogen oxides form at very high temperatures.		
NO_2 and NH_3 are examples of nitrogen oxides.		

[2]

(b) The graph shows information about the concentration in parts per billion (ppb) of nitrogen oxides in the air between 1980 and 2012.



Key
- highest daily concentration
- lowest daily concentration
- mean daily concentration

Describe how the **highest daily** concentration of nitrogen oxides changed between 1980 and 2012.

.....

.....

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

(c) The World Health Organisation recommends a safe limit for people to be exposed to nitrogen oxides. They recommend that this limit is 100 ppb.

(i) Why is it necessary to set a safe limit for exposure to nitrogen oxides?

.....

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

(ii) Layla and Mia talk about the graph.
Layla says that the nitrogen oxides have been below the safe limit since 1990.
Mia says that nitrogen oxides have only been below the safe limit since 2004.

Explain how the graph could be used to support both of these ideas.

Layla's idea .....

.....

Mia's idea .....

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

3 Mauritius is a country of small islands surrounded by sea.
There is almost no fresh water in Mauritius.

(a) A distillation process is used to produce fresh water.

Statements **A–G** describe some **correct** and some **incorrect** stages in the distillation process.

A	Cold water is used to cool the steam.
B	Water evaporates.
C	Water condenses.
D	Water is heated.
E	Seawater is taken from the sea.
F	Water is sent through pipes to homes.
G	Salt is filtered out from the seawater.

Put the **correct** statements in the correct order.

The first and last have been done for you.

E					**F**

[2]

(b) **(i)** Chlorine is used to treat drinking water before it is sent to homes.
The waste water from homes is treated with oxygen.

The table shows some information about oxygen and chlorine.

Gas	**Formula of gas**	**Type of water treated**	**Reason gas is used in water treatment**
oxygen	.....	waste water	removes waste dissolved in water
chlorine	.....	drinking water	.....

Table 3.1

Complete **Table 3.1** by filling in the missing information. **[2]**

(ii) Complete **Table 3.2** below to show the tests and results used to identify oxygen and chlorine gas.

Gas	Test	Result
oxygen	.....	.....
chlorine	damp blue litmus paper	.....

Table 3.2

[3]

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4 The **alkanes** and the **alkenes** are both examples of homologous series.

(a) **Table 4.1** shows the names and chemical formulae of some alkanes.

Alkanes	
methane	CH_4
ethane	C_2H_6
propane	C_3H_8
butane	C_4H_{10}

Table 4.1

(i) Down the series, the number of carbon atoms and hydrogen atoms increases by the same amount each time.

Use examples from **Table 4.1** to show that this statement is true.

.....

.....

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

(ii) Pentane is an alkane with five carbon atoms.

Predict the formula of pentane.

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

(b) **Table 4.2** shows the names and formulae of some alkenes.

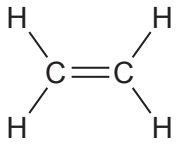
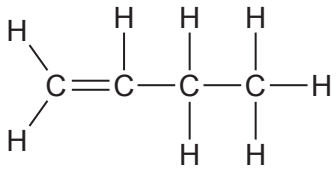
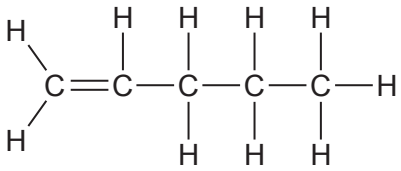
Alkene	Number of carbon atoms	Formula	Displayed formula
methene	does not exist		
ethene	2	C_2H_4	
propene	3	C_3H_6	
butene	4	C_4H_8	
pentene	5	C_5H_{10}	

Table 4.2

(i) Complete **Table 4.2** by drawing the displayed formula for **propene**. **[2]**

(ii) There is no alkene called 'methene'.

Which statement explains why 'methene' cannot exist?

Tick (✓) **one** box.

Methene cannot be a gas at room temperature. ☐

Alkenes contain all single bonds. ☐

Alkenes need to contain at least two carbon atoms. ☐

Methene would be too flammable. ☐

[1]

(c) The general formula for all of the alkenes is C_nH_{2n}.
The empirical formula for all of the alkenes is CH_2.

(i) Use examples from **Table 4.2** to explain why all of the alkenes have the same general formula, C_nH_{2n}.

.....

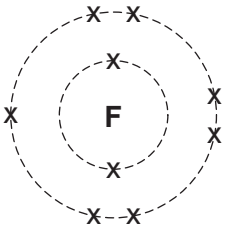
..... **[2]**

(ii) Explain why the empirical formula of all of the alkenes is CH_2.

.....

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

5 The diagram shows the arrangement of electrons in an **atom** of fluorine.



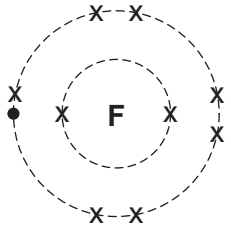
fluorine

(a) Use the diagram and the Periodic Table provided to complete the missing information in the table.

Name of atom	fluorine
Atomic Number	9
Number of electrons	9
Number of protons	
Number of neutrons	
Periodic Table Group	

[3]

(b) This diagram shows the arrangement of electrons in a fluoride **ion**.



fluoride ion

(i) Describe one way that an **atom of fluorine** and a **fluoride ion** are the same and one way that they are different.

Same.....

.....

Different.....

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

(ii) What is the formula of a fluoride ion?

Put a (ring) around the correct answer.

F **F^-** **F_2** **F^+**

[1]

6 Amir makes some copper chloride. He reacts copper oxide with dilute hydrochloric acid.

This is an equation for the reaction.

copper oxide + hydrochloric acid → copper chloride + water

$CuO + 2HCl \rightarrow CuCl_2 + H_2O$

(a) Amir does a calculation to work out how much copper chloride he can make from some copper oxide (the **theoretical yield**).

(i) He starts by working out the relative formula masses of the compounds in the equation.

Complete **Table 6.1** by working out the missing relative formula masses.

Use the Periodic Table to help you.

Name of compound	Formula	Relative formula mass
copper oxide	CuO	79.5
hydrochloric acid	HCl	
copper chloride	$CuCl_2$	134.5
water	H_2O	

Table 6.1

[2]

(ii) Amir uses 8 g of copper oxide in his experiment.

What is the theoretical yield of copper chloride from 7.95 g of copper oxide?
Use **Table 6.1** and the equation to help you.

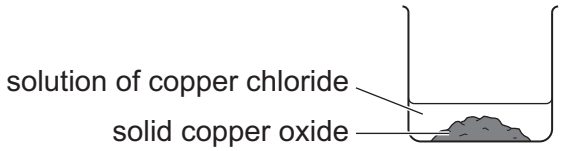
Put a (ring) around the correct answer.

0.1345 g **1.345 g** **13.45 g** **134.5 g**

[1]

(b) Amir adds 8 g of solid copper oxide to a small amount of dilute hydrochloric acid in a beaker. Some of the copper oxide does not react.

He now has a mixture which contains a solution of copper chloride and some solid copper oxide.



(i) Amir uses different techniques to separate solid copper oxide and to obtain crystals of copper chloride from the mixture.

Draw lines from each **substance** to the correct **technique**.

Substance	**Technique**
	Distillation
Solid copper oxide	Evaporation
Copper chloride crystals	Filtration
	Titration

[2]

(ii) Amir's percentage yield for this experiment is very low.

Suggest a reason why.

.....

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

7 Eve measures the volume of gas given off when solid calcium carbonate reacts with a dilute acid.

Fig. 7.1 shows a graph of her results.

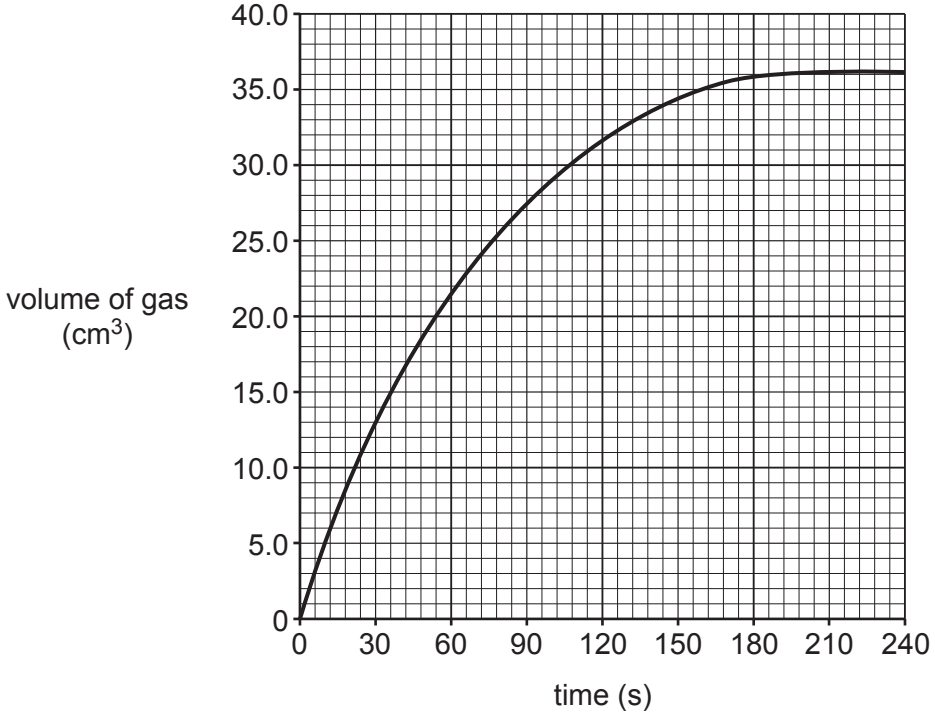


Fig. 7.1

(a) (i) What volume of gas is given off during the first minute of the reaction?

Volume = ... cm^3 **[1]**

(ii) What volume of gas is given off during the second minute of the reaction?

Volume = ... cm^3 **[2]**

(b) Look at the graph in **Fig. 7.1**.

Describe what happens to the rate of the reaction during the experiment.

.....

.....

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

(c) Eve does some more experiments.

She measures the rate of reaction when she uses different concentrations of acid.

Table 7.1 shows her results.

Concentration of acid (mol / dm^3)	**Rate of reaction (cm^3 / s)**
0.2	1.4
0.4	2.8
0.6	4.2
0.8	5.6
1.0	7.0

Table 7.1

(i) Predict the rate of reaction when acid of concentration 0.5 mol / dm^3 is used.

Rate of reaction = ... cm^3 / s **[2]**

(ii) Eve says that the data shows that rate of reaction is proportional to the concentration.

How does the data show that Eve is right?

.....

.....

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

(iii) Eve writes an expression to show that rate of reaction is proportional to concentration.

Which expression shows that rate of reaction is proportional to concentration?

Tick (✓) **one** box.

rate of reaction $\rightleftharpoons$ concentration ☐

rate of reaction $\rightarrow$ concentration ☐

rate of reaction α concentration ☐

rate of reaction ~ concentration ☐

[1]

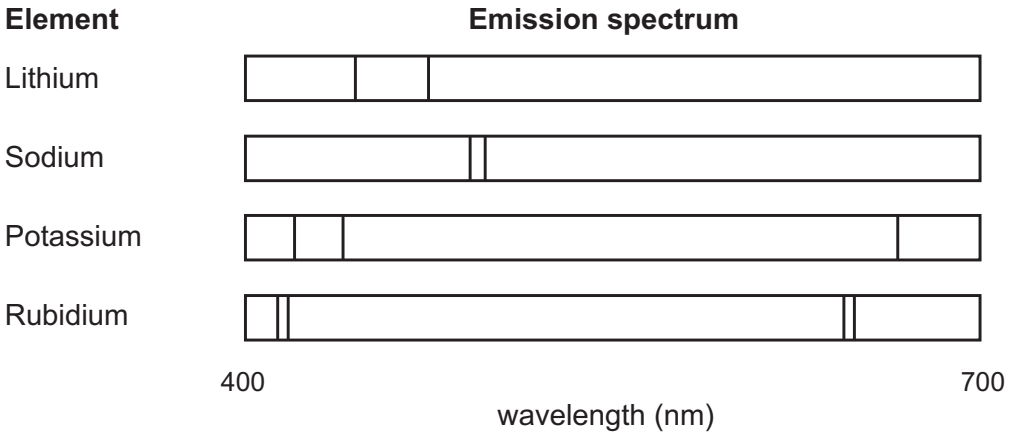
8 Salt that is used for food contains compounds of Group 1 elements.
One type of food salt is called ‘Healthy salt’.

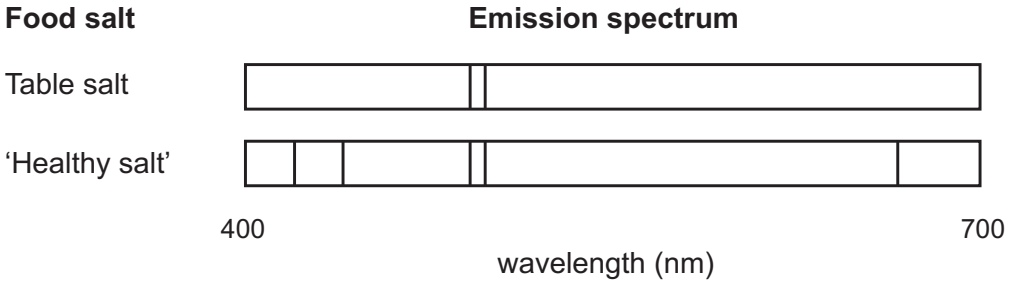
Ben wants to find out what the difference is between table salt and ‘Healthy salt’.

He does some experiments to find the emission spectra of some Group 1 elements. He also does experiments to find the emission spectra of table salt and ‘Healthy salt’.

He puts small samples of each element and salt in a spectroscopy machine and looks at the print-out of results.

Here are Ben’s results.





(a)* What conclusions can you make about the elements that table salt and 'Healthy salt' do and do not contain? Explain how the lines in both emission spectra support your conclusions.

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

(b) Elements in salts can also be identified using chemical tests.

Each test involves adding chemicals to the salts and looking for colour changes or reactions.

Ben thinks that spectroscopy is a better method to use to identify the elements.

What are the **advantages** and **disadvantages** of using spectroscopy rather than chemical tests to identify elements?

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.....

.....

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

(c) Ben says that spectroscopy is a qualitative technique.
He says that he wants to try a quantitative technique to find out more about the salts.

Draw lines to connect each **technique** with its **use**.

Technique	Use
	Used to make samples of chemicals.
	Used to measure the amount of chemical in a sample.
Qualitative technique	
	Used to investigate the reactivity of a sample.
Quantitative technique	
	Used for separation of chemicals.
	Used to find out what chemicals are in a sample.

[2]

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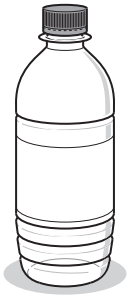
9 Soft drinks are sold in containers made from PET (a polymer), aluminium and glass.



PET bottle

Aluminium can

Glass bottle

All three containers are non-biodegradable.

Many people want to choose containers that cause less harm to the environment.

Table 9.1 shows some information about the life cycle of the containers.

	Total life cycle energy and waste per 1000 litres of drink		
	Energy use (GJ)	**Waste produced**	
		Mass (kg)	**Volume (m^3)**
PET bottle	4.1	48	0.2
Aluminium can	5.9	120	0.3
Glass bottle	9.8	730	0.6

Table 9.1

(a)* Use the data from **Table 9.1** to explain why all of the containers cause some harm to the environment and decide which container causes the least harm.

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

(b) Table 9.1 does not include all of the factors needed to do a full life cycle assessment for the drinks containers.

Which **two** factors will have the biggest effect on the life cycle assessment of the drinks containers?

Tick (✓) **two** boxes.

The amount of sugar in each drink.	☐
The distances that the containers have to be transported.	☐
The design of the label on the container.	☐
The amount of water used to manufacture the containers.	☐
Whether the containers are used for fizzy or non-fizzy drinks.	☐

[2]

10 Kai works in a research laboratory for a company that produces organic carbon compounds.

(a) Kai has three unlabelled samples of different compounds. All are colourless liquids.

Kai thinks that one of the compounds might be an alkene.
He thinks that another of the compounds might be a carboxylic acid.
He thinks the third compound is neither an alkene nor a carboxylic acid.

Describe some simple experiments that Kai could use to find out which compound is which.

Include **two** tests and the expected results in your answer.

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.....

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

(b) Hazard symbols are used to give safety information.


harmful


corrosive

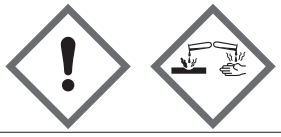

oxidising


toxic


flammable

Kai uses ethanoic acid.

The table shows the hazard symbols for ethanoic acid at different concentrations.

Concentration (mol / dm^3)	**Hazard symbol**
< 1.7	none
$\geqslant 1.7$ and < 4.0	
$\geqslant 4.0$	
very concentrated	

(i) At what concentrations is ethanoic acid harmful, but not corrosive?

.....

.....

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

(ii) Suggest a concentration at which ethanoic acid is flammable.

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

(iii) Kai adds very concentrated ethanoic acid to ethanol and heats the mixture.

Suggest some safety procedures for Kai to use to make sure that he is safe during this experiment.

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

11 About 150 years ago, Dimitri Mendeleev developed an early version of the Periodic Table. His Periodic Table had eight groups. He put elements with similar properties into the same group.

The table shows some of the elements that Mendeleev grouped together.

Mendeleev's groups							
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Li Na K Cu	Be Mg Zn	B A*l*	C Si	N P	O S Cr	F C*l* Br	Fe Co Ni

(a) Some of Mendeleev's groups contain similar elements to groups in the modern Periodic Table.

Which group in Mendeleev's table contains the elements now found in Group 14 of the modern Periodic Table?

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

(b) None of the elements from Group 18 of the modern Periodic Table are shown on Mendeleev's table.

Suggest a reason why.

.....

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

(c) Mendeleev put some of the transition metals into his Group 8.

He put some other transition metals into the other groups.

Give the symbols for **three** transition metals in Mendeleev's table that he did not put in Group 8.

1.....

2.....

3.....

[2]

(d) The transition metals are in the same block of the modern Periodic Table because their properties are similar to each other.

Which property do all the transition metals have?

Tick (✓) **one** box.

They act as catalysts in reactions. ☐

They have low melting points and boiling points. ☐

They react very quickly with cold water. ☐

They are coloured gases at room temperature. ☐

[1]

(e) Transition metal salts are acidic.

Sundip does an experiment to test the acidity of some solutions of transition metal salts. She uses Universal Indicator and a colour chart to find the pH of each salt.

These are Sundip's results.

Name of salt	pH
copper sulfate	3
iron sulfate	3
zinc sulfate	4
nickel sulfate	4

(i) Describe how Sundip uses Universal Indicator to test the pH of the solutions of the salts.

.....

.....

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

(ii) Sundip thinks her results do not show the difference in pH between the salts. She thinks she needs to improve the precision of her pH results.

Explain why she needs to improve her precision and suggest how she can change her experiment to do this.

.....

.....

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

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).