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

J258/04 Depth in Chemistry (Higher Tier)

Wednesday 13 June 2018 – Morning

Time allowed: 1 hour 45 minutes

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

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 **24** pages.

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Answer **all** the questions.

1 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

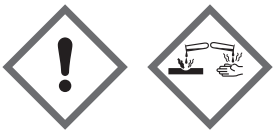
oxidising

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	

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(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]**

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2 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]

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(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.

.....

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

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

Seawater cannot be used as drinking water because it contains a large amount of salt.

(a) The flowchart shows the stages in a process which produces drinking water from seawater.

(i) Which stage removes the salt from the seawater?

Explain your answer.

Stage .....

Explanation .....

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

(ii) Explain why there are no harmful bacteria in the water **after stage 2**.

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

(iii) Explain why **stage 3** is needed.

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

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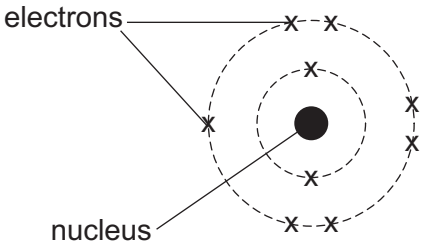
4 The diagram shows the arrangement of electrons in an atom of an element, **element X.**



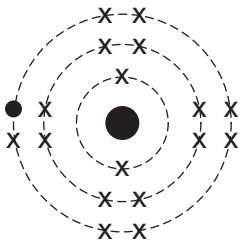
element X

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

Name of element	
Number of electrons	9
Number of protons	
Number of neutrons	
Periodic Table Group	

[3]

(b) The diagram below shows the arrangement of electrons in **an ion** of another element from the same group, **element Y**.



ion of element Y

(i) What is the charge on the ion?

Explain your answer.

Charge .....

Explanation .....

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

(ii) Explain how you can tell from the diagrams that **element X** and **element Y** are in the same group of the Periodic Table.

.....

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

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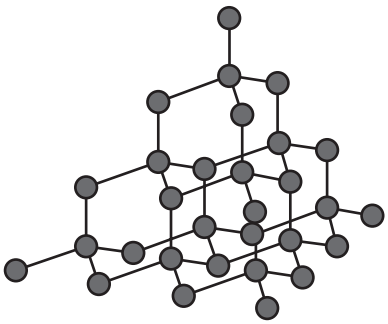
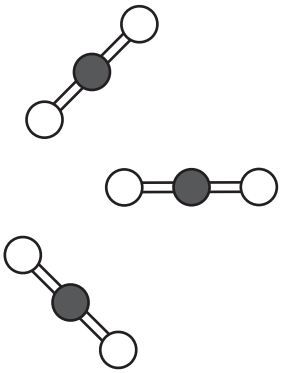
5 The table shows some information about diamond and carbon dioxide.

	Diamond	**Carbon dioxide**
Diagram of structure		
Type of structure	giant	simple
State at room temperature and pressure	solid	gas

(a) The structures of diamond and carbon dioxide are different, but the bonds are similar.

Write down some similarities between the bonds in diamond and carbon dioxide.

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

(b) Explain why diamond is a solid and carbon dioxide is a gas at room temperature and pressure.

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

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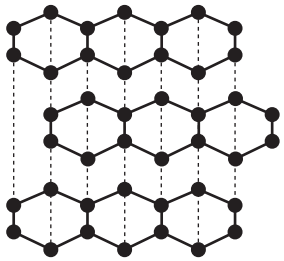
(c) Diamond is an allotrope of carbon.

Graphite is another allotrope of carbon.



Graphite

Carbon dioxide is not an allotrope of carbon.

Explain why diamond and graphite are allotropes but carbon dioxide is not.

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

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6 The table shows the names and chemical formulae of some alkanes and alkenes.

Number of carbon atoms (n)	Alkanes		Alkenes	
1	methane	CH_4		
2	ethane	C_2H_6	ethene	C_2H_4
3	propane	C_3H_8	propene	C_3H_6
4	butane	C_4H_{10}	butene	C_4H_8

(a) An alkene called 'methene' cannot exist.

Explain why.

.....

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

(b) All the alkenes are members of the same homologous series.

(i) How do the formulae of the alkenes show that they are from the same homologous series?

.....

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

(ii) How do the formulae of the alkanes and alkenes show that they are from different homologous series'?

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

(c) The general formula for an alkane is $C_nH_{(2n+2)}$.

Use this general formula to predict the chemical formula for an alkane which contains 50 carbon atoms.

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

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(d) The general formula for an alkene is C_nH_{2n}.

A **general equation** for the complete combustion of alkenes uses the number of carbon atoms in the alkene to balance the equation.

general equation $C_nH_{2n} + \mathbf{1.5n}O_2 \rightarrow \mathbf{n}CO_2 + \mathbf{n}H_2O$

(i) Use the general equation to write a balanced equation for the combustion of butene, C_4H_8.

Explain your reasoning for each part of the equation.

Equation .....

Reasons .....

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

(ii) This general equation can be used to balance equations for the complete combustion of alkenes, but does **not** work for alkanes.

Give **one** reason why the equation does **not** work for alkanes.

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

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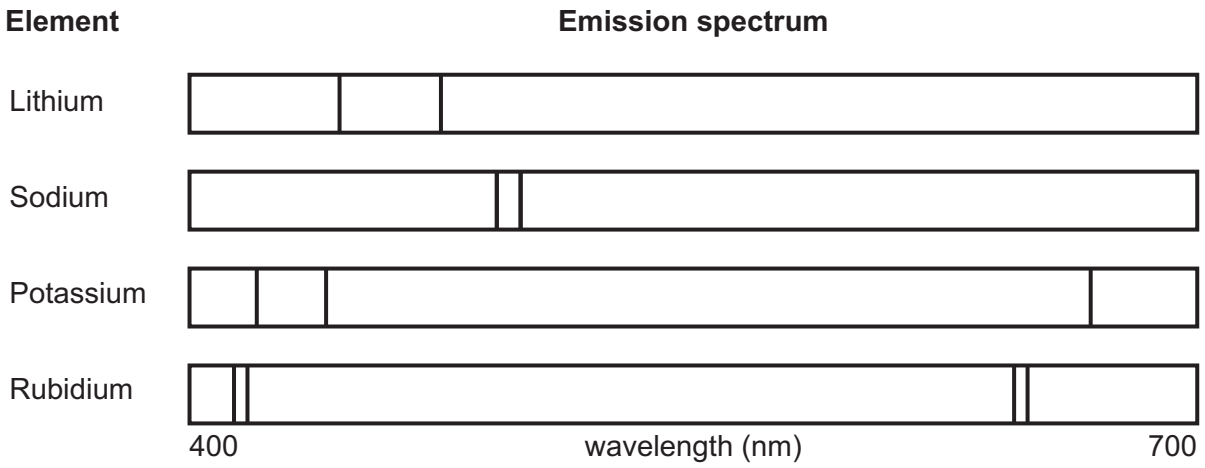
7 A new type of salt for using on food is called ‘Lo-So salt’.

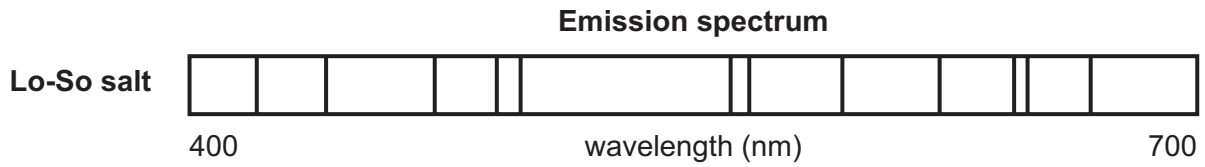
Nina wants to find out what elements ‘Lo-So salt’ contains.

She does some experiments to find the emission spectra of some compounds of Group 1 elements. She also does an experiment to find the emission spectrum of ‘Lo-So salt’.

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

Here are Nina’s results.





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(a)* Nina says that she thinks she needs to do further experiments to identify all the elements in 'Lo-So salt'.

State which elements 'Lo-So salt' does and does not contain, giving your reasons, and describe what further experiments Nina needs to do to identify all the elements in 'Lo-So salt'.

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

(b) The label for 'Lo-So salt' claims that it is 'low in sodium'.

Nina says that she cannot use spectroscopy to check this claim because spectroscopy is a qualitative, not a quantitative technique.

Explain why Nina is right.

.....

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

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8 Alex does some experiments to make some salts.

(a) In his first experiment, he uses 0.2 moles of magnesium oxide. He works out the mass of magnesium oxide in 0.2 moles.

He uses this equation: number of moles = mass of substance (g) ÷ relative formula mass (g)

Use the equation and the Periodic Table to work out the mass of magnesium oxide in 0.2 moles.

Give your answer to **1** decimal place.

Mass = ... g **[3]**

(b) In another experiment, Alex reacts 4.0 g copper oxide with hydrochloric acid to make copper chloride. This is an equation for the reaction.

copper oxide	+	hydrochloric acid	→	copper chloride	+	water
CuO	+	$2HCl$	→	$CuCl_2$	+	H_2O

Alex works out the mass of copper chloride he can make in the experiment.

He uses these relative formula masses.

Name of compound	Formula	Relative formula mass
copper oxide	CuO	79.5
copper chloride	$CuCl_2$	134.5

What mass of copper chloride can be made from 4.0 g of copper oxide?

Use the relative formula masses and the equation to help you.

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

Mass = ... g **[4]**

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(c) Alex adds 4.0 g of solid copper oxide to 25.0 cm^3 dilute hydrochloric acid.

At the end of the experiment, Alex sees that there is a problem because he has some unreacted solid left.

(i) How will this problem affect his actual yield?

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

(ii) How could Alex change his experiment to solve this problem?

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

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

Fig. 9.1 shows a graph of her results.

She draws a tangent at the start of her graph.

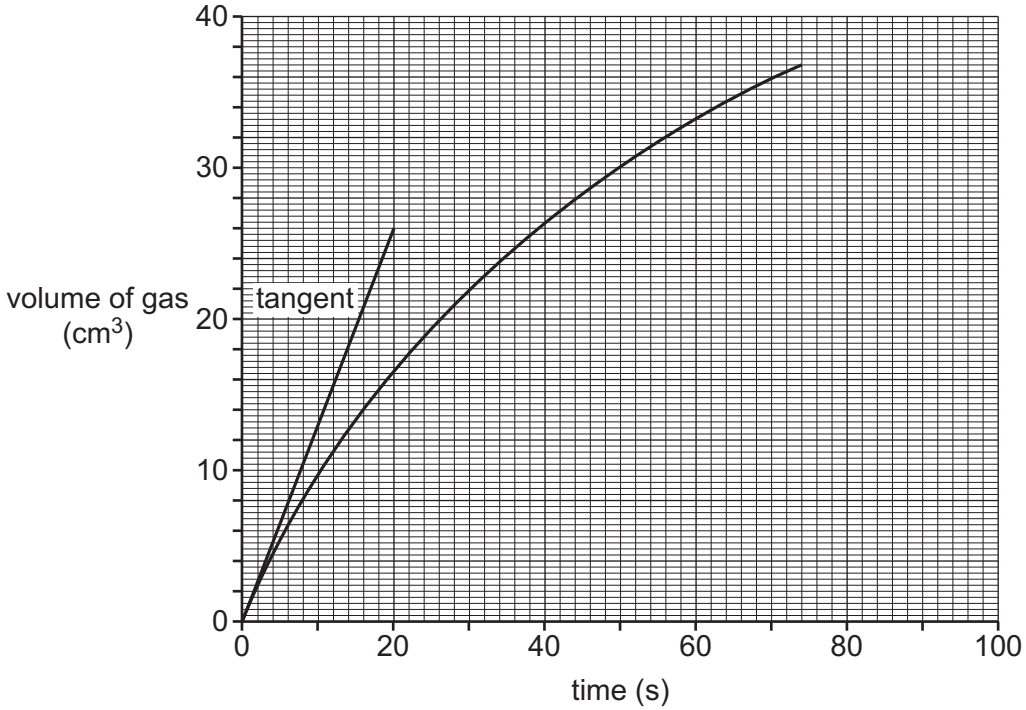

Fig. 9.1

(a) **(i)** Calculate the rate of reaction at the start by calculating the gradient of the tangent.

Rate = ... cm^3/s **[3]**

(ii) Draw a new tangent on the graph at time = 60 s. **[1]**

(iii) How do the tangents show that the rate of reaction has changed from the start to 60 s?

.....

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

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(b) Eve does some more experiments.

This time she finds out the rate of reaction at the start when she reacts different concentrations of acid with solid calcium carbonate.

She plots a graph of rate of reaction against concentration, as shown in **Fig. 9.2**.

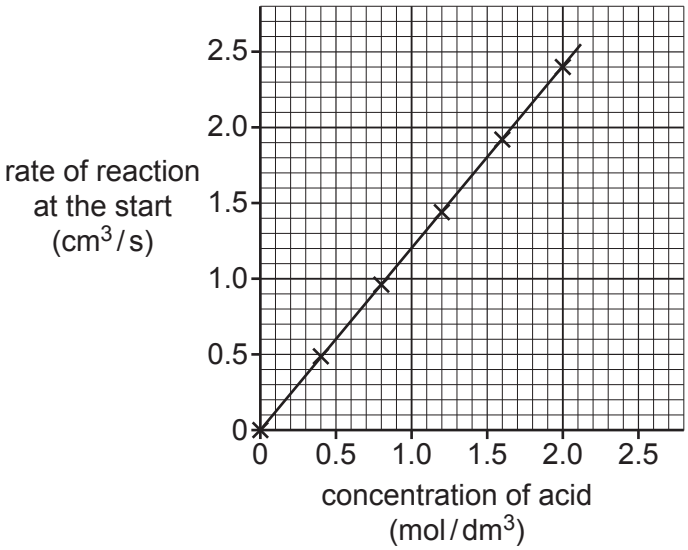

Fig. 9.2

(i) Eve thinks that the relationship between rate and concentration in the **graph** in **Fig. 9.2** can be shown using this equation: rate α concentration

Does the graph in **Fig. 9.2** agree with this equation?
Use the data to explain your reasons.

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

(ii) Using the graph in **Fig. 9.2** estimate the rate of reaction when acid of concentration 3.0 mol/dm^3 is used.

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

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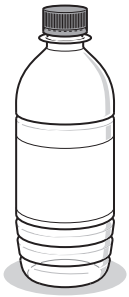
10 Soft drinks are sold in containers made from PET (a plastic), aluminium and glass.



PET bottle

Aluminium can

Glass bottle

All three containers are non-biodegradable.

Table 10.1 and **Fig. 10.1** show information about the life cycle assessment of containers from two different companies.

Company 1

	Total life cycle energy and waste per 1000 litres of drink			
	Energy use (GJ)	**Emissions**	**Waste produced**	
		CO_2 equivalent emission (kg)	**Mass (kg)**	**Volume (m^3)**
PET bottle	4.1	180	48	0.2
Aluminium can	5.9	440	120	0.3
Glass bottle	9.8	770	730	0.6

Table 10.1

Company 2

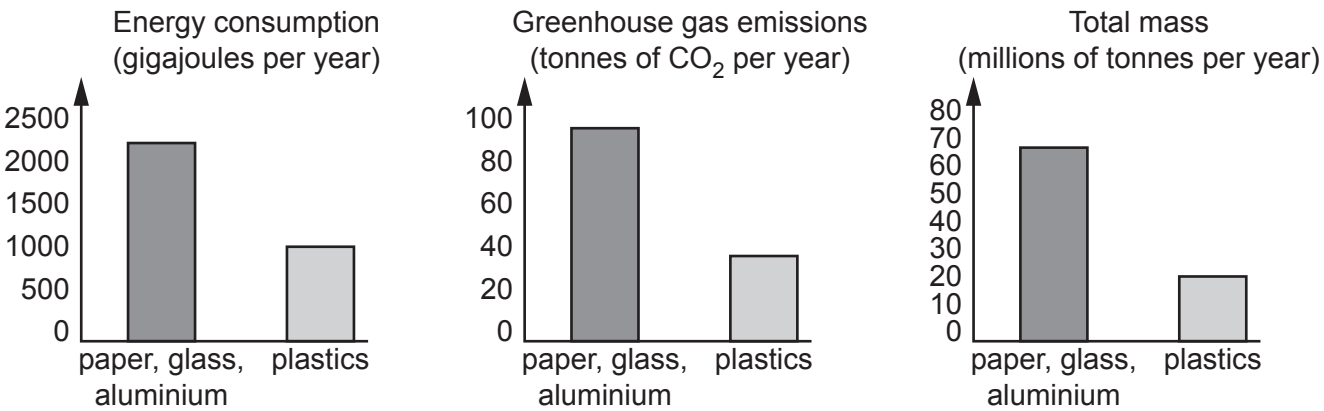


Fig. 10.1

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(a)* Both companies show that the same material is likely to cause the least harm to the environment when used for making containers.

Use the information in **Table 10.1** and **Fig. 10.1** to state and explain which material is best to use for containers and identify any differences in the information from the two companies.

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

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(b) The way that plastic bottles are collected for recycling has changed over time.

In the past, people had to sort their waste plastic bottles and take them to bins in towns or supermarket car parks.

Now, over 90% of local authorities collected waste plastic bottles directly from homes.

Suggest how this change affects the life cycle assessment of plastic bottles.

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

(c) **Company 1** and **Company 2** both manufacture drinks containers from polymers.

Some people want to ban the use of all non-biodegradable packaging, including polymers.

Explain why these people have different views to the polymer companies about the use of non-biodegradable materials

.....

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

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11 Nitrogen oxides are pollutant gases that are produced when coal is burned in a power station.

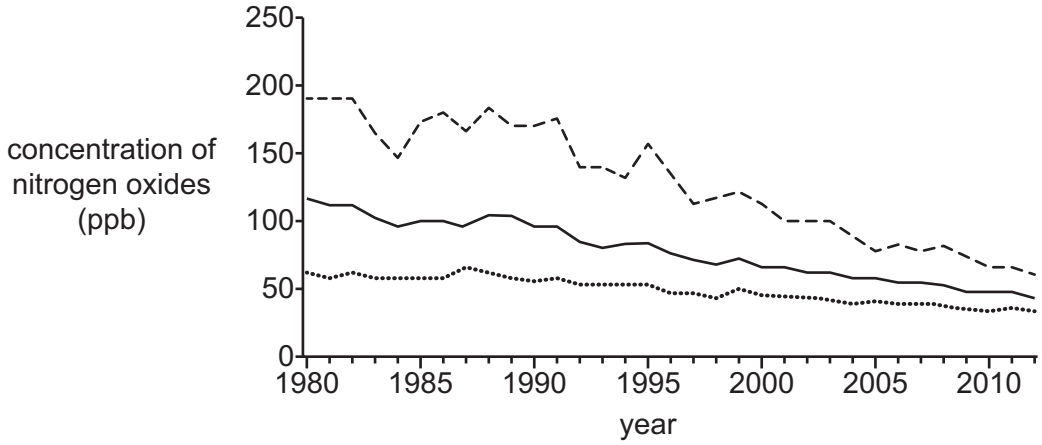
(a) Which statements about nitrogen oxides are **true** and which are **false**?

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

	True	False
Nitrogen oxides form in an oxidation reaction.		
Nitrogen oxides come from impurities in the coal.		
Nitrogen oxides are acidic oxides.		
Ammonia is an example of a nitrogen oxide.		

[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

(i) A scientist comments that the daily concentration of nitrogen oxides in 2012 has fallen by more than 50% compared to 1980.

To what extent does the data support this statement?

Use the data to explain your reasoning.

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

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(ii) The concentration of nitrogen oxides is measured in ppb.

1 ppb = 0.000 001 mg / cm^3

What was the lowest daily concentration of nitrogen oxides in 1980?

Tick (✓) **one** box.

- 6.0×10^{-5} mg / cm^3 ☐
- 0.000 006 ppb ☐
- 60 mg / cm^3 ☐
- 6.0×10^{-1} ppb ☐

[1]

(c) Scientists first collect data about the concentration of nitrogen oxides in the air from a monitoring station near a power station.

They then set up 30 monitoring stations to collect data to work out a mean daily concentration of nitrogen oxide across the whole country.

Suggest some factors the scientists should consider when they choose where to set up these monitoring stations.

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

END OF QUESTION PAPER

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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).

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