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GCSE (9-1)

Examiners' report

TWENTY FIRST CENTURY SCIENCE CHEMISTRY B

J258
For first teaching in 2016

J258/02 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 J258/02 series overview

This paper was designed to assess the depth of chemical knowledge shown by the candidates. It was the first paper of this kind in the new specification. It replaced much shorter module tests. Even lower ability candidates were able to attempt most questions, even if they didn't always manage to earn many marks. To do well, candidates needed to make use of the information they had been given but also to bring their own knowledge of chemistry into play.

The assessment included more mathematical assessment than previous specifications and some candidates did not expect to have the mathematical skills in the specification assessed directly (Q7 and Q10). Practical skills are now assessed in the written examination instead of a coursework assessment and some candidates showed a limited ability to describe laboratory practice (Q3, and Q6).

To achieve a good grade, candidates needed to take careful note of the questions as there is often key information in the stem. Some candidates also lost marks by misreading the question or answering a question of their own devising.

The language of the examination was inclusive and there was no evidence that any were disadvantaged by this or cultural issues. There was little or no indication of time pressure or other constraints for most candidates.

Question 1(b)

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

.....

.....

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

Candidates should be aware that an element contains only one type of atom and a compound has more than one type of atom joined together in a fixed ratio. In this case it was sufficient to identify that the elements contained only carbon atoms but that carbon dioxide had carbon and oxygen.

Question 1(c)

(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]**

Both structures have covalent bonding, so a good answer is focused on the scale of the structure, with many atoms or bonds in a giant structure and very few in a simple structure.

Question 2(a)(i)

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]

Many candidates scored one mark for correctly completing the word equation, but fewer were familiar with the formula for nitrogen gas.

Question 2(a)(ii)

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

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

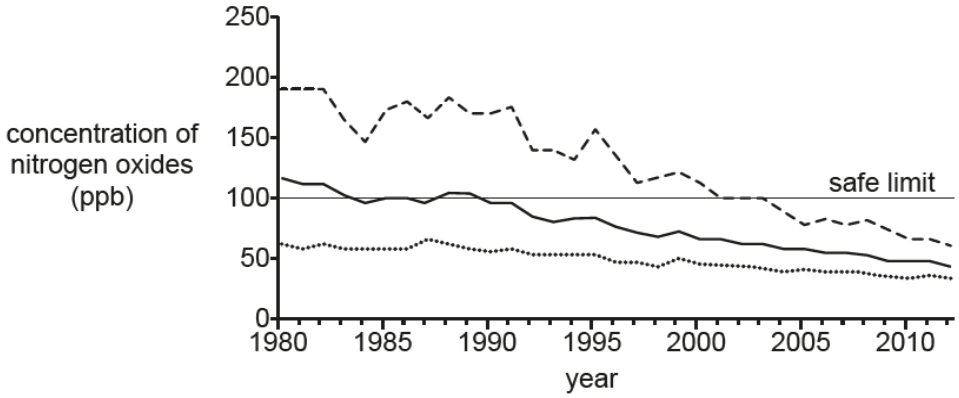
	True	False
Nitrogen oxides are also produced in car engines.		
Nitrogen oxides form at very high temperatures.		
NO_2 and NH_3 are examples of nitrogen oxides.		

[2]

Despite recent concerns over diesel vehicle emissions, some candidates did not recognise the formation of NOx at the high temperatures inside car engines.

Question 2(b)

(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]**

Most candidates identified the overall drop in the highest daily concentration figures. The best responses also identified that the decrease was quite irregular.

Question 2(c)(i)

(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]**

It was well known that nitrogen oxides could be harmful to human beings and candidates often also associated this with breathing difficulties.

Question 2(c)(ii)

(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]**

Most candidates successfully explained that the mean daily concentration had been below the safe limit since 1990, whereas 2004 was the date when all the lines (specifically the highest daily values) had been considered safe.

Question 3(a)

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]

Although almost all candidates attempted this item, many did not correctly sequence all the steps in distillation. The most common error was to start by filtering in the expectation that this might remove salt from the seawater.

Question 3(b)(i)

(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]**

The diatomic nature of oxygen was well known but the equivalent formula for chlorine gas was less commonly given. Most candidates were aware that the chlorine was intended to make drinking water safe, but the mechanism involves removing micro-organisms. Making the water "clean" or "pure" shows a poor understanding of the concept of purity.

Question 3(b)(ii)

(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]

Many candidates recalled that the test for oxygen involved a splint, but full marks required relighting a glowing splint. This was commonly confused with the test for hydrogen. Some candidates identified that the damp litmus paper would change colour with chlorine but an appreciation of chlorine's bleaching properties was not well known.

Question 4(a)

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]**

Full marks required the use of examples, but most candidates only identified the pattern.

Question 4(a)(ii)

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

Predict the formula of pentane.

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

Most candidates were able to extend the series to give this formula.

Question 4(b)(i)

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

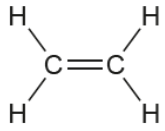
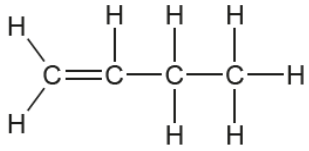
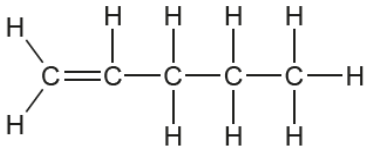
Alkene	Number of carbon atoms	Formula	Displayed formula
methene	does not exist		
ethene	2	C_2H_4	
propene	3	C_3H_6	
butene	4	C_4H_8	
pentene	5	C_5H_{10}	

Table 4.2

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

A correct diagram for propene was worth two marks. Most candidates were credited I mark for either a structure with one double bond or with three carbon atoms and six hydrogen atoms. The requirement for each carbon atom to have exactly four bonds was not widely appreciated.

Question 4(c)(i)

(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]**

Most answers were limited to 1 mark as candidates did not use examples in their answers.

Question 4(c)(ii)

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

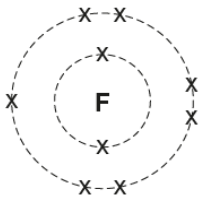
.....

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

This question was not well answered with many candidates seeming to find it difficult to explain this concept.

Question 5(a)

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.

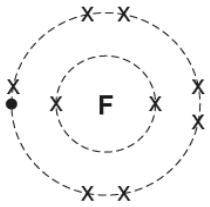
Name of atom	fluorine
Atomic Number	9
Number of electrons	9
Number of protons	
Number of neutrons	
Periodic Table Group	

[3]

Most candidates were able to gain credit on this question and a number could use the Periodic Table to get full marks.

Question 5(b)(i)

(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]**

Lower ability candidates limited themselves to describing the two diagrams. Ideally, candidates should be able to identify the difference in the number of electrons and a similarity from the other particles present.

Question 6(a)(i)

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]

Despite the examples given in the table, a few candidates had no idea how to find the formula mass.

Question 6(ii)

(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.

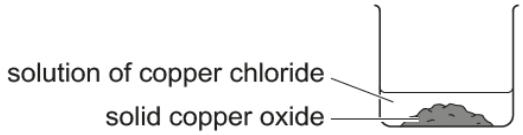
0.1345 g **1.345 g** **13.45 g** **134.5 g**

[1]

Question 6(b)(i)

(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]

Question 6(b)(ii)

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

Suggest a reason why.

.....

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

Despite the mention of a "small amount" of acid and the statement in the question stem that "some copper oxide does not react" few candidates could explain why the theoretical yield could not be achieved.

Question 7(a)(i)

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.

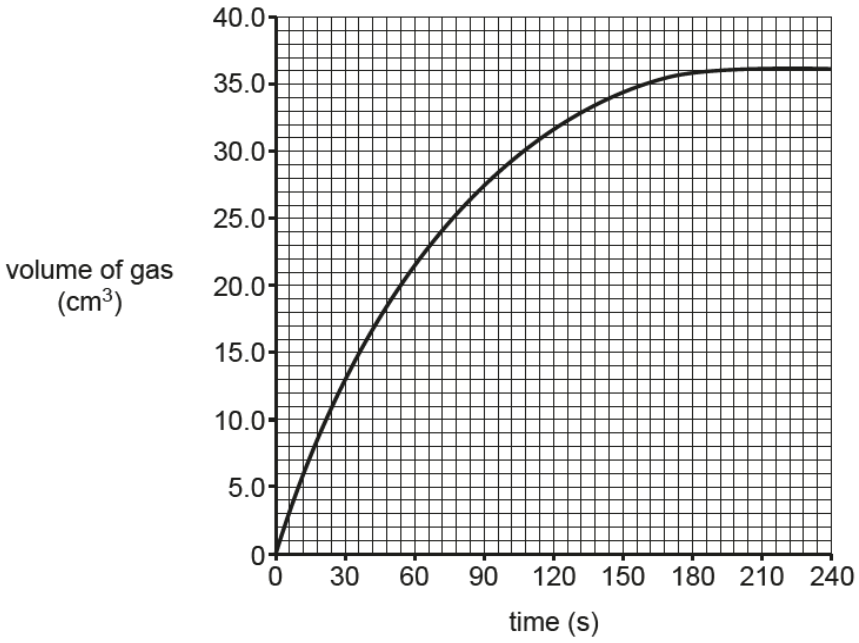


Fig. 7.1

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

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

Question 7(a)(ii)

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

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

For (a)(i) most candidates read off the correct volume at 60 seconds.

However for part (ii), most candidates then answered with the volume at 120 seconds (and not the amount given off during the second minute).

Question 7(b)

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

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

.....

.....

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

Almost all candidates described the volume directly (increasing to a constant value) rather than the rate of the reaction (which decreases to zero) shown by the slope of the line.

Question 7(c)(i)

(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]**

Many higher ability candidates gave the right answer here. A few candidates gave answers which were close but not quite correct. If they had not attempted to show their working, their answers did not gain any credit.

AfL It is important to stress to candidates that they should always show their working in calculation questions so if they get the answer wrong they may still gain credit for their method.

Key

AfL Guidance to offer for future teaching and learning practice.

Question 7(c)(ii)

(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]**

It was commonly understood that an increase in concentration gave an increase in the rate of reaction, but the fact that direct proportion involves the two terms changing by the same percentage (e.g. both doubling) was often missing from the answer.

Question 7(c)(iii)

(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]

This was not well known. The symbol for proportionality is given in the assessable maths skills, Appendix 5e, skill M3, in the specification.

Question 8(a)*

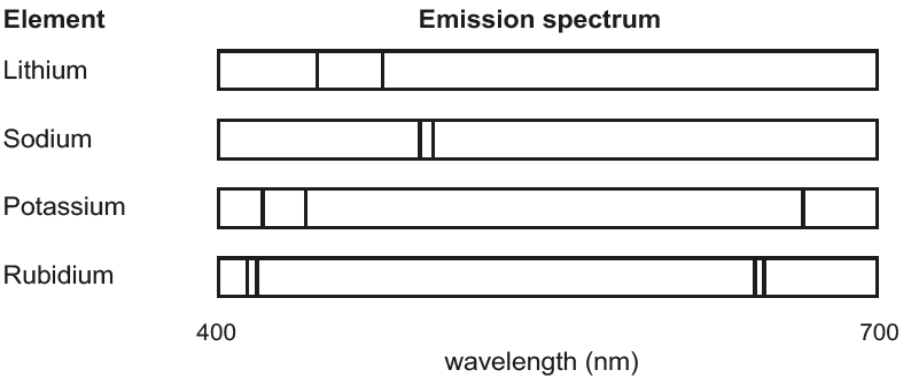
8 Salt that is used for food contains compounds of Group 1 elements.
One type of food salt is called 'Healthy salt'.

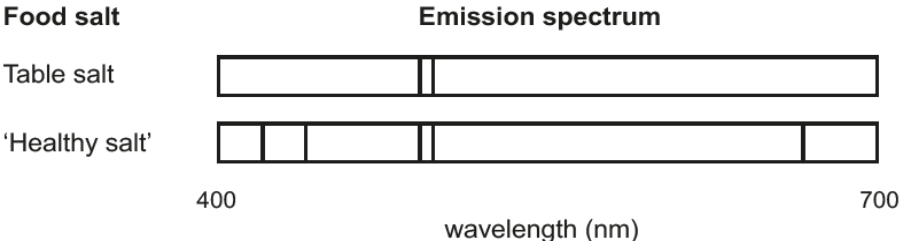
Ben wants to find out what the difference is between table salt and 'Healthy salt'.

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.

.....

.....

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

A good number of candidates showed that they understood how to process the data from the spectra and so identified sodium in table salt and both sodium and potassium in the "healthy salt". Although it was sometimes implied, many did not state which elements were <u>not present</u> in each. Explanations of how the elements were identified from the spectra were highly variable.

Although the question mentions that the salts contain "compounds of group 1 elements" a significant minority of candidates turned to their understanding of the reactivity of each alkali metal element. They then deduced that "healthy salt" was actually very dangerous as potassium was more reactive than sodium.

Exemplar 1

L3

I can conclude that table salts only contain sodium as they are the only lines that add up and are equal to each other, I can safely say it contains no other elements because it has no other lines that are matching. 'Healthy Salt' contains sodium and potassium as all the lines are equal and add up to each other. I can safely say it doesn't contain rubidium or lithium as it doesn't have the lines to match. [6]

This answer identifies that 'table salt' contains just sodium and 'Healthy salt' contains sodium and potassium. It also identifies that lithium and rubidium are not present. The answer justifies the claims by saying that the lines of the spectra match up to sodium and potassium but not to lithium and rubidium which shows an understanding of how to identify elements from emission spectra. This answer was Level 3 and credited 6 marks.

Question 8(b)

(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?

.....

.....

.....

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

Even the higher ability candidates found it difficult to compare the two approaches to analysis.

Question 8(c)

(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**.

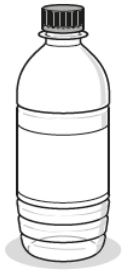
Technique	Use
	Used to make samples of chemicals.
	Used to measure the amount of chemical in a sample.
Qualitative technique	
	Used to investigate the reactivity of a sample.
Quantitative technique	
	Used for separation of chemicals.
	Used to find out what chemicals are in a sample.

[2]

Many of the higher ability candidates understood both of these terms.

Question 9(a)*

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

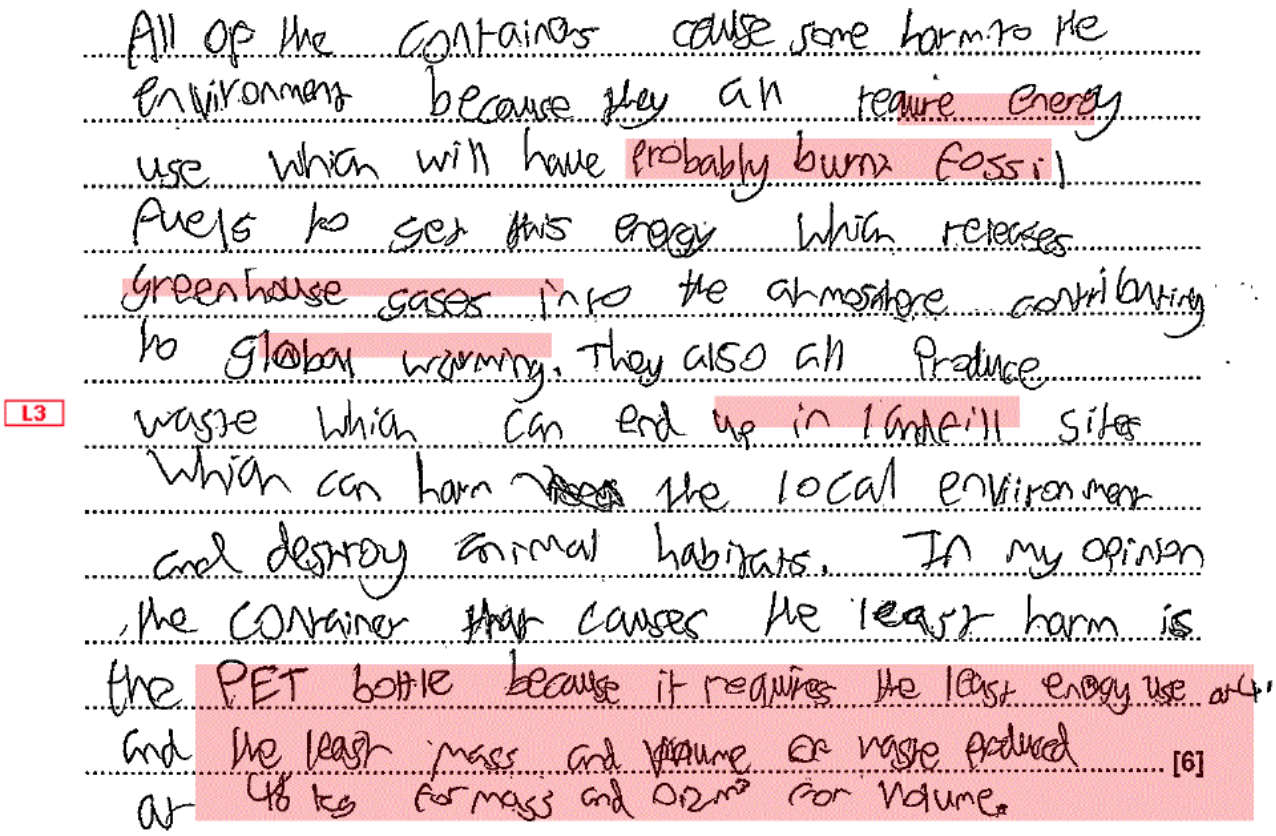
Table 9.1

(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.

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

Most candidates were able to identify the PET bottle as having the lowest score in each column. To achieve the highest level response, it was necessary to use the data explain how environmental harm would be caused by a large energy use (e.g. use of fossil fuels) or a large mass or volume of waste (transport or landfill). Lower ability candidates sometimes resorted to answering their own question by describing pollution by microplastics (as described in recent TV programmes).

Exemplar 2



In this answer the candidate has identified that the production and disposal of all containers will cause harm to the environment. They talk about burning fossil fuels for the energy needs so producing greenhouse gases and the filling up of land fill sites with the waste. The candidate identifies PET as being the least harmful material to use and uses data from the table to justify their choice. This answer was credit a Level 3, 6 marks.

Question 10(a)

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.

.....

.....

.....

.....

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

This was the first overlap question and most candidates found it difficult to describe two suitable tests. When a suitable test was identified (usually an indicator to identify the carboxylic acid) the results were rarely clear.

Question 10(b)

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


harmful


corrosive

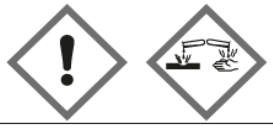

oxidising


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	

Question 10(b)(i)

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

.....

.....

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

Most candidates could recognise that the second row of the table was the important one, scoring a mark for identifying 1.7 and 4.0 as the relevant numbers. However, the other mark was for correctly interpreting the meaning of the symbols ≥ and < (and not just repeating the symbols). This is the assessable maths skill M3 found in Appendix 5e in the specification.

Question 10(b)(ii)

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

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

Some candidates simply repeated "very concentrated" from the table and did not give a concentration.

Question 10(b)(iii)

(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.

.....

.....

.....

.....

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

This required candidates to interpret the hazard signs into practical safety procedures. A good response linked relevant procedures to the specific and relevant hazards and was not limited to generic advice.

Question 11(a)

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]**

Most candidates identified carbon and silicon from group 14 on the modern Periodic Table and thus correctly chose Mendeleev's group 4.

Question 11(b)

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

Suggest a reason why.

.....

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

Many candidates understood that the noble gases had not been identified when Mendeleev was working.

Question 11(c)

(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]

A significant minority of candidates identified three elements in the modern group 8 which are not in Mendeleev's table (Ru, Os & Hs).

Question 11(e)(i)

(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]**

The marks here were for stating that the indicator would change colour and then using a chart to link the colour to a pH value. Most candidates were aware that colour was involved, but some focused on the mechanical aspects of adding the indicator rather than the way the pH would be identified.

Question 11(e)(ii)

(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]**

Since all four salts were covered by only one pH unit, the only way to distinguish them was to measure the values more precisely (e.g. to one or more decimal place). Most candidates did not get this idea and gain no credit.

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