AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.3.1.1

Conservation of mass and balanced chemical equations

Past-paper questions

Tier	**Foundation**
Question groups	**12**
Available paper years	**2018–2025**

Using this booklet

1. Answer the questions in order and show your working.
2. Original question numbers and marks are retained.
3. Print at actual size (100%) for measuring questions.
4. Use the companion answer booklet to check your work.

Name: _____ **Date:** _____

Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

5.3.1.1 Conservation of mass and balanced chemical equations

Question 01

June 2018 | 8464/C/1F | Original Q2

0 2 This question is about the halogens.

0 2 . 1 Which group in the periodic table is known as the halogens?

[1 mark]

Tick **one** box.

Group 1 ☐

Group 2 ☐

Group 7 ☐

Group 0 ☐

0 2 . 2 A fluorine atom has 7 electrons in the outer shell.

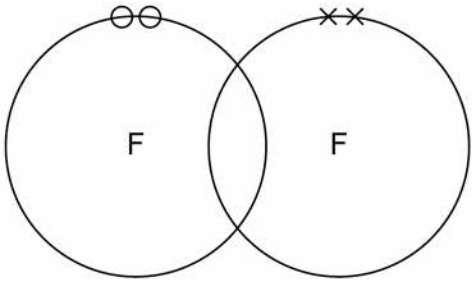
Figure 8 shows part of a dot and cross diagram to represent a molecule of fluorine (F_2).

Complete the dot and cross diagram.

You should show only the electrons in the outer shells.

[2 marks]

Figure 8



0 2 . 3 Chlorine reacts with potassium bromide solution.

Complete the word equation.

[2 marks]

chlorine + potassium bromide → _____ + _____

5.3.1.1 Conservation of mass and balanced chemical equations

Question 01 · continued

0 2 . 4 What type of reaction happens when chlorine reacts with potassium bromide solution?

[1 mark]

Tick **one** box.

- decomposition ☐
- displacement ☐
- neutralisation ☐
- precipitation ☐

0 2 . 5 Complete the sentence.

Choose the answer from the box.

[1 mark]

an atom	**an electron**	**a neutron**	**a proton**

Chlorine is more reactive than bromine.

This is because chlorine gains _____ more easily.

0 2 . 6 How does the size of a chlorine atom compare with the size of a bromine atom?

Complete the sentence.

Choose the answer from the box.

[1 mark]

bigger than	**the same size as**	**smaller than**

A chlorine atom is _____ a bromine atom.

5.3.1.1 Conservation of mass and balanced chemical equations

Question 01 · continued June 2018 | 8464/C/1F | Original Q2

0 2 . 7 Give a reason for your answer to question **02.6**

[1 mark]

Reason _____

_____

0 2 . 8 Fluorine reacts with chlorine to produce ClF_3

Balance the chemical equation for the reaction.

[1 mark]

$Cl_2 +$ _____ $F_2 \rightarrow 2\ ClF_3$

0 2 . 9 Explain why fluorine is a gas at room temperature.

Use the following words in your answer:

energy **forces** **molecules** **weak**

[3 marks]

13

5.3.1.1 Conservation of mass and balanced chemical equations

Question 02

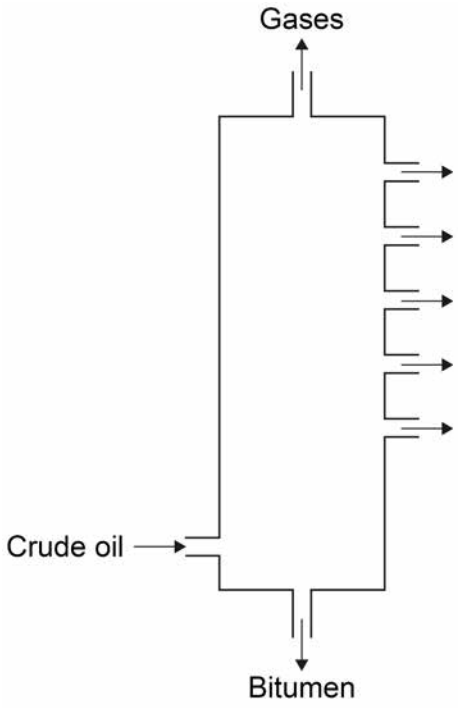
June 2018 | 8464/C/2F | Original Q6

0 6 Crude oil is a mixture of hydrocarbons.

0 6 . 1 The hydrocarbons in crude oil are separated into fractions by fractional distillation.

Figure 13 shows a fractional distillation column.

Figure 13



Crude oil vapour passes up the column.

Complete the sentence.

Choose the answer from the box.

[1 mark]

condenses	**dissolves**	**freezes**	**melts**

Each fraction _____ at a different level.

5.3.1.1 Conservation of mass and balanced chemical equations

Question 02 · continued

0 6 . 2 Why do the fractions separate?

[1 mark]

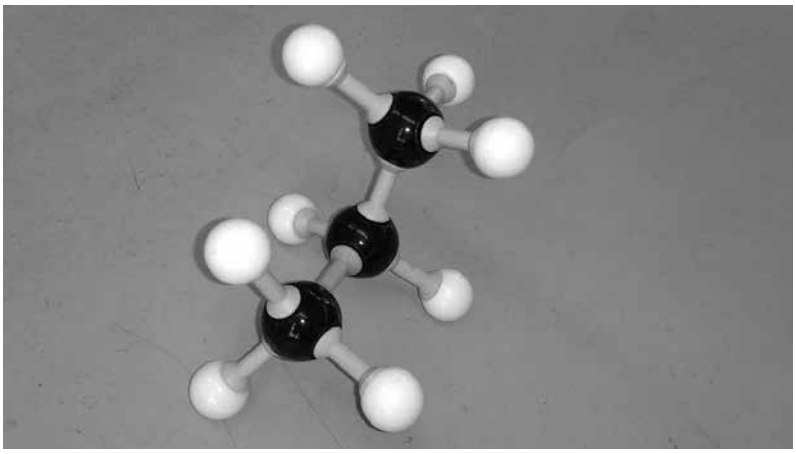
Tick **one** box.

- The fractions have different boiling points. ☐
- The fractions have different flammability. ☐
- The fractions have different melting points. ☐
- The fractions have different viscosity. ☐

Most of the hydrocarbons in crude oil are alkanes.

0 6 . 3 **Figure 14** represents an alkane molecule.

Figure 14



Name the alkane.

[1 mark]

5.3.1.1 Conservation of mass and balanced chemical equations

Question 02 · continued

0 6 . 4 Methane (CH_4) is an alkane.

What is the general formula for alkanes?

[1 mark]

Tick **one** box.

- C_nH_n ☐
- C_nH_{2n} ☐
- C_nH_{2n-2} ☐
- C_nH_{2n+2} ☐

0 6 . 5 Alkanes burn in oxygen.

Balance the equation for methane burning.

[1 mark]

$$____ CH_4 + ____ O_2 \rightarrow ____ CO_2 + ____ H_2O$$

0 6 . 6 Ethene is an alkene.

Which reagent is used to test for alkenes?

[1 mark]

Tick **one** box.

- Anhydrous copper sulfate ☐
- Bromine water ☐
- Damp litmus paper ☐
- Limewater ☐

5.3.1.1 Conservation of mass and balanced chemical equations

Question 02 · continued

Table 6 shows data from a life cycle assessment (LCA) for the disposal of 10 000 biodegradable plastic bags.

Table 6

	Burning and using the energy to generate electricity	Landfill
Mass of carbon dioxide produced in kg	25	15
Mass of solid residue in kg	0.050	0.070
Mass of sulfur dioxide produced in kg	0.20	0.30

0 6 . 7 Why are life cycle assessments (LCA) done?

[1 mark]

0 6 . 8 Compare the **two** methods for the disposal of biodegradable plastic bags.

Use information from **Table 6**

[4 marks]

11

5.3.1.1 Conservation of mass and balanced chemical equations

Question 03

June 2019 | 8464/C/1F | Original Q4

0 4 This question is about Group 1 elements.

0 4 . 1 Sodium reacts with chlorine to produce sodium chloride.

Balance the equation for the reaction.

[1 mark]

$$____ Na + Cl_2 \rightarrow ____ NaCl$$

0 4 . 2 4.6 g of sodium reacts with chlorine to produce 11.7 g of sodium chloride.

What mass of chlorine reacted?

[1 mark]

Mass of chlorine = _____ g

0 4 . 3 A teacher puts hot sodium into a gas jar of chlorine.

The changes seen before, during and after this reaction were observed.

Complete the sentences.

Choose the answers from the box.

[4 marks]

colourless	**green**	**lilac**	**silver**	**white**	**yellow**

Sodium is a _____ solid.

Chlorine is a _____ gas.

The hot sodium burns with a _____ flame.

The product sodium chloride is a _____ solid.

5.3.1.1 Conservation of mass and balanced chemical equations

Question 03 · continued

0 4 . 4 Sodium chloride (NaCl) is an ionic compound.

Write the formulae of the ions in sodium chloride.

[2 marks]

Sodium ion _____

Chloride ion _____

0 4 . 5 Complete the sentence.

Choose the answer from the box.

[1 mark]

an atom	**an electron**	**a neutron**	**a proton**

Potassium is more reactive than sodium.

This is because potassium loses _____ more easily than sodium.

0 4 . 6 How does the size of a potassium atom compare with the size of a sodium atom?

Give a reason for your answer.

[2 marks]

_____

Reason _____

_____

_____

11

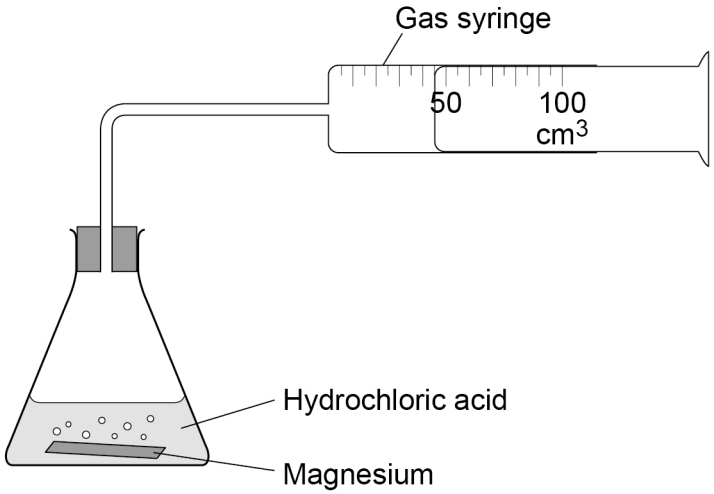
5.3.1.1 Conservation of mass and balanced chemical equations

Question 04

0 3 A student investigated the rate of the reaction between magnesium and hydrochloric acid.

Figure 4 shows the apparatus the student used.

Figure 4



0 3 . 1 Balance the equation for the reaction.

[1 mark]

$$Mg + ____ HCl \rightarrow MgCl_2 + H_2$$

0 3 . 2 The student used 50 cm^3 of hydrochloric acid.

Which apparatus would measure 50 cm^3 of hydrochloric acid with the greatest accuracy?

[1 mark]

Tick (✓) **one** box.

50 cm^3 beaker ☐

50 cm^3 conical flask ☐

50 cm^3 measuring cylinder ☐

5.3.1.1 Conservation of mass and balanced chemical equations

Question 04 · continued

0 3 . 3 The student measured the volume of gas produced every 20 seconds for 2 minutes.

The volume of gas was zero at the start of the experiment.

The measured volumes of gas were:

26 cm^3 38 cm^3 47 cm^3 55 cm^3 59 cm^3 60 cm^3

Complete **Table 2** to show these results.

[4 marks]

Table 2

0	0

0 3 . 4 The volumes of gas were lower than expected.

Suggest **one** reason.

[1 mark]

_____

_____

0 3 . 5 The student repeated the experiment using different concentrations of hydrochloric acid.

Give **two** variables the student should keep the same.

[2 marks]

1 _____

2 _____

5.3.1.1 Conservation of mass and balanced chemical equations

Question 04 · continued

0 3 . 6 Complete the sentences.

[3 marks]

As the concentration of the hydrochloric acid increased, the rate of the reaction _____ .

This is because there were more acid _____ in each cubic centimetre (cm^3).

So the collisions happened more _____ .

12

5.3.1.1 Conservation of mass and balanced chemical equations

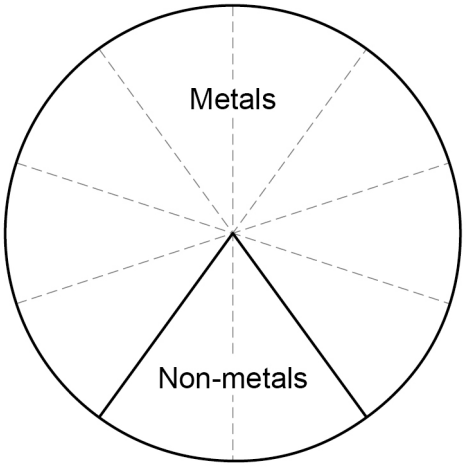
Question 05

November 2020 | 8464/C/1F | Original Q4

0 4 This question is about elements and compounds.

0 4 . 1 **Figure 5** shows the proportion of elements in the periodic table that are metals and non-metals.

Figure 5



Determine the percentage of the elements in **Figure 5** that are metals.

[2 marks]

Percentage = _____ %

0 4 . 2 Give **two** physical properties of metals.

[2 marks]

1 _____

2 _____

0 4 . 3 Sodium reacts with chlorine to produce sodium chloride.

Balance the equation for the reaction.

[1 mark]

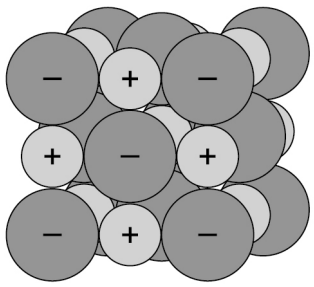
_____ $Na + Cl_2 \rightarrow$ _____ $NaCl$

5.3.1.1 Conservation of mass and balanced chemical equations

Question 05 · continued

Figure 6 shows part of the structure of sodium chloride (NaCl).

Figure 6



Sodium chloride

0 4 . 4 What holds the particles together in sodium chloride?

Use **Figure 6**.

[1 mark]

Tick (✓) **one** box.

Electrostatic attractions ☐

Intermolecular forces ☐

Metallic bonds ☐

0 4 . 5 Solid sodium chloride does not conduct electricity.

Give **two** ways in which sodium chloride can be made to conduct electricity.

[2 marks]

1 _____

_____

2 _____

_____

8

5.3.1.1 Conservation of mass and balanced chemical equations

Question 06

0 6 This question is about the Earth's resources.

When most fuels burn carbon dioxide is produced.

Propane (C_3H_8) is a fuel.

0 6 . 1 Balance the equation for the combustion of propane.

[1 mark]

$$C_3H_8 + ____ O_2 \rightarrow 3\,CO_2 + 4\,H_2O$$

0 6 . 2 Describe the test for carbon dioxide.

Give the result of the test.

[2 marks]

Test _____

Result _____

_____

0 6 . 3 Propane can be cracked to produce propene and hydrogen.

Complete the symbol equation for the reaction.

[1 mark]

$$\underset{\text{propane}}{C_3H_8} \rightarrow \underset{\text{propene}}{_____} + \underset{\text{hydrogen}}{H_2}$$

5.3.1.1 Conservation of mass and balanced chemical equations

Question 06 · continued

0 6 . 4 Describe the test for hydrogen.

Give the result of the test.

[2 marks]

Test _____

Result _____

_____

0 6 . 5 Propene is an alkene.

Describe the test for alkenes.

Give the colour change in the test.

[3 marks]

Test _____

Colour change _____ to _____

9

5.3.1.1 Conservation of mass and balanced chemical equations

Question 07

November 2021 | 8464/C/1F | Original Q4

0 4 Sodium and potassium are Group 1 elements.

0 4 . 1 What is the name of Group 1 elements?

[1 mark]

Tick (✓) **one** box.

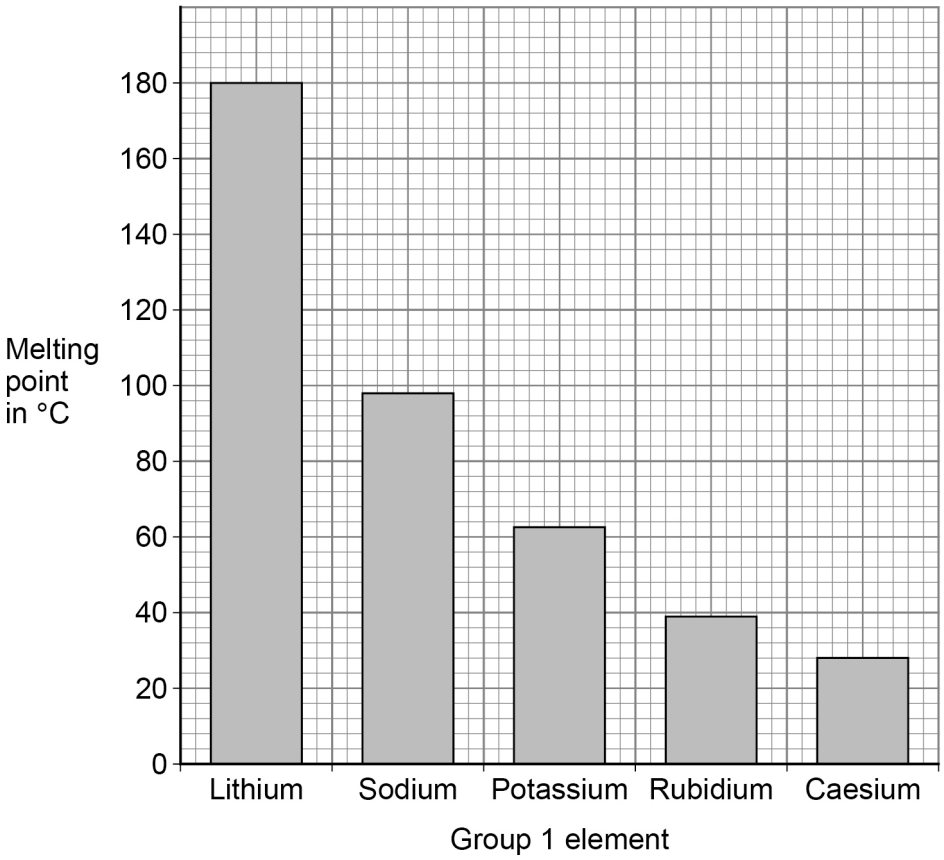
- Alkali metals ☐
- Halogens ☐
- Noble gases ☐

5.3.1.1 Conservation of mass and balanced chemical equations

Question 07 · continued

0 4 . 2 **Figure 5** represents the melting points of Group 1 elements.

Figure 5



What is the melting point of sodium?

[1 mark]

Melting point of sodium = _____ °C

0 4 . 3 Sodium reacts with water to produce sodium hydroxide and hydrogen.

Balance the equation for the reaction.

[1 mark]

$$____ Na + 2H_2O \rightarrow 2NaOH + H_2$$

5.3.1.1 Conservation of mass and balanced chemical equations

Question 07 · continued

0 4 . 4 Calculate the relative formula mass (M_r) of sodium hydroxide (NaOH).

Relative atomic masses (A_r): H = 1 O = 16 Na = 23

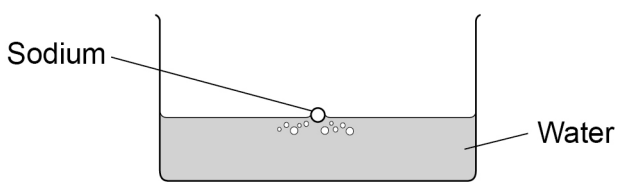
[2 marks]

Relative formula mass (M_r) = _____

0 4 . 5 Sodium and potassium both react with water.

Figure 6 shows sodium reacting with water.

Figure 6



Compare what is seen when sodium reacts with water and when potassium reacts with water.

[4 marks]

9

5.3.1.1 Conservation of mass and balanced chemical equations

Question 08

0 4 This question is about elements and compounds.

0 4 . 1 Magnesium and oxygen react to produce magnesium oxide.

Balance the equation for the reaction.

[1 mark]

$$_____ Mg + O_2 \rightarrow 2\,MgO$$

0 4 . 2 Suggest **one** safety precaution that should be taken when heating magnesium and oxygen.

[1 mark]

0 4 . 3 Calculate the relative formula mass (M_r) of magnesium fluoride (MgF_2).

Relative atomic masses (A_r): F = 19 Mg = 24

[2 marks]

Relative formula mass (M_r) = _____

0 4 . 4 Argon is a noble gas.

Explain why **no** product is formed when magnesium and argon are heated together.

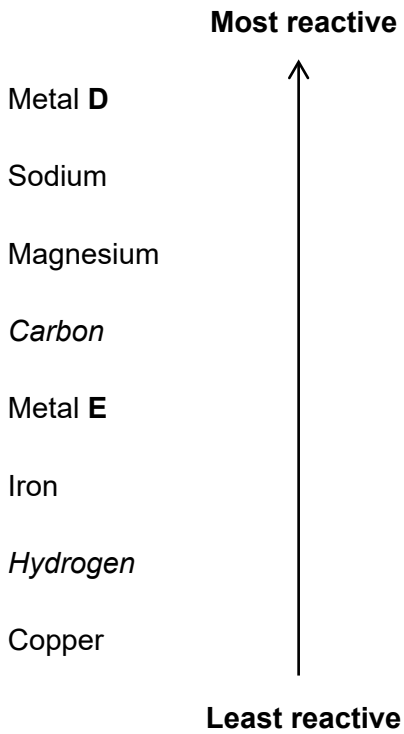
[2 marks]

5.3.1.1 Conservation of mass and balanced chemical equations

Question 08 · continued

0 4 . 5 **Figure 10** shows a reactivity series.

Figure 10



5.3.1.1 Conservation of mass and balanced chemical equations

Question 08 · continued

Draw **one** line from each metal to the method used to extract that metal.

Use **Figure 10**.

[2 marks]

Metal	Method used to extract that metal
	Extracted by electrolysis of a molten ionic compound.
Metal **D**	Extracted from its oxide by reduction with carbon.
	Extracted from its oxide by reduction with hydrogen.
Metal **E**	
	Removed from the Earth as the metal itself.

Question 4 continues on the next page

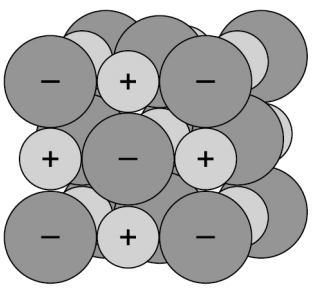
5.3.1.1 Conservation of mass and balanced chemical equations

Question 08 · continued

A substance conducts electricity when it has charged particles that are free to move.

0 4 . 6 **Figure 11** represents the structure of sodium chloride.

Figure 11



Sodium chloride

Explain why sodium chloride conducts electricity when molten but **not** when solid.

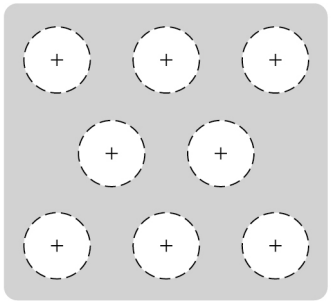
[3 marks]

5.3.1.1 Conservation of mass and balanced chemical equations

Question 08 · continued

0 4 . 7 **Figure 12** represents the structure of sodium metal.

Figure 12



Sodium metal

Explain why sodium metal conducts electricity when solid.

[2 marks]

13

5.3.1.1 Conservation of mass and balanced chemical equations

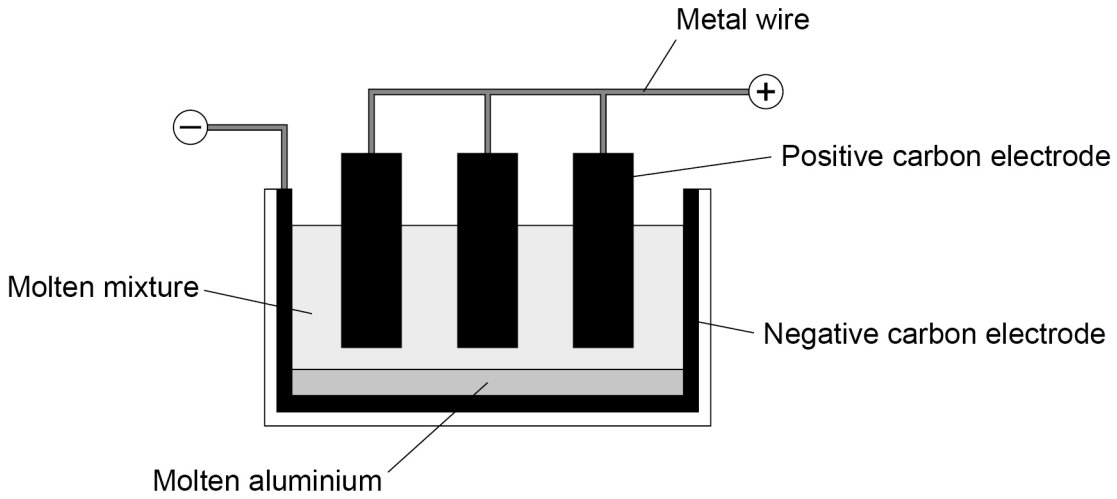
Question 09

0 5 This question is about extraction of metals.

Aluminium is extracted from a molten mixture of aluminium oxide and cryolite using electrolysis.

Figure 12 shows the electrolysis cell.

Figure 12



0 5 . 1 Complete the sentence.

[1 mark]

The extraction of aluminium is expensive because the process uses large amounts of _____ .

0 5 . 2 Oxygen is produced at the positive carbon electrodes.

The oxygen reacts with the carbon electrodes.

Which gas is produced when oxygen reacts with the positive carbon electrodes?

[1 mark]

_____

5.3.1.1 Conservation of mass and balanced chemical equations

Question 09 · continued

Titanium is extracted from titanium chloride by reacting titanium chloride with sodium.

The reaction between titanium chloride and sodium is carried out in an inert atmosphere.

0 5 . 3 Suggest why the reaction is carried out in an inert atmosphere.

[1 mark]

0 5 . 4 Complete the sentence.

Choose the answer from the box.

[1 mark]

argon	**chlorine**	**hydrogen**

The gas used for the inert atmosphere is _____ .

0 5 . 5 Balance the equation for the reaction.

[1 mark]

$$TiCl_4 + 4\,Na \rightarrow Ti + ____\ NaCl$$

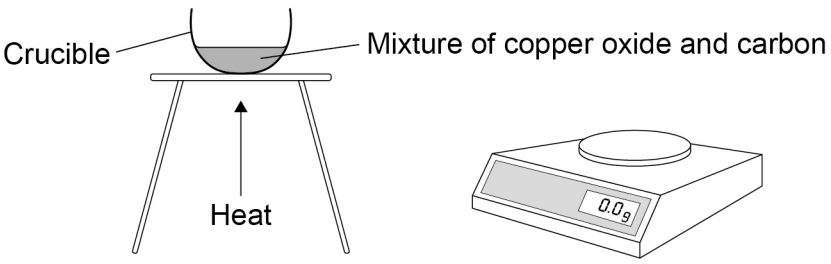
5.3.1.1 Conservation of mass and balanced chemical equations

Question 09 · continued June 2023 | 8464/C/1F | Original Q5

Copper is extracted from copper oxide by reacting copper oxide with carbon.

Figure 13 shows the apparatus.

Figure 13



The equation for the reaction is:

$$2\,CuO(s) + C(s) \rightarrow 2\,Cu(s) + CO_2(g)$$

In an experiment 15.9 g of copper oxide and 1.2 g of carbon reacted.

12.7 g of copper was produced in the reaction.

0 5 . 6 Calculate the mass of carbon dioxide produced in this experiment.

[1 mark]

Mass of carbon dioxide = _____ g

0 5 . 7 Explain why the mass of the contents in the crucible changed during the experiment.

[2 marks]

5.3.1.1 Conservation of mass and balanced chemical equations

Question 09 · continued

0 5 . 8 What happens to copper oxide in the reaction?

Give **one** reason for your answer.

Use the equation for the reaction.

[2 marks]

Tick (✓) **one** box.

The copper oxide is dissolved ☐

The copper oxide is oxidised ☐

The copper oxide is reduced ☐

Reason _____

_____

10

Turn over for the next question

5.3.1.1 Conservation of mass and balanced chemical equations

Question 10

June 2023 | 8464/C/2F | Original Q5

0 5 The combustion of fuels is a source of atmospheric pollutants.

0 5 . 1 Methane is a fuel.

Balance the equation for the combustion of methane.

[1 mark]

$$CH_4 + ____ O_2 \rightarrow CO_2 + ____ H_2O$$

0 5 . 2 Many fuels are mixtures.

Petrol and diesel are mixtures of hydrocarbons.

Table 4 shows properties of petrol and of diesel.

Table 4

	Petrol	**Diesel**
Range of number of carbon atoms in a hydrocarbon molecule	4 to 12	12 to 20
Range of boiling points in °C	40 to 205	250 to 350

Compare the properties of petrol and diesel.

Use **Table 4**.

[2 marks]

5.3.1.1 Conservation of mass and balanced chemical equations

Question 10 · continued

0 5 . 3 The gases released when a fuel is burned in car engines may include:

- oxides of nitrogen
- carbon monoxide
- water vapour.

Which chemical element do all these gases contain?

[1 mark]

Tick (✓) **one** box.

Carbon ☐

Hydrogen ☐

Nitrogen ☐

Oxygen ☐

0 5 . 4 When diesel burns in car engines, oxides of nitrogen are produced.

Where does the nitrogen come from?

[1 mark]

0 5 . 5 When diesel burns, particulates may be produced.

What environmental effect do particulates from burning diesel cause?

[1 mark]

5.3.1.1 Conservation of mass and balanced chemical equations

Question 10 · continued June 2023 | 8464/C/2F | Original Q5

0 5 . 6 Carbon monoxide may be produced when diesel burns.

Give **one** reason why carbon monoxide is difficult to detect.

[1 mark]

0 5 . 7 Explain why water vapour and **not** liquid water is produced when diesel burns.

[2 marks]

0 5 . 8 Sulfur is a common impurity in diesel.

Explain why this causes an environmental problem.

[3 marks]

12

5.3.1.1 Conservation of mass and balanced chemical equations

Question 11

June 2024 | 8464/C/2F | Original Q6

0 6 Alkanes and alkenes are hydrocarbons.

0 6 . 1 Define the term 'hydrocarbon'.

[1 mark]

0 6 . 2 The general formula for alkanes is C_nH_{2n+2}

Determine the formula of the alkane with 10 carbon atoms.

[1 mark]

Formula = _____

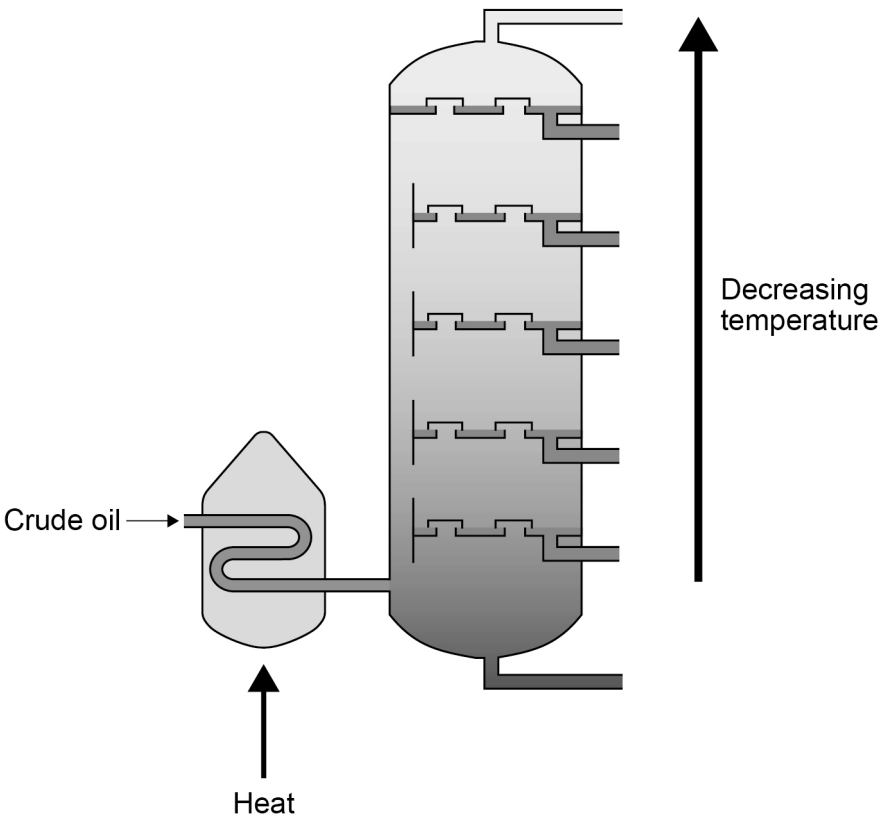
Question 6 continues on the next page

Question 11 · continued

0 6 . 3 Crude oil is a mixture of hydrocarbons.

Figure 4 represents industrial equipment used to separate crude oil into fractions.

Figure 4



Explain how crude oil is separated into fractions.

Use **Figure 4**.

[4 marks]

5.3.1.1 Conservation of mass and balanced chemical equations

Question 11 · continued

0 6 . 4 The alkane molecule $C_{14}H_{30}$ can be cracked to produce smaller molecules.

Balance the equation for the reaction.

[1 mark]

$$C_{14}H_{30} \rightarrow C_8H_{18} + ____ C_3H_6$$

Question 6 continues on the next page

Question 11 · continued

Propene (C_3H_6) is an alkene.

0 6 . 5 Describe the test for alkenes.

Give the result.

[2 marks]

Test _____

_____

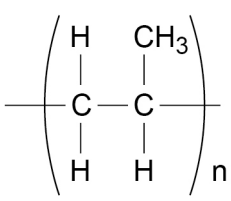
Result _____

_____

0 6 . 6 Poly(propene) is made from propene.

Figure 5 represents the repeating unit of poly(propene).

Figure 5



What type of substance is poly(propene)?

[1 mark]

_____

10

5.3.1.1 Conservation of mass and balanced chemical equations

Question 12

June 2025 | 8464/C/2F | Original Q3

0 3 Screenwash is a mixture designed to keep car windscreens clean.

The components in screenwash include glycerol, methanol and water.

0 3 . 1 Screenwash is made by mixing the components in carefully measured quantities so that the product has the required properties.

What name is given to this type of mixture?

[1 mark]

Tick (✓) **one** box.

Catalyst ☐

Formulation ☐

Polymer ☐

0 3 . 2 Glycerol has the formula $C_3H_8O_3$

How many atoms are there in one molecule of glycerol?

[1 mark]

Tick (✓) **one** box.

3 ☐ 8 ☐ 11 ☐ 14 ☐

Question 3 continues on the next page

5.3.1.1 Conservation of mass and balanced chemical equations

Question 12 · continued

0 3 . 3 Incomplete combustion happens when glycerol burns in limited oxygen.

Incomplete combustion produces carbon monoxide gas.

Why can the production of carbon monoxide gas be a problem?

[1 mark]

Tick (✓) **one** box.

Carbon monoxide is a greenhouse gas. ☐

Carbon monoxide is a toxic gas. ☐

Carbon monoxide is an acidic gas. ☐

0 3 . 4 Complete combustion happens when methanol (CH_4O) burns in excess oxygen.

Balance the equation for the reaction.

[1 mark]

$$2\,CH_4O + 3\,O_2 \rightarrow ____ CO_2 + 4\,H_2O$$

5.3.1.1 Conservation of mass and balanced chemical equations

Question 12 · continued

Methanol can be produced by the reaction of carbon dioxide with hydrogen.

0 3 . 5 Describe the test for hydrogen gas.

Give the result of the test.

[2 marks]

Test _____

_____

Result _____

_____

0 3 . 6 Carbon dioxide is a greenhouse gas.

An increase in greenhouse gases in the atmosphere has led to an increase in average global temperature.

The increase in average global temperature has caused global climate change.

Give **two** effects of global climate change.

[2 marks]

1 _____

_____

2 _____

_____

Question 3 continues on the next page

5.3.1.1 Conservation of mass and balanced chemical equations

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Anhydrous cobalt chloride can be used to test for water.

The word equation for the reaction is:

anhydrous cobalt chloride (blue) + water ⇌ hydrated cobalt chloride (pink)

0 3 . 7 Suggest **one** observation that could be made when water is added to anhydrous cobalt chloride.

[1 mark]

0 3 . 8 The reaction between anhydrous cobalt chloride and water is exothermic.

What type of reaction is the reverse reaction?

[1 mark]

10