AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.3.1.1

Conservation of mass and balanced chemical equations

Past-paper questions

Tier	**Higher**
Question groups	**16**
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/1H | Original Q4

0 4 This question is about the halogens.

0 4 . 1 Write the state symbol for chlorine at room temperature.

[1 mark]

Cl_2 (_____)

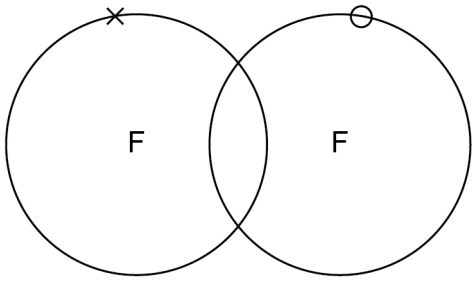
0 4 . 2 **Figure 4** represents one molecule of fluorine.

Complete the dot and cross diagram on **Figure 4**

You should show only the electrons in the outer shells.

[2 marks]

Figure 4



0 4 . 3 A fluorine atom can be represented as $^{19}_{9}F$

What is the total number of electrons in a fluorine molecule (F_2)?

[1 mark]

Tick **one** box.

9 ☐ 14 ☐ 18 ☐ 38 ☐

0 4 . 4 Aluminium reacts with bromine to produce aluminium bromide.

Complete the balanced chemical equation for this reaction.

[2 marks]

_____ Al + _____ Br_2 → 2 _____

5.3.1.1 Conservation of mass and balanced chemical equations

Question 01 · continued

0 4 . 5 When chlorine reacts with potassium bromide, chlorine displaces bromine.

$$Cl_2 + 2\,KBr \rightarrow Br_2 + 2\,KCl$$

Explain why chlorine is more reactive than bromine.

[3 marks]

9

5.3.1.1 Conservation of mass and balanced chemical equations

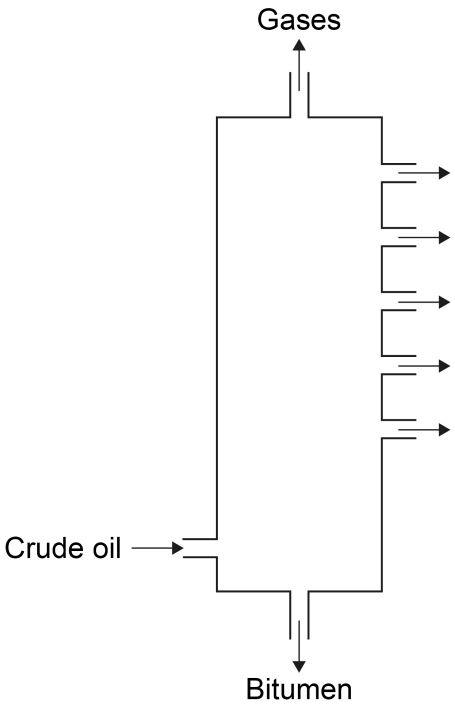
Question 02

0 1 Crude oil is a mixture of hydrocarbons.

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

Figure 1 shows a fractional distillation column.

Figure 1



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 1 . 2 Why do the fractions separate?

[1 mark]

Tick **one** box.

The fractions have different boiling points. ☐

The fractions have different flammability. ☐

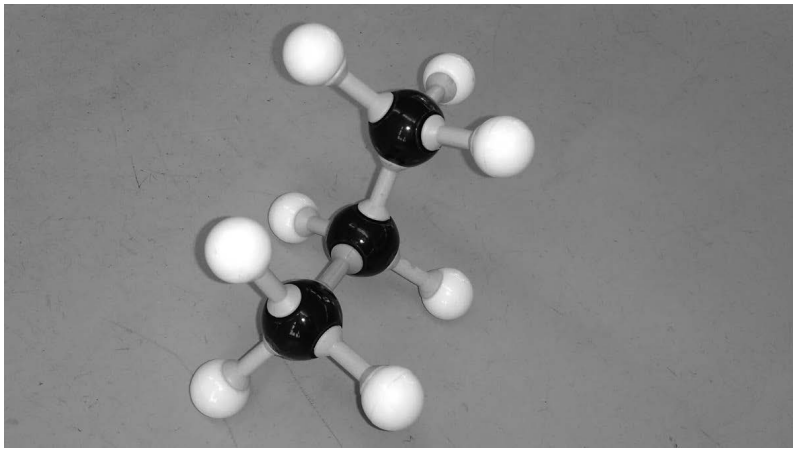
The fractions have different melting points. ☐

The fractions have different viscosity. ☐

Most of the hydrocarbons in crude oil are alkanes.

0 1 . 3 **Figure 2** represents an alkane molecule.

Figure 2



Name the alkane.

[1 mark]

_____

Question 1 continues on the next page

5.3.1.1 Conservation of mass and balanced chemical equations

Question 02 · continued

0 1 . 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 1 . 5 Alkanes burn in oxygen.

Balance the equation for methane burning.

[1 mark]

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

0 1 . 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 1 shows data from a life cycle assessment (LCA) for the disposal of 10 000 biodegradable plastic bags.

Table 1

	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 1 . 7 Why are life cycle assessments (LCA) done?

[1 mark]

0 1 . 8 Compare the **two** methods for the disposal of biodegradable plastic bags.

Use information from **Table 1**

[4 marks]

11

5.3.1.1 Conservation of mass and balanced chemical equations

Question 03

June 2019 | 8464/C/1H | Original Q6

0 6 This question is about sodium.

0 6 . 1 Sodium reacts with chlorine.

What is the balanced equation for the reaction?

[1 mark]

Tick (✓) **one** box.

$Na + Cl \rightarrow NaCl$ ☐

$Na + Cl_2 \rightarrow NaCl_2$ ☐

$2\ Na + Cl_2 \rightarrow 2\ NaCl$ ☐

$2\ Na + Cl \rightarrow Na_2Cl$ ☐

0 6 . 2 Hot sodium is put in a gas jar of chlorine.

Describe the observations made before, during and after the reaction.

[3 marks]

Before reaction _____

_____

During reaction _____

_____

After reaction _____

_____

5.3.1.1 Conservation of mass and balanced chemical equations

Question 03 · continued

0 6 . 3 Explain why sodium is less reactive than potassium.

[4 marks]

Question 6 continues on the next page

5.3.1.1 Conservation of mass and balanced chemical equations

Question 03 · continued

0 6 . 4 Chlorine reacts with sodium and with hydrogen.

Compare the structure and bonding in sodium chloride and hydrogen chloride.

[6 marks]

5.3.1.1 Conservation of mass and balanced chemical equations

Question 04

June 2019 | 8464/C/2H | Original Q7

0 7 This question is about hydrocarbons and crude oil.

0 7 . 1 Hydrocarbon fuels are produced from crude oil.

Describe how crude oil is separated into fractions.

[4 marks]

Butane is a hydrocarbon.

0 7 . 2 Two equations for the combustion of butane are:

- $2\,C_4H_{10} + 13\,O_2 \rightarrow 8\,CO_2 + 10\,H_2O$
- $2\,C_4H_{10} + 5\,O_2 \rightarrow 8\,C + 10\,H_2O$

Why are different products formed?

[1 mark]

0 7 . 3 One other product of the combustion of butane is carbon monoxide.

Balance the equation.

[1 mark]

____ C_4H_{10} + ____ O_2 → ____ CO + ____ H_2O

5.3.1.1 Conservation of mass and balanced chemical equations

Question 04 · continued

0 7 . 4 Carbon dioxide is a greenhouse gas.

Describe the greenhouse effect in terms of the interaction of short and long wavelength radiation with matter.

[4 marks]

10

5.3.1.1 Conservation of mass and balanced chemical equations

Question 05

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

0 4 This question is about acids, alkalis and bases.

A student reacted zinc oxide powder with hydrochloric acid to produce zinc chloride solution.

0 4 . 1 Complete the equation for the reaction by writing the state symbols.

[2 marks]

$$ZnO(\quad) + 2\,HCl(\quad) \rightarrow ZnCl_2(\quad) + H_2O(\quad)$$

0 4 . 2 Give **one** way that the student could speed up the reaction between zinc oxide powder and hydrochloric acid.

[1 mark]

Hydrochloric acid was the limiting reactant.

0 4 . 3 How could the student know when all the hydrochloric acid has reacted?

[1 mark]

0 4 . 4 How could the student obtain zinc chloride solution from the reaction mixture when all the hydrochloric acid has reacted?

[1 mark]

5.3.1.1 Conservation of mass and balanced chemical equations

Question 05 · continued

0 4 . 5 Describe how zinc chloride crystals are produced from zinc chloride solution.

[2 marks]

Sulfuric acid and sodium hydroxide react to produce sodium sulfate.

0 4 . 6 Sulfuric acid is gradually added to sodium hydroxide solution.

The pH of the mixture changes as the sulfuric acid is added until in excess.

Suggest the pH at:

- the start before sulfuric acid is added
- the end when sulfuric acid is in excess.

[2 marks]

pH at start = _____

pH at end = _____

0 4 . 7 Complete the symbol equation for the preparation of sodium sulfate.

You should balance the equation.

[2 marks]

_____ $NaOH$ + H_2SO_4 → _____ + _____

Question 4 continues on the next page

5.3.1.1 Conservation of mass and balanced chemical equations

Question 05 · continued

0 4 . 8 A solution of hydrochloric acid had a hydrogen ion concentration of 1.0 mol/dm^3

Water was added to the hydrochloric acid until the pH increased by 1

What was the hydrogen ion concentration of the hydrochloric acid after water had been added?

[1 mark]

Tick (✓) **one** box.

100 mol/dm^3 ☐

10 mol/dm^3 ☐

0.10 mol/dm^3 ☐

0.010 mol/dm^3 ☐

12

5.3.1.1 Conservation of mass and balanced chemical equations

Question 06

November 2020 | 8464/C/2H | Original Q1

0 1 This question is about the Earth's resources.

When most fuels burn carbon dioxide is produced.

Propane (C_3H_8) is a fuel.

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

[1 mark]

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

0 1 . 2 Describe the test for carbon dioxide.

Give the result of the test.

[2 marks]

Test _____

Result _____

_____

0 1 . 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 1 . 4 Describe the test for hydrogen.

Give the result of the test.

[2 marks]

Test _____

Result _____

_____

0 1 . 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

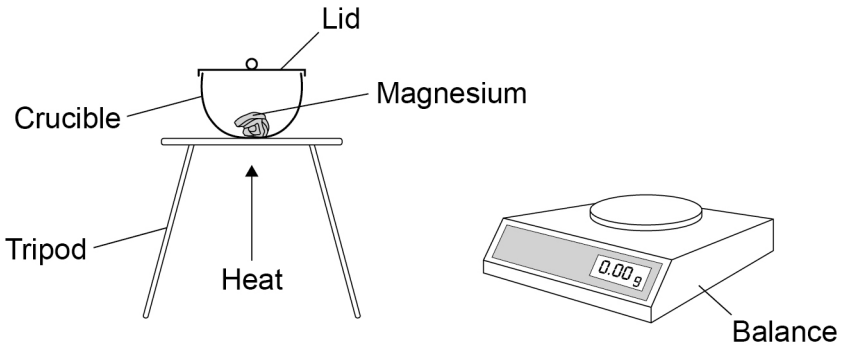
November 2021 | 8464/C/1H | Original Q6

0 6 Metal oxides are produced when metals are heated in air.

A student investigated the change in mass when 0.12 g of magnesium was heated in air.

Figure 5 shows the apparatus.

Figure 5



The student measured the mass of magnesium oxide produced.

0 6 . 1 0.12 g of magnesium reacted to produce 0.20 g of magnesium oxide.

Calculate the number of moles of oxygen gas (O_2) that reacted.

Relative atomic mass (A_r): O = 16

[3 marks]

Moles of oxygen gas = _____

5.3.1.1 Conservation of mass and balanced chemical equations

Question 07 · continued

0 6 . 2 The student repeated the experiment **without** a lid on the crucible.

Suggest why the mass of magnesium oxide produced would be different without a lid on the crucible.

[2 marks]

0 6 . 3 Copper reacts with oxygen to produce copper oxide.

63.5 g of copper produces 79.5 g of copper oxide.

Calculate the mass of copper oxide produced when 0.50 g of copper reacts with oxygen.

Give your answer to 3 significant figures.

[3 marks]

Mass (3 significant figures) = _____ g

Question 6 continues on the next page

5.3.1.1 Conservation of mass and balanced chemical equations

Question 07 · continued

0 6 . 4 Iron reacts with oxygen to produce an oxide of iron.

0.015 moles of iron reacts with 0.010 moles of oxygen gas (O_2).

Determine:

- the formula of the iron oxide produced
- the balanced symbol equation for the reaction.

[4 marks]

Formula of iron oxide = _____

Balanced symbol equation

_____

12

5.3.1.1 Conservation of mass and balanced chemical equations

Question 08

November 2021 | 8464/C/2H | Original Q5

0 5 Atmospheric pollution is emitted by cars.

Some car emissions contain nitrogen dioxide.

0 5 . 1 Describe how nitrogen dioxide (NO_2) is produced in the engine of a car that burns fossil fuels.

[3 marks]

Table 3 shows the concentration of nitrogen dioxide in the air in three different areas for 1 week.

Table 3

	Concentration of nitrogen dioxide in the air in micrograms per m^3		
Day	**City centre**	**Countryside**	**Motorway**
Monday	35	8	22
Tuesday	37	8	23
Wednesday	37	8	23
Thursday	34	8	23
Friday	37	8	23
Saturday	29	7	20
Sunday	**X**	6	17

5.3.1.1 Conservation of mass and balanced chemical equations

Question 08 · continued

0 5 . 2 The mean value for nitrogen dioxide in the air for the whole week in the city centre is 33 micrograms per m^3.

Calculate the value (**X**) for the concentration of nitrogen dioxide in the air in the city centre on Sunday.

[2 marks]

X = _____ micrograms per m^3

0 5 . 3 Each value in **Table 3** has an uncertainty of ± 2 micrograms per m^3.

Explain why this uncertainty is **most** significant for countryside data.

[2 marks]

Question 5 continues on the next page

5.3.1.1 Conservation of mass and balanced chemical equations

Question 08 · continued

Nitrogen dioxide is removed from car emissions by catalytic converters.

0 5 . 4 In a catalytic converter nitrogen dioxide (NO_2) reacts to produce nitrogen and oxygen.

Complete the equation for the reaction.

You should balance the equation.

[2 marks]

_____ $NO_2 \rightarrow$ _____ + _____

0 5 . 5 The catalyst in a catalytic converter contains platinum.

Platinum is a finite resource.

What is meant by a 'finite resource'?

[1 mark]

0 5 . 6 Emissions from cars contain carbon dioxide.

Explain why carbon dioxide emissions during use and operation are **not** the total carbon footprint for a car.

Refer to the stages of the life cycle assessment of a car in your answer.

[3 marks]

13

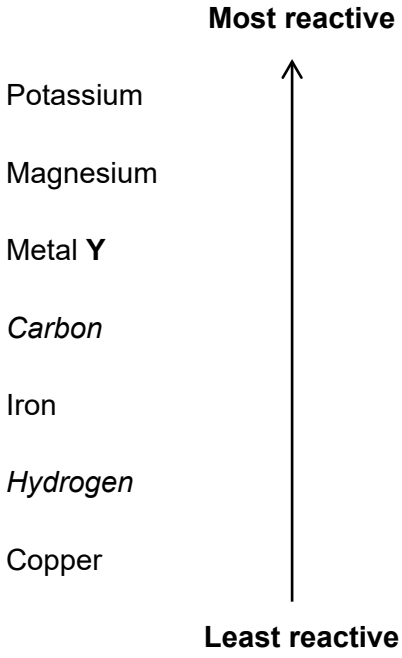
5.3.1.1 Conservation of mass and balanced chemical equations

Question 09

0 7 This question is about elements and compounds.

0 7 . 1 **Figure 8** shows a reactivity series.

Figure 8



Give the method and conditions used to extract metal **Y** from a compound of metal **Y**.
[2 marks]

Question 7 continues on the next page

5.3.1.1 Conservation of mass and balanced chemical equations

Question 09 · continued

Sodium reacts with titanium chloride ($TiCl_4$) to produce titanium.

0 7 . 2 Complete the equation.

You should balance the equation.

[2 marks]

____ Na + $TiCl_4$ → _____ + _____

0 7 . 3 The reaction between sodium and titanium chloride is a redox reaction.

Write a half-equation to show that sodium is oxidised in this reaction.

[2 marks]

_____

5.3.1.1 Conservation of mass and balanced chemical equations

Question 09 · continued

0 7 . 4 108 g of aluminum reacts with 1.21 kg of copper chloride to produce copper.

The equation for the reaction is:

$$2\,Al + 3\,CuCl_2 \rightarrow 3\,Cu + 2\,AlCl_3$$

Calculate the maximum mass of copper produced in grams (g).

You should determine the limiting reactant.

Relative atomic masses (A_r): Al = 27 Cu = 63.5

Relative formula masses (M_r): $CuCl_2$ = 134.5 $AlCl_3$ = 133.5

[6 marks]

Limiting reactant is _____

Mass of copper = _____ g

Question 7 continues on the next page

5.3.1.1 Conservation of mass and balanced chemical equations

Question 09 · continued

Sodium metal and sodium chloride are both able to conduct electricity.

0 7 . 5 Describe how sodium metal conducts electricity.

[2 marks]

0 7 . 6 Explain how sodium chloride can conduct electricity.

[3 marks]

17

5.3.1.1 Conservation of mass and balanced chemical equations

Question 10

June 2023 | 8464/C/1H | Original Q3

0 3 Sodium is in Group 1 of the periodic table.

Sodium reacts with oxygen to produce sodium oxide.

0 3 . 1 Balance the equation for the reaction.

[1 mark]

$$___\ Na + O_2 \rightarrow ___\ Na_2O$$

0 3 . 2 Explain what happens to sodium atoms and to oxygen atoms when sodium reacts with oxygen to produce sodium oxide (Na_2O).

Answer in terms of electrons.

[4 marks]

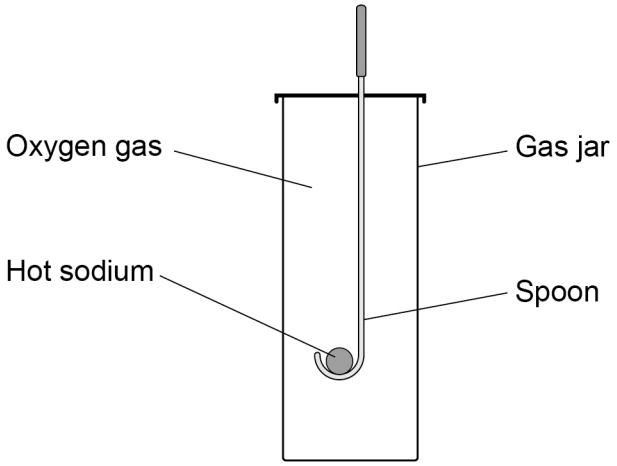
5.3.1.1 Conservation of mass and balanced chemical equations

Question 10 · continued

0 3 . 3 Sodium burns in a gas jar of oxygen.

Figure 3 shows the apparatus.

Figure 3



Give **two** observations seen during the reaction.

[2 marks]

1 _____

_____

2 _____

_____

0 3 . 4 Describe **two** differences in the observations if potassium is used instead of sodium.

[2 marks]

1 _____

_____

2 _____

_____

9

5.3.1.1 Conservation of mass and balanced chemical equations

Question 11

June 2023 | 8464/C/2H | Original Q1

0 1 The combustion of fuels is a source of atmospheric pollutants.

0 1 . 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 1 . 2 Many fuels are mixtures.

Petrol and diesel are mixtures of hydrocarbons.

Table 1 shows properties of petrol and of diesel.

Table 1

	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 1**.

[2 marks]

5.3.1.1 Conservation of mass and balanced chemical equations

Question 11 · continued

0 1 . 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 1 . 4 When diesel burns in car engines, oxides of nitrogen are produced.

Where does the nitrogen come from?

[1 mark]

0 1 . 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 11 · continued

0 1 . 6 Carbon monoxide may be produced when diesel burns.

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

[1 mark]

0 1 . 7 Explain why water vapour and **not** liquid water is produced when diesel burns.

[2 marks]

0 1 . 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 12

June 2024 | 8464/C/2H | Original Q1

0 1 Alkanes and alkenes are hydrocarbons.

0 1 . 1 Define the term 'hydrocarbon'.

[1 mark]

0 1 . 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 1 continues on the next page

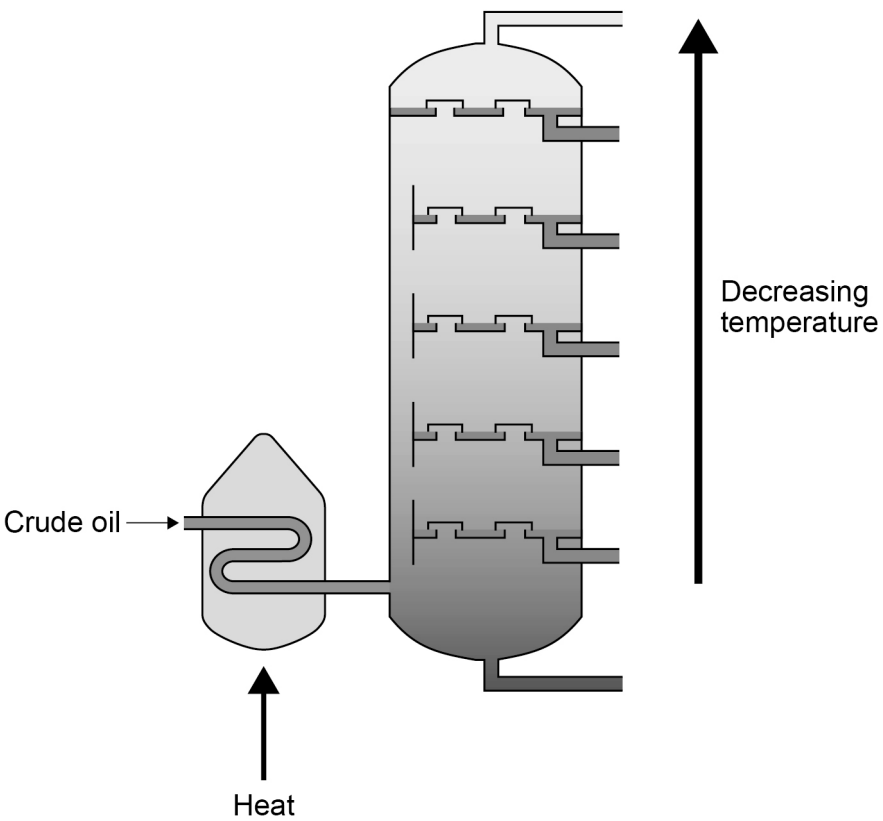
5.3.1.1 Conservation of mass and balanced chemical equations

Question 12 · continued

0 1 . 3 Crude oil is a mixture of hydrocarbons.

Figure 1 represents industrial equipment used to separate crude oil into fractions.

Figure 1



Explain how crude oil is separated into fractions.

Use **Figure 1**.

[4 marks]

5.3.1.1 Conservation of mass and balanced chemical equations

Question 12 · continued

0 1 . 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 1 continues on the next page

5.3.1.1 Conservation of mass and balanced chemical equations

Question 12 · continued

Propene (C_3H_6) is an alkene.

0 1 . 5 Describe the test for alkenes.

Give the result.

[2 marks]

Test _____

_____

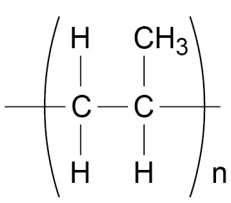
Result _____

_____

0 1 . 6 Poly(propene) is made from propene.

Figure 2 represents the repeating unit of poly(propene).

Figure 2



What type of substance is poly(propene)?

[1 mark]

_____

10

5.3.1.1 Conservation of mass and balanced chemical equations

Question 13

June 2024 | 8464/C/2H | Original Q3

0 3 Some fractions of crude oil are processed to produce fuel for transport.

0 3 . 1 Describe how crude oil was formed.

[4 marks]

5.3.1.1 Conservation of mass and balanced chemical equations

Question 13 · continued

Transport is a source of atmospheric pollutants.

0 3 . 2 Suggest how sulfur dioxide can be produced by transport.

[2 marks]

0 3 . 3 Give **two** problems caused by sulfur dioxide as an atmospheric pollutant.

[2 marks]

1

2

Question 3 continues on the next page

5.3.1.1 Conservation of mass and balanced chemical equations

Question 13 · continued

0 3 . 4 Describe how carbon monoxide can be produced by transport.

[2 marks]

0 3 . 5 Catalytic converters are fitted to car exhausts to reduce the amount of pollution from cars.

Carbon monoxide and nitrogen dioxide (NO_2) react in a catalytic converter.

Nitrogen and carbon dioxide are produced.

Write a balanced equation for the reaction.

[2 marks]

_____ + _____ → _____ + _____

12

5.3.1.1 Conservation of mass and balanced chemical equations

Question 14

0 4 This question is about metals.

0 4 . 1 Iron is extracted from iron oxide by reduction with carbon.

Why can iron be extracted by reduction with carbon?

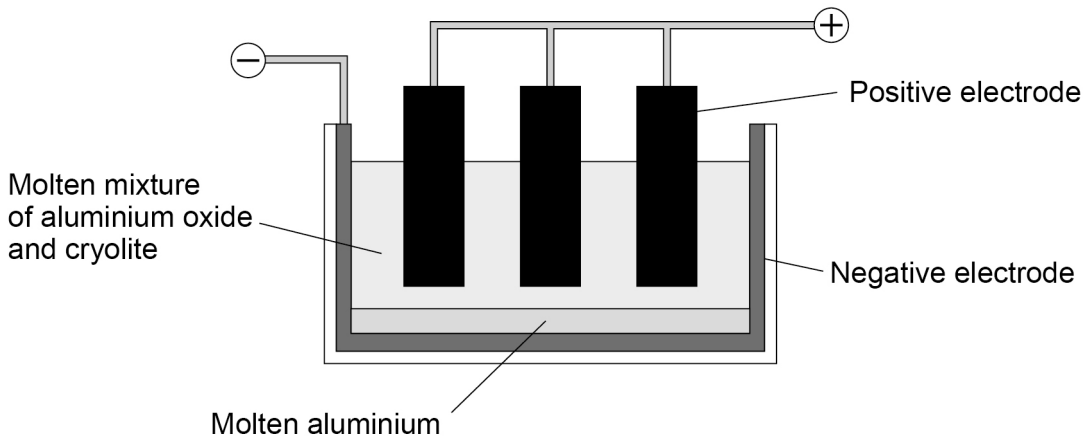
Answer in terms of reactivity.

[1 mark]

Aluminium is extracted by the electrolysis of aluminium oxide.

Figure 4 shows the apparatus used to extract aluminium.

Figure 4



5.3.1.1 Conservation of mass and balanced chemical equations

Question 14 · continued

0 4 . 2 Explain why a mixture of aluminium oxide and cryolite is used as the electrolyte instead of only aluminium oxide.

[2 marks]

0 4 . 3 Oxygen gas is produced at the positive electrode.

Write a balanced half equation for the production of oxygen at the positive electrode.

[2 marks]

_____ → _____ + _____

Question 4 continues on the next page

5.3.1.1 Conservation of mass and balanced chemical equations

Question 14 · continued

Chromium is extracted by reacting chromium oxide with aluminium.

The equation for the reaction is:

$$Cr_2O_3 + 2\,Al \rightarrow Al_2O_3 + 2\,Cr$$

0 4 . 4 Which substance in the equation is reduced?

[1 mark]

Table 3 shows the relative cost of extracting equal masses of aluminium, chromium and iron.

Table 3

Metal	Relative cost of extraction
Aluminium	2
Chromium	20
Iron	1

0 4 . 5 Give **one** reason for the difference in the cost of extracting aluminium and **iron**.

Use **Table 3**.

[1 mark]

5.3.1.1 Conservation of mass and balanced chemical equations

Question 14 · continued

0 4 . 6 Give **one** reason for the difference in the cost of extracting aluminium and **chromium**.

Use **Table 3**.

[1 mark]

0 4 . 7 Metals are mixed together to form alloys.

Explain why alloys are harder than pure metals.

[3 marks]

11

5.3.1.1 Conservation of mass and balanced chemical equations

Question 15

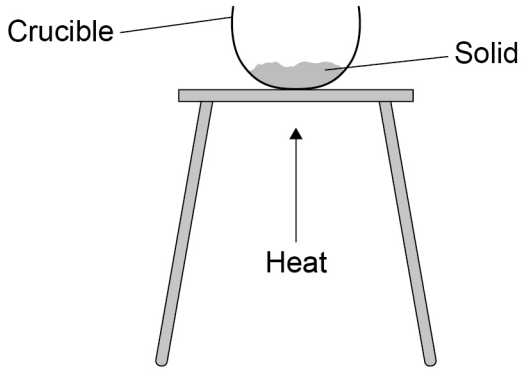
June 2025 | 8464/C/1H | Original Q6

0 6 Some reactions appear to involve a change in mass.

A student investigated the change in mass when solids were heated.

Figure 7 shows the apparatus.

Figure 7



The student determined the mass of the contents of the crucible at regular intervals.

0 6 . 1 The student used a Bunsen burner instead of a water bath to heat the crucible.

Suggest **one** reason why.

[1 mark]

Question 6 continues on the next page

Question 15 · continued

The student planned to heat:

- 0.01 mol of magnesium
- 0.01 mol of magnesium carbonate.

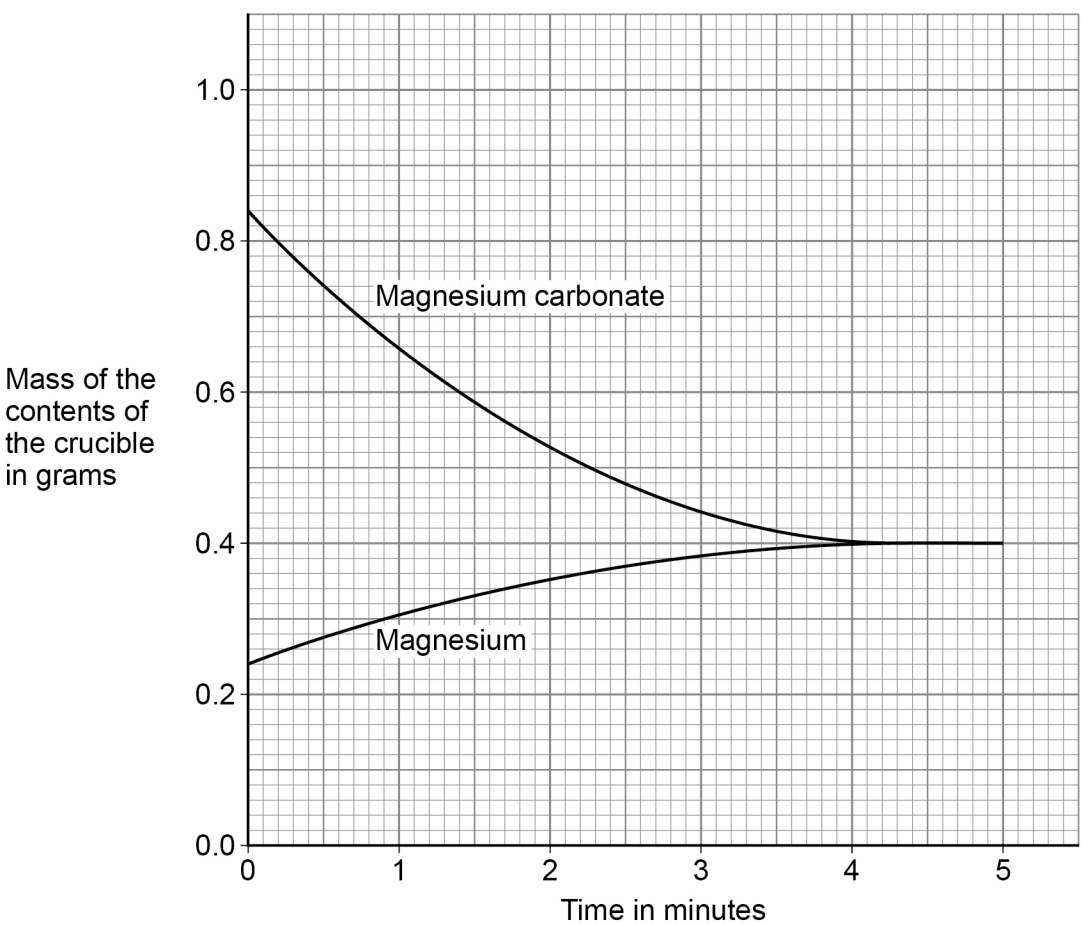
The equations for the reactions are:

$$Mg + \tfrac{1}{2}O_2 \rightarrow MgO$$

$$MgCO_3 \rightarrow MgO + CO_2$$

Figure 8 shows the student's **predicted** results.

Figure 8



5.3.1.1 Conservation of mass and balanced chemical equations

Question 15 · continued

0 6 . 2 Look at **Figure 8**.

Explain the **two** trends for the first 3 minutes.

[4 marks]

Magnesium _____

_____

_____

_____

Magnesium carbonate _____

_____

_____

_____

0 6 . 3 **Figure 8** shows that both reactions are complete after 5 minutes.

Why is the final mass of the contents of the crucible the same for both reactions?

[1 mark]

_____

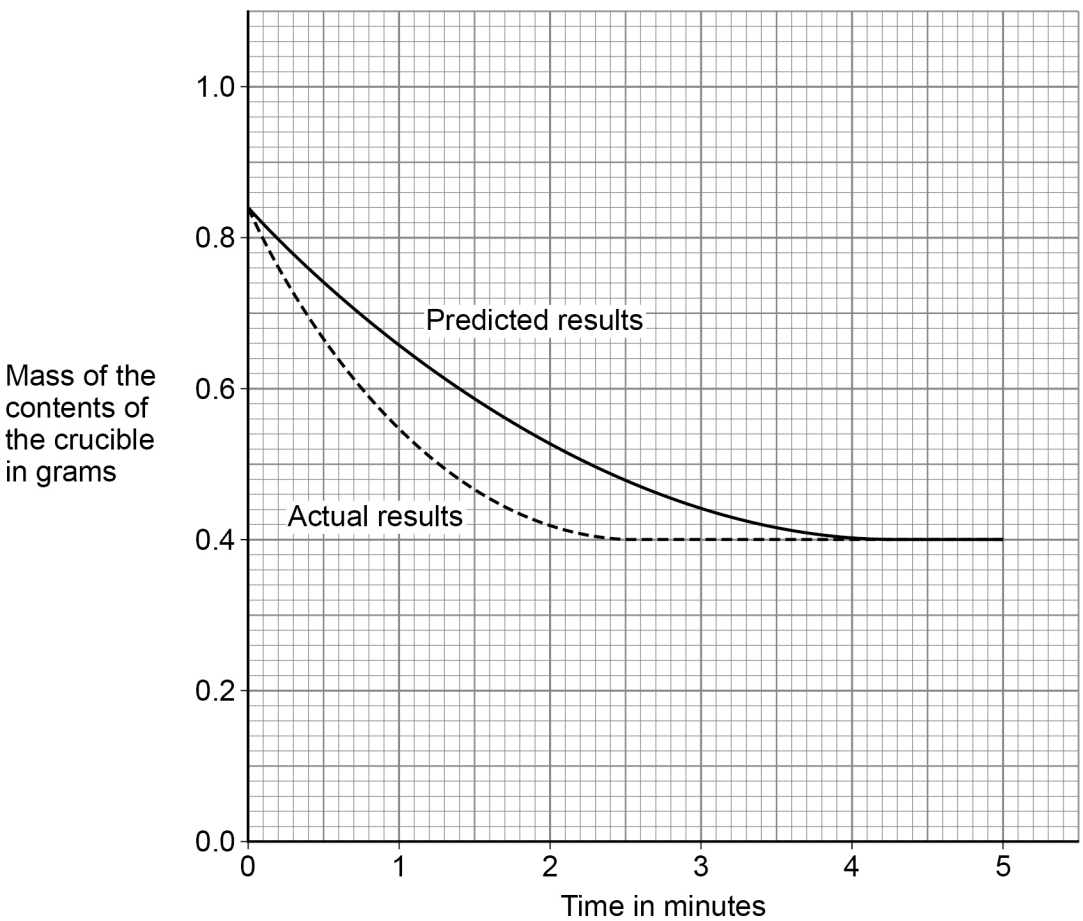
_____

Question 6 continues on the next page

0 6 . 4 The student heated magnesium carbonate.

Figure 9 shows the results.

Figure 9



The student concluded:

'The difference between the predicted results and the actual results is caused by solid escaping from the crucible.'

Give **one** reason why the results show the student is **not** correct.

[1 mark]

5.3.1.1 Conservation of mass and balanced chemical equations

Question 15 · continued

0 6 . 5 Iron reacts with steam (H_2O) to produce an oxide of iron and hydrogen gas.

0.120 moles of iron reacts with 0.160 moles of steam.

Determine the balanced equation for the reaction.

You should determine:

- the simplest whole number mole ratio of Fe : H_2O
- the formula of the iron oxide produced.

[4 marks]

Simplest mole ratio of Fe : H_2O = _____ : _____

Formula of the iron oxide = _____

Balanced equation for the reaction:

_____ + _____ → _____ + _____

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5.3.1.1 Conservation of mass and balanced chemical equations

Question 16

June 2025 | 8464/C/2H | Original Q4

0 4 This question is about methanol.

0 4 . 1 Methanol is used in screenwash.

Screenwash is used to keep car windscreens clean.

Screenwash is a formulation.

Define the term 'formulation'.

[1 mark]

Question 4 continues on the next page

5.3.1.1 Conservation of mass and balanced chemical equations

Question 16 · continued

Carbon monoxide and hydrogen are used to produce methanol.

The conditions used in the production of methanol are:

- high temperature
- high pressure
- a catalyst.

The equation for the reaction is:

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$

91 kJ/mol of energy is transferred during the exothermic forward reaction.

0 4 . 2 How much energy is transferred when methanol is decomposed into carbon monoxide and hydrogen?

[1 mark]

Tick (✓) **one** box.

< 91 kJ/mol ☐

91 kJ/mol ☐

> 91 kJ/mol ☐

0 4 . 3 A scientist developed a principle to predict the effect of changing conditions on a system at equilibrium.

What was the name of the scientist?

[1 mark]

5.3.1.1 Conservation of mass and balanced chemical equations

Question 16 · continued

0 4 . 4 What is the effect of increasing the temperature on the proportion of methanol in the equilibrium mixture?

[1 mark]

Tick (✓) **one** box.

The proportion of methanol decreases. ☐

The proportion of methanol stays the same. ☐

The proportion of methanol increases. ☐

0 4 . 5 What is the effect of using a catalyst on the proportion of methanol in the equilibrium mixture?

[1 mark]

Tick (✓) **one** box.

The proportion of methanol decreases. ☐

The proportion of methanol stays the same. ☐

The proportion of methanol increases. ☐

0 4 . 6 Explain the effect of increasing the pressure on the proportion of methanol in the equilibrium mixture.

[3 marks]

5.3.1.1 Conservation of mass and balanced chemical equations

Question 16 · continued

0 4 . 7 Explain the effect of using a catalyst on the **rate** of production of methanol.

[3 marks]

0 4 . 8 The catalyst allows the reaction to take place at a lower temperature.

Explain **one** advantage of using a lower temperature in the production of methanol.

Do **not** refer to the position of equilibrium in your answer.

[2 marks]

0 4 . 9 Methanol (CH_3OH) can also be produced by reacting carbon dioxide with hydrogen.

Water is the other product of the reaction.

Write a balanced equation for the reaction.

[2 marks]

_____ + _____ → _____ + _____

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