AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.9.3.1

Atmospheric pollutants from fuels

Past-paper questions

Tier	**Higher**
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.

5.9.3.1 Atmospheric pollutants from fuels

Question 01

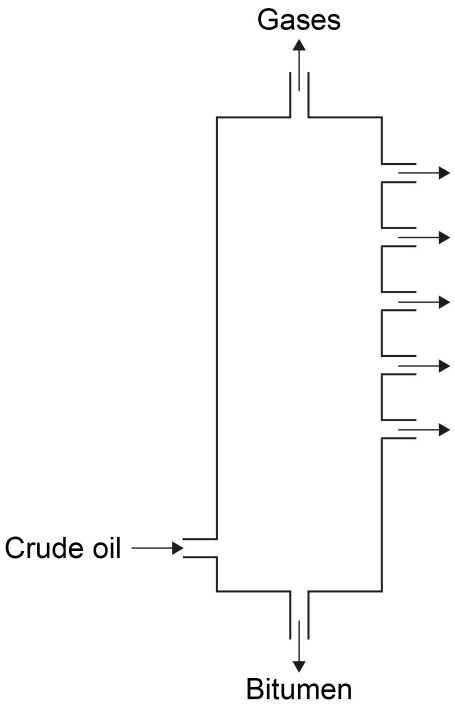
June 2018 | 8464/C/2H | Original Q1

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.

5.9.3.1 Atmospheric pollutants from fuels

Question 01 · 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. ☐

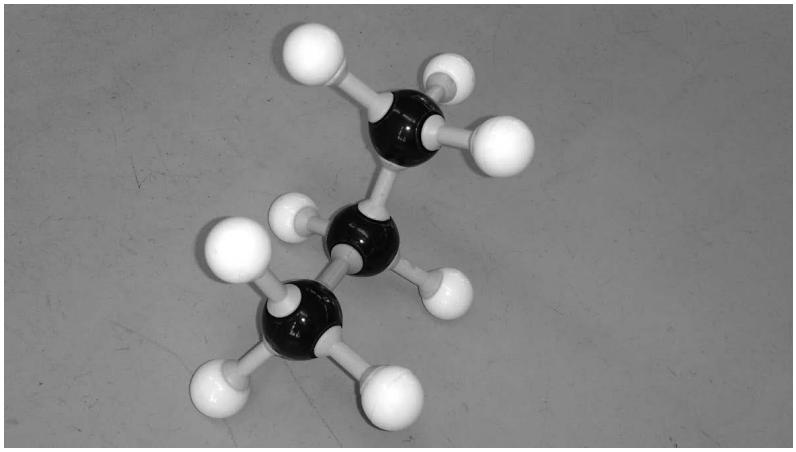
The fractions have different melting points. ☐

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

5.9.3.1 Atmospheric pollutants from fuels

Question 01 · 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 ☐

5.9.3.1 Atmospheric pollutants from fuels

Question 01 · 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

5.9.3.1 Atmospheric pollutants from fuels

Question 02

June 2019 | 8464/C/2H | Original Q2

0 2 This question is about atmospheric pollutants from fuels.

0 2 . 1 Fuel burns in a car engine.

Describe how oxides of nitrogen are produced in a car engine.

[2 marks]

Question 2 continues on the next page

5.9.3.1 Atmospheric pollutants from fuels

Question 02 · continued

0 2 . 2 **Table 1** shows the carbon footprint during the manufacture and use of three cars.

Table 1

Car	Mass of CO_2 produced during manufacture in kg	Mass of CO_2 produced when driving in kg per km	Total mass of CO_2 produced from manufacture and 40 000 km driving in kg	Total mass of CO_2 produced from manufacture and 100 000 km driving in kg
Car A	14 000	0.123	18 920	26 300
Car B	20 000	0.085	23 400	28 500
Car C	23 000	0.044	24 760	27 400

Evaluate the carbon footprint of the cars.

Use information from **Table 1**.

[6 marks]

8

5.9.3.1 Atmospheric pollutants from fuels

Question 03

June 2019 | 8464/C/2H | Original Q6

0 6 This question is about oxygen (O_2) and sulfur dioxide (SO_2).

0 6 . 1 Give the test and result for oxygen gas.

[2 marks]

Test _____

Result _____

0 6 . 2 The reaction between oxygen and sulfur dioxide is at equilibrium.

$$O_2(g) + 2SO_2(g) \rightleftharpoons 2SO_3(g)$$

Some of the sulfur trioxide (SO_3) is removed.

Explain what happens to the position of the equilibrium.

[2 marks]

_____

_____

_____

_____

5.9.3.1 Atmospheric pollutants from fuels

Question 03 · continued June 2019 | 8464/C/2H | Original Q6

0 6 . 3 Sulfur dioxide is an atmospheric pollutant.

Sulfur dioxide pollution is reduced by reacting calcium oxide with sulfur dioxide to produce calcium sulfite.

$$CaO + SO_2 \rightarrow CaSO_3$$

7.00 g of calcium oxide reacts with an excess of sulfur dioxide.

Relative atomic masses (A_r): O = 16 S = 32 Ca = 40

Calculate the mass of calcium sulfite produced.

[4 marks]

Mass of calcium sulfite produced = _____ g

8

5.9.3.1 Atmospheric pollutants from fuels

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]

$$____\ C_4H_{10} + ____\ O_2 \rightarrow ____\ CO + ____\ H_2O$$

5.9.3.1 Atmospheric pollutants from fuels

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

5.9.3.1 Atmospheric pollutants from fuels

Question 05

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

5.9.3.1 Atmospheric pollutants from fuels

Question 05 · 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

5.9.3.1 Atmospheric pollutants from fuels

Question 05 · 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

5.9.3.1 Atmospheric pollutants from fuels

Question 06

November 2021 | 8464/C/2H | Original Q6

0 6 Ammonia is produced when a mixture of nitrogen and hydrogen reacts.

The equation for the reaction is:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

0 6 . 1 Nitrogen is obtained from the air.

The mixture of nitrogen and hydrogen must **not** contain carbon dioxide and oxygen.

Explain how a sample can be tested to show that carbon dioxide is **not** present in the mixture.

[2 marks]

0 6 . 2 A catalyst is used in the reaction.

Explain how a catalyst increases the rate of a reaction.

[2 marks]

Question 6 continues on the next page

5.9.3.1 Atmospheric pollutants from fuels

Question 06 · continued

The equation for the reaction to produce ammonia is repeated here.

$$N_2\,(g) + 3\,H_2\,(g) \rightleftharpoons 2\,NH_3\,(g)$$

0 6 . 3 The reaction reaches equilibrium.

Explain how an equilibrium is reached.

[2 marks]

0 6 . 4 Suggest how the catalyst affects the equilibrium position.

Give **one** reason for your answer.

[2 marks]

0 6 . 5 What is the effect of increasing the pressure on the reaction to produce ammonia?

[1 mark]

Tick (✓) **one** box.

The yield of ammonia decreases. ☐

The yield of ammonia stays the same. ☐

The yield of ammonia increases. ☐

5.9.3.1 Atmospheric pollutants from fuels

Question 06 · continued

0 6 . 6 The forward reaction is exothermic.

Explain the effect of increasing the temperature on the yield of ammonia gas produced at equilibrium.

[2 marks]

11

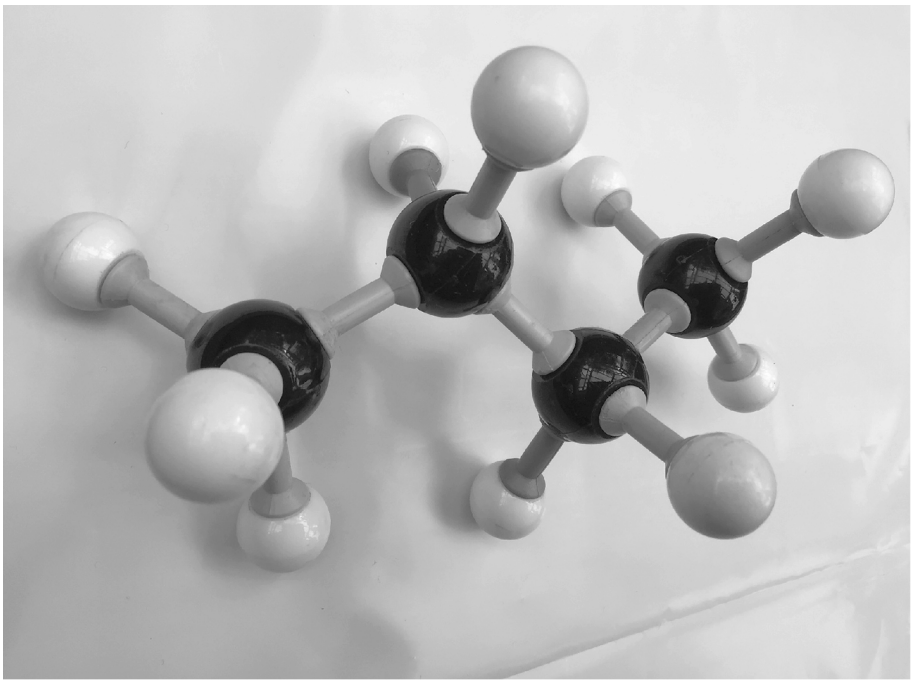
5.9.3.1 Atmospheric pollutants from fuels

Question 07

0 4 This question is about hydrocarbons and the uses of hydrocarbons.

0 4 . 1 **Figure 6** shows a model of an alkane.

Figure 6



What is the name of the alkane in **Figure 6**?

[1 mark]

0 4 . 2 What is a hydrocarbon?

[1 mark]

5.9.3.1 Atmospheric pollutants from fuels

Question 07 · continued

Large hydrocarbon molecules are cracked.

0 4 . 3 When $C_{11}H_{24}$ is cracked, three products are formed.

Complete the equation for the reaction.

[2 marks]

$$C_{11}H_{24} \rightarrow C_5H_{10} + 2 \text{ _____} + \text{ _____}$$

0 4 . 4 Explain why **one** of the products of cracking is in high demand.

[2 marks]

Question 4 continues on the next page

5.9.3.1 Atmospheric pollutants from fuels

Question 07 · continued

0 4 . 5 Window frames can be manufactured from wood or from plastic.

Table 2 shows data from a life cycle assessment (LCA) for a wooden window frame and a plastic window frame.

Both window frames are the same size.

Table 2

	Wood	Plastic
Sources of hydrocarbons used for production in kg	5.37	18.23
Greenhouse gases released during production, use and disposal in kg equivalent of CO_2	457	487
Oxides of nitrogen and sulfur dioxide produced in arbitrary units	29.6	37.7
Waste materials in kg	16.5	28.8
Total energy consumption in production, use and disposal in MJ	9150	9713
Lifetime cost to customer to buy and maintain in £	147	102

5.9.3.1 Atmospheric pollutants from fuels

Question 07 · continued

Evaluate the sustainability of wooden and plastic window frames.

You should include environmental and economic factors.

[6 marks]

12

5.9.3.1 Atmospheric pollutants from fuels

Question 08

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]

5.9.3.1 Atmospheric pollutants from fuels

Question 08 · 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]

5.9.3.1 Atmospheric pollutants from fuels

Question 08 · 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

5.9.3.1 Atmospheric pollutants from fuels

Question 09

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]

5.9.3.1 Atmospheric pollutants from fuels

Question 09 · 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

5.9.3.1 Atmospheric pollutants from fuels

Question 09 · 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

5.9.3.1 Atmospheric pollutants from fuels

Question 10

June 2024 | 8464/C/2H | Original Q5

0 5 Sulfuric acid is produced by an industrial process.

In the process, sulfur dioxide (SO_2) reacts with oxygen (O_2) to produce sulfur trioxide (SO_3).

The equation for the reversible reaction is:

$$2\,SO_2(g) + O_2(g) \rightleftharpoons 2\,SO_3(g)$$

The forward reaction releases 198 kJ/mol of energy.

0 5 . 1 What is the amount of energy transferred during the reverse reaction?

[1 mark]

Tick (✓) **one** box.

< 198 kJ/mol ☐

= 198 kJ/mol ☐

> 198 kJ/mol ☐

0 5 . 2 The concentration of oxygen is increased.

What is the effect on the position of the equilibrium?

[1 mark]

Tick (✓) **one** box.

Equilibrium position shifts to the left ☐

Equilibrium position does not change ☐

Equilibrium position shifts to the right ☐

5.9.3.1 Atmospheric pollutants from fuels

Question 10 · continued

0 5 . 3 The pressure is decreased.

What is the effect on the position of the equilibrium?

[1 mark]

Tick (✓) **one** box.

Equilibrium position shifts to the left ☐

Equilibrium position does not change ☐

Equilibrium position shifts to the right ☐

0 5 . 4 The temperature is increased.

What is the effect on the position of the equilibrium?

[1 mark]

Tick (✓) **one** box.

Equilibrium position shifts to the left ☐

Equilibrium position does not change ☐

Equilibrium position shifts to the right ☐

0 5 . 5 A catalyst is used in the reaction.

Suggest what effect the catalyst has on the position of the equilibrium.

Give **one** reason for your answer.

[2 marks]

Effect _____

_____

Reason _____

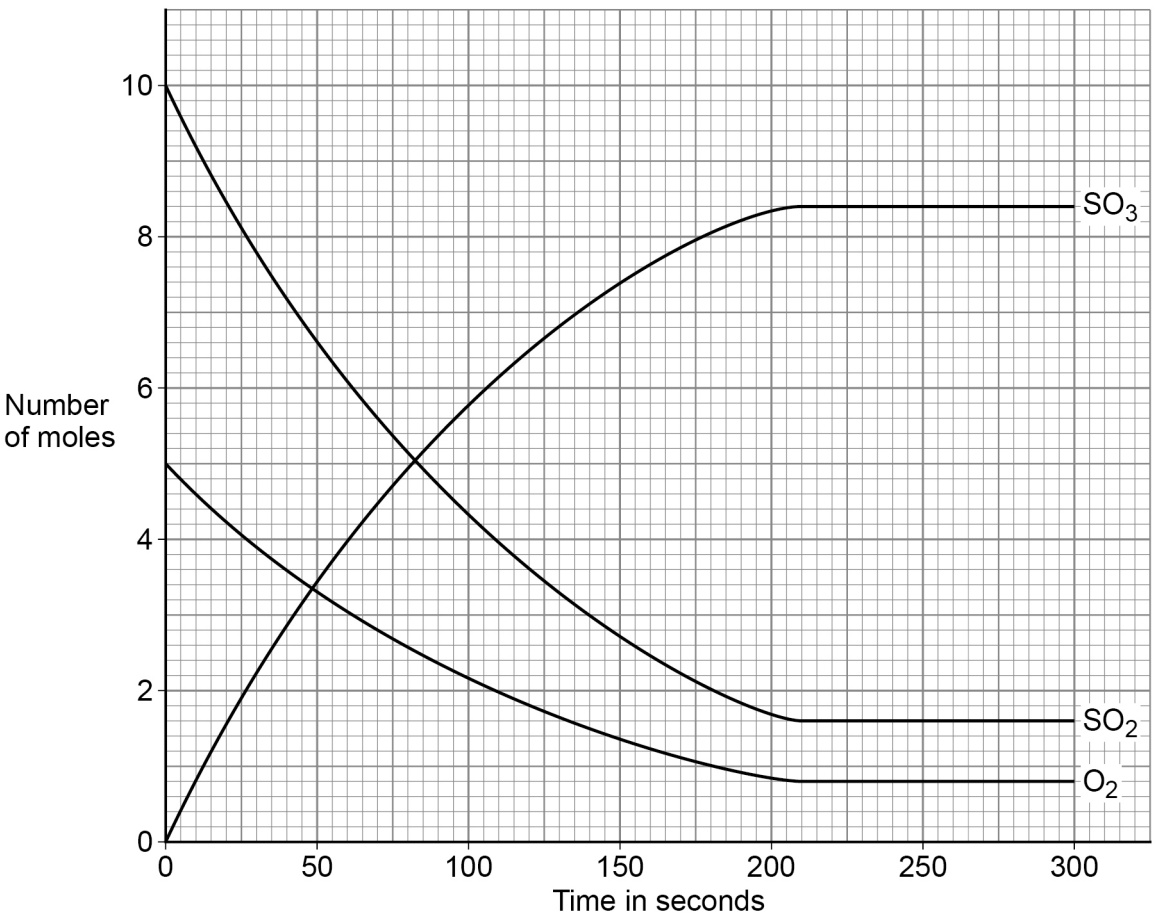
_____

Question 10 · continued

A scientist measured how the number of moles of sulfur dioxide, oxygen and sulfur trioxide varied with time during the reaction.

Figure 5 shows the results.

Figure 5



5.9.3.1 Atmospheric pollutants from fuels

Question 10 · continued

0 5 . 6 Determine the time taken for the reaction to reach equilibrium.

Explain your answer.

Use **Figure 5**.

[3 marks]

Time _____ s

Explanation _____

_____

_____

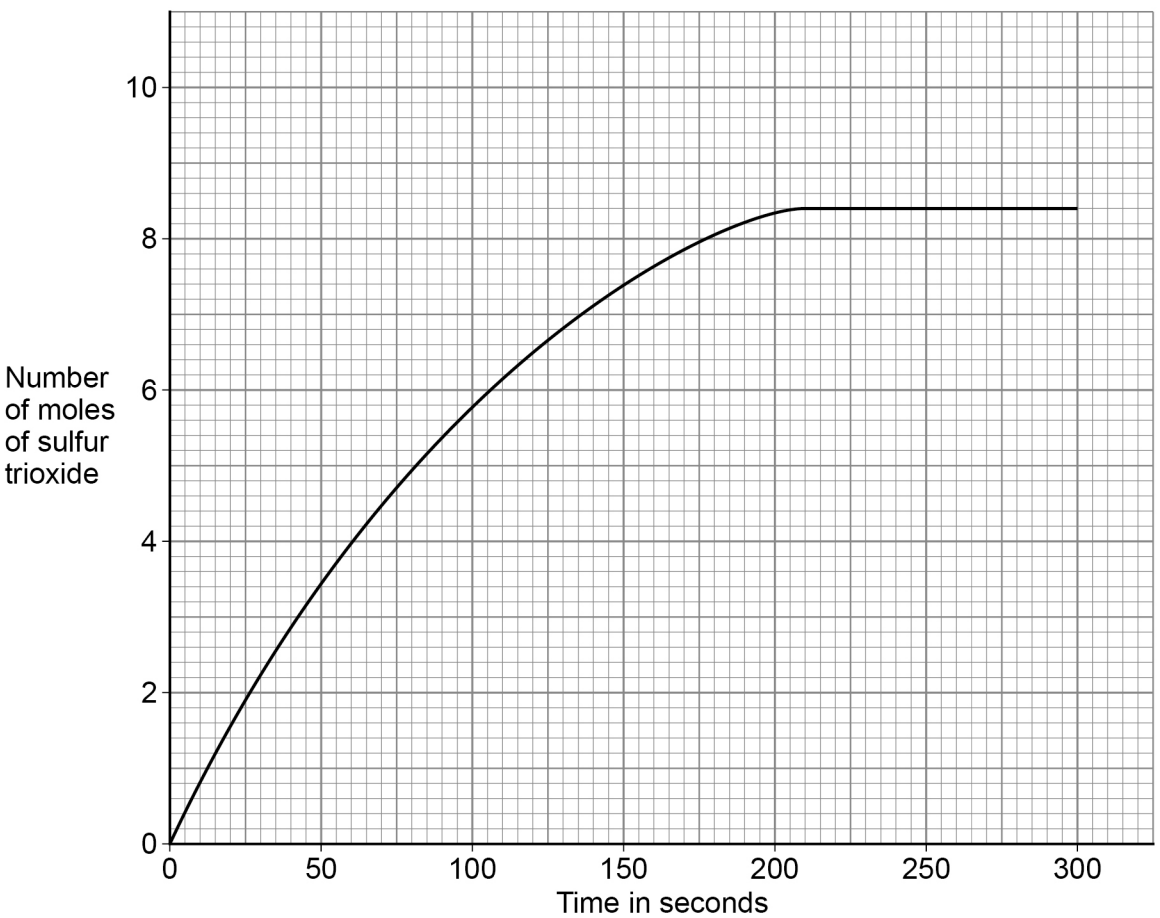
_____

_____

Question 5 continues on the next page

0 5 . 7 **Figure 6** shows the results for sulfur trioxide.

Figure 6



Determine the rate of reaction at 60 seconds.

[4 marks]

Rate = _____ mol/s

13

5.9.3.1 Atmospheric pollutants from fuels

Question 11

0 2 The proportions of most gases in the Earth's atmosphere have not changed much for the past 200 million years.

0 2 . 1 About one-fifth of the atmosphere is oxygen.

Describe the test for oxygen gas.

Give the result of the test.

[2 marks]

Test _____

_____

Result _____

_____

0 2 . 2 **Table 1** shows the percentages of some gases in the Earth's early atmosphere and in the Earth's atmosphere today.

Table 1

	Percentage (%) of gas in the atmosphere	
Gas	**Earth's early atmosphere**	**Earth's atmosphere today**
Carbon dioxide	95	0.04
Nitrogen	3	78.0
Oxygen	Less than 1	21.0

5.9.3.1 Atmospheric pollutants from fuels

Question 11 · continued

Explain how the percentages of gases have changed from Earth's early atmosphere to Earth's atmosphere today.

You should refer to all three gases in **Table 1**.

[6 marks]

Extra space

0 2 . 3 Methane is a greenhouse gas.

Give **two** ways to reduce methane emissions into the atmosphere.

[2 marks]

1

2

5.9.3.1 Atmospheric pollutants from fuels

Question 11 · continued

The percentage of sulfur dioxide in the Earth's atmosphere increased between 1850 and 1980.

0 2 . 4 Describe how sulfur dioxide emissions are produced.

[2 marks]

0 2 . 5 Give **one** harmful effect of sulfur dioxide emissions.

[1 mark]

0 2 . 6 Suggest **one** reason why the percentage of sulfur dioxide in the Earth's atmosphere has decreased since 1980.

[1 mark]

14

5.9.3.1 Atmospheric pollutants from fuels

Question 12

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

5.9.3.1 Atmospheric pollutants from fuels

Question 12 · 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]

_____

5.9.3.1 Atmospheric pollutants from fuels

Question 12 · 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]

5.9.3.1 Atmospheric pollutants from fuels

Question 12 · 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]

_____ + _____ → _____ + _____

15