AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.9.3.2

Properties and effects of atmospheric pollutants

Past-paper questions

Tier	**Higher**
Question groups	**9**
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.

5.9.3.2 Properties and effects of atmospheric pollutants

Question 01

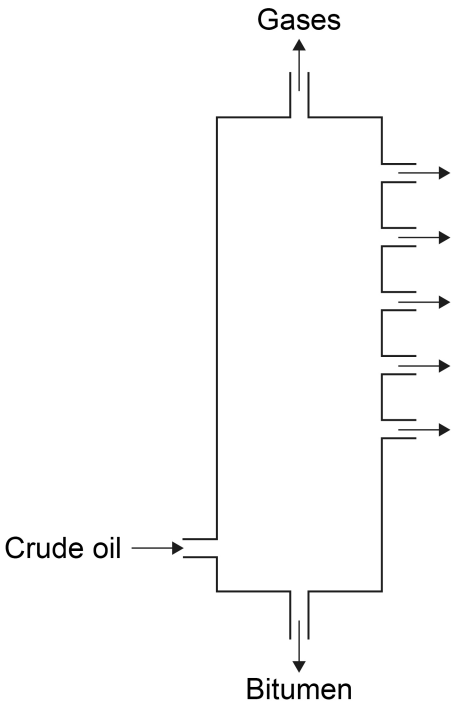
June 2018 | 8464/C/2H | Original Q1

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.

5.9.3.2 Properties and effects of atmospheric pollutants

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. ☐

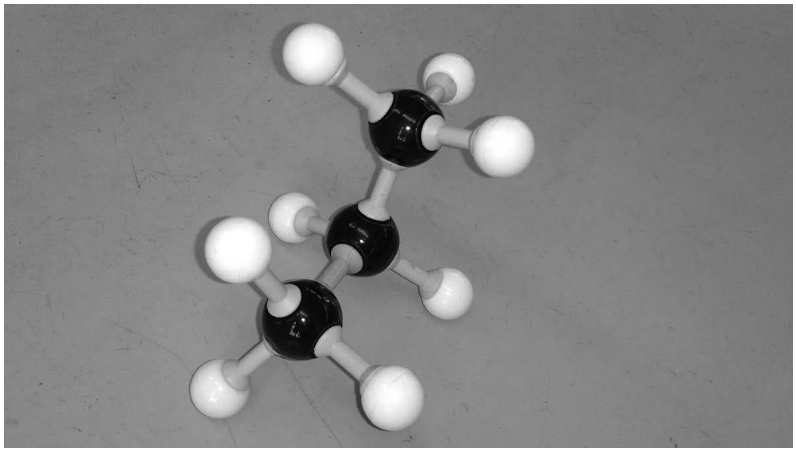
The fractions have different melting points. ☐

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

5.9.3.2 Properties and effects of atmospheric pollutants

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 → ____ 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 ☐

5.9.3.2 Properties and effects of atmospheric pollutants

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

5.9.3.2 Properties and effects of atmospheric pollutants

Question 02

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]

_____

_____

_____

_____

5.9.3.2 Properties and effects of atmospheric pollutants

Question 02 · 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

5.9.3.2 Properties and effects of atmospheric pollutants

Question 03

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]

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

5.9.3.2 Properties and effects of atmospheric pollutants

Question 03 · 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

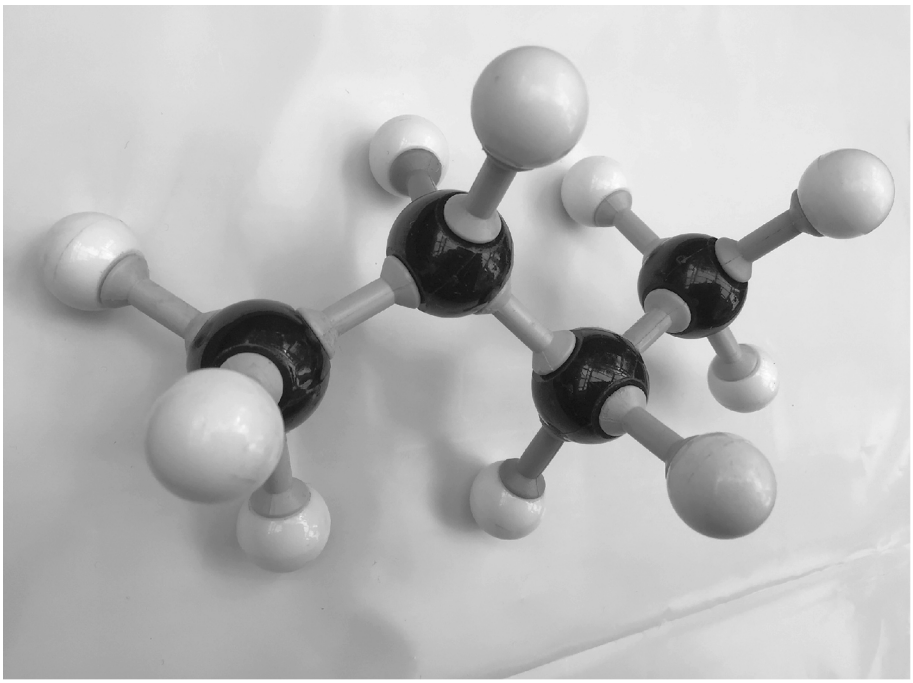
5.9.3.2 Properties and effects of atmospheric pollutants

Question 04

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]

5.9.3.2 Properties and effects of atmospheric pollutants

Question 04 · 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

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

5.9.3.2 Properties and effects of atmospheric pollutants

Question 04 · continued

Evaluate the sustainability of wooden and plastic window frames.

You should include environmental and economic factors.

[6 marks]

12

5.9.3.2 Properties and effects of atmospheric pollutants

Question 05

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]

5.9.3.2 Properties and effects of atmospheric pollutants

Question 05 · 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]

5.9.3.2 Properties and effects of atmospheric pollutants

Question 05 · 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

5.9.3.2 Properties and effects of atmospheric pollutants

Question 06

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]

5.9.3.2 Properties and effects of atmospheric pollutants

Question 06 · 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

5.9.3.2 Properties and effects of atmospheric pollutants

Question 06 · 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

5.9.3.2 Properties and effects of atmospheric pollutants

Question 07

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 ☐

5.9.3.2 Properties and effects of atmospheric pollutants

Question 07 · 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 _____

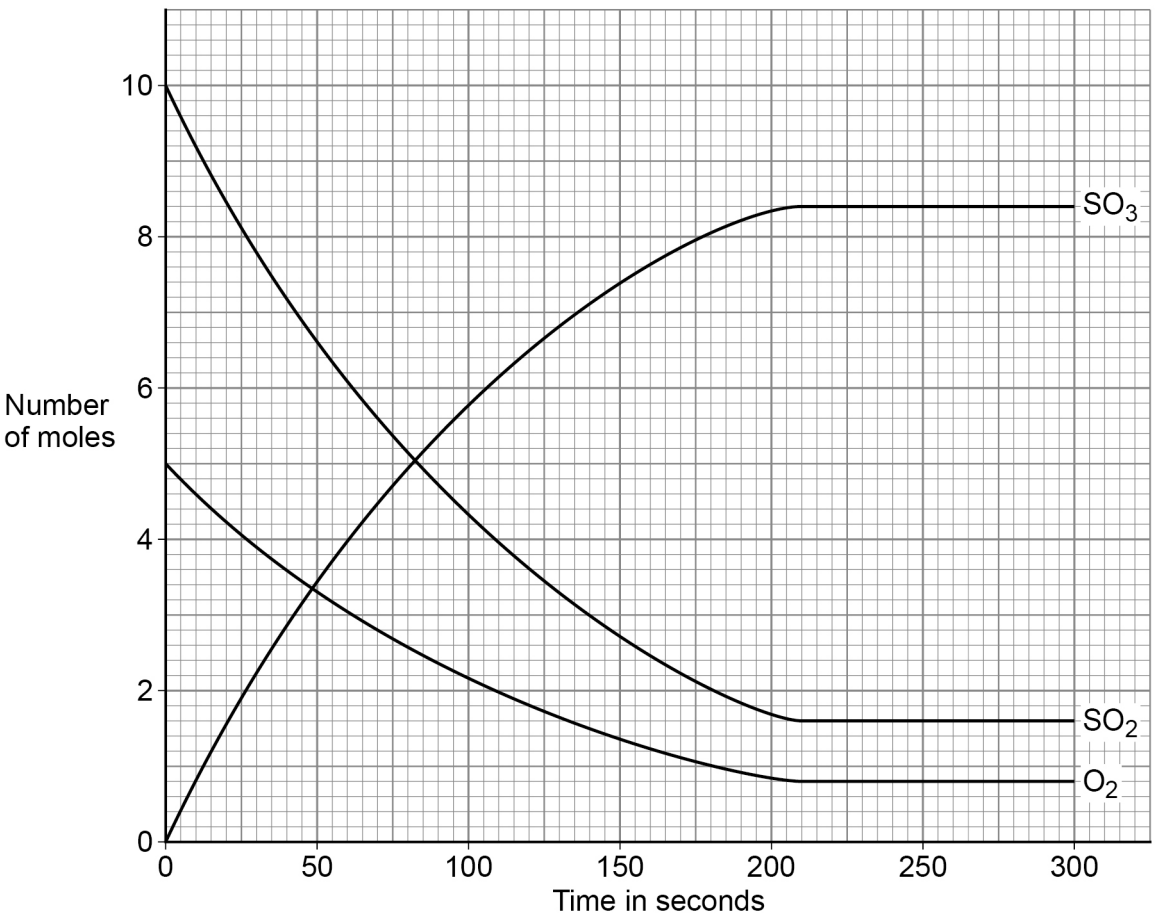
_____

Question 07 · 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



5.9.3.2 Properties and effects of atmospheric pollutants

Question 07 · 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 _____

_____

_____

_____

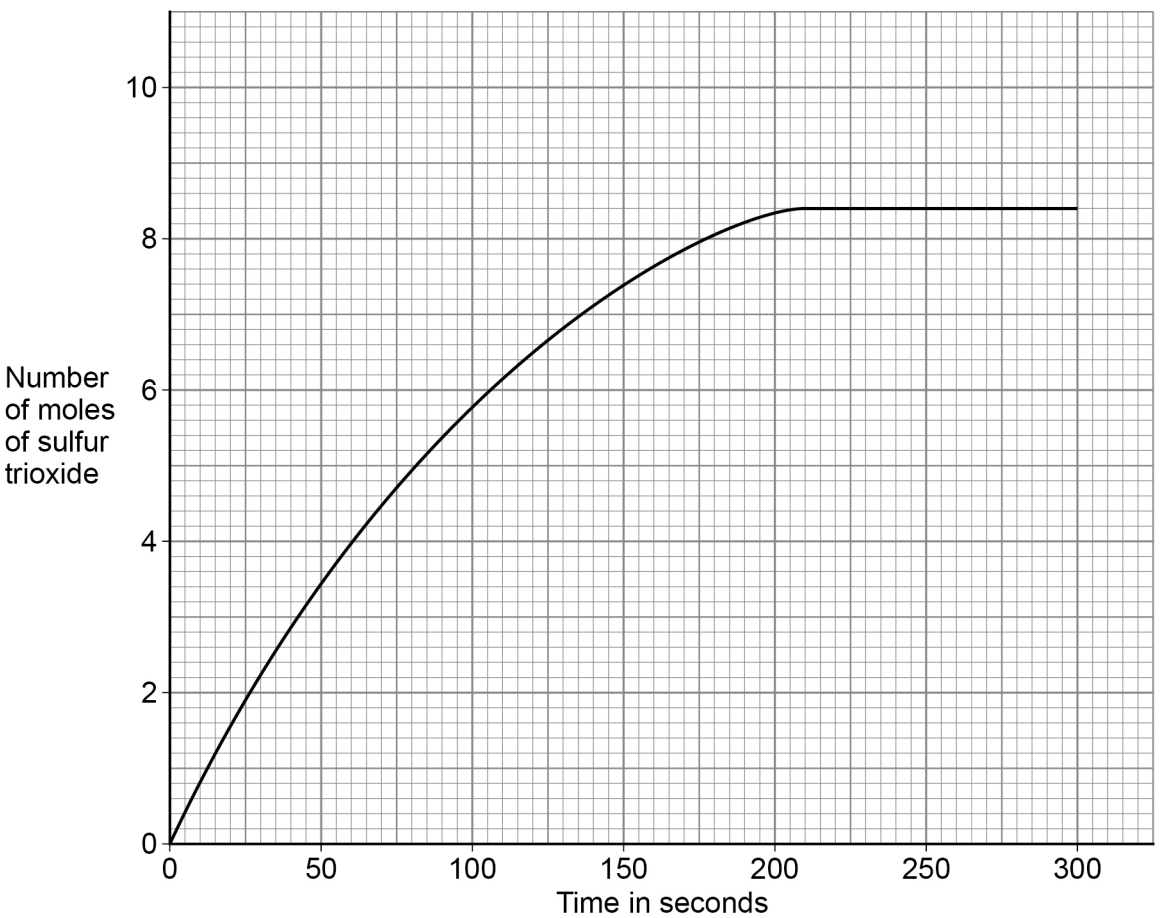
_____

Question 5 continues on the next page

Question 07 · continued

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

5.9.3.2 Properties and effects of atmospheric pollutants

Question 08

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

5.9.3.2 Properties and effects of atmospheric pollutants

Question 08 · 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

5.9.3.2 Properties and effects of atmospheric pollutants

Question 08 · 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

5.9.3.2 Properties and effects of atmospheric pollutants

Question 09

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

Question 09 · 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]

_____

5.9.3.2 Properties and effects of atmospheric pollutants

Question 09 · 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]

5.9.3.2 Properties and effects of atmospheric pollutants

Question 09 · 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