OCR
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Monday 29 November 2021 – Morning

GCSE (9–1) Combined Science (Chemistry) A (Gateway Science)

J250/10 Paper 10 (Higher Tier)

Time allowed: 1 hour 10 minutes

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You must have:
- a ruler (cm/mm)
- the Data Sheet for GCSE (9–1) Combined Science (Chemistry) A (inside this document)

You can use:
- a scientific or graphical calculator
- an HB pencil

J250107

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

Last name _____

INSTRUCTIONS
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

INFORMATION
- The total mark for this paper is **60**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **24** pages.

ADVICE
- Read each question carefully before you start your answer.

SECTION A

Answer **all** the questions.

You should spend a maximum of 20 minutes on this section.

Write your answer to each question in the box provided.

1 A copper ore contains 66.4% copper. The ore is CuS.

What is the maximum mass of copper that can be extracted from 500 tonnes of the ore?

A 7.53 tonnes

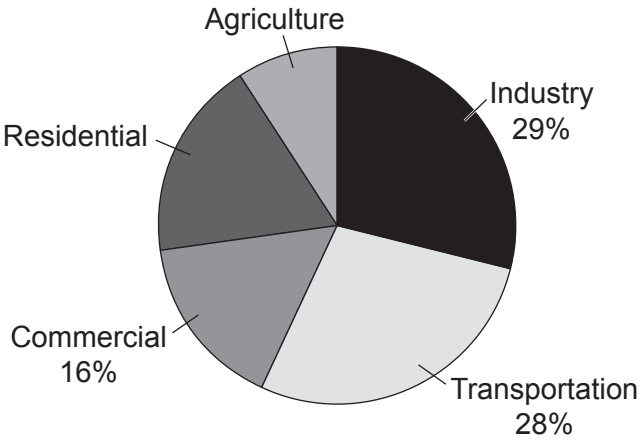
B 66.4 tonnes

C 332 tonnes

D 33 200 tonnes

Your answer ☐ **[1]**

2 The diagram shows the percentage of greenhouse gases made from different sources.



The percentage of greenhouse gases produced from Residential is **twice** that produced from Agriculture.

What is the percentage of greenhouse gases produced from Residential?

A 9%

B 18%

C 27%

D 36%

Your answer ☐ **[1]**

3 An aqueous solution of sodium chloride, NaCl, is electrolysed using inert electrodes.

Which product is formed at the cathode?

A Chlorine

B Hydrogen

C Oxygen

D Sodium

Your answer ☐ **[1]**

4 The table shows some information about the Group 7 elements.

Group 7 element	Melting point (°C)	Boiling point (°C)
fluorine	−220	−188
chlorine	−101	−34
bromine	−7	59
iodine	114	185

How many Group 7 elements are liquid at −40 °C?

A 0

B 1

C 2

D 3

Your answer ☐ **[1]**

5 Which row correctly shows a gas produced in a car engine and the problem it can cause?

	Gas produced by a car engine	Problem caused by the gas
A	Water vapor	Toxic to humans
B	Carbon monoxide	Lung disease
C	Methane	Breathing difficulties
D	Nitrogen dioxide	Acid rain

Your answer ☐ **[1]**

6 The table shows the composition of the atmosphere of four different planets.

Planet	Composition of the planet's atmosphere		
A	Carbon dioxide 96%	Nitrogen 3%	Other gases 1%
B	Hydrogen 80%	Helium 19%	Methane 1%
C	Nitrogen 97%	Methane 2.5%	Carbon monoxide 0.5%
D	Nitrogen 78%	Oxygen 21%	Other gases 1%

Which planet, **A**, **B**, **C** or **D**, has an atmosphere closest to the Earth's **early** atmosphere?

Your answer ☐ **[1]**

7 The alkanes are members of a **homologous** series.

Which statement does **not** explain why alkanes are a homologous series?

A They are hydrocarbons.

B They have the same general formula.

C They react in similar ways.

D They show trends in physical properties.

Your answer ☐ **[1]**

8 The equation shows the reaction for the cracking of the alkane $C_{15}H_{32}$.

$C_{15}H_{32} \longrightarrow 2C_2H_4 + C_8H_{18} + \mathbf{X}$

What is the formula of **X**?

A C_3H_6

B C_3H_8

C C_5H_{10}

D C_5H_{12}

Your answer ☐ **[1]**

9 Silver, Ag, does **not** react with dilute hydrochloric acid, HC*l*.

Which statement is the correct explanation for this?

A Silver forms negative ions less easily than chlorine.

B Silver forms negative ions more easily than chlorine.

C Silver forms positive ions less easily than hydrogen.

D Silver forms positive ions more easily than hydrogen.

Your answer ☐ **[1]**

10 Look at the equations.

$Na^+ + e- \longrightarrow Na$

$2Cl^- \longrightarrow Cl_2 + 2e-$

They show the two half equations that happen during the electrolysis of molten sodium chloride.

What is the correctly balanced equation for the electrolysis of molten sodium chloride?

A $Na^+ + 2Cl^- \longrightarrow Na + Cl_2$

B $Na^+ + 2Cl^- \longrightarrow NaCl_2$

C $2Na^+ + 2Cl^- \longrightarrow 2Na + Cl_2$

D $2Na^+ + 2Cl^- \longrightarrow 2NaCl$

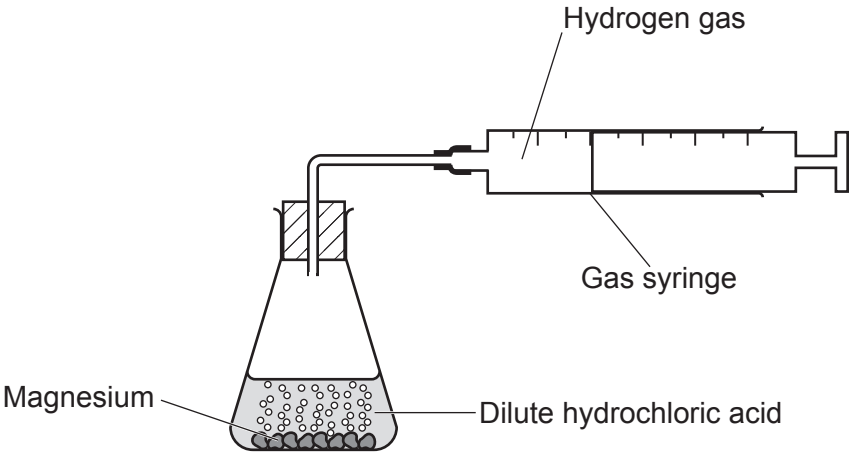
Your answer ☐ **[1]**

SECTION B

Answer **all** the questions.

11 A student investigates the rate of reaction between magnesium and an **excess** of dilute hydrochloric acid.

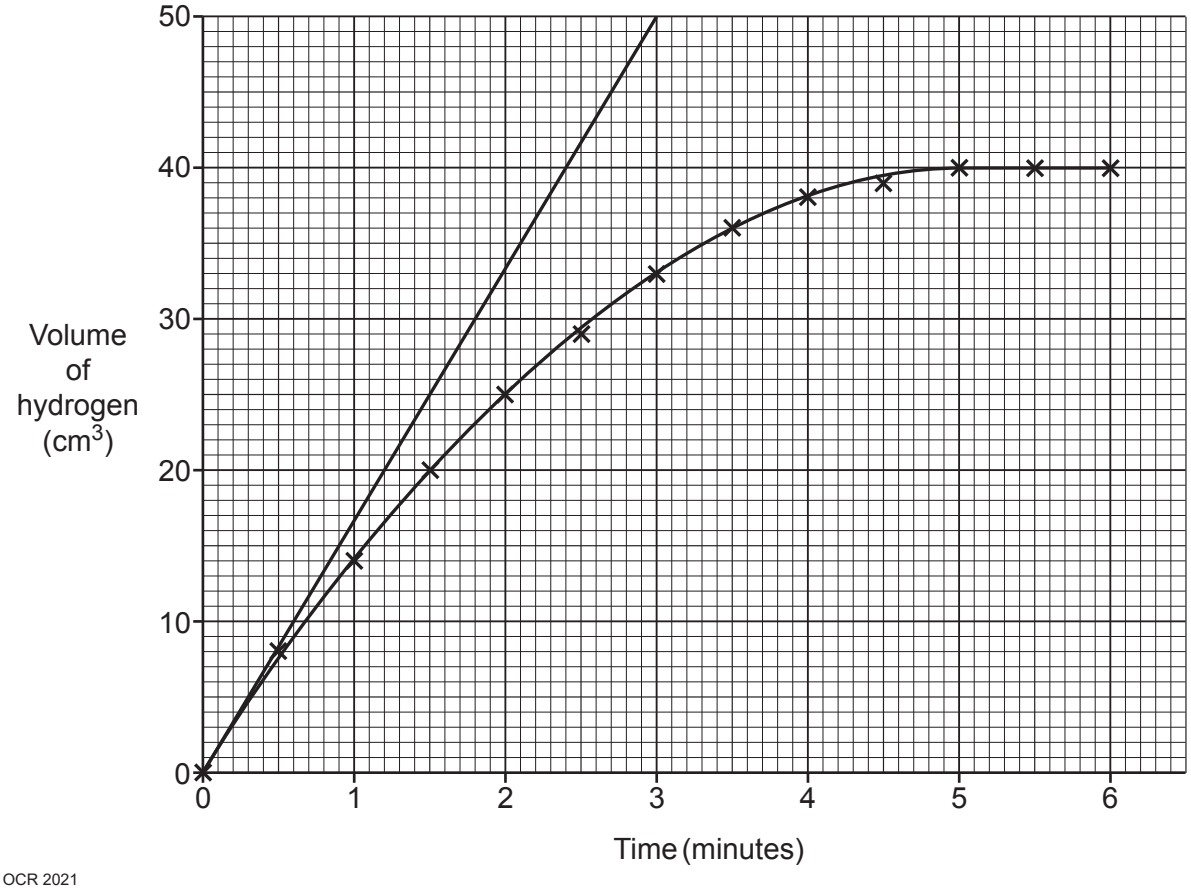
The diagram shows the equipment they use.



The student measures the total volume of hydrogen gas produced every 30 seconds.

The student plots a graph of their results.

They want to calculate the rate of reaction at the start of the reaction. They draw a tangent on the graph at the start of the reaction.



(a) The gradient of the tangent gives the rate of reaction. Use the tangent to calculate the rate of reaction at the start of the reaction.

Give your answer to **1** decimal place.

Rate of reaction = ... cm^3 / minute **[3]**

(b) What happens to the **rate of reaction** as the reaction progresses?

Explain your answer using ideas about particles and collisions.

.....

.....

.....

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

(c) Another student repeats the experiment.

They increase the concentration of the dilute hydrochloric acid. They keep everything else in the experiment the same.

(i) Does the gradient of the graph at the start of this student's reaction decrease, increase or stay the same compared to the first student's experiment?

Tick (✓) **one** box.

Decrease ☐

Increase ☐

Stay the same ☐

Give a reason for your answer.

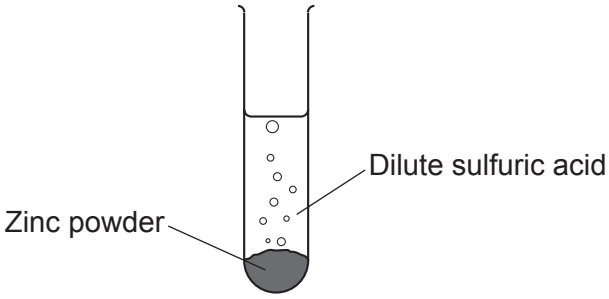
.....

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

(ii) Write down the volume of hydrogen gas that is produced at the end of this reaction.

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

12 A student investigates the reaction between zinc and dilute sulfuric acid.



The student observes that bubbles are produced slowly during the reaction.

They want to find a catalyst for the reaction. They repeat the experiment, but each time they add a small piece of a different metal, **R**, **S** and **T**.

Look at the student's results.

Metal	Appearance of metal at start of reaction	Observations
R	silvery-white	fast bubbling the silvery-white metal disappears
S	reddish-brown	fast bubbling the metal remains reddish-brown
T	dark grey	slow bubbling the metal remains dark grey

State if the metals, **R**, **S** and **T** are catalysts or not.

Explain your answers using the information in the table and your knowledge of catalysts.

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..... **[4]**

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13 A teacher demonstrates the reactions of the Group 1 metals with water.

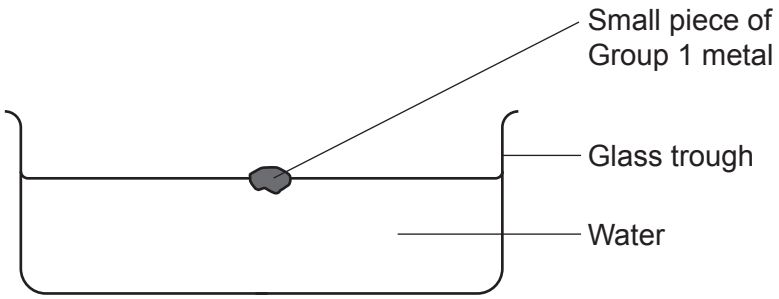


Table 13.1 shows information about how the first four elements in Group 1 react with water.

Element	Observations with cold water	Formulae of products
Lithium	Fizzes and moves slowly across the surface of the water.	LiOH(aq) $H_2(g)$
Sodium	Fizzes, melts into a silvery ball and moves quickly across the surface of the water.	NaOH(aq) $H_2(g)$
Potassium		KOH(aq) $H_2(g)$
Rubidium	Explodes with a white flame.	....

Table 13.1

(a) When potassium is added to cold water it melts and moves very quickly across the surface of the water.

Write down **one** other observation when potassium is added to cold water.

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

(b) Complete **Table 13.1** for rubidium. **[2]**

(c) Explain, in terms of electron loss or gain, the difference between lithium and sodium when they react with cold water.

.....

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

(d) **Table 13.2** shows the density of the Group 1 metals from lithium to caesium.

Group 1 metal	Density (g/cm^3)
lithium	0.53
sodium	0.97
potassium	0.86
rubidium	1.53
caesium	1.88

Table 13.2

Which Group 1 metal does not fit the general trend?

Explain your answer using information from **Table 13.2**.

.....

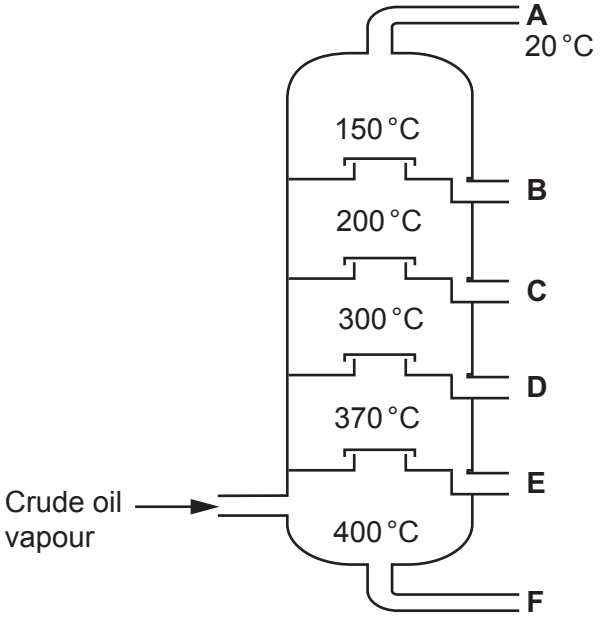
.....

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

14 Crude oil is a mixture of alkanes which can be separated into different fractions.

The different fractions have a range of different boiling points.

The diagram shows the process of fractional distillation.



(a) Explain how fractional distillation separates the crude oil into fractions.

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

(b) Icosane, $C_{20}H_{42}$, is an alkane found in one of the fractions.

It has a boiling point of 343 °C.

(i) Which fraction, **A**, **B**, **C**, **D**, **E** or **F**, contains icosane?

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

(ii) Icosane is converted into more useful products by cracking.

State the **two** conditions used for cracking.

1 .....

2 ..... **[1]**

(iii) Many different products can form when cracking icosane.

In one reaction, a molecule of icosane ($C_{20}H_{42}$) forms a molecule of hydrogen, H_2, and one other product.

Write the **balanced symbol** equation for this reaction.

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

(c)* Fraction **A** contains the alkanes methane, ethane, propane and butane.

Table 14.1 shows some information about these four alkanes.

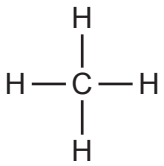
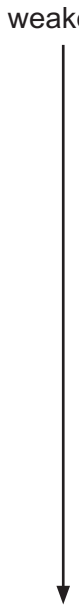
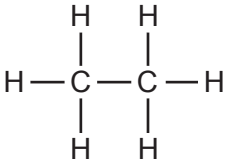
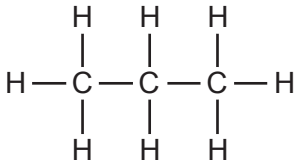
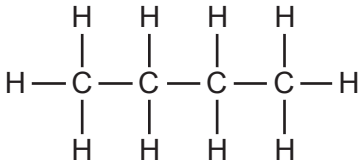
Alkane	Structure	Boiling point (°C)	Strength of the intermolecular forces
Methane		–162	
Ethane		–89	
Propane		–43	
Butane		–1	

Table 14.1

Describe and explain the similarities and differences in the boiling point of these four alkanes.

Use information in **Table 14.1** and your knowledge of structure and bonding in your answer.

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

15 Phytoextraction is a method of producing metals such as copper using plants which are harvested and burnt to produce an ash.

(a) The ash is reacted with sulfuric acid to produce a solution of copper(II) sulfate.

Copper can be extracted by adding iron to the solution of copper(II) sulfate.

Explain why.

.....

.....

.....

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

(b) 1 kg of plant ash can produce 2500 mg of copper.

Calculate the mass of ash (in kg) needed to produce 50 kg of copper.

1 kg = 1×10^6 mg

Mass of ash = ... kg **[2]**

(c) Describe one advantage **and** one disadvantage of producing copper by phytoextraction.

Advantage: .....

.....

Disadvantage: .....

.....

[2]

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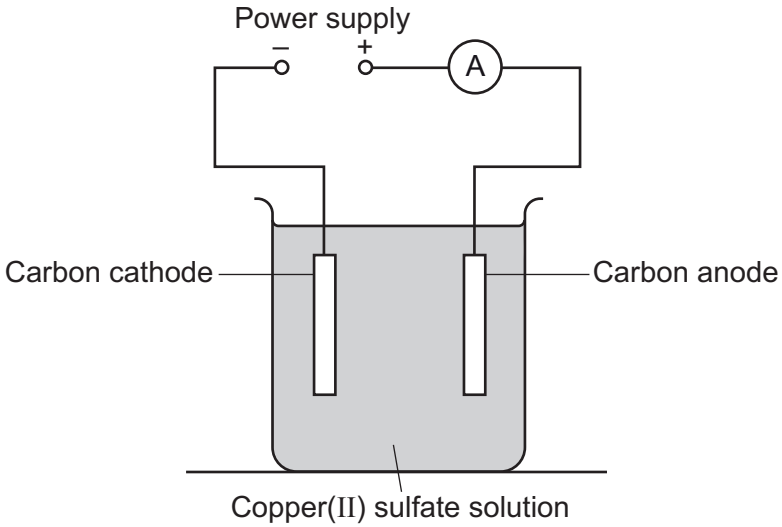
16 Copper can be produced from a copper(II) sulfate solution by electrolysis.

A student investigates how the mass of copper produced changes with the size of the current used during the electrolysis. The student varies the current used during electrolysis and investigates the mass of copper produced at the cathode.

The diagram shows the apparatus they use.

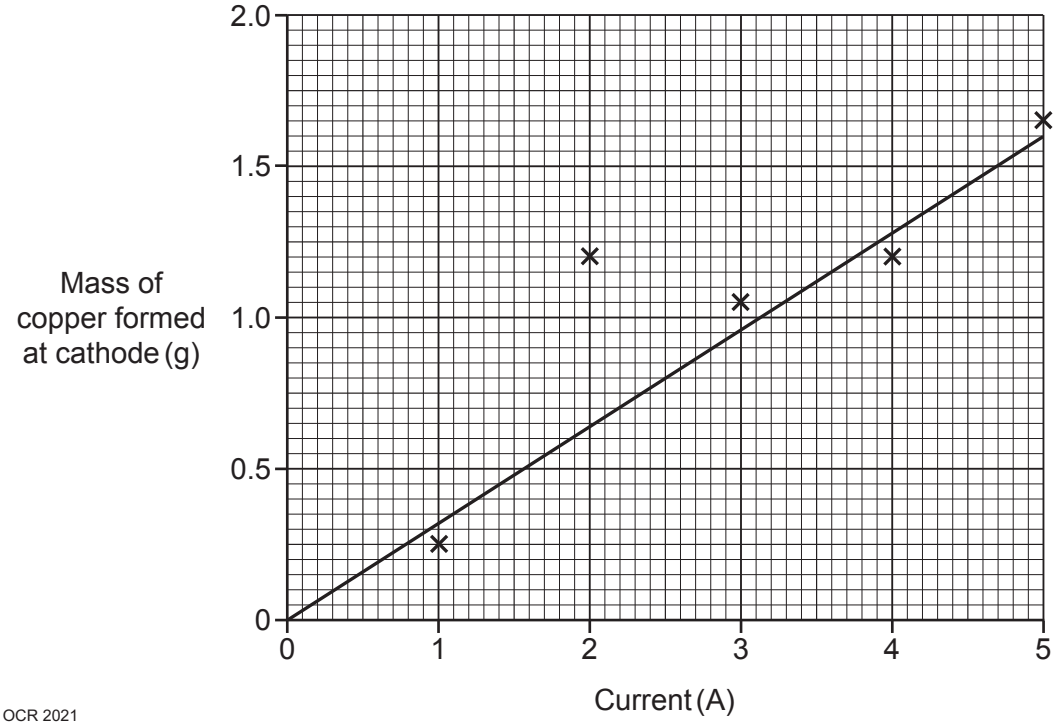


The student:

- Measures the mass of the dry cathode at the start of the experiment.
- Switches the power pack on for 10 minutes.
- Removes the cathode and washes it with water.
- Dries the cathode.
- Measures the mass of the cathode again.
- Calculates the mass of copper formed at the cathode.

The student repeats the experiment at different currents.

They plot a graph of their results.



(a) The copper(II) sulfate solution contains copper ions, Cu^{2+}.

Write the balanced **half equation** for the formation of copper at the cathode.

Include state symbols in the equation.

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

(b) Look at the graph.

(i) The student decides that the result for the mass of copper formed at the cathode at 2A is incorrect.

Give a reason for this result.

.....

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

(ii) Has the student drawn the correct line of best fit?

Give a reason for your answer.

.....

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

(iii) Explain how **repeating** the experiment could improve the accuracy of the results.

.....

.....

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

(c) Use the graph to calculate the mass of copper produced by a current of 15A.

Give your answer to **1** significant figure.

Mass of copper = ... g **[3]**

17 When a reversible reaction is left in a closed system, an equilibrium is reached.

(a) Look at the equation.

$2NO_2(g) \rightleftharpoons N_2O_4(g)$

It shows the equilibrium between $NO_2(g)$ and $N_2O_4(g)$.

(i) **Fig. 17.1** shows how the reaction rate of the forward and backward reactions change as the equilibrium is reached.

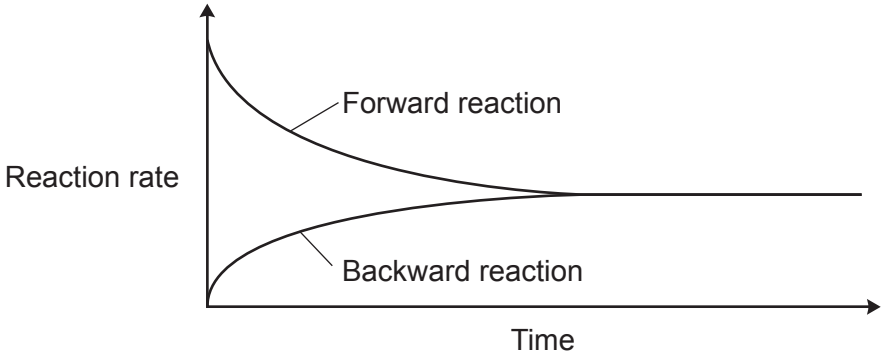


Fig. 17.1

Describe how **Fig. 17.1** shows that the equilibrium has been reached.

.....

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

(ii) **Fig. 17.2** shows how the concentrations of $NO_2(g)$ and $N_2O_4(g)$ change as the equilibrium is reached.

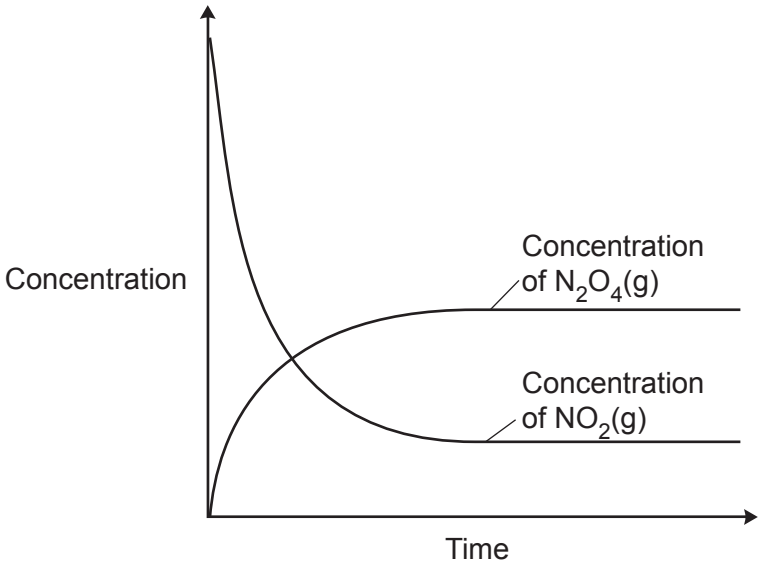


Fig. 17.2

Describe how **Fig. 17.2** shows that the equilibrium has been reached.

.....

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

(b) Each of the equations, **A**–**E**, shows a reversible reaction.

A $N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$ $\Delta H = +180\,kJ/mol$

B $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ $\Delta H = -196\,kJ/mol$

C $2HI(g) \rightleftharpoons H_2(g) + I_2(g)$ $\Delta H = +10\,kJ/mol$

D $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ $\Delta H = -92\,kJ/mol$

E $CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$ $\Delta H = +206\,kJ/mol$

ΔH shows the energy change of the **forward** reaction.

- If ΔH is negative the forward reaction is exothermic.
- If ΔH is positive the forward reaction is endothermic.

(i) Write the letter, **A**–**E**, of **one** equation where **more** product is formed when the temperature is decreased.

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

(ii) Write the letter, **A**–**E**, of **one** equation where the amount of product is **unchanged** when the pressure is increased.

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

(iii) Write the letter, **A**–**E**, of **one** equation where **more** product is formed when either the temperature is increased **or** when the pressure is decreased.

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

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).