OCR
Oxford Cambridge and RSA

Tuesday 13 June 2023 – 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

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

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

Write your answer to each question in the box provided.

1 Which reactions can be catalysed by an enzyme?

A Combustion reactions

B Electrolysis of metal ores

C Reactions in biological systems

D Reactions of metals with acids

Your answer ☐ **[1]**

2 Which row correctly describes the Group 0 elements?

	Physical state at 25 °C	**Reactivity**
A	gas	very reactive
B	gas	very unreactive
C	liquid	very reactive
D	liquid	very unreactive

Your answer ☐ **[1]**

3 A small piece of a Group 1 metal is added to a trough of water.

The metal floats, fizzes vigorously and melts to form a silvery ball.

Which Group 1 metal was added to the water?

A Lithium

B Potassium

C Rubidium

D Sodium

Your answer ☐ **[1]**

4 The equation shows a reaction of decane, $C_{10}H_{22}$, when it is heated with a catalyst.

$C_{10}H_{22} \rightarrow C_5H_{12} + C_3H_6 + C_2H_4$

What is the name of this process?

A Cracking

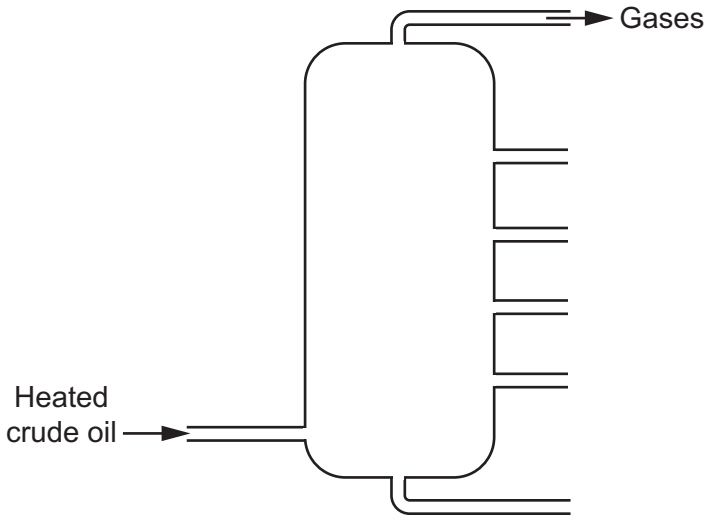
B Displacement

C Electrolysis

D Reduction

Your answer ☐ **[1]**

5 The diagram shows the fractional distillation of crude oil.



Which row in the table describes the Gases fraction?

	Size of molecules	Strength of intermolecular forces
A	large	strong
B	large	weak
C	small	strong
D	small	weak

Your answer ☐ **[1]**

6 What is the percentage change in sulfur dioxide emissions from 1970 to 2010?

Year	Sulfur dioxide emissions (million tonnes per year)
1970	141
2010	87

A 38%

B 54%

C 62%

D 162%

Your answer ☐ **[1]**

7 Iron, Fe, can be extracted from iron oxide, Fe_2O_3, in a blast furnace, by the reaction shown in the equation.

$Fe_2O_3 + 3\mathbf{X} \rightarrow 2Fe + 3\mathbf{Y}$

What are the formulae of **X** and **Y**?

	X	Y
A	C	CO_2
B	CO	C
C	CO	CO_2
D	CO_2	CO

Your answer ☐ **[1]**

8 When a solution of bromine, $Br_2(aq)$, is mixed with a solution of sodium chloride, $NaCl(aq)$, there is **no** reaction.

Why is there **no** reaction?

A Bromine gains electrons more easily than chlorine.

B Bromine loses protons more easily than chlorine.

C Chlorine gains electrons more easily than bromine.

D Chlorine loses protons more easily than bromine.

Your answer ☐ **[1]**

9 Which Group 7 element is most often added to tap water to make it potable?

A Bromine

B Chlorine

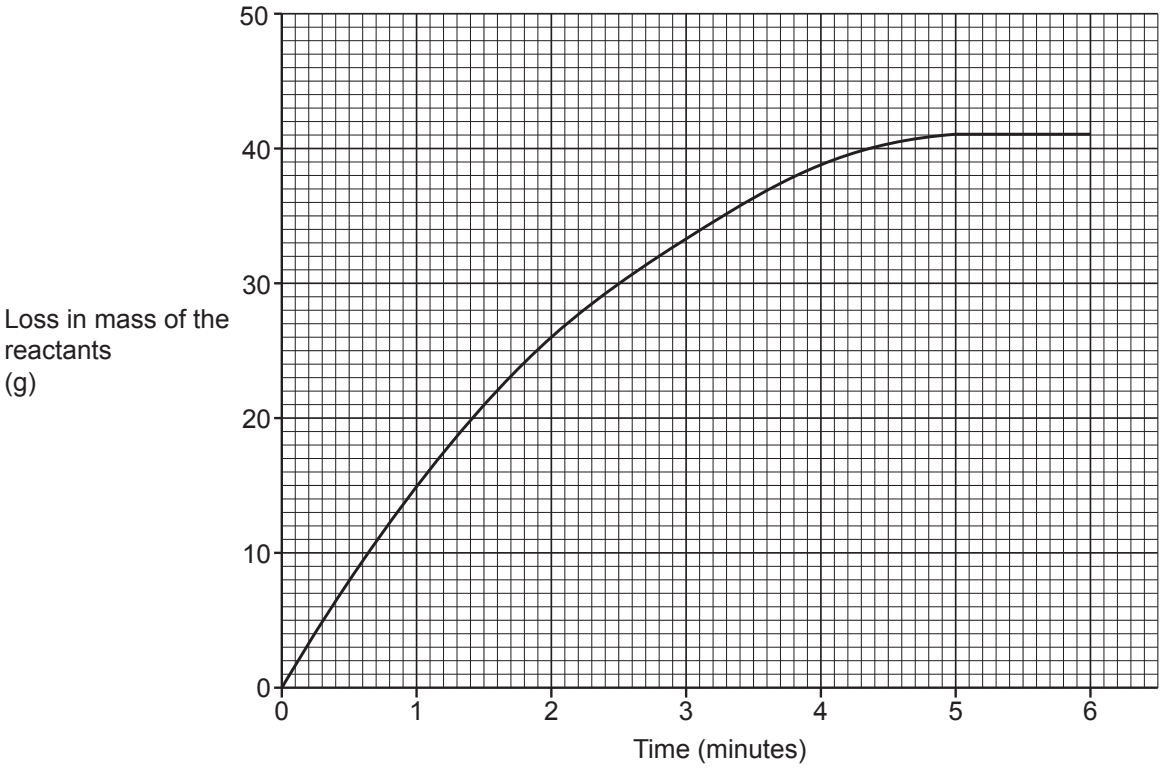
C Fluorine

D Iodine

Your answer ☐ **[1]**

10 When marble chips react with dilute hydrochloric acid, the mass of the reactants decreases.

The graph shows the loss in mass of the reactants with time.



What is the **correct formula** used to calculate the mean rate of reaction between 2 and 4 minutes?

A $\frac{2-4}{26-39}$

B $\frac{4-2}{39-26}$

C $\frac{26-39}{2-4}$

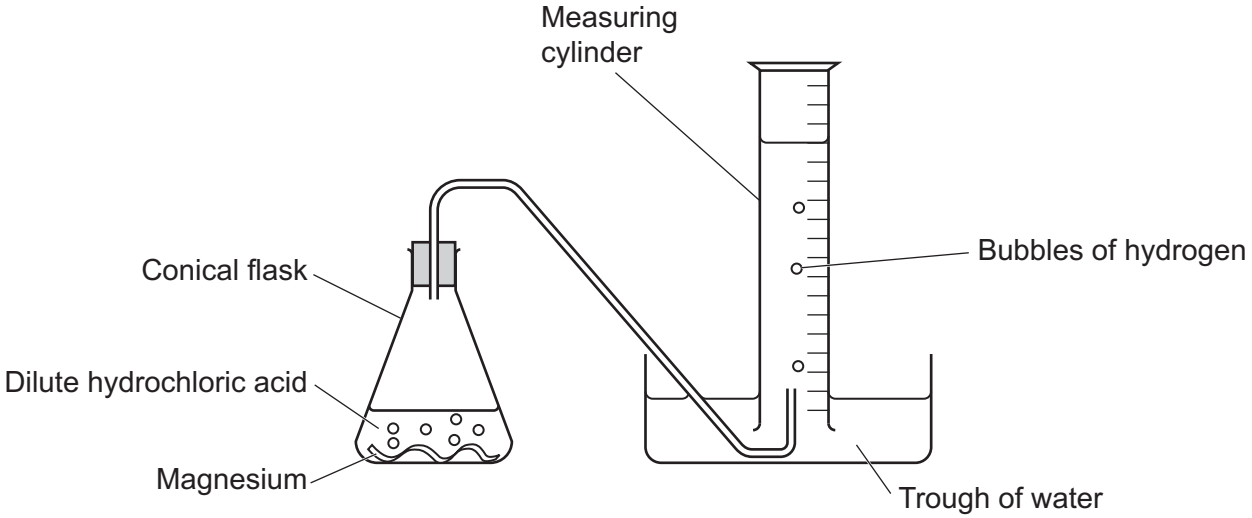
D $\frac{39-26}{4-2}$

Your answer ☐ **[1]**

Section B

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

The diagram shows the apparatus they use.

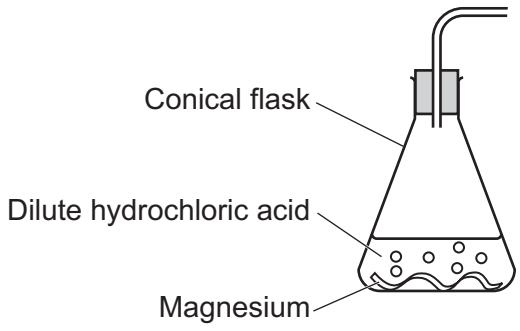


(a) The student has difficulty filling the measuring cylinder with water.

They change the measuring cylinder for a different piece of apparatus which allows them to measure the volume of hydrogen more accurately.

Name the piece of apparatus they use and complete the diagram below to show this apparatus.

Name of piece of apparatus .....



[3]

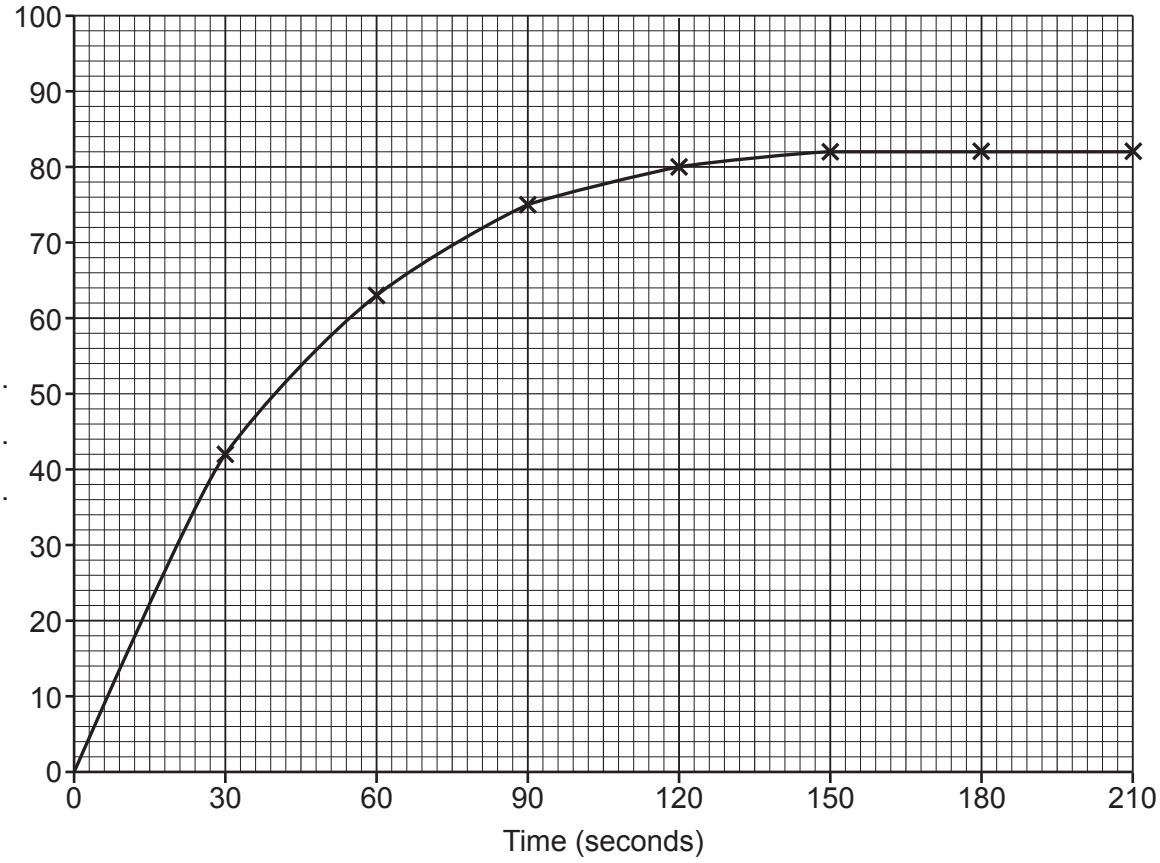
(b) Complete the **balanced symbol** equation for the reaction.

$$Mg(s) + 2HC\ell(.....) \rightarrow ..... (aq) + H_2(g)$$

[2]

(c) The student records the results of the experiment every 30 seconds. The graph shows the student's results.

Write the correct label, including the units, for the y-axis on the graph. **[2]**



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(d) The student repeats the experiment. The only difference is they use a **higher** concentration of acid.

Draw a line on the graph to show the results of this experiment. **[2]**

(e) If the experiment is repeated at a **higher** temperature, the rate of reaction increases.

Explain why. Use ideas about particles and collisions.

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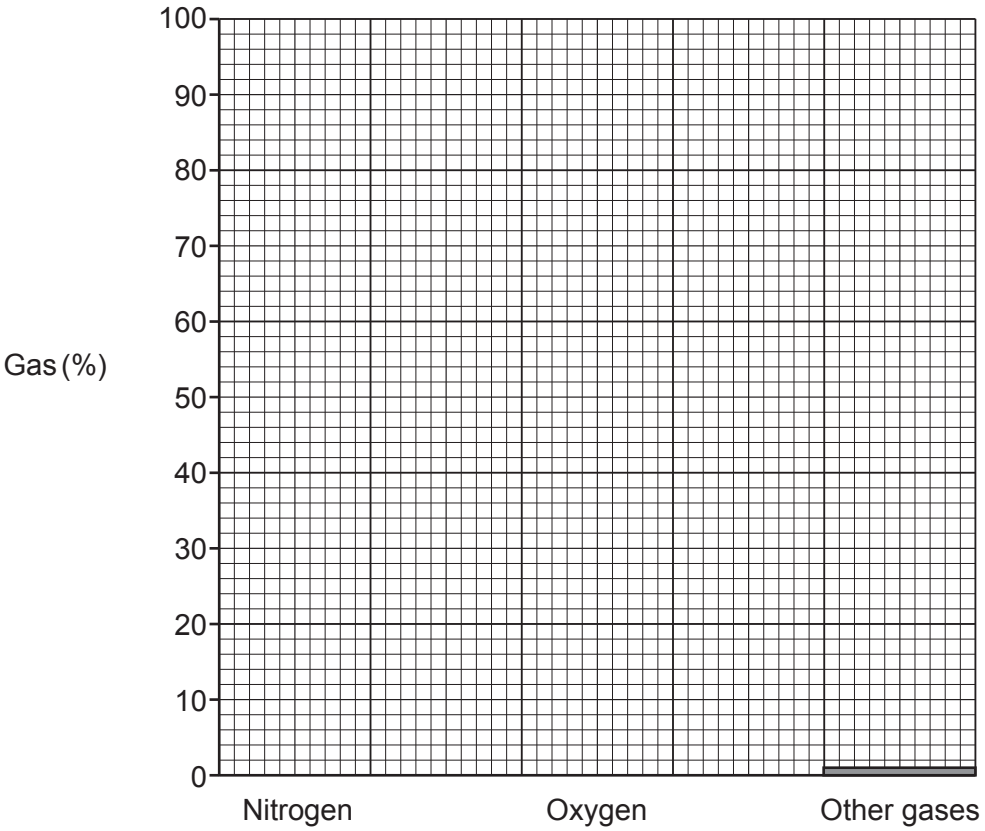
..... **[3]**

12 The Earth's early atmosphere was mainly water vapour and carbon dioxide.

The Earth's atmosphere today is mainly nitrogen and oxygen with small amounts of other gases including carbon dioxide.

(a) Complete the bar chart to show the percentage of nitrogen and oxygen found in the Earth's atmosphere today. **[2]**



(b) Explain how the amounts of water vapour and carbon dioxide in the Earth's early atmosphere decreased over time.

Water vapour .....

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Carbon dioxide .....

.....

[2]

(c) Explain how the amount of oxygen in the Earth's atmosphere has increased over time.

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

(d) The Earth's early atmosphere may have trapped more of the sun's heat than Earth's atmosphere traps today.

Give a reason why.

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

(e) The amount of carbon dioxide in the Earth's atmosphere is 409.8 parts per million.

1 part per million is equal to 0.0001%

Calculate the percentage of carbon dioxide in the Earth's atmosphere today.

Give your answer to **3** decimal places.

Percentage of carbon dioxide = ... % **[3]**

13 Copper can be extracted from its compounds by different processes.

(a)

Process 1

- Copper is extracted from copper oxide, CuO.
- The copper is extracted by heating copper oxide with carbon.

This is the equation for the reaction in **Process 1**.

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

(i) Explain why carbon can be used to extract copper from copper oxide.

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

(ii) One of the products of this reaction causes an environmental problem.

Identify the product and describe its impact on the environment.

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

(b)

Process 2

- Copper is extracted from copper sulfide, CuS.
- Solid copper sulfide is broken down by bacteria to form a solution of copper sulfate, $CuSO_4$.
- The copper is extracted from the solution of copper sulfate by either reacting it with iron or by electrolysis.

(i) Why is process 2 described as a **biological** method of metal extraction?

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

(ii) Describe **two** advantages of extracting copper from the solution of copper sulfate by reacting it with iron rather than using electrolysis.

1 .....

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2 .....

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[2]

(c) Ores are rocks that contain metals or their compounds.

The table shows some information about high-grade and low-grade ores.

Grade of ore	Mass of ore (kg)	Mass of metal in the ore (kg)
high	50	1.5
low	500	8.0

Explain the difference in the mass of metal contained in a high-grade and low-grade ore.

Use information from the table.

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

14* Magnesium, calcium and strontium are metals in Group 2 of the Periodic Table.

Tables 14.1 and **14.2** show some information about these metals.

Table 14.1

Reactions of the metals with cold water

Metal	Observations
Magnesium	• metal disappears very slowly • fizzes very slowly • forms a white solid
Calcium	• metal disappears slowly • fizzes slowly • forms a cloudy solution
Strontium	• metal disappears quickly • fizzes quickly • forms a colourless solution

Table 14.2

Energy required to form a 2+ ion

Metal	Energy required (kJ / mol)
Magnesium	2189
Calcium	1735
Strontium	1614

Barium is below strontium in Group 2.

Describe and explain the reactivity of barium.

Include observations of the reaction of barium with water.

Use information from **Tables 14.1** and **14.2**.

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

15 Iodine is an element in Group 7 of the Periodic Table.

Seaweed has small amounts of compounds containing iodine. It is possible to extract iodine from seaweed.

The diagram shows the stages in the extraction of iodine.

Stage 1	The seaweed is heated until an ash containing iodide ions is formed.
↓	
Stage 2	The ash is dissolved to form a solution, and the iodide ions are converted to iodine.
↓	
Stage 3	A purified solution of iodine is heated to leave solid iodine.

(a) In **Stage 1** iodide ions are produced by reduction.

Explain reduction in terms of electrons.

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

(b) In **Stage 2** iodide ions are oxidised to iodine.

Complete the **half-equation** for the oxidation of iodide ions into iodine.

$2I^- \rightarrow$ ..... **[2]**

(c) In **Stage 3** if the solution is heated for too long, iodine vapour is formed.

What colour is iodine vapour?

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

(d) 0.13 g of iodine is produced from 5.0 g of seaweed.

Calculate the percentage mass of iodine in the seaweed.

Percentage mass of iodine = ... % **[2]**

16 When a solution of yellow $Fe^{3+}(aq)$ ions is mixed with a solution of colourless $SCN^{-}(aq)$ ions they react to form a solution of red $FeSCN^{2+}(aq)$ ions.

This is an example of a **dynamic equilibrium**.

(a) Complete the equation for this reaction.

$$\underset{\text{yellow}}{Fe^{3+}(aq)} + \underset{\text{colourless}}{SCN^{-}(aq)} \quad \cdots\cdots\cdots \quad \underset{\text{red}}{FeSCN^{2+}(aq)}$$

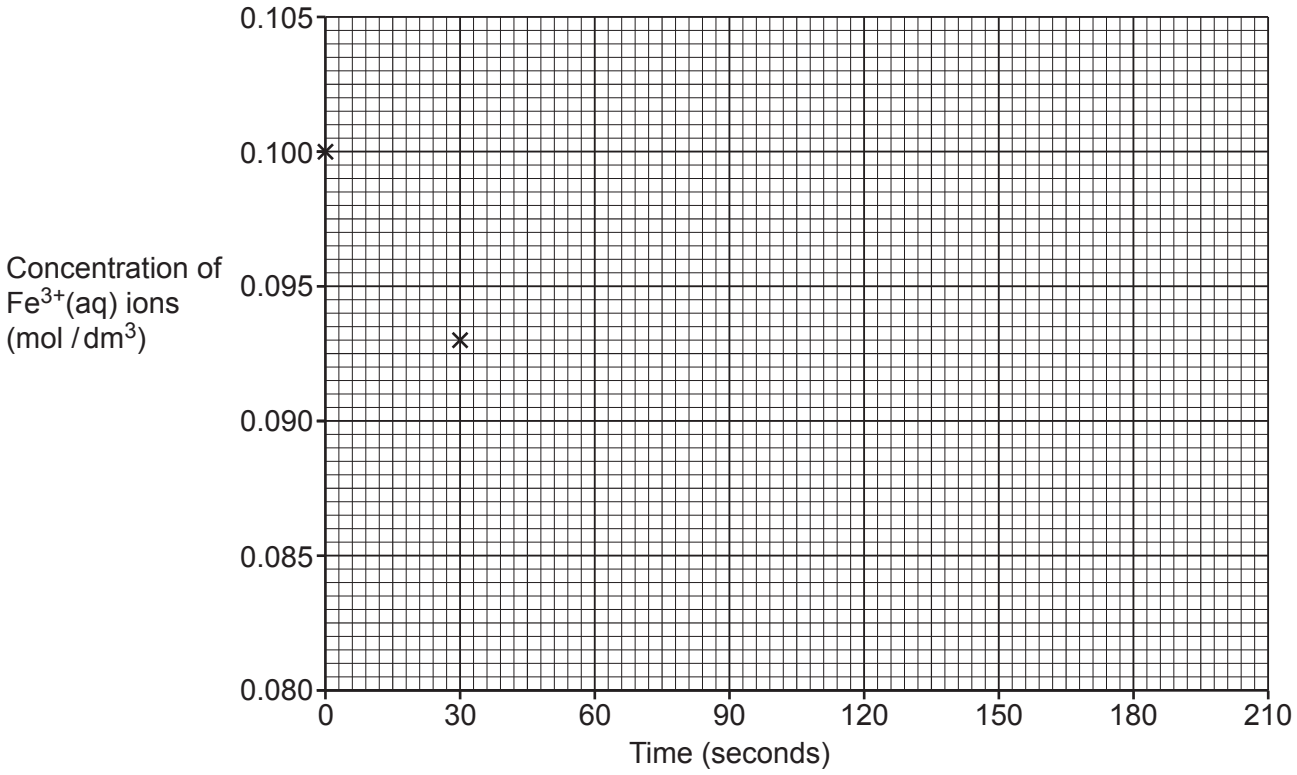
[1]

(b) The table shows how the concentration of $Fe^{3+}(aq)$ ions change when solutions of $Fe^{3+}(aq)$ ions and $SCN^{-}(aq)$ ions are mixed together.

Time (seconds)	0	30	60	90	120	150	180
Concentration of $Fe^{3+}(aq)$ ions (mol / dm^3)	0.100	0.093	0.087	0.083	0.081	0.081	0.081

(i) Plot the results from the table on the graph. Two points have already been plotted for you. **[2]**

(ii) Draw a line of best fit. **[1]**



(iii) What is the time it takes for the reaction to reach equilibrium?

Give a reason for your answer.

Time to reach equilibrium = ... seconds

Reason .....

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

(c) A student increases the concentration of $SCN^-(aq)$ ions in the mixture.

The mixture turns **darker red**.

Use Le Chatelier's principle to explain the change in colour.

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

(d) The student thinks that the forward reaction shown in **(a)** for the equilibrium is **exothermic**.

Describe what the student should do to the equilibrium mixture to show that the forward reaction is exothermic.

Predict the student's observations.

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

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).