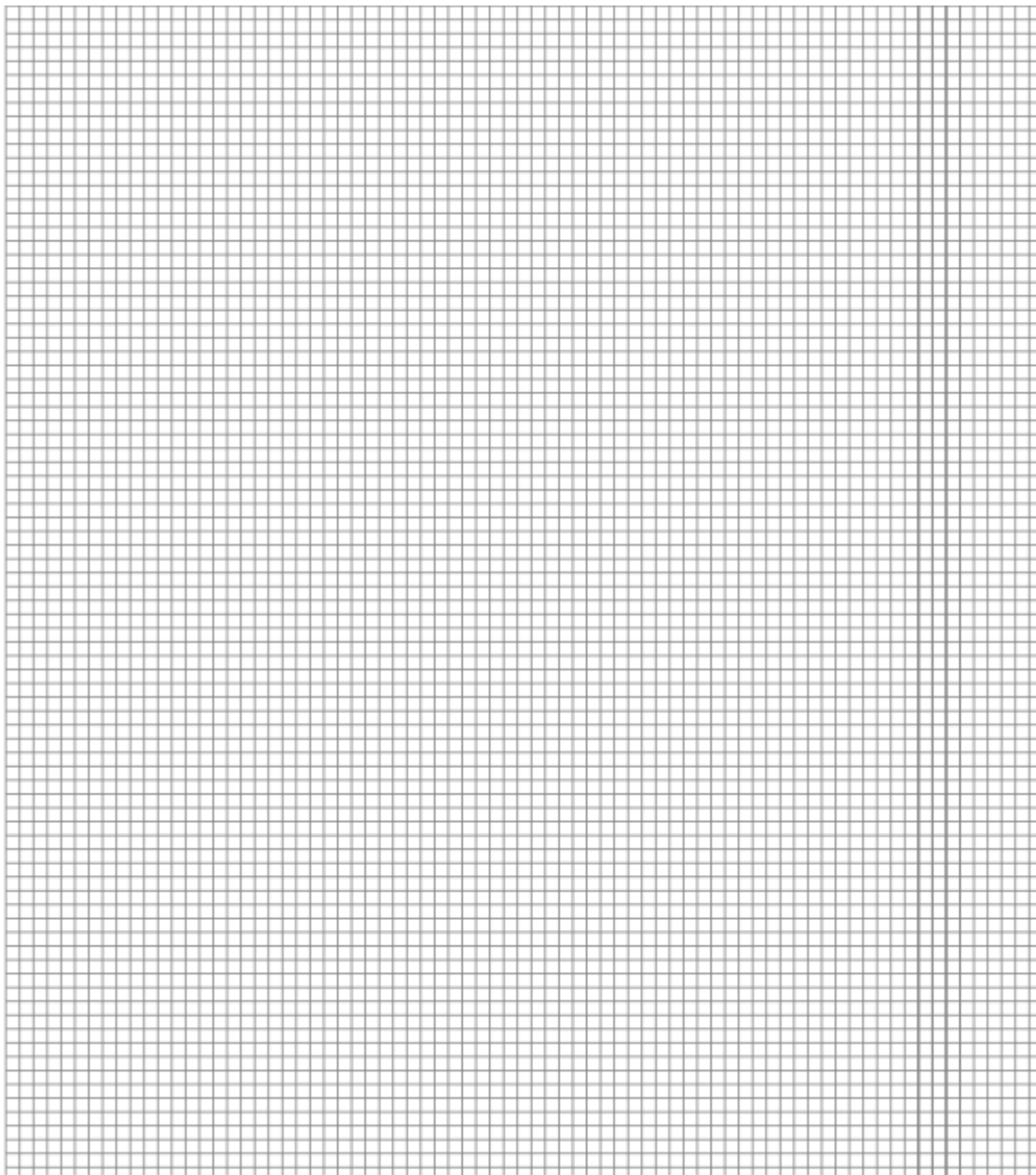


- Q1.(a)** The concentration of iron(III) ions in a dilute solution can be determined by visible spectrometry. The absorption of light by a number of solutions of iron(III) sulfate,  $\text{Fe}_2(\text{SO}_4)_3(\text{aq})$ , was measured. The results are shown in the table below.

<b>Concentration of <math>\text{Fe}_2(\text{SO}_4)_3(\text{aq})</math> / mol dm<sup>-3</sup></b>	<b>Absorbance / %</b>
0.020	2.2
0.040	4.7
0.060	7.0
0.080	9.4
0.100	11.8

- (i) Use these results to plot a graph of percentage absorbance (*y*-axis) against concentration of iron(III) sulfate solution on the grid below. Draw a straight line of best fit.



(2)

- (ii) Use your graph to determine the concentration of iron(III) ions in a solution of  $\text{Fe}_2(\text{SO}_4)_3$  that has an absorbance of 5.4%.

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(2)

- (iii) Calculate the volume of water that should be added to 100 cm<sup>3</sup> of a 0.10 mol dm<sup>-3</sup> solution of iron(III) sulfate to make a 0.040 mol dm<sup>-3</sup> solution. Show your working.

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(2)

- (b) Give **one** reason why well-water may be more beneficial to health than pure water.

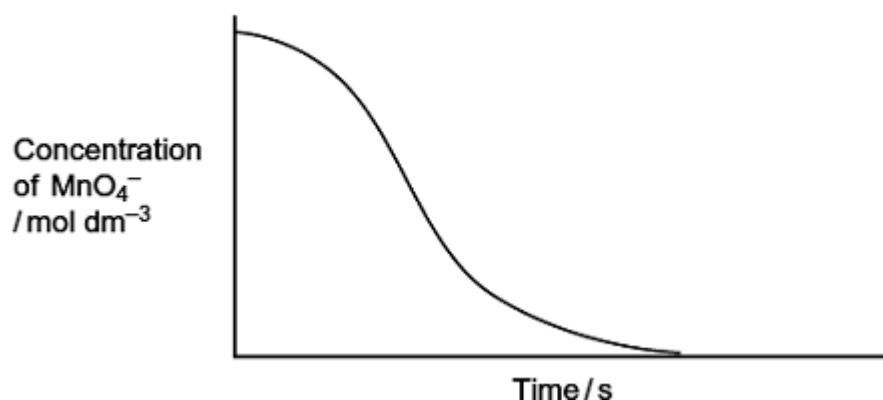
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(1)

(Total 7 marks)

**Q2.** An acidified solution of potassium manganate(VII) was reacted with a sample of sodium ethanedioate at a constant temperature of 60 °C. The concentration of the manganate(VII) ions in the reaction mixture was determined at different times using a spectrometer to measure the light absorbed.

The following results were obtained.



- (a) Write an equation for the reaction between manganate(VII) ions and ethanedioate ions in acidic solution.

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(Extra space) .....  
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(2)

(b) By considering the properties of the reactants and products, state why it is possible to use a spectrometer to measure the concentration of the manganate(VII) ions in this reaction mixture.

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(2)

(c) This reaction is autocatalysed. Give the meaning of the term *autocatalyst*. Explain how the above curve indicates clearly that the reaction is autocatalysed.

Meaning of *autocatalyst* .....

.....

Explanation .....

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(3)

(d) Identify the autocatalyst in this reaction.

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(1)

(e) Write **two** equations to show how the autocatalyst is involved in this reaction.

Equation 1 .....

Equation 2 .....

(2)  
(Total 10 marks)

**Q3.** This question is about copper chemistry.

(a) Aqueous copper(II) ions  $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}(\text{aq})$  are blue.

(i) With reference to electrons, explain why aqueous copper(II) ions are blue.

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(3)

(ii) By reference to aqueous copper(II) ions, state the meaning of each of the **three** terms in the equation  $\Delta E = h\nu$ .

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(3)

- (iii) Write an equation for the reaction, in aqueous solution, between  $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$  and an excess of chloride ions.  
State the shape of the complex produced and explain why the shape differs from that of the  $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$  ion.

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(3)

- (b) Draw the structure of the ethanedioate ion ( $\text{C}_2\text{O}_4^{2-}$ ).  
Explain how this ion is able to act as a ligand.

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(2)

(c) When a dilute aqueous solution containing ethanedioate ions is added to a solution containing aqueous copper(II) ions, a substitution reaction occurs. In this reaction four water molecules are replaced and a new complex is formed.

(i) Write an ionic equation for the reaction. Give the co-ordination number of the complex formed and name its shape.

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(4)

(ii) In the complex formed, the two water molecules are opposite each other. Draw a diagram to show how the ethanedioate ions are bonded to a copper ion and give a value for one of the O–Cu–O bond angles. You are **not** required to show the water molecules.

(2)

(Total 17 marks)

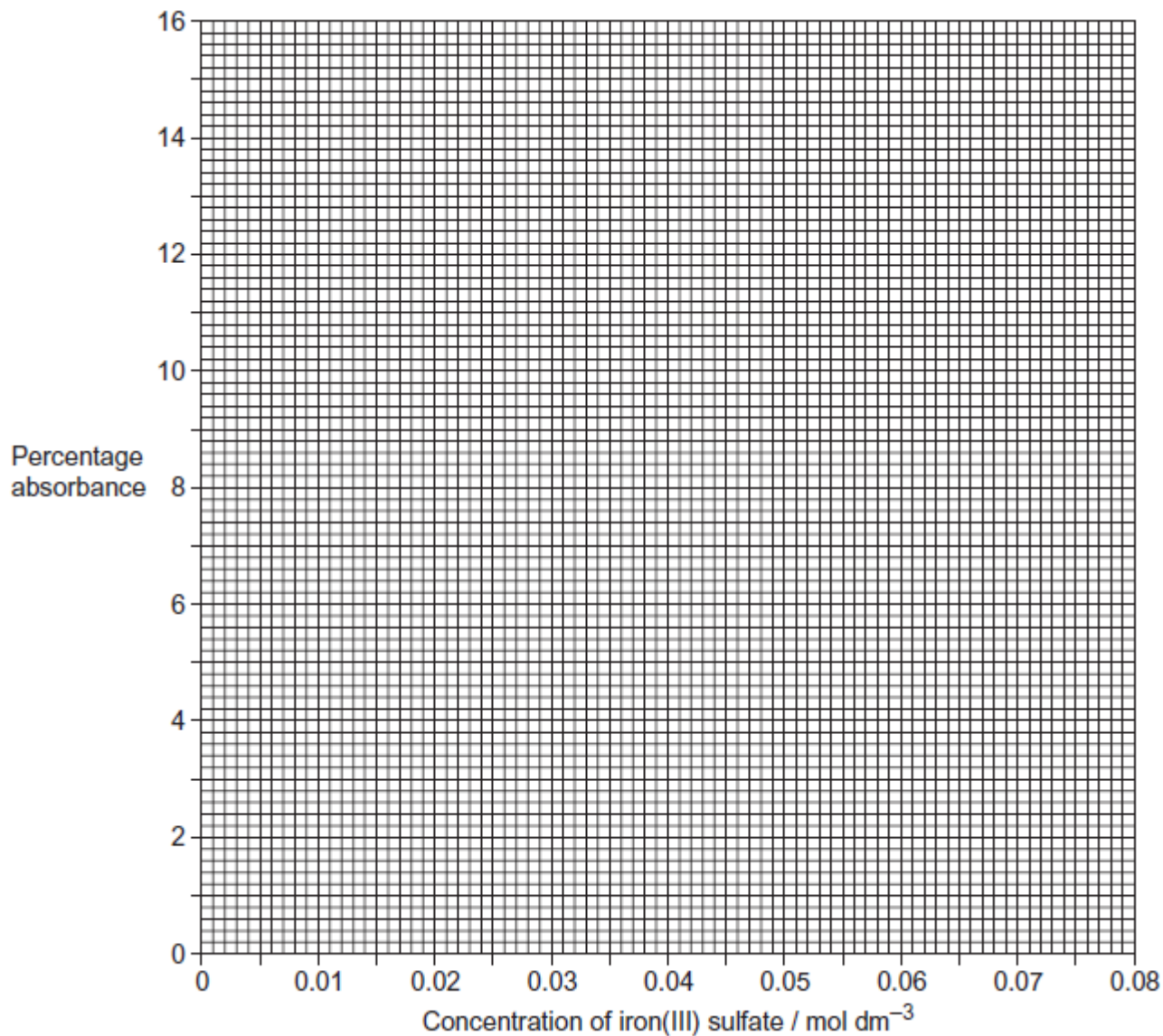
**Q4.** The concentration of iron(III) ions in a dilute solution can be determined by visible spectrometry. The absorption of light of a particular frequency by solutions of iron(III) sulfate of different concentrations was measured. The results are shown in the table

below.

Percentage absorbance	Concentration of iron(III) sulfate / mol dm <sup>-3</sup>
1.0	$7.5 \times 10^{-3}$
2.5	$14.0 \times 10^{-3}$
5.0	$27.5 \times 10^{-3}$
7.0	$37.5 \times 10^{-3}$
10.0	$54.0 \times 10^{-3}$
12.0	$65.0 \times 10^{-3}$

- (a) Use these results to plot a graph of percentage absorbance (*y*-axis) against concentration of iron(III) sulfate on the grid below. Draw a straight line of best fit.





(2)

- (b) Use your graph to determine the concentration of an iron(III) sulfate solution that has a percentage absorbance of 14.0%.

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(1)

(Total 3 marks)