

PART 3 (42 marks = % of the paper)

Answer ALL questions in Part 3. The calculations are to be set out in detail in this Question/Answer Booklet. Marks will be allocated for correct answers and clear setting out, even if you cannot complete the problem. When questions are divided into sections, clearly distinguish each section using (a), (b) and so on. **Express your final numerical answers to three (3) significant figures or as appropriate to the question, and provide units where applicable.** Information which may be necessary for solving the problems is located on the separate Chemistry Data Sheet. Show clear reasoning: if you don't, you will lose marks.

1. A sample of 5.318 g of a chlorofluorocarbon (a compound containing carbon, fluorine and chlorine only) was analysed as follows:

All the carbon in the sample was converted into carbon dioxide gas, and all its chlorine was converted into hydrochloric acid. The carbon dioxide weighed 1.703 g, and the hydrochloric acid formed required 56.6 mL of 2.052 mol L⁻¹ ammonia solution for complete neutralisation.

A second sample of the same chlorofluorocarbon of mass 1.542 g occupied 0.2516 L at 104.3 kPa and 17.63°C .

- (a) Determine the empirical formula of the compound. [8 marks]

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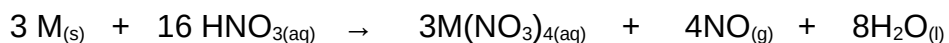
(b) Determine the molecular formula of the compound.

[2 marks]

[illegible]

2. Nitric acid reacts with metals differently than other acids, but still reacts as 'normal' when mixed with a base.

A 2.972 g sample of an unknown metallic element (M) was dissolved in 125.0 mL of 2.107 mol L⁻¹ HNO_{3(aq)}. The reaction produced a soluble salt with the formula M(NO₃)₄.

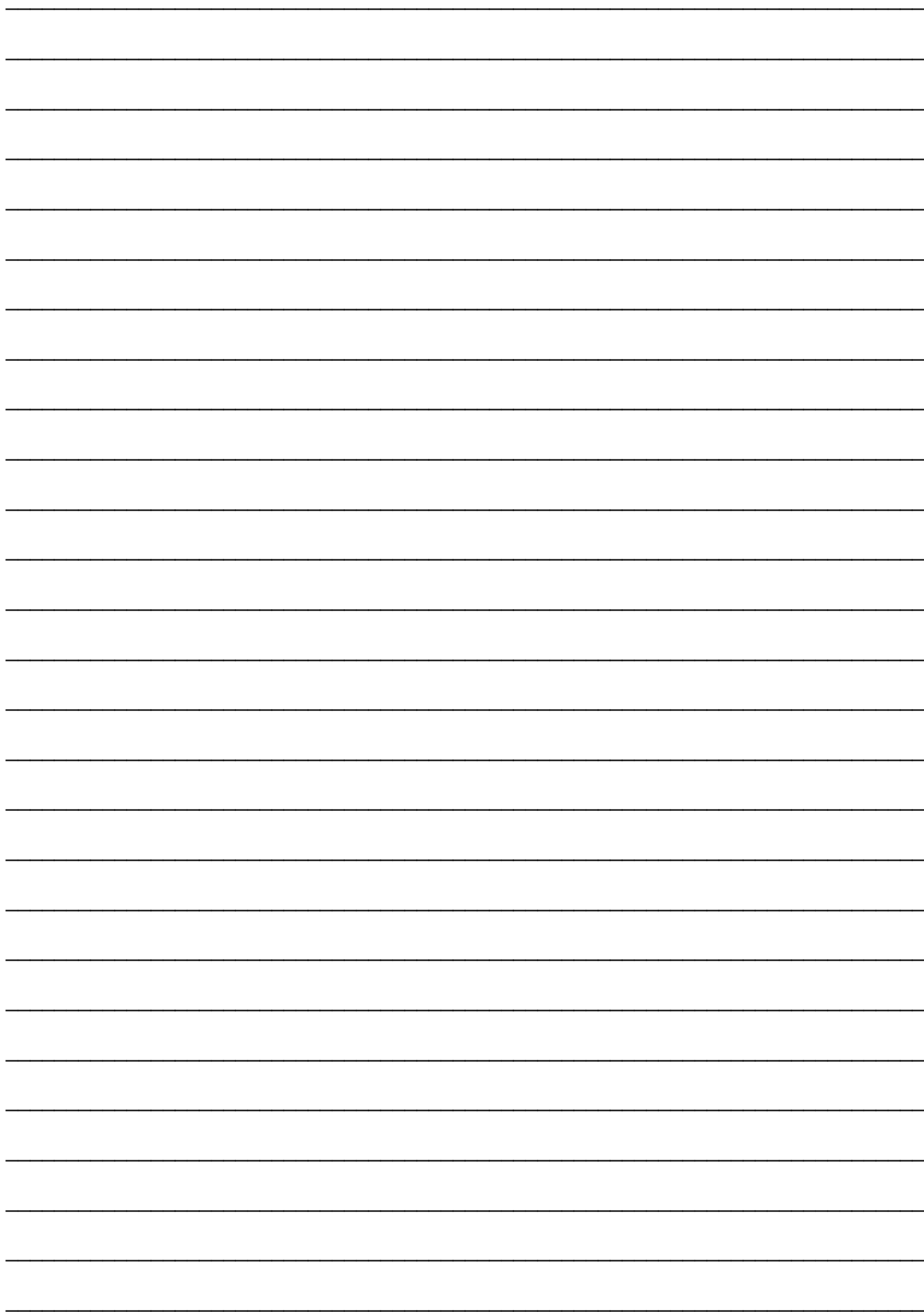


The remaining solution which was known to contain excess HNO_3 was diluted to 250.0 mL. A 20.00 mL sample of the diluted solution containing excess HNO_3 was titrated to equivalence using 32.95 mL of $0.3152 \text{ mol L}^{-1} \text{ NaOH}$.

Using the above equation, calculate the molar mass of the metal, and hence identify the metal element.

[10 marks]

[illegible]



[6 marks]

[illegible]

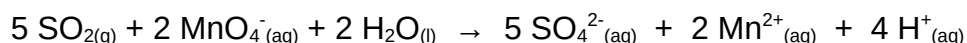
You are given standard solutions of $0.1000 \text{ mol L}^{-1} \text{ NaOH}$ and $0.10000 \text{ mol L}^{-1} \text{ HCl}$.

- (b) Select the appropriate standard solution, and calculate the volume required to neutralise a 20mL sample of the original solution.

[6 marks]

[illegible]

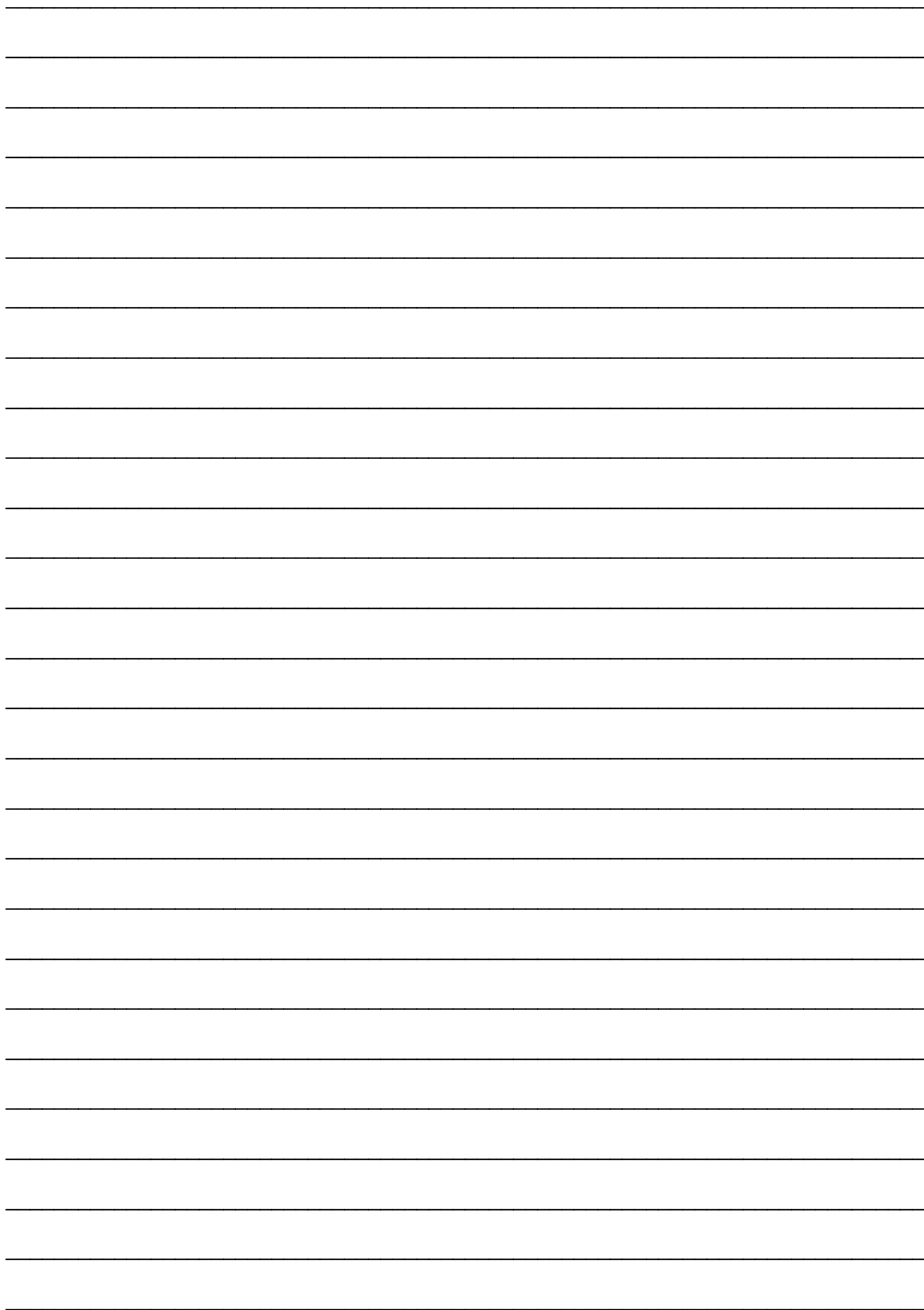
4. The concentration of the atmospheric pollutant sulphur dioxide (SO_2) can be found by bubbling are through a dilute KMnO_4 solution of known concentration.

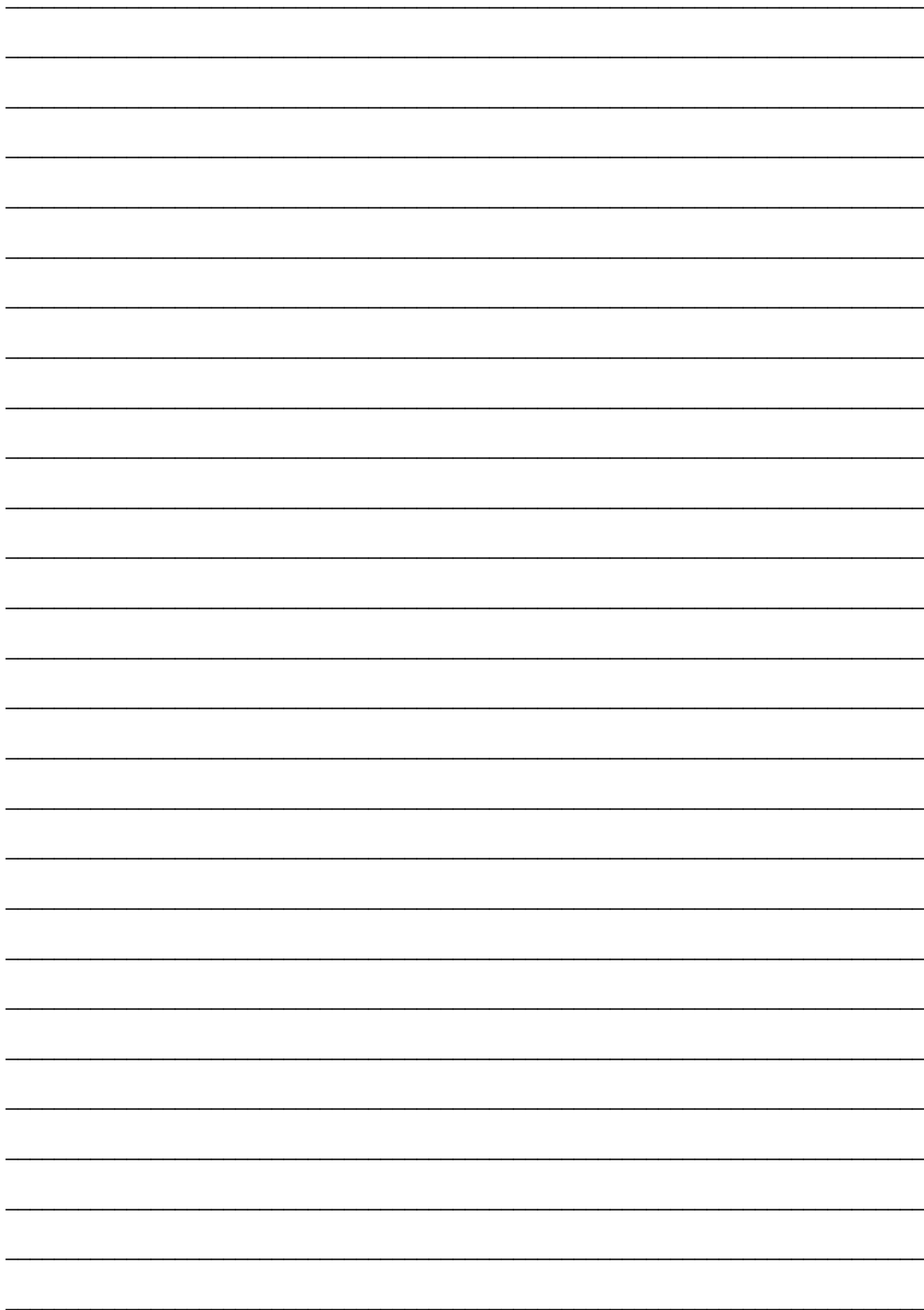


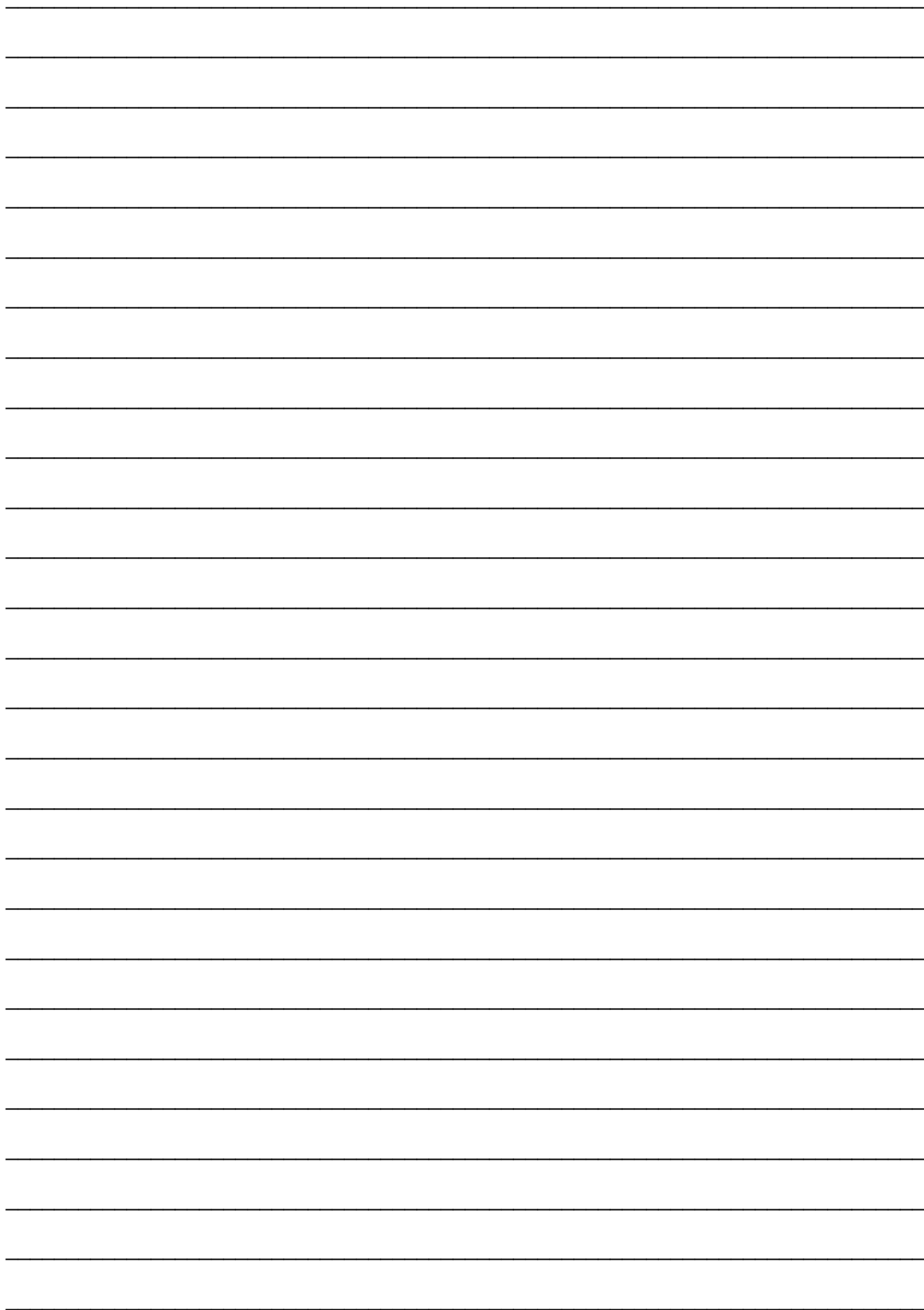
The concentration of the remaining KMnO_4 can be found by titration with standardised oxalic acid. This allows the amount of KMnO_4 reacting with sulphur dioxide to be found and thus its concentration in the air sample can be calculated. In such a procedure 51.802 kg of SO_2 polluted air was bubbled through 215.0 mL of $5.007 \times 10^{-3} \text{ mol L}^{-1}$ KMnO_4 . The unreacted KMnO_4 was acidified and diluted to a volume of 250.0 mL. 20.00 mL samples of this diluted KMnO_4 solution were titrated to equivalence with 38.50 mL of $2.194 \times 10^{-3} \text{ mol L}^{-1}$ oxalic acid solution. What is the concentration of the $\text{SO}_{2(g)}$ in ppm.

[12 marks]

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