

Iron by thiocyanate assay

Student worksheet

Principle

Iron(III) ions in solution react with thiocyanate ions to form an intense red coloured complex ion:



or, more fully, $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}(\text{aq}) + \text{SCN}^{-}(\text{aq}) \rightarrow [\text{Fe}(\text{H}_2\text{O})_5\text{SCN}]^{2+}(\text{aq}) + \text{H}_2\text{O}(\text{l})$

You can use this reaction for the quantitative analysis of low concentrations of $\text{Fe}^{3+}(\text{aq})$ in solution. You can find the concentration of the solution of Fe^{3+} using a colorimeter. You can also use simple colour matching although the results will be less precise.

Equipment and materials

- burettes x 3 (for greater accuracy, graduated pipettes could be used)
- 10 cm³ pipette
- 100 cm³ beaker x 7
- colorimeter and suitable filter (blue) A solution of the complex displays maximum absorption at 480 nm
- iron(III) ammonium sulfate solution containing 0.050 g dm⁻³ Fe³⁺ (50 ppm) (15 cm³)
- ammonium thiocyanate solution, 1 mol dm⁻³ (70 cm³)
- solution of unknown Fe³⁺ concentration (10 cm³)

Method

Care: Wear eye protection.

1. Fill three burettes, one with the iron(III) solution (50 ppm Fe³⁺), one with distilled or deionised water and one with 1 mol dm⁻³ ammonium thiocyanate solution.
2. Label six 50 or 100 cm³ beakers A to F and use the burettes to add the volumes of solutions shown in the table:

Beaker	A	B	C	D	E	F
Volume of iron(III) solution (50 ppm Fe ³⁺) / cm ³	5.0	4.0	3.0	2.0	1.0	0.0
Volume of water/cm ³	5.0	6.0	7.0	8.0	9.0	10.0
ppm iron	25	20	15	10	5	0

3. Add 10.0 cm³ of 1 mol dm⁻³ ammonium thiocyanate solution and 10 cm³ of water to each beaker, stir and leave to stand for 15 minutes.
4. Measure the absorbance of each solution. If the colour of the solutions is too intense for the colorimeter to measure, dilute the solution by adding more water to the beakers from the burette and measure the absorbance of the diluted solutions.
5. Plot a graph of absorbance (y axis) against Fe³⁺(aq) concentration (in ppm iron) (x axis) for beakers A-F.
6. Using a pipette, add 10 cm³ of the iron(III) solution of unknown Fe³⁺ concentration to a beaker. Add 10.0 cm³ of 1 mol dm⁻³ ammonium thiocyanate solution and 10 cm³ of water to the beaker, stir and leave to stand for 15 minutes.

7. Measure the absorbance of the solution made up using the iron(III) solution whose concentration is unknown.
8. Use the graph to find the concentration of $\text{Fe}^{3+}(\text{aq})$ as ppm iron in the unknown solution.