

The chemistry of thiosulfate ions – teacher notes

Topic

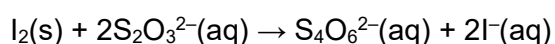
Redox reactions; transition elements – redox reactions, catalysis, variable oxidation states.

Timing

20 minutes

Description

Sixth-form students usually encounter sodium thiosulphate in volumetric analysis where it is used as the titrant in a redox reaction with iodine:



However, in this experiment students investigate some of the many interesting reactions of sodium thiosulphate. These reactions illustrate many important chemical principles.

Apparatus

- Student worksheet
- Clear plastic sheet (eg OHP sheet)

Chemicals

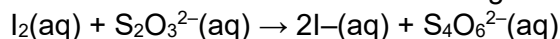
Solutions should be contained in plastic pipettes. See the accompanying guidance on apparatus and techniques for microscale chemistry, which includes instructions for preparing a variety of solutions here <https://rsc.li/3ydAQom>

- Silver nitrate, 0.1 mol dm⁻³
- Sodium chloride, 0.1 mol dm⁻³
- Potassium bromide, 0.2 mol dm⁻³
- Potassium iodide, 0.2 mol dm⁻³
- Iron(III) nitrate, 0.1 mol dm⁻³
- Copper(II) sulfate, 0.2 mol dm⁻³
- Iodine solution, 0.05 mol dm⁻³ in 0.2 mol dm⁻³ KI.

Observations

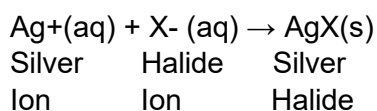
Part A

The brown colour of iodine is discharged as it is reduced by thiosulphate ions:



Part B

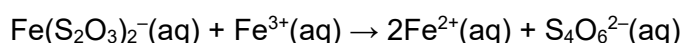
The addition of halide ions to the silver nitrate solution produces precipitates of the silver halides – pale yellow (silver bromide) and deeper yellow (silver iodide). Silver bromide dissolves readily in sodium thiosulphate solution, whereas silver iodide is less soluble. This could be used as a test to distinguish a bromide from an iodide.



The dissolution of silver bromide in thiosulfate solution is used in the fixing stage in photographic developing. Here, thiosulfate is used to dissolve unreacted silver bromide through the formation of soluble complexes such as $\text{Ag}(\text{S}_2\text{O}_3)_2^{3-}(\text{aq})$.

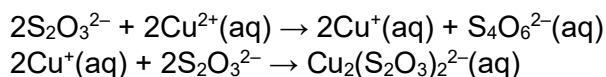
Part C

The reaction of iron(III) with thiosulfate produces a deep violet complex anion, $\text{Fe}(\text{S}_2\text{O}_3)_2^-$. This decomposes slowly with the fading of the violet colour:



The presence of copper(II) ions catalyses the decomposition reaction, and the violet colour fades more rapidly.

Thiosulfate reduces Cu(II) to Cu(I) and complexes the Cu(I):



The characteristic blue colour of copper(II) fades, leaving a colourless solution containing the complex ion $\text{Cu}_2(\text{S}_2\text{O}_3)_2^{2-}(\text{aq})$.

Health, safety and technical notes

- Read our standard health and safety guidance here <https://rsc.li/3SWS6q5>
- Wear eye protection for part B and splash resistant goggles to BS EN166 3 for part C.
- Silver nitrate, $\text{AgNO}_3(\text{aq})$, 0.1 mol dm^{-3} is an eye irritant (see CLEAPSS Hazcard [HC087](#)). Keep separate from organic waste containers.
- Copper(II) sulfate 0.2 mol dm^{-3} causes eye damage and is toxic to aquatic life (see CLEAPSS Hazcard [HC027c](#)).
- Iron(III) nitrate, $\text{Fe}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}(\text{aq})$, 0.1 mol dm^{-3} (see CLEAPSS Hazcard [HC055c](#)), potassium bromide, $\text{KBr}(\text{aq})$, 0.2 mol dm^{-3} , and potassium iodide, $\text{KI}(\text{aq})$, 0.2 mol dm^{-3} (see CLEAPSS Hazcard [HC047b](#)), are low hazard. As is Iodine solution 0.05 mol dm^{-3} , but this is also toxic to aquatic life (see CLEAPSS Hazard [HC054](#)).
- Sodium thiosulphate, 0.1 mol dm^{-3} is low hazard (see CLEAPSS [RB087](#) for preparation and Hazcard [HC95a](#)).