

The chemistry of thiosulphate ions

Topic

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

Timing

20 min.

Apparatus (per group)

- One student worksheet
- One clear plastic sheet (eg ohp sheet).

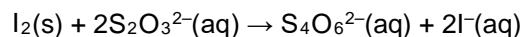
Chemicals (per group)

Solutions contained in plastic pipettes, see 'Apparatus and techniques for microscale chemistry' handout- Sodium thiosulphate 0.1 mol dm^{-3}

- 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.

Description

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

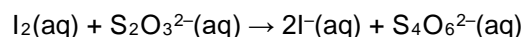


However, in this experiment students investigate some of the many interesting reactions of sodium thiosulphate. These reactions illustrate many important chemical principles.

Observations

Part A

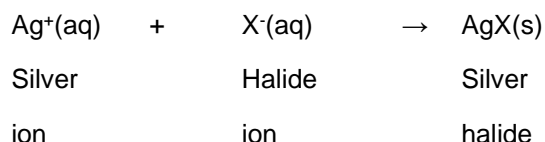
The brown colour of iodine is discharged as it is reduced by thiosulphate ions:



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.

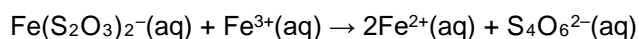




The dissolution of silver bromide in thiosulphate solution is used in the fixing stage in photographic developing. Here thiosulfate is used to dissolve unreacted silver bromide through the formation of soluble complexes such as $\text{Ag}(\text{S}_2\text{O}_3)_2^{3-}(\text{aq})$.

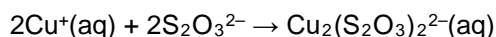
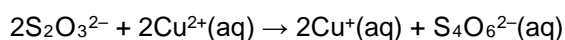
Part C

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

Wear eye protection for part B and splash resistant goggles to BS EN166 3 for part C.

Silver nitrate, 0.1 mol dm^{-3} , $\text{AgNO}_3(\text{aq})$ is an eye irritant. Keep separate from organic waste containers.

Copper(II) sulfate 0.2 mol dm^{-3} causes eye damage and is toxic to aquatic life.

Iron(III) nitrate, 0.1 mol dm^{-3} , $\text{Fe}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}(\text{aq})$, Potassium bromide, 0.2 mol dm^{-3} , $\text{KBr}(\text{aq})$ and Potassium iodide, 0.2 mol dm^{-3} , $\text{KI}(\text{aq})$ are low hazard. As is Iodine solution 0.05 mol dm^{-3} but this is also toxic to aquatic life.

Credits

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Health & safety checked May 2018

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