Microscale redox reactions – teacher notes

In this experiment students observe and interpret two redox reactions.

Topic

Transition elements – redox reactions; electrochemistry – redox reactions – changes in reduction potentials down Group VII.

Timing

20 minutes

Equipment

Apparatus

- Eye protection
- Student worksheet
- Clear plastic sheet (eg ohp sheet)
- Magnifying glass

Chemicals

Solutions should be contained in plastic pipettes. See the accompanying guidance on apparatus and techniques for microscale chemistry (https://rsc.li/3udpzAy), which includes instructions for preparing solutions.

- Potassium bromide, 0.2 mol dm^{-3}
- Potassium iodide, 0.2 mol dm^{-3}
- Sodium chloride, 0.2 mol dm^{-3}
- Silver nitrate, 0.1 mol dm^{-3}
- Copper(II) sulfate, 0.2 mol dm^{-3}
- Iron(II) sulfate, 0.2 mol dm^{-3}
- Iron(III) nitrate, 0.2 mol dm^{-3}
- Potassium thiocyanate, 0.1 mol dm^{-3}
- Starch solution (freshly made)

Observations

Part 1

No changes are observed on adding chloride or bromide to the copper(II) solution. However, the addition of iodide gives an immediate light brown precipitate of copper(I) iodide. The addition of starch solution gives the intense blue-black colour characteristic of the starch–iodine complex (see reference below). Iodide reduces copper(II):

$2Cu^{2+}(aq) + 4I^{-}(aq) \rightarrow 2CuI(s) + I_2(s)$

Part 2

The addition of iron(II) solution to silver nitrate produces silver metal by reduction. Glittering can be seen in the drop.

The addition of a drop of thiocyanate produces a deep red colour indicative of iron(III). A whitish precipitate of silver thiocyanate can also be seen.

The second part of this experiment is for students to do sequential reactions of thiocyanate with silver(I), iron(II) and iron(III), helping them to interpret this redox reaction.

Note

Unless very pure and freshly prepared, iron(II) solutions will contain a small amount of iron(III) which gives a slight red coloration in the reaction between the iron(III) solution and the thiocyanate. However, the intensity of the colour is less than that observed in the reaction between iron(III) solution and thiocyanate ions. This point could be explored further in subsequent discussions on the purity of chemicals.

Reference

School Sci. Rev., 1990, **72**, 104.

Health, safety and technical notes

- Read our standard health and safety guidance (https://rsc.li/3ykbTq3).
- Wear eye protection throughout (splash-resistant goggles to BS EN166 3).
- Silver nitrate, $AgNO_3(aq)$, 0.1 mol dm^{-3} – see CLEAPSS Hazcard HC087 and CLEAPSS Recipe Book RB077. Silver nitrate is an eye IRRITANT. Keep separate from organic waste containers.
- Copper(II) sulfate solution, $CuSO_4(aq)$, 0.2 mol dm^{-3} – see CLEAPSS Hazcard HC027c and CLEAPSS Recipe Book RB031. Copper(II) sulfate causes eye damage and is HAZARDOUS to the aquatic environment.
- The following chemicals are low hazard:
    - Potassium bromide, KBr (aq), 0.2 mol dm^{-3} – see CLEAPSS Hazcard HC047b and CLEAPSS Recipe Book RB068.
    - Iron(II) sulfate, $FeSO_4.7H_2O$ (aq), 0.2 mol dm^{-3} – see CLEAPSS Hazcard HC055B and CLEAPSS Recipe Book RB051.
    - Iron(III) nitrate, $Fe(NO_3)_3.9H_2O$ (aq), 0.2 mol dm^{-3} – see CLEAPSS Hazcard HC055C and CLEAPSS Recipe Book RB052.
    - Potassium thiocyanate, KBr (aq), 0.1 mol dm^{-3} – see CLEAPSS Hazcard HC095A and CLEAPSS Recipe Book RB122.
    - Potassium iodide, KI(aq), 0.2 mol dm^{-3} see CLEAPSS Hazcard HC047b and CLEAPSS Recipe Book RB072.