

Transition elements and complex compounds microscale experiment

This resource accompanies the article **Teaching transition metals and complex ions at post-16** in *Education in Chemistry* which can be viewed at: rsc.li/3szfl1y.

Learning objectives

- 1 Develop an understanding of sustainable practices by carrying out a microscale experiment to minimise the use and disposal of toxic substances.
- 2 Relate experimental observations to the oxidation state, ligand type and coordination number of transition element compounds.

Health and safety


Read our standard health and safety guidance (rsc.li/3vDwEuC) and carry out a risk assessment before running any practical. Do the experiment in a well-ventilated laboratory and see the **Teacher notes** for the expected observations.







Equipment






- Safety goggles (to BS EN166 3)
- Chemical resistant gloves (optional – none of the chemicals require gloves but learners should avoid skin contact with some of the solutions)
- Student worksheet (page 3 laminated)
- Clear plastic sheet (eg, acetate sheet overlay if you are not using a laminated worksheet)
- Magnifying glass

Chemical reagents

Provide solutions in plastic dropper bottles or in plastic pipettes. See the accompanying guidance on apparatus and techniques for microscale chemistry (rsc.li/3nRRXpz), including instructions for preparing a variety of solutions.

Chemicals supplied for the practical	Preparation
Acidified potassium dichromate, 0.2 mol dm ⁻³  Danger: corrosive (skin, eyes). Harmful (ingestion). Irritant (respiratory). Sensitiser (skin, respiratory). Serious health	CLEAPSS recipe book RB070. If not acidified, add excess sulfuric acid 1 mol dm ⁻³ to the stock solution bottle.

hazard (RE). Serious health hazard (CMR). Avoid skin contact. CLEAPSS hazard card HC078c.	
Potassium manganate(VII), 0.2 mol dm ⁻³  Warning: irritant (skin, eyes). Suspected of damaging the unborn child. Stains skin and clothes. CLEAPSS hazard card HC081.	CLEAPSS recipe book RB073. Store solutions in dark bottles and shield from light to avoid decomposition and staining of containers.
Cobalt(II) nitrate, 0.5 mol dm ⁻³  Danger: sensitiser (skin, respiratory). Serious health hazard (CMR – hazard to fertility and/or the unborn child). CLEAPSS hazard card HC025.	CLEAPSS recipe book RB030.
Ammonia solution, 2.0 mol dm ⁻³  Danger: corrosive (eyes) and irritant (skin). CLEAPSS hazard card HC006.	CLEAPSS recipe book RB006. The concentration will decrease over time. Check that the solution is giving adequate results if you are using a pre-prepared stock.
Ammonium vanadate(V), 0.1 mol dm ⁻³ (made in sulfuric acid, 1 mol dm ⁻³)  Warning: irritant (skin, eyes). CLEAPSS hazard card HC009b and HC098a.	CLEAPSS recipe book RB008.
Hydrochloric acid, 1 mol dm ⁻³ Currently not classified as hazardous. CLEAPSS hazard card HC047a.	CLEAPSS recipe book RB043.
Sulfuric acid, 1 mol dm ⁻³  Warning: irritant (skin, eyes). CLEAPSS hazard card HC098a.	CLEAPSS recipe book RB098.
Hydrogen peroxide, 5% solution (equivalent to 18 vol which is about 1.5 mol dm ⁻³)  Warning: irritant (eyes). CLEAPSS hazard card HC050.	CLEAPSS recipe book RB045. Prepare the dilute solution before use. Dilute solutions deteriorate rapidly. Test that the solution is giving adequate results if using for several classes.

Sodium hydroxide, 1 mol dm ⁻³  Danger: corrosive (skin, eyes). CLEAPSS hazcard HC091a.	CLEAPSS recipe book RB085. Store the solution in plastic screw cap bottles or plastic dropper bottles as it can etch glass when kept for a long period of time.
Copper(II) sulfate, 0.2 mol dm ⁻³  Danger: corrosive (eyes) and irritant (skin). CLEAPSS hazcard HC027c.	CLEAPSS recipe book RB031.
Iron(II) sulfate, 0.2 mol dm ⁻³ (made in sulfuric acid, 1 mol dm ⁻³)  Warning: irritant (skin, eyes). CLEAPSS hazcard HC055b and HC098a.	CLEAPSS recipe book RB051. This solution will oxidise over time even if prepared in sulfuric acid. Check the solution if using a pre-prepared stock.
Iron(III) nitrate, 0.2 mol dm ⁻³  Warning: irritant (skin, eyes). CLEAPSS hazcard HC055c.	CLEAPSS recipe book RB052.
Potassium iodide, 0.2 mol dm ⁻³ Currently not classified as hazardous. CLEAPSS hazcard HC047b.	CLEAPSS recipe book RB072. Store the solution in dark bottles or away from sunlight.
Starch solution, 1% (w/v) (freshly made) Currently not classified as hazardous. CLEAPSS hazcard HC040c.	CLEAPSS recipe book RB123.
Zinc metal granules Currently not classified as hazardous. CLEAPSS hazcard HC107.	N/A
Zinc(II) sulfate solution, 0.2 mol dm ⁻³  Danger: corrosive (eyes). CLEAPSS hazcard HC108b.	CLEAPSS recipe book RB106.

Tips

- Try the experiment in advance especially if you are using pre-prepared solutions.
- Use freshly made starch solution.
- Iron(II) sulfate solution, potassium manganate(VII) solution and ammonia solution are likely to deteriorate. If you are using dropper bottles, consider decanting them into a larger container when not being used.

Disposal

Wipe the laminated sheets or plastic pockets with paper towel – take care not to touch the chemicals with your skin and wash your hands afterwards – and place the sheets in a bucket of water. Discard the paper towel in the general waste bin. Recycle or reuse small quantities of zinc granules and then dispose of in general waste. Further dilute the water in the bucket and pour down a foul-water drain.

Most chemicals can be re-used for another class. If a chemical has deteriorated, check the waste disposal code and instructions on the CLEAPSS hazard card. The chemicals used are diluted enough to be poured down a foul-water drain or they will need to be diluted before being poured down a foul-water drain.