

# Oxidation-Reduction Chemistry of Manganese

by Paul Wormell

## Experiment Overview

Students prepare a pale-yellow tetrahedral complex of manganese(II) and a brown-black stable octahedral complex of manganese(III). Students carry out a series of solution-phase reactions to demonstrate transformations between some oxidation states of manganese, and to rationalise the reactions in terms of standard reduction potentials,  $E^\circ$ . The progress of the reactions can be followed using the characteristic colours of the different oxidation states,

The experiment has been used successfully in second- and third-year undergraduate classes since 1990. The laboratory work is straightforward, but students benefit from taking care and being patient (some of the reactions do not occur instantaneously). Students appear to find the colour changes interesting, and the reactions are generally reliable and reproducible. Colour-blind students might encounter difficulties, but none have been noted in recent years. However, analysing the results may present some challenges, especially for students who had difficulties with balancing redox equations in first year. Some of the equations are very straightforward, but others are more difficult and require students to recognise that acid-base and precipitation reactions may also occur. The experiment has benefits for students across a range of different abilities.

## Aims and Objectives

To demonstrate transformations between some oxidation states of manganese, and to rationalise the reactions in terms of standard reduction potentials,  $E^\circ$ .

## Level of Experiment

Second year undergraduate

## Keyword Descriptions of the Experiment

### **Domain**

inorganic chemistry

### **Specific Descriptors**

oxidation-reduction, reduction potentials, oxidation states

## Course Context

This is a compulsory one-week experiment in the second-year undergraduate subject 300230 Inorganic Chemistry at the Hawkesbury Campus of the University of Western Sydney. Students in this class have already completed some introductory experiments on the synthesis of cobalt(III) complexes. The experiment reinforces students' understanding of oxidation-reduction reactions, multiple oxidation states for transition metals, and basic coordination chemistry.

## Prerequisite Knowledge and Skills

Students must have completed first-year university chemistry, or equivalent, and be familiar with redox concepts and some basic inorganic chemistry. Preferably they should also have a basic grounding in coordination chemistry and inorganic synthesis.

## Time Required to Complete

**Prior to Lab:** 10 min (in current form)

**In Laboratory:** 3 h

**After Laboratory:** 2 h

## Experiment History

This experiment has been used the Hawkesbury Campus of the University of Western Sydney, predominantly in second-year inorganic chemistry subjects, since 1990. It was adapted by the author of the educational analysis from a University of Newcastle experiment, as referenced below. Apart from minor editing of the student notes it has not changed during the past fifteen years.

## Submission Details

This experiment is submitted by the author of the educational analysis with due acknowledgement of the original source, as referenced below.

## References

Anonymous, (late 1980s), Chemistry IIA Inorganic Practical Notes, University of Newcastle, Department of Chemistry.