

|  |
| --- |
| Chemical Demonstrations |
| Oxidation states of Manganese |



**Advanced Higher (CfE)** –

**Inorganic and Physical Chemistry**

Oxidation states of transition metals

Oxidation States of Manganese

In its compounds manganese exhibits oxidation states from +2 to +7. The common oxidation states are +2, +4, and +7, but the less common +3, +5, and +6 states are easily prepared. Since the colours of the six oxidation states are all different, showing them on an overhead projector makes for a colourful display – alternatively using a visualiser against a white background works well

**You will need**

|  |  |
| --- | --- |
| An OHP/visualiser | 6 small petri dishes (or beakers or other containers that will fit. |
| MnSO4 solution 20g per l00 cm3 (1.18 M) *(using the 1.H2O form)* | KMnO4 solution 0.02g per l00 cm3 (0.00125 M) |
| Na2SO3 solution 2g per 100 cm3 (0.07 M) *(using the 10.H2O form)* | 6 M H2S04 (33 cm3 conc. H2S04 per 100 cm3) |
| 6M NaOH (24g per l00 cm3) | Pearls of solid NaOH |
| KMnO4 solution (0.1 M) |  |

**To Do**

On the stage of an overhead projector line up six small petri dishes labelled +2, +3, +4, +5, +6, and +7 (using a marking pen on an underlying transparency sheet – or you can test your spatial awareness by writing back to front on the underside).

(1) In the +2 petri dish place 10 cm3 of MnSO4 solution (enough to cover the bottom). Although the colour is pale pink, it will appear to be essentially colourless.

(2) In the +7 petri dish place 10 cm3 of 0.02% KMnO4 solution. The colour is the familiar purple colour of permanganate.

(3) In the +4 petri dish place 10 cm3 of MnSO4 solution, and then, without mixing, add a few drops of 0.02% KMnO4 scattered over the surface, Brown spots of MnO2 will form wherever the drops of permanganate fall.

(4) In the +3 petri dish place 10 cm3 of MnSO4 solution and add 1.5 cm3 of 6 M H2S04, Then add 0.1M KMnO4 a few drops at a time, swirling the beaker after each addition, until the solution takes on a reddish colour.

(5) In the +6 petri dish place 10 cm3 of 0.02% KMnO4 solution and add 1.5 cm3 of 6M NaOH. Then add 1.5 cm3 of Na2SO3 solution. The colour changes from purple to green as the MnO4 ion (permanganate) is reduced to MnO4 2- (manganate).

Within a few minutes, the solution goes cloudy, which makes it less suitable for use on an OHP.

(6) For the +5 oxidation state, place 10 cm3 of 6M NaOH solution in a small beaker and then add about 10 pearls of solid NaOH. Add 3 cm3 of 0.02% KMnO4 and swirl the beaker rapidly until the solution turns blue, the colour of MnO43- . (This will take about 30s) Pour into the petri dish.

The 5+ oxidation state is not very stable. It will quite rapidly, within a minute or two, change to the green of the 6+ form. You can reverse this by adding a small amount more KMnO4 and giving a quick swirl again. (If you use a more concentrated solution of KMnO4, such as 0.1M, you only need to add 2 or three drops)

Some of these oxidation states are rather unstable, but for a while the six beakers will appear as follows:

+2 colourless (or very pale pink), Mn2+ (manganous, or manganese (II))

+3 rose coloured, Mn 3+ (manganic, or manganese (III))

+4 brown, MnO2 (manganese (IV) oxide)

+5 blue, MnO4 3- (manganate (V))

+6 green, MnO4 2- (manganate (VI))

+7 purple, MnO4 (permanganate)

**Safety Notes**

6M H2SO4 and NaOH are very corrosive. Wear goggles (BS EN166 3) and gloves.

MnSO4 is a category 2 specific target organ toxin.

**Disposal**

You can pour the MnSO4 and KMnO4 solutions from containers +2 and +7 back into their bottle and keep them for the next time. (Though the MnSO4 will not last for more than a day or so before decomposing). The sodium sulphite (Na2SO3) is also unstable and will stop working after a few days.

The contents of the other dishes contain only small amounts of manganese salts and can be safely run to waste with copious quantities of water.

**References:**

[1] D. Kolb (ed) J. Chem. Educ 1988 Vol 65 No 11 p1004

[2] D.W. Brooks. Department of Teaching, Learning, & Teacher Education, University of Nebraska-Lincoln. <http://dwb4.unl.edu/Chemistry/DoChem/DoChem055.html>