

Multiple Oxidation States of Manganese

Purple KMnO_4 solutions change colors during the reduction of manganese from Mn^{7+} to Mn^{2+}

Chemicals Needed

- d- H_2O
- KMnO_4 – **F5**
- NaOH – **G1**
- Sucrose – **N4**
- EDTA solution – **prep lab**
- Oxalic acid – **N3**
- $\text{MnSO}_4 \cdot 4 \text{H}_2\text{O}$ – **F3**
- Drop bottle of concentrated H_2SO_4 – **K2**

Equipment Needed

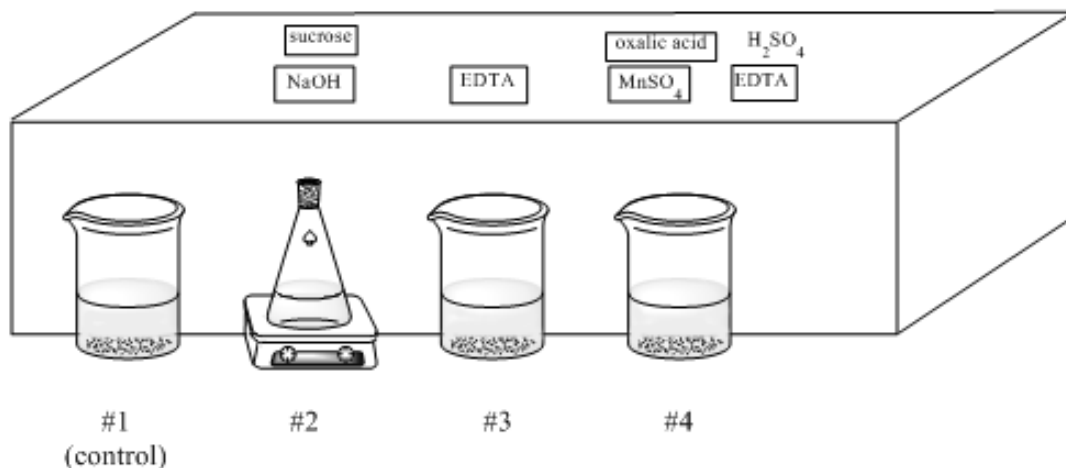
- 3-300 mL tall beakers – **Q2**
- 1 L beaker – **Q1**
- 500 mL Erlenmeyer flask – **P1**
- 5 petri dish lids – **P3**
- 2-10 mL graduated cylinders – **Q3**
- 4 weighing dishes – **A3**
- 3 glass stirring rods – **U1**
- Magnetic stir bar – **U1**
- Light box – **A4**
- Stir plate – **A4**

Hazards

- KMnO_4 can stain skin and clothing
- NaOH is a strong base. If it comes in contact with skin, it can cause chemical burns. Flush with water and seek medical attention as needed

Preparation

- Pour 800 mL d- H_2O into the large beaker, add a small amount of KMnO_4 , and stir until the solution is a uniform pink/fuchsia/magenta. Add more solid if needed for a darker solution.
- Divide the solution between the 300 mL beakers and the Erlenmeyer flask (200 mL in each). Label glassware and lids (for beakers) 1-4.
- Measure out the following compounds into the weighing dishes, and label:
 - two samples of 10 mL EDTA solution (graduated cylinders)
 - 2 g sucrose
 - 3 g NaOH
 - 0.5 g oxalic acid
 - Tip of a microspatula of MnSO_4
- On delivery, place the glassware and stirplate in front of the light box, and arrange the measured compounds according to the diagram below:



Presentation

- **Beaker #1** – Reference solution (Mn⁷⁺)
- **Beaker #2** – Add sucrose and NaOH while the magnetic stirrer is on. The solution will first turn purple → blue → green (Mn⁶⁺).
 - Allow the solution to keep stirring, and the manganese will continue to oxidize green → yellow → colloidal amber [formation and suspension of MnO₂ (s)] (Mn⁴⁺)
 - The change to the amber Mn⁴⁺ state will take at least 5 minutes.
- **Beaker #3** – Add EDTA and stir. The solution will turn rose (Mn³⁺)
- **Beaker #4** – Add EDTA and stir. Add oxalic acid, MnSO₄, 5 drops concentrated H₂SO₄ and stir. The solution will slowly turn from yellow to colorless (takes about 20 min) (Mn²⁺)

Clean-Up

- All other solutions can be poured down the drain with plenty of water.

NOTES: The original protocol used KCN and NaOH to get the Mn⁶⁺ state, and sodium formate to obtain the Mn⁴⁺ state. This protocol seems safer, though it does take a little longer to get to the Mn⁴⁺ state

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Instructions for Lecturer

- **Beaker #1** – Reference solution (Mn^{7+})
- **Beaker #2** – Add sucrose and NaOH while the magnetic stirrer is on. The solution will first turn purple → blue → green (Mn^{6+}).
 - Allow the solution to keep stirring, and the manganese will continue to oxidize green → yellow → colloidal amber [formation and suspension of MnO_2 (s)] (Mn^{4+})
 - The change to the amber Mn^{4+} state will take at least 5 minutes.
- **Beaker #3** – Add EDTA and stir. The solution will turn rose (Mn^{3+})
- **Beaker #4** – Add EDTA and stir. Add oxalic acid, MnSO_4 , 5 drops concentrated H_2SO_4 and stir. The solution will slowly turn from yellow to colorless (takes about 20 min) (Mn^{2+})