

Intro:

Many elements can exist in several oxidation states, which may differ noticeably in color. Manganese is another element whose various oxidation states have different colors, including MnO_4^- (+7 violet), MnO_4^{2-} (+6 green), MnO_2 (+4 orange), Mn_2O_3 (+3 violet), and Mn^{2+} (+2 pale pink).

In this laboratory, we'll begin with a solution of potassium permanganate, in which manganese is in the +7 oxidation state and reduce the oxidation state to observe the color changes associated with various oxidation states of manganese. To achieve these changes in oxidation state, we'll react potassium permanganate with sodium bisulfite in neutral, basic (sodium hydroxide), and acid (sulfuric acid) solutions, which are represented by the equations shown in Table 1.

Table 1: Oxidation states of manganese

Solution	Oxidation State	Ion	Colour	Equation
Neutral	+4	MnO_2	Orange	$2\text{MnO}_4^- (\text{aq}) + 3\text{HSO}_3^- + \text{OH}^- \rightarrow 2\text{MnO}_2 (\text{s}) + 3\text{SO}_4^{2-} (\text{aq}) + 2\text{H}_2\text{O} (\text{l})$
Basic (sodium hydroxide)	+6	MnO_4^{2-}	Green	$2\text{MnO}_4^- (\text{aq}) + \text{HSO}_3^- + 3\text{OH}^- \rightarrow 2\text{MnO}_4^{2-} (\text{aq}) + \text{SO}_4^{2-} + 2\text{H}_2\text{O} (\text{l})$
Acid (sulfuric acid)	+2	Mn^{2+}	Pink	$2\text{MnO}_4^- (\text{aq}) + 5\text{HSO}_3^- + \text{H}^+ \rightarrow 2\text{Mn}^{2+} (\text{aq}) + 5\text{SO}_4^{2-} + 3\text{H}_2\text{O} (\text{l})$

Preparation of solutions

- Prepare a 0.1M of potassium permanganate solution in 100ml
- Prepare a 1.0 M sodium hydroxide solution in 100ml
- Prepare a 0.1M of sodium bisulfite solution in 100ml
- 1.0M sulfuric acid will be provided.

Procedure

1. Goggles on!
2. Label four test tubes A through D, place them in the test tube rack, and transfer about 10ml of 0.01 M potassium permanganate solution to each of the tubes.
3. Test tube A will contain only the potassium permanganate solution, and will serve as the control and example of manganese in oxidation state +7. Record the colour of this solution on line A of Table 2
4. With stirring, slowly add 0.01M sodium bisulfite solution to test tube B until no further colour change occurs. Record the colour and the presence or absence of any precipitate on line B of Table 2.
5. Add 9ml of 1.0M sodium hydroxide solution to test tube C.
6. With stirring, slowly add 0.01 M sodium bisulfite solution to test tube C until no further colour change occurs. Record the colour and the presence or absence of any precipitate on line C of table 2.
7. Add 6ml of 1.0 M sulfuric acid solution to test tube D.
8. With stirring, slowly add 0.01 M sodium bisulfite solution to test tube D until no further colour change occurs. Record the colour and the presence or absence of any precipitate on line D of table 2.
9. Comparing the appearances of the contents of four test tubes, decide which oxidation state of manganese is represented by the contents of each test tube and enter the value on the appropriate line of table 2.

Data Table 2:

Test tube	Colour	Precipitate?	Oxidation state
Potassium permanganate only			
Potassium permanganate + sodium bisulfite			
Potassium permanganate + sodium hydroxide + sodium bisulfite			
Potassium permanganate + sulfuric acid + sodium bisulfite			

1. What are the final oxidation states of manganese in test tubes A, B, C and D?

2. What are the oxidation states of each atom in the following species: NH_3 , H_2O , H_2O_2 , $\text{K}_2\text{Cr}_2\text{O}_7$, NaNO_3 , FeCl_2 and AgNO_3 ?