

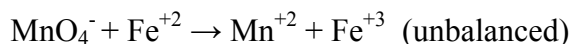
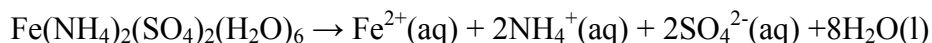
## Fe Analysis by REDOX Titration

### Reaction of Ferrous Ion with Permanganate

Potassium permanganate is a widely used as an oxidizing agent in volumetric analysis. In acid solution  $\text{MnO}_4^-$  undergoes reduction to  $\text{Mn}^{+2}$ . Since the permanganate ion,  $\text{MnO}_4^-$ , is pink and the  $\text{Mn}^{+2}$  ion is colorless, the endpoint using permanganate as the titrant can be taken as the first permanent pink color that appears in the titration.

In this experiment  $\text{KMnO}_4$  will be used to determine the percentage of  $\text{Fe}^{+2}$  by mass in an unknown sample. The oxidation of  $\text{Fe}^{+2}$  to  $\text{Fe}^{+3}$  is carried out acidic solution to prevent the air oxidation of  $\text{Fe}^{+2}$ . Phosphoric acid,  $\text{H}_3\text{PO}_4$ , is added to form a colorless complex with  $\text{Fe}^{+3}$  ion.

The  $\text{KMnO}_4$  solution (about 0.02M) is first standardized by titration using Mohr's salt, ferrous ammonium sulfate hexahydrate,  $(\text{Fe}(\text{NH}_4)_2(\text{SO}_4)_2(\text{H}_2\text{O})_6)$  as the source of  $\text{Fe}^{+2}$ . The  $\text{Fe}^{+2}$  is oxidized to  $\text{Fe}^{+3}$  while the  $\text{MnO}_4^-$  is reduced to  $\text{Mn}^{+2}$ . The exact molarity of the  $\text{KMnO}_4$  is then determined.



Next the standardized  $\text{KMnO}_4$  is reacted with a known mass of an unknown sample containing  $\text{Fe}^{+2}$ . The mass and percent by mass of  $\text{Fe}^{+2}$  in the unknown is then calculated.

### Procedure

#### Standardization of $\text{KMnO}_4$ Solution

Prepare a 1 M  $\text{H}_2\text{SO}_4$  solution by slowly pouring 20 mL of concentrated (18M)  $\text{H}_2\text{SO}_4$  into 340 - 350 mL of distilled water in a 500 mL Erlenmeyer flask. Swirl to insure thorough mixing of the solution.

Weigh two 0.60 gram samples of Mohr's salt into two separate 250 mL Erlenmeyer flasks. To each flask add 50 mL of the 1 M  $\text{H}_2\text{SO}_4$  and swirl to dissolve the salt. Then add 3 mL of concentrated (85%)  $\text{H}_3\text{PO}_4$  to each flask. Titrate each solution with the permanganate until a stable pink color (30 seconds) is reached. Do a third trial if there is a big difference in the two results. The volume of  $\text{KMnO}_4$  in each titration should agree within 1 %. Calculate the average molarity of the permanganate (about 0.02M)

#### Analysis of Unknown

Accurately weigh two 1.00 gram samples of your unknown into two separate 250 Erlenmeyer flasks. Add 50 mL of the 1M  $\text{H}_2\text{SO}_4$  and 3 mL of the 85%  $\text{H}_3\text{PO}_4$  to each flask and swirl to dissolve the unknown. Titrate each sample with the  $\text{KMnO}_4$  to a stable pink color. Calculate the percent by mass of  $\text{Fe}^{+2}$  in each sample and determine the average percentage of  $\text{Fe}^{+2}$ .

Name: \_\_\_\_\_

**Data and Calculations**

**Standardization of  $\text{KMnO}_4$**

**(Permanganate is approximately 0.02M)**

	Trial # 1	Trial # 2	Trial # 3 (If necessary)
Mass of Mohr's Salt, g	_____	_____	_____
Moles of Mohr's salt	_____	_____	_____
Moles of $\text{Fe}^{+2}$	_____	_____	_____
Moles $\text{KMnO}_4$	_____	_____	_____
Final mL $\text{KMnO}_4$	_____	_____	_____
Initial mL $\text{KMnO}_4$	_____	_____	_____
Volume $\text{KMnO}_4$ used	_____	_____	_____
Molarity of $\text{KMnO}_4$	_____	_____	_____
Average Molarity of $\text{KMnO}_4$	_____		

**DISPOSE ALL SOLUTIONS IN THE HEAVY METAL WASTE CONTAINER.**

Name : \_\_\_\_\_

### Analysis of Unknown

Average  $\text{KMnO}_4$  Molarity \_\_\_\_\_

	Trial #1	Trial # 2	Trial # 3 (If necessary)
Final mL of $\text{KMnO}_4$	_____	_____	_____
Initial mL of $\text{KMnO}_4$	_____	_____	_____
mL of $\text{KMnO}_4$ used	_____	_____	_____
Molarity of $\text{KMnO}_4$ (page 2)	_____	_____	_____
Moles of $\text{KMnO}_4$ used	_____	_____	_____
Moles of $\text{Fe}^{+2}$ in sample	_____	_____	_____
Grams of $\text{Fe}^{+2}$ in Sample	_____	_____	_____
Mass of unknown, g	_____	_____	_____
Percent by mass of $\text{Fe}^{+2}$ in sample	_____	_____	_____
Average percent $\text{Fe}^{+2}$	_____		
Unknown Number	_____		

**DISPOSE ALL SOLUTIONS IN THE HEAVY METAL WASTE CONTAINER.**

Name: \_\_\_\_\_

## Fe Analysis by REDOX Titration

### Prestudy

1. Write the balanced net-ionic equation for the reaction of ferrous ion with permanganate in an acidic solution.



2. A 0.5585 g sample of ferrous ammonium sulfate hexahydrate,  $\text{Fe}(\text{NH}_4)_2(\text{SO}_4)_2(\text{H}_2\text{O})_6$ , requires 21.45 mL of a  $\text{KMnO}_4$  solution to reach a pink endpoint. What is the molarity of the  $\text{KMnO}_4$  solution ?
3. A 1.787 g sample containing some  $\text{Fe}^{+2}$  ion requires 31.50 mL of a 0.02188 m  $\text{KMnO}_4$  solution to reach a stable pink endpoint. What is the percent by mass of  $\text{Fe}^{+2}$  in the sample ?
4. Calculate the percent by mass of  $\text{Fe}^{+2}$  in Mohr's salt (ferrous ammonium sulfate hexahydrate),  $\text{Fe}(\text{NH}_4)_2(\text{SO}_4)_2(\text{H}_2\text{O})_6$  to **four significant figures**. This is the maximum percent of  $\text{Fe}^{+2}$  you can have in your unknown