

29.5 / 30



Chemistry 205 Report

Redox Titration

Name:

Date: 22-02-2013

- Purpose: 1. To learn a technique in volumetric analysis Redox titration
 2. To review the stoichiometry of an oxidation-reduction reaction
 3. To determine the concentration of an unknown sodium oxalate ($\text{Na}_2\text{C}_2\text{O}_4$) solution by titrating it against standardized potassium permanganate solution (KMnO_4)
 4. To determine the percent by mass of Fe (II) in the form of

Part I Ferrous ammonium sulfate $\text{Fe}(\text{NH}_4)_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$, in a mixture by redox titration.

Table 1. Preparation of Standard $\text{Na}_2\text{C}_2\text{O}_4$ Solution

Mass of bottle + cap + $\text{Na}_2\text{C}_2\text{O}_4$	10,0868 g $\pm 0,0003$ g
Mass of empty bottle + cap	9,2768 g
Mass of $\text{Na}_2\text{C}_2\text{O}_4$	0,8100 g
Volume of solution	250,0 mL $\pm 0,1$ mL

$$\begin{aligned} m_{\text{Na}_2\text{C}_2\text{O}_4} &= \frac{m}{M} = \frac{0,8100 \text{ g}}{134,00 \text{ g/mol}} = 6,045 \times 10^{-3} \text{ mol} \\ M_{\text{Na}_2\text{C}_2\text{O}_4} &= \frac{m_{\text{Na}_2\text{C}_2\text{O}_4}}{V_{\text{Na}_2\text{C}_2\text{O}_4}} \\ &= \frac{6,045 \times 10^{-3}}{250,0 \text{ mL}} = 0,02418 \text{ M} \end{aligned}$$

Table 2. Standardization of KMnO_4 Solution

Trial	Buret upper reading	Buret lower reading	Volume of KMnO_4
1	0,00	26,60 $\pm 0,2$	26,60
2	0,00	26,80	26,80
3	0,00	26,20	26,20
Blank	0,00	0,40	0,40

$$\bar{V}_{\text{KMnO}_4} = 26,53$$

$$\begin{aligned} V_{\text{KMnO}_4} &= \bar{V}_{\text{KMnO}_4} - V_{\text{Blank}} \\ &= 26,53 - 0,4 \\ &= 26,13 \text{ mL} \end{aligned}$$

Ionic equation:Volume of $\text{Na}_2\text{C}_2\text{O}_4$ = 25,00 mL.Calculations: (show your work)

$$M_{\text{KMnO}_4} = 0,02418 \text{ M}$$

$$\frac{m_{\text{MnO}_4^-}}{2} = \frac{m_{\text{C}_2\text{O}_4^{2-}}}{5}$$

$$\frac{(M \times V)_{\text{MnO}_4^-}}{2} = \frac{(M \times V)_{\text{C}_2\text{O}_4^{2-}}}{5}$$

$$M_{\text{C}_2\text{O}_4^{2-}} = 2 \times 0,02418 \times \frac{25,0 \times 10^{-3}}{5} = 0,02418 \text{ M}$$





Table 3. Analysis of Unknown Oxalate
Unknown #: 5

Trial	Buret upper reading	Buret lower reading	Volume of KMnO ₄ mL
1	0,00	27,50	27,50
2	0,00	27,30	27,30
3	0,00	27,10	27,10

Volume of unknown Na₂C₂O₄ = 25.00 mL ± 0.02 mL

$$\bar{V}_{\text{KMnO}_4} = 27.30$$

$$\begin{aligned}\bar{V}_{\text{KMnO}_4} &= \bar{V}_{\text{KMnO}_4} - V_{\text{Blank}} \\ &= 27.30 - 0.40 \\ &= 26.9 \text{ mL}\end{aligned}$$

Calculations: (show your work)

Molarity of unknown Na₂C₂O₄ =

$$\frac{(M \times V)_{\text{NaO}_4^-}}{2} = \frac{(M \times V)_{\text{Na}_2\text{C}_2\text{O}_4}}{5}$$

$$M_{\text{Na}_2\text{C}_2\text{O}_4} = \frac{5 \times 9.254 \times 10^{-3} \times 26.9 \times 10^{-3}}{2 \times 25.0 \times 10^{-3}} = 0.02489 \text{ M}$$



% error = 2% ✓

Part II

Table 4. Preparation of the Iron Unknown Solution
Unknown #: 12

Mass of bottle + cap + impure Fe(NH ₄) ₂ (SO ₄) ₂ ·6H ₂ O	12,3927 ± 0.001
Mass of empty bottle + cap	10,3689
Mass of impure Fe(NH ₄) ₂ (SO ₄) ₂ ·6H ₂ O	2,0238g
Volume of solution	100.0 mL ± 0.1 mL

Table 5. Titration of the Iron Unknown Sample with KMnO₄ Solution

Trial	Buret upper reading	Buret lower reading	Volume of KMnO ₄
1	0,00	5,80	5,80
2	5,80	11,70	5,90
3	11,70	17,30	5,60

$$\bar{V}_{\text{KMnO}_4} = 5.77 \text{ mL}$$



Ionic equation:



Calculations: (show your work)

$$\text{Number of moles of Fe}^{2+} (\text{in titrated sample}) = \frac{\text{m}_1 \text{Fe}^{2+}}{\text{m}_1 \text{MnO}_4^-} = \frac{1}{5} \times 9,254 \times 10^{-3} \times 5,77 \times 10^{-3}$$

$$= 2,167 \times 10^{-4} \text{ mol.}$$

$$\text{Number of moles of Fe(NH}_4)_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O} (\text{in titrated sample}) = \frac{\text{m}_1 \text{Fe}^{2+}}{\text{m}_1 \text{Fe}^{2+}} = 2,167 \times 10^{-4} \text{ mol.}$$

$$\text{Number of moles of Fe(NH}_4)_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O} (\text{in the original sample}) = \text{m}_1 \text{Fe}^{2+} \times 10$$

$$\text{Mass of Fe(NH}_4)_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O} = n \times M = 2,167 \times 10^{-3} \times 395,00 = 2,167 \times 10^{-3} \text{ mol.}$$

$$= 1,05 \text{ g}$$

$$\% \text{ by mass of Fe(NH}_4)_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O} = \frac{\text{mass of iron}}{\text{mass of powder}} \times 100 = \frac{1,05}{2,0238} \times 100$$

good job

$$\% \text{ error} = 2.8\%$$

$$= 51.9\%$$

Questions

1. Give the oxidation number of the underlined atoms in the following species:

a. C₂O₄²⁻ $2C + 4(-2) = -2 \Rightarrow C = +3$

b. Mg₃N₂ $3(+2) + 2N = 0 \Rightarrow N = -3$

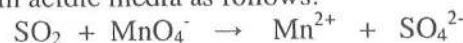
c. H₃AsO₃ $3(+1) + As + 3(-2) = 0 \Rightarrow As = +3$

d. WO₄²⁻ $W + 4(-2) = -2 \Rightarrow W = +6$

e. PtCl₆²⁻ $Pt + 6(-1) = -2 \Rightarrow Pt = +4$

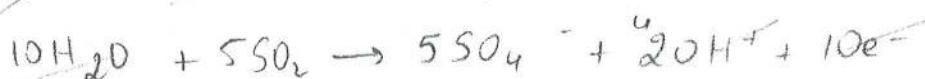
f. SbF₆⁻ $Sb + 6(-1) = -1 \Rightarrow Sb = +5$

2. SO₂ present in air is mainly responsible for the acid rain phenomenon. Its concentration can be determined by titrating against a standard permanganate solution in acidic media as follows:



- a. Balance the above reaction, show your work.

- b. Calculate the number of grams of SO₂ in a sample of air if 7.37 ml of 0.00800 M KMnO₄ solution are required for titration.



$$\frac{5 \times 896 \text{ mg}}{2} = \frac{n}{5}$$