

Colorimetric analysis: manganese in steel essay sample



**ASSIGN
BUSTER**

The goal of the experiment is to determine the percentage of Mn in an unknown metal sample by means of colorimetric analysis.

First stock solution of KMnO_4 with known concentration was diluted and then carried to spectrometer for analysis. The peak with highest absorbance was taken as λ_{max} . Then the molar extinction coefficient is calculated by plugging the value into the Beer-Lambert equation. Then the concentration of Mn^{2+} in unknown sample can be determined by scanning it in the spectrometer. 1

UV/VIS Spectrophotometry is used to determine the absorption or transmission of UV/VIS light (180 to 820 nm) by a sample. A spectrometer is used in the process. Inside a spectrometer light from a source is separated into narrow bands by wavelength, pass through the sample and then measured by the detector. 2 In this experiment UV/VIS Spectrophotometry is used to determine the absorbance of MnO_4^- ion in the solution.

Beer-Lambert law states that absorbance is proportional to the concentration of the absorbing species. The equation is $A = \epsilon b C$, where A is the absorbance, b is the path length, ϵ is the molar extinction coefficient and C stands for concentration. 2 In the experiment with the absorbance of MnO_4^- ion in stock solution determined by UV Vis spectrophotometry in part A and the absorbance in unknown sample was determined in part B, the concentration of Mn^{2+} can be calculated.

Experimental

There was no change in the experiment. 1

Results and Discussion (Sample # 2061)

Part A

Dilution of KMnO_4

10mL transferred to 100mL volumetric flask: $9.9958\text{mL} \times 0.$

$003998\text{M}/100\text{mL}$

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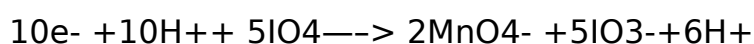
The wavelength used was 526nm.

$$A = \epsilon bC$$

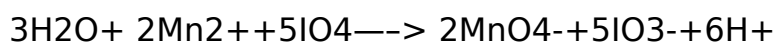
$$\epsilon = A/bC = 0.935455/1 \times 0.00039963 = 2340.8027 \text{ L mol}^{-1} \text{ cm}^{-1}$$

Part B

Half-cell equations:



Net balanced redox equation:



Calculation for KIO_4 :

$$1\text{g} \times 2\% = 0.02\text{g}$$

$$\text{Molar mass of } \text{Mn}^{2+} = 54.938\text{g/mol}$$

$$n\text{Mn}^{2+} = 0.02/54.938 = 3.64046\text{E-}4\text{mol}$$

$$n\text{KIO}_4 = n\text{Mn}^{2+} \times 2/5 = 9.10115\text{E-}4\text{mol}$$

$$m\text{KIO}_4 = 9.10115\text{E-}4 \times 306.0037 = 0.2093\text{g}$$

Calculation for Unknown:

$$C = A/b \epsilon = 0.462799 / 1 \times 2340.8027 = 1.977E-4 M$$

$$n = CV = 1.977E-4 \times 0.25 L = 4.9425E-5 \text{ mol}$$

$$m = 4.9425E-5 \times 54.938 = 2.7153E-3 g$$

Mass of unknown: 0.9629g

$$\%Mn = 2.7153E-3 / 0.9629 \times 100\% = 0.282\%$$

Overall summary questions:

1. According to Beer's law, the absorbance is dependent on the path length of the cuvette. Thus the value of observed absorbance will be lower if 1mm cell is used. The molar extinction coefficient is an intrinsic property, which means it would not change when the path length changes. 2. No the result would be less accurate. The change in absorbance around the highest peak is minimized thus the value derived from the highest peak is the most accurate and closest to the true value. Conclusion

In part A, by scanning the stock $KMnO_4$ solution, the highest peak of absorption was found to be 526nm with absorbance of 0.935455. The molar extinction coefficient for Mn^{2+} was then calculated 2340.8027 $L \text{ mol}^{-1} \text{ cm}^{-1}$. Then by scanning the sample solution at the wavelength 526nm, the absorbance was found to be 0.462799 and the concentration of Mn^{2+} in the sample was calculated to be 1.977E-4M. Thus the percentage of Mn^{2+} in the sample was calculated 0.282%. There are several possible sources of error in the experiment including error in readings of pipette, contamination of solution and sample may not completely dissolve. Reference

1. Ding, Z. Maslen, R; Stillman, M; Yeung, K. Chemistry 2272 Laboratory Manual; 2012 Ed; Dept. of Chemistry, London, ON, 2012-2013; p 6. 1-6. 5. 2.
- Harris, C. H, Quantitative Chemical Analysis, 8th ed.; W. H. Freeman and Company: New York, 2010