Colorimetric analysis: manganese in steel essay sample

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 KMnO4 with known concentration was diluted and then carried to spectrometer for analysis. The peak with highest absorbance was taken as λmax. Then the molar extinction coefficient is calculated by plugging the value into the Beer-Lambert equation. Then the concentration of Mn2+ 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 MnO4- ion in the solution.

Beer-Lambert law states that absorbance is proportional to the concentration of the absorbing species. The equation is A= ƐbC, where A is the absorbance, b is the path length, Ɛ is the molar extinction coefficient and C stands for concentration. 2 In the experiment with the absorbance of MnO4- 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 Mn2+ can be calculated.

Experimental

There was no change in the experiment. 1

Results and Discussion (Sample # 2061)

Part A

Dilution of KMnO4

10mL transferred to 100mL volumetric flask: 9. 9958mL x 0.

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The wavelength used was 526nm.

A= ƐbC

Ɛ= A/bC= 0. 935455/1×0. 00039963= 2340. 8027 L mol−1 cm−1

Part B

Half-cell equations:

8H2O + 2Mn2+ —-> 2MnO4- +16 H+ +10e-

10e- +10H++ 5IO4—–> 2MnO4- +5IO3-+6H+

Net balanced redox equation:

3H2O+ 2Mn2++5IO4—–> 2MnO4-+5IO3-+6H+

Calculation for KIO4:

1g x2%= 0. 02g

Molar mass of Mn2+= 54. 938g/mol

nMn2+= 0. 02/54. 938= 3. 64046E-4mol

nKIO4= nMn2+ x2/5= 9. 10115E-4mol

mKIO4= 9. 10115E-4 x230. 00037= 0. 2093g

Calculation for Unknown:

C= A/b Ɛ= 0. 462799/1×2340. 8027= 1. 977E-4M

n= CV= 1. 977E-4 x 0. 25L= 4. 9425E-5 mol

m= 4. 9425E-5 x54. 938= 2. 7153E-3g

Mass of unknown: 0. 9629g

%Mn= 2. 7153E-3/0. 9629 x100%= 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 KMnO4 solution, the highest peak of absorption was found to be 526nm with absorbance of 0. 935455. The molar extinction coefficient for Mn2+ was then calculated 2340. 8027 L mol−1 cm−1. Then by scanning the sample solution at the wavelength 526nm, the absorbance was found to be 0. 462799 and the concentration of Mn2+ in the sample was calculated to be 1. 977E-4M. Thus the percentage of Mn2+ 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