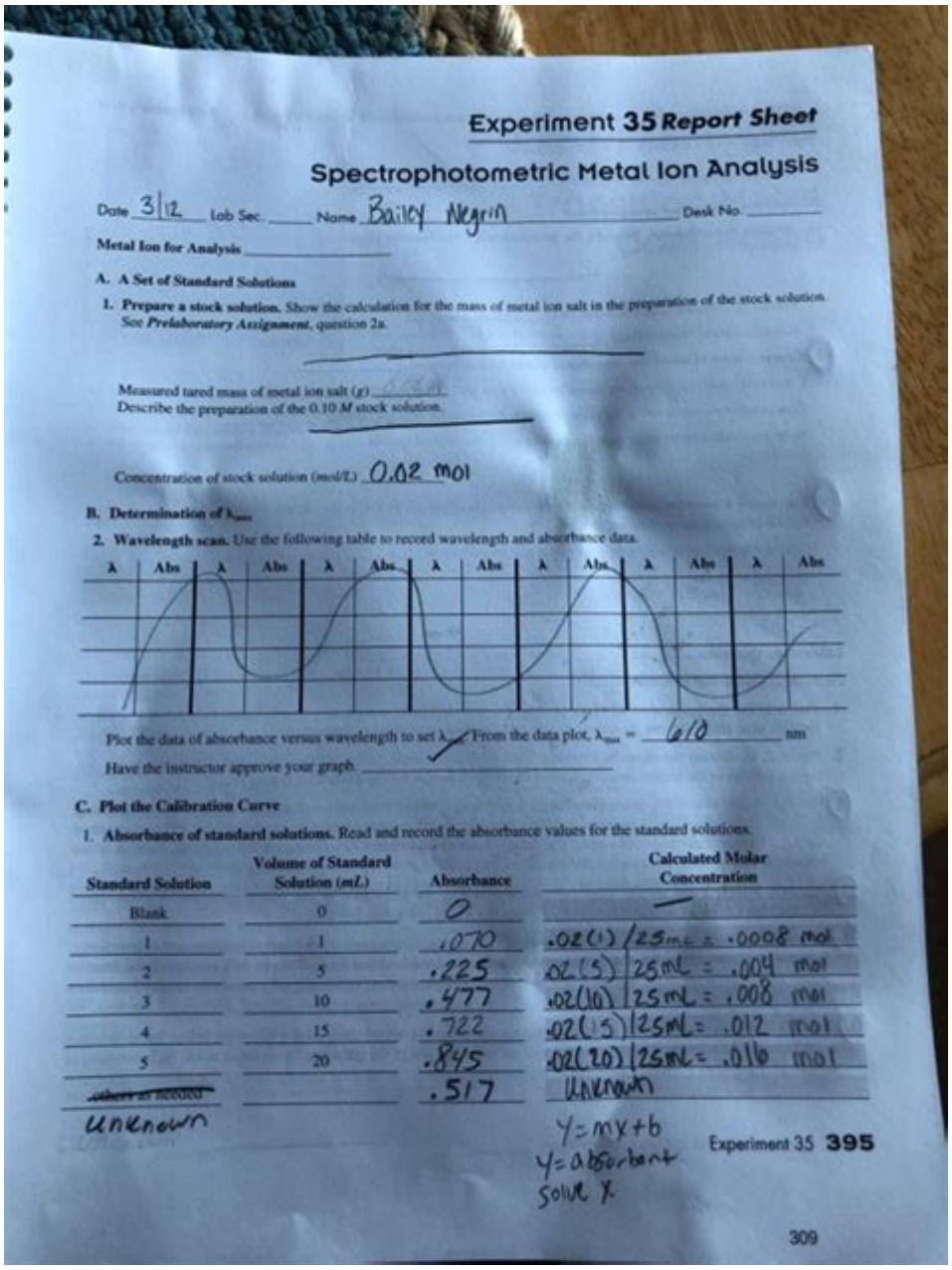
Experiment 35 Spectrophotometric Metal Ion Analysis



Experiment 35 *Report Sheet*

Spectrophotometric Metal Ion Analysis

Date 3/12 Lab Sec. ____ Name Bailey Negrin Desk No. ____

Metal Ion for Analysis ____

A. A Set of Standard Solutions

1. Prepare a stock solution. Show the calculation for the mass of metal ion salt in the preparation of the stock solution. See *Prelaboratory Assignment*, question 2a.

Measured tared mass of metal ion salt (*g*) ____

Describe the preparation of the 0.10 *M* stock solution.

Concentration of stock solution (*mol/L*) 0.02 mol

B. Determination of λ_{max}

2. Wavelength scan. Use the following table to record wavelength and absorbance data.

λ	Abs	λ	Abs	λ	Abs	λ	Abs	λ	Abs	λ	Abs	λ	Abs

Plot the data of absorbance versus wavelength to set λ_{max}. From the data plot, λ_{max} = 610 nm

Have the instructor approve your graph. ____

C. Plot the Calibration Curve

1. Absorbance of standard solutions. Read and record the absorbance values for the standard solutions.

Standard Solution	Volume of Standard Solution (*mL*)	Absorbance	Calculated Molar Concentration
Blank	0	0	—
1	1	.070	.02(1)/25mL = .0008 mol
2	5	.225	.02(5)/25mL = .004 mol
3	10	.477	.02(10)/25mL = .008 mol
4	15	.722	.02(15)/25mL = .012 mol
5	20	.845	.02(20)/25mL = .016 mol
~~other as needed~~		.517	Unknown

Unknown

y=mx+b
y=absorbant
solve x

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Experiment 35 Spectrophotometric Metal Ion Analysis is a crucial laboratory procedure used to determine the concentration of metal ions in various samples. This technique utilizes the principles of spectrophotometry, which involves measuring the amount of light absorbed by a solution. The experiment is widely used in environmental monitoring, industrial processes, and research laboratories to ascertain the presence and concentration of metal ions like copper, lead, iron, and others. In this article, we will delve into the principles, procedures, applications, and benefits of experiment 35, as well as the importance of spectrophotometric methods in metal ion analysis.

Understanding Spectrophotometry

Spectrophotometry is a quantitative analytical method that measures how much light a substance absorbs at various wavelengths. This technique is predicated on the Beer-Lambert Law, which states that the absorbance (A) of a solution is directly proportional to its concentration (c) and the path length (l) of light through the solution:

$$ A = \epsilon \cdot c \cdot l $$

Where:
- A = Absorbance
- ε = Molar absorptivity (a constant for each substance)
- c = Concentration of the solution
- l = Path length of the light through the solution

Principles of Metal Ion Analysis

Metal ion analysis using spectrophotometry is based on the selective absorption of light by specific metal ions when they are complexed with chromogenic agents. These agents react with metal ions to form colored complexes, which can be quantified spectrophotometrically. The intensity of the color is proportional to the concentration of the metal ion in the solution.

Procedure for Experiment 35

The following outline describes the standard procedure for conducting experiment 35 to analyze metal ions via spectrophotometry.

Materials Required

1. Reagents:
- Metal ion solutions (e.g., copper sulfate, lead nitrate)
- Chromogenic reagents (e.g., ammonium pyrrolidine dithiocarbamate for copper)
- Distilled water
- Buffer solutions (if necessary)

2. Equipment:
- Spectrophotometer
- Cuvettes
- Pipettes and volumetric flasks
- Beakers and magnetic stirrer
- Analytical balance

Step-by-Step Procedure

1. Preparation of Standard Solutions:
- Prepare a series of standard solutions of known metal ion concentrations. This will help in constructing a calibration curve.

2. Complex Formation:
- To each standard solution and sample, add the appropriate chromogenic reagent. Mix well to ensure complete reaction and formation of the colored complex.

3. Incubation:
- Allow the mixtures to incubate for a specified duration as per the protocol to ensure that the reaction reaches completion.

4. Measurement of Absorbance:
- Using a spectrophotometer, measure the absorbance of each solution at the wavelength that corresponds to the maximum absorbance of the colored complex.

5. Calibration Curve:
- Plot a calibration curve using the absorbance values of the standard solutions against their concentrations. This curve will be used to determine the concentration of metal ions in unknown samples.

6. Sample Analysis:
- Measure the absorbance of the unknown sample solutions and use the calibration curve to find their concentrations.

Applications of Spectrophotometric Metal Ion Analysis

This analytical method has a wide array of applications across various fields:

- **Environmental Monitoring**: Detecting heavy metals in water samples to assess pollution levels.
- **Industrial Processes**: Monitoring metal ion concentrations in manufacturing processes, such as electroplating and metal refining.
- **Food and Beverage Industry**: Ensuring compliance with safety standards regarding metal contaminants in food products.
- **Pharmaceuticals**: Analyzing metal ion impurities in drugs and formulations.
- **Research and Development**: Conducting studies on metal ion interactions and their biological effects.

Benefits of Using Spectrophotometric Methods

Spectrophotometric metal ion analysis offers several advantages:

1. Sensitivity: Capable of detecting low concentrations of metal ions, making it suitable for environmental and clinical analyses.

2. Precision and Accuracy: Provides reliable results when the method is correctly calibrated and executed.

3. Cost-Effectiveness: Compared to other analytical techniques such as atomic absorption spectroscopy, spectrophotometry can be more affordable while still providing accurate data.

4. Simplicity and Speed: The procedure is relatively straightforward and can yield results in a short amount of time, making it ideal for routine analyses.

5. Versatility: Applicable to a wide range of metal ions and various sample types, including liquids, solids, and slurries.

Conclusion

Experiment 35 Spectrophotometric Metal Ion Analysis is an invaluable technique in the field of analytical chemistry. By leveraging the principles of light absorption, researchers and analysts can gain critical insights into the concentration of metal ions in various samples. The method’s accuracy, sensitivity, and versatility make it essential for environmental monitoring, industrial applications, and research endeavors. As industries and regulatory bodies continue to prioritize safety and environmental protection, spectrophotometric analysis will remain a pivotal tool for ensuring compliance and safeguarding public health.

Frequently Asked Questions

What is Experiment 35 in the context of spectrophotometric metal ion analysis?

Experiment 35 typically refers to a laboratory procedure that utilizes spectrophotometry to quantitatively analyze metal ions in a solution by measuring the intensity of light absorbed by the metal ion complexes.

What types of metal ions can be analyzed using spectrophotometry?

Common metal ions that can be analyzed include copper, iron, lead, nickel, and zinc, among others, depending on the specific reagents and wavelengths used in the analysis.

Why is spectrophotometry a preferred method for metal ion analysis?

Spectrophotometry is preferred due to its high sensitivity, accuracy, and the ability to provide rapid results without the need for extensive sample preparation.

What are the key steps involved in conducting a spectrophotometric metal ion analysis?

Key steps include preparing standard solutions, calibrating the spectrophotometer, measuring the absorbance of samples, and comparing this data against calibration curves to determine the concentration of metal ions.

How does the Beer-Lambert Law apply to spectrophotometric analysis in Experiment 35?

The Beer-Lambert Law relates the absorbance of light by a solution to the concentration of the absorbing species, allowing for the quantification of metal ion concentrations based on absorbance measurements.

What role do reagents play in the spectrophotometric analysis of metal ions?

Reagents, such as complexing agents or chromogenic agents, are crucial as they form colored complexes with metal ions, enhancing the absorbance properties and enabling accurate measurements.

What are some common sources of error in spectrophotometric metal ion analysis?

Common sources of error include improper calibration, interference from other substances in the sample, incorrect wavelength selection, and variations in sample preparation.

How can the results of spectrophotometric metal ion analysis be validated?

Results can be validated by using standard addition methods, comparing with results from alternative analytical methods (e.g., atomic absorption spectrometry), and performing replicate measurements.

Experiment 35 Spectrophotometric Metal Ion Analysis

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