Seperation and Qualitative Determination of Cations and Anions

Inquiry Guidance and AP* Chemistry Curriculum Alignment

Introduction

Much of laboratory chemistry is focused on the question of how much of a given substance is contained in a sample. Sometimes, however, the focus shifts to what substances are in the sample, rather than their quantity. The purpose of qualitative analysis is to identify a series of either cations or anions in a solution through a sequence of chemical reactions and separation procedures.

Opportunities for Inquiry

Identifying the substance that may be present in a solution has a strong connection to tests in the laboratory but also to quality control procedures for commercial and personal products. Developing a scheme for qualitative analysis reinforces and integrates the concepts of chemical reactions and solubility.

Qualitative analysis is driven by the questions "what is present" and "how is it known." Use some or all of the following techniques to add inquiry to the lab and increase students' abilities to answer those questions.

- Provide a list of the possible precipitation and complex-ion formation reactions for the metal cations that will be studied. Guide the students to develop the actual separation schematic through a series of leading questions. How can silver ions be separated and removed from a mixture of iron(III), silver, and zinc ions? What reaction will con firm the presence of silver ions?
- For Part 1 of the lab, provide the students with salts of each cation and anion and the necessary reactants to determine any and all reactions using microscale techniques. In Part 2 of the lab, the students can use their observations from Part 1 to develop a separation scheme to identify and isolate a mixture of the tested ions.
- The qualitative analysis flowcharts are a great resource for the students. Make the lab more challenging by removing some information! The flowchart walks through the procedure stepwise. Take away some of the products in the bolded boxes for students to determine those formulas.
- Build connections between qualitative and quantitative analysis by asking students to adapt one possible precipitation reaction from the analysis scheme (flowchart) for use in quantitative analysis. For example, silver ions are separated from a mixture of other metal cations by precipitating silver chloride. What conditions are needed to ensure that this reaction will be quantitative with respect to the amount of silver ions in solution? Will other cations interfere with the analysis of silver using this reaction?

Alignment with AP Chemistry Curriculum Framework—Big Ideas 1 and 3

Enduring Understandings and Essential Knowledge

All matter is made of atoms. There are a limited number of types of atoms; these are the elements. (Enduring Understanding 1A)

1A2: Chemical analysis provides a method for determining the relative number of atoms in a substance, which can be used to identify the substance or determine its purity.

Chemical changes are represented by a balanced chemical equation that identifies the ratios with which reactants react and products form. (Enduring Understanding 3A)

3A1: A chemical change may be represented by a molecular, ionic, or net ionic equation.

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Chemical and physical transformations may be observed in several ways and typically involve a change in energy. (Enduring Understanding 3C)

3C1: Production of heat or light, formation of a gas, and formation of a precipitate and/or a color change are possible evidences that a chemical change has occurred.

Learning Objectives

3.1 The student can translate among macroscopic observations of change, chemical equations, and particle views.

3.2 The student can translate an observed chemical change into a balanced chemical equation and justify the choice of equation type (molecular, ionic, or net ionic) in terms of utility for the given circumstances.

Science Practices

4.3 The student can collect data to answer a particular scientific question.

5.1 The student can analyze data to identify patterns or relationships.

6.1 The student can justify claims with evidence.

The *Separation and Qualitative Determination of Cations and Anions—AP Chemistry Classic Laboratory Kit* is available from Flinn Scientific, Inc.

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