Synthesis and Analysis of a Coordination Compound

Inquiry Guidance and AP* Chemistry Curriculum Alignment

Introduction

Coordination compounds are interesting substances. They are usually highly colored and produce beautiful crystals. In this lab, green crystals of the coordination compound potassium trioxalatoferrate(III) trihydrate will be synthesized. The crystals are then analyzed to determine their identity, purity and the percent yield of the product.

Opportunities for Inquiry

The study of coordination compounds bridges principles and ideas from several big ideas in chemistry, including atomic and electronic structure, stoichiometry, chemical reactions and chemical bonding. Analysis and identification of coordination compounds provides valuable experience using fundamental analytical procedures such as gravimetric analysis and spectroscopy.

Improve students' understanding of these topics by deleting some of the steps in the procedure and adding independent modifications to the traditional experiment.

- In addition to confirming the compound through colorimetric measurements, ask the students to determine the number of waters of hydration in the crystals through gravimetric measurements. Provide a detailed overview of the purpose and the general calculations: "The purpose of this confirmation experiment is to determine the number of waters of hydration in an iron–oxalate coordination compound. A sample of the coordination compound, $K_3[Fe(C_2O_4)_3]\cdot nH_2O$, will be massed and heated to expel water from the crystals to form $K_3[Fe(C_2O_4)_3]$. The mole ratio of the expelled water and anhydrous residue reflects the number of waters of hydration."
- Give students the general procedure for synthesizing and isolating the coordination compound, but not the amounts of chemicals to use. Students should extrapolate back from the desired amount of product to calculate the moles and mass of the starting materials.
- Extend the experiment to synthesize other transition metal oxalato compounds using manganese, cobalt, nickel, copper, etc.
- In a similar way, students may also investigate other possible ligands for the preparation of iron(III) coordination compounds. Iron(III) ions form a large number of complexes with chelating ligands such as acetylacetone, phenanthroline, ethylenediamine, EDTA, etc. Can these compounds be isolated and crystallized?

Alignment with AP Chemistry Curriculum Framework—Big Ideas 1 and 6

Enduring Understandings and Essential Knowledge

All matter is made of atoms. There are a limited number 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.

Atoms are so small that they are difficult to study directly; atomic models are constructed to explain experimental data on collections of data. (Enduring Understanding 1D)

1D3: The interaction of electromagnetic waves or light with matter is a powerful means to probe the structure of atoms and molecules, and to measure their concentration.

Publication No. 10153
061616

Systems at equilibrium are responsive to external perturbations, with the response leading to a change in the composition of the system. (Enduring Understanding 6B)

6B1: Systems at equilibrium respond to disturbances by partially countering the effect of the disturbance (LeChâtelier's principle).

6B2: A disturbance to a system at equilibrium causes *Q* to differ from *K*, thereby taking the system out of the original equilibrium state. The system responds by bringing *Q* into agreement with *K*, thereby establishing a new equilibrium state.

Learning Objectives

1.2 The student is able to select and apply mathematical routines to mass data to identify or infer the composition of pure substances and/or mixtures.

1.3 The student is able to select and apply mathematical relationships to mass data in order to justify a claim regarding the identity and/or estimated purity of a substance.

1.16 The student can design and/or interpret the results of an experiment regarding the absorption of light to determine the concentration of an absorbing species in a solution.

6.9 The student is able to use LeChâtelier's principle to design a set of conditions that will optimize a desired outcome, such as product yield.

Science Practices

2.2 The student can apply mathematical routines to quantities that describe natural phenomena.

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 *Synthesis and Analysis of a Coordination Compound—AP Chemistry Classic Laboratory Kit* is available from Flinn Scientific, Inc.

Catalog No.	Description
AP6454	Synthesis and Analysis of a Coordination Compound—AP Chemistry Classic Laboratory Kit

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.