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Overhead Precipitation

Double Replacement Reactions

Introduction

Combine potassium iodide and lead(II) nitrate to introduce students to the topic of double replacement reactions!

Concepts

- Solubility
- Precipitation
- Double replacement reactions

Background

Potassium iodide and lead(II) nitrate are combined and undergo a double-replacement reaction. Potassium iodide reacts with lead(II) nitrate and produces lead(II) iodide and potassium nitrate. Potassium nitrate is water soluble. However, lead(II) iodide is only partially soluble in water. Most of the lead(II) iodide precipitates out of the solution as a yellow solid. See Equation 1.

$$2KI(s) + Pb(NO_3)_2(s) \rightarrow 2KNO_3(aq) + PbI_2(s)$$ *Equation 1*

The potassium iodide and lead(II) nitrate are added to opposite sides of a Petri dish that contains water. Both ionic compounds will separate into their individual ions. Once the ions are separated they are hydrated by the water in the Petri dish, which allows them to be carried in solution. The lead ions and iodide ions will eventually meet to form a yellow precipitate. They do not meet exactly in the middle of the Petri dish. The reaction takes place closer to the side of the dish where lead was initially added. The iodide ions are able to migrate further faster due to their smaller atomic mass. The lead ions are heavier and larger thus they take longer to separate, hydrate and migrate through the solution.

Materials

Lead(II) nitrate, $Pb(NO_3)_2$, 1 g
Potassium iodide, KI, 2 g
Water, distilled or deionized
Beaker, 250-mL, 2
Filter paper
Funnel
Overhead projector
Petri dish
Ring, support
Scoop, metal, 2
Support stand

Safety Precautions

Lead nitrate is moderately toxic by inhalation and ingestion, a strong oxidant, and a dangerous fire risk when in contact with organic material. Wear chemical splash goggles, chemical-resistant gloves and a chemical-resistant apron. Wash hands thoroughly with soap and water before leaving the laboratory. Follow all laboratory safety guidelines. Please review current Material Safety Data Sheets for additional safety, handling and disposal information.

Procedure

1. Fill a Petri dish approximately half-full with distilled or deionized water.
2. Using a clean metal scoop obtain approximately one gram of potassium iodide and set aside next to the Petri dish.
3. Using a second clean metal scoop obtain approximately one gram of lead(II) nitrate. *Note:* The exact amount is not crucial as long as the amounts of potassium iodide and lead(II) nitrate are roughly equal.

4. Add the entire contents of both scoops to opposite sides of the Petri dish.
5. Allow the reaction to take place until a yellow precipitate is formed.
6. After observations have been made, stir the solution until it exhibits a uniform yellow color.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory wastes.

Disposal Preparation Procedure

1. Set up a support stand with a ring support clamp, funnel, filter paper, and a 250-mL beaker to collect the waste.
2. Pour the resulting solution from the Petri dish into a 250-mL beaker.
3. Add another scoop full of potassium iodide to react with any lead ions that may still be in solution. Stir.
4. Carefully pour the solution through the filter. *Note:* If done properly, the yellow precipitate will all be trapped by the filter paper and the filtrate in the beaker will be clear.
5. Use a wash bottle containing DI water to rinse the beaker and Petri dish over the filter to clean out any excess lead iodide.
6. Test the filtrate by stirring in additional potassium iodide. If the solution remains clear it is potassium nitrate and it may be disposed of according to Flinn Suggested Disposal Method #26b. If it turns yellow there are still non-reacted lead ions in the system, repeat steps 2–6.
7. The precipitate (lead iodide) must be disposed of by a licensed hazardous waste disposal company according to Flinn Suggested Disposal Method #27f.

Tips

- A Beral pipet may be used as a substitute for a metal scoop. Using scissors remove half the bulb and use the remaining portion of the bulb as a scoop.
- The following ionic compounds may be substituted for potassium iodide and lead(II) nitrate to avoid producing a precipitate containing lead. Silver nitrate ($AgNO_3$) and sodium bromide (NaBr) or calcium nitrate ($Ca(NO_3)_2$) and sodium sulfate (Na_2SO_4).

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12
Evidence, models, and explanation
Content Standards: Grades 5–8
Content Standard B: Physical Science, properties and changes of properties in matter
Content Standards: Grades 9–12
Content Standard B: Physical Science, structure of atoms, structure and properties of matter, chemical reactions

Flinn Scientific—Teaching Chemistry™ eLearning Video Series

A video of the *Overhead Precipitation* activity, presented by Peg Convery, is available in *Double Replacement Reactions* and in *Precipitation Reactions and Solubility Rules*, part of Flinn Scientific—Teaching Chemistry eLearning Video Series.

Materials for *Overhead Precipitation* are available from Flinn Scientific, Inc.

Catalog No.	Description
L0014	Lead Nitrate, reagent, 100 g
P0278	Potassium Iodide, 100 g

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