Making Prussian Blue Paint

Introduction

Color your world blue! In this activity, Prussian blue pigment will be made, then added to linseed oil to prepare a blue, oil-based paint.

Concepts

- Chemistry of paint
- Pigments
- History of paint-making

Materials

Iron(III) chloride solution, saturated, $FeCl_3$, 20 mL
Linseed oil, 5 mL
Potassium ferrocyanide solution, saturated, $K_4[Fe(CN)_6]$, 20 mL
Beakers, 150-mL, 2
Funnel with filter paper
Graduated cylinder, 25-mL
Mortar and pestle
Paintbrush or wooden splint
Paper for testing paint
Ring stand with ring
Stirring rod
Watch glass

Safety Precautions

Iron(III) chloride is corrosive, slightly toxic by ingestion, and a skin and tissue irritant. Potassium ferrocyanide is slightly toxic by ingestion. If potassium ferrocyanide is heated to decomposition or comes into contact with strong acids, toxic hydrogen cyanide gas may evolve. The pigment will easily stain skin and clothing and is not easy to remove by washing. Handle it carefully. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. Please review current Material Safety Data Sheets for additional safety, handling, and disposal information.

Preparation

1. To prepare a saturated iron(III) chloride solution, dissolve 92 g of iron(III) chloride hexahydrate, $FeCl_3 \cdot 6H_2O$, in enough distilled or deionized water to make 100 mL of solution.
2. To prepare a saturated potassium ferrocyanide solution, dissolve 30 g of potassium ferrocyanide trihydrate, $K_4[Fe(CN)_6] \cdot 3H_2O$ in enough distilled or deionized water to make 100 mL of solution.

Procedure

1. Mix 20 mL of saturated iron(III) chloride solution with 20 mL of saturated potassium ferrocyanide solution in a beaker. Stir to mix.
2. Filter the precipitate using a funnel supported by a ring stand and ring.
3. Scrape the precipitate from the filter paper onto a watch glass and allow it to dry completely. It may take up to a week for the pigment to dry completely. This is the Prussian blue pigment.
4. Pour about 10 mL of linseed oil into a mortar. Add a small, pea-size amount (about 2 g) of the pigment to the mortar and grind with a pestle until a uniform paste is obtained. Add additional pigment to achieve the desired color.
5. Dip a small paintbrush or wooden splint into the paint and paint a design on a piece of paper. Allow the oil to dry completely (about 24 hours) before evaluating the finished (painted) product.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory waste. Dispose of any excess pigment according to Flinn Suggested Disposal Method #14. Dispose of painted samples in the trash according to Flinn Suggested Disposal Method #26a.

Publication No. 10211
061616

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
Constancy, change, and measurement
Content Standards: Grades 5–8
Content Standard B: Physical Science, properties and changes of properties in matter
Content Standard E: Science and Technology
Content Standard F: Science in Personal and Social Perspectives, science and technology in society
Content Standard G: History and Nature of Science, history of science
Content Standards: Grades 9–12
Content Standard B: Physical Science, structure and properties of matter, chemical reactions
Content Standard E: Science and Technology
Content Standard G: History and Nature of Science, historical perspectives

Tips

- The pigment will stain skin and clothing quite easily and is not easy to remove by washing. Handle it carefully.
- This is oil-based paint which has a different consistency than the familiar latex paints commonly used today. The correct consistency is a grainy mix of pigment in oil.
- This recipe will make approximately 8 g of pigment. About 2 g of pigment mixed with 10 mL of linseed oil are needed for each student or student group to paint a nice design.
- Other pigments can be prepared. To prepare school bus yellow pigment, mix 20 mL of saturated sodium chromate solution with 20 mL of saturated zinc sulfate solution. To prepare permanent white pigment, mix 20 mL of saturated sodium sulfate solution with 20 mL of saturated barium chloride solution. To prepare brunswick green pigment, mix small, but equal, amounts of school bus yellow and Prussian blue. To lighten the color of the green paint, add more permanent white pigment. With each pigment, stir the mixtures, filter, allow to dry completely, and mix with linseed oil as with the Prussian blue pigment.

Discussion

The early use of paint was mainly for art and beautification. Primitive pigments were used to draw pictures on the walls of caves. Ancient peoples also decorated their faces and bodies with pigments. Many of these ancient pigments were derived from minerals and clays taken from the earth. Clays rich in iron oxide produced red and brown pigments, while ores of copper were ground into green and blue pigments. These pigments were mixed with sticky materials to form a primitive type of paint.

Today, paint is used for protection as well as decoration. A typical modern paint contains two essential ingredients: the pigment, or coloring material, and the liquid in which the pigment is suspended. For oil-based paints, this liquid is an oil, while latex paints use water. A good paint must form a solid film that adheres to the painted surface and serves to protect it against attacks by oxygen in the air, sunlight, and environmental pollutants.

The Prussian blue pigment used in this activity is formed by the reaction between iron(III) chloride and potassium ferrocyanide to produce iron(III) ferrocyanide, also called Prussian blue.

$$3[Fe(CN)_6]^{4-}(aq) + 4Fe^{3+}(aq) \rightarrow Fe_4[Fe(CN)_6]_3(s)$$

Linseed oil is the preferred oil to use in oil-based paints because it contains unsaturated fatty acids such as oleic, linoleic, and linolenic acids. When these unsaturated oils are exposed to the oxygen in the air, the double bonds are oxidized by (react with) the oxygen to produce more saturated substances which form tough and lasting films.

References

Eby, D. *The Chemistry of Color;* Flinn Scientific: Batavia, IL, 1989; pp 17–26.

Materials for *Making Prussian Blue Paint* are available from Flinn Scientific, Inc.

Catalog No.	Description
F0006	Iron(III) chloride, 100 g
L0023	Linseed oil, 500 mL
P0053	Potassium ferrocyanide, 100 g

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