Dynamic Duo

A Co-Catalysis Demonstration

Introduction

Two catalysts cooperate to accelerate the decomposition of hydrogen peroxide.

Concepts

- Co-catalysis
- Kinetics
- Decomposition reactions

Materials

Cupric chloride solution, $CuCl_2 \cdot 2H_2O$, 1 M, 12 mL
Ferric chloride solution, $FeCl_3 \cdot 6H_2O$, 1 M, 12 mL
Hydrogen peroxide solution, H_2O_2, 6%, 300 mL
Balloons, 11″, 3
Erlenmeyer flasks, 500-mL, 3
Test tubes, 20 × 150 mm (34-mL), 3

Safety Precautions

Hydrogen peroxide solution is an oxidizer and an eye and skin irritant. Cupric chloride solution is toxic by ingestion. Ferric chloride solution is a skin and tissue irritant. Wear chemical-resistant gloves, chemcal splash goggles, and a chemical-resistant apron. Please review current Material Safety Data Sheets for additional safety, handling, and disposal information.

Preparation

Prepare or purchase the following solutions:

1. 6% Hydrogen peroxide solution: Dilute 60 mL of 30% hydrogen peroxide with 240 mL of distilled or deionized water.
2. 1 M Cupric chloride solution: Dissolve 17.05 grams of cupric chloride, $CuCl_2 \cdot 2H_2O$ in 100 mL of distilled or deionized water.
3. 1 M Ferric chloride solution: Dissolve 27.03 grams of ferric chloride, $FeCl_3 \cdot 6H_2O$, in 100 mL of distilled or deionized water.

Procedure

1. Obtain three test tubes and label them A, B, and C. Repeat this process with the three Erlenmeyer flasks.
2. Add 100 mL of 6% hydrogen peroxide solution to each of the Erlenmeyer flasks.
3. Add 8 mL of 1 M cupric chloride solution to test tube A and carefully slide it into flask A without spilling the contents of either the flask or the tube.
4. Add 8 mL of 1 M ferric chloride solution to test tube B and carefully slide it into flask B without spilling the contents of either the flask or the tube.
5. Add 4 mL each of 1 M ferric chloride solution and 1 M cupric chloride solution to test tube C and carefully slide it into flask C without spilling the contents of either the flask or the tube.

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6. Secure a balloon over the mouth of each of the three flasks (see Figure 1).

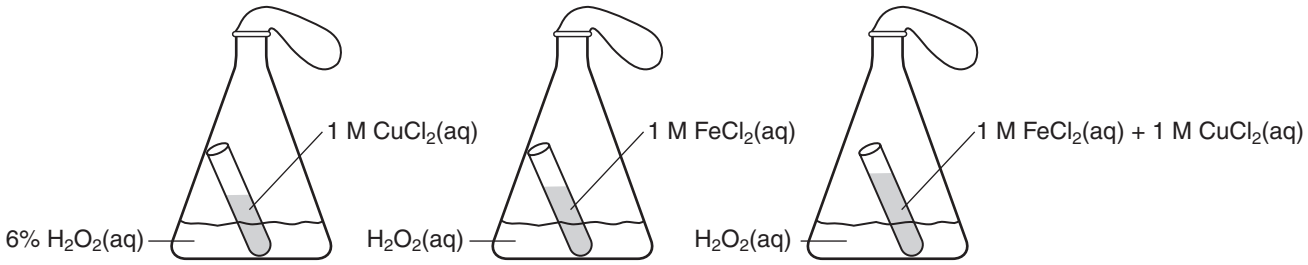

Figure 1.

7. Quickly, yet carefully, tilt each of the flasks, allowing the contents of the test tubes to mix with the hydrogen peroxide solution in the flasks.
8. Return the flasks to upright positions and observe the rates at which the balloons expand.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory waste. The resulting solutions may be disposed of according to Flinn Suggested Disposal Method #26b.

Discussion

Cupric chloride and ferric chloride each act as a catalyst for the decomposition of H_2O_2:

$$H_2O_2(aq) \rightarrow H_2O(l) + O_2(g) \qquad \textit{Equation 1}$$

While the mechanism is not fully understood, when the two catalysts are mixed, the Cu^{2+} and Fe^{3+} ions act together as co-catalysts and dramatically increase the rate of reaction, compared to the reaction rate when only one of the catalysts is present.

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 Standards: Grades 9–12
Content Standard B: Physical Science, structure of atoms, structure and properties of matter, chemical reactions

References

Bilash, B.; Gross, G. R.; Koob, J. K. *A Demo A Day;* Flinn Scientific: Batavia, IL, 1995; p 193.

Walton, J. H. *J. Chem Ed.*, **1931,** *8;* p 303.

Materials for *Dynamic Duo—A Co-Catalysis Demonstration* are available from Flinn Scientific, Inc.

Catalog No.	Description
C0161	Cupric Chloride, $CuCl_2z2H_2O$, 500 g
F0069	Ferric Chloride Solution, $FeCl_3z6H_2O$, 100 mL
H0028	Hydrogen Peroxide, 6%, 500 mL
AP1900	Balloons, Latex, 110, 20/pkg.

Consult the Flinn Scientific website for current prices.