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Keep Your Eye on the Ions

Double-Replacement Model Demonstration

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Introduction

Colored molecular model balls are used to illustrate solubility, ionization, double replacement reaction, and precipitation. This demonstration will help students visualize the key concepts of a double-replacement reaction.

Concepts

- Solubility
- Ionization
- Double replacement reaction
- Precipitation

Background

In *double-replacement reactions* or *ionic reactions*, the ions of two compounds exchange places in an aqueous solution to form two new compounds. One of the compounds formed is usually a precipitate. The other compound is often soluble and remains dissolved in solution as aqueous ions. A double-replacement reaction is represented by the following general equation:



A, X, B, and Y in the reactants represent ions. AY and BX represent ionic or molecular compounds.

The formation of a precipitate occurs when the positive ions of one reactant combine with the negative ions of another reactant and form an insoluble or slightly soluble compound. For example, when a solution of silver nitrate is added to a solution of sodium chloride, a white precipitate (AgCl) separates from the mixture.



The precipitate of silver chloride (AgCl) forms as a result of very strong attractive forces between the Ag^+ and the Cl^- ions. Sodium ions and nitrate ions do not take part in the reaction and remain in solution as aqueous ions—they are called spectator ions.

In the model depicted in this demo, a compound, such as AgNO_3 , is represented by two colored balls (one magnetic and one not magnetic). A second compound (like sodium chloride) is similarly made with different colored balls. When each compound is dissolved in water, the ions dissociate. When the two resulting solutions are mixed together, the two magnetic balls form a precipitate that sinks to the bottom of the resulting solution (magnetic attraction). The other two ions (non-magnetic) are separate and dispersed (floating) in the solution—a perfect analogy of a typical double-replacement reaction.

Materials (for each demonstration)

Beakers, 400-mL, 2
Beaker, 1000-mL
Water, 600 mL
Scissors

White glue
Colored balls, 4, four different colors
(two magnetic and two non-magnetic)*
Cellulose paper strips, $\frac{1}{2}$ " \times 2", 4*

*Materials included in kit.

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Safety Precautions

This demonstration is considered safe. Follow all normal laboratory safety rules.

Preparation

1. Use white glue to glue two strips of cellulose paper to two colored balls (one magnetic and one non-magnetic) as shown in Figure 1.
2. Create another model compound using different colored balls than those used in step 1. The two model compounds should contain four balls, all different colors. Allow the glue to dry.

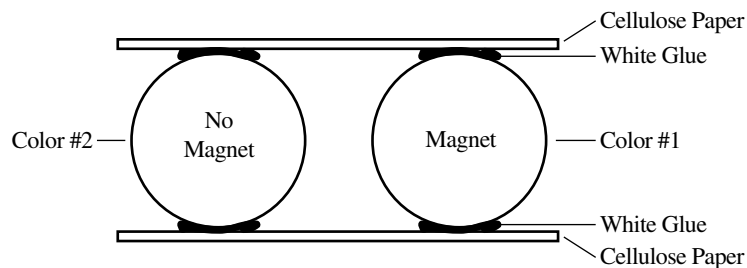


Figure 1. Model Preparation

Procedure

1. Place 300 mL of water into each of two 400-mL beakers.
2. Show one of the pre-made model compounds to students. Have them note the colors of the balls in the model. Explain that the glued paper strips represent the bonds holding the atoms together.
3. Place the model compound into one of the beakers of water. The paper will dissolve very quickly and the two balls will separate. One should sink and one should float, making them separate dramatically. The ions have “dispersed” in the water.
4. Repeat step 3 with the other model compound in the other beaker of water. Again note the colors of the atoms and the ionization depicted.
5. Simultaneously pour the contents of the two “solutions” into the 1000-mL beaker and note the results. The two magnetic balls should bond and “precipitate” in the bottom of the beaker. The two floating balls will not bond and will float freely in the solution.
6. Discuss the entire demonstration. Be sure students understand all of the analogies illustrated and can explain the concepts illustrated by all of the model components. A specific chemical example, like the one given in the *Background* information, can be used to illustrate an actual chemical reaction shown in the demonstration.

Disposal

All the glue can be soaked off the balls and they can be reused many times.

Tips

- The kit contains enough materials to perform the demonstration at least seven times for one glue drying cycle.
- Dissolving mole dollars (Flinn AP8678) can be used for making bonds when the paper in this kit is consumed.
- Use your imagination to illustrate other chemical reactions and principles with the materials in this kit.
- Double-sided tape might be used instead of glue to speed up the preparation time.

Acknowledgment

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Materials for *Keep Your Eye on the Ions* are available from Flinn Scientific, Inc.

Catalog No.	Description	Price/Each
AP6377	Keep Your Eye on the Ions Double-Replacement Model Demonstration	Consult Your Current <i>Flinn Catalog/Reference Manual</i> .
AP8678	Melting Mole Dollars	