



Observing Double Displacement Reactions

A double displacement reaction involves the exchange of cations between two ionic compounds, usually in aqueous solution. It can be represented with the general equation



Most often, double displacement reactions result in the formation of a precipitate. However, some double displacement reactions result in the formation of an unstable compound which then decomposes to water and a gas.

The reaction of an acid and a base—a neutralization reaction—is also a type of double displacement reaction. It results in the formation of a salt and water.

Question

How can you tell if a double displacement reaction has occurred? How can you predict the products of a double displacement reaction?

Prediction

For each reaction in Tables A and B, write a balanced chemical equation. Use the following guidelines to predict precipitate formation in Table A.

- Hydrogen, ammonium, and Group I ions form soluble compounds with all negative ions.
- Chloride ions form compounds that are not very soluble when they bond to silver, lead(II), mercury(I), and copper(I) positive ions.
- All compounds that are formed from a nitrate and a positive ion are soluble.
- With the exception of the ions in the first bulleted point, as well as strontium, barium, radium, and thallium positive ions, hydroxide ions form compounds that do not dissolve.
- Iodide ions that are combined with silver, lead(II), mercury(I), and copper(I) are not very soluble.
- Chromate compounds are insoluble, except when they contain ions from the first bulleted point.

Materials

well plate
 sheet of white paper
 several test tubes
 test tube rack
 test tube holder
 2 beakers (50 mL)
 tongs
 scoopula
 laboratory burner
 flint igniter
 red litmus paper
 wooden splint
 wash bottle with distilled water
 HCl solution
 the following aqueous solutions in dropper bottles: BaCl₂, CaCl₂, MgCl₂, Na₂SO₄, NaOH, AgNO₃, Pb(NO₃)₂, KI, FeCl₃, solid Na₂CO₃ and NH₄Cl

Safety Precautions



- Hydrochloric acid is corrosive. Use care when handling it.
- Before lighting the laboratory burner, check that there are no flammable liquids nearby.
- If you accidentally spill a solution on your skin, immediately wash the area with copious amounts of water.
- Wash your hands thoroughly after the experiment.

Procedure

1. Copy Tables A and B into your notebook. Do not write in this textbook.
2. Place the well plate on top of the sheet of white paper.
3. Carry out each of the reactions in Table A by adding several drops of each solution to a well. Record your observations in Table A.

If you are unsure about the formation of a precipitate, repeat the reaction in a small test tube for improved visibility.

- Place a scoopula tipful of Na_2CO_3 in a 50 mL beaker. Add 5 mL of HCl. Use a burning wooden splint to test the gas produced. Record your observations in Table B.
- Place a scoopula tipful of NH_4Cl in a test tube. Add 2 mL NaOH. To detect any odour, gently waft your hand over the mouth of the test tube towards your nose. Warm the tube gently (do not boil) over a flame. Record your observations in Table B.
- Dispose of all chemicals in the waste beaker supplied by your teacher. Do not pour anything down the drain.

Table A Double Displacement
Reactions That May Form a Precipitate

Skeleton equation	Observations
$\text{MgCl}_2 + \text{NaOH}$	
$\text{FeCl}_3 + \text{NaOH}$	
$\text{BaCl}_2 + \text{Na}_2\text{SO}_4$	
$\text{CaCl}_2 + \text{AgNO}_3$	
$\text{Pb}(\text{NO}_3)_2 + \text{KI}$	

Table B Double Displacement
Reactions That May Form a Gas

Reaction	Observations
$\text{Na}_2\text{CO}_3 + \text{HCl}$	
$\text{NH}_4\text{Cl} + \text{NaOH}$	

Analysis

- Write the balanced chemical equation for each reaction in Table A.
- For each reaction in Table B, write the appropriate balanced chemical equation

Conclusion

- How did you know when a double displacement reaction had occurred?

Application

- Suppose that you did not have any information about the solubility of various compounds, but you did have access to a large variety of ionic compounds. What would you need to do before predicting the products of the displacement reactions above? Outline a brief procedure.