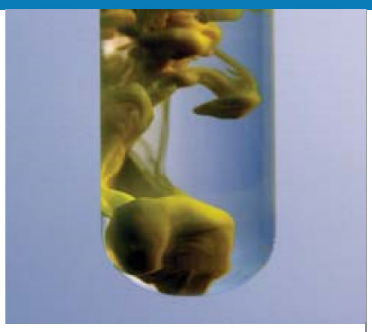

NATIONAL MATH + SCIENCE INITIATIVE

Not My Type

Classifying Chemical Reactions

In this activity, you will observe and predict products for some simple chemical reactions. You will classify the reactions as synthesis, decomposition, single replacement, or double replacement. In addition, reactions may also be described as redox, precipitation, or neutralization.

MATERIALS

aprons
Bunsen burner
clamp, test tube
crucible tongs
goggles
graduated cylinder, 50 mL
paper towels
splint, wooden
test tube rack
4 test tubes, medium
hydrochloric acid, 1 M
hydrochloric acid, 3 M
magnesium, ribbon
4 pipettes, thin stem
potassium iodide, 1 M
silver nitrate, 0.1 M
sodium chloride, 0.1 M
sodium hydroxide, 1 M
hydrogen peroxide, 3%
lighter, fireplace

SAFETY ALERT!

- Goggles and aprons must be worn at all times.
- Magnesium metal is flammable. Avoid looking directly at the metal as it burns. The light is damaging to your eyes.
- Hydrogen peroxide is slightly toxic by ingestion. It is also an irritant to skin, eyes, and the respiratory tract.
- Potassium iodide is irritating to body tissue.
- Hydrochloric acid is slightly toxic by inhalation and ingestion. It is a severe body tissue irritant and is corrosive to the eyes.
- Silver nitrate is moderately toxic by ingestion. It is also a body tissue irritant that discolors skin and clothing.

GAS IDENTIFICATION

- Hydrogen gas pops or “barks” when ignited.
- Oxygen gas causes a flame to enlarge or brighten.
- Carbon dioxide gas extinguishes a flame.

PROCEDURE

It is important to rinse the graduated cylinder several times with deionized water before filling with a different solution.

1. Put on your goggles and aprons.
2. Obtain a small strip of magnesium ribbon from your teacher. Using the crucible tongs, clamp them tightly to one end of the metal.
3. Have your partner light the Bunsen burner. Using the tongs, position the free end of the magnesium into the blue cone—the hottest portion—of the flame. There must be enough of the metal exposed to the air (oxygen) for the reaction to occur. Once the metal ignites, look away from the flame as it burns.

   IMPORTANT! *Do not look directly at the metal.*

   The light emitted as the metal burns can cause permanent damage to your eyes. In the data table on your student answer page, record the two reactants involved in the reaction along with your observations for this experiment.
4. Use a pipette to add a small amount of 0.1 *M* silver nitrate, $AgNO_3$, to a medium-sized test tube. Using a clean pipette, add a small amount of 0.1 *M* sodium chloride, NaCl, solution. In your data table, record the two reactants involved in this experiment and record your observations.
5. Rinse the graduated cylinder with distilled water several times. Measure 20.0 mL of hydrogen peroxide, H_2O_2. Pour the hydrogen peroxide into a clean medium-sized test tube.
6. Use a pipette to obtain a small amount of potassium iodide, KI. Slowly drop the KI into the test tube containing the hydrogen peroxide.

   A catalyst is neither a reactant nor a product.

   The KI in this reaction serves as a catalyst; it will enable the decomposition of hydrogen peroxide to occur quickly. Allow the reaction to proceed for at least 1 min.

PROCEDURE (CONTINUED)

7. Light a wooden splint. Blow out the flame on the splint and insert the glowing splint into the reaction tube. Be sure not to insert the splint into the liquid.

   Observe what happens to the wooden splint. Touch the outside of the test tube and observe any temperature changes. In your data table, record the reactant involved in the reaction along with all of your observations.

8. Obtain another strip of magnesium from your teacher. Using a clean graduated cylinder, measure 10.0 mL of 3.0 *M* hydrochloric acid, HCl, solution and pour it into a test tube.

The second test tube must be dry.

9. Place the test tube into the test tube rack. Carefully add the magnesium to the hydrochloric acid. Use a second medium-sized test tube inverted over the reaction tube to capture any gas produced. Allow the reaction to proceed for at least 1 min.

10. Leave the collection tube turned upside down, light a wooden splint and insert the flaming splint into the gas collection tube. Be careful—it might scare you! Record your observations.

    Touch the outside of the test tube and observe any temperature changes. In your data table, record the two reactants involved in this experiment along with all of your observations.

11. Use a pipette to obtain a small amount of 1.0 *M* HCl and add 10 drops to a test tube. Use a pipette to obtain a small amount of 1.0 *M* NaOH and add 10 drops to the test tube containing the acid. Swirl the test tube gently to mix the solutions. Record your observations.

    Touch the outside of the test tube and observe any temperature changes. In your data table, record the two reactants involved in this experiment along with all of your observations.

12. Clean all lab equipment by washing and rinsing it thoroughly. Dispose of any remaining materials as your teacher instructs.

DATA AND OBSERVATIONS

Table 1. Types of Chemical Reactions	
Reactants (Symbols)	**Observations**

CONCLUSION QUESTIONS

1. Using your knowledge of types of reactions, predict the products for the reactions you observed. Write complete balanced chemical equations in the space provided.

   a.

   b.

   c.

   d.

   e.

2. For each investigation, determine which type of reaction occurred from the list in Table 2. Some reactions may be classified as more than one type.

Table 2. Types of Reactions	
Synthesis	Redox
Decomposition	Precipitation
Single replacement	Neutralization
Double replacement	Combustion

   a.

   b.

   c.

   d.

   e.

CONCLUSION QUESTIONS (CONTINUED)

3. How is it possible that a reaction can be both synthesis and redox? Include a particulate drawing to support your answer.

4. When chemical changes occur, the new substances formed have properties that are distinguishable from the initial substance or substances. Such chemical processes may be observed in a variety of ways, and often involve changes in energy as well. For each reaction you observed, describe the evidence that let you know a chemical change occurred.

   a.

   b.

   c.

   d.

   e.

CONCLUSION QUESTIONS (CONTINUED)

Scientists often refer to an *activity series* of metals to determine which metal can displace another metal from a compound. The most active metals are found at the top of the series. When using the activity series of metals located on the student reference page, remember that the most active metals are listed first. When comparing two metals, the one at the top of the list is the most active and can displace the metals below it.

Notice that hydrogen is included in this list—treat it the same way you would a metal. For example, using the activity series on your student reference page you can see that magnesium is more active than zinc because it is higher in the series. Therefore, magnesium metal can displace a zinc ion from a compound in a single replacement reaction.

5. Using the activity series on your student reference page, explain what happened when magnesium and hydrochloric acid were combined.

6. Which metals can calcium replace in a single replacement reaction? Which metals could it not replace?

7. Provide an example of a single replacement reaction where calcium replaces a metal from any ionic salt.

CONCLUSION QUESTIONS (CONTINUED)

8. Scientists also use solubility rules to determine which aqueous solutions are soluble with one another and which ones are not. Those that are not soluble form a solid called a precipitate. Using the solubility rules on your student reference page, examine the reaction between silver nitrate and sodium chloride. Predict which one of the products was the solid white precipitate. Explain your reasoning.

9. Using the solubility rules from your student reference page, determine which product in each reaction is the precipitate and write an (*s*) to the immediate right of the insoluble compound.

$$Cu(NO_3)_2 + K_2S \rightarrow CuS + 2\ KNO_3$$

$$CaCl_2 + Na_2CO_3 \rightarrow CaCO_3 + 2\ NaCl$$

EXTENSION

In the reaction between magnesium and hydrochloric acid, a specific type of a gas was produced that was the same gas used to fill the Hindenburg airship. Research the Hindenburg airship and its ultimate demise and explain why they no longer use this gas for inflation of dirigibles.

REFERENCE

ACTIVITY SERIES OF METALS

Li

K

Ca

Na

Mg

Al

Mn

Zn

Cr

Fe

Cd

Co

Ni

Sn

Pb

H (a nonmental)

Sb (a metalloid)

Cu

Hg

Ag

Pt

SOLUBILITY RULES

1. All ionic compounds involving Group 1 metals or ammonium are soluble in water.
2. Most ionic compounds containing nitrates, acetates, and chlorates are soluble.
3. Most ionic compounds containing chlorides are soluble except chlorides combined with silver, mercury(I), and lead.
4. Most ionic compounds containing sulfates are soluble except sulfates combined with calcium, barium, strontium, silver, mercury(I), and lead.
5. Most ionic compounds containing carbonates, phosphates, and silicates are insoluble except with those ions mentioned in Rule 1.
6. Most ionic compounds containing sulfides are insoluble except the sulfides combined with those mentioned in Rule 1 and calcium, barium, strontium, and magnesium.