11 TYPES OF CHEMICAL REACTIONS
EXPERIMENT

Text Reference
Section 8.2

PURPOSE

To identify and classify chemical reactions based on five general categories.

BACKGROUND

Although countless chemical reactions exist, nearly all of them can be classified into a few specific categories. In this experiment, you will learn to differentiate five general types of chemical reactions. Some of the reaction you will perform; others will be demonstrated by your teacher. From observations, you will identify the products of each reaction and determine the type of reaction that has taken place. You will consider the following reaction types: *combination reactions, decomposition reactions, single-replacement reactions, double-replacement reactions,* and *combustion reactions*. The majority of common chemical reactions can be classified as belonging to one of these categories.

MATERIALS (PER PAIR)

(Student Experiment)

safety goggles
2 small test tubes
2 medium test tubes
1 test-tube rack
1 gas burner
1 ring stand
1 utility clamp
1 dropper pipet
1 crucible tongs
iron filings, Fe
magnesium turnings, Mg [F]
0.1*M* copper(II) sulfate, $CuSO_4$ [T]
0.1*M* lead(II) nitrate, $Pb(NO_3)_2$ [T]
0.1*M* potassium iodide, KI [T]
3% hydrogen peroxide, H_2O_2
6*M* hydrochloric acid, HCl [C] [T]
2 wood splints
1 book of matches

(Teacher Demonstration)

1 electrolysis apparatus
1 rubber stopper, one-holed
1 large test tube
1 glass tube, 25-cm length, bent at 90° angle in center
sodium hydrogen carbonate, $NaHCO_3$
limewater, saturated solution of calcium oxide, CaO [I]
wood splints
matches

SAFETY FIRST!

In this lab, observe all precautions, especially the one listed below. If you see a safety icon beside a step in the procedure, refer to the list below for its meaning.

Caution: Wear your safety goggles. (All steps.)

Caution: Hydrochloric acid is corrosive and can cause severe burns. (Step 3.)

Caution: Lead and copper compounds are toxic. Use as little of these compounds as practical. (Steps 1, 2.)

Caution: Exercise care when working with an open flame. Tie back hair and loose clothing. Do not use the burner near flammable materials. (Step 4.)

Note: Return or dispose of all materials according to the instructions of your teacher (Step 7.)

PROCEDURE

As you perform the experiment, record your observations in Data Table 1.

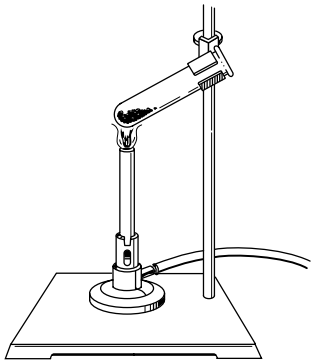

Figure 11.1

Part A. Student Experiments

1. **Iron metal and copper(II) sulfate solution.** Half-fill a small test tube with copper(II) sulfate solution. Add about 2 g of iron filings to the solution. After 5 minutes, record your observations.
2. **Lead(II) nitrate and potassium iodide solutions.** Put 2 mL of lead(II) nitrate solution into a small test tube. Add 5–10 drops of potassium iodide solution. Record your observations.
3. **Magnesium metal and hydrochloric acid.** ***Caution:*** *Hydrochloric acid is corrosive.* Half-fill a medium-sized test tube with 6*M* hydrochloric acid. Place the test tube in a test-tube rack and add several magnesium turnings. Identify any gas that forms by using crucible tongs to hold a *burning* wood splint at the mouth of the test tube. Record your observations.
4. **Action of heat on hydrogen peroxide.** Add 2 mL of the 3% hydrogen peroxide solution to a medium-sized test tube. Clamp the test tube to a ring stand, as shown in Figure 11.1. **CAUTION:** *Make sure that the mouth of the tube is pointed away from you and away from everyone else.* Heat the solution *very gently*. Identify any gas that forms by using crucible tongs to insert a *glowing* wood splint into the mouth of the test tube. Record your observations.

Step 4:
Tell students to allow sufficient time for the concentration of hydrogen gas to build up before inserting the glowing splint.

Part B. Teacher Demonstrations

5. **Action of electricity on water (electrolysis).** Water can be broken down into its component elements by passing electricity through it. This process is called *electrolysis*. Your teacher will explain the apparatus shown in Figure 11.2. Make observations of the reaction during a 10-minute period.

6. **Action of heat on sodium hydrogen carbonate.** Solid sodium hydrogen carbonate will be heated strongly in a large test tube for 2 minutes. The gas that is given off will be tested by exposing it to a burning splint and by bubbling it through limewater. Record your observations of these tests.

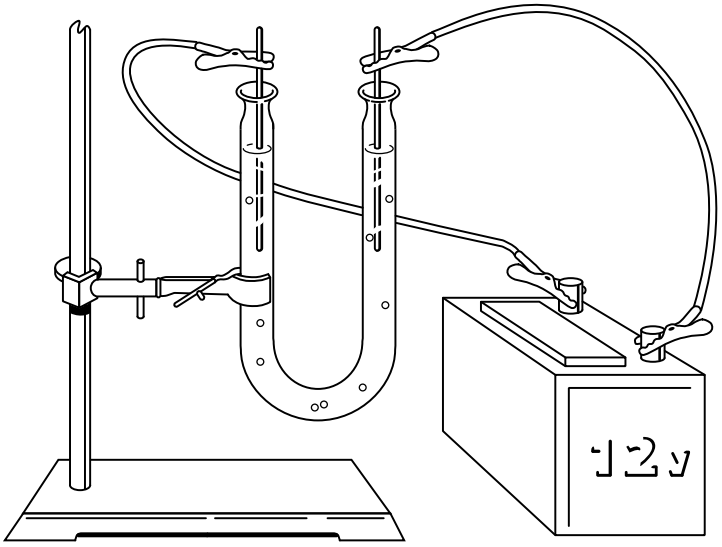

Figure 11.2

7. Follow your teacher's instructions for proper disposal of the materials.

Name _____ Class _____ Date _____

OBSERVATIONS

DATA TABLE 1: CHEMICAL REACTION TYPES

Reaction	Observations	Reaction Type
Fe and $CuSO_4$		
$Pb(NO_3)_2$ and KI		
Mg and HCl		
H_2O_2 and heat		
electrolysis of H_2O		
$NaHCO_3$ and heat		

ANALYSES AND CONCLUSIONS

1. Classify each of the observed reactions as one of the five reaction types listed in the Background section. Record your answers in Data Table 1.

2. Write an equation for each reaction observed. Indicate the state (*s*, *l*, *g*, *aq*) for each reactant and product, then balance each equation.

rxn 1: _____

rxn 2: _____

rxn 3: _____

rxn 4: _____

rxn 5: _____

rxn 6: _____

3. Although no combustion reactions were described in the Procedure section, two combustion reactions did occur in the course of this experiment. The reactants were H_2 and CH_4 (natural gas), respectively. Write a balanced equation for the combustion of each of these substances.

_____

_____

Name _____ Class _____ Date _____

4. Identify the combustion reaction in the previous question that is also a combination reaction.

$2H_2 + O_2 \longrightarrow 2H_2O$

5. Describe in your own words the five types of chemical reactions listed in the Background section. Explain how to distinguish each of these types of reactions.

A combination reaction has a single product.

A decomposition reaction has a single reactant.

In a single-replacement reaction, one element displaces another element from an aqueous solution of a compound, to form a new compound and a free element.

In a double-replacement reaction, two new compounds are formed when aqueous solutions of two ionic compounds are mixed. One of the newly formed compounds is a precipitate, a gas, or a molecular compound.

In a combustion reaction, O_2 reacts with another chemical to produce an oxide and to generate heat and light. When the chemical that O_2 reacts with is a hydrocarbon, the products of the reaction are CO_2 and H_2O.

6. List the tests that were used to identify the three gases produced in this experiment.

Positive test for O_2: Glowing splint flames up when inserted into test tube.

Positive test for H_2: Burning splint causes explosion when inserted into test tube containing H_2.

Positive test for CO_2: Limewater turns milky when CO_2 is bubbled through it.

Burning splint is extinguished when inserted into test tube containing CO_2.

Name _____ Class _____ Date _____

7. Which type(s) of reactions are characterized by:

a. two products

double replacement, single replacement, combustion, and decomposition (sometimes)

b. a single reactant

decomposition

c. two reactants

combination, single replacement, double replacement, and combustion

d. a single product

combination

GOING FURTHER

Develop a Hypothesis

Based on the results of this lab, develop a hypothesis about the type of chemical reaction (and the predicted chemical equation) that occurs when iron filings are added to 6*M* hydrochloric acid.

Based on the observations made when magnesium reacted with hydrochloric acid, students may predict that iron will react in a similar fashion to produce hydrogen gas—a single-replacement reaction.

Design an Experiment

Propose an experiment to test your hypothesis. If resources are available and you have your teacher's permission, perform the experiment.

Students' experimental design should be similar to the procedure in Step 3.