

## Activity Series of Metals

### Introduction:

There are many ways to classify chemical reactions. Some might be classified as acid–base, oxidation- reduction, or as synthesis or decomposition reactions. This experiment will focus on single replacement reactions. In a single replacement reaction, one element replaces another in a compound. When writing equations or predicting products for these equations, it must be remembered that not all equations proceed as written. For example, in the reaction between copper and silver  $\text{Cu} + \text{AgNO}_3 \rightarrow \text{Ag} + \text{Cu}(\text{NO}_3)_2$ , the reaction proceeds as written. The reverse reactions,  $\text{Ag} + \text{Cu}(\text{NO}_3)_2 \rightarrow \text{Cu} + \text{AgNO}_3$ , however, does not occur.

Not all elements are equal in their ability to replace other elements. Metals, such as sodium and potassium, are referred to as “active” metals. These metals can replace hydrogen from water.  $\text{K} + \text{H}_2\text{O} \rightarrow \text{KOH} + \text{H}_2$ . “Somewhat less active” metals, such as aluminum, can’t displace hydrogen from water, but they can displace hydrogen from acids such as a hydrochloric acid.  $\text{Al} + \text{HCl} \rightarrow \text{H}_2 + \text{AlCl}_3$ . Some “less active” metals will not displace hydrogen from HCl but will displace other metal ions in aqueous solutions. The reaction  $\text{Cu} + \text{AgNO}_3 \rightarrow \text{Ag} + \text{Cu}(\text{NO}_3)_2$ , mentioned above, is an example of such a reaction.

In order to predict products of single replacement reactions or to predict if they will occur at all, a method is needed. An activity series allows one to make such predictions. After observing or carrying out a series of reactions, you will construct an activity series for some elements.

### Purpose:

The purpose of this experiment is to construct an activity series for some metallic elements.

### Equipment/ Materials:

Metal samples:	(Mg, Fe, Cu, Ca, Pb, Zn)
Solutions of the metals:	$\text{Mg}(\text{NO}_3)_2$ , $\text{FeSO}_4$ , $\text{Cu}(\text{NO}_3)_2$ , $\text{Ca}(\text{NO}_3)_2$ , $\text{Pb}(\text{NO}_3)_2$ , $\text{Zn}(\text{NO}_3)_2$
Test tubes/ test tube rack	
Hot plate	
24-well well plate	
3 M HCl	

### Safety:

An apron and goggles should be worn in the lab.

**Procedure:**

1. Sodium metal is unsafe to work with in lab. If available, observe the reaction between sodium and water on a videodisc or videotape.
2. Place small samples of the metals in test tubes containing 5 mL of cold water. For metals like magnesium, it may be necessary to clean the outside of the metal with steel wool. Watch for evidence for reaction. Note any reactions on the data sheet. Dispose of the metal as directed by your instructor.
3. Place the test tubes in a 250 mL beaker that is about 1/3 full of boiling water. After a few minutes, look for evidence of reaction. Note any reactions on the data sheet. Dispose of the metal as directed by your instructor.
4. Place small samples of the metals in test tubes containing 5 mL of dilute hydrochloric acid HCl. Watch for evidence of reaction. Note any reactions on the data sheet. Dispose of any unreacted metals as directed by your instructor.
5. Using 24-well well plates set up a grid like the one on the data sheet. Six wells should be filled with each of the solutions. A different metal is then placed in each well. After a few minutes, look for evidence of a chemical reaction. Note the wells in which a reaction is taking place on the data sheet. Dispose of any unreacted metals as directed by your instructor. Wash the well plates thoroughly.

## Activity Series of Metals

### Data:

1. Circle the metals that reacted with either cool or warm water. For those metals that did react, write the molecular and net-ionic equations.

Mg, Fe, Na, Cu, Ca, Pb, Zn

2. Circle the metals that reacted with the diluted hydrochloric acid. For those metals that did react, write molecular and net-ionic equations.

Mg, Fe, Na, Cu, Ca, Pb, Zn

3. Record your observations for the reactions between the metals and the solutions of their compounds. Write "no reaction" if no reaction took place.

	Mg(NO <sub>3</sub> ) <sub>2</sub>	FeSO <sub>4</sub>	Cu(NO <sub>3</sub> ) <sub>2</sub>	Ca(NO <sub>3</sub> ) <sub>2</sub>	Pb(NO <sub>3</sub> ) <sub>2</sub>	Zn(NO <sub>3</sub> ) <sub>2</sub>
Mg						
Fe						
Cu						
Ca						
Pb						
Zn						

4. Write molecular and net ionic equations for each reaction that took place. You may continue on the back of this page.

5. Arrange the metals in order of decreasing activity. Remember to include sodium.

Most \_\_\_\_\_ > \_\_\_\_\_ > \_\_\_\_\_ > \_\_\_\_\_ > \_\_\_\_\_ > \_\_\_\_\_ Least