EXPERIMENT 6:
THE ACTIVITY SERIES OF METALS

PURPOSE

To determine the activities of several metals based on observations of single replacement reactions.

BACKGROUND

A **single replacement reaction** is one in which one element replaces another element in a compound.

In the following reaction, zinc replaces the copper in copper(II) chloride:

$$Zn_{(s)} + CuCl_{2(aq)} \rightarrow ZnCl_{2(aq)} + Cu_{(s)}$$

If you were to observe this reaction, you would witness the decomposition of zinc metal and the simultaneous formation of copper metal. This reaction occurs because zinc is *more active* than copper, therefore zinc can replace copper in an aqueous compound.

Very active metals can also replace hydrogen in water or acids, producing hydrogen gas:

$$Na_{(s)} + H_2O_{(l)} \rightarrow NaOH_{(aq)} + H_{2(g)}$$

In the above equation, sodium has replaced the hydrogen in water. However, the equation is not balanced. The balanced equation is:

$$2Na_{(s)} + 2H_2O_{(l)} \rightarrow 2NaOH_{(aq)} + H_{2(g)}$$

The products of single replacement reactions can be predicted by looking at the **Activity Series of Metals.** The Activity Series orders metals (and hydrogen) from most active to least active. Elements which are higher in the activity series can replace elements which are lower. In this experiment, you will be determining your own activity series based on your observations of single replacement reactions. You will check your results against the activity series given in your textbook.

Name: _____ Date: _____

PRE-LAB QUESTIONS

Predict the products of these single-replacement reactions, then balance the equations and indicate physical states (assume all reactions will occur):

1. $Fe_{(s)} + CuSO_{4(aq)} \rightarrow$

2. $Mg_{(s)} + HCl_{(aq)} \rightarrow$

3. $Na_{(s)} + NiSO_{3(aq)} \rightarrow$

4. $Ba_{(s)} + H_3PO_{4(aq)} \rightarrow$

5. $Ag_{(s)} + Pb(NO_3)_{3(aq)} \rightarrow$

MATERIALS

Copper metal	0.1M-0.5M Solutions of:	Copper(II) sulfate
Zinc metal		Zinc chloride
Magnesium metal		Magnesium chloride
8 test tubes		Potassium chloride
Test tube rack		Lead(II) nitrate
Towel or sandpaper		Silver nitrate

PROCEDURE

Obtain eight clean test tubes in a rack and label them A-H.

In each of the test tubes, you are to combine 1-2 ml of a solution with a small piece of metal. This experiment is qualitative, so you do not need to measure the amounts of solution or metal that you use. However, it is helpful to polish the metals (to remove any corrosion) with a towel, sandpaper or steel wool before you begin.

Test Tube Contents:

CAUTION!! LEAD IS HARMFUL IF INGESTED!! WASH YOUR HANDS AFTER LAB!!

A.	**Lead**(II) nitrate solution	+	Copper metal
B.	Silver nitrate solution	+	Copper metal
C.	Copper(II) sulfate solution	+	Zinc metal
D.	**Lead**(II) nitrate solution	+	Zinc metal
E.	Magnesium chloride solution	+	Zinc metal
F.	Zinc chloride solution	+	Magnesium metal
G.	Sodium chloride solution	+	Magnesium metal
H.	Potassium chloride solution	+	Magnesium metal

Record your observations for each test tube, particularly noting any color change on the surfaces of the metals.

Name: _____ Date: _____

THE ACTIVITY SERIES OF METALS

RESULTS & POST-LAB QUESTIONS

1. Write and balance the equations for the eight reactions that you observed, remembering to indicate physical states.

A.

B.

C.

D.

E.

F.

G.

H.

2. Construct an activity series, placing the most active metals first, and compare this with the activity series given in your textbook.