Metal/Metal Ion Reactions
Laboratory Activity*

Name_____   Lab Section_____

Problem Statement: How do metals and metal ions react?

I.   Data Collection: Eight Solutions

   C. The simulation is located at
       http://intro.chem.okstate.edu/1515F01/Laboratory/ActivityofMetals/home.html. Open the
       software and go to the opening activity. You should see a graphic that appears in part like
       figure A.

   B. Hold the magnifier over each beaker and "click" to view it's submicroscopic contents.
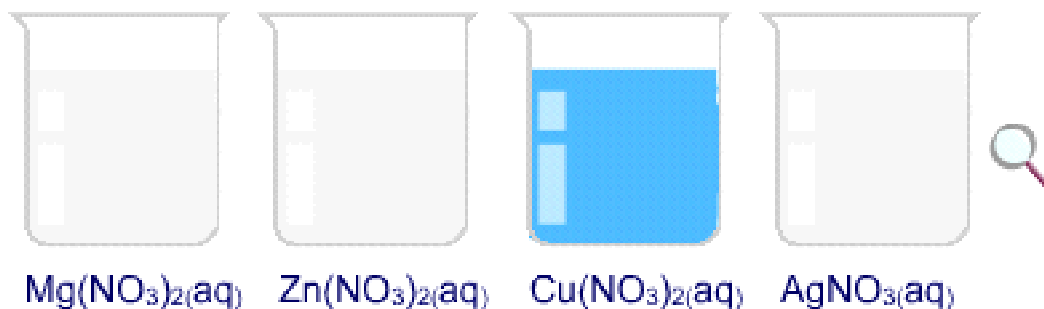   Record what you see on the beakers in Figure A.

$Mg(NO_3)_{2(aq)}$ $Zn(NO_3)_{2(aq)}$ $Cu(NO_3)_{2(aq)}$ $AgNO_{3(aq)}$

Figure A

   C. In your own words describe why H_2O molecules are not displayed when the magnifier
       shows the submicroscopic contents of each beaker.

II. Data Analysis

Record the number of each species in each beaker. How are these numbers related to the formula of the compound?

III. Interpretation

A. List three characteristics that are the same for all of these solutions and three characteristics that make them different.

B. Identify the species that accounts for the color of each of the four solutions. What evidence did you use to arrive at your conclusions?

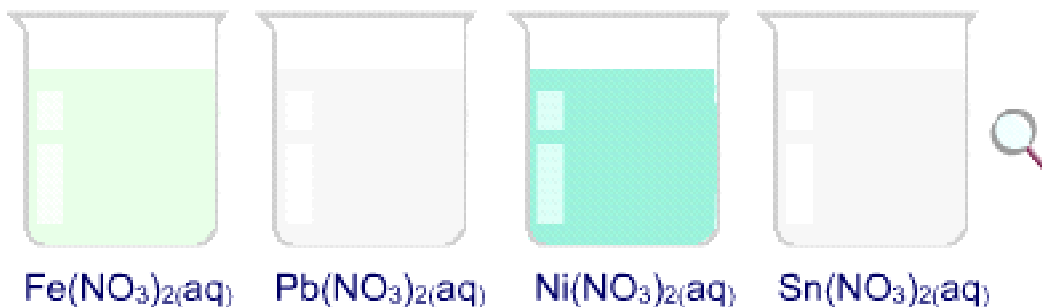C. Predict and record in Figure B what you would expect to see with the magnifier in the other beakers.

$Fe(NO_3)_{2(aq)}$ $Pb(NO_3)_{2(aq)}$ $Ni(NO_3)_{2(aq)}$ $Sn(NO_3)_{2(aq)}$

Figure B

IV. Data Collection: Activity One

A. Go to Activity One in the simulation, pick one of the metals and follow the instructions to test its interaction with each of the solutions. Record your observations in Table 1 below. Describe any evidence you see for a chemical reaction. What changes do you see in the metal? What changes do you see in the solution?
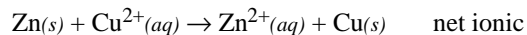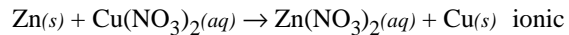
B. Repeat this process with each of the metals.

|	$Mg^{2+}(aq)$	$Cu^{2+}(aq)$	$Zn^{2+}(aq)$	$Ag^+(aq)$
$Mg(s)$				
$Cu(s)$				
$Zn(s)$				
$Ag(s)$				

Table 1

V. Data Analysis

    A. Write a chemical equation and the net ionic equation for each chemical reaction you observed in IVA.

> Example:
> $$Zn_{(s)} + Cu(NO_3)_{2(aq)} \rightarrow Zn(NO_3)_{2(aq)} + Cu_{(s)} \quad \text{ionic}$$
> $$Zn_{(s)} + Cu^{2+}_{(aq)} \rightarrow Zn^{2+}_{(aq)} + Cu_{(s)} \quad \text{net ionic}$$

    B. For each metal in Table 1 indicate the metal ions it reacted with, and for each metal ion indicate the metals it reacted with.

In Column 2a rank the four metal ions used in IVA in order of reactivity as indicated. In Column 2b rank the four metals used in IVA in order of reactivity as indicated.

Metal Ion   Metal

Most Reactive

Column 2a   **Column 2b**

Most Reactive

4
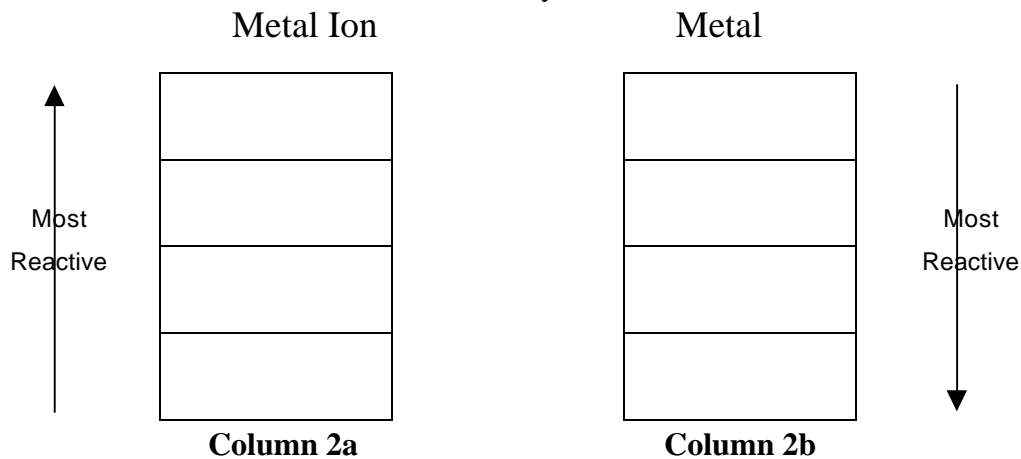
VI. Interpretation

A. How are Columns 2a and 2b in the previous section related to each other?

B. Pick one of the metals in Column 2b. Using the reactivity data you collected (Table 1), mark the metal ions in Column 2a that chemically reacted with it. Note the position of these reacting ions in relation with the position of those that don't react. Repeat this process for each of the metals. Summarize your findings concerning the combination of reacting metals and metal ions in Column 2a and 2b.

Summarize your findings concerning the combination of non-reacting metals and metal ions in Column 2a and 2b.

C. "Click" on the molecular scale button in the laboratory simulation to view the metal/metal ion interactions at the molecular (submicroscopic) level.

Follow the instructions in the software. Select a combination of metal and solution that results in a reaction (Table 1). Click through the slides. Relate what you observe in this Molecular Level view with your macroscopic observation for the reaction.

Select a combination of metal and solution that does not result in a reaction (Table 1). Click through the slides. Relate what you observe in this Molecular Level view with your macroscopic observation for the reaction.

D. Write a balanced equation relating each metal ion (Column 2a) to its corresponding metal (Column 2b).

VII.   Data Collection: Activity Two

Go to Activity Two and repeat what you did in Sections IV, V, and VI with a new set of metal/metal ions.
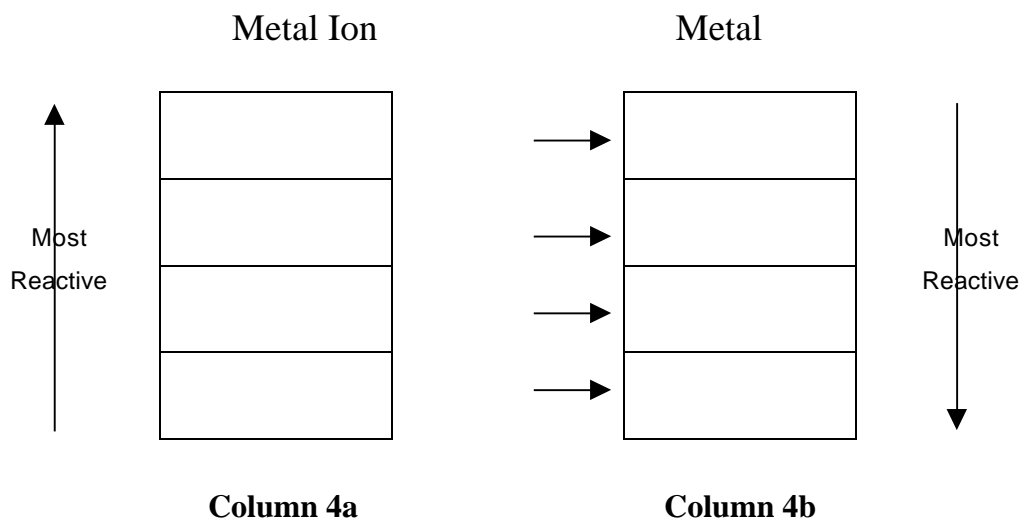
	Fe^{2+} (aq)	Pb^{2+} (aq)	Ni^{2+} (aq)	Sn^{2+} (aq)
Fe(s)				
Pb(s)				
Ni(s)				
Sn(s)				

Table 3

VIII. Data Analysis and Interpretation

A. Write net ionic chemical equations for the chemical reactions you observed.

B. Rank the metal ions and metals as you did in section V.B. Write balanced equations relating the metal ion/metal combinations.
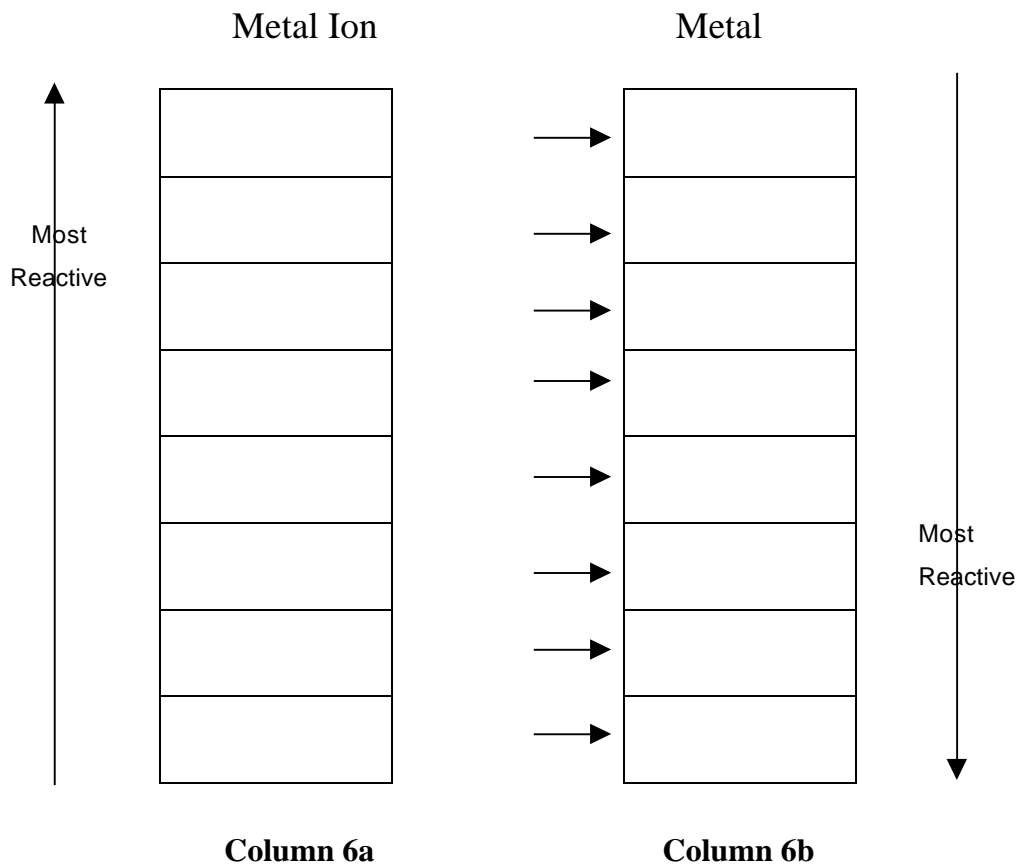
Metal Ion   Metal

Most
Reactive

Most
Reactive

Column 4a   **Column 4b**

IX. Data Collection: Activity Three

 A. Go to Activity Three and repeat what you did in Sections IV, V, and VI with a combination of metal/metal ions taken from Activities One and Two.

	$Zn^{2+}_{(aq)}$	$Cu^{2+}_{(aq)}$	$Fe^{2+}_{(aq)}$	$Pb^{2+}_{(aq)}$
$Zn_{(s)}$				
$Cu_{(s)}$				
$Fe_{(s)}$				
$Pb_{(s)}$				

Table 5

X. Data Analysis and Conclusions

Use the data you collected in Activities One, Two, and Three (Tables 1,3 and 5) to rank the eight metal ion and metals you have studied. Write balanced equations relating the metal/metal ion combinations.

Metal Ion   Metal

Most
Reactive

                                                          Most
                                                          Reactive

Column 6a   **Column 6b**

XI. Data Collection – Activity Four

Go to Activity Four and follow the directions. Record your observation concerning the reaction of the five metals with HCl.

XII. Data Analysis
  A. Write a chemical equation for the reaction between one of the metals and HCl.
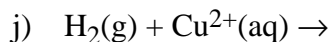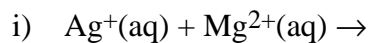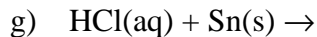
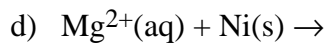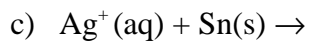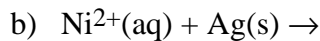 B. Observe the reaction at the molecular scale. Write an equation for what is happening to the metal and a separate equation for what is happening to the acid. How are these equations related to each other and to the chemical equation you wrote in section XII.A.

XIII. Interpretation and Conclusions
  A. Add the hydrogen gas /hydrogen ion combination in the correct location in the tables from section X.

Metal Ion   Metal

Most
Reactive

                                                Most
                                                Reactive

Column 7a   **Column 7b**
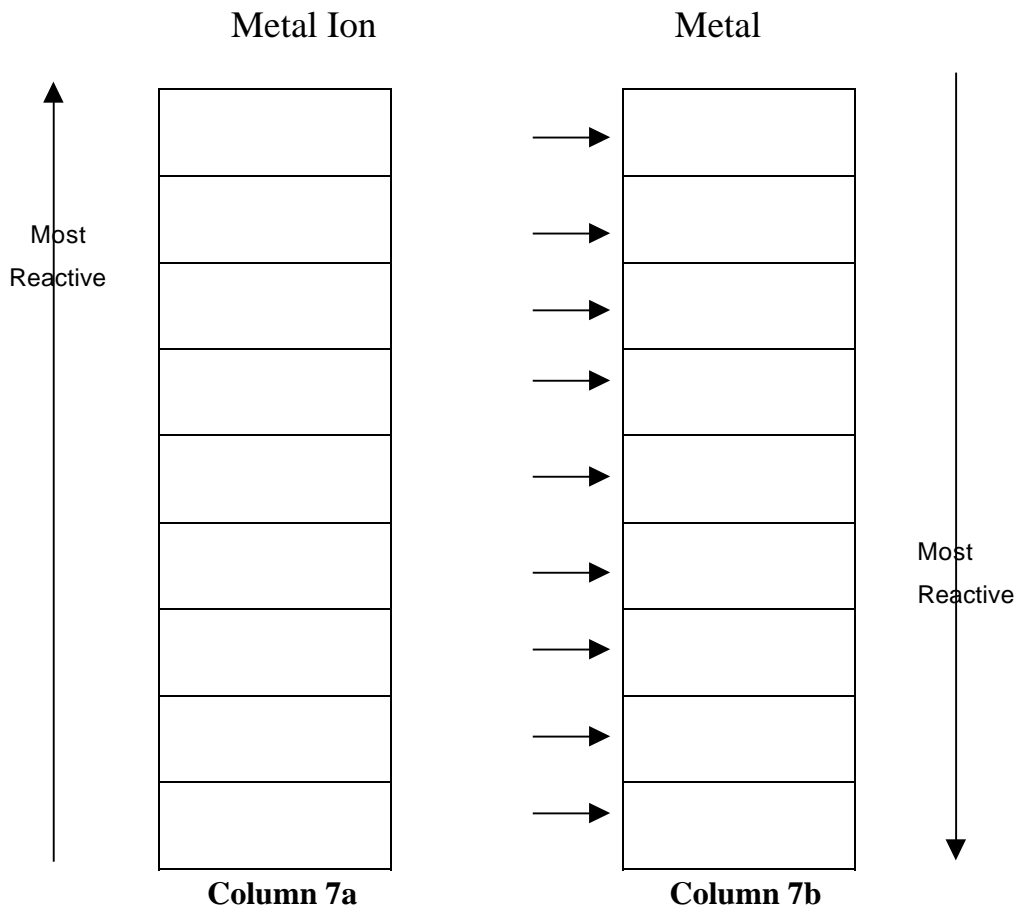
B. Use the information in Tables 7a and 7b predict the products of the following reactions.

    a) $Ag^+(aq) + Ni(s) \rightarrow$

    b) $Ni^{2+}(aq) + Ag(s) \rightarrow$

    c) $Ag^+(aq) + Sn(s) \rightarrow$

    d) $Mg^{2+}(aq) + Ni(s) \rightarrow$

    e) $Mg(s) + Sn(NO_3)_2(aq) \rightarrow$

    f) $H^+(aq) + Mg(s) \rightarrow$

    g) $HCl(aq) + Sn(s) \rightarrow$

    h) $Fe^{2+}(aq) + H_2(g) \rightarrow$

    i) $Ag^+(aq) + Mg^{2+}(aq) \rightarrow$

    j) $H_2(g) + Cu^{2+}(aq) \rightarrow$
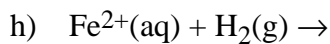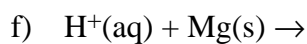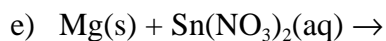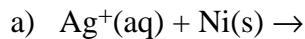
C. Mental Model: Draw a picture(s) that illustrates what happens at the molecular level when Ag^+ ion and Sn metal are mixed. In words explain what is happening in your picture(s).

D. An unknown metal, M, not studied in this experiment is found to react with Ag^+ ion, Pb^{2+} ion and Cu^{2+} ion, but not with Ni^{2+} ion, Mg^{2+} ion or Zn^{2+} ion. Where does the unknown metal, M, appear in your activity series?