Metal/Metal Ion Reactions
Laboratory Simulation

Name_____   Lab Section_____

Problem Statement: How do metals and metal ions react?

I. Data Collection: Eight Solutions

   A. Your laboratory instructor will give you instructions on how to obtain access to the Metal/Metal Ion Laboratory Simulation software. 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.
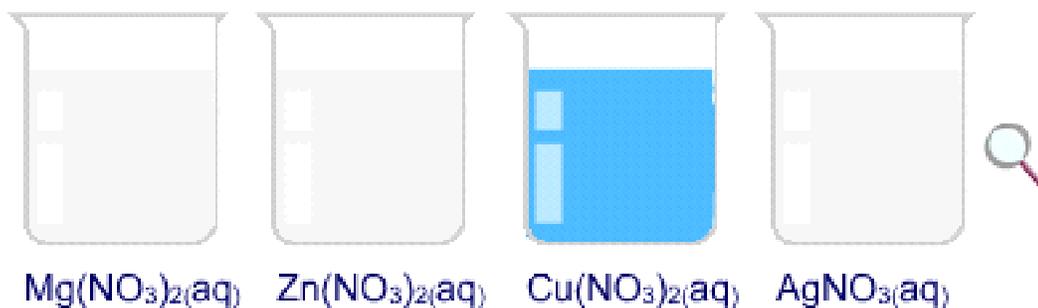

$Mg(NO_3)_{2(aq)}$ $Zn(NO_3)_{2(aq)}$ $Cu(NO_3)_{2(aq)}$ $AgNO_{3(aq)}$
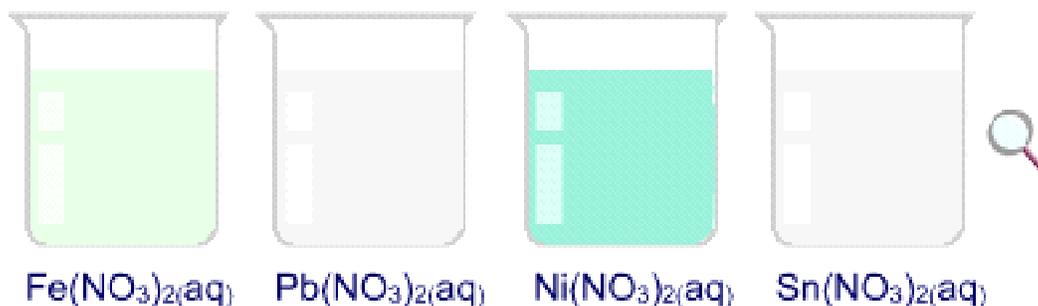
Figure A

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 solutions?

B. Repeat this process with each of the metals.

	Mg^{2+}	Cu^{2+}	Zn^{2+}	Ag^+
Mg				
Cu				
Zn				
Ag				

Table 1

V. Data Analysis

    A. Write a chemical equation for each chemical reaction you observed.

    B. Rank the metal ions in order of reactivity using Table 2a below. Rank the metals in reverse order of reactivity using table 2b below. What criteria did you use for your rankings?

<div align="center">

Metal Ion Table   Metal Table

</div>

Most
Reactive

Most
Reactive

<div align="center">

Table 2a   **Table 2b**

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VI. Interpretation

    A. How are Tables 2a and 2b in the previous section related to each other? Write a balanced equation relating each metal ion to its corresponding metal.

    B. Pick one of the metals in Table 2b. Using the reactivity data you collected (Table 1), mark the metal ions in Table 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 Tables 2a and 2b.

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

    C. "Click" on the molecular scale button in the laboratory simulation to view the metal/metal ion interactions at the submicroscopic level. Follow the instructions in the software. Describe your observations of reacting combinations and non-reacting combinations. Write a chemical equation for one of the reacting combinations. Relate your submicroscopic observation with your macroscopic observations for one example of a reacting and one example of a non-reacting combination.

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.
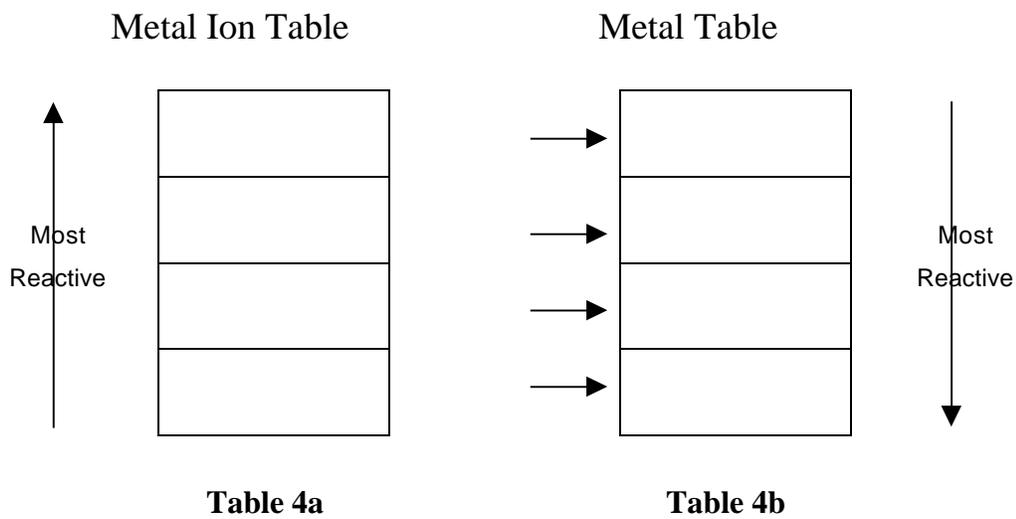
	Fe^{2+}	Pb^{2+}	Ni^{2+}	Sn^{2+}
Fe				
Pb				
Ni				
Sn				

Table 3

VIII.   Data Analysis and Interpretation

A. Write 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 Table   Metal Table

Most   Most
Reactive   Reactive

Table 4a   **Table 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+}	Cu^{2+}	Fe^{2+}	Pb^{2+}
Zn				
Cu				
Fe				
Pb				

Table 5

8

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 Table   Metal Table

Most
Reactive

                                                        Most
                                                        Reactive

Table 6a   **Table 6b**

XI. Data Collection – Activity Four

Go to Activity Four and follow the directions. Record your observation concerning the reaction of the eight metals with HCl.
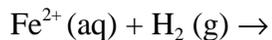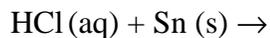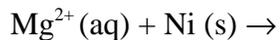
XII. Data Analysis
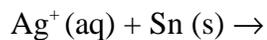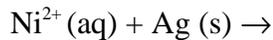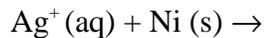
A. Write a chemical equation for the reaction between one of the metals and a HCl.

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 Table   Metal Table

Most
Reactive

Most
Reactive

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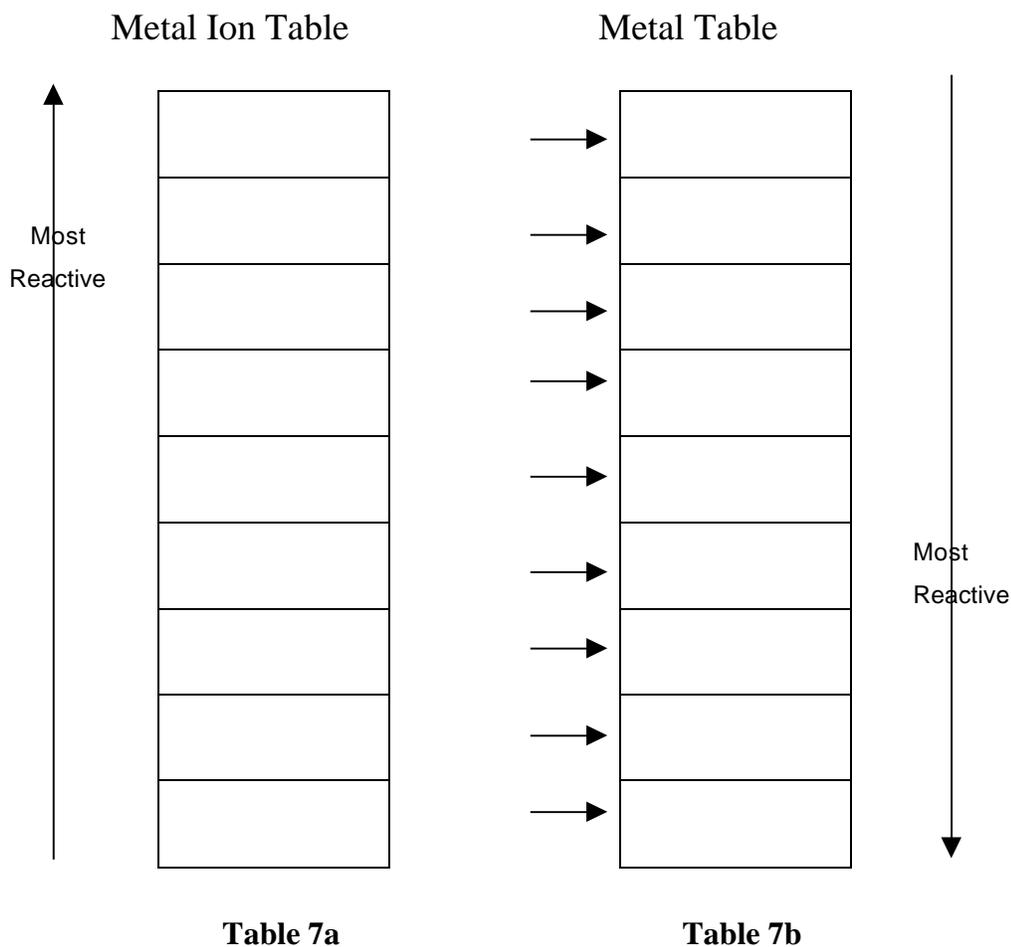
B. Use the information in Tables 7a and 7b to predict the products of the following reactions.

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

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

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

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

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

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

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

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

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

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

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, 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?