

# Metal/Metal Ion Reactions

## Laboratory Activity\*

Name \_\_\_\_\_ Lab Section \_\_\_\_\_

Problem Statement: How do metals and metal ions react?

### I. Data Collection: Eight Solutions

- A. The simulation is located <https://teachchemistry.org/classroom-resources/metals-in-aqueous-solutions-simulation>.

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## METALS IN AQUEOUS SOLUTIONS

# Metals In Aqueous Solutions

Test several metals with different aqueous solutions. Select an activity to begin.

Start →

Special thanks to Tom Greenbowe and John Gelder.

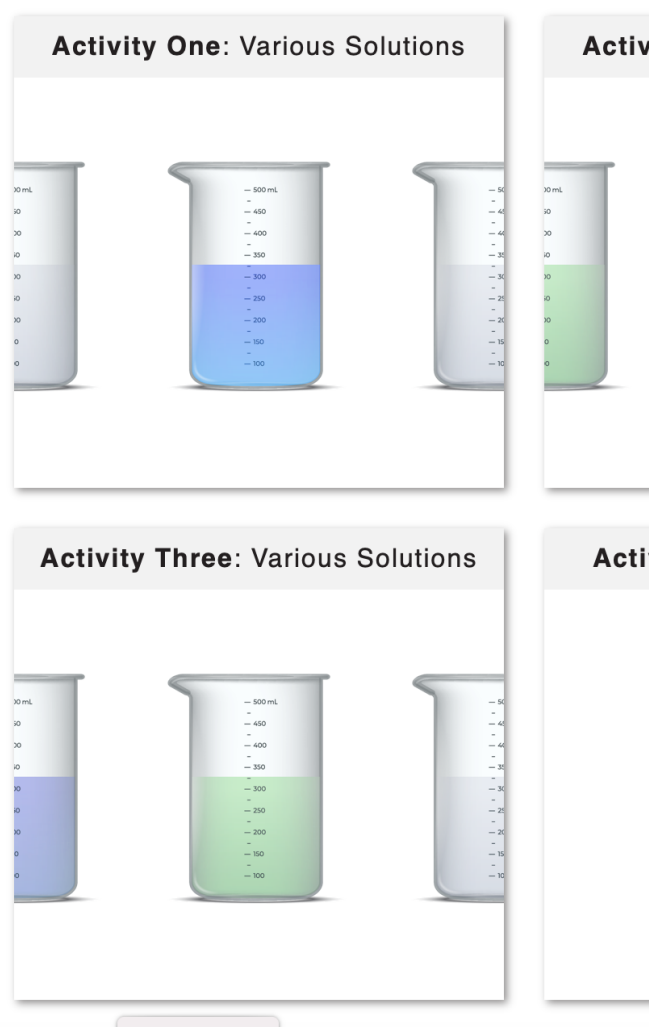


Figure A

## II. Data Collection: Activity One

Click on the image for Activity One shown in Figure 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?
- Repeat this process with each of the metals.

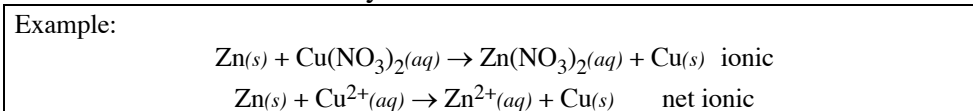
	$\text{Mg}^{2+}(\text{aq})$	$\text{Zn}^{2+}(\text{aq})$	$\text{Cu}^{2+}(\text{aq})$	$\text{Ag}^{+}(\text{aq})$

Mg(s)				
Cu(s)				
Zn(s)				
Ag(s)				

**Table 1**

### III. Data Analysis

- A. Write a chemical equation and the net ionic equation for each chemical reaction you observed in IIA. Note: If you are having difficulty writing the chemical equation and net ionic equation using the information from Table I you may find the following helpful. In Activity One click on Molecular Scale Reactions box and follow the directions on the new page. You will be able to watch the reaction occur at the molecular scale for whatever combination of metal and solution you have selected.



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 IIA in order of reactivity as indicated. In Column 2b rank the four metals used in IIA in order of reactivity as indicated.

Most Reactive 	<b>Metal Ion</b> <div style="border: 1px solid black; height: 150px; width: 100%; margin: 5px 0;"> <div style="border-bottom: 1px solid black; height: 30px;"></div> <div style="border-bottom: 1px solid black; height: 30px;"></div> <div style="border-bottom: 1px solid black; height: 30px;"></div> <div style="border-bottom: 1px solid black; height: 30px;"></div> </div>	<b>Metal</b> <div style="border: 1px solid black; height: 150px; width: 100%; margin: 5px 0;"> <div style="border-bottom: 1px solid black; height: 30px;"></div> <div style="border-bottom: 1px solid black; height: 30px;"></div> <div style="border-bottom: 1px solid black; height: 30px;"></div> <div style="border-bottom: 1px solid black; height: 30px;"></div> </div>	Least Reactive 
Least Reactive	<b>Column 2a</b>	<b>Column 2b</b>	Most Reactive

IV. Interpretation

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

B. For each of the metals in Column 2b, use the reactivity data you collected (Table 1) to identify 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 in the table below.

Metal Selected in Column 2b	Metal Ions in Column 2a that React with Metal from Column 2b	Metal Ions in Column 2a that do not react with Metal from Column 2b

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Write a general statement that describes the reactivity of a metal (Column 2b) with the metal ions (Column 2a)

"Click" on the molecular scale button in the laboratory simulation Activity One 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). Watch the animation, then 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). Watch the animation and Click through the slides. Relate what you observe in this Molecular Level view with your macroscopic observation for the reaction.

- C. When looking at the metal in Column 2b and the metal ion in Column 2a the charge is not balanced. Write a balanced equation relating each metal ion (Column 2a) to its corresponding metal (Column 2b).

V. Data Collection: Activity Two

Go to Activity Two and complete the Table below using the new set of metal/metal ions.

	$\text{Fe}^{2+}(\text{aq})$	$\text{Pb}^{2+}(\text{aq})$	$\text{Ni}^{2+}(\text{aq})$	$\text{Sn}^{2+}(\text{aq})$
Fe(s)				
Pb(s)				
Ni(s)				
Sn(s)				

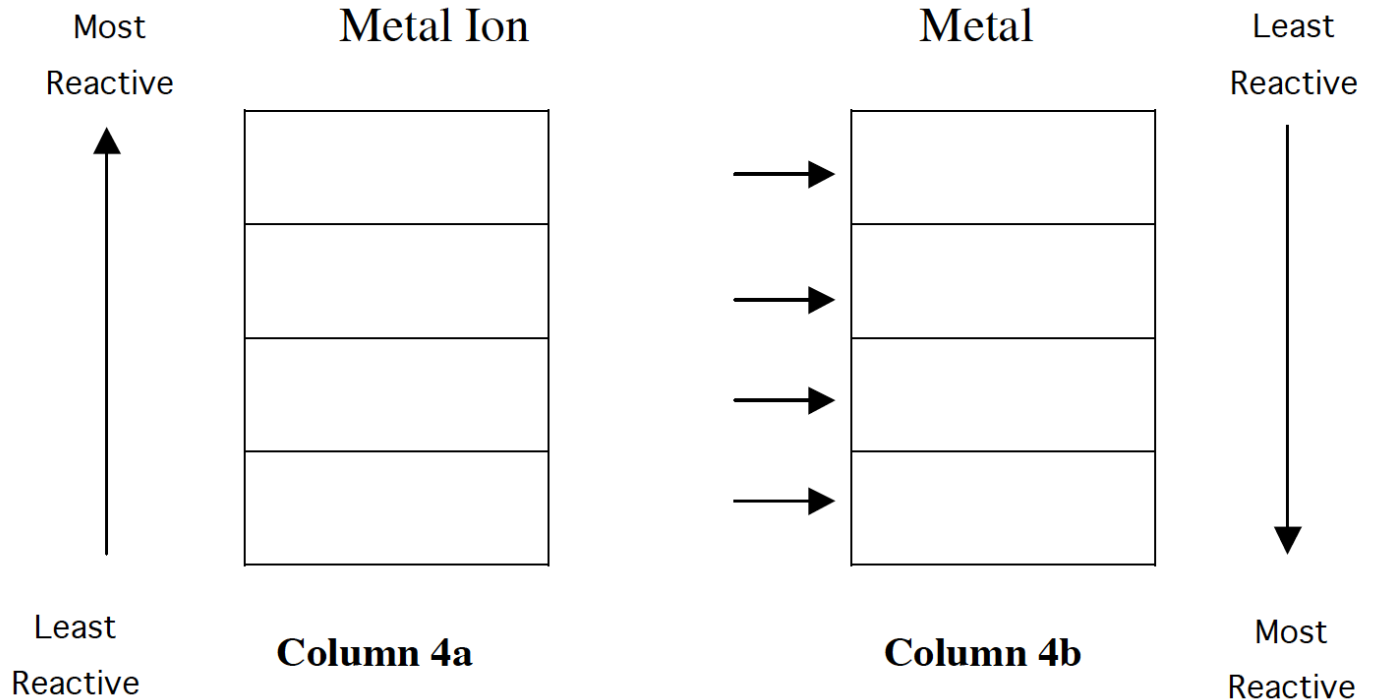
**Table 3**

VI. Data Analysis and Interpretation



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

B. In Column 4a rank the four metal ions used in V in order of reactivity as indicated. In Column 4b rank the four metals used in V in order of reactivity as indicated.



VII. Data Collection: Activity Three

A. Go to Activity three and complete the Table below using the set of metal/metal ions. taken from Activities One and Two.

	$\text{Fe}^{2+}(\text{aq})$	$\text{Zn}^{2+}(\text{aq})$	$\text{Cu}^{2+}(\text{aq})$	$\text{Pb}^{2+}(\text{aq})$
$\text{Fe}(\text{s})$				
$\text{Cu}(\text{s})$				
$\text{Zn}(\text{s})$				
$\text{Pb}(\text{s})$				

**Table 5**

VIII. Data Analysis and Interpretation

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

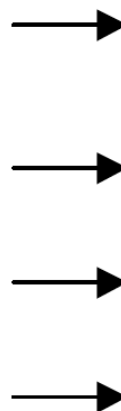
B. In Column 6a rank the four metal ions used in VII in order of reactivity as indicated. In Column 6b rank the four metals used in VII in order of reactivity as indicated.

Most  
Reactive



Metal Ion


Metal




Least  
Reactive

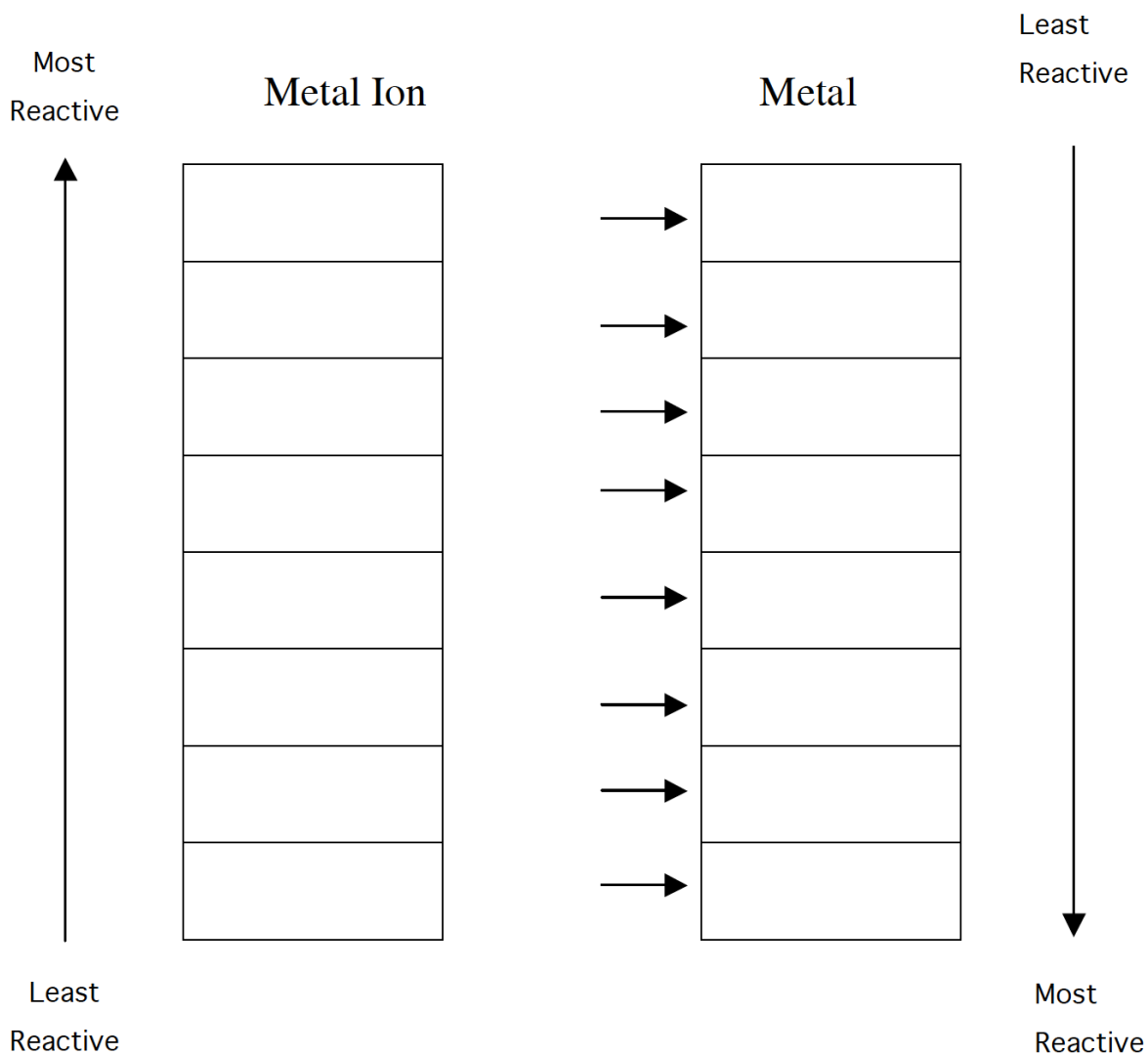
**Column 6a**

Most  
Reactive

**Column 6b**

IX. Data Analysis and Conclusions

In Columns 2a/2b, Columns 4a/4b, Columns 6a/6b you have ranked sets of metal and metal ions. In Activity 2 you investigated a pair of metals and metal ions from the two sets in Activity 1 and 3. Based on the reactivity of these combinations of metals and metal ions rank the eight metal ions and metals you have studied.



Column 7b

Column

7a

X. Data Collection – Activity Four

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

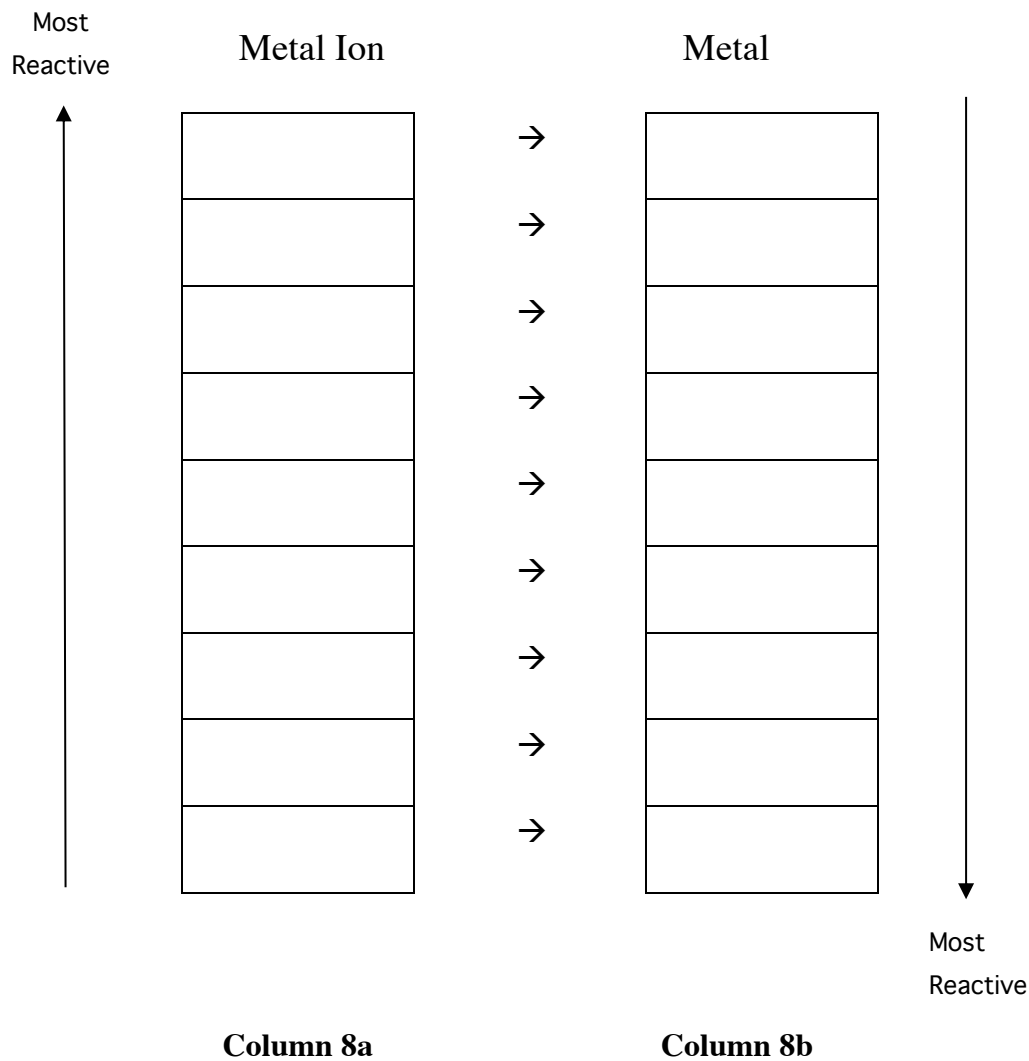
## XII. Data Analysis

A. For a combination of metal and HCl that reacts, write a chemical equation that describes the reaction.

B. In Activity 4 observe the reaction of a metal and HCl at the molecular scale that you described in part A above. Watch the animation and then step through the frames and write an equation that describes what is happening to the metal and a separate equation that describes 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.

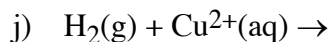
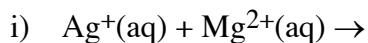
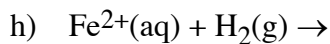
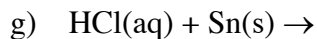
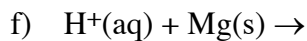
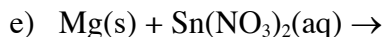
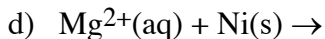
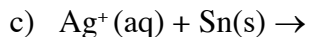
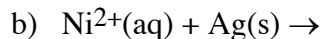
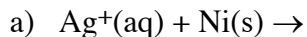
### XIII. Interpretation and Conclusions

A. Add the hydrogen gas /hydrogen ion combination in the correct location in the tables from section X. studied.



Least  
Reactive

B. Use the information in Columns 8a and 8b predict the products of the following reactions.



C. Mental Model: Draw a picture(s) that illustrates what happens at the molecular level when  $\text{Ag}^+$  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  $\text{Ag}^+$  ion,  $\text{Pb}^{2+}$  ion and  $\text{Cu}^{2+}$  ion, but not with  $\text{Ni}^{2+}$  ion,  $\text{Mg}^{2+}$  ion or  $\text{Zn}^{2+}$  ion. Where does the unknown metal, M, appear in your activity series?