

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 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.

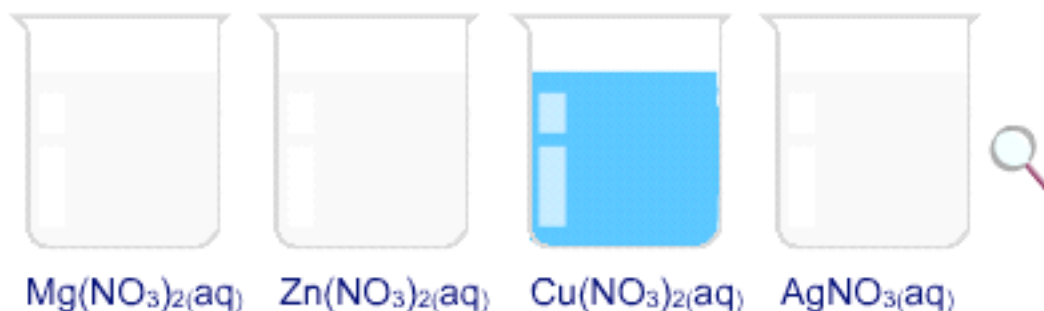


Figure A

- C. In your own words describe why H₂O molecules are not displayed when the magnifier shows the submicroscopic contents of each beaker.

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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.

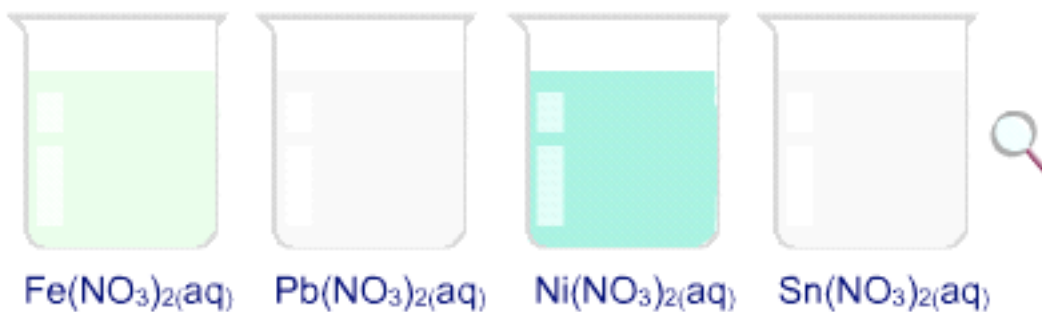


Figure B

IV. Data Collection: Activity One, Two or Three

A. Go to the Activity assigned to you by your TA, 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.

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

Table 1 (Activity 1)

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

Table 2 (Activity 2)

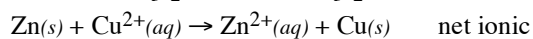
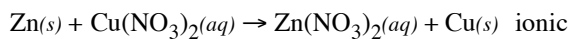
| | $\text{Fe}^{2+}(\text{aq})$ | $\text{Zn}^{2+}(\text{aq})$ | $\text{Cu}^{2+}(\text{aq})$ | $\text{Pb}^{2+}(\text{aq})$ |
|-----------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
| $\text{Fe}(\text{s})$ | | | |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

Table 3 (Activity 3)

V. Data Analysis

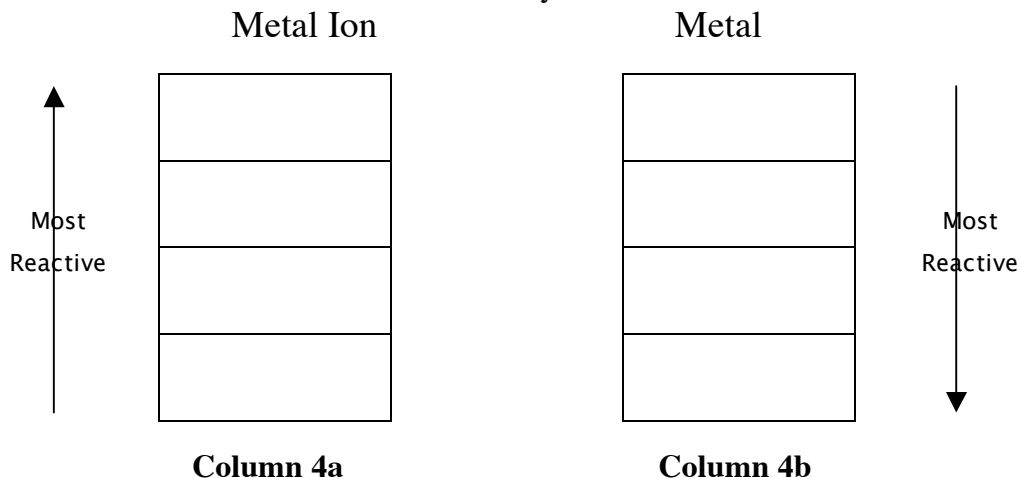
- A. Write a chemical equation and the net ionic equation for each chemical reaction you observed in IVA. Note: If you are having difficulty writing the chemical equation and net ionic equation using the information from Table I you may find the following helpful. In Activity One click on Molecular Scale 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.

Example:



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



VI. Interpretation

A. How are Columns 4a and 4b in the previous section related to each other?

B. For each of the metals in Column 4b, use the reactivity data you collected (Table 1, 2 or 3) to identify the metal ions in Column 4a 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 4a and 4b in the table below.

| Metal Selected in Column 4b | Metal Ions in Column 4a that React with Metal from Column 4b | Metal Ions in Column 4a that do not react with Metal from Column 4b |
|-----------------------------|--|---|
| | | |
| | | |
| | | |

Write a general statement that describes the reactivity of a metal (Column 4b) with the metal ions (Column 4a)

"Click" on the molecular scale button in the laboratory simulation Activity 1, 2 or 3 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, 2 or 3). 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, 2 or 3). 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 4b and the metal ion in Column 4a the charge is not balanced. Write a balanced equation relating each metal ion (Column 4a) to its corresponding metal (Column 4b).

VII. Data Analysis and Conclusions

Your instructor will assign you to meet with several other groups to discuss your observations and summary results in Column 4a and 4b. In Activity 3 a pair of metals and metal ions from the two sets in Activity 1 and 2 were investigated. Based on the reactivity of these combinations of metals and metal ions, and your responses in part VI. Interpretation (page 6), rank the eight metal ions and metals you have studied.

| | Metal Ion | | Metal | |
|--|-----------|---|-------|--|
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↑
Most
Reactive

↓
Most
Reactive

Column 6a **Column 6b**

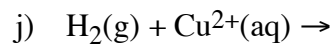
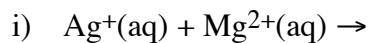
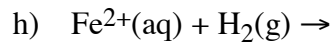
VIII. Data Collection – Activity Four

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.



A. 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).

B. 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?