# Metal Activity Series Simulation Lab

Name _____ Period _____

**Background Information**

This experiment will focus on single replacement reactions. In a single replacement reaction, one element replaces another in a compound.

When writing equations or predicting products for these reactions, it must be remembered that not all equations proceed as written. For example, in the reaction between copper and silver ions $Cu + AgNO_3 \rightarrow Ag + Cu(NO_3)_2$, the reaction proceeds as written. The reverse reaction, $Ag + Cu(NO_3)_2 \rightarrow Cu + AgNO_3$, however, does not occur spontaneously.

Not all elements are equal in their ability to replace other elements. In order to predict products of single replacement reactions or to predict if they will occur at all, a method is needed. An activity series allows one to make such predictions. After observing or carrying out a series of reactions, you will construct an activity series for some elements.

The following simulation by Tom Greenbowe allows you to test several metals with different aqueous solutions. You will choose a single metal to place in the solutions and observe in which solutions a reaction occurs. If the single metal is stronger than the metal in the compound in solution, the metal in the compound will be displaced and the metal strip of the single metal that you insert will become coated with the displaced metal.

The metals used in the simulations have the following colors:

| Activity 1 | Activity 2 | Activity 3 |
|---|---|---|
| Mg = light gray | Iron = light gray | Iron = light gray |
| Copper = copper | Copper = copper | Lead = dark gray |
| Zinc = dark gray | Zinc = dark gray | Nickel = light gray |
| Silver = silver | Lead = dark gray | Tin = light gray |

Now, log on to the website and follow the steps below. It may take a minute for the site to open.

http://www.chem.iastate.edu/group/Greenbowe/sections/projectfolder/flashfiles/redox/home.html

**Activity 1**

- Click START.
- You will get a dialogue box that tells you NOT to hit the back button. Say O.K.
- Click on Activity 1
- You will be given a series of solutions containing different compounds. Note that they are all nitrates. What is different about them is the metal. $Mg(NO_3)_2$ $Zn(NO_3)_2$ $Cu(NO_3)_2$ $AgNO_3$.
- You will also be given a list of the same single metals from which to choose. Mg Zn Cu Ag
- Choose Mg and click the left hand blue box to insert magnesium strips down into each solution. Note that the magnesium is light gray in color.
- It will take a minute for the reaction to occur, if one is going to occur. When the reactions are complete, you will get a red message telling you to remove them metal strips. Click on the lower left hand box to remove the strips.
- Observe each metal strip. If the metal was strong enough to replace the metal in the solution, the strip is coated with the metal that was in solution. If it was NOT strong enough, no reaction occurred.
- Fill in your results for Mg in Data Table 1. If no reaction occurs, put NR in the box. If a reaction DOES occur, put Y for yes in the box.
- Repeat the steps above for Cu, Zn, and Ag and fill in Data Table 1.

**Data Table 1: Activity #1**

| | **$Mg(NO_3)_2$** | **$Zn(NO_3)_2$** | **$Cu(NO_3)_2$** | **$AgNO_3$.** |
|---|---|---|---|---|
| **Mg** | | | | |
| **Cu** | | | | |
| **Zn** | | | | |
| **Ag** | | | | |

Questions

1. Which metals can Mg replace?
2. Which metals can Cu replace?
3. Which metals can Zn replace?
4. Which metals can Ag replace?
5. Which metal is the strongest in this series of metals?
6. Which metal is the weakest in this series of metals?
7. Which metal is stronger because it can replace more metals, Cu or Zn?
8. Fill in the Activity Series box to the right for Activity 1 metals. The most reactive metal goes on the top and the least reactive metal goes on the bottom. Then fill in the middle two according to which metal is stronger than the other one.

Activity Series #1

**Activity 2**

- Now click on **Activity 2**. Notice that some of the solutions have changed and some of the single metals have changed.
- Follow the same procedure as with Activity 1. Test each single metal in each solution.
- Fill in Data Table 2. If no reaction takes place, but **NR** in the box. If a reaction does take place, put **YES** in the box.

**Data Table 2: Activity 2**

| | **$Fe(NO_3)_2$** | **$Zn(NO_3)_2$** | **$Cu(NO_3)_2$** | **$Pb(NO_3)_2$** |
|---|---|---|---|---|
| **Fe** | | | | |
| **Cu** | | | | |
| **Zn** | | | | |
| **Pb** | | | | |

Questions

9. Which metals can Fe replace?
10. Which metals can Cu replace?
11. Which metals can Zn replace?
12. Which metals can Pb replace?
13. Which metal is the strongest in this series of metals?
14. Which metal is the weakest in this series of metals?
15. Which metal is stronger because it can replace more metals, Fe or Pb?
16. Fill in the Activity Series box to the right for Activity 2 metals. The most reactive metal goes on the top and the least reactive metal goes on the bottom. Then fill in the middle two according to which metal is stronger than the other one.

Activity Series #2

**Activity 3**

- Now click on **Activity 3**. Notice that some of the solutions have changed and some of the single metals have changed.

- Follow the same procedure as with Activity 1. Test each single metal in each solution.
- Fill in Data Table 2. If no reaction takes place, but **NR** in the box. If a reaction does take place, put **YES** in the box.

**Data Table 3: Activity #3**

| | $Fe(NO_3)_2$ | $Pb(NO_3)_2$ | $Ni(NO_3)_2$ | $Sn(NO_3)_2$ |
|---|---|---|---|---|
| **Fe** | | | | |
| **Pb** | | | | |
| **Ni** | | | | |
| **Sn** | | | | |

Questions

17. Which metals can Fe replace?
18. Which metals can Pb replace?
19. Which metals can Ni replace?
20. Which metals can Sn replace?
21. Which metal is the strongest in this series of metals?
22. Which metal is the weakest in this series of metals?
23. Which metal is stronger because it can replace more metals, Fe or Pb?
24. Fill in the Activity Series box to the right for Activity 3 metals. The most reactive metal goes on the top and the least reactive metal goes on the bottom. Then fill in the middle two according to which metal is stronger than the other one.

Activity Series #3

**Creating a Larger Activity Series**

The Activity Series Boxes for activities 1 – 3 are placed side by side below. Re-list each activity series in each box. **Then, combine the lists, placing all of the elements in one large activity series list in lthe last box.**

Activity Series #1

Activity Series #2

Activity Series #3

Total Activity Series

Questions

25. Which metal is the **MOST** reactive?

26. From the lab, what evidence do you have that it is most reactive?

27. Which metal is the **LEAST** reactive?

28. From the lab, what evidence do you have that it is the least reactive?

## Activity 4

When a metal is placed in an acid, if it is strong enough to replace the hydrogen in the acid, the hydrogen will be displaced and will be released as hydrogen gas. When this occurs, bubbles will be given off. Remember that the presence of bubbles is one of the ways we can identify that a chemical reaction occurs.

- Click on **Activity #4.**
- You are given a beaker containing hydrochloric acid and a series of single metals.
- In this activity, you will click on one metal at a time, followed by START.
- The metal will be lowered into the acid. If the metal is strong enough to replace the hydrogen in the acid, bubble of hydrogen gas will be released.
- If the metal is NOT strong enough to replace hydrogen in the acid, no reaction will occur.
- Test each metal and record your observations in Data Table #4. If a reaction occurs, write **YES** in the box. If a reaction does NOT occur, write **NR** in the box.

**Data Table 4: Activity #4**

| | **HCl** |
|---|---|
| **Ag** | |
| **Cu** | |
| **Fe** | |
| **Mg** | |
| **Ni** | |
| **Pb** | |
| **Sn** | |
| **Zn** | |

Questions

29. Which of the metals in Activity #4 are strong enough to replace hydrogen in an acid?

30. Based on your Total Activity Series, complete the following statement:

    In order for a single metal to replace a metal in a compound, the single metal must be _____(stronger or weaker) than the metal in the compound. Therefore, the metal in the compound must be located _____( above or below) the single metal in the activity series.