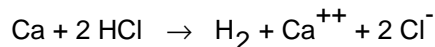


## ACTIVITY SERIES

### PROBLEM PRESENTATION / EXPLORATION

- A. Some metals react with dilute hydrochloric acid (HCl) to form hydrogen gas bubbles, while others do not. The reaction may be very slow or extremely fast, and the rate of this reaction is one way of determining the activity of a metal.
- B. Let us first look at the reaction of a metal with acid (TEACHER DEMO):



Notice that the H<sub>2</sub> bubbles are released very fast, meaning that Ca is an active metal.

**CAUTION: There must be no flames in the lab while this experiment is being conducted.**

- C. The Determination of the Relative Activity of Mg, Cu, Zn Through Hydrogen Displacement
1. Remember, if the metal does react with the acid, it is **more** active than hydrogen; if it doesn't react with the acid, it is **less** reactive than hydrogen.
  2. Before each part of the experiment clean each metal briefly with sand paper.
  3. Place about 3 mL of 3M hydrochloric acid in three different test tubes. Carefully drop the metal into the acid to see if it displaces the hydrogen.

|          |          |          |
|----------|----------|----------|
| Mg + HCl | Cu + HCl | Zn + HCl |
|----------|----------|----------|

4. Try to compare the rate of formation of the bubbles of hydrogen so that you can rank them according to their activity.

#### Mini Activity Series

Highest

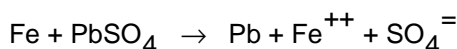
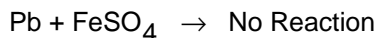
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Lowest

### CLASS RESPONSE / CONCEPT INVENTION

- A. In addition to displacement of hydrogen from acids by metals, other reactions can happen when a metal is placed in a solution of a salt of another metal. Sometimes a reaction happens, and the metals seem to switch places. The more active metal displaces the less active one.
- B. Now let's look at the reaction of a metal reacting with the salt of another metal. Sometimes a reaction will happen and sometimes it won't (TEACHER DEMO).

Example:



**RULE I** If a metal, A, reacts with a solution of metal B's salt, then A is more active than B.

**RULE III** If A doesn't react with a solution of B's salt, then A is less active than B.

C. The Determination of the Relative Reactivity of Mg, Cu, Zn Through Displacement of Each Others' Salts

- Place 3 mL of Mg salt solution in each of two test tubes. Place 3 mL of Cu salt solution in each of two test tubes. Place 3 mL of Zn salt solution in each of two test tubes. You should have six test tubes of solutions.
- Carefully add a piece of Cu to the first tube, and a piece of Zn to the second tube. Observe any changes in the metal, the color of the solutions, or the change in temperature of the tubes.
- Carefully add a piece of Mg to the third tube, and a piece of Zn to the fourth tube. Observe any changes in the metal, the color of the solutions, or the change in temperature of the tubes.
- Carefully add a piece of Mg to the fifth tube, and a piece of Cu to the sixth tube. Observe any changes in the metal, the color of the solutions, or the change in temperature of the tubes.
- On the basis of your observations, what is the ranking of the three metals according to their activity? Remember when using metal A and the salt of metal B, or metal B and the salt of metal A, if one reaction works the "opposite" one can't work!

|    | Mg <sup>++</sup> | Cu <sup>++</sup> | Zn <sup>++</sup> |
|----|------------------|------------------|------------------|
| Mg |                  |                  |                  |
| Cu |                  |                  |                  |
| Zn |                  |                  |                  |

Mini Activity Series

Highest

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|--|
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|  |

Lowest

- If you were going to do this experiment over again, what would be the fewest number of tests that you could do (instead of doing all 6 of them) to decide the ranking? [Three]

**CONCEPT EXTENSION**

- Construction of a Six Metal Activity Series
  - You will be given six metals (Mg, Zn, Fe, Sn, Cu, and Al) and asked to build an activity series.
  - The object of this experiment is to build the activity series with doing the fewest number of experiments that you can.
  - Before starting any experimentation, write out your plan, thinking how you

4. can build the series using the fewest steps.  
Obviously, filling in the table below would allow you to do the job, but it can be done with less than the thirty experiments needed to fill in the table.

|    | Mg <sup>++</sup> | Zn <sup>++</sup> | Fe <sup>++</sup> | Sn <sup>++++</sup> | Cu <sup>++</sup> | Al <sup>+++</sup> |
|----|------------------|------------------|------------------|--------------------|------------------|-------------------|
| Mg |                  |                  |                  |                    |                  |                   |
| Zn |                  |                  |                  |                    |                  |                   |
| Fe |                  |                  |                  |                    |                  |                   |
| Sn |                  |                  |                  |                    |                  |                   |
| Cu |                  |                  |                  |                    |                  |                   |
| Al |                  |                  |                  |                    |                  |                   |

Activity Series

Highest

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|  |

Lowest

- B. Determination of an Unknown Metal in the Activity Series
1. Use the unknown metal given to you by the instructor and figure out where it belongs in the activity series you have just built.
  2. Describe your procedure for determining its position.
- C. Any common metals and their salts may be used as unknowns. Ni or Co would probably be two good choices if you have access to them.