

Activities of Metals

Some metals are more reactive than others. By comparing how different metals react with the ions of the other metals and hydrogen in aqueous solutions, an activity series for the tested metals and hydrogen can be developed. The activity series will reflect the relative reactivity of the tested metals. It can be used to predict whether reactions will occur.

Problem

Which is the most reactive metal tested? Which is the least reactive metal tested? Can this information be used to predict whether reactions will occur?

Objectives

- **Observe** single-replacement reactions.
- **Determine the Sequence** of the activities of some metals.
- **Predict** if reactions will occur between certain substances.

Materials

In Dropper Bottles:

- 3 M ZnCl_2 (aq)
- 1 M AlCl_3 (aq)
- 1 M CuCl_2 (aq)
- 1 M MgCl_2 (aq)
- 3 M HCl (aq)
- 8 cm Cu wire
- 8 cm Al wire
- 8 cm Mg ribbon
- 8 cm Zn strip
- scissors
- steel wool or fine sandpaper
- 24-well microscale reaction plate

Safety Precautions

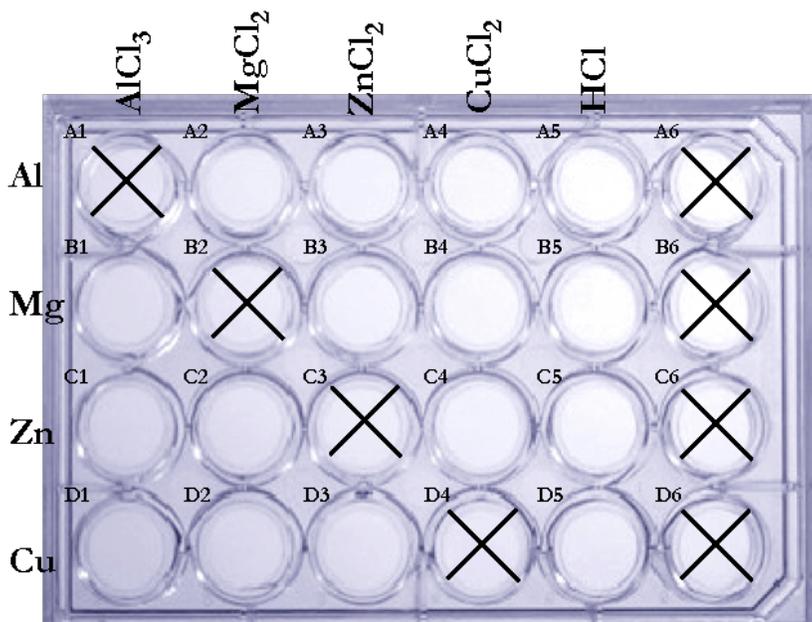
- **Always wear safety goggles and a lab apron.**
- **Use caution when using sharp and coarse equipment.**

Pre-Lab

1. Read the entire lab, including the **Analyze and Conclude** section.
2. In the space provided on the lab data sheet, predict which reactions will occur.

Procedure

1. Use the dropper bottle to half-fill each of the three wells in column 1 (B1-D1) of the well plate with 1 M AlCl_3 solution, as illustrated at right. Skip A1 (that's "A-one") because Al will not react with its ion.
2. Repeat the procedure in step 1 to half-fill the three wells in column 2 (A2, C2 & D2) with 1 M MgCl_2 solution, the three wells in column 3 (A3, B3 & D3) with 3 M ZnCl_2 solution, the three wells in column 4 (A4-C4) with 1 M CuCl_2 solution. Always skip the cell that would react the metal with its ion. Finally, fill ALL four wells in column 5 (A5-D5) with 3 M HCl solution. Leave the last column empty.



3. With the steel wool or sandpaper, polish the 8 cm aluminum wire until it is shiny. Wipe the wire with a damp paper towel (use deionized water!) to remove particulate residue. Use scissors to cut the aluminum wire into four approximately equal pieces (cut in half, then cut those in half). Place one piece of the aluminum wire in each cell A2-A5 (again, skip cell A1).
4. Repeat the procedure in step 3 with the 8 cm magnesium ribbon, 8 cm zinc strip, and 8 cm copper wire. Place one piece of the Mg ribbon in cells B1 & B3-B5, one piece of the Zn wire into cells C1, C2, C4 & C5, and one piece of Cu wire into cells D1-D3 & D5. As before, skip the cell that would have the metal react with itself.
5. If a reaction occurs in a particular cell, describe the reaction and its products in the data table on the front page of the data sheet. Some reactions are slow to get started, so WAIT 10 MINUTES before entering NR in the cells for which no reaction occurs.

Cleanup and Disposal

1. Dispose of all chemicals and solutions in the waste beaker at the front of the room.
2. Clean your equipment and return it to its proper place.
3. Wash your hands thoroughly before you leave the lab.

Minilab [20 pts]
Activities of Metals

NAME _____
 Lab Partner(s) _____
 Period _____ Date _____

Pre-Lab

- [3 pts] Before you begin, use Chart E to predict in which cells (or reactant combinations) reactions will occur. For each reaction predicted to occur, *explain* why.

Data and Observations [3 pts]

Reactions Between Solutions and Metals					
	AlCl ₃	MgCl ₂	ZnCl ₂	CuCl ₂	HCl
Al	A1	A2	A3	A4	A5
Mg	B1	B2	B3	B4	B5
Zn	C1	C2	C3	C4	C5
Cu	D1	D2	D3	D4	D5

Analyze and Conclude

1. [3 pts] **Observing and Inferring**

- In which wells of the reaction plate did chemical reactions occur?
- How many solutions did each metal react with (list each metal)?
- Which metal reacted with the most solutions? Which with the fewest?
- Which metal is the most reactive? Which is the least?
- Which metal(s) is (are) more active than hydrogen? Which is (are) less active?

2. **[1 pt] Sequencing** The most active metal reacted with the most solutions. The least active metal reacted with the fewest solutions. Any metals that reacted in HCl are more active than H₂, any that did not are less. Order the four metals *and hydrogen* from the most active to the least active.

Most Active $\xrightarrow{\hspace{10em}}$ Least Active

3. **[1 pt] Comparing and Contrasting** Compare your activity series with the activity series in Chart E of your reference packet. Does your order agree with Chart E? If not, what is incorrect?
4. **[3 pts] Applying Concepts** Write a complete, balanced chemical equation for each single-replacement reaction that occurred on your reaction plate.
5. **[2 pts] Predicting** Use the activity series in Chart E to predict if a single-replacement reaction will occur between the following reactants. Write a balanced chemical equation for each reaction that will occur, otherwise write "N.R."
- Ca (s) + ZnCl₂ (aq)
 - Ag (s) + ZnCl₂ (aq)
 - Cu (s) + PbCl₂ (aq)
6. **[1 pt] Analyzing** Why might it be important to know the activity tendencies of a series of elements?
7. **[2 pts]** What gas was produced when metals and hydrochloric acid reacted? How could you test for the presence of this gas?
8. **[1 pt]** Why was it important to clean the metals? How might not polishing a piece of metal affect the reaction involving that metal? (Hint: what do metals like Mg or Fe form in the presence of O₂, and how would that affect the reaction?)