Investigating the Activity Series of Metals

Background
A chemical reaction does not occur every time two chemicals interact with each other; however, often times a reaction does occur. How can scientists predict when a reaction will or will not occur? One way to determine the probability of a reaction moving forward is to use an activity series. In this lab, you will make observations about the reactivity of different metals and use this information to create an activity series that can be used to predict when chemical reactions will occur.

Metals that are highly reactive are found at the top of the activity series. Many times, these metals are alkali metals or alkaline earth metals. These metals tend to be found as compounds as they are more stable this way. Once these metals are bonded to an anion in a compound, they will not react with elements in single replacement reactions. If they did react, that would cause them to change to their elemental form, which is unstable.

Transition elements are more stable in their elemental form, and therefore less reactive. These elements will only react with compounds when the metal in the compound is more stable (therefore less reactive) than it is. The most stable metals are those that hardly react at all; these metals are often used for jewelry because they will not react with skin or water. These metals are found at the bottom of an activity series.

Pre-lab Questions
1. Name two stable, nonreactive metals that may be found at the bottom of the activity series (hint: they are used for jewelry).

2. Name two metals that may be toward the top of the activity series.

3. What signs of chemical change may be observed during a chemical reaction?

Objective
Determine the activity series of metals by making observations about the reactivity of compounds and elements.

Materials
- Test tube rack
- Test tubes
- 10 ml graduated cylinder
- Solutions: 1.0 M KNO₃, 1.0 M MgSO₄, 1.0 M FeSO₄, 1.0 M CuSO₄, 1.0 M AgNO₃, and 1.0 M ZnSO₄
- Small samples of each metal (copper, magnesium, iron, and zinc)
Safety
- Always wear safety goggles when handling chemicals in the lab.
- Wash your hands thoroughly before leaving the lab.
- Clean up your lab station and dispose of chemicals according to your teacher’s directions.
- When working with acids, if any solution gets on your skin, immediately alert the teacher and thoroughly flush your skin with water.

Procedure
1. Carefully measure and pour 5mL of the solution in to each of the 5 test tubes in the rack.
2. Place one small piece of copper in one of the test tubes containing the solution. Observe what happens (if anything) and record your observations on your data table for the appropriate solution.
3. Place one small piece of magnesium in the next test tube. Observe what happens (if anything) and record your observations on your data table.
4. Place one small piece of iron in the next test tube. Observe what happens (if anything) and record your observations on your data table.
5. Place one small piece of zinc in the last test tube containing Sodium chloride solution. Observe what happens (if anything) and record your observations on your data table.
6. Keep observing the test tubes for 3 minutes. Record any changes you observe in your data table.
7. After 3 minutes, pour the contents of the test tubes in to the waste chemical beaker at your station.
8. Using the spoon, remove any unreacted, solid pieces of metal from the waste chemical beaker. Dispose of these pieces of metal in the trash can.
9. Make sure your station is clean- throw away any paper towels, wipe up any water, make sure the materials are organized and ready for the next group to use.
10. Wait for your teacher’s instructions before you move to the next station.

Data
Record your observations in the space provided. Signs of a chemical reaction you may observe include color change, the formation of a gas (bubbles), or temperature change.

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<th>Copper (II) sulfate (CuSO₄)</th>
<th>Magnesium sulfate (MgSO₄)</th>
<th>Potassium Nitrate (KNO₃)</th>
<th>Silver nitrate (AgNO₃)</th>
<th>Zinc sulfate (ZnSO₄)</th>
<th>Iron (II) Sulfate (FeSO₄)</th>
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**Analysis**

1. Which metal reacted most often?

2. Which metal reacted least often?

3. In which solution were no chemical reactions observed?
   - a. Is the metal in this solution reactive (unstable as an element) or unreactive (stable as an element)?

4. In which solution did every metal react?
   - a. Is the metal in this solution reactive (unstable as an element) or unreactive (stable as an element)?

5. Based on this data, create an activity series, putting the metals in order from most reactive to least reactive, with the most reactive metal on top of the list.
6. Write a balanced chemical equation for each reaction you observed in the lab.

7. Given the following reactants, determine which reactions are likely to move forward and which reactions will not occur:
   a. K + FeSO₄
   b. Ag + CuSO₄
   c. Ag + KNO₃
   d. K + AgNO₃

8. If hydrogen is found just above copper in the activity series, which metals from the lab (copper, iron, magnesium, zinc) will react with HNO₃?
Conclusion
Explain how scientists are able to predict whether or not a reaction will proceed. Use the following vocabulary: single replacement, element, compound, stable, unstable, reactive, unreactive, and activity series.