Let's Get Active: An Electrochemical Inquiry

Problem/Question:

How can we use the activity series to identify different metals?

Table J
Activity Series**

Most Active	Metals	Nonmetals	Most Active
↓	Li	F_2	↓
	Rb	Cl_2	
	K	Br_2	
	Cs	I_2	
	Ba		
	Sr		
	Ca		
	Na		
	Mg		
	Al		
	Ti		
	Mn		
	Zn		
	Cr		
	Fe		
	Co		
	Ni		
	Sn		
	Pb		
	H_2		
	Cu		
	Ag		
Least Active	Au		Least Active

**Activity Series is based on the hydrogen standard. H_2 is *not* a metal.

Background:

One of the defining characteristics of metals is that they easily lose electrons to form positively charged ions. But *not all metals are equally metallic*; some metal elements lose their electrons more easily than others. Chemists use the term "**activity**" to describe a metal's tendency to lose electrons. It has been observed that when ions of a less active metal are combined with atoms of a more active metal, the more active metal atoms will spontaneously transfer electrons to the less active metal ions. This reaction causes the less active metal ions to become neutrally charged atoms, and the more active metal atoms to become positively charged ions. Because these reactions involves the gain (or **reduction**), and loss (or **oxidation**) of electrons, chemists classify them as one example of Reduction-Oxidation reactions (or "**Redox**" reactions).

The relative activity of different metals is frequently represented as an Activity Series, in which metals are listed from "Most Active" to "Least Active". One version of an Activity Series is provided on **New York State Chemistry Reference Table J** (shown at left). The activity series can be used to predict the spontaneity of chemical reactions between atoms and ions of different metal elements. For example, the following reaction will occur spontaneously:

$$Mg(s) + CoCl_2(aq) \rightarrow Co(s) + MgCl_2(aq)$$

The reason why no energy input is required for this reaction to occur is because Magnesium is more active than Cobalt, so it will spontaneously donate electrons to the Cobalt ions. However, the reverse reaction:

$$Co(s) + MgCl_2(aq) \rightarrow Mg(s) + CoCl_2(aq)$$

will not occur without an additional input of energy.

Objectives

- Utilize the activity series, and observations of chemical behavior in the laboratory to determine the identity of several samples of unknown metals, and justify your determinations.
- **Honors Only**: Determine the voltages involved in the spontaneous reactions that you observe.

Materials

- **Metal Samples.** Your instructor will provide you with the possible identities of each of the metals that will be used. **Possible Identify of Metals that will be used:**

- **Solution Samples.** Your instructor will provide you with the identities of each of the solutions that are available. **Solutions that are available:**

- **Goggles and Gloves**

Safety Guidelines

- Goggles and gloves must be worn at all times that your group is using the materials for the lab (until such time as you are cleaned up, and your instructor tells you that they are no longer required).
- For every test that you do, only use 1 drop of solution.
- Follow all cleanup/chemical disposal guidelines as per your instructor.

Procedure

1. Design a flowchart to show the series of tests that you will perform on each metal sample to determine its identity.
2. Design a data table that will be used to collect data on the possible reactions/no reactions that you will observe.
3. Once you have completed steps 1 & 2, show your instructor and receive approval before beginning the lab (Goggle and gloves must be worn from this point forward).
4. Once your procedure has been completed, clean up as per instructor directions.
5. Formulate a conclusion as to the identity of each metal sample.
6. Answer all Questions for further thought.

Questions for further thought:

1. Pick three reactions you observed and write correctly balanced half reactions/single replacement reactions. Identify the species that is oxidized, and the species that is reduced in each reaction.
    a. Honors Only: Determine the voltage of each of the reactions you have written. Show all work.
2. Why didn't we use sodium as a metal sample in our tests?
3. Why were all of the solutions we used nitrates/halides instead of sulfates/carbonates?