Midn

Experiment 6E: Establishing an Activity Series for Several Metals

Problem: Given small pieces of copper, iron, magnesium, and zinc metal; and solutions of copper(II) nitrate, iron(III) sulfate, magnesium nitrate, silver nitrate, sodium nitrate, and zinc nitrate, devise an experiment to determine the order of reactivity of copper, iron, magnesium, silver, sodium, and zinc.

Pre-laboratory Assignment

1. Consider these two statements:

   If metal A reacts with a solution containing a salt of metal B, then metal A is more active than metal B.

   If metal A does *not* react with a solution containing a salt of metal B, then metal A is less active than metal B.

   Apply this information to these reactions and order the metals from most to least reactive.

   $Sn\ (s) + Pb(NO_3)_2\ (aq) \rightarrow Pb\ (s) + Sn(NO_3)_2\ (aq)$
   $Ni(NO_3)_2\ (aq) + Sn\ (s) \rightarrow$ no reaction
   $Pb\ (s) + Hg(NO_3)_2\ (aq) \rightarrow Pb(NO_3)_2\ (aq) + Hg\ (\ell)$

   most active _____ > _____ > _____ > _____ least active

2. If metal A is placed in a solution containing a salt of metal A, would you expect a reaction to happen? Briefly explain.

3. Some metals react with hydrochloric acid to form hydrogen gas and a solution of the metal chloride salt. Write a balanced chemical equation for the reaction of tin metal in hydrochloric acid. Indicate the physical state of each reactant and product, using the abbreviations: (aq) for aqueous solution, (s) for solid, (ℓ) for liquid, and (g) for gas.

   When mercury is placed in hydrochloric acid no reaction occurs. Where should the element hydrogen be placed in the activity series you established in Question 1? Briefly explain.

4. Write the chemical formula for each solution listed in the problem statement box.

Experimental Design and Procedure

1. Devise a procedure for testing systematically each of the four metals with each of the six metal salt solutions. Use only a small piece of metal and 2 mL of solution for each test.

   Construct a data grid for recording the results of your tests before collecting any data.

2. Test each of the four metals with hydrochloric acid. Record your observations.

3. Dispose of unreacted metals in beaker labeled metal waste.

4. Pour reaction solutions down the drain and rinse with plenty of water.

Experimental Observations

Post-Laboratory Questions

1. Using your experimental observations, order the metals: copper, iron, magnesium, silver, sodium, and zinc from most to least reactive.

   most reactive _____ > _____ > _____ > _____ > _____ > _____ least reactive

2. Based on your experimental observations from the hydrochloric acid tests where does hydrogen fit into your activity series?

   most reactive _____ > _____ > _____ > _____ > _____ > _____ > _____ least

3. Write a balanced chemical equation for each positive test you observed with silver nitrate. Indicate the physical state of each reactant and product, using the abbreviations: (aq) for aqueous solution, (s) for solid, (ℓ) for liquid, and (g) for gas.

4. Write a balanced chemical equation for each positive test you observed with hydrochloric acid. Indicate the physical state of each reactant and product, using the abbreviations: (aq) for aqueous solution, (s) for solid, (ℓ) for liquid, and (g) for gas.

5. Answer the following questions for the situation in which you have dissolved 1.000 g of magnesium metal in an excess of concentrated HCl solution.

   a. How many mols of HCl are required to react completely with the magnesium?

   b. What is the theoretical yield of the magnesium salt produced in this reaction?

   c. What is the percent yield of the reaction if 3.00 g of $MgCl_2$ were isolated?

   d. If 0.0500 grams of hydrogen gas were produced in this reaction, how many grams of Mg must have reacted?