Finding Trends in Chemical Reactions

TEACHER LAB INSTRUCTIONS

Introduction:

In this investigation, students are required to design their own plan for testing reactions between all of these reagents. Students should be able to plan and carry out their own investigation, testing all possible combinations of all pairs of reagents. It also makes perfect sense for the students to design their own data table, most likely in the form of a matrix.

Purpose and Learning Outcomes:

One of the most important characteristics of a metal is its activity (reactivity). The activity of a metal is its ability to react with nonmetals. In such reaction a metal typically loses electrons to the nonmetal to form cations and the product is an ionic compound.

Different metals have different activities. Some metals are very active such as lithium, sodium, potassium, and cesium; some are slowly active such as tin, lead, and iron; and some are not active at all (inactive) such as copper, silver, and mercury. Inactive metals are those metals which resist oxidation (reaction with oxygen in air). These are often called the noble metals.

An activity series is the ranking of metals according to their reactivity. In an activity series metals are arranged in order of decreasing ability to lose electrons. Generally, the more reactive metals are placed at the top of the list. Any metal above hydrogen will not displace hydrogen from an acid.

In performing this experiement, you will observe and compare the reaction of some common metals with nitrate salt solutions (and HCl, if desired) and establish an order of reactivity, from most active to least active metals.

This activity list is called an activity series and is very useful in predicting the results of single displacement reactions.

Materials:

All materials are safe to use and safe to combine in the laboratory, and all except lead are safe to dispose in the laboratory sink and chemical wastecan.

- **Each team will need approximately 10 mL of the following 0.25 M nitrate salt solutions:**
  - **magnesium nitrate $Mg(NO_3)_2$**
  - **copper (II) nitrate $Cu(NO_3)_2$**
  - **lead (II) nitrate $Pb(NO_3)_2$**
  - **zinc nitrate $Zn(NO_3)_2$**
  - **silver nitrate $Pb(NO_3)_2$**
  - **(optional) $Fe(NO_3)_2$ may also be used safely.**
- **(5-6) lead shot pellets**
- **(6) 1 cm long magnesium strips**
- **(6) 1 cm long copper strips**
- **(6) 1 cm long zinc strips**
- **distilled water**
- **spot plates**
- **toothpicks**
- **pipettes**

Students must wear safety goggles, lab aprons, and gloves.
Follow teacher guidelines for chemical disposal.

Data Table:

Make a data table with enough room to write down observations of the reaction you see. A data table meant to simply record check marks or "yes" or "no" remarks is not thorough enough.

Procedure:

Students should write a brief description of each metal before reacting.

Place a small piece of each metal, such as Mg, Pb, Cu, Zn in each of the holes in a clean spot test plate and add 5 to 10 drops 0.25 M aqueous nitrate solution. Watch for evidence of the reaction by noting changes in the color or size of the metal and liquid. Record observations in your data table. Based on these observations, determine whether or not a reaction has occurred, and, if so, with what intensity, slowly or rapidly. Write balanced equations for all reactions.

Because a solution of many metal ions is colorless, often we must examine the reaction of a mixture carefully to establish whether or not a reaction has occurred. Changes in the appearance of the metal, a solution-color change, or the formation of precipitate all indicate that a reaction of this type has occurred.

Note: It is OK to omit plkacing a metal into its own metal nitrate salt solution The data table can simply be marked with an “X” in the appropriate box.

Questions:

1. Rank Sn, Cu, H, Zn, Cu, Fe, Mg, Ag, Pb, and Na in order of their activity. Place the least active element on the left and the most active element on the right.

2. Define the following terms and give an example of each.
   a. cation

   b. anion

3. What changes will you look for to determine if a metal undergoes a reaction?

4. What cautions and/or safety practices must you observe during this experiment?

5. Complete and balance the following equations. If no reaction occurred, mark it as "NR" for no reaction. All salts are in aqueous solution, and all metals have a +2 charge in the salts we are using.

magnesium + magnesium nitrate
magnesium + copper nitrate
magnesium + lead nitrate
magnesium + zinc nitrate
magnesium + silver nitrate

copper + magnesium nitrate
copper + copper nitrate
copper + lead nitrate
copper + zinc nitrate
copper + silver nitrate

lead + magnesium nitrate
lead + copper nitrate
lead + lead nitrate
lead + zinc nitrate
lead + silver nitrate

zinc + magnesium nitrate
zinc + copper nitrate
zinc + lead nitrate
zinc + zinc nitrate
zinc + silver nitrate