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Experiment 5 – Single Displacement Reactions

Discussion

The chemical reactivity of an element is related to its tendency to lose or gain electrons. In theory, it is possible to arrange nearly all the elements into a single series in order of their reactivities. A series of this kind indicates which free elements are capable of displacing other elements from their compounds, known as the activity series. To illustrate the preparation of such a list, we will examine certain single displacement reactions, symbolized generically below:

$$A + BC \rightarrow B + AC$$

where metal (A) comes into contact with a solution of a metal salt, acid, or water (BC). Metal (B) and metal salt (AC) are formed if A is the more active metal. If metal B is more active than element A, no reaction occurs.

Procedure

Obtain a 24 well-plate and place it on a sheet of white paper. Fill wells 1 to 6 with the following solutions (each well should be approximately ½ full of solution).

Well 1: Silver nitrate, $AgNO_3$
Well 2: Copper(II) nitrate, $Cu(NO_3)_2$
Well 3: Lead(II) nitrate, $Pb(NO_3)_2$
Well 4: Magnesium sulfate, $MgSO_4$
Well 5: 3 M sulfuric acid, H_2SO_4
Well 6: 3 M sulfuric acid, H_2SO_4

Clean the metal pieces with fine sandpaper to expose fresh metal surfaces. Place copper in well 1, lead in well 2, zinc in both wells 3 and 4, copper in well 5, and another piece of zinc in well 6.

Observe the contents of each carefully and record any evidence of a chemical reaction. Some of these reactions may be slow or no reaction may occur. Take your time.

Once the experiment is completed, remove the metal strips with your forceps and place them in the appropriate waste boat located along the lab bench top. DO NOT allow the metal strips to go into the sink. Then pour the solutions from the well plate into the appropriate waste containers in the hood. DO NOT pour the solutions down the drain as they contain heavy metals that can be toxic.

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Data for Experiment 5

Record your observations for each combination below. If a reaction occurs, write balanced MOLECULAR and NET-IONIC equations. If no reaction occurs, write NR. Make sure to include the physical states of all the products.

1. Cu(s) and $AgNO_3$(aq)

   Observations:

   Molecular:

   Net-Ionic:

2. Pb(s) and $Cu(NO_3)_2$(aq)

   Observations:

   Molecular:

   Net-Ionic:

3. Zn(s) and $Pb(NO_3)_2$(aq)

   Observations:

   Molecular:

   Net-Ionic:

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4. Zn(s) and $MgSO_4$(aq)

   Observations:

   Molecular:

   Net-Ionic:

5. Cu(s) and H_2SO_4(aq)

   Observations:

   Molecular:

   Net-Ionic:

6. Zn(s) and H_2SO_4(aq)

   Observations:

   Molecular:

   Net-Ionic:

Questions

1. Complete the following table by writing the symbols of the two elements whose reactivities are being compared in each test:

Well #	**1**	**2**	**3**	**4**	**5**	**6**
Greater Activity						
Lesser Activity						

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2. Based upon the comparisons in the table, draw further conclusions by:

   A. arranging Pb, Mg, and Zn in order of decreasing activity (most active first).

   _____ > _____ > _____

   B. arranging Cu, Ag, and Zn in order of decreasing activity (most active first).

   _____ > _____ > _____

   C. arranging Mg, H, and Ag in order of decreasing activity (most active first).

   _____ > _____ > _____

3. Now arrange the five metals from Question #2 above in order of decreasing activity. Explain why the position of hydrogen (H_2) cannot be exactly assigned.

   _____ > _____ > _____ > _____ > _____

4. What additional test(s) would be required to determine the exact position of hydrogen in the activity series of elements in this study?

5. Would silver react with dilute hydrochloric acid? Briefly explain why or why not.

6. Would magnesium react with dilute sulfuric acid? Briefly explain why or why not.