Oxidation-Reduction Reactions

Theory: Redox

Purpose: To examine redox reactions on a microscale.

Micro Apparatus
6 thin pipettes
open 24-well microtitration plate

Micro Materials
3 pieces copper wire .5 cm
.1 M zinc nitrate
3 pieces zinc wire .5 cm
3 pieces lead wire .5 cm
.1 M copper(II) nitrate
.1 M lead (II) nitrate
.1 M iron(II) chloride
M sulfuric acid
.1 M potassium permanganate
tin(II) chloride
iron(II) sulfate

Procedure

1. Place 5 drops copper(II) nitrate solution in each of four wells in the top row of a microtitration plate as shown in the illustration. Put 5 drops zinc nitrate in each of four wells in the next row. Place 5 drops of lead(II) nitrate in each of four wells in third row.
2. Add a small piece of copper wire to the solutions in first column of the microtitration plate. Add a small piece of zinc to the solution to the microtitration plate in the second column and a small piece of lead to those in the third column. The fourth column is comparison.
3. Put the microtitration plate on a white sheet of paper and observe for several minutes. Record results in your data table.
4. Pour 3.0 mL of $FeCl_3$ into a small TT. Add 2 crystals of $SnCl_2$ at a time while stirring until the color disappears. Note the results. Dispose of solution into the hazardous bin.
5. Dissolve 2 small crystals of $KMnO_4$ solution in 10.0 mL of DI in a small beaker. Observe the color. The products formed by the reduction of permanganate ion are colorless or brown. Dissolve 2 or 3 crystals of $FeSO_4$ in 5.0 mL of water in a TT. Add 5-7 drops of 6.0 M sulfuric acid to the $FeSO_4$. Now add one drop of this solution to the beaker of $KMnO_4$. Note the color change. Add another drop. Continue (while solution is on the stirring machine) to add drops of the $FeSO_4$ solution until the color doesn't change. Dispose of in the hazardous bin.

Data: Make a data table reflecting the observations before, during and after all steps. Suggestion: Make a grid-style data table for #1-3.

Discussion

1. Which metal was oxidized by two other ions?
2. Which metal was oxidized by only one other ion?
3. Which metal was not oxidized by any of the ions?
4. Arrange the three metals in order of their strengths as reducing agents, placing the strongest first. Write each metal as a half reaction: M--->M^{2+} + 2 e-
5. Arrange the three metallic ions in order of their relative strengths as oxidizing agents, placing the strongest first.
6. Copper is oxidized in the presence of silver ions. The net ionic reaction is Cu + 2 Ag^+ --->Cu^{2+}+ 2Ag. Write net ionic reactions for a) Zinc and Copper b) zinc and lead c) Copper and lead. (Hint: form your answers to questions 4 and 5, determine which metal is oxidized and which is reduced.)
7. In procedure 4. The Fe3+ ion was reduced to Fe2+ ion a) what was the reducing agent? b) what change did $Sn2^+$ ion undergo? c) Write the net ionic equation for the overall reaction: 2 Fe^{3+}+ 6Cl^- +Sn^{2+} + 2Cl^- ---> 2 Fe^{2+} + 4 Cl^- + Sn^{4+} + 4 Cl^-
8. The permanganate ion, which is purple in color, is a strong oxidizing agent. The manganese (II) ion is practically colorless. What occurred during the addition of the permanganate to the Fe2+

ions?

9. An unknown metal, X, was found to react with lead(II) or copper (II) ions, but not with zinc ions. Insert it in the series in Questions 4 and 5. What will be in the new series?

10. Predict the result of using iron nails to secure sheets of copper to a roof? Explain.

11. In many communities, large, buried iron pipes carry water supply to houses. Whenever it is necessary to connect the house plumbing (often copper) to this pipe, regulations usually require that an official inspector observe the connection. Explain.

12. Why is step 5 in the procedure like a titration, but on a small scale. Explain in terms of redox.

Error Analysis:

Resources:

Conclusion: