Copper Series (Part I – Part IV)

Copper Series Part II

Place twenty drops of 0.1 M $Cu(NO_3)_2$ in a clean test-tube. What color is the aqueous Cu^{2+} ion?

Add 10 drops of 0.2 M Na_2CO_3 to your test-tube and stir. Do you see evidence for precipitates of both $CuCO_3$ and $Cu(OH)_2$? If so, describe the evidence. If not, propose a reason why you do not see evidence for both precipitates.

If you add HCl to your test-tube, it will react with $CuCO_3$ to form bubbles of CO_2 and aqueous Cu^{2+}. It will also react with $Cu(OH)_2$ to produce aqueous Cu^{2+}. Add 12 drops 1 M HCl to your test-tube and stir. Watch the solution carefully and describe what happens.

Write a separate equation for the reaction of each precipitate, $CuCO_3$ and $Cu(OH)_2$, with HCl.

From the solutions available to you, propose a reagent that will allow you to prepare a precipitate of $Cu(OH)_2$ without also precipitating $CuCO_3$?

To receive the next worksheet, check your answers with the instructor.

Copper Series Part III

Add 10 drops of 1.0 M NaOH to your test-tube and stir. Record your observations and write an equation for this reaction.

Dissolve your $Cu(OH)_2$ by adding 36 drops of 0.1 M H_2SO_4 to your test-tube with stirring. What happens? If the process does not seem complete, continue to add drops of 0.1 M H_2SO_4 until it is, mixing after every 2–3 drops.

Write a chemical equation for this reaction.

Add 5 drops of 1.0 M KI to your test-tube, stir, and record your observations.

The reaction between Cu^{2+} and I^- is shown here:

$$2\,Cu^{2+}(aq) + 4\,I^-(aq) \longrightarrow 2\,CuI(s) + I_2(s)$$

Is this an acid–base, a precipitation, an oxidation–reduction, or a complexation reaction? Or is it a combination of two or more of these reactions? Explain your reasoning.

To receive the next worksheet, check your answers with the instructor.

Copper Series Part IV

The reaction between Cu^{2+} and I^-

$$2\,Cu^{2+}(aq) + 4\,I^-(aq) \longrightarrow 2\,CuI(s) + I_2(s)$$

is both an oxidation–reduction reaction and a precipitation reaction. Which reactant, Cu^{2+} or I^-, is oxidized (loses electrons) and which is reduced (gains electrons)? How do you know this?

If we remove the solid iodine it is easier to see the color of $CuI(s)$. You can reduce I_2 to I^- using the thiosulfate ion, $S_2O_3^{2-}$. Notice that a number of other species take part in this reaction.

$$3\,H_2O(l) + S_2O_3^{2-}(aq) + 3\,I_2(s) \longrightarrow S_2O_6^{2-}(aq) + 6\,I^-(aq) + 6\,H^+(aq)$$

Slowly add 3 drops of 1.0 M $Na_2S_2O_3$ with stirring until the change in color is complete. What color is CuI?

One way to dissolve a precipitate that contains a metal ion, such as Cu^+, is to react it with a suitable ligand to form a soluble metal-ligand complex. Examine the reagents available to you and suggest one that might form a soluble complex with copper. Hint: you might wish to review your work from the first experiment.

To receive the next worksheet, check your answers with the instructor.

Copper Series Part V

Add nine drops of 3M NH_3 to your test-tube and stir. The following reaction occurs:

$$CuI(s) + 2\,NH_3(aq) \longrightarrow Cu(NH_3)_2^{+}(aq) + I^{-}(aq)$$

What color is $Cu(NH_3)_2^{+}$?

If you oxidize Cu^{+} to Cu^{2+}, you will see the characteristic color of the $Cu(NH_3)_4^{2+}$ complex ion. Add one drop of 3% H_2O_2, a good oxidizing agent, to your test-tube and stir. What color is your solution?

If you add Na_2S to the solution, a precipitate of CuS will form. ***Working in the hood***, add 5 drops of 0.5 M Na_2S to your test-tube. What color is CuS? ***Before you leave the hood, empty the contents of your test-tube into the waste container and rinse your test-tube at least once, placing the rinsing in the waste container.***

Write a balanced chemical equation showing the reaction of the $Cu(NH_3)_4^{2+}$ with S^{2-}.

This completes the series of reactions for copper. Discard the contents of your test-tubes into the waste container and then begin the series of reactions for iron using a clean test-tube.