Copper Series (page 2)

Place twenty drops of 0.1 M $Cu(NO_3)_2$ in a clean test-tube. What color is aqueous Cu(II)?

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(II). It will also react with $Cu(OH)_2$ to produce aqueous Cu(II). Add 12 drops 1 M HCl to your test-tube and stir. Watch the solution carefully and describe what happens.

Write a separate equations 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 (page 3)

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 the $Cu(OH)_2$ 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 adding drops of 0.1 M H_2SO_4 until it is, mixing after adding 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 copper(II) and iodide is shown here:

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

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

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Copper Series (page 4)

For the reaction

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

which reactant undergoes oxidation (loses electrons) and which undergoes reduction (gains electrons)?

If we remove the solid iodine it is easier to see the color of the 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:

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

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

Which reactant is oxidized?

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.

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your answers with the instructor

Copper Series (page 5)

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

$$CuI(s) + 2NH_3(aq) \rightarrow Cu(NH_3)_2^+(aq) + I^-(aq)$$

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

If you oxidize Cu(I) to Cu(II), 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 forms. ***Working in the hood***, add 5 drops of 0.5 M Na_2S to your test-tube. What color is CuS?

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.

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