

## Copper Series (page 2)

Place twenty drops of 0.1 M  $\text{Cu}(\text{NO}_3)_2$  in a clean test-tube. What color is aqueous Cu(II)?

Add 10 drops of 0.2 M  $\text{Na}_2\text{CO}_3$  to your test-tube and stir. Do you see evidence for precipitates of both  $\text{CuCO}_3$  and  $\text{Cu}(\text{OH})_2$ ? 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  $\text{CuCO}_3$  to form bubbles of  $\text{CO}_2$  and aqueous Cu(II). It will also react with  $\text{Cu}(\text{OH})_2$  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,  $\text{CuCO}_3$  and  $\text{Cu}(\text{OH})_2$ , with HCl.

From the solutions available to you, propose a reagent that will allow you to prepare a precipitate of  $\text{Cu}(\text{OH})_2$  without also precipitating  $\text{CuCO}_3$ ?

to receive the next worksheet, check  
your answers with the instructor

### Copper Series (page 3)

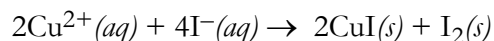
Add 10 drops of 1.0 M NaOH to your test-tube and stir. Record your observations and write an equation for this reaction.

Dissolve the  $\text{Cu}(\text{OH})_2$  by adding 36 drops of 0.1 M  $\text{H}_2\text{SO}_4$  to your test-tube with stirring. What happens? If the process does not seem complete, continue adding drops of 0.1 M  $\text{H}_2\text{SO}_4$  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:

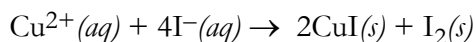


Is this an acid–base, a precipitation, an oxidation–reduction, or a complexation reaction? Or is a combination of two or more of these reactions? Explain your reasoning.

to receive the next worksheet, check  
your answers with the instructor

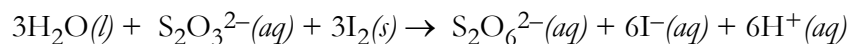
## Copper Series (page 4)

For the reaction



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  $\text{CuI}(\text{s})$ . You can reduce  $\text{I}_2$  to  $\text{I}^{-}$  using the thiosulfate ion,  $\text{S}_2\text{O}_3^{2-}$ . Notice that a number of other species take part in this reaction:



Slowly add 3 drops of 1.0 M  $\text{Na}_2\text{S}_2\text{O}_3$  with stirring until the change in color is complete.

Which reactant is oxidized?

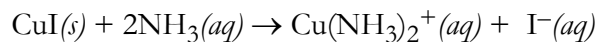
What color is  $\text{CuI}$ ?

One way to dissolve a precipitate that contains a metal ion, such as  $\text{Cu}^{+}$ , 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 (page 5)

Add nine drops of 3M NH<sub>3</sub> to your test-tube and stir. The following reaction occurs:



What color is Cu(NH<sub>3</sub>)<sub>2</sub><sup>+</sup>?

If you oxidize Cu(I) to Cu(II), you will see the characteristic color of the Cu(NH<sub>3</sub>)<sub>4</sub><sup>2+</sup> complex ion. Add one drop of 3% H<sub>2</sub>O<sub>2</sub>, a good oxidizing agent, to your test-tube and stir. What color is your solution?

If you add Na<sub>2</sub>S to the solution, a precipitate of CuS forms. **Working in the hood**, add 5 drops of 0.5 M Na<sub>2</sub>S to your test-tube. What color is CuS?

Write a balanced chemical equation showing the reaction of the Cu(NH<sub>3</sub>)<sub>4</sub><sup>2+</sup> with S<sup>2-</sup>.

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.

to receive the next worksheet, check  
your answers with the instructor