The Copper Cycle

In this series of reactions, you will start with $Cu_{(s)}$ and then end with $Cu_{(s)}$. In theory, the final amount of Cu should be the same as the initial amount of Cu.

The reactions involved in this cycle allow us to look at the different classifications of reactions.

- **Combination:** $A + B \rightarrow AB$
- **Decomposition:** $AD \rightarrow AB + C$
- **Single Displacement:** $AC + B \rightarrow A + BC$
- **Double Displacement:** $AC + BD \rightarrow AD + BC$
- **Oxidation-Reduction:** $A \rightarrow A^{+n} + ne^-$

  $B + me^- \rightarrow B^{-m}$

  $A + B \rightarrow A^{+n} + B^{-m}$

Reactions:

Dissolution of Cu: Oxidation-Reduction Rxn

$Cu^0_{(s)} \rightarrow Cu^{+2} + 2e^-$

$H_2O_{2(aq)} + 2\,H^+_{(aq)} + 2e^- \rightarrow 2\,H_2O_{(\ell)}$

$Cu_{(s)} + H_2O_{2(aq)} + H_2SO_{4(aq)} \rightarrow CuSO_{4(aq)} + 2\,H_2O_{(\ell)}$

(Note the $SO_4^{-2}{}_{(aq)}$ ions are spectator ions.)

Precipitation of Cu^{+2}: Double Displacment Rxn

$$CuSO_{4(aq)} + 2\ NaOH_{(aq)} \rightarrow Cu(OH)_{2(s)} + Na_2SO_{4(aq)}$$

Conversion of $Cu(OH)_2$ to CuO: Decomposition Rxn

$$Cu(OH)_{2(s)} \xrightarrow[\Delta]{} CuO_{(s)} + H_2O_{(\ell)}$$

Dissolution of CuO: Double Displacement Rxn

$$CuO_{(s)} + H_2SO_{4(aq)} \rightarrow CuSO_{4(aq)} + 2\ H_2O_{(\ell)}$$

Reclamation of $Cu_{(s)}$: Single Displacement Rxn

$$CuSO_{4(aq)} + Zn_{(s)} \rightarrow Cu_{(s)} + ZnSO_{4(aq)}$$

Calculations:

Theoretical Yield: In theory, the amount of product that could be produced.

In this cycle of reactions, the amount of Cu(product) is equal to amount of Cu(reactant).

Actual or Experimental Yield:

The actual amount of *product* recovered in the experiment.

Percent Yield: The ratio of the actual (or experimental) yield to the theoretical yield multiplied by 100%.

$$\%\ \text{yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100\%$$