Project: Wastewater Recovery

FOR THE TEACHER

Summary
In this project, students will analyze test results in order to design a procedure for recovering certain metals from wastewater using their knowledge of the Activity Series of Metals and single replacement reactions. Based on their analysis, students will create a proposal for presentation in an effort to recommend the best plan for reclaiming the metals from the wastewater.

Grade Level
High School

NGSS Alignment
This project will help prepare your students to meet the performance expectations in the following standards:

- **HS-ETS1-3**: Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

- **Scientific and Engineering Practices**:  
  o Analyzing and Interpreting Data  
  o Engaging in Argument from Evidence  
  o Obtaining, Evaluating, and Communicating Information

Objectives
By the end of this project, students should be able to

- Apply the Activity Series of Metals to a real world problem.  
- Analyze data pertaining to single replacement reactions.  
- Design a procedure to recover the results of a single replacement reaction.  
- Communicate their findings to a fictitious company.

Chemistry Topics
This project supports students’ understanding of

- Activity Series of Metals  
- Single Replacement Reactions  
- Predicting Products  
- Data Analysis

Time
**Teacher Preparation:** ~15 minutes  
*Lesson:* 120–180 minutes

Materials
- [Metals in Aqueous Solutions Online Simulation](#) (Adobe Flash needed)  
- Computer or laptops for each group of 2–4 students  
- Student handouts for each group:  
  o Company Memo  
  o Simulation Activity  
  o Presentation Requirements
Safety
- No specific safety precautions need to be observed for this activity.

Teacher Notes
- Group size recommendation: 2-4 students
- Introduce project by handing out Company Letter that outlines the problem.
- Students will use the lab simulation listed in an internal memo to perform single replacement reactions and collect data.
- Students analyze data to determine the recycling procedure to use in their proposal based on the data collected in the lab simulation.
- Students incorporate costs for the materials (metals) used in their proposal.
- Students write a formal business letter to the company outlining their proposal including the recycling procedure, safety, and cost of the project.
- Students present the proposal to the class and/or teacher.
- An Answer Key for the simulation activity has been provided for teacher reference.
- For the presentation/proposal, potential answers/recommendations by students could be:
  o Mg will precipitate all metals in waste water.
  o Specific sequence for separating each individual metal from waste water:
    ▪ Sn would be added first to remove Cu^{2+}
    ▪ Zn would be added next to remove Sn^{2+}
    ▪ Mg would be added next to remove Zn^{2+}
  o Note: Students may not make the connection between single replacement reactions and the recycling aspect. You might have to emphasize what happen at the molecular level, ie. Cu^{2+} changes to Cu when Cu is replaced in a reaction.