12 Recovering Copper

LABORATORY

IN THE FIRST activity of this unit, the reaction you used to produce circuit boards also produced waste. Deciding how to handle waste produced from manufacturing is challenging. In some cases, the waste is toxic. In other cases, the waste contains valuable materials that can be reclaimed and then reused. To **reclaim** metal means to get it back so it can be used again. Reclaiming metal from waste reduces the amount of new metal needed for manufacturing.

One way to reclaim copper from used copper chloride is to combine the waste with a substance that precipitates the copper. Some methods produce copper metal; other methods produce solid copper compounds that do not dissolve in water. The copper precipitates because of a chemical reaction. Reclaiming the copper can be a useful way to deal with waste. It reduces the amount of toxic waste discarded and provides copper that can be used again to make new products.

Chemists have found that certain other metals are effective in removing copper from waste products. In this activity, you will test three metals to find out which one is best at reclaiming copper from waste.

Mixing two chemicals (left) results in a chemical reaction that creates an orange precipitate. Test tubes (right) hold the results of several metal precipitation reactions.

GUIDING QUESTION

Which metal is best at reclaiming copper from the used copper chloride solution?

MATERIALS

For each group of four students

- 1 dropper bottle of used copper chloride solution from the "Producing Circuit Boards" activity
- 1 dropper bottle of 5% ammonia solution
- 1 cup of water

For each pair of students

- 1 SEPUP tray
- 1 aluminum washer
- 1 iron washer
- 1 zinc washer
- 1 plastic spoon
- 1 dropper
- 1 pair of forceps
- paper towels

For each student

- 1 pair of chemical splash goggles
- 1 Student Sheet 12.1, "Reclaiming Copper from Waste"

SAFETY

Wear chemical splash goggles at all times during this lab. Do not allow solutions to touch your skin or clothing. Clean up any spills immediately. If accidental contact occurs, inform your teacher and rinse any exposed areas. Wash your hands thoroughly with soap and water after you finish the activity.

PROCEDURE

1. With your partner, carefully examine each of the three metal washers: aluminum, iron, and zinc. Record your observations on Student Sheet 12.1, "Reclaiming Copper from Waste."
2. Add 10 drops of used copper chloride solution to Cups 1–4 of the SEPUP tray.
3. Using forceps, place the aluminum washer in Cup 1, the iron washer in Cup 2, and the zinc washer in Cup 3. Cup 4 will serve as a control for comparison purposes.

4. Observe the reaction in each cup for 5–10 min. Record your observations of each reaction on Student Sheet 12.1. Be sure to include a comparison of the results obtained with each different metal.
5. Using the plastic spoon, remove all the solid pieces of metal from the cups (leaving as much liquid in the cups as you can), and place them on a paper towel. Clean the spoon with a paper towel after you remove each piece.
6. On your Student Sheet, record your final observations of each metal.
7. Record your observations of the solutions left in each cup.
8. Using a dropper, put 5 drops of each solution into a clean cup in the SEPUP tray. Do this by transferring 5 drops from Cup 1 to Cup 6, from Cup 2 to Cup 7, from Cup 3 to Cup 8, and from Cup 4 to Cup 9. Be sure to clean the dropper with water after each transfer so the solutions do not mix.
9. Test for copper in each solution by adding 2 drops of ammonia solution to Cups 6–9. If copper is present in the solution, a deep blue color or a blue-green precipitate will form.
10. Record your observations of the ammonia test on your Student Sheet. Dispose of the metals and solutions in your SEPUP tray as directed by your teacher.

EXTENSION

What other metals can precipitate copper from the used copper chloride solution? Design an experiment to find out. After your teacher approves your investigation, conduct the experiment, and present your results to the class.

ANALYSIS

1. Explain the purpose of including Cup 4 and Cup 9 in your investigation.
2. Explain, using evidence from this investigation, which metal seemed to work best at removing the copper from solution.

3. **Revisit the issue:** Companies that make circuit boards often reclaim copper from copper-containing solutions. This allows them to reuse the copper or to sell it. Based on your results from this investigation and the information in the following table, which metal would you recommend that a company use to reclaim copper? Support your answer with evidence, and identify the trade-offs of your decision.

More Information on Metals

METAL	APPROXIMATE COST PER POUND IN 2017 (U.S. DOLLARS)	MAXIMUM WASTEWATER CONCENTRATION (PPM)	HEALTH BENEFITS	HEALTH HAZARDS
Aluminum	$0.93	Not restricted	Trace amounts may help important chemical reactions in the human body.	High levels may cause bone disease.
Copper	$3.09	1	Essential for nervous system functions and energy metabolism; the recommended daily intake for an average adult is 2 mg.	Large amounts ingested over time cause liver and kidney damage.
Iron	$0.03	100	Essential for formation of red blood cells; the recommended daily intake for an average adult is 18 mg.	Large amounts ingested over time may cause inflammation and damage to organs.
Zinc	$1.47	2.4	Small amounts are needed for functioning enzymes and forming proteins; the recommended daily intake for an average adult is 15 mg.	Large amounts ingested over time may cause inflammation and damage to organs.

Name_____ Date_____

STUDENT SHEET 12.1

RECLAIMING COPPER FROM WASTE

Cup	Metal	Initial observations of metal	Final observations of metal	Observations of reaction	Observations of remaining liquid	Observations of ammonia test	Copper present?
1							
2							
3							
4							

Name_____ Date_____

STUDENT SHEET 12.2

WRITING FRAME: EVIDENCE AND TRADE-OFFS

There is a lot of discussion about the issue of _____

_____

My decision is that _____

_____

My decision is based on the following evidence:

First, _____

_____

_____

Second, _____

_____

_____

Third, _____

_____

_____

The trade-off is _____

_____

_____

People who disagree with my decision might say that _____

_____

_____