Lab: Reduction of Metal Oxides Using Carbon

FOR THE TEACHER

Summary
In this lab, students reduce metal ores using an alternative apparatus to a traditional crucible. Read more about this apparatus in the May 2015 issue of Chemistry Solutions.

Grade Level
High school

Objectives
By the end of this lesson, students should be able to
• Understand that metal ores can be reduced to their pure metal with the help of carbon.
• Understand redox reactions.
• Calculate percent yield.

Chemistry Topics
This lesson supports students’ understanding of
• Reduction
• Redox reactions
• Percent yield

Time
Teacher Preparation: 20 minutes
Lesson: one class period

Materials
• Metal oxide sample (copper(II) oxide, lead(II) oxide, or iron(III) oxide)
• Carbon
• Balance
• Paper
• Beaker
• Bottle cap crucible with a screw through the center
• Tongs/pliers
• Bunsen burner
• water

Safety
• Always wear safety goggles when handling chemicals in the lab.
• Always be aware of an open flame. Do not reach over it, tie back hair, and secure lose clothing.
• Students should wash their hands thoroughly before leaving the lab.
• When students complete the lab, instruct them how to clean up their materials and dispose of any chemicals.
Teacher Notes

- Do not use aluminum bottle caps, make sure they are steel. The bottle cap first needs to be heated strongly in a fume hood to burn the plastic insert. Then, drill a hole through the middle and thread a nut and bolt through. The bottle cap acts as a suitable replacement for porcelain crucibles. Refer to the May 2015 article in *Chemistry Solutions* for the rationale behind using a bottle cap instead of a crucible.

- For copper, after about a minute there is a distinct colour change. Take care heating does not continue for too long (the copper reoxidizes). Red copper metal can be seen.
  - Add 25 mL of 0.5-M sulfuric acid, warm to boiling, and immediately filter. This dissolves any unreacted copper(II) oxide. The mass of copper can be found and the yield can be calculated based on the initial mass of copper(II) oxide. As an example, 0.51 g of copper oxide would be expected to give 0.41 g of copper. In fact 0.15 g was collected so the yield was 37%. Loss of product was caused by poor transfer of materials and the washing process.

- For iron, place filter paper on the end of a magnet and put this under the beaker. Raise the magnet with the magnetic iron on the paper up the side of the beaker.

**FOR THE STUDENT**

**Lesson**

**Background**
Carbon is a reducing agent and ever since the Bronze Age it has been used to convert ores into metals. The extraction of metals is an important process even now. The experiment can even be extended into determining yield.

**Procedure**

1. Place about 0.15 g of the metal oxide on a piece of paper and about 0.05 g of carbon on another piece of paper. Make sure you know your exact masses of the substances. Record their masses in a data table.

2. Pour one solid onto the other and vice versa until there is a good mix and then pour the mixture into the bottle cap.

3. Half-fill a 250-mL beaker with tap water.

4. Hold the bottle cap by the screw with tongs or pliers. Heat the base of the bottle cap as hot as possible with a Bunsen burner flame with the air-hole open.

5. Observe the heating carefully and when ready, drop the bottle cap into the beaker of cold water.

6. Decant the water and floating carbon into the sink or basin and repeat the washing.

**Analysis**

Write the balanced chemical equation of the reaction you just carried out.

Calculate the percent yield of your product.