

# The Floating Tin Sponge

## Single Replacement Reactions



### Introduction

Create a floating tin sponge that rises to the surface upon reaction of an acidic tin(II) chloride solution with zinc. Two distinct single replacement reactions are clearly visible in this demonstration of the activity series of metals and the reactivity of metals with hydrochloric acid. Beautiful crystalline tin needles are deposited immediately on the zinc surface and aggregate to give an open, lattice-like arrangement that resembles steel wool. As hydrogen gas is released, the solution effervesces and the tin sponge gradually bobs and rises and finally floats to the surface.

### Concepts

- Single replacement reaction
- Oxidation–reduction
- Activity series of metals

### Materials

Hydrochloric acid, 3 M, HCl, 200 mL

Tin(II) chloride,  $\text{SnCl}_2 \cdot 2\text{H}_2\text{O}$ , 23 g

Zinc, mossy, Zn, 15 g

Water, distilled

Beaker, 500-mL

Forceps or tweezers

Graduated cylinder, 100- or 250-mL

Narrow-mouth reaction vessel (beaker or graduated cylinder)

### Safety Precautions

*Tin(II) chloride is moderately toxic; it is a skin irritant and is corrosive. Hydrochloric acid solution is toxic by ingestion or inhalation and is corrosive to skin and eyes. Zinc metal dust may be present at the bottom of the bottle of mossy zinc. Zinc dust can be flammable. Please review the enclosed Material Safety Data Sheets for safety information and proper handling and disposal information. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. Please review current Material Safety Data Sheets for additional safety, handling, and disposal information.*

### Preparation

To 22.5 g of tin(II) chloride dihydrate in a 500-mL beaker add 65 mL of distilled water followed by 135 mL of 3 M hydrochloric acid solution. Mix thoroughly to dissolve. The solution will be cloudy and milky-white. Filter the solution through filter paper. (The solution is approximately 0.5 M in  $\text{SnCl}_2$  and 2 M in HCl.)

### Procedure

1. Pour 200 mL of the acidic tin(II) chloride solution into a tall and fairly narrow reaction vessel.
2. Add 20–30 pieces (15–20 g) of mossy zinc—enough to cover most of the bottom of the reaction vessel.
3. Observe the formation of finely divided tin crystals on the zinc surface and the evolution of hydrogen gas bubbles generated by reaction of zinc with hydrochloric acid.
4. As the reaction proceeds the tin begins to resemble a steel-wool sponge. The tin sponge rises slowly to the surface, buoyed by the hydrogen gas bubbles and the presence of pockets of air. This phase of the demonstration may take between 10 and 30 minutes.
5. After the reaction is complete remove the tin sample from the solution using forceps or tweezers. Rinse the tin under running water and allow to air dry on paper towels.
6. In contrast to mossy zinc, which is very hard, the tin is soft and spongy and easily compressed.

### Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures, and review all federal, state and local regulations that may apply, before proceeding. The elemental tin sponge may be rinsed thoroughly under cold running water, dried, and discarded according to Flinn Suggested Disposal Method #26a. The remaining acidic tin(II) chloride solution may be neutralized according to Flinn Suggested Disposal Method #24b.

### Tips

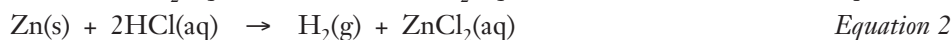
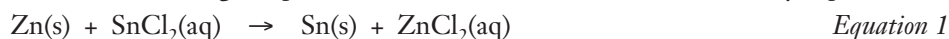
- It is desirable, although not essential, to filter the acidic tin(II) chloride solution before use. The cloudy solution will eventually turn clear on its own as the reaction proceeds.
- Avoid stirring or agitating the tin sponge—the tin metal will compact and not float.
- Physical variables have a noticeable effect on the time needed for the tin sponge to float. Small, flat, and irregularly shaped zinc pieces provide a large surface area for the buoyancy effect of hydrogen gas bubbles and give the best result. A narrow reaction vessel traps gas bubbles more effectively and provides the maximum buoyancy effect as well.
- It may be convenient to prepare a reference demonstration: during pre-lab preparation carry out the reaction using one-half of the recommended amounts of reagents. This reference demo will then be ready ahead of time to illustrate to the class the fact that the tin sponge floats in water.
- Floating tin forms instantaneously if granular zinc is used in place of mossy zinc. Granular zinc poses a relatively greater safety and health hazard.

### Discussion

Addition of mossy zinc to acidic tin(II) chloride solution results in two separate single replacement reactions. The zinc pieces are coated immediately with tin crystals that look like shiny steel wool. The solution begins to effervesce with bubbles of hydrogen gas; as hydrogen gas continues to evolve the tin sponge bobs and floats to the surface.

Two oxidation–reduction reactions take place simultaneously. In the first reaction (Equation 1) metallic zinc is oxidized to  $\text{Zn}^{2+}$  by reaction with tin(II) chloride in solution;  $\text{Sn}^{2+}$  is correspondingly reduced to tin metal. This reaction is classified as a single replacement reaction in which the more reactive zinc metal replaces tin(II) ions to give tin, a less active metal. Single replacement reactions of metals with metal salt solutions are used to demonstrate the activity series of metals. Only metals that are more reactive than the other metal in the metal salt solution will react in this manner.

The second reaction (Equation 2) illustrates the oxidation of a metal by reaction with acid and is accompanied by reduction of  $\text{H}^+$  to hydrogen gas. This reaction is also classified as a single replacement reaction in which zinc ion formally replaces  $\text{H}^+$  ion.



### Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

**Unifying Concepts and Processes: Grades K–12**

Evidence, models, and explanation

**Content Standards: Grades 9–12**

Content Standard B: Physical Science, structure and properties of matter, chemical reactions

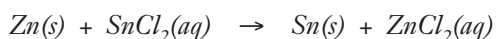
### Answers to Worksheet Questions

1. Describe what happened in this demonstration.

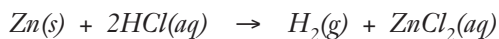
*Mossy zinc was added to an acidic tin(II) chloride solution. Very small tin crystals began to form on the surface of the zinc. The tin formed a sponge-like substance that looks like steel wool. The sponge eventually rose to the surface of the solution.*

2. This demonstration consisted of two single replacement reactions that occur simultaneously. Write a balanced chemical equation for each reaction.

a. Oxidation of metallic zinc and reduction of tin from the tin(II) chloride.



b. Oxidation of zinc with an acid and reduction of hydrogen ions.



3. What is an oxidation/reduction reaction?

*An oxidation/reduction (or “redox”) reaction occurs when one or more electrons are transferred between molecules. Oxidation refers to a loss of electrons (and rise in oxidation state), and reduction refers to a gain of electrons (and subsequent decrease in oxidation state).*

## Reference

Summerlin, L. R. and Ealy, Jr., J. L., *Chemical Demonstrations: A Sourcebook for Teachers*; American Chemical Society: Washington, D.C., 1988; Vol. 1.

## Flinn Scientific—Teaching Chemistry™ eLearning Video Series

A video of the *The Floating Tin Sponge* activity, presented by Jamie Benigna, is available in *Single Replacement Reactions* and in *Activity Series of Metals*, part of the Flinn Scientific—Teaching Chemistry eLearning Video Series.

## Materials for *The Floating Tin Sponge* are available from Flinn Scientific, Inc.

Materials required to perform this activity are available in the *The Floating Tin Sponge—Chemical Demonstration Kit* available from Flinn Scientific. Materials may also be purchased separately.

Catalog No.	Description
AP4425	The Floating Tin Sponge—Chemical Demonstration Kit
Z0003	Zinc, Mossy, 500 g

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.

# The Floating Tin Sponge Worksheet

## Discussion Questions

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2. This demonstration consisted of two single replacement reactions that occur simultaneously. Write a balanced chemical equation for each reaction.
  - a. Oxidation of metallic zinc and reduction of tin from the tin(II) chloride
  - b. Oxidation of zinc with an acid and reduction of hydrogen ions.
3. What is an oxidation/reduction reaction?