

# Smashing Thermit Reaction

A Safe, Indoor Thermit Demonstration



## Introduction

Take two rusty iron balls, wrap one in aluminum foil, then bang them together and watch the sparks fly!

## Concepts

- Single replacement reaction
- Exothermic reaction
- Thermit reaction
- Oxidation–reduction
- Activation energy

## Materials

Rusted iron balls, 2½-inch diameter, 2\*

Aluminum foil

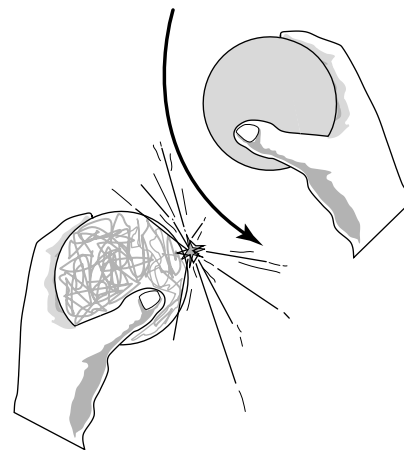
\*See Tips section.

## Safety Precautions

*This demonstration will produce sparks that may shoot several feet. Wear protective goggles or safety glasses and gloves when performing this demonstration. The balls are heavy. Make sure to have a tight grip on the balls before striking them together. Keep fingers to the side of the balls so they are not pinched. Take care to avoid causing hand, arm or shoulder pain from repeated strikes. A teacher demonstration only. Do not allow students to perform this demonstration. Please review current Safety Data Sheets for additional safety, handling, and disposal information.*

## Procedure

1. Wrap one of the rusted iron balls with a single layer of aluminum foil.
2. Place the rusted iron ball in one hand and the aluminum foil-wrapped one in the other hand.
3. **Making sure the fingers are out of the way**, strike down on the aluminum foiled-wrapped ball with the rusted one. Try to strike a glancing blow with the two surfaces.
4. As the balls strike and slide past one another, a loud crack and white sparks are produced and the aluminum is literally welded to the iron ball.
5. Rotate the rusted iron ball to get a fresh surface of iron oxide. Repeat the process for further sparks and cracks! With a little practice, a loud and flashy scene will be created.



## 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 iron balls may be reused many times and ultimately be disposed of in the trash according to Flinn Suggested Disposal Method #26a. See *Tips* for procedure to clean and recharge balls with rust.

### Tips

- The iron balls can be rusted by soaking them in a salt-water solution for 2–3 days and allowing them to air dry. Storing them exposed to the normal atmosphere in a chemical storeroom should also keep them well rusted.
- Practice, practice, practice! A repetitive motion tends to enhance the effects. However, too much practice does lead to sore and tired hands and arms.
- Strike the balls at very rusted spots, not clean areas.
- Make sure your fingers are out of the way when striking the balls together.
- The use of gloves is recommended. This will prevent the hands from being coated in iron oxide and lessen the likelihood of developing blisters when repeatedly striking the balls together.
- The aluminum coating, formed at the points of impact, can be removed by cleaning the ball with a scouring pad.
- Don't expect sparks every time. The activation energy is reached through friction and pressure. A glancing blow is necessary to generate a large amount of concentrated friction and heat needed to initiate the thermit reaction.

### Discussion

The reaction is the same as the classic thermit reaction but much safer. When the balls are struck, the rust ( $\text{Fe}_2\text{O}_3$ ) reacts with the aluminum foil (Al) to produce aluminum oxide ( $\text{Al}_2\text{O}_3$ ), elemental iron (Fe) and heat. This reaction is a highly exothermic, single replacement reaction. Aluminum is oxidized and iron is reduced. The melting point of iron is  $1530^\circ\text{C}$  and the reaction temperature reaches approximately  $2200^\circ\text{C}$ . ( $\Delta H^\circ = -849 \text{ kJ/mole}$ )



The reaction coordinate diagram for this reaction is shown in Figure 1.

The activation energy ( $E_{\text{act}}$ ) needed for the reaction to occur is provided by the mechanical (kinetic) energy of the iron balls being struck against one another and the aluminum foil. Once the activation energy is reached, the reaction proceeds very rapidly to produce the products and heat. The loud noise and the sparks result from the large amount of thermal energy ( $\Delta H$ ) released by the reaction.

### 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, interactions of energy and matter

### Acknowledgment

This reaction was first presented to Flinn Scientific by Larry Peck, Texas A&M University, at the 16th Biennial Conference on Chemical Education. Special thanks to Alan Slater, retired, Stratford Central Secondary School, Stratford, Ontario, who provided Flinn Scientific with instructions for this activity.

**The *Smashing Thermit Reaction*—A Safe, Indoor Thermit Demonstration is available from Flinn Scientific, Inc.**

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