

Hand-Held Thermit Reaction

Endothermic and Exothermic Reactions

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

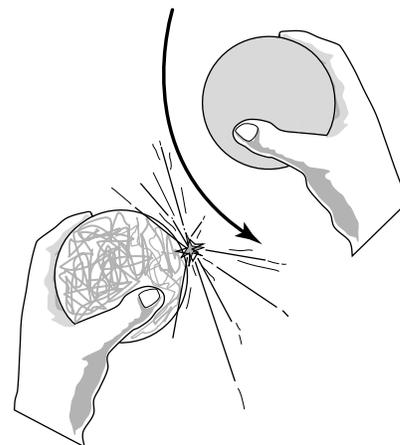
Aluminum foil

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.

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

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

Tips

- Practice, practice, practice! A repetitive motion tends to enhance the effects. Strike the balls at very rusted spots, not clean areas. However, too much practice does lead to sore and tired hands and arms.
- 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 iron balls can be recharged with rust by soaking them in a salt-water solution overnight and allowing them to air dry. Storing them exposed to the normal atmosphere in a chemical storeroom should also keep them well rusted.

Hand-Held Thermit Reaction *continued*

- 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 (Fe_2O_3) reacts with the aluminum foil (Al) to produce aluminum oxide (Al_2O_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 $1530\text{ }^\circ\text{C}$ and the reaction temperature reaches approximately $2200\text{ }^\circ\text{C}$. ($\Delta H^\circ = -849\text{ kJ/mole}$)



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

The activation energy (E_{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 (ΔH) released by the reaction.

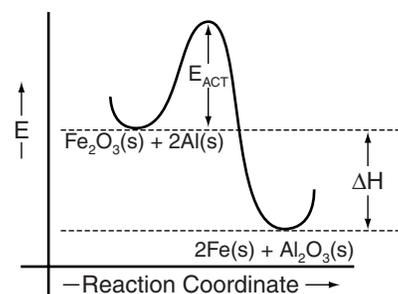


Figure 1

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

Answers to Worksheet Questions

1. Describe what happened in this demonstration.

Two iron balls, one rusted and the other one coated in aluminum foil, were struck sharply together. There was a loud crack and a lot of sparks. Where the balls collided, aluminum was welded to the iron ball.

2. What is the difference between an endothermic and an exothermic reaction? Was this reaction endothermic or exothermic? How do you know?

An endothermic reaction is a reaction that takes in heat, using heat as a reactant. An exothermic reaction, on the other hand, is a reaction that gives off heat as a product. The reaction was exothermic, as evidenced by the loud crack and the sparks that were produced.

3. In this demonstration, rust (iron oxide) reacted with aluminum foil. Write a balanced chemical equation for this reaction. Include heat on the correct side of the equation.



4. How was the activation energy needed for this reaction reached?

Because the iron balls were struck together quickly and forcefully, enough kinetic energy was present to pass the activation energy threshold.

Acknowledgment

This demonstration originated from the work of Troy Lilly, Western Texas College, Snyder, Texas and 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.

Flinn Scientific—Teaching Chemistry™ eLearning Video Series

A video of the *Hand-Held Thermit Reaction* activity, presented by Bob Becker, is available in *Endothermic and Exothermic Reactions* and in *Industrial Chemistry*, part of the Flinn Scientific—Teaching Chemistry eLearning Video Series.

Materials for *Hand-Held Thermit Reaction* are available from Flinn Scientific, Inc.

Materials required to perform this activity are available in the *Smashing Thermit Reaction—Chemical Demonstration Kit* available from Flinn Scientific. Materials may also be purchased separately.

Catalog No.	Description
AP6256	Smashing Thermit Reaction—Chemical Demonstration Kit
A0019	Aluminum Foil

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

