# Thermite Reaction

**Description:** A thermite reaction is demonstrated by igniting a mixture of aluminum and iron oxide generating molten iron and aluminum oxide.

**Materials:**

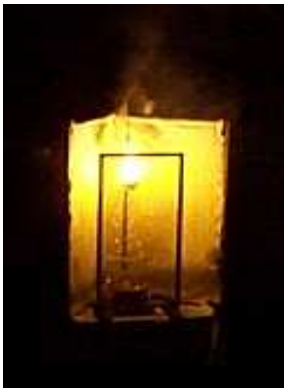
$Fe_2O_3$ powder
Aluminum powder
Magnesium strip (fuse)
$Na_2O_2$
Clay pot
Thermite cart (Dab 125)

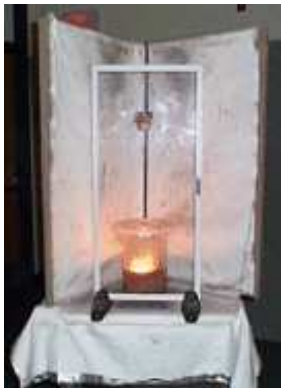
**Procedure:**

1. Prepare the thermite mixture as follows: Cover the hole in the bottom of the clay pot with a small piece of paper. Mix 40 g of $Fe_2O_3$ with 10 g of Al in the clay pot. Prior to the demonstration, create a depression in the $Fe_2O_3$/Al mixture and add a spatula tip of $Na_2O_2$ into the pit. Insert a Mg strip straight up into the $Na_2O_2$ and place the clay pot on the ring stand behind the blast shield.

2. Lay out the flame resistant cloth in front and to the sides of the thermite cart to avoid starting a fire on the floor. Inform the audience that the light produced from burning Mg can cause retinal damage. Ensure that all room entrances are blocked off so that no one can enter the room beside the demonstration as ignition occurs. Make sure that the cart has a decent clearing below the ceiling (at least 6 feet). Ensure that the blast shield is securely placed in front of the clay pot. If the cart is close to the audience, have front rows move back. Once all safety precautions are taken, light the Mg fuse with a lighter and immediately stand back.

3. After the reaction is over, retrieve the iron (will still be red hot) with tongs and allow to cool on a fireproof mat. Do not immerse in water to cool as this may result in the generation of hydrogen gas which is explosive. After a couple of minutes, the piece of iron can be cooled in water and broken open with a hammer to reveal the pure iron core. The magnetic properties of the iron can be demonstrated at this point.





**Discussion:**

The thermite reaction can be described by the chemical equation below:

$$Fe_2O_3\,(s) + 2\,Al\,(s) \rightarrow Al_2O_3\,(s) + 2\,Fe\,(s)$$

This reaction is initiated by heat (burning Mg) and becomes self-sustaining. The reaction generates oxygen and therefore combustion occurs even in the absence of oxygen. The reaction creates so much heat that the iron generated is melted. The melting point of iron is 1530 $^{o}$C and has $\Delta H_{fus}$ = 14.9 kJ/mol. The overall free energy change ($\Delta G$) of this reaction at 298 K is -838 kJ/mol (Shakhashiri, 85).

**Safety:** DEMONSTRATORS MUST PRACTICE THIS DEMONSTRATION PRIOR TO PERFORMING THIS DEMONSTRATION IN CLASS. Do not look directly at the burning magnesium fuse. This reaction produces intense heat and molten metal. A fire extinguisher should be readily available. Water should never be used to extinguish this reaction as hydrogen gas, which is explosive, may be produced. A safety shield is necessary to protect from sparks. Heat protective gloves should be worn to handle the molten iron.

**Disposal:** Once materials are cooled they can be disposed of in a solid waste container.

**References:**

Shakhashiri, B. Z. In *Chemical Demonstrations: A Handbook for Teachers of Chemistry*; The University of Wisconsin Press: 1983; Vol. 1, p 85-89.

Arnáiz, F. J.; Aguado, R.; Arnáiz, S. *J. Chem. Educ.* **1998**, *75*, 1630. (microscale)

**Video:**

http://www.youtube.com/watch?v=818YAUHrE9w

http://www.youtube.com/watch?v=PPAYZMzGMwQ (Mythbusters style)

http://www.youtube.com/watch?v=a8XSmSdvEK4