

HOT SHOT

RUSTY IRON CANNON BALLS VS. STEEL SPHERES

Introduction:

The physics of collisions is always interesting. In a collision kinetic energy QUICKLY changes into other forms of energy, such as sound or heat. To learn about this phenomena, we will be colliding steel and rusty iron spheres in various scenarios.



Iron Sphere Collisions: This reaction is essentially the same as the classic thermit reaction



- ✓ When the balls are struck, the rust in the form of iron (III) oxide (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 $2200\text{ }^\circ\text{C}$. ($\Delta H^\circ = -849\text{ kJ/mole}$)
- ✓ $\text{Fe}_2\text{O}_3(\text{s}) + 2\text{Al}(\text{s}) \rightarrow \text{Al}_2\text{O}_3(\text{s}) + 2\text{Fe}(\text{s}) + \text{heat}$

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.

Background Research:

1. Define the following terms:
 - a. Thermit:
 - b. Thermal Energy:
 - c. Kinetic Energy
 - d. Law of conservation of energy
 - e. Phenomena
 - f. Exothermic
 - g. Single replacement reaction
 - h. Oxidized
 - i. Reduced
 - j. Redox reaction
 - k. Activation Energy (E_{act})
2. What is the difference between steel and iron?



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.

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SAFETY!!!!

- ✓ Make sure that you are wearing safety glasses or goggles.
- ✓ When you are colliding the spheres and such be mindful of where your fingers are located.
- ✓ If you smash a finger between these spheres it is going to cause some serious pain!!!

Scientific Inquiry:

- ➔ Obtain all materials listed below for the experiments: Make sure you keep your work station orderly.
 - 2 – rusty iron spheres
 - 2 – pretty steel spheres
 - 1 pair crucible tongs
 - Aluminum foil
 - Regular Paper
 - Cardstock
 - other paper
 - Magnesium strips (Discuss with Coach Hyde)
- ➔ Bang the spheres together so that they collide while holding a sheet of paper between them. Make note of what happens to the paper in each collision
- ➔ Repeat the experiment with varying thicknesses of paper.
- ➔ Wrap one of each spheres in aluminum foil. Bang them together now. Try it with the lights off if you are comfortable risking a digit. Record what happens.
- ➔ Hold a strip of magnesium