



# CALIFORNIA STATE SCIENCE FAIR 2005 PROJECT SUMMARY

<b>Name(s)</b> <b>Nathan R. Pederson</b>	<b>Project Number</b> <b>J1529</b>
<b>Project Title</b> <b>The Study of the Force Generated from a Changing Magnetic Field</b>	
<p style="text-align: center;"><b>Abstract</b></p> <p><b>Objectives/Goals</b> The objective of this experiment was to measure the induced magnetic force due to a changing magnetic field (Lenzs Law) by dropping a strong magnet down conductive metal tubes.</p> <p><b>Methods/Materials</b> Two different strength Neodymium-Iron-Boron (NIB) magnets were dropped down a 0.91 m length aluminum and copper tubes. As each magnet passed through a given portion of the metal tube, a changing magnetic field was set up that exerted a braking force on the falling magnets to slow them down. Thus, due to magnetic repulsion, the magnets fall much slower than a non-magnetic reference weight. Then Newtons Second Law (<math>F = ma</math>) was used to measure the magnetic braking force by connecting the NIB magnet with a string that was attached to a cart (with weights) that was pulled up an incline ramp (using a pulley) as the magnet was dropped down the aluminum tube.</p> <p><b>Results</b> Measured freefall times of the large NIB magnet were 23.2 and 12.6 times longer than the reference weight for the copper and aluminum tubing due to Lenzs law. For copper tubing, the magnet takes the longest time to fall and it is a much better conductor than aluminum, therefore it generates a larger braking force. The NIB magnet force, mass of the cart, and its velocity were experimentally measured and found to be linear. The measured force of the larger NIB magnet ranged from 0.5 to 0.84 Newtons (weight of cart affected force), with the smaller NIB magnet varying from 0.15 to 0.29 Newtons for a 0.635 cm thick aluminum tube.</p> <p><b>Conclusions/Discussion</b> The larger NIB magnet and the thicker copper tube took the longest time to fall due to a larger magnetic force generated to oppose the falling magnet. Changing from aluminum tubing (tw = 0.635 cm) to copper tubing (tw = 0.3 cm) for the large NIB magnet increases the measured magnetic breaking force for freefall from 0.94 to 1.8 Newtons, almost a factor of 2 for about half the tube wall thickness.</p>	
<b>Summary Statement</b> When a NIB magnet is dropped down a conductive metal tube a changing magnetic field is established, causing a current to flow and an induced magnetic force created to oppose the magnet fall (Lenzs Law), which was experimentally measured.	
<b>Help Received</b> My dad helped me understand the basic laws and principles; helped build the experiment; also helped durring the experiment if I needed more than two hands.	