



**CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY**

Name(s) Michael S. Bertch	Project Number J0702
Project Title Are Voltage and Current Directly Related to the Force Generated by an Electromagnet?	
Abstract Objectives/Goals The purpose of this experiment is to determine the relationship of varying voltage and magnetic force generation in an AC electromagnet. My interest in electricity prompted me to examine the variable of changing the voltage and measuring the actual force produced by an electromagnet. Methods/Materials I decided to measure the force generated by an electromagnet as voltage is gradually increased starting from zero volts. I used a 120-volt AC relay as my test platform. The relay has a built-in electromagnet, which actuates its function. It made sense to use an electromagnet that was already wound with wire rather than starting from scratch. There were several reasons for this including safety. I had to employ a load cell with a display in grams to record the force generated. I included a voltmeter to measure voltage and an amp meter to measure AC current. The relay was connected to the load cell assembly by a spring. It made sense to start off at zero volts to measure and record force findings and voltage measurements to make it easy to chart this information on a graph. My voltage source was the use of a variac (variable AC Voltage transformer). The display and the load cell have their own voltage source to operate. The load cell was pre-calibrated to accurately measure the force in grams. At the beginning of each trial I reset the #zero# on the force display. Results I did 6 trials consisting of 14 voltage and force readings. I would increase the voltage until an increase of force was noted. I continued to increase voltage on each trial noting a force change until I had 14 readings per trial. In some trials I had 14 readings before reaching my maximum voltage. I found an increase of voltage was closely proportional to the force generated as shown in my graphs. Conclusions/Discussion Based on the data from each graph and the composite average graph my hypothesis proved correct. I found a direct relationship between voltage applied and force generated in an electromagnet. Ohm's Law states that voltage equals resistance multiplied by current with both alternating and direct current circuits. Because the resistance in the circuit was more or less stable the voltage applied also raised the current proportionally. The electromagnetic field was increased in proportion to power applied. As the electromagnetic field increased the force generated on the tension gauge increased proportionally.	
Summary Statement Demonstrating that Electromagnetic force is directly proportional to the volage and current applied.	
Help Received My father helped me with the load cell sensor and the safety involved with household voltage.	