Ryan Rogers

Dr. John Stewart

Honors University Physics II Lab

18 April 2010

Constructing a Solenoid

The initial plan was to build a solenoid that would draw an iron object through a solenoid by the magnetic field and ring a bell. What I finally figured out was that the proposal was geared more towards the set up of a gauss gun; however, I was not using a capacitor and therefore had no way to store the current and create a large magnetic field to move an object down the solenoid by shorting the capacitor. I started out trying to make an air solenoid by wrapping 14 gauge wire around a two inch cardboard tube. I then connected the wires up to a 6V battery and tried to transport various objects down the solenoid. The initial idea was to move a magnet down the solenoid by creating opposite directions of magnetic field between the solenoid and the dipole of the magnet. Placing the magnet into solenoid with current running through it only caused the magnet to spin and stick to the side of the solenoid. Next, I tried to suspend a string down the middle of the solenoid with washers hanging form it. The magnetic field produced by the solenoid did not have any affect on the washers.

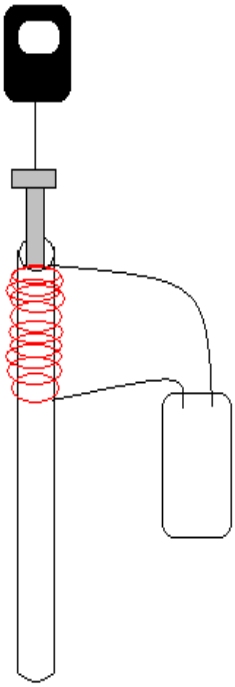
Since the initial framework of the solenoid did not produce results, I decided to go with much smaller tubing, specifically a 5/8 inch pvc pipe, and smaller wire so that I would create a much larger turn density, specifically an 18 gauge magnetic wire. The final set up of the solenoid consisted of an 11.43 cm section of pvc pipe with 100 turns. Two more coils of wires were stacked on top of the initial coil thereby making three

separate wraps of wire on the solenoid. Each coil was wrapped in a manner that would not conflict with the other coils fields. Also, instead of using a magnet or washers, I went with a ½ inch diameter bolt with a length of 10 inches, which reduced the amount of open airspace in the solenoid. I then set the solenoid horizontally on a flat surface, placed a portion of the bolt into the solenoid, and ran current through the wire. This created a magnetic field strong enough to pull the bolt completely into the solenoid.

Each wire was connected to the 6V battery and tested individually with an amp meter and was found to carry on average 115 milliamps (on average because the wraps are not perfectly symmetrical). Therefore, the first wire was calculated to have a current of 114.2 mA, 100 turns over 11.43cm, and a magnetic field of 1.26×10^{-4}T. I then connected the two inner coils together and attached them to the 6V battery and measured a current of 126.6mA. By connecting the two coils together, the turn density of the wires was increased from 100 to 200 over the same length and therefore producing a magnetic field of 2.911×10^{-4}T. Finally, the last coil was connected to the first two coils, and connected to the 6V battery, which measured a current of 142.2mA. Again, by connecting the three coils together, the turn density of the wires was increased from 200 to 300 over the same length and therefore producing a magnetic field of 4.27×10^{-4}T.

The experimental variable that I decided to measure was the amount of force the magnetic field inside the solenoid exerted on the bolt. I accomplished this by suspending the 208g, 10 inch bolt from a digital scale, which allowed the bolt to be hung freely in the top of the solenoid. The coils were then hooked up to the 6V battery, causing the bolt to be pulled into the solenoid, which allowed me to measure the force in ounce which I later converted to newtons. The amount of force acting on the bolt was measured with one

coil at 0.56N, two coils at 0.83N, and three coils at 1.11N. This agrees with my hypothesis and the general rule surrounding the infinite solenoid equation that by increasing the number of turns on a solenoid you can increase the magnetic field, which will in turn create a larger force on an object in a solenoid. The figure below gives an example of the solenoid that was constructed for the project.



Reference:
UP II Spring 2010 Course Guide
www.miniscience.com
http://www.wisegeek.com/what-is-a-solenoid.htm