Honors Project

University Physics 2

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For my project I constructed an electric motor with the intention of testing certain variables associated with the motor. These were variables such as the strength of the magnetic field, the number of coils of wire on the armature, as in two coils that both have ten turns, and the length of the area affected by the magnets, in other words the length of the coils. Although constructing my motor was somewhat difficult, the finish product works quite well.

The electric motor I constructed utilized the spinning armature with brushes design to rotate. This requires the use of permanent magnets placed on opposite sides of the armature to achieve the desired spin, they must be aligned so that the north side of one magnet is on one side of the armature and the south side on the other. This is absolutely necessary or the resulting Lorentz force will make it so that armature does not experience any torque (Stewart 2011). The armature is constructed by wrapping insulated copper wire around a block of Styrofoam, with a varnish covered light metal pole in the center, this pole must not conduct electricity, this provides the axis that the object will rotate around (Yap 2006). The armature is placed on a rig that allows it spin in such a way that the current switches off once the armature has completed a fourth of a rotation. This is achieved by placing the armature in such a way that it brushes the ends of the copper on two conducting lines, with opposite charges, at the same time. I am currently powering this with four 1.5V D-Cell batteries, it is my suspicion that these motors would be better served with a stronger power source of about 9V, however I have not been able to test this hypothesis.

An electric motor utilizes a very simple physical principle known as the Lorentz force. When a current passes through the coil in the presence of a magnetic field a Lorentz force is created according to the right hand rule where you cross the current with the field to find the direction of the Lorentz force. The way my motor is built it requires that it be spun to be started.

That is because when the armature lies in the equilibrium position the resulting Lorentz forces cancel out resulting in no net torque (Stewart 2012). However, once the motor is spun to start it and the current changes position inside the magnetic field, the Lorentz force creates a resulting torque that causes the armature to rotate in a counter clockwise direction. This is shown by the following diagrams.

The second part of my honors project consisted of testing the variables associated with the design of the electric motor. These variables were the strength of the magnetic field, the length of the coil affected by the magnetic field, and the number of coils surrounding the armature. This however proved somewhat difficult to test, with only one of the variables offering an observable difference. As the strength of the magnetic field increased so did the rotational speed of the armature. To observe this I used a length of fishing line and a stopwatch to time how long it took to collect the known length of fishing line. When I double the strength of the magnetic field the rotational very nearly doubled as well. When I increased the length of the coil affected by the magnetic field it slowed the rotational speed, but not very considerably. However I feel that this was due to the weight increase and that this does not actually affect the speed of rotation. When I increased the coils surrounding the armature there was no observable difference in the rotational speed. However, the armature reached its top rotational speed quicker and maintained a smoother rotation. Again I feel as though the weight was to blame here. Without a change in weight I feel as though it would have been entirely possible to notice an observable increase in rotational speed however slight.

In conclusion, even though I observed quite a few setbacks along the way I feel as though my project was quite successful. There were two major issues surrounding my earlier designs. The first being the friction associated with the way I was suspending the armature. The second was the fact that I had the magnets positioned in such a way that there was no net torque being created. Once these issues were overcome the electric motor functioned quite well. The variables I tested, and the data that I observed allowed me to conclude that the magnetic field and the rotational speed are directly related; the length of the armature affected by the field and the rotational speed unrelated, and the number of coils and the rotational speed are directly related.