Physics 14, Spring 1997  
Lab 5 - The Electric Motor

Purpose

The purpose of this lab is to build a simple electric motor from the common materials in a kit which will be supplied in the lab. The materials in the kit include: two paper clips, two thumb tacks, copper wire, a block of wood, sandpaper and two ceramic magnets. The design of the motor is up to you, but you can only use the materials provided to you in the motor kit. To build a motor that works is not so difficult; to build one that runs fast is a different story. That is your challenge.

Procedure

1. Start by constructing the moving coil of wire (the armature) such as the one pictured below.

![Figure 1](image)

Here are a few of the practical things you need to keep in mind along with all the physics theory as you think about an armature design:

a. The more wire you use in a coil:
   
   • the more turns of wire you can have enclosing a given area (hence the more torque);
   
   • the more resistance your coil will have (hence the smaller the current and the smaller the torque);
   
   • the more mass your coil will have (hence the greater the moment of inertia about
its rotation axis);

b. The larger you make the area enclosed by your coil the greater the torque, but also the greater the moment of inertia.

To make the windings of the loop stay together, you can clip off a few pieces of the wire and twist them around the loop at a few places (you will not cause any "shorts"; the copper wire is insulated). [Note: these loops of wire can also be strategically placed to “balance” the armature.]

2. Next you need to think about suspending your armature so that it can spin. The suspension mechanism is generally called a "bearing" and your bearing must also be able to supply the armature with electrical energy. The paper clips can be used for this purpose. One possible way to suspend the wire is shown below.

![Figure 2](image)

A battery charger will later be connected to the paper clips and will supply the current for your armature.

3. Now comes the hardest part - getting the current to flow in the armature in such a way that the coil will spin! The wire supplied is coated with plastic as shown in figure 3 on the next page. The insulation on the two ends of the copper wire must be removed so that the current can flow. This can be done with the supplied sandpaper (or the blade of a pocket knife).
You will not want current to flow in the coil all the time, however. If you remove the insulating material all around the wire, the loop may not continue to rotate! You will need to make what is called a "commutator" which is a mechanism to make the flow of current intermittent.

One simple solution is to only remove the insulating material on one "half" of the wire as shown below. You have to think through which half in relation to the plane of the loop and the magnetic field configuration that you will choose. To get a truly fast motor, you will need to be more clever. Can you think of a design that will force the current to flow through the loop all the time (not half the time), giving you on average a higher torque on the loop? To build a commutator in such a way that there is a net gain is not so easy; friction is the killer.
4. Place the two ceramic magnets under the loop or choose another magnetic field configuration.

5. Connect the clips on the leads from the battery charger to the paper clips, and your "motor" should run; it may need a small push, but that is allowed!