Massachusetts Institute of Technology - Physics Department

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Build your own Electric Motor - Have Fun, and earn Extra Credit.

In a separate envelope you will find:
2 magnets, 2 thumbtacks, 1 block of wood, 2 paper clips, and approximately 2 m of insulated copper wire.

Objective.
The goal is to build an electric motor using **ONLY** the material in the envelope plus a dry cell size D (1.5 V regular flashlight battery) which you have to provide yourself. You may use any tool, you may cut the wood, drill holes, etc., but the motor must be built *only* of the material that is in the envelopes (even a small piece of tape, or a drop of glue, if noticed, will disqualify you).

Fun and Extra Credit.
Building a motor can be great fun. In addition, you can earn up to 20 *bonus* credit points. You will get 1 point for every 100 rpm of your motor. As an example, if your motor runs 445 rpm you will get 4 extra credit points (455 rpm is good for 5 points). If your motor runs faster than 2000 rpm, you may fall in the prizes (see below), and in addition you will get the maximum of 20 extra credit points (which is equivalent to 2 homework assignments). These extra points can help you get a better course grade.

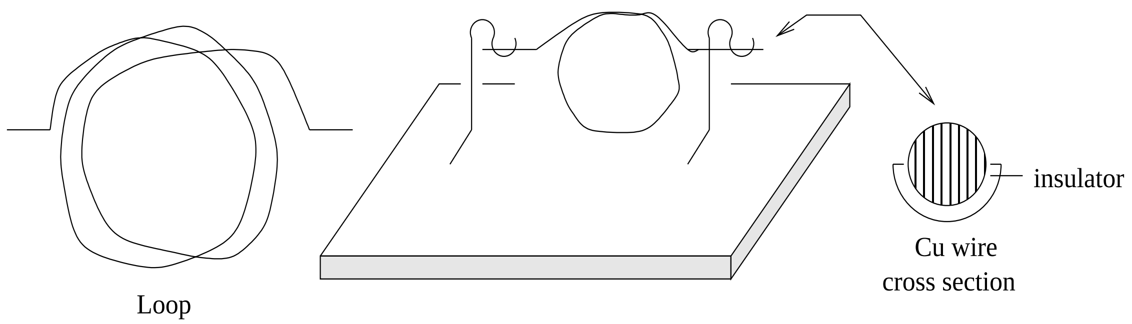
Contest.
The builders of the six fastest motors will be invited to have dinner with me at a nearby restaurant on Saturday, April 13 (6 PM). The person who builds the fastest motor will, in addition, receive a special prize which will be handed out in my lectures on April 3.

Due Date and Testing (after spring vacation).
The motors will be tested on **Tuesday, April 2, 1-5 PM** in Room **26-110**. Please bring your motor in person (if possible). **To avoid possible mix-ups, make sure your name is clearly written on the motor!** Soft drinks and cookies will be awaiting you.

How to get your Motor back?
You can pick up your motor in **4-352** on April 3 and 4 between 9 AM and 5 PM. Or you may take your motor home (on 4/2) after it has been tested and your credit has been recorded. We will write the rotation rate of your motor (in rpm) on the wooden block so that you know how much credit you got; divide that number by 100, and round it off, but remember, 20 is the maximum number of credit points. *I would like to keep the six fastest motors, if the owners do not object.*

How to build a motor?

To build one that works is not so difficult; to build one that runs faster than 1950 rpm (*and thus earn the* ***maximum of 20 credit points***) is a different story. We give you here some general guidelines.



1. Make a loop of the copper wire with a diameter of about 1” (left figure). The smaller the diameter, the more turns you can make, but that does not necessarily make the motor go faster!

2. To make the windings of the loop stay together, if necessary, you could clip off a few pieces of the wire and twist them around the loop at a few places (you will not cause any “shorts” as the copper wire is insulated).

3. Make a support for the loop. Use the paper clips as brackets (see figure); they can be fastened to the wood with the thumbtacks. Your battery can then be connected to the paper clips which will feed the current through the loop .

4. The ends of the loop could be freely supported by the paper clips (bend them any way you want to). Thus the loop can rest on the paper clip-support brackets (see figure).

5. Now comes the hardest! The insulation on the 2 ends of the copper wire must be removed so that the current can flow; that can be done, e.g., with a knife (scrape). If you remove the insulating material all around the wire, the loop will not continue to rotate as the torque will then reverse during one revolution. One simple solution is to only remove the insulating material on one “half” of the wire (see the right figure, which is a schematic cross section through the copper wire).

   You have to think through which half in relation to the plane of the loop and the magnetic field configuration that you will choose!

   Another solution is to build a commutator as schematically shown in your book (Fig. 27-25, page 698). The advantage of a commutator is that the current will flow through the loop all the time (not half the time) which will give you on average a higher torque on the loop. However, to build a commutator in such a way that there is a net gain, is not so easy; friction is the killer.

6. Place the 2 magnets under the loop or choose another magnetic field configuration.

7. Connect your 1.5 V battery to the paper clips, and your motor should run; it may need a small push, but that is allowed!

How to build a super fast motor?

Your imagination is the limit, and you may want to ignore all, or most, of my above advice.

Good luck and have fun!

Walter Lewin