

# Making an Electric Motor

## 8<sup>th</sup> Grade Physics

### Notes:

- This design is originally from Patrick Marooney, and appears in Trostli's book, *Physics is Fun!*
- The instructions are quite clearly outlined in Trostli's book. However, I have made some changes which are outlined below.
- I have every student in the class make their own motor.
- These motors are relatively complex. There are other simpler motor designs that other teachers do, but I don't think they give students the same degree of satisfaction and sense of accomplishment.
- It takes about 3 hours to build, in total, which I break up over the period of five classes.

### Equipment:

- Hammer (one per student, but can share)
- Needle-nose pliers (one per student, but can share)
- Phillips head screwdriver (one per student, but can share)
- Ruler (one per student, but can share)
- Power source. The motors run on 6-volt lantern batteries, but burn through them fairly quickly. I use a power source (which I got in an electric supply store) that plugs into the wall and produces about 8-volts of DC.
- A few 8"-long insulated wires with alligator clips at the end.
- Bolt cutters (just one for the whole class)
- (I don't use any soldering.)

### Supplies needed for the Field magnet (per motor)

- Three 16-penny 3½"-long nails – two of them bent at 90° 1¼" from the head, and one cutoff 1¼" from the head (and the head is thrown away)
- 2¼"-long piece of 3/8" heat-shrink insulation
- 17-foot long piece of #24 magnet wire
- Two ½" plastic staples

### Supplies needed for the Armature (per motor)

- 5"-long piece of 1/16" brass brazing rod
- Two 2"-long 6-penny nails
- 1<sup>15</sup>/<sub>16</sub>" piece of ¼" heat-shrink insulation
- 1<sup>3</sup>/<sub>8</sub>"-long piece of 5/8" foam caulking rod (or foam rope)
- Two square pieces (7/8" by 7/8") of 36 gauge (0.005 thick) copper foil
- Two pieces of 2½"-long, ¼"-wide electrical tape
- 11-foot long piece of #24 magnet wire

#### Other Supplies needed (for the rest of the motor, per motor)

- Platform: One piece of wood that measures  $\frac{3}{4}$ " x  $3\frac{1}{2}$ " x 8"
- Brackets: Two  $8\frac{1}{2}$ "-long pieces of brass brazing rod, and four  $\frac{1}{2}$ "-long #6 Phillips-head metal screws, and four washers with  $\frac{1}{8}$ " holes
- Terminals: Two  $\frac{5}{8}$ "-long pieces of brass brazing rod
- Brushes: one  $\frac{3}{4}$ "-long piece of  $\frac{5}{8}$ " foam caulking rod (or foam rope), and one 5"-long piece of #24 magnet wire, and one 8"-long piece of  $\frac{1}{2}$ "-wide electrical tape
- One piece of sandpaper  $\frac{3}{4}$ " x  $\frac{3}{4}$ "

#### Total Supplies needed (for a class of 20 students) – get a bit extra of each!

(From a hardware store unless stated otherwise)

- Sixty 16-penny  $3\frac{1}{2}$ "-long nails
- 4 feet of  $\frac{3}{8}$ " heat-shrink insulation (electronics supply store)
- 600 feet of #24 magnet wire (electric motor supply store)
- Two  $\frac{1}{2}$ " plastic staples
- 40 feet of  $\frac{1}{16}$ " brass brazing rod
- Forty 2"-long 6-penny nails
- $3\frac{1}{2}$  feet of  $\frac{1}{4}$ " heat-shrink insulation
- 4 feet of  $\frac{5}{8}$ " foam caulking rod (or foam rope)
- One sheet of 36 gauge (0.005 thick) copper foil
- One roll of  $\frac{1}{4}$ "-wide electrical tape, and one roll  $\frac{1}{2}$ "-wide electrical tape
- 14 feet of 1-by-4 wood (that measures  $\frac{3}{4}$ " x  $3\frac{1}{2}$ " )
- 80  $\frac{1}{2}$ "-long #6 Phillips-head metal screws
- 80 washers with  $\frac{1}{8}$ " holes
- One sheet of medium grit sandpaper

#### Tips for Success

- For brackets: bend rod first at middle (with just one side of the needle nose pliers), then bend it  $\frac{1}{2}$ " from either side of the middle. Bend the feet last, ensuring that the low point of the middle is  $1\frac{3}{4}$ " above the floor of the platform.
- Be sure all connections are sanded very well.
- Bend the copper plates around a marker pen to form a cylindrical shape that fits best around the foam plug.
- Whenever wrapping the magnet wire, start by making a simple overhand knot in order to secure it.
- Adjust the brushes so that they run vertically and apply some pressure when touching the commutator.