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Build Your Own Simple DC Motor

Introduction

Motors are the fundamental driving force of the modern world. It is a very rare occasion when you do not see or use the action of a motor during your daily life. So how do they work? With this activity, you will build your own simple DC motor.

Concepts

- Motor fundamentals
- Electric circuits

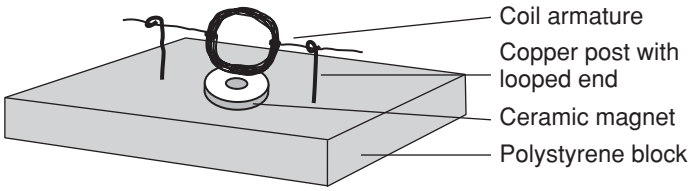

Figure 1.

Materials

Battery, 9-V
Battery clips with alligator clip leads, 9-V
Copper wire pieces, 16–18 gauge, 7–8 cm, 2
Magnet, ceramic disc
Magnet wire, 20–22 gauge, 60 cm
Pliers, needle-nose with wire cutters
Sandpaper strip
Polystyrene foam or cardboard piece, 8 cm × 8 cm × 2.5 cm
Tube or rod, approximately 2 cm in diameter

Safety Precautions

Please follow normal laboratory safety guidelines. 9-V batteries do not have enough electrical current to be harmful.

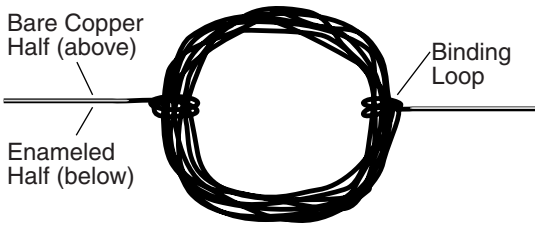

Figure 2. Coil Armature

Procedure

1. Obtain 60 cm of magnet wire and a tube or rod approximately 2 cm in diameter (such as a pen, PVC pipe, battery, etc.)
2. Tightly wind the magnet wire around the tube or rod to create a thinly-coiled loop. Wind completely (approximately 15–20 coils) and leave 2–3 cm of free wire at both ends. The two free ends of the wire should be 180° apart when the winding is complete.
3. Carefully pull the coil off the tube or rod.
4. To secure the loop shape permanently, wrap each free end through the loop and around the coil of wire 2 to 3 times. Make sure the binding loops are 180° apart and wrapped tightly around the coil wires. Straighten the free ends so that they are perpendicular to, but in the same plane, as the coil to serve as the axle to the coil armature (see Figure 2).
5. Check the balance of the coil armature by spinning the coil by the axles between your thumb and index fingers. Make sure the coil spins smoothly.
6. Obtain a small piece of sandpaper. Hold the coil at the edge of a table so the coil is straight up and down and one of the free ends is lying flat on the table. With the sandpaper, sand off the top half of the insulating enamel. Leave the bottom half of the enamel intact. Do the same to the other free end. make sure the shiny bare copper side faces up on both ends (see Figure 2).
7. Obtain two 7–8 cm long pieces of 16–18 gauge copper wire (uninsulated).
8. Use needle-nose pliers to make a small, complete loop at one end of each piece of copper wire. If necessary, use the needle-nose pliers to straighten the copper wires as well (see Figure 1).
9. Obtain an 8 cm × 8 cm polystyrene foam block or thick cardboard piece.

10. Stick the copper wire posts into the polystyrene foam block so that the loops are approximately 5 cm apart and about 3 cm above the polystyrene foam surface.
11. Place the coil armature axles into the loops in the copper wire posts. The axle of the coil armature should be parallel to the polystyrene foam surface and the armature should be balanced and spin freely (see Figure 1).
12. Place the ceramic magnet beneath the coil armature.
13. Connect alligator connector cords to the base of the copper wire posts. Connect the other ends to a 9-V battery.
14. To start the DC motor, give the coil armature a slight spin. If it does not begin to spin continuously, give the motor a spin in the opposite direction. If it still does not spin continuously see *Tips* section.

Tips

If the motor does not spin continuously—

- Check to make sure the enamel on the axle is completely removed and the copper magnet wire is exposed on only one side so that half the "axle rod" is copper and the other half is enameled. Make sure that the copper side and the enameled side are the same for both axle ends. Make sure the coil spins freely on the copper coil loops and that it is balanced and level to the ground.
- Check to make sure the electrical circuit is closed and the battery has enough power. A 9-V battery works the best. Other batteries and connector cords may be used. 1.5-V batteries provide enough electrical energy but the motor will spin slower. Connecting the leads closer to the loops in the copper coil posts may help. Also, remove any tarnish or contamination that may be on the copper wire post loops with sandpaper.
- Manually adjust the position of the magnet by holding the magnet above the coil armature with the north or the south end of the magnet pointing at the coil armature. Adjust the distance and position of the magnet while initiating the spin to the coil armature. Determine the best distance for the magnet. The height of the copper posts above the polystyrene foam can be adjusted accordingly.
- Once the motor spins, adjust the position and the polarity of the external magnet and observe how the motor spin and direction respond.

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12
Evidence, models, and explanation
Content Standards: Grades 5–8
Content Standard B: Physical Science, understanding of motions and forces, transfer of energy
Content Standards: Grades 9–12
Content Standard B: Physical Science, motions and forces, interactions of energy and matter

References

Faugh, Jerry S. and Raymond A. Serway. *Physics;* Holt, Rinehart and Winston: Austin, 1999; pp 770–779, 811–812.

Tipler, Paul A. *Physics for Scientists and Engineers,* 3rd Ed., Vol. 2; Worth Publishers: New York, 1990; pp 782–786, 798–800, 854–856.

Materials for *Build Your Own Simple DC Motor* are available from Flinn Scientific, Inc.

Catalog No.	Description
AP6204	Magnet wire
C0146	Copper wire, bare, 16 gauge
AP1430	Battery, 9-V
AP8954	Battery clips with alligator clip leads
AP4655	Ceramic Disk Magnets, pkg. of 6
S0165	Sandpaper, Fine, 90 × 110, pkg. of 4
AP8389	Pliers, Long-Nose

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.

