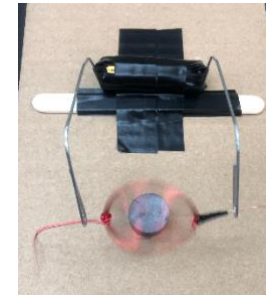


# DIY Air Force Activities:

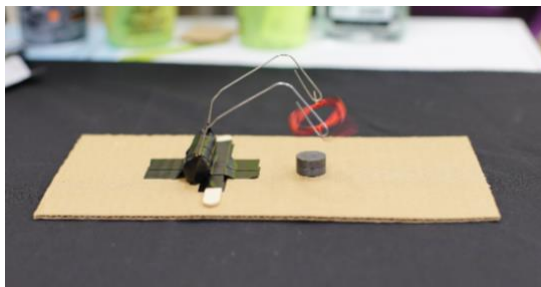
## Simple Magnetic Motor



### Materials:

- 2 paper clips
- 1 piece of cardboard (~13 cm x 20 cm)
- 77 cm of 22 AWG enameled magnetic wire
- 1 AA battery and one D battery
- electrical tape and duct tape
- 2 ceramic magnets
- sand paper
- 1 popsicle stick
- ruler

\*\*\*See back for images of the step-by-step instructions!



An electromagnet is a type of magnet produced by an electric current. Flowing electrons create a magnetic field, and spinning magnets cause an electric current to flow. Electromagnetism is the interaction of these two important forces. Electromagnets are an important element of almost all motors. When the current flows through the wire, the electromagnet is “on.” When the same poles of the electromagnet and the permanent magnet below it align they repel one another and give the coil a push to keep it moving! To prevent the opposite poles attracting and getting stuck, we strip half of the wire, creating a “break” in the circuit. Following the instructions below you will learn how to make your own magnetic motor!

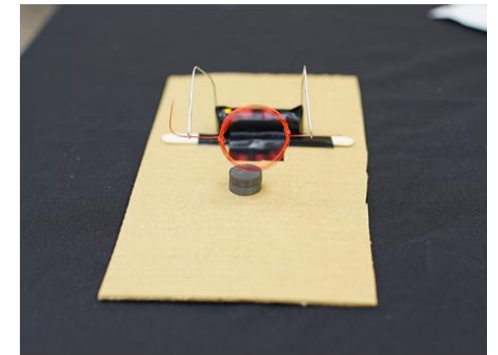
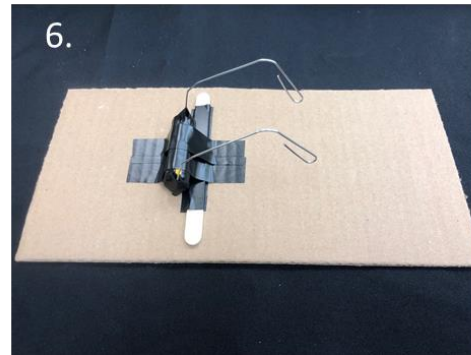
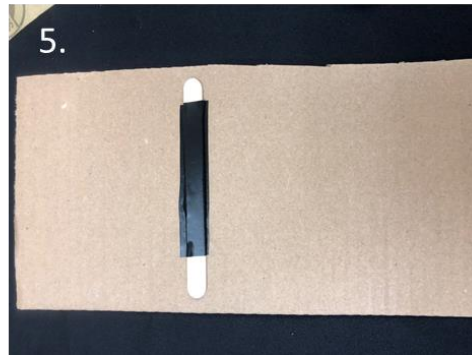
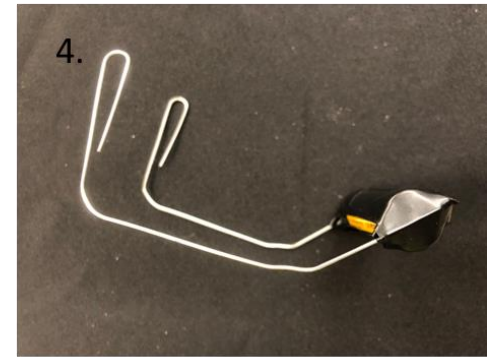
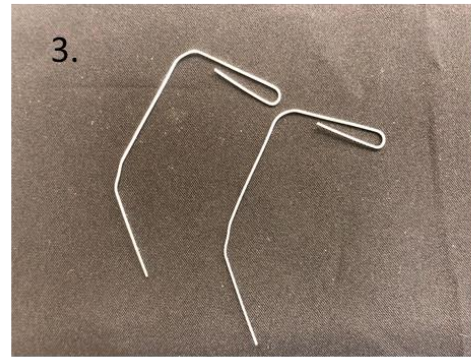
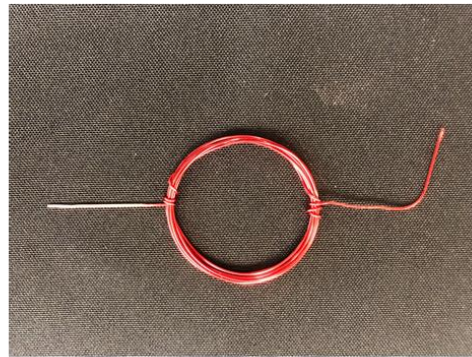
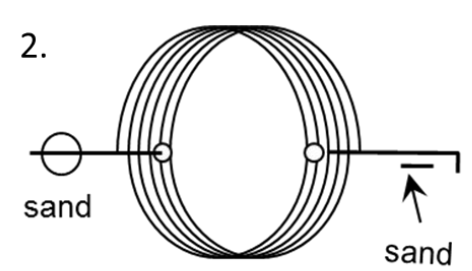
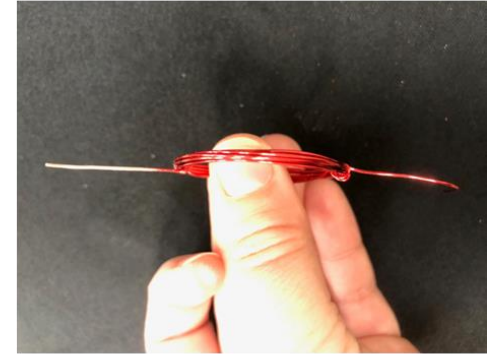
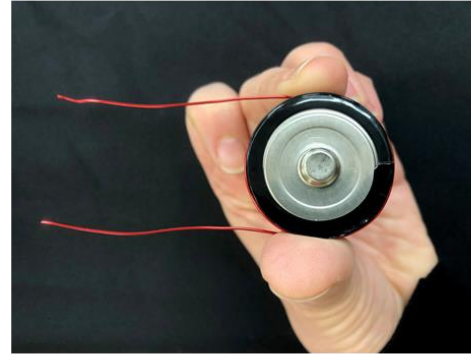
### Directions:

1. Coil the wire around the D battery leaving about 5-6 cm at each end. Remove coil from the battery and secure by wrapping the excess wire around the loops. Make sure at least 4 cm remains on each end.
2. Sand all sides of one wire tail and one side of the other. Bend the end of the partially sanded wire.
3. Straighten the end of the paperclips, leave a cradle for the coiled wired ends to sit in.
4. Use 2 cm long pieces of electrical tape to attach a paper clip to each end of the battery. Then cut a ~30 cm piece of electrical tape. Wrap **TIGHTLY** lengthwise around the battery and attached paperclips to secure the connection.
5. Tape the Popsicle stick to your cardboard using a 9 cm piece of duct tape.
6. Attach the paperclip cradle and battery using 2 pieces of 9 cm long duct tape as shown on the next page. Tape another popsicle stick behind it with duct tape for support. Hang the wire coil and place your magnets underneath so that the coil is suspended above the magnet and the **magnet is centered**.
7. Spin the coil to start the motor. Make adjustments as needed until it runs independently!

What happens to your motor when you flip the magnet over? How long will it run? Experiment with the amount of coils by using longer and shorter pieces of wire!

### Air Force Associations:

Electric motors and generators use permanent magnets to develop their flux fields. The voltage and frequency of a permanent-magnet generator are directly proportional to speed. Permanent magnets are critical components for almost all major military platforms, and are used in hybrid vehicles, computers, appliances, motors, generators and office automation equipment, as well as alternative energy sources like wind turbines. New types of magnetic materials are being designed and researched at Wright Patterson U.S. Air Force Research Lab.



**Troubleshooting:** Try: moving the magnet slightly or cleaning off the sanded areas of wire. Centering the wire hoop in the basket can also help, make sure it hangs straight! Try tightening the connection between the paperclips and the battery. It may take some adjustment, but the motor will run once the forces are in the correct place!