

Construct an Electromagnetic Rail Gun (Teacher)

Group Materials

- Cardboard or wood for a base 50 cm by 15 cm
- 2 strips of aluminum foil, 55 cm by 5 cm
- 5 cm long piece of steel wire (coat hanger). File the ends of the wire flat, perpendicular to the wire.
- 2 disc magnets
- White glue
- 9 V battery
- Alligator Clips

Instructions

1. Apply glue to the base to paste down the aluminum foil “rails” approximately 1.5 cm apart. Leave 5 cm of foil hanging off the end of the base upon which to attach the alligator clips.
2. Attach the rails to the battery in series, using the alligator clips.
3. Stick the neodymium magnets to opposite ends of the steel wire. They should be placed with the poles facing in opposite directions.
4. Drop the axle with wheels on the two rails. If it does not accelerate, flip one of the magnets.

Discussion

- A. How does the railgun work?

An electric current runs from the positive terminal of the power supply, up the positive rail, across the armature, and down the negative rail back to the power supply. The force lines of the magnetic field run in a counterclockwise circle around the positive rail and in a clockwise circle around the negative rail. The net magnetic field between the rails is directed vertically and the projectile experiences a Lorentz force. The Lorentz force is directed perpendicularly to the magnetic field and to the direction of the current flowing across the armature, parallel to the rails, and acting away from the power supply. See <http://science.howstuffworks.com/rail-gun1.htm> for more details.

- B. Why will the projectile only accelerate if the magnets are in a certain configuration?
The permanent magnets are not theoretically necessary but enhance the magnetic field of the rails acting on the armature. They should be facing with like poles away from each other and should repel so that the armature is not attracted to the magnetic field created by the rails.