Magnets on a Stick

A Magnetic Force Demonstration Device
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Background

A simple magnet will contain two magnetic poles, one north and one south. Just like electrical charges, opposite magnetic poles attract each other and like magnetic poles repel. The Magnetic Force Demonstration Device very simply demonstrates this fact.

Overview

The Magnetic Force Demonstration Device consists of four ring-shaped, permanent magnets arranged on two different bases. On one base, two magnets are arranged on a wooden dowel with opposite poles facing each other while on the other base, two magnets are arranged on a wooden dowel with like poles facing each other. The diameter of the wooden dowel is slightly less than the diameter of the magnets' central hole, so the magnets are free to slide along the dowel. The interaction between the pairs of magnets is easily observed.

Component List

- ring magnets with a 2 3/4" outer diameter and a 1 1/8" inner diameter (4 needed)
- 3/4" thick particle board (roughly 1/2 square foot needed)
- 1 1/8" diameter dowel rod (roughly 1 foot needed)
- 1 1/4" diameter dowel rod (roughly 2 inches needed)
- 1/8" thick rubber O-rings with a 1 1/4" outer diameter and a inner diameter of 1" (3 needed)
- 2" long, coarse thread drywall screws (2 needed)
- adhesive feet (8 needed)
- magnet polarity labels
- wood glue
All of the components have been gathered. The wood for the bases has been cut and holes for the dowel rods have been drilled.
**Base Construction**

1. Cut two square pieces of 3/4" thick particle board that measure 3 7/8" on a side.
2. Mark the center of each square piece and drill a 5/64" diameter pilot hole completely through the center of each piece.
3. Use a 1 1/8" diameter Forstner bit to remove approximately a quarter inch of material from the top surface of each of the square pieces.
4. Widen the pilot hole to 1/8" diameter.
5. As an optional nicety, countersink the pilot hole on the bottom surface of each of the square pieces.
6. The base sections are now complete.

**Dowel Rod Preparation**

1. Cut two lengths of 1 1/8" diameter dowel rod. Make one approximately 6 1/2" long and the other approximately 3 1/2" long.
2. Cut two lengths of 1 1/4" diameter dowel rod. Make both approximately 3/4" long. These small pieces will be used as 'caps' for the two 1 1/8" diameter pieces.
3. Use wood glue to attach one of the 1 1/4" diameter 'caps' to one end of the 3 1/2" long, 1 1/8" diameter piece. Center the pieces as best as you can. Clamp the two pieces together and allow the glue to dry.
4. Use wood glue to attach the second 1 1/4" diameter 'caps' to one end of the 6 1/2" long, 1 1/8" diameter piece. Center the pieces as best as you can. Clamp the two pieces together and allow the glue to dry.
5. Once the glue has set and the clamps have been removed, the dowel rods are ready for action!

**Magnet Preparation**

1. Identify the north and south poles of each of the four permanent magnets. This can be done by using a magnet of known polarity, such as a magnetic compass, or by suspending each magnet by a string and allowing it to align itself with the earth's magnetic field. Keep in mind that while the magnet's north pole will point towards the earth's geographic north pole, the magnet's north pole will attract the magnetic compass' south pole.

2. Cut out the labels found in Appendix A and attach them to the permanent magnets as appropriate. Although there are eight total surfaces, only six need to be covered since the faces that are in contact with the base aren't visible. If these devices are going to be heavily used, it is strongly recommended that you laminate the labels.

3. Now that we know which end is which, it's time to put everything together!
Assembly

1. Insert the uncapped end of the 6 1/2" long dowel rod into the 1 1/8" diameter hole in one of the two base pieces. Make certain that the dowel is completely seated within the base.

2. Extend the 1/8" pilot hole into the dowel rod by using the existing pilot hole in the base as a guide.

3. Insert the uncapped end of the 3 1/2" long dowel rod into the 1 1/8" diameter hole in the second base. Extend the pilot hole in this piece as well.

4. Remove both dowel rods from both bases.

5. The 6 1/2" long dowel rod will hold two permanent magnets which repel each other. Slide one magnet onto the dowel rod. This magnet's south pole should be pointing toward the 'cap' glued to the end of the dowel rod. Place an O-ring on the dowel rod, followed by a second permanent magnet. The second magnet should have its north pole pointing toward the 'cap' end.
6. Reattach the base and secure it to the dowel rod with a 2" long drywall screw.

7. With the device standing upright and with the bottom magnet resting on the base, move the O-ring down until it is pressing against the bottom magnet.

8. The 3 1/2" long dowel rod will hold two permanent magnets which attract each other. Slide one magnet onto the dowel rod. This magnet's north pole should be pointing toward the 'cap' glued to the end of the dowel rod. Place two O-rings on the dowel rod, followed by a second permanent magnet. The second magnet should have its north pole pointing toward the 'cap' end.

9. Reattach the base and secure it to the dowel rod with a 2" long drywall screw.

10. With the device standing upright and with the bottom magnet resting on the base, move the two O-rings down until they are both pressing against the bottom magnet. Two O-rings are used in this configuration in order to prevent the user's fingers from getting pinched between the two magnets.

11. Attach four adhesive feet to the bottom of each base.

12. All done!
Appendix A - Magnet Labels

North Pole

South Pole

North Pole

South Pole

North Pole

North Pole