

- Remember compass needles point north and opposites attract! If the needle follows the magnet, that is the magnet's south pole. If the needle moves away from the magnet, that is the north pole.
- Label the north and south poles of all 6 ring magnets you will use for your project with a permanent marker.

Magnetic Levitation:

- Using a box cutter or knife, cut a trapezoid out of an old CD case that is about 2.5 inches in height and 1 inch wide along the bottom base.
- Make a dimple in the center of the plastic trapezoid by hammering a nail into the plastic just below the shorter top base of the trapezoid.
- Prepare your base board by measuring and trimming it to about 4-5 inches wide and 10-12 inches long.
- Using the box cutter or knife, cut a 1-inch slit at one end of the base board. Position the slit parallel to one of the sides with a 4-5-inch width. Place the bottom of the plastic trapezoid into the slit.
- Make slits in the base board for the magnets. Measuring from the plastic trapezoid, one slits should be cut 1.75-inches away and the other slit 4.25-inches away. These slits should be 1-inch wide, centered in the base board, and parallel to the plastic trapezoid. Two magnets will fit side-by-side in each slit.
- Slide two ring magnets onto a pencil where the north pole of each magnet is facing towards the writing tip of the pencil. Orient the pencil with the tip pointed towards the plastic trapezoid.
- Place the ring magnets into the slits. It is important to place each magnet in a certain direction to levitate the pencil. The two ring magnets closer to the plastic trapezoid should attract the ring magnet closer to the tip of the pencil. The two ring magnets farther from the plastic trapezoid should repel the ring magnet near the eraser end of the pencil.
- To position the ring magnets that are closer to the plastic trapezoid, find the attractive side of each base magnet by hanging each magnet onto the ring magnet near the tip of the pencil. After you can hang the magnets, place each base ring magnet straight down into its slit without changing its position.
- Now we will position the base ring magnets farther from the plastic trapezoid. Repeat the hanging method in step 8 off the ring magnet near the eraser end of the pencil. When you place each base magnet into its slit, flip the magnet 180° or upside-down so the base ring magnets will now repel the ring magnet at the eraser end of the pencil.
- Fit the pencil tip into the dimple of your plastic trapezoid. Spread the magnets on the pencil to be above the magnets in your base board. You may have to adjust the magnets on the pencil so that the pencil will levitate.
- Holding the pencil at the eraser end, slowly release and watch it levitate. If you twirl the eraser end, the pencil will continue to spin by itself!



<http://www.arvindguptatoys.com/toys/levitation.html>

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STEM Explanation:

Magnetism is a type of force that occurs between objects due to charged particles. When positive particles and negative particles are together, the opposites attract. However, particles with the same charge repel each other. Magnetic levitation is possible by positioning strong magnets with the same charges towards each other because they push against each other. The repelling magnetic force between the magnets is strong enough to overcome the gravity pulling objects to Earth and allows the objects to hover in the air. Magnetic levitation is being used around the world in transportation systems to offer new types of maglev trains that have magnetic tracks repelling train cars with magnetic bases. The maglev trains are much faster than traditional trains because the levitation has less friction to overcome.

Career Connection:

Mechanical engineers are involved with the processing of materials, the control and automation of manufacturing systems, the design and development of machines, finding solutions to environmental problems, and the production, delivery, and use of energy. Magnetic mechanical engineers use their knowledge of physics and magnetism to create new products and innovations that use magnetic materials.

Resources:

<http://www.arvindguptatoys.com/toys/levitation.html>

https://www.amazon.com/Round-Disk-Magnets-Crafts-Office/dp/B000RB7E5Q/ref=sr_1_5?ie=UTF8&qid=1508772796&sr=8-5&keywords=ring+magnets

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