raft resource area for teaching
www.raft.net

Curriculum topics:

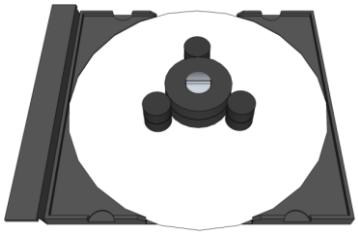
- Magnetism
- Symmetry
- Conservation of Momentum
- Modeling
- Problem Solving

Subject:
Physical Science

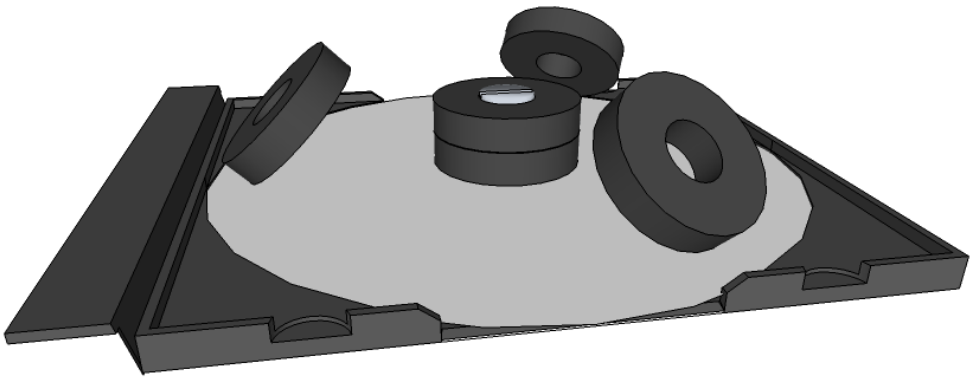
Grade range: 3 – 12

MYSTERIOUS MAGNETIC MOVEMENTS

Explore magnetic attraction **and** repulsion



A variety of scientific and gravity "defying" demonstrations can be done by combining pill and ring magnets in unique ways to create a multipurpose demo unit.



Who we are:

Resource Area for Teaching (RAFT) helps educators transform the learning experience through affordable "hands-on" activities that engage students and inspire the joy and discovery of learning.

For more ideas and to see RAFT Locations

www.raft.net/visit-raft-locations

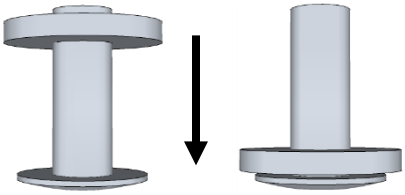
http://www.raft.net/raft-idea?isid=700

Materials required

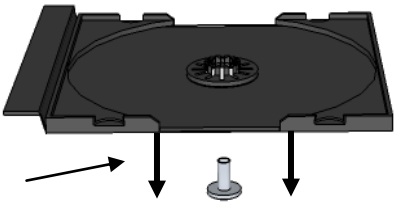
Per Mysterious Magnetic Movements unit:

- Screw and post fastener, aluminum, 13 mm (½") long; post diameter 5 mm (3/8")
- Washer, non-magnetic, 13 mm (½") OD, 5 mm (3/8") ID.
- Media tray (white or clear preferred), from a CD jewel case, with an open center hole into which can fit the post of the fastener above
- Paper disc, white, 12 cm (4-3/4") with 2 cm (3/4") center opening (**only** needed if using a black media tray)
- 5 Ring magnets, 30 mm (~1-1/8") diameter with 10 mm (~3/8") hole
- 12 pill magnets, a little less than 10 mm (3/8") in diameter
- Optional: Sticker, small, 1 or more
- Jumbo craft stick or screwdriver

How to build it



1 Place the washer over the post (the portion of the fastener with internal screw threads), and push downward toward the head of the post.

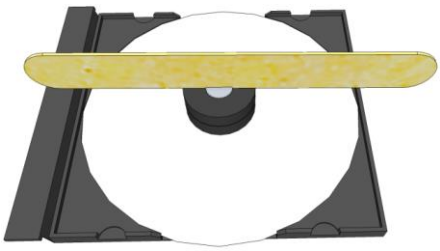


Lower media tray over post

2 Lower the media tray (CD side up) over the post and washer. Align the washer so it will fit into the tray's circular indentation. If using a black media tray, place paper disc into the CD section on the top of the tray.

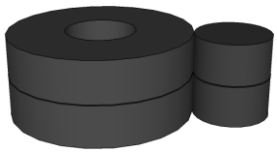
3 Place a ring magnet over the end of the post; stack a second magnet so it is attracted to the first.

4 Insert the screw into the narrow end of the post and carefully twist the two parts together. The post and screw should thread together easily, if not unscrew and try again. If needed, reposition the magnets, so that the head of the screw and the magnets are centered as shown.



5 Use the narrow edge of the jumbo craft stick as a "screwdriver" to tighten the screw and post. Hold the post, if needed. (Turn clockwise)

To do and notice

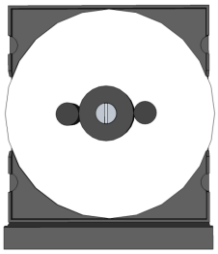


Modeling with Pill Magnets

1 Orient 2 stacked pill magnets so the sides of the pill magnets are attracted to the ring magnet stack.

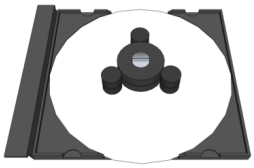
2 **Model orbiting planets or moons:** Rotate the pill magnets around the rim by moving the tray in a “hula-hoop” type motion.

3 Add a 2nd pair of pill magnets. Repeat the “hula-hoop” motion and note how one pair of pill magnets repels the other pair. It is possible to make the pill magnets move so that it appears that one pair of magnets is passing through the other pair as the momentum is transferred from the moving stack to the stationary stack. Mark the top of one pill magnet with a sticker to make what is really happening more apparent.

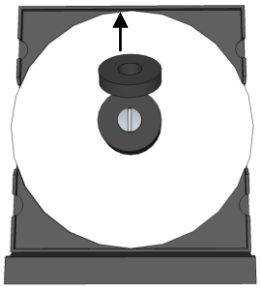


4 Add a 3rd, 4th, 5th, and 6th pair of pill magnets. Observe after each addition.

5 **Model the regular patterns in crystal:** Note that as more pill magnet pairs are added the pill magnet pairs will move to be evenly spaced around the ring magnets.



6 **Model the flow of electric current:** Place all 6 pairs of pill magnets around the ring magnets. Move 1 pair of pill magnets to cause the others to move around in a “circuit.” Move the pill magnets either clockwise or counterclockwise to model DC (direct current) flow. Wiggling a pair of pill magnets back and forth causes the other pill magnets to wiggle and models AC (alternating current). Electric utility companies charge for the AC “wiggle” provided, not the electrons!



Tilting Ring Magnets

1 Remove any pill magnets, if present. Place a third ring magnet on top of the pair of ring magnets, positioned so the third magnet is attracted.

2 Lift the 3rd magnet off the stack and lower to the media tray, keeping the bottom face tilted towards the stack.

3 Slide the magnet until the back edge is at a point near the edge of the circle.

4 Position the magnet so that the magnet will not fall when released:

a. If the magnet “jumps” to the stack of magnets - move it a little farther away and release.

b. If the magnet falls flat - move it closer to the stack before releasing.

Repeated trials will be required to find the correct position and angle for the magnet to remain tilted!

5 Once one magnet is able to remain in a tilted position, without being held, add a 2nd magnet on the opposite side. Once 2 ring magnets are stable add a 3rd ring magnet between the two! Note how the magnets move to be equal distance from each other.

Curriculum Standards:

Magnetic forces and interactions (Next Generation Science Standards, Grade 3, Physical Science 2-3; Middle School, Physical Science 2-3 & 2-5)

Solve a problem with Magnets (Next Generation Science Standards: Grade 3, Physical Science 2-4)

Energy can be transferred from place to place and converted from one form to another (Next Generation Science Standards, Grade 4, Physical Science 3-2; High School, Physical Science 3-3)

Forces & Motion (Next Generation Science Standards: Grade 3, Physical Science 2-1 & 2-2; Middle School, Physical Science, 2-2; High School, Physical Science 2-1)

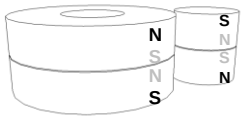
Science & Engineering Practices (Next Generation Science Standards: Grades 3 – 12)

Additional standards at: http://www.raft.net/raft-idea?isid=700

The science behind the activity

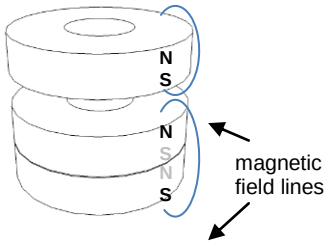
Modeling with Pill Magnets

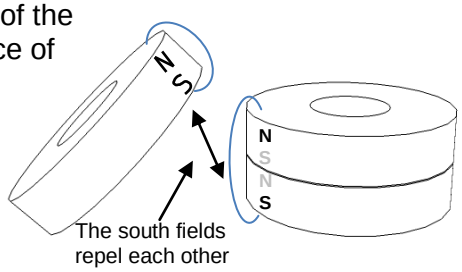
The pairs of ring and pill magnets are oriented so their opposite poles are attracting each other. The pill magnets have their magnetic poles oriented opposite to the poles of the ring magnets so as to also be attracted. The pill magnet pairs will repel each other since the pill magnets share the same orientation of their poles when attached to the ring magnet (like magnet poles repel each other).



Tilting Ring Magnets

Initially the 3 stacked magnets are attracted – but when the top magnet is pulled off and tilted it is repelled.
At a certain distance from the stack the magnet can be oriented so that the repelling force of the magnet counterbalances the attractive force of gravity – so the magnet does not fall when released.





Learn more

- Set up two tilting ring magnet; touch one tilting magnet to make it bounce up and down. Note what happens to the other tilting ring magnet.

Related activities: See RAFT Idea Sheets:

Floating Garden of Magnets –
http://www.raft.net/ideas/Floating Garden of Magnets.pdf

Magnetic Field Line Viewer –
http://www.raft.net/ideas/Magnetic Field Line Viewer.pdf

Magnetic Perturbations –
http://www.raft.net/ideas/Magnetic Perturbations.pdf

Mini Magnet Wands –
http://www.raft.net/ideas/Mini Magnet Wands.pdf

Where is the Magnet? –
http://www.raft.net/ideas/Where is the Magnet.pdf

Resources

Visit www.raft.net/raft-idea?isid=700 for "how-to" video demos & more ideas!
See these websites for more information on the following topics:

- **Physicist Paul Doherty shares the history of magnetism** – http://www.exo.net/~pauld/technorama/technoramaforum.html
- **More information about magnetism and how magnets are used** – http://my.execpc.com/~rhoadley/magwhy.htm

Acknowledgements:
Modeling with Pill Magnets section based on an activity created by Paul Doherty.