Sparking Discovery in the Classroom

TRAVELING SCIENCE WORKSHOPS

DISCOVERY MUSEUM

Force & Magnetism

Teacher Resource Guide

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Force & Magnetism

<u>MA STE Curriculum Connections</u>

3rd grade Force and Interactions concepts
3-PS2-1 Multiple forces affect the motion of an object – friction, gravity, push, pulls, and stops. Balanced forces do not change the motion of an object. Unbalanced forces change the motion of an object.

3-PS2-3 Conduct an investigation to determine the nature of the forces between two magnets based on their orientation and distance relative to each other.

3-PS2-4 Define a simple design problem that can be solved by applying the use of the interactions between magnets.

Pre-K, K, and 2nd grade Force and Motion concepts revisited
PreK-PS2-1 Using evidence, discuss ideas about what is making something move the way it does and how some movements can be controlled

K-PS2-1 How do different strengths or different directions of push and pulls effect the motion of an object

2-PS3-1 Design and conduct and experiment to show the effects of friction on the relative temperature and speed of objects that rub against each other

K-2-ETS1-3 Analyze data from tests of two objects designed to solve the same design problem to compare the strengths and weaknesses of how each object performs

Force and Magnetism

Force and Motion Reviewed

Movement is happening all around us. So much so, that we may not take much notice of it. It can be interesting then, to begin a unit on force and motion by simply stopping and taking note of all the things in the universe that move around us.

Exploring Movement with Toys

Supplies: A collection of toys that use pushes and pulls to work such as balls, spinning tops, ramp walkers, pull along animals, ball mazes, etc.

Students have lots of prior experience with how things move, but they may not immediately realize it. Providing some toys that use motion to work or asking them to find a toy and mess around with it, can be a fun way to discover the science concepts behind what makes things move.

Ask students to select a toy and play around with it. When they have finished with one toy, they can try another. What can they discover about the way these toys move? What makes the toy go? What makes it stop? Can it move by itself? Can they make it move in different directions? Can they make it move at different speeds? If they can control the movement, ask them to describe how. What happens if two moving toys collide? You might have students jot down a list of words to describe the movement. Does the toy roll, slide, bounce?

Processing the experience:

Select a few random toys to place at the front of the room. Then ask “What did you notice about these toys? Did they move on their own or did they need you to make them move? What did you do to make them move? Ask “Did you find that you could control the movement of the toy and if so, how?” (Push, pull, redirect, tilt the surface it was moving on, stop it, make it move faster or slower). Help the children make the connection that all of these toys needed a force to act on them to make them move. What was that force? A push or a pull.

To make something move, a force has to act on it. A push or pull are forces that we can use to make things move.

Magnetic Force

Magnets are a big part of everyday life. Because a magnet's force is invisible, students may not realize how many items contain magnets. You'll find magnets not only on refrigerators, but also in electric motors, generators, televisions, computers, credit cards, telephones, and audio speakers. By making the force from a magnet "visible," we can show both its direction and its shape. By experimenting with how magnets can be used to make things move, students can begin to appreciate magnetic force. The various hands-on, magnet-based activities that follow encourage speculation (forming hypotheses) and experimentation.

Push and Pull Activity:

This project will show that magnets can both attract and repel, depending on which magnetic poles face each other. Have your students mark the poles of your classroom magnets to facilitate thoughtful play during these activities.

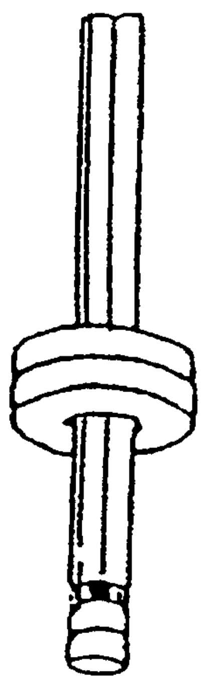
Materials

2 ring magnets per group
unsharpened pencil

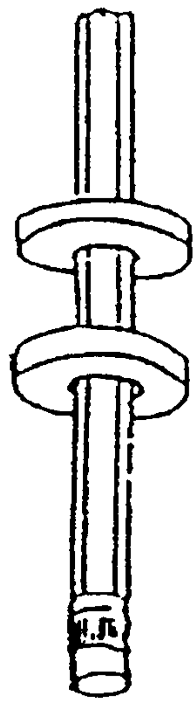
Procedure

1. Pass out ring magnets and pencils.
2. Hold the pencil by one end.
3. Place both magnets on the pencil so that the magnets are sticking together (attracting).
4. Lift the top magnet up and turn it over on the pencil so it "floats" (repelling).

Have students think of everyday uses for magnets. Are the magnets attracting or repelling in their examples? For instance, refrigerator magnets attract, while magnetic trains repel, floating above the tracks.



ATTRACT



REPEL

Magnetic Mystery Boxes

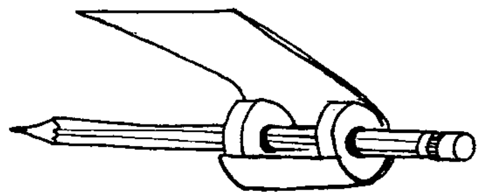
In the mystery box game, students try to stump one another by hiding the orientation of three magnets in a film container. Using the large magnetic field viewing box, students can see the shape of the field produced by the hidden magnets and discover their orientation.

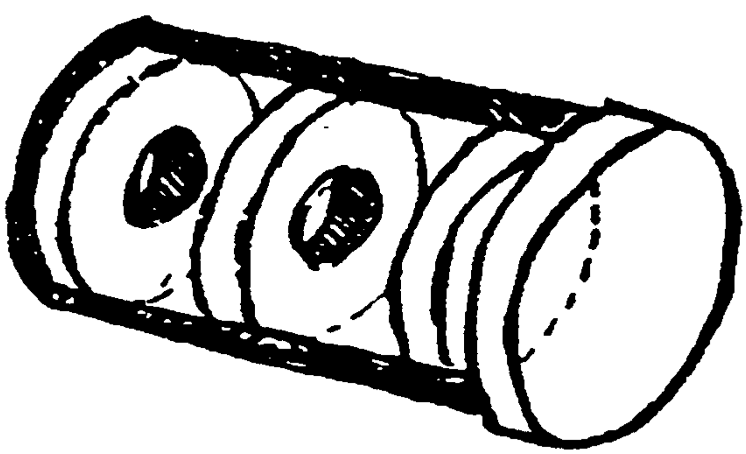
Materials

3 ring magnets per group
unsharpened pencil
black plastic film canister, with lid
large magnetic field viewer
masking tape

Procedure

1. Pass out all materials.
2. Half of each group should secretly orient two magnets along the pencil about 1 cm. apart, either attracting or repelling.
3. Roll a piece of tape around the outside of the magnets, securing their position.
4. Orient a third magnet along the pencil 1 cm. from the second magnet and tape to secure.
5. Slide magnets off the pencil and into the film canister.
6. Put the lid on the film canister.
7. Ask the rest of the group to determine the orientation of the magnets using the large magnetic field viewer.



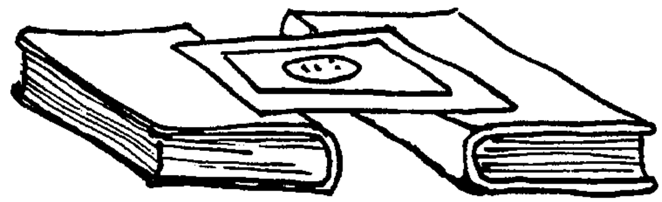


Funny Faces Activity

This activity allows students to understand the different shapes a magnetic field can produce as the students create arrangements of “hair” (iron filings) on a paper face.

Materials

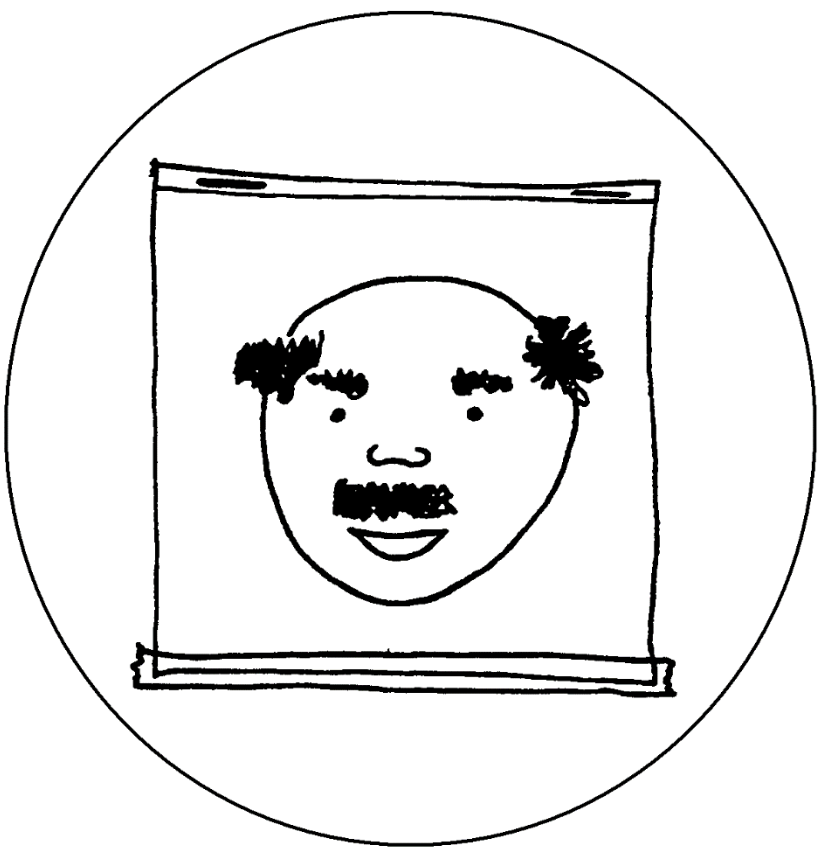
white paper plates
pencil, pen, or marker
iron filings
¼ tsp. measuring spoon
zipper sandwich bag
stapler
tape
magnets



Procedure

1. Draw a face, without hair or eyebrows, on a paper plate.
1. Put ¼ teaspoon of iron filings into a zipper sandwich bag.
2. Seal the bag and center it on the plate.
3. Staple top corners of the bag, above the zipper, to the plate.
4. Tape bottom corners of the bag to the plate.
5. Shake the plate side to side to distribute the filings.
6. Keep the plate horizontal or suspend it between two books.
7. Move a magnet along the back of the plate to draw hair, eyebrows, beards, bangs, braids, and mustaches with the iron filings.

For further exploration, use an assortment of magnets (bar, ring, button, horseshoe) as a shape stamp for the iron filings.



Magnetic Field Viewing Jar

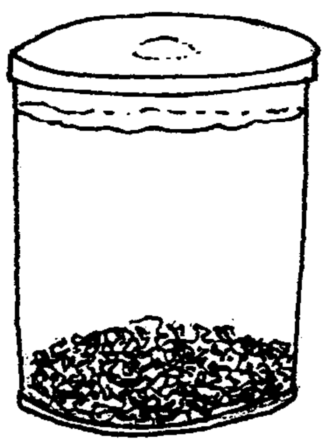
With magnetic field viewing jars, students can visualize the force around and between magnets. Have students answer the following questions using their viewing jars: Is the force from several magnets put together stronger than the force from one magnet? Do the edges of magnets produce the same field (the shape of the force) as the poles? Do different shaped magnets produce different fields?

Materials

1 clear plastic jar with screw-on cap per person or group
iron filings
¼ tsp. measuring spoon
mineral oil
2 or more ring magnets per person or group

Procedure

1. Pass out clear plastic jars.
2. Put ¼ teaspoon of iron filings into each jar.
3. Fill each jar almost full with mineral oil.
4. Screw cap on tightly and advise students not to open.
5. Shake the container to distribute the iron filings evenly.
6. Hold one or more magnets near the jar to see how they attract the filings.
7. Try different magnet arrangements and hold near various locations on the jar to see how the field is affected.



Large Magnetic Field Viewer

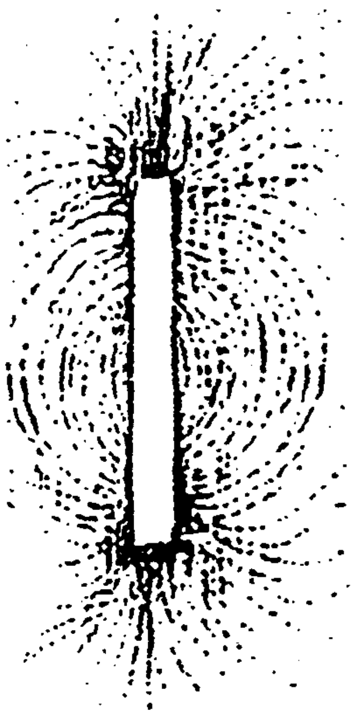
The large magnetic field viewer allows students to see magnetic fields clearly.

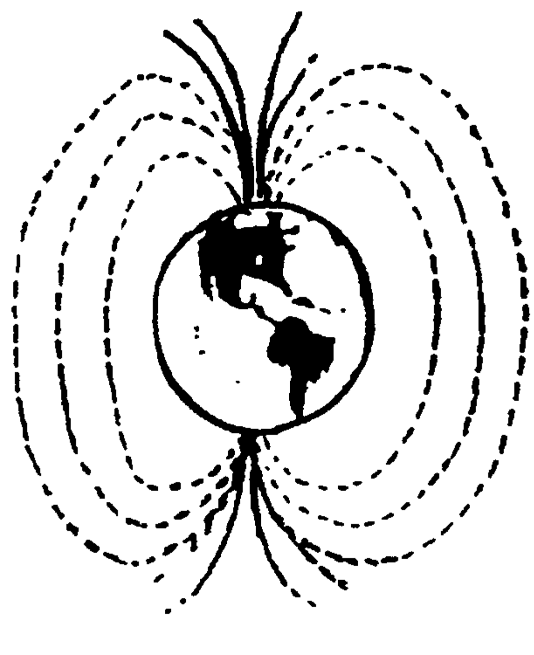
Materials

flat, clear plastic bottle with cap (Neutrogena or CVS brand shampoo bottles work well)
iron filings
mineral oil
2 or more ring magnets per group
optional, but advised: superglue to permanently seal the bottle

Procedure

1. Put ¼-½ teaspoon of iron filings into a bottle.
2. Fill the bottle almost full with mineral oil.
3. Put the cap on firmly (you may want to put superglue on the threads of the bottle before closing it).
4. Shake to distribute the iron filings evenly.
5. Hold one or more magnets near the bottle to see the shape of the magnetic field.
6. Put several ring magnets together to make a "bar" magnet and view the field. (Bar magnets have field lines similar to the magnetic field around the earth.)
7. Put one or more magnets on either side of the bottle. Compare the difference in the shape of the force between attracting magnets and repelling magnets.





The Engineering Brainstorm Challenge
During the workshop, students worked alone or with a partner to quickly design a toy or game that uses magnetic force to make something move. They were allowed to use one sheet of paper, one straw, one tongue depressor, a paperclip, pipe cleaner, bottle cap, cup, canister, and two magnets, They did not have to use all of the materials, but they were asked to use at least two of them. Tape, string, and scissors were also provided. This was a quick challenge and was meant to be a brainstorm. Students were not expected to design a perfect toy, but simply were asked to see what they could come up with in 7 minutes.

Following the 7 minutes, students were asked to share their toy with another person or team. The toy brainstorm is just a quick way to get students designing and working with making things move. Students should have the opportunity to review other students work and discuss their ideas with each other. This is a jumping off point – a perfect way to launch into a longer engineering design process. A brainstorm piques kids interest, gives them a chance to test out some materials and identify what works and what doesn’t work the way they anticipated, etc.

Where to go from here:

Up the challenge 1:
Assign each material a cost, such as $1/item. Challenge the students to design the least expensive toy with the highest entertainment value. Lengthen the amount of time students have to work on this challenge, but still keep it relatively short. The goal should be to have students designing a toy that works a little better than in the first challenge, but still has room for improvement. Classmates can anonymously review each other’s toys and assign an entertainment value to each one. They can also give suggestions for ways to improve the toy.

Up the challenge 2:
Can students redesign their toy using less expensive materials or fewer materials?

Language and visual arts connections:
Have students consider how they might market their toy. Write a radio announcement or TV commercial, design a newspaper ad, or a promotional poster/brochure.

Develop a sales pitch to present their toy to a manufacturer or set-up a classroom version of the television show, “Shark Tank”.

Sources of Materials:

Magnets: Dowling Magnets, Sonoma, CA 1-800-MAGNET-1
Iron Filings: Chem Scientific, Foxboro, MA 1-888-527-5827

Resources:

Lower Elementary (K-3) Print Resources:

- *Push and Pull*, Patricia J. Murphy, 2002, Children's Press
- *Everyone Shouted Pull!* Claire Llewellyn, 2004 Picture Window Books
- *Roll, Slope, and Slide*, Michael Dahl, 2006 Picture Window Books
- *Pushing and Pulling*, Sue Barraclough, 2006 Raintree
- *Forces Make Things Move*, Kimberly Bradley, 2005 Harper Collins
- *What Makes a Magnet?,* Franklyn Branley, HarperCollins, 2016
- *Magnets: Pulling Together, Pushing Apart,* Natalie Rosinsky, Picture Window Books, 2002
- *Magnets Push, Magnets Pull,* David Adler, Holiday House, 2018
- *Magnet Max,* Monica Hughes, Brown Books Kids, 2015

Upper Elementary (4-6) Print Resources:

- *Isaac Newton and the Laws of Motion* by Andrea Gianopoulos Graphic Novel, 2007 Capstone Press
- *A Crash Course in Forces and Motion with Max Axion, Super Scientist*, by Emily Sohn, 2007 Capstone Press
- *Forces and Motion: From High Speed Jets and Wind-up Toys,* Tom DeRosa and Carolyn Reeves, Master Books 2009
- *Driving Force*, James D. Livingston, 1996, Harvard University Press
- *Investigating Science: What Does a Magnet Do?* Jacqui Bailey, Franklin Watts, London, 2007

Online Resources

- NASA STI Program, Toys in Space, 2
  - https://www.youtube.com/watch?v=E9RDlIjgftI
- Top 6 kinetic art objects by MIT scientist and artist, Arthur Ganson
  - https://www.youtube.com/watch?v=R-d7l48-95A
- http://www.coolmagnetman.com/magindex.htm
  - Listing of magnet information and experiments.
- http://www.exploratorium.edu/snacks/iconmagnetism.html
  - Many engaging experiments with magnetism.
- Magnetism on Raz Kids
  - https://www.raz-kids.com/main/BookDetail/id/82

Additional Resources and extension activities

Gym teacher – share your force and motion unit with your physical fitness teacher. Many of the sports students play in physical education are excellent opportunities for students to explore and think about concepts of force and motion.

Poems are an excellent way for students to experience Force and Motion through an alternative subject matter. In our programs we use a poem from Kwame Alexander's book, The Crossover, and with younger audiences Kevin Lewis's The Runaway Pumpkin, but there are many poems that use rhythm and language to express movement. Challenge students to find or to write their own work that does the same.