Bay Area Scientists in Schools Presentation Plan

Lesson Name Poles Apart: Electro-magnetic Attraction & Repulsion

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Grade Level 4th
Standards Connection(s) Physical Science: Electricity/magnetism: Electro-magnetic fields and interactions (repulsion, attraction, [neutrality])

Abstract: We live in Earth's magnetic field and magnetism is involved wherever there's electricity. Whenever electrical currents make something move, in motors, door locks, stereo speakers or automatic switches it's because of magnetism. Magnetism is attracted to steel and some other metals, and can be used to hold things tight. We call this magnetic attraction. But two magnets don't always attract each other. Sometimes they push each other away. Each magnet has two ends we call north and south poles. North and South poles attract each other, but two Norths or two Souths will try to push each other apart. We call this repulsion or repelling. Strong magnets (and the Earth) create magnetic fields around them in space. Compasses, iron filings, steel pins, and anything else magnetic will tend to line up along the magnetic field lines.

Vocabulary/Definitions:
3 – 6 important (new) words (On board front center, pre-written on printer paper & posted):

- ***Atom:*** tiniest bit of matter
- ***Electrons:*** negatively (–) charged atom particles
- ***Poles:*** ends of a magnet that point North or South
- ***Attract/attraction:*** pull together
- ***Repel/repulsion:*** push apart
- ***Magnetic field:*** invisible lines of force in space between N and S magnetic poles
- ***Induced magnetism:*** when metals become magnetic while in a strong magnetic field
- ***Levitate:*** float in space with any solid support

Materials:
Volunteer brings to class:

- 32 ring magnets,
- compass,
- 8 bags of test materials & paper clips,
- 'Linear Accelerator',
- 2 mini-motors,
- speaker magnet & paper-clip levitation setup,
- magnetic field box & magnetite sand,
- 'Bozo' & pins,
- 2 lodestones & black sand,
- Multi-tester & wire coil solenoid,
- 2 steel nails wrapped in copper wire,
- 5 D-cell batteries,
- Work sheets (unless run off by teacher.)

S*tudents should have ready:* Pencils, run off work sheets.

Classroom Set-up:

Student in 6-8 groups of 3-4 students.
Desks or tables clear.
Overhead projector and cart at front.
5 min. set-up, 5 min. clean-up time.

Classroom Visit

1. Personal Introduction & Topic Introduction: 5 Minutes

I'm "Dr. J." I've had several careers—in Washington and embassies overseas, in the phone company with computers, and in schools with students of all ages. Science has always been a hobby—I've tinkered with electrical stuff all my life.

At your age I was living in Arizona and playing with toys that had little magnets in them. We had a little toy model of King Tut that wouldn't stay put in his sarcophagus. My brother and I had horseshoe magnets that we would drag through the dist and collect iron filings and all sorts of iron or steel scraps. Who else has played with magnetic toys? Where else can you find magnets?

- *Distribution of work sheets for recording data*

Point out key words on board & discuss them briefly. You've all experienced magnetism. Today we'll be doing activities with magnetism and electricity that will deepen your understanding of magnetism and probably raise a bunch of new questions. If you observe carefully, listen carefully, and think about it, you should be able to explain what's happening in each activity!

2. Hands-on Learning Experiences 28 Minutes

A. Initial demo: Compass on the overhead, along with broken ring magnet**.** All students silent and watching carefully.

- *ID of materials manager in each group. Distribution of Magnetism bags. Instructions on care with materials, classroom rules. Following directions. Checking materials list at beginning and end.*

B. Magnetism explorations: Ring magnets tested with various metallic and non-metallic materials to see which are attracted to magnets and which seem unaffected and allow magnetism to pass through. Students work individually, trading materials in their groups. Students develop rules of magnetic behavior based on their observations. Group sharing, then short class discussion as volunteers report results & explanations.

C. Magnets as compasses: Students use thread to hang their ring magnets in the air and then identify and label their north and south-facing sides. Students use their "compasses" to point north, south, east & west.

D. Magnetic attraction and repulsion: Students work with partners to see and record what happens when different combinations of N & S faces of their magnets are brought together. They use the terms attract/attraction and repel/repulsion to describe behavior of the magnets. They develop and record a rule for "like poles" and "opposite poles."

E. Magnetic levitation: Students in pairs and groups use their ring magnets threaded on a pencil to achieve magnetic levitation. They sketch their levitation setup and discuss possible ways this phenomenon could be used.

F. Induced magnetism: Students work individually to explore how paper clips become magnets themselves when placed in a magnetic field and can pick up other paper clips. They sketch their setup and label the poles of the paper clips in their sketches.

3. Rotating group experiences: **32 Minutes**

Trays with magnetic exploration materials are set up at 8 tables or desks. Trays (not students) move every 4 minutes.

Students in small groups take turns working with each tray of magnetism materials learning about:

1) using magnetite sand to show magnetic fields;
2) behavior of pins in a magnetic field;
3) behavior of small magnets in a strong magnetic field;
4) how magnets in motion create electrical currents in wires;
5) making electromagnets with wire and nails;
6) interaction of electromagnetic fields with permanent magnets;
7) understanding simple electric motors made with common materials;
8) lodestones and separating grains of magnetite from sand.

4. Wrap-up: Sharing Experiences and Building Connections **10 Minutes**

Magnetic fields: Overhead projector demonstration of magnetic field created with magnetite sand. Discussion of field strength, importance of magnetosphere to life on earth, connection to northern lights, levitating frogs & mice. Demo of paper clips hanging from magnet, how to get clips to drop (almost by magic.) Quick whole-group check for understanding of vocabulary words. Congratulations on work, ideas.

5. Close: **5 Minutes**

Clean-up. Magnets counted, all magnetism materials back in plastic bags; all worksheets to teacher. All demo materials packed up. *How can kids learn more?* Packet of follow-up Xerox masters for possible homework to teacher. *Thanks and good-bye!*

TOTAL 75 Minutes

Name: _____ Date: _____

Magnetism Investigations

Partner: _____

Part I. Check off each box when done. Each student must do the activities and complete 1—8.

❒ 1. **Safety**: ***Read twice***: Don't experiment with magnets near clocks, watches, cell phones, TV's, or computer equipment. You could cause expensive damage.

❒ 2. **Exploring** what magnets like or ignore: Use one ❍ magnet.

a. touch your magnet to each of the following and mark what happens in the correct column to the right: *paper, paper clips, plastic, a penny, a brass fastener, aluminum foil, a steel nail, copper wire, an aluminum nail.*

paper or cardboard……	❑ likes	❑ ignores
iron strip……..……	❑ likes	❑ ignores
plastic……	❑ likes	❑ ignores
copper penny……	❑ likes	❑ ignores
brass fastener……	❑ likes	❑ ignores
aluminum foil……..…	❑ likes	❑ ignores
steel nail ……..……	❑ likes	❑ ignores
copper wire……..…	❑ likes	❑ ignores
steel can lid……..…	❑ likes	❑ ignores
aluminum nail……..…	❑ likes	❑ ignores

*Extra if time

* b. test whether magnetism goes through each of the following and record your observations: *cloth, paper, plastic, aluminum foil, and steel can lids.*

clothing…….……	❑ goes through	❑ blocked
paper or cardboard……	❑ goes through	❑ blocked
plastic……	❑ goes through	❑ blocked
aluminum foil…...……	❑ goes through	❑ blocked
steel can lids……..…	❑ goes through	❑ blocked

❒ **3. Magnetism rules.** Complete these rules, based on what you have observed:

a. Magnets attract _____, but don't attract _____

*Extra: b. Magnetism goes through _____, but not _____

❒ 4. **Magnets as compasses**

a. Push one end of your thread through the small hole in the tape sticking out from your magnet and hang the magnet away from your desk until it rests without spinning. Lift it up so you can look through the hole. You're looking due north or due south. Decide which.

b. Use a pencil and mark the North side ***N*** and the South side ***S***. ***Congratulations! You have just turned your magnet into a compass!*** **Return the thread to its yellow holder.**

Part II. Work with a partner, but both of you must write down your results.

❒ 5. **Two magnets together**. (Before you start, both magnets must be marked as in step 4.

a. Write "attract" or "repel" in the space after each arrangement of magnets:

N and N together: _____ Side by side on your desk, S & S up: _____

S and S together: _____ Side by side on your desk, N & N up: _____

S and N together: _____ Side by side on your desk, S & N up: _____

b. Complete the following rule, based on your observations:

Rule: "Like poles _____, but opposite poles _____"

❒ 6. **Magnetic levitation**: Using two magnets and a pencil to keep them lined up, arrange the magnets so that one "floats" or levitates above the other.

a. Draw a picture of your levitating magnets and label it to show the N and S poles of each magnet.

b. How might this property of magnets be used? _____

_____

❒ 7. **Induced magnetism**.

a. Hold a paper clip so one end touches a magnet on a flat side (N or S).

Will the other end of the clip pick up a second clip? _____

b. Will it still pick up another clip if the top end is separated ¼ inch from the magnet? _____

c. Draw a sketch of the magnet and paper clips. **1)** Label the N and S poles of the magnet. **2)** Mark the N and S poles of the paper clips.

Part III. Rotating demonstrations:

- ***Read the directions for each tray before you touch anything!***
- ***sketch and record your observations for each.***
- ***Share materials & take turns.***

Lodestones and black sand Notes: _____ _____	***Bozo*** magnet and pins Notes: _____ _____
Electromagnetism in action Notes: _____ _____	Simple DC motors Notes: _____ _____

Follow-up Possibilities

- Students could look in their science books to see how the magnetism activities fit in.
- Student could write letters to "Dr J" about what they learned about magnetism.
- I will leave some Exploratorium handouts about things students could try at home and report back on.
- I will leave some sheets of suggestions the teacher could try in the classroom.
- Here's a list of websites for further exploration
    - http://www.exploratorium.edu/snacks/
    - http://my.execpc.com/~rhoadley/magreview.htm
    - http://www.kidskonnect.com/subject-index/15-science/90-magnets.html
    - http://www.kids-science-experiments.com/cat_magnetic.html
- Here's a short list of things for Googling:
    - Magnetite and hematite
    - Lodestones
    - Diamagnetism & paramagnetism
    - Magnetic levitation
    - Neodymium magnets (supermagnets)
    - Solenoids & alarms
    - Maglev trains
    - Magnetic eddy currents
    - Superconducting electromagnets
    - Electric motors
    - Speakers & microphones
    - Commutators & brushes

Magnets are Fun! (Center of Science and Industry) http://smile.cosi.org/magnets-are-fun-teacher-packet.pdf#page=4

Reading Connections:

- Awesome Experiments in Electricity and Magnetism by Michael Dispezio - More than 70 experiments explore electric charges, static electricity, currents, circuits, switches, and magnetism. Each one includes a brief introduction, a list of materials, directions, and a scientific explanation of the results. http://www.amazon.com/Awesome-Experiments-Electricity-Magnetism-DiSpezio/dp/1402723709
- Experiments with Magnets by Salvadore Tocci - http://www.amazon.com/Experiments-Magnets-True-Books-Science/dp/0516273507
- Sources of Forces: Science Fun with Force Fields by Vicki Cobb - With this book, you take ordinary objects and test different properties of force fields. Make an electric field detector out of a film can, a plastic drinking straw, tape, and a pencil. Build a device that measures electric current using a compass, a soda can, some string, and some tape. http://www.amazon.com/Sources-Forces-Science-Force-Fields/dp/0822570238