Electricity and Magnetism, Part 2
Supplemental and Background Information
For Teachers and Volunteers

Rationale:
According to the new California Science Standards, electricity and magnetism are important science concepts for 4th grade students. While the new science standards have not yet been implemented in most schools, these modules were designed to complement these standards. Specific science standards addressed in this Electricity and Magnetism lesson plan are:

3rd grade:
- Students are asked to predict the outcome of a simple investigation and compare the result with the prediction.
- Students are asked to collect data in an investigation and analyze the data to develop a logical conclusion.

4th grade:
- Students know how to build a simple compass and use it to detect magnetic effects, including Earth’s magnetic field.
- Students know that magnets have two poles (north and south) and that like poles repel each other while unlike poles attract each other.

Disclaimer: Some of the procedures for the activities contained in the lessons have been adapted from various resources listed throughout the module.

Part 2: Magnetism

Objectives:
After participating in the program Electricity and Magnetism, Part 2, students will be able to:
- recognize that some materials exhibit magnetism and others do not
- restate that magnetic objects have a north pole and a south pole
- explain that like poles repel each other while opposite poles attract each other
- describe magnetism as a force with force lines extending from an object into space
- recognize that most magnetic objects contain iron (some other less common elements are also magnetic)
- demonstrate that iron-containing objects can be magnetized
- explain how induced magnetism can be destroyed
- restate that magnetic field lines can pass unaffected through some materials and are gathered in by others

Vocabulary:
permanent magnet - a magnet, usually of hard steel, which keeps most of its magnetism after it has once been magnetized
repulsion - the mutual action by which bodies or particles of matter tend to push each other apart
attraction - the mutual action by which bodies or particles of matter tend to draw together
magnetic force - the attracting or repelling force between a magnet and a magnetic object
magnetic field lines - imaginary lines in a region of space in which there is an appreciable magnetic force
magnetic poles - either pole of a magnet, where the magnetic lines of force seem to be concentrated
north pole - that end of a straight magnet that points north when the magnet hangs free
south pole - that end of a straight magnet that points south when the magnet hangs free
magnetic domain - microscopic regions in an object in which magnetic dipoles (north and south poles) tend to align parallel to each other
temporary magnet - an object whose magnetism is not permanent
permeable - a material which interacts with a magnetic force passing into it
nonpermeable - a material which does not interact with a magnetic force passing into and through it

Lesson Notes:
1. Students should discover that magnets stick to some things and not to others. These magnets are permanent magnets. They should discover that certain orientations of the two magnets will produce a repulsive force, while other orientations cause the two magnets to attract each other. They should reach the conclusion that a (magnetic) force is involved. These observations should be recorded in worksheet item 1.

2. The discussion of magnetic poles starts with recognizing that each magnet has a north and a south pole. No matter how small the magnet is, it will have both poles. Students may be familiar with the idea of a compass which uses magnetism to tell directions. This is because our Earth is really a very large magnet. The students can use a magnet with the iron filing display in order to visualize the magnetic force (filings will line up with magnetic field lines). Their observations from this exercise should be recorded in worksheet item 2.

3. Students use their common knowledge about the world around them to sort the objects in their materials bag. Predictions should be recorded in worksheet item 3.

4. Get students to propose how they would test the objects for magnetic behavior (see if the magnet will attract the object). Let them test the objects and record the results in their worksheets. Were there any materials that fooled the students? What do all the magnetic objects have in common? (They are made of metals that contain iron (Fe). Objects made of aluminum (Al) and copper (Cu) tested negative with the magnet.)

5. Does it matter which pole of the magnet? (No. That is because a magnetic material is not necessarily a magnet. A magnetic material has many domains inside that are magnetic, i.e., possess a north and south magnetic pole. In most magnetic materials, these domains are randomly oriented. The result is that there is no net magnetic field. In a magnet,
the situation is different. In this case, most of the domains will have north and south poles in the same direction.)
What happens inside the material when it is exposed to a magnetic field? (The magnetic field of the magnet causes some of the domains in the magnetic material to align temporarily with those of the magnet. In this way an attractive force is developed between the magnet and the object.)

6. Can you turn an iron-containing object into a magnet? (By properly stroking an iron-containing object with the magnet, students can make a temporary magnet.)
How can they prove that the nail is now magnetized? (Let the students propose methods such as having the nail pick up paper clips. Testing for attraction to the magnet will not work because the object was attracted to the magnet to begin with.)
Can this temporary magnetism be destroyed? (Yes, by heat or by dropping several times.)

7. Will magnetic force go through matter and/or air? You can show the students how to test by using air inside the cardboard tester (that is what is there if you do not insert anything). Place the magnet(s) on top of the tester and hold it over a pile of paper clips. You will be able to pick several paper clips up even though the magnet is separated from them by the air and the cardboard. Air and cardboard are nonpermeable materials (non-magnetic) because the magnetic field passes through as if they were not there. Permeable materials will absorb all the magnetic field lines trying to pass through (magnetic materials). If such an object is inserted in the tester, the paper clips will fall off (let students discover this for themselves). Students record the results from this test in worksheet item 4.

8. How can we determine which end of the induced magnet is the N or S pole? Consider this question if neither a magnet nor a compass were available. This is given as an assignment and should be done before beginning Electricity and Magnetism, Part 3. (In case you will not be doing Part 3, we solve this problem by suspending the magnetized nail from a support. If you do this, you have made a compass. Depending on the orientation of the magnet during the magnetization process, the head or point of the nail will point north. This will be the north end of the magnet you have made.)

Answers to the worksheet are located in the file: E&M_2_wksht_key.

References and Extension Ideas:
The following resources were used in developing this lesson plan. Some of the activities were adapted from these sources. Many ideas for extension activities can be found in them as well.

2. www.beakman.com
3. Foss Magnetism and Electricity Module
4. www.freeweb.pdq.net/headstrong/mag.htm
5. www.freeweb.pdq.net/headstrong/mag2.htm
6. www.pausd.palo-alto.ca.us/k6science/electric/e_tips.html
7. www.edtech.kennesaw.edu/web/electric.html
8. *Exploratorium Science Snackbook* or www.exploratorium.edu/snacks/
9. www.pbs.org/ktca/newtons/12/electric.html
11. www.pbs.org/wgbh/nova/specialfx/fxguide/fxmshtr2.html
15. www.chss.montclair.edu/~pererat/pertel.html
16. www.chss.montclair.edu/~perat/perbuild.html
17. www.chss.montclair.edu/~pererat/perwirls.html