Electricity-Magnetism Connection
Grades 3-5

David Lang
Sealey Elementary School
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Unit: Electromagnetism

*This unit follows teaching of permanent magnets and electric circuits.

Science benchmarks covered (grades 3-5)

SCA 1.2.1 determines that the properties of materials can be compared and measured
SCB 1.2.2 recognizes various forms of energy
SCB 1.2.4 knows the many ways in which energy can be transformed from one type to another
SCB 1.2.5 knows that various forms of energy can be measured in ways that make it possible to determine the amount of energy that is transformed
SCC 2.2.1 recognizes that forces of…magnetism and electricity operate simple machines
SCH 1.2.2 knows that a successful method to explore the natural world is to observe and record, and then analyze and communicate the results
SCH 1.2.3 knows that to work collaboratively, all team members should be free to reach, explain, and justify their own individual conclusions
SCH 1.2.4 knows that to compare and contrast observations and results is an essential skill in science
SCH 1.2.5 knows that a model of something is different from the real thing, but can be used to learn something about the real thing
SCH 3.2.2 knows that data are collected and interpreted in order to explain an event or concept

Lesson Plan 1: Oersted and the Electric/Magnet relationship

Hand out the Oersted worksheet. Go over the following vocabulary prior to reading:

Iron magnet
Lodestone
Electric Current
Magnetism
Compass needle
Attract
Repel

Have the students come up with definitions and write them on the board.

Also, go over the following words for pronunciation:

Hans Christian Oersted
University
Copenhagen
Demonstrate
Phenomenon
Explanation

Have the students read to themselves or as a group the description of Oersted's experiment. Then, as a whole group or in partners, have the students conduct the experiment using the attached method.

The students can then complete a results and conclusion page for the experiment using the directions on the worksheet. As a whole group, go over results to make sure all students understand what happened.

Hans Christian Oersted:

Electricity and Magnetism

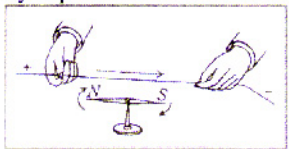
Before 1820, the only magnetism known was that of iron magnets and of lodestones. This was changed by a professor of science at the University of Copenhagen, Denmark, **Hans Christian Oersted.**

In 1820 Oersted arranged in his home a science demonstration to friends and students. He planned to demonstrate the heating of a wire by an electric current, and also to carry out demonstrations of magnetism, for which he provided a compass needle mounted on a wooden stand.

While performing his electric demonstration, Oersted noted to his surprise that every time the electric current was switched on, the compass needle moved. He kept quiet and finished the demonstrations, but in the months that followed worked hard trying to make sense out of the new phenomenon.

Oersted's Experiment.

But he couldn't! The needle was neither attracted to the wire nor repelled from it. Instead, it tended to stand at right angles (see drawing below). In the end he published his findings (in Latin!) without any explanation.



What Oersted saw.

Repeat Oersted's Experiment

You will need:

- A pocket compass.
- A one-foot (30 cm) length of fairly thick wire, insulated or bare.
- A 1.5 volt electric cell ("battery") of size "D" or "C". (The voltage is too low to cause any risk.)

Method:

1. Lay the compass on a table, face upwards. Wait until it points north.
2. Lay the middle of the wire above the compass needle, also in the north-south direction. Bend the ends of the wire so that they are close to each other.
3. Grab **one end** of the wire in **one hand** and press against one end of the battery.
4. Grab **the other end** with your **other hand**, and press momentarily against the other terminal of the battery. Observe to see the action of the compass needle.

   Quickly disconnect (it is not good for the battery to draw such a large current). The needle will swing back to the north-south direction. Note that **no iron is involved** in producing the magnetic effect!
5. Repeat with the connections of the battery reversed. Observe what the compass needle does this time.
6. Repeat the experiment with the compass **above** the wire (if two people perform the experiment, one can hold the compass, the other the wire and battery). Note how the compass needle moves.

Copy and complete the data table:

Compass Position (above or below wire)	Current flow (normal or reversed)	compass reaction (movement, spin direction)
Above	Normal	
Above	Reversed	
Below	Normal	
Below	Reversed	

Conclusions: Write to explain why you think the compass reacted the way that it did.

Lesson Plan 2: extension of Oersted's experiment

As a group or in partners, have the students conduct the extension experiment. They can complete a results and conclusion page following in the experiment. As a whole group, go over results, and hand out the "What Oersted's experiment really meant" worksheet and read with the class. Help all students comprehend what the experiments implied in the field of magnetism and electricity (ie. Electricity creates magnetic fields).

Extension of Oersted's experiment

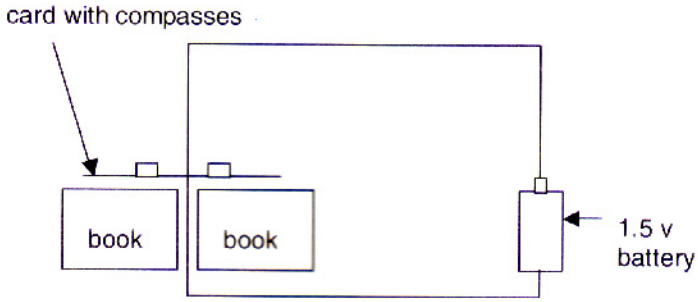
You will need:

- 8 pocket compasses.
- A two-foot (60 cm) length of fairly thick wire, insulated or bare.
- A 1.5 volt electric cell ("battery") of size "D" or "C". (The voltage is too low to cause any risk.
- Piece of card or construction paper.
- 2 or more large textbooks or wooden blocks.

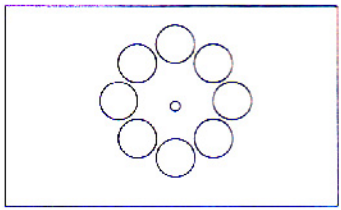
Method:

1. Place the textbooks beside each other with about a 3cm gap between them.
2. Pierce a hole in the center of the card and place the card on the books, spanning the gap.
3. Place the wire from the battery along the table and then up perpendicularly through the hole in the paper. Let it go about 5 cm above the paper before bending back toward the battery. (See diagram).
4. Place the compasses around the wire on the card. (See diagram in results).
5. Connect the wire to the battery for a brief moment, and note what happens with the compasses.
6. Repeat the current flow, but reverse the wire connections to the battery. Again, note your observations.

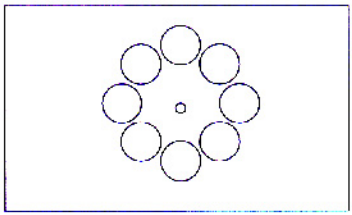
Diagram:



Results: Draw in the **compass needles** in the following two diagrams. Use red for the north end of the **compass needles**.



Normal current flow



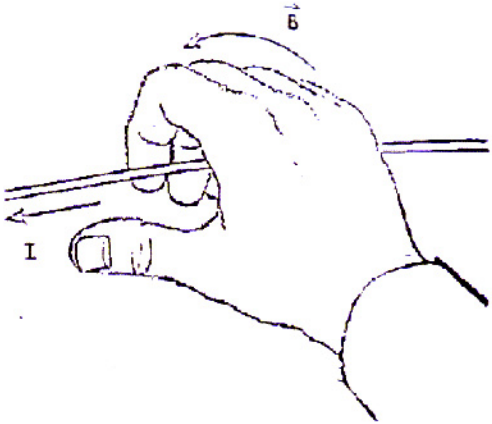
Reversed current flow

Conclusion:

Write to explain what happened when current was passed through the wire. Write to tell me about the what the compass directions indicate.

What Oersted's experiment really meant.

The compass needles react to the wire due to a magnetic influence. This means that a current carrying wire puts out a magnetic field. If the direction of the current is reversed, then the magnetic field is reversed. This can be identified by the "right-hand rule." Make a fist with your thumb sticking out. If you let your thumb represent the direction that current is flowing in, then your fingers represent the magnetic field created. Note that if you turn your hand in an opposite direction, then the field is also reversed. This was seen in the second experiment concerning the 8 compasses.



- Thumb points in the direction of the current
- Fingers curl in the direction of the magnetic field around the wire