

Grade Level/Course:

3 -5 Physical Science: Electromagnetism

Lesson/Unit Plan Name:

Building an electromagnet

Rationale/Lesson Abstract:

In this lesson, students will demonstrate how electric currents produce magnetic fields. They will learn how to build an electromagnet. They will investigate how to make their electromagnet stronger by increasing the number of winds of wire around a nail. They will investigate other ways to make their electromagnet stronger.

Timeframe:

1-2 class periods

Common Core Standard(s):**Mathematics:****3.MD Measurement and Data**

3.MD.3 Draw a scaled bar graph to represent data with several categories.

3.MD.4 Generate measurement data by measuring lengths using rulers, marked with halves and fourths of an inch. Show the data by making a line plot, where the horizontal scale is marked off in appropriate units.

4.MD Measurement and Data

4.MD.1. Know relative sizes of measurement units within one system of units including km, m, cm.

4.MD.4. Make a line plot to display a data set of measurements.

5.MD Measurement and Data

5.MD.1. Convert among different-sized standard measurement units within a given measurement system, and use these conversions in solving multi-step, real-world problems.

5.MD.2. Make a line plot to display a data set of measurements in fractions of a unit ($\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$). Use operations on fractions for this grade to solve problems involving information presented in line plots.

Next Generation Science Standards:**3-PS2 Motion and Stability: Forces and Interactions**

3-PS2-3-4. Electric, and magnetic forces between a pair of objects do not require that the objects be in contact.

4-PS3 Energy

4-PS3-2, 4PS3-4. Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light.

5-PS2 Motion and Stability: Forces and Interactions

5-PS2-1. Cause and effect relationships are routinely identified and used to explain change.

Instructional Resources/Materials:

For each group of 4 students:

- 2 large iron nails
- 2 electromagnetic insulated wires, 24 gauge, 150 cm
- 2 electromagnetic insulated wires, 24 gauge, 50 cm
(strip wires 3 cm from plastic insulation at each end)
- 2 D cell batteries
- 2 battery holders
- 4 alligator clips
- 40 paper clips (small)
- 2 tape measures or rulers
- 1 plastic cup to hold paper clips
- 4 electromagnet data charts
- 2 bar graph charts
- 4 exit slips
- science notebooks

For Teacher:

- Wire stripper
- Extra D cell batteries
- Document camera and LCD projector

Background Knowledge

This lesson is adapted from Full Option Science Systems (FOSS), *Magnetism and Electricity*. (Investigation 4: Current Attractions.) Ideally, this lesson is taught after the WCCUSD Science Department lesson "Introduction to Magnetism and Electricity." Students already have some prior knowledge of electricity and its relationship to magnetism. Students have worked with magnets and understand that magnets have two opposite poles, north and south, and that opposite poles attract and like poles repel. Students have a rudimentary understanding about the electromagnetic field that is created by electrical circuits.

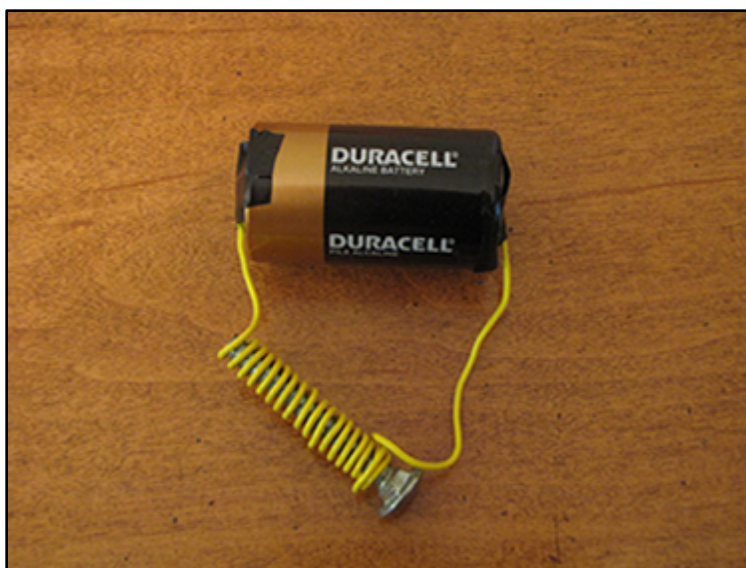
An electromagnet is a magnet that can be turned on and off with a switch. In this case, the electromagnet will be powered by a D cell battery and will be turned on when the electrical circuit is completed. The simplest way to make an electromagnet is by wrapping an insulated wire around an iron nail or bolt and then connecting it to a source of electricity. (In this lesson, wrapping is referred to as winding with the end result being "winds" around a nail.) Once the circuit is closed, the iron nail becomes a magnet. When the circuit is open, the magnetism stops.

Examples of real life applications of electromagnetism include doorbells, junkyard cranes, electric motors and simple alarms.

This lesson will reinforce the knowledge of the relationship between magnetism and electricity in students' minds.

First Activity/Lesson:

For this activity, students should be organized in science teams of four students. As a warm-up, have students complete a quickwrite in their science notebooks. Ask students to make a K-W graphic organizer by dividing a blank page in their notebook in half. Then on the left side, write “What I know about electricity and magnetism” and on the right side of the page, write “What I want to know.” Model some examples of language for both sections including questions about electromagnetism. Give students ten minutes to work on this graphic organizer. Then have students share out their ideas in their groups (or full class if preferable). Record some of their ideas on the whiteboard or on chart paper. Tell students they should continue to record their thoughts and ideas in their science notebook as they conduct the experiment.



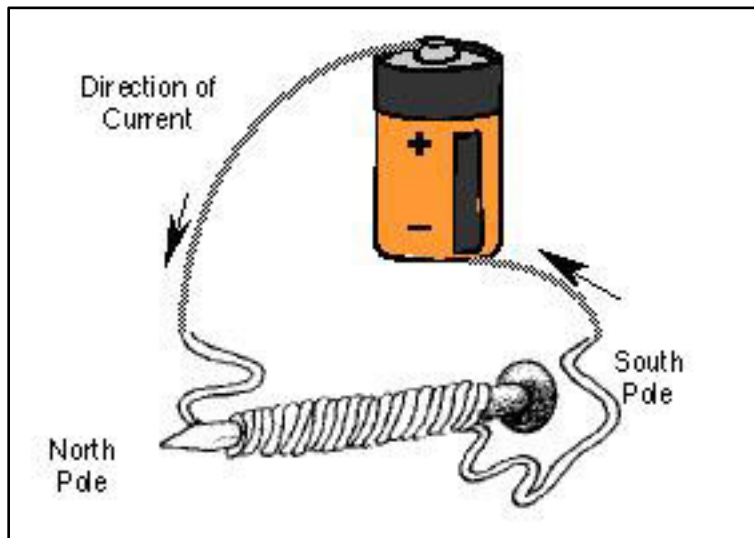
Building the Electromagnet

In this first activity, students will work together in pairs within a team of four students to make their electromagnets. Students will test each wire separately. First, only use the wire that is 60 cm long. Students will measure each wire to identify the correct one for the experiment. Have students put aside the longer one. Then, have students make a prediction about how many paper clips they will pick up. They should record their prediction on their data chart.

Students will

- Wrap the wire 40 times around the nail. The ends of the wire must extend past the nail.
- Pour paper clips onto the desk in a pile.
- Place the d cell battery into the battery holder. Have students align positive and negative ends of the battery with the battery holder.
- Connect each alligator clip to the metal end of the battery holder thereby making a circuit.

- Connect the ends of the alligator clips to the extended exposed wire wrapped around the nail.
- Attempt to pick up as many paper clips as possible with the electromagnet. Record the amount in data chart.
- Turn off the electromagnet after completing this first part of the activity so as not to drain the battery. This is done by disconnecting the alligator clips from the battery holder.
- Compare data results with other pair of students in team.



Students should then remove the 60 cm wire from their nail and using the 150 cm wire, they will make 40 winds around the nail and repeat the procedure with the longer wire. First, they should make their prediction. Then, carry out the experiment.

After this second step of the experiment is conducted, students should share out their results full class. Does the length of the wire affect the strength of the electromagnet? If so, which wire was stronger?

As an extension to this activity, teacher will record collected data on measuring length of wire and number of paper clips lifted on a bar graph or line plot.

Second Activity:

After completing the first activity, students will conduct a new activity to discover if increasing the number of winds of their wire on the nail will increase the strength of the electromagnet. This activity is more unstructured in terms of the number of winds. Students should be encouraged to test each length of wire with different numbers of winds. The results of these tests should be recorded on student data charts. Students will work in their groups to record data on a bar graph, this time comparing different number of winds with number of paper clips lifted. For grades 4-5, teacher will work with class to put data on a line plot.

Names _____

Date: _____

Electromagnet Data Chart

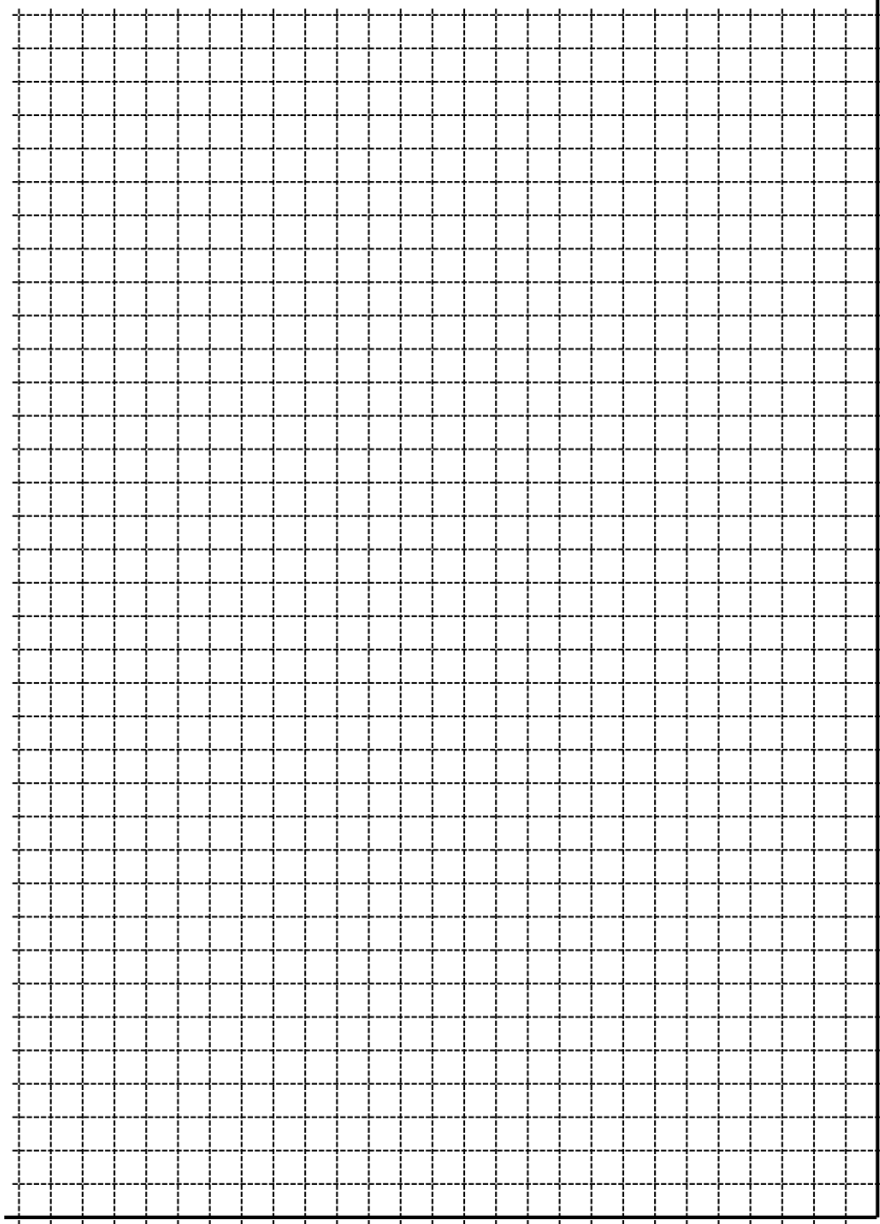
First Activity:

Length of Wire	# of winds	Prediction – how many do you think you will pick up?	# of paper clips actually picked up
60 cm	40 winds		
150 cm	40 winds		

Second Activity:

Length of Wire	# of winds	Prediction – how many do you think you will pick up?	# of paper clips actually picked up.
60 cm			
60 cm			
60 cm			
150 cm			
150 cm			
150 cm			

Electromagnet Bar Graph



of paper clips

of winds around nail

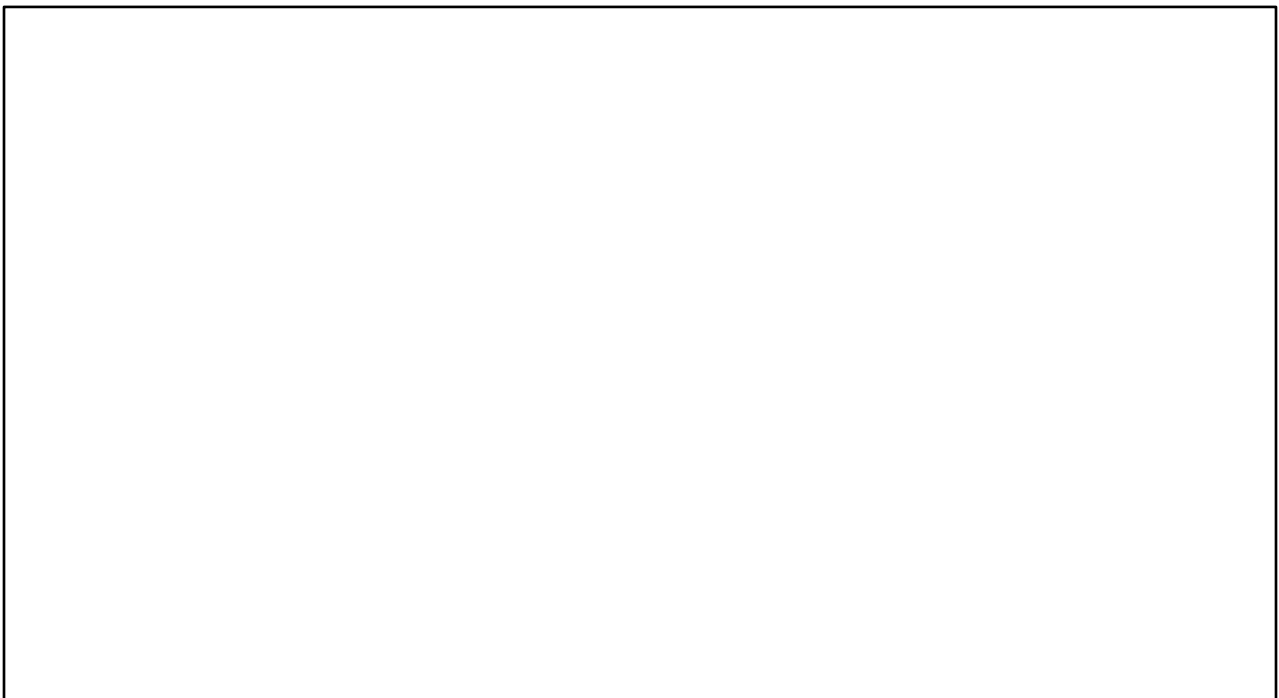
Name: _____ Date: _____

Exit Slip: Building an Electromagnet

1. How do you make an electromagnet?

2. Give two examples of what you learned about electromagnets.

3. Draw a picture of your electromagnet.



Assessments:

Group work and class discussions will be used for informal assessment. Completion of data charts, K-W chart, bar graph and an exit slip with key questions will serve as formal assessments of these activities.