

5TH GRADE

HOW MANY PAPER CLIPS CAN AN ELECTROMAGNET PICK UP?

SCIENCE FAIR PROJECT DEMONSTRATION

Summary: The students use the steps of the scientific method to ask a question, form a hypothesis, design a test, collect data, and draw conclusions. Students are testing the strength of an electromagnet. They will compare if the number of items picked up by an electromagnet is correlated to its mass.

Intended Learning Outcomes for 5th Grade:

- 1c. Given the appropriate instrument, measure length, temperature, volume, and mass in metric units as specified.
- 1f. Plan and conduct simple experiments.
- 1g. Formulate simple research questions.
- 1i. Use data to construct a reasonable conclusion.
- 2e. Seek and weigh evidence before drawing conclusions.
- 3a. Know and explain science information specified for the grade level.
- 3c. Solve problems appropriate to grade level by applying science principles and procedures.
- 4a. Record data accurately when given the appropriate form.
- 4b. Describe or explain observations carefully and report with pictures, sentences, and models.
- 4c. Use scientific language in oral and written communication.
- 6c. Science findings are based upon evidence.

Standard 3 Objective 1:

- c. Compare permanent magnets and electromagnets.

Preparation time: 1 hour, after electromagnets are made the set up time is minimal for future lessons

Lesson time: 1 hour

Small group size: works best with one adult for every 5 students

Materials:

8 - 2" long nails

copper wire – can be purchased from nasco.com #SB10519M which is 26 gauge copper magnet wire (1260 ft.) for \$15.75

1 D battery for each group, should be new because they quickly get drained

small paper clips

large paper clips

washers that have a larger mass than the large paper clip

balance and gram mass cubes. (Gram mass cubes can be ordered from enasco.com TB16755M Set of 500 for \$12.50.)
one science fair presentation board per group
half pieces of white paper

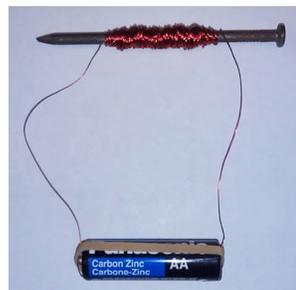
Preparation:

For each electromagnet you need about 20 feet of copper wire. Leave about 10 cm of one end of the wire free from the nail. Then start wrapping the rest of the wire very tightly up and down the nail. Continue wrapping, in the same direction, until about 10 cm of the other end of the copper wire is left. Use masking tape to hold both ends of the wire in place around the nail. Use sandpaper to scrape both ends of the copper wire. The insulation around the wire needs to be removed or else contact cannot be made with the battery ends.

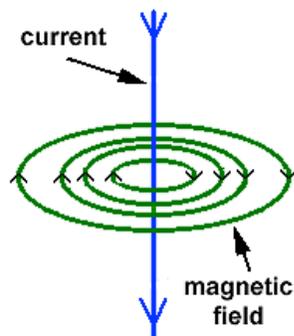
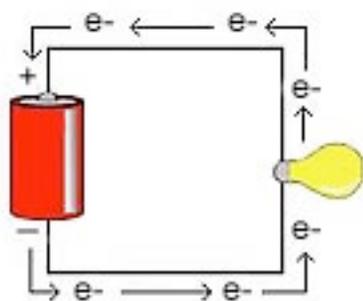
If using a larger gauge copper wire then use less than 20 feet of the wire. Experiment with enough wire turns to pick up at least 15 small paper clips.

Background information:

Electromagnets are temporary magnets. Electromagnets are used in all motors, generators, stereo speakers, doorbells, and many switches. Asia and Europe use electromagnets to levitate cars in trains. A crane uses an electromagnet to move a car around the junkyard. An advantage to electromagnets is that they can be turned on and off with electricity allowing the user to turn a magnet on and off on demand.



A battery has two ends, one marked plus (+) and the other marked minus (-). Electrons collect at the negative end of the battery, and, if you connect the two ends with a wire, they will flow to the positive end. As the electrons flow through the wire to the positive end, they generate a small magnetic field. If the wire is wrapped many times around a nail, the small magnetic field is multiplied by the number of times the wire is wrapped around the nail. Therefore, the more times wire is wrapped around a nail, the stronger the electromagnet.



In this lab, students will test whether the number of objects an electromagnet can pick up depends on the object's weight. For each electromagnet made only a certain amount of mass can be picked up. The electromagnet picks up more light objects and fewer heavier objects.

Pre-lab discussion: Ask the students if they think there are any electromagnets in the classroom. Identify several of them and then discuss how an electromagnet is useful. Show the students a battery and the diagram of how a battery operates. Discuss how an electromagnet is made and explain to students that the electricity flowing through a wire creates a magnetic field and wrapping the wire around the nail makes a great electromagnet. Finally, discuss the student's science fair projects and explain that each group is going to perform and write up all the sections of a science fair project and place them on a practice science fair board.

Instructional procedure:

I. Before you start the experiment: Each group should complete the first four steps for the science fair display board and place their written responses on their project board before they begin the experiment. In each group, different students should be responsible for writing the following sections.

A. **Introduction** – This explains the purpose of the project and includes any background information that students would research in a formal science fair project. Students should explain what an electromagnet is and what we want to test. For example, the purpose is to see whether an electromagnet can pick up the same number of different objects if the types of objects have three different masses.

B. **Title** -- Think of something fun that still pertains to the experiment.
(Powerful Electromagnets)

C. **Hypothesis** -- This is one sentence that states what they think will happen in the experiment. (We think an electromagnet will pick up fewer objects if they have a higher mass.)

D. **Procedure** -- Discuss how they should write down the experimental procedure. They should have a simplified version that is written in a 1, 2, 3 fashion.

II. The experiment: One electromagnet can be used for each group of 5 students.

1. Have students test the electromagnet by holding one end of the sanded copper wire to the batteries positive end and the other end of the sanded copper wire to the batteries negative end. To hold the wire their fingers can be used or they can try putting a small, tight rubber band around the two ends that are touching the terminals.

2. Dip the nail into a pile of small paper clips and make sure the paper clips are pulled up by the electromagnet. Works best if the objects to be picked up are in a small bowl and the nail placed inside the bowl.

3. Do not leave the electromagnet connected to the battery longer than is required because the system quickly drains the battery of its power.

4. Students should assemble their electromagnet then place the electromagnet in a small container holding one type of the objects to be picked up. They should bathe the magnet in the objects to ensure that they pick up the maximum number of objects each time. Students should repeat the experiment three times and find the average for their data.

5. Students should repeat step 4 for the other two objects.

6. Students find the mass of one of each of their objects (small paper clip, large paper clip, and washer).

III. Experiment Evaluation: After completing the experiment, have students again take turns writing up the final sections for the science fair board.

E. **Data** -- Gather the results and compare the data in a data table and a bar graph. For the bar graph, place the type of object on the x-axis and the average number of items picked up on the y-axis.

F. **Results** -- Explain what happened without drawing conclusions. This is very brief. (For example, our electromagnet could pick up 3 washers, 6 large paper clips, and 10 small paper clips.)

G. **Conclusions** -- Was the student's hypothesis correct? Decide if the hypothesis was supported. Explain to the students that it is fine if it was wrong. That's why they did the experiment was to learn the answer. List any problems they had and describe what they would do better next time if they did the experiment again.

H. **Bibliography** -- Explain that if they had used resources for their background information they would place it in this section. Do not complete this section.

I. **Abstract** -- The students do not write one now, but it is the final piece of information they put on their board. It is a brief summary of the experiment from beginning to end.

BOARD OUTLINE

<u>left panel</u>	<u>center panel</u>	<u>right panel</u>
ABSTRACT	TITLE	RESULTS
INTRODUCTION	DATA	CONCLUSION
HYPOTHESIS	Drawings photos tables graphs	BIBLIOGRAPHY
PROCEDURE		