

Electromagnet Design Activity

Introduction: This design activity uses the theory of electricity and magnetism to design an electromagnet, while keeping the market in mind.

Target Age Range: High School Sophomores and Juniors (10th & 11th grade)

Duration: 0.75 hours

Supply List:

Variety of wire (14 g solid wire, 20 g solid wire, 18 g copper wire)	Work gloves
Variety of batteries (C, D)	Safety glasses
Rubber bands	Wire cutters
Large and small nails	Electrical tape

No. of Facilitators: 2 (ideally, can be done with 1 facilitator for smaller groups)

Purpose: This is a design activity. This activity is geared toward 10th and 11th graders and is meant to exercise (relatively) advanced knowledge and skills that high school students with an aptitude for math and science should master.

This activity reinforces the concepts of electricity, specifically magnetism, and the concept of magnetic fields and which materials best conduct electricity. The activity emphasizes the importance of a product market, encouraging students to keep track of cost of material and compare that to the efficiency of the product.

Event Preparation: Gather all materials listed above. Each group should receive a variety of materials to creatively design their electromagnet.

Prepare a short lecture to remind students of the concepts of electricity and magnetism.

Prior to beginning, decide who will keep track of money spent per group and measure the number of nails lifted with the magnet. It is recommended to track this data in a spreadsheet for students to follow.

Assign costs to each material. For example, \$1.27/inch for 14 g solid wire, \$2.11 for C battery.

Procedure:

Facilitator(s): Initiate a conversation with the students:

- What is electricity?
- How does magnetism work? Discuss magnetic fields.
- What materials best conduct electricity?

Pair students up into teams of 2-4. Distribute materials to each group.

Explain the experiment procedure.

Student Teams: Perform the following procedure:

1. Collaborate with the team and come up with a design plan.
2. Note the cost of each material used in the magnet prototype.
3. Put on work gloves and safety glasses. Batteries can get hot.
4. Wrap a large nail with the wire to form a tight coil around the nail.
5. Connect each end of the wire to each side of the battery. Students can use electrical tape, rubber bands, or just simply hold the wire to the battery (with gloves on).

Electromagnet Design Activity

6. Test the magnet by attempting to pick up the smaller nails using the end of the large nail of the magnet. Note that the magnetic side of the large nail depends on the direction of the magnetic field, or the direction of the coiled wire.
7. Once the team feels confident in their prototype, they can compete against other teams to see which prototype picks up the most small nails.

Facilitator(s) Record each Student Team's data spreadsheet.

- Data should include:
 - The cost of the prototype
 - The number of nails each team's magnet picked up
- Record the ratio of the number of nails picked up to the cost of the prototype.
- The team with the highest ratio wins!

Example electromagnet:



(<https://www.sciencelearn.org.nz/resources/2564-making-an-electromagnet>)