

MAKING A MAGNET

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F q cdZ nf d 93-5

NUDQUHDV

In this activity, students will create a simple electromagnet using a nail, a battery, and copper wire. They will attempt to pick up nails using the magnet, and they will investigate how different variables affect the strength of the magnet.

Snoh9L f nshri zdkbsqbsx

Qd' kv nqc Zbhdmbd Snoh9

- An exploration of the force of magnetism
- An exploration of how electrical currents can induce magnetic fields

Naidbshud

Students will gain an understanding of magnetic fields and magnetic forces. They will also observe how electrical currents can create magnetic fields in certain materials.

L` sdq k Vtdcdc enqRst cdms@bshux

Materials Needed for Teacher Demonstration

- bar magnet
- iron nails of varying length
- thin gauge copper wire
- D-cell battery
- thick gardening gloves
- wire cutters
- tape
- paper clips
- ruler
- battery holder (optional)
- alligator clips (optional)

Materials Needed for Student Teams (Grades 2-3 only)

- thin gauge copper wire
- D-cell battery
- iron nails of varying length
- paper clips
- ruler
- battery holder (optional)
- alligator clips (optional)

MAKING A MAGNET

Materials

For each group, you will need: Prepare a 2-meter (approximately 6 feet) length of the copper wire for the demonstration. Cut the wire insulation down so that at least 2 centimeters (approximately 1 inch) of bare wire is exposed on each end.

For each group, you will also need: Prior to the activity, cut the copper wire into 2-meter (approximately 6 feet) lengths. Cut the wire insulation down so that at least 2 centimeters (approximately 1 inch) of bare wire is exposed on each end. Each group will need one wire.

Resources

MSHM@KRBHDMBDRS@MC@OCR@CCODRRDC

CONTENT STANDARD A: Science as Inquiry

As a result of activities in grades K-4, all students should develop

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

CONTENT STANDARD B: Physical Science

As a result of the activities in grades K-4, all students should develop understanding of

- Understandings of the properties of objects and materials
- Understandings about light, heat, electricity, and magnetism

CONTENT STANDARD E: Science and Technology

As a result of activities in grades K-4, all students should develop

- Abilities of technological design
- Understandings about science and technology

CONTENT STANDARD F:

As a result of activities in grades K-4, all students should develop

- Understanding of science and technology in local challenges

MSHM@KRBHDMBDRS@MC@OCR@CCODRRDC

- Investigate how a change in one variable relates to a change in a second variable.
- Identify and draw a two-dimensional representation of a three-dimensional object.
- Select and apply appropriate standard units and tools to measure length, area, volume, weight, time, temperature, and the size of angles.
- Design investigations to address a question and consider how data-collection methods affect the nature of the data set.
- Collect data using observations, surveys, and experiments.
- Represent data using tables and graphs such as line plots, bar graphs, and line graphs.

RSDORŽENQ *MAKING A MAGNET*

Q V`q ,tož@bshulsx9 Hold a bar magnet up in front of the class. Ask students to identify the object. Find out what prior knowledge students have about magnets and how they work. Use the bar magnet to pick up some paper clips, then explain that the magnetic force of the bar magnet attracts the metal in the paper clips. Next, hold an iron nail in front of the class. Ask students to identify the object. Tell students that in this activity, they will learn how to turn the nail into a magnet that can pick up paper clips.

1- Walk students through the process of creating an electromagnet.

Fq cdrŽ ,09 Demonstrate how to create the electromagnet by taking a nail and then wrapping the copper wire many times around the nail. Explain to students that it is important that the wires do not cross or overlap. The coils should be wound tightly around the nail, and should all be going in the same direction. Leave enough wire at each end to reach the battery. Tape one end of the wire to each end of the battery to complete the electrical circuit. Make sure to wear the gardening gloves when working with the wires and the battery. Explain to students that this is an important safety precaution, as the wires will start to get hot.

Fq cdrŽ ,29 Divide students into teams, and pass out the materials and student handouts. Each student group should have a copper wire, a battery, an iron nail, and a bunch of paper clips. If supplies are available, you may provide students with battery holders and alligator clips. This will make it easier to assemble the battery and wire circuits.

Instruct students in each group to choose a nail. Then, have them wrap the copper wire many times around the nail. Tell students to take care that the wires do not cross; the coils should all be going the same direction and should not overlap at any point. The coils should be wound tightly around the nail, with enough wire left over at either end to reach both ends of the battery. An example of the finished coil is shown below:



To ensure student safety, you should help each group assemble the battery by taping one end of the wire to each end of the battery. Be sure to wear the gardening gloves, and explain to students that it is important to wear protective gloves when working with the wires and the battery, as the wires will start to get hot. Each terminal must have one end of the wire attached in order to complete the electrical circuit. If you are using a battery holder, attach the wires to each end of the battery holder using the alligator clips.

Have students complete Questions 1-2 in their handouts.

2- Use the newly created electromagnet to pick up paper clips.

F q cdrĚĪ , 09Show students how you can use the newly created electromagnet to pick up paper clips. Note that you may need to wait up to a minute for the nail to begin acting as a magnet. In addition, if the magnet is weak, you can improve the circuit connection by pressing the wires to the terminators of the battery (be sure to use gloves!).

F q cdrĚĪ , 29Once all of the electromagnets have been assembled, have students use them to pick up paper clips. Students may need to wait up to a minute for the nail to begin acting as a magnet.

3- Tell students that the strength of an electromagnet depends on different variables, such as the length of the nail and the number of coils.

F q cdrĚĪ , 0 Count the coils on the demonstration magnet, and use a ruler to measure the length of the magnet. Write both numbers on the board. Determine how many paper clips you were able to pick up with the electromagnet, and write that number on the board as well.

F q cdrĚĪ , 29Have students measure the length of the iron nail with a ruler and count the number of coils on the nail. They should then count the number of paper clips they were able to pick up. Tell them to record this information on Question 3 on the Student Handout.

4- Experiment with manipulating variables, to see how they affect the strength of the electromagnet.

F q cdrĚĪ , 09Demonstrate how changing a variable affects the strength of the electromagnet. Repeat the demonstration 2-3 more times (as time permits), making the following alterations:

- Trial #1: Use the original nail and wire but change the number of coils.
- Trial #2: Use a different size nail but keep the number of coils the same.
- Trial #3: Use the original nail and make the same number of coils but use a wire that is twice as long as the original.

After each trial, count and record the number of paper clips you are able to pick up with the electromagnet.

F q cdrĚĪ , 29Have the student groups choose one variable to manipulate, which they should record in Question 4 of the handout. Each group may either:

- Use a different size nail but keep the number of coils the same for each nail.
- Change the number of coils on the nail they used in the previous experiment.

Provide students with any additional material they may need to test their variables, and allow them time to complete their new coils. Using the gardening gloves, help them attach the wires to the battery to complete the electromagnet. Then, instruct them to complete Question 3 on the Student Handout, in which they will record their results. If time allows, have groups switch and test the other variable.

5- Discuss the results of the experiment with the class.

F q cdrĚĪ , 09After the last trial demonstration is complete, discuss the results with the class. Determine which battery/wire/nail setup maximized the number of paper clips in each trial.

F q cdrĚĪ , 29Have students analyze their results and, within their groups, discuss the properties of the battery/wire/nail setup that maximized the number of paper clips picked up in each investigation.

6- **V q o, t oĚĪ@bsuhlsx9**Have students observe and describe which properties made the electromagnet most effective. Then, prompt students to draw conclusions about the strength of the magnetic force produced in this investigation. Have them discuss how the number of coils, length of the nail, and/or length of wire influenced the strength of the magnetic force. Explain to students that some magnets exist naturally in nature. Earth, for example, is a magnet with a north and south pole. Other magnets can be created using electrical currents. Many of the machines we use today have electromagnets.

F q cdrĚĪ , 09Discuss some of the uses of electromagnets with the class. Prompt students to come up with others.

F q cdrĚĪ , 29Discuss some of the uses of electromagnets with the class. Have student groups come up with others on their own, which they should record in Question 5 of the handout.

Making a Magnet DvšdntmnrĚĪ@bsuhlsdtr

F q cdrĚĪ , 09Show students how to create an electromagnet using different materials, such as tightly wrapped aluminum foil, pencils, pens, drinking straw, and so on. Discuss with students how different materials affect the strength of the magnetic field and its ability to pick up small objects, such as paper clips.

F q cdrĚĪ , 29Challenge students to create an electromagnet using different materials, such as tightly wrapped aluminum foil, pencils, pens, drinking straw, and so on. Have students examine how different materials affect the strength of the magnetic field and its ability to pick up small objects, such as paper clips.

MAKING A MAGNET

A@BJ F QNT MCŽMENQL @SHNM

V g` sĀrŽ Ā ` f nls>

All materials contain electrons. Electrons are negatively charged particles that are constantly spinning around. Each spinning electron produces a small magnetic field with a north and south pole. In normal materials, each electron spins in a random direction. This cancels out the magnetic fields associated with the electrons in the material. However, in a permanent magnet, each electron spins in the same direction. This causes the material to have a north and south pole and creates a magnetic field. The north pole of a magnet will attract the south pole of another magnet. A bar magnet is an example of a permanent magnet. Earth is also an example of a permanent magnet that occurs in nature.

Gnv žb` nŽ ža` ssdqxŽt qnŽ nĀqpnĀm kĀmsnŽ Ā ` f nls>

Three things are needed to create a simple electromagnet: electricity, a copper wire, and a ferromagnetic material, such as an iron nail. Ferromagnetic material is any material that can be attracted by magnets. When you attach the copper wire to the positive and negative ends of a battery, electric current flows through the wire. Electric current is a flow of charged particles. The flow of current creates a magnetic field. If you place an iron nail in the middle of this magnetic field, the spin of electrons in the material will align. At this point, the material will become magnetized. This creates a temporary magnet that attracts other ferromagnetic materials. If the electrical current is stopped, the electrons go back to a random alignment and the nail stops being magnetized.

V g` sŽ qĀrni dĀrdrĀnqĀdklksqnl ` f nlsr>

Electromagnets have lots of different uses. They are used in motors to help things spin. Cars, vacuums, fans, and blenders all use electromagnets. Electromagnets are also used to create giant magnets that can move huge loads, like the magnets in junkyards. Electromagnets are also becoming more commonly in the medical field. They are used for magnetic resonance imaging, or MRIs, which can help doctors diagnose health problems.

J dxĀJnb` at k qx

a` ssdqx9a container that stores chemical potential energy

dklksqnl ` f nls9a material that becomes magnetized when electrical current passes around it

dklksqnm9a negatively charged particle that is in constant spinning motion

edqnl ` f nls9a material property that causes it to be attracted by magnets

l ` f nls9a material that has a north and south pole

MAKING A MAGNET

SD@BGDOŽ@MCNT SŽ

Draw a picture of your electromagnet. Label all of the parts.

[Images will vary.]

Describe the properties of your electromagnet:

- How long is the nail?
- How many coils of wire are wrapped around the nail?
- How many paper clips did your magnet pick up?

[Sample answer: The nail is 6 cm long. We wrapped 40 coils around the nail. The magnet picked up 8 paper clips.]

Create a table to show the variable you tested and the results that occurred.

[Sample table below.]

U` qñ akdž Ml adqñež O` odqžktr	Ml adqñež O` odqžktr
3/ žntr	8
5/ žntr	12

Decide which property of the magnet you will change in this investigation and list it below.

[Sample answer: We varied the number of coils wrapped around the nail.]

Work with your group to come up with two uses for electromagnets.

[Sample answer: Electromagnets can be used in junkyards to help pick up cars and move them. They can also be used in motors to help things spin.]

MAKING A MAGNET

RST CDMSŽ@MCNT SŽ

Name:

Date:

Draw a picture of your electromagnet. Label all of the parts.

Describe the properties of your electromagnet:

- How long is the nail?
- How many coils of wire are wrapped around the nail?
- How many paper clips did your magnet pick up?

Create a table to show the variable you tested and the different results that occurred.

Decide which property of the magnet you will change in this investigation and list it below.

Work with your group to come up with two uses for electromagnets.