
IMH TEP'S

LEGACY ACADEMY

THE POWER OF MAGNETS

Grade 6 Activity Plan

Reviews and Updates

6.5 The Power of Magnets

Objectives:

1. To learn about magnetic fields
2. To learn about some of the different applications for magnets and electromagnets.
3. To learn about the difference between permanent magnets and electromagnets.
4. To describe the relationship between electricity and magnetism when using an electromagnet.
5. To discover factors that affect the strength of electromagnets.

Keywords/concepts: Magnets, compass, electromagnet, permanent magnet, forces, magnetic poles, magnetic field, magnetization

Curriculum Outcomes: 106-3, 106-4, 204-1, 205-3, 205-9, 206-5, 207-2, 303-22, 303-26, 303-27.

Take-home product: Electromagnetic toy train

Segment	Details
African Proverb (5 min.)	"Unity is strength, division is weakness." Swahili proverb
Pre-test (10 min.)	Where do we see magnets everyday? What are some uses for magnets? Show this video explaining the Maglev train: https://www.youtube.com/watch?v=alwbrZ4knpg
Background (10 min.)	What is a magnet? What is an electromagnet? Permanent magnet vs. electromagnet.
Activity 1 (15 min.)	Students make compasses with magnetized needles.
Activity 2 (30 min.)	Students make an electromagnetic train using a coiled copper wire, magnets and a battery.
Activity 3 (20 min.)	Students make and test a simple electromagnet out of an iron nail, a battery and copper wire.
Post-test (10 min.)	Word Search

Suggested interpretation of the proverb

In life when you work as a team it is usually more effective than working on your own. In this activity students will learn about the power of magnets, including the way magnets (usually weak) and electromagnets can combine to make powerful and useful machinery for example the Maglev electromagnetic train and electromagnetic motors.

Background Information

Magnet

A material or object that produces a magnetic field.

Permanent magnet

A permanent magnet is a magnet that is permanent, in contrast to an electromagnet, which only behaves like a magnet when an electric current is flowing through it. Permanent magnets are made out of substances like magnetite (Fe_3O_4), the most magnetic naturally occurring mineral, or neodymium, a powerfully magnetic synthetic substance. The Earth itself is a huge permanent magnet, though its magnetic field is quite weak relative to its size. Humans have used the magnetic field of the Earth for navigation since the compass was invented in ancient China.

Even the most powerful permanent magnet is not as strong as the stronger electromagnets, so their applications are limited, but they still have many uses. The most mundane would be use as refrigerator magnets, but magnets can be found everywhere, including your hard disk, ATM and credit cards, speakers and microphones, electric motors, and toys. Electric motors work through an interaction between an electromagnet and a permanent magnet.

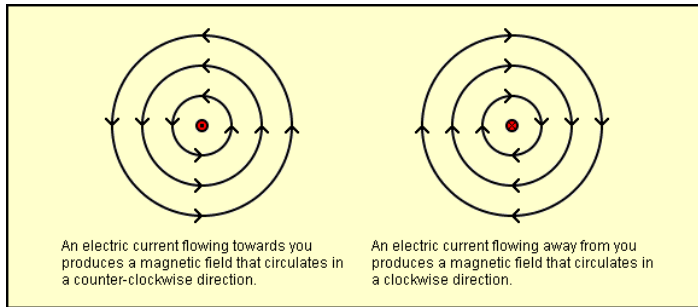
Every permanent magnet generates a magnetic field, just like any other magnet, which circulates around the magnet is a distinct pattern. The size of the magnetic field is related to the size of the magnet and its strength. The easiest way to view a magnetic field generated by a permanent magnet is to scatter iron filings around a bar magnet, which quickly orient themselves along the field lines.

Every permanent magnet has two poles, named north and south, though they could have just as easily been called A and B. Similar poles repel while opposite poles attract. It takes a lot of effort to hold repelling poles of a magnet together, while it takes effort to remove attracting poles

For thousands of years, permanent magnets were the only magnets that humans had. The electromagnet was only invented in 1823. Before that, magnets were mostly novelties. Using an electromagnet, it is possible to induce a current in any ferromagnetic materials, such as an iron paperclip. The effect quickly fades, however.

Electromagnets

An electromagnet is a magnet that runs on electricity. Unlike a permanent magnet, the strength of an electromagnet can easily be changed by changing the amount of electric current that flows through it. The poles of an electromagnet can even be reversed by reversing the flow of electricity. An electromagnet works because an electric current produces a magnetic field. The magnetic field produced by an electric current forms circles around the electric current, as shown in the diagram below:



If a wire carrying an electric current is formed into a series of loops, the magnetic field can be concentrated within the loops. The magnetic field can be strengthened even more by wrapping the wire around a core. The atoms of certain materials, such as iron, nickel and cobalt, each behave like tiny magnets. Normally, the atoms in something like a lump of iron point in random directions and the individual magnetic fields tend to cancel each other out. However, the magnetic field produced by the wire wrapped around the core can force some of the atoms within the core to point in one direction. All of their little magnetic fields add together, creating a stronger magnetic field.

As the current flowing around the core increases, the number of aligned atoms increases and the stronger the magnetic field becomes. At least, up to a point. Sooner or later, all of the atoms that can be aligned will be aligned. At this point, the magnet is said to be saturated and increasing the electric current flowing around the core no longer affects the magnetization of the core itself.

Compasses

A compass points north because all magnets have two poles: a north pole and a south pole, and the north pole of one magnet is attracted to the south pole of another magnet. (You may have seen this demonstrated by a pair of simple bar magnets or refrigerator magnets pushed end to end.)

The Earth is a magnet that can interact with other magnets in this way, so the north end of a compass magnet is drawn to align with the Earth's magnetic field. Because the Earth's magnetic North Pole attracts the "north" ends of other magnets, it is technically the "South Pole" of our planet's magnetic field.

References:

<http://www.wisegeek.com/what-is-a-permanent-magnet.htm>

http://education.jlab.org/qa/electromagnet_is.html

<http://www.livescience.com/32732-how-does-a-compass-work.html>

Activity 1: Making a Compass

Purpose: To show an application for magnets. To learn about earth's magnetic field. To learn about magnetization.

Suggested format: Students work in pairs

Item	Quantity (10 students)
Metal sewing needle	1
Strong magnet	6 Tbsp
Pair of pliers	2 Tbsp
Cork	1
Scissors	1
Bowl	1
Water	1
Compass or GPS (on a smart phone)	1

Procedure:

- 1) Rub the magnet against the sewing needle at least five times. Always rub the magnet in the same direction against the needle. Your needle should now be magnetized.
- 2) Cut off about one quarter inch of the cork from one of the ends, making a small cork disk that is about one-quarter-inch tall.
- 3) Laying the cork disk on a flat surface, carefully push the needle through the side of the disk by using the pair of pliers. Push the needle all the way through the disk so that about the same amount of needle shows on either side of the disk.
- 4) Fill the bowl with at least one inch of water
- 5) Put the cork disk (with the needle) on the water in the cup. Try to keep the disk floating in the center of the water, away from the sides of the cup. *What does the needle do? When it stops moving, what direction does it point towards?*
- 6) The needle will point either north or south. Find out which way it is pointing by using a compass or a GPS and mark it as north.

Suggested Variation:

- o Put a magnet next to your compass. *What happens to the needle as the magnet is moved close to it? How close does the magnet need to be to affect the compass? You could also try this with a steel object (such as a nail or possibly the pliers).*

Reference:

<http://www.scientificamerican.com/article/steering-science-make-a-homemade-compass/>

Activity 2: Make your own Electromagnetic Train

Purpose: To learn about the difference between permanent magnets and electromagnets. To introduce the subject of applications for electromagnets.

Item	Quantity (10 students)
AA Battery	10
6m Thin Copper wire with 0.8 or 1.0mm diameter coated specific wire	60m
2 Disk Magnets 15mm diameter X 8mm thickness	20
25cm Wooden rod with approximately 15mm diameter	10
Wire Cutter	1

Procedure:

- 1) **TO BE DONE BY MENTOR (prior to activity):** Cut approximately 6m of wire for each student.
- 2) Wrap the 6m of copper wire evenly around the rod and then remove the rod.



- 3) Place the magnets on the battery in a way that either both north poles or both south poles are connected with the battery. Otherwise the train won't run.



- 4) Now put the battery in the tunnel and be amazed by how the battery bolts through it!



The Science:

The battery passes electricity into the magnets, and when the magnets touch the copper coil electricity will pass into that as well.

When electricity goes into a copper coil like that, it makes the coil magnetic too (electromagnet), but the opposite polarity to the magnets (like how north and south ends of a magnet are opposite). It looks something like this:

S-----N

The configuration with the battery ("====") and the permanent magnets (S-N and N-S) looks like this:

S-----S-N====N-S-----N

The battery travels as the permanent magnets touch new coils, where the S-----S side creates repulsion and the S----N side creates attraction, hence the battery is pushed to the right and shoots through the tunnel.

References:

<http://4kindness.weebly.com/science/worlds-simplest-electric-train>

<http://www.supermagnete.de/eng/Magnet-applications/The-world-s-simplest-electronic-train>

<http://thekidshouldseethis.com/post/how-to-make-the-worlds-simplest-electric-toy-train>

Activity 3: Making and Testing an Electromagnet

Purpose: To observe the relationship between electricity and magnetism using an electromagnet. To learn about and test a factor that affects the strength of electromagnets.

Suggested format: Students work in pairs

Item	Quantity (10 students)
Iron nail (15cm or 6in)	5
Thinly insulated copper wire	5m
D-cell battery	5
Paperclips	1 large box
Wire stripper	1

Procedure:

- 1) **TO BE DONE BY MENTOR (prior to activity):**
 - a. Cut each pair approximately 1m of copper wire and remove the insulation from each end of the wire, just enough to provide a good connection with the battery.
 - b. Print off the "Testing an Electromagnet" worksheet.
- 2) Wrap the wire around the nail the amount of times specified in the table below; the tighter you can wrap it, the more powerful the magnetic field will be.
- 3) Connect the battery by attaching one end of the wire to the positive terminal and one to the negative terminal (it doesn't matter which end of the wire gets paired with which terminal).
- 4) Test the power of the electromagnet by picking up paperclips and record how many paperclips it was able to pick up.
- 5) Repeat steps 2-4 for each number of coils

References:

<http://www.instructables.com/id/How-To-Make-An-Electromagnet/>

<http://science.howstuffworks.com/electromagnet5.htm>

Testing an Electromagnet

Number of Coils	Number of paperclips picked up
1	
5	
10	
50	
100	

Post Test

Print off the "The Power of Magnets" worksheet.

The Power of Magnets Word Search

J N P A E D L Z L G L E H P L U M N A S R A E O E
S J S D K M T T R P I N E E Y O A T S S K O T S S
D I I X P D S E E Y A K A N E H G S O I F O A O A
A E N N E P Z L O A E A A E O R N M V E V A P J H
M E Q S D R D A G R E P E L J R E L S T X N F W I
S W X O R A A S I H W C W E N C T S H R E D V P H
O E R S Y V I L O K O I K C K M A H B E T T R Z A
Y M Y T C R F I E U P I E T R P F D B D A T N E S
O I S V Q L E N N H T E R R M E V N E T E X E R T
V I N P E O F M U I Z H R O H W W Z D E S T A A M
G O R I E I G S A M N C C M C O I L M Y U C S J A
W N S T J I K P O L E S G A A T T R A C T L F S O
A Z H O M F I H N L B T H G E N D H N T E O P H E
L E V T V L T H S E I E I N C P E N T U M T T N O
X Y A R G Z O G F N W O G E E J N N E Z O P E E T
I Z L P H R E E O Y A A O T B S M P T D S A Z S R
N F Z N L O A Z R N M E C M R E D E B F G V R H G
N R O N I L D A C V M L L L K E Q L R M M P M R Y
E E Y T W E A M E X E V L L C E I K C K I V P T D
A T L D P R C L S A A Y Z D J E C K W G O S N H O
Q X P N O I G N P R J N D G H N N W T F E V T L W
F O D F R A S T E V S D T O A M V S E C L P N A D
W D K T M Z E I R S I T B L E R O E U C B E I E E
Y S A J R H S S S H T T O K E O F E B D E T S F P
A S Z L B A O N L X O S I O U E C I I A R P D N L

Find the following words:

Electromagnet

Magnet

Maglev

Poles

North

South

Electromagnet

Attract

Repel

Compass

Permanent

Forces

Magnetized

Coil

Materials list

Materials	Source	Cost and quantity
Metal sewing needle	Walmart http://www.walmart.ca/en/ip/70-assorted-hand-sewing-needles/6000157095891	\$1.00 (70 needles)
Strong magnet	Activity bin: 9.6	-
Pair of pliers (wire cutter included)	Walmart http://www.walmart.ca/en/ip/needle-nose-plier-with-cutter/6000016932819	\$5.97 (1 Pair)
Cork stoppers	Michael's http://www.michaels.com/10309631.html#start=11	\$2.99 (10 corks)
Scissors	Activity bins: 7.1, 7.2, 7.7, 7.8, 8.4, 8.5, 8.9 and 9.2	-
Bowl	Activity bins: 8.4 and 8.8 Walmart http://www.walmart.ca/en/ip/royal-chinet-bowls/6000153707030	\$2.49 (15 bowls)
Compass or GPS (on a smart phone)	Smartphone Walmart http://www.walmart.ca/en/ip/pocket-compass/6000188514569	- \$4.97 (1 compass)
AA Battery	Walmart (http://www.walmart.ca/en/ip/duracell-coppertop-aa-20/6000016946488)	\$15.97 (20 batteries)
6m Thin Copper wire with 0.8 or 1.0mm diameter (lightly coated)		
2 Disk Magnets 15mm diameter X 8mm thickness	Home Depot *Smaller thickens (0.125 in) http://www.homedepot.com/p/Master-Magnetics-1-2-in-Neodymium-Rare-Earth-Magnet-Discs-6-per-	\$3.98 (6 magnets)

	Pack-07046HD/202526367	
Wooden rod (dowel) 15mm diameter	Home Depot http://www.homedepot.com/p/Waddell-7-16-in-x-36-in-Round-Birch-Dowel-6607U/203706870	\$0.91 (36 inches)
Iron nail (15cm or 6in)	Home Depot http://www.homedepot.com/p/Grip-Rite-4-x-6-in-60D-Bright-Steel-Spikes-50-lb-Pack-60C/100192956	\$49.97 (500 nails, 50lb)
Thinly insulated copper wire		
D-cell battery	Walmart http://www.walmart.ca/en/ip/duracell-coppertop-d-batteries/6000016950623	\$12.47 (8 batteries)
Paperclips	Activity bins: 7.1, 7.4, 7.9, 9.2, 9.4 and 9.5	
Wire stripper	Home Depot http://www.homedepot.com/p/Commercial-Electric-7-in-Wire-Stripper-and-Cutter-06010/202039360	\$7.93 (1 pair)