

Magnetism – Answer Key

Vocabulary

Term	Definition
Magnet	A material that can create magnetic effects by itself
Electromagnet	Magnets created by electric current flowing in wires. A simple electromagnet is a coil of wire wrapped around an iron core.
Diamagnetic	A type of matter in which the magnetic fields of individual electrons cancel out, leaving each atom with zero magnetic field.
Paramagnetic	A material where the magnetism of electrons in individual atoms does not cancel completely.
Ferromagnetic	A material (like iron) with very strong magnetic properties.
Magnetic Declination	The difference between the direction a compass points and the direction of true north.
Permanent Magnet	A type of matter in which the magnetic fields is always present.
Magnetic Poles	Each magnet has a North and South Pole. They behave similar to opposite particles in electrostatics.
Soft Magnet	A material that can be attracted to a magnet, but does not retain magnetic ability after being removed.
Hard Magnet	The material that is easily magnetized and holds its magnetism.

Magnetism

Physics

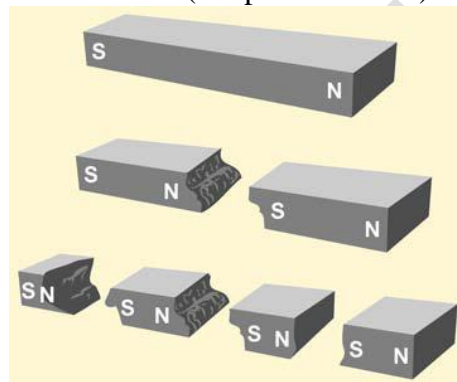
16.1 Properties of Magnets

A magnet is a material that can create magnetic effects by itself.

All magnets have two opposite magnetic poles, called the

- North Pole
- South Pole

What happens if a magnet is cut in half? (see picture below)

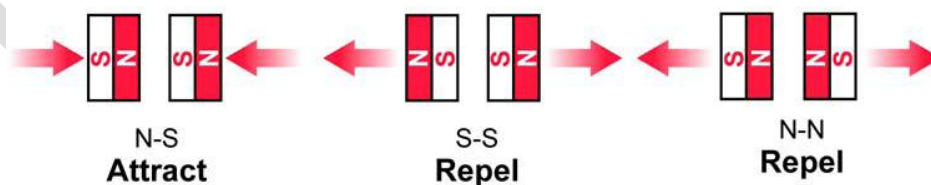


The magnet breaks up into a bunch of smaller magnets, each with their own North and South Poles.

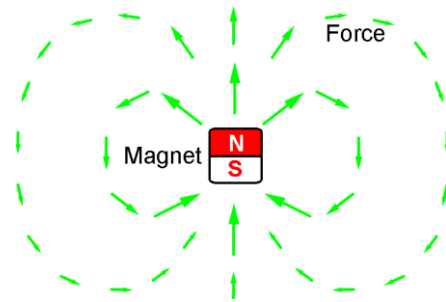
Magnets exert forces. Two magnets can either attract or repel.

- If two of the same poles face each other, the magnets repel (push away).
- If two of the opposite poles face each other, the magnets attract (pull towards).

The three interactions between two magnets



Two magnets create a force on each other at a distance much larger than the size of the magnets. Physicists represent this force by drawing the magnetic field around a magnet. The magnetic field is a magnetic force that surrounds a magnetic object at all points in space.

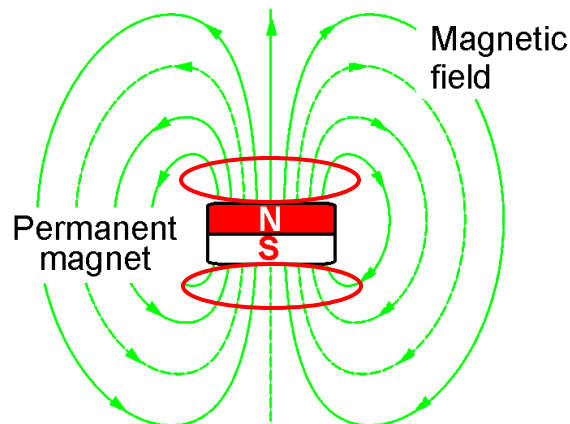


The diagram above represents the magnetic field around a magnet. Notice how the force/magnetic field lines point away from the magnet's North pole and toward its South pole.

Notice below how the magnetic field lines spread out as they get farther away from the magnet. If field lines are close together, the force is stronger. If field lines are farther apart, the force is weaker.

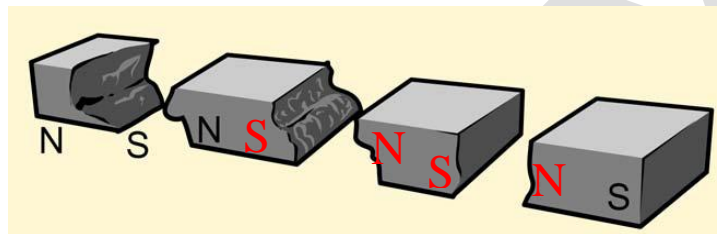
Identify in the picture below where the magnetic field is the strongest.

Drawing a magnetic field

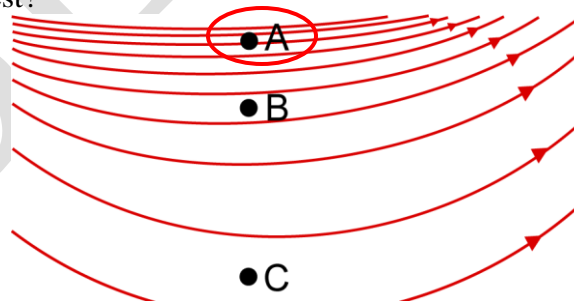


16.1 Check Questions

1. Is it possible to have a south pole without a north pole or a north pole without a south pole. Explain.
No it is not possible! They need to have opposite sides because they are each aligned to have North on one side and South on the opposite side.
2. Think about what happens to a magnet if it is cut in half to answer the next question. A student knocked a ceramic permanent magnet off her desk, and it shattered when it hit the floor. Copy the broken pieces and label the north and south poles on each one.



3. Two magnetic north poles **repel** each other. Two south poles **repel** each other. A north pole and a south pole **attract** each other.
4. Magnetic field lines outside a magnet always point away from its **North** pole and toward its **South** pole.
5. The diagram below shows the magnetic field in a region. The source of the field is not shown. At which of the labeled points in the diagram below is the magnetic field the strongest?



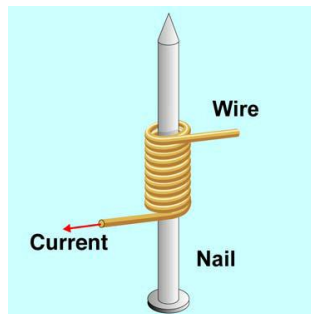
Point A because the magnetic field lines are closest together in that area.

16.2 The Source of Magnetism

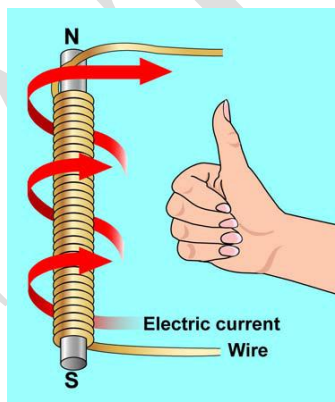
What are electromagnets?

A simple electromagnet is a coil of wire wrapped around an iron core.

Example of an electromagnet:



The North and South poles of an electromagnet are at each end of the coil. When the fingers of your right hand curl in the direction of the current, your thumb points toward the magnet's north pole. This method is known as the Right Hand Rule.



What happens if you reverse the direction of current flow in an electromagnet?

If you reverse the direction, the poles of the magnet that you created flip.

Two ways to make the electromagnet's field stronger:

1. Add more coils of wire around the iron core.
2. Increase the amount of current traveling in the wire.

Diamagnetic: A type of matter in which the magnetic fields of individual electrons cancel out, leaving each atom with zero magnetic field.

Paramagnetic: A material where the magnetism of electrons in individual atoms does not cancel completely.

Ferromagnetic: A material (like iron) with very strong magnetic properties.

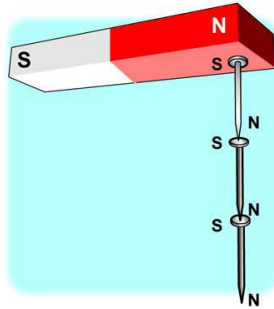
How can a permanent magnet be demagnetized?

1. Dropping it on a hard surface.
2. Heating it to very high temperature.
3. Forcing two north poles together.

What is a soft magnet?

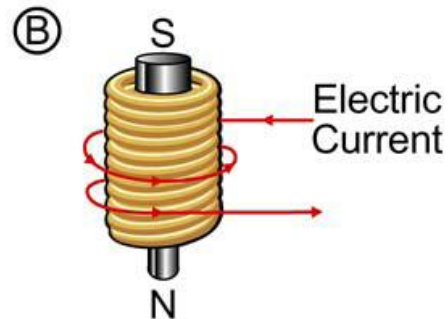
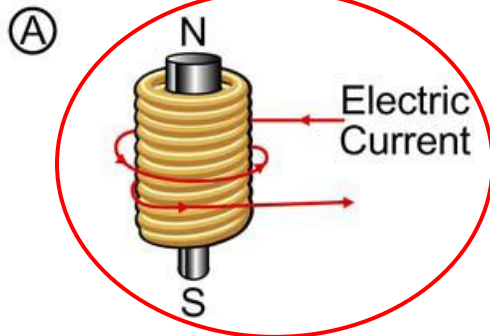
A magnetic material that is relatively easily magnetized or demagnetized.

A nail is attracted to a magnet and attracts other nails as well. If the nail is removed from the magnet, it does not attract other nails because the nail is an example of a soft magnet.



16.2 Check Questions

1. What is the difference between diamagnetic, paramagnetic, and ferromagnetic?
See previous page.
2. What happens to the north and south poles in an electromagnet's if the direction of the current is reversed? **The poles flip**
3. Describe two ways you could increase the strength of an electromagnet.
 - a. **Add more coils of wire around the iron core.**
 - b. **Increase the amount of current traveling in the wire.**
4. Which picture below shows the correct location of the north and south poles of the electromagnet?



5. A permanent magnet attracts a steel pin as shown below. The pin has become a soft magnet. Copy the picture and then use what you know about magnetism to label the north and south poles of the pin.

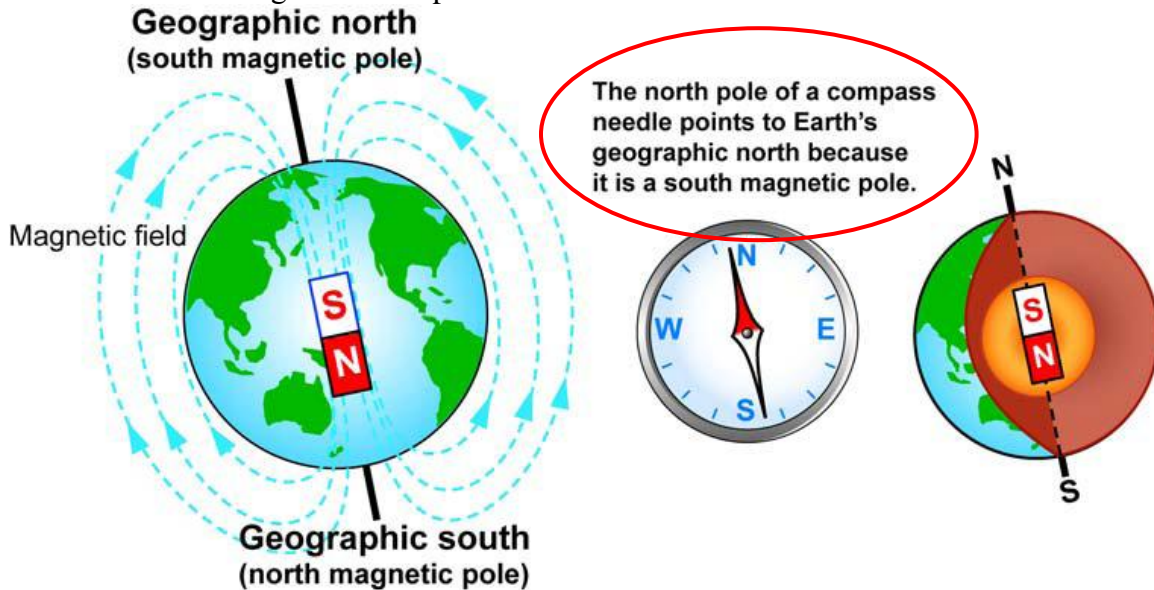


16.3 Earth's magnetic field

What people discovered that some naturally occurring materials have magnetic properties?

The Greeks discovered this through the use of Lodestone.

Where is Earth's magnetic north pole?



The north pole of a compass needle points to Earth's geographic North because it is a south magnetic pole. Think about it! A compass needle is a magnet that is free to spin. The north pole of a compass needle (magnet) will always point towards the south pole of another magnet.

What is magnetic declination?

It is the difference between the direction a compass points and the direction of true north.

Earth behaves like a giant magnet.

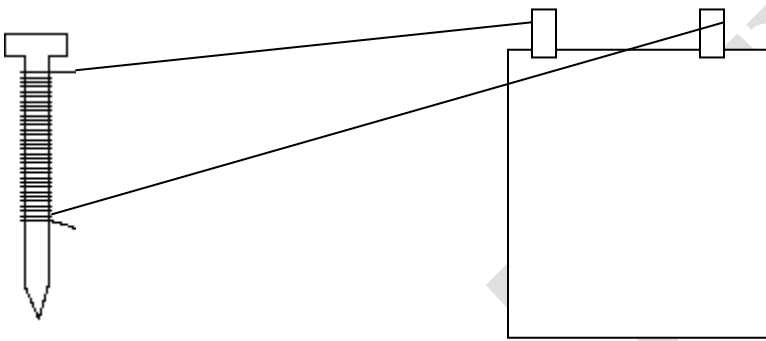
16.3 Check Questions

1. Is Earth's magnetic north pole at its geographic north pole? Explain.
No, the Geographic North Pole is Earth's South Magnetic Pole. This is because the North end of the magnet points up, so it must be attracted to the opposite pole.
2. Why does a compass point north?
The compass points to Geographic North, which is really the magnetic South Pole. Therefore the North Pole of the compass is attracted to the South magnetic end of Earth.
3. What is magnetic declination?
It is the difference between the direction a compass points and the direction of true north.

Investigation #1 The Electromagnet

1. Try to pick up the paper clips by touching them with the nail. What happens?

2. Hook up a battery to the wire on the nail so that electricity is running through the wire.



3. Try again to pick up the paper clips. What happens? Why?

4. Now disconnect the battery and try the paper clips again. Does the same thing happen as in step 3? What has happened to the nail?

5. Experiment with how many paper clips the nail can pick up. Each nail has a different number of wraps of wire around it. Investigate the relationship between the number of wraps and how many paper clips are picked up. Record the number of paper clips that you pick up each time in the table below.

# Wraps	10	20	30	40	50	60	80
# Paper Clips							

6. What can you conclude about the number of wraps around the nail and the number of paper clips it can hold? Explain why.
7. Predict what will happen to the number of paper clips picked up if you increase the current through the electromagnet.
8. Construct a graph using Microsoft Excel showing how the number of paper clips picked up by the magnet varies as the number of wraps are increased.
9. Prepare a poster summarizing the results of this experiment. Include your data table and graph on the poster.
10. Look at other groups' electromagnets, data tables, and graphs. Did some electromagnets work better than others?

Poster Project

Physics

Your 3-dimensional poster **must** contain the following information:

1. The first, middle (if applicable) and last name of your scientist.
2. One sentence explaining why your scientist is famous.
3. A picture of your scientist.
4. Date of birth.
5. City and country of birth.
6. Specific location where he/she conducted their work.
7. Date of death. If your scientist is still alive, how old is he/she now?
8. 3-5 sentences summarizing your scientist's accomplishments, in your own words.
9. Add objects to make your poster appear 3-dimensional (give the poster depth).

You **must** choose any 5 of the following options to include on your poster:

1. A quote about science by your scientist.
2. Additional pictures of your scientist.
3. A picture of what they worked on. Ex: if he invented the microscope, include a picture of a microscope.
4. Educational background. What college(s) did he/she graduate from?
5. Any additional jobs held by the scientist outside the science field. Ex: Gregor Mendel is known as the "Father of Genetics" for his work with pea plants. He was also a monk.
6. Family information. Provide names of parents, spouses, children, brothers, sisters, etc. when applicable.
7. List 3 events that happened in history when this scientist became famous. Events should include specific wars, top movie for the year, top song for the year or other discoveries.
8. The name(s) of other scientists that your scientist worked with.
9. Has anything been named after your scientist? If so, include the city and country. Ex: colleges, cities, museums, etc.
10. Mounting on a decorative piece of construction paper to make it sturdy.

Your "Wanted" poster can be reflect your personal design style, but must follow a few basic guidelines:

1. **All posters must be neat, completed on poster paper and must be colorful.**
2. **The name of your scientist must be clearly visible on your poster.** Anyone who glances at your poster should be able to tell which scientist you researched.
3. **The "Wanted" poster theme must be followed.** Meaning, your poster should read: "<Name of Scientist> Wanted for <one sentence explaining his/her importance>".
4. **Your name must be printed on the bottom right corner.**

Rubric Poster Project

General Physics

Category	Total Points	Earned Points
Poster includes first, middle (if applicable) and last name of your scientist	5	
One sentence explaining why your scientist is famous	5	
Picture of scientist	5	
Date of birth	5	
City and country of birth	5	
Specific location where he/she conducted their work	5	
Date of death	5	
3-5 sentences summarizing your scientist's accomplishments, in your own words	10	
Five additional options provided	25	
Poster is 3-dimensional	15	
Poster is neat and colorful	15	
	Total Points	

****No late projects will be accepted****

Project due date: _____

Activity – Brain Pop Magnetism

Physics

Directions

Go to <http://www.brainpop.com/science/motionsforcesandtime/magnetism/>

Why do magnets stick to things?

What is a magnet?

What is a magnetic field?

When the video finishes click on Questions and Answers.

What is an electromagnet? How could you create your own?

Do magnetic fields get stronger or weaker the further away they are from a magnet?
What happens if you cut a magnet in half? Draw a picture of the new magnets and label each pole. Look at section 16.1 in your online book for help.

Go to <http://www.brainpop.com/science/energy/electromagnets/>

Any material that contains what will be attracted to a magnet?

What happens if you reverse the direction of the current?

Investigations

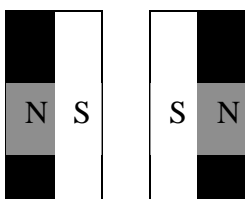
Physics

Magnetic Poles

For electricity we found that there were positive and negative charges, that like charges repel each other and opposites attract. Let's see if there's an analogy for magnetism.

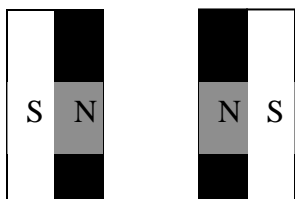
Observe how two magnets affect each other.

Try holding two magnets with their south poles facing each other. What happens?



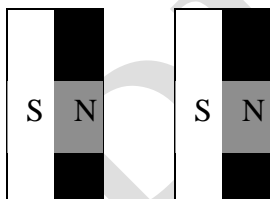
They repel each other!

Try holding two magnets with their north poles facing each other. What happens?



They repel each other!

Try holding two magnets with north and south poles facing each other. What happens?



They attract each other!

Write down a rule that describes how magnets exert forces on each other. Your rule should include using the following words: attract, repel, north, south, pole.

Rule: Opposite poles of magnets attract, while the same poles repel away from each other. The North and South Poles will come together, but if a North and North were placed next to each other, they would repel.

Magnetism Simulation

Physics

Directions: Answer the following questions in complete sentences on a separate sheet of paper.

Purpose

After reading the lab, create your own research question(s) below:

Procedure

Using the Site

Access the site by either clicking on the link: <http://phet.colorado.edu/en/simulation/magnets-and-electromagnets>

Part 1 – Bar Magnets

1. What happens when you place the compass near the North Pole of the magnet?
2. What happens when you place the compass near the South Pole of the magnet?
3. Based upon your observations and answers to #'s 1 and 2 what conclusion can you make about the relationship between a magnet and compass?
4. Move the compass slowly along a semicircular path above the bar magnet until you've moved it from the north pole to the south pole. Describe what happens to the compass needle.
5. Does the compass needle always point in the same direction?

Does the compass needle always point to the same end of the magnet?

Which end of the magnet does the compass needle point toward?

Which end of the magnet does the needle point away from?

6. On the right side menu, click “Flip Polarity” and repeat step 3 after you’ve let the compass stabilize. What is different? What is the same?

Part 2 – The Earth’s Magnetic Field

7. On the right side menu, check off “Show planet Earth.”
8. Place the compass over the United States. Which part of the compass (red is North, white is South) is attracted to the Earth’s geographic North Pole?

Part 3 - Electromagnets

9. Move the compass along a semicircular path below the coil until you’ve put it on the opposite side of the coil. Describe what happens to the compass needle.
10. Use the voltage slider to change the direction of the current and repeat step 8 for the coil after you’ve let the compass stabilize. What is different? What is the same?
11. Based on your observations, summarize the similarities between the bar magnet and the coil.
12. What happens to the magnetic field around the coil when you set the voltage of the battery to zero? Explain.
13. Play with the voltage slider and describe what happens to the current in the coil and the magnetic field around the coil.
14. What is your guess as to the relationship between the voltage/current in the coil and the magnetic field?

(continued on next page)

Part 4 - Field Strength vs. Position

1. Using the Bar Magnet simulation, click on “Show Field Meter.”
2. Count 5 compass needles from the left of the magnet, and record the value of B. Move one compass needle to the right and record the value of B. Repeat until you’ve completed the table below. NOTE: Be sure to take all of your values along the axis of the magnet. You’ll know you’re on the axis because the y component of the magnetic field is zero along the axis.

Meter position	Magnetic Field Strength
-5 (left)	
-4	
-3	
-2	
-1	
0	
1	
2	
3	
4	
5 (Right)	

3. Switch back to Electromagnet. What happens to the value of magnetic field strength inside the coil?
4. Graph the compass position on the x-axis and magnetic field magnitude on the y-axis. Print your graph. Make sure to label the axes and title the graph.
5. Is your graph symmetrical? What does this tell you about the relationship between distance from the field and the force you encounter?

Magnetism

Physics

Research Question

Can you bend bullets?

Introduction

From a scene in the movie Wanted a character seems to defy the laws of physics by bending a bullet around another person. Do you think this is possible outside of Hollywood cinema? Explain why or why not.

Procedure

Our class will watch Mythbusters test whether or not you can bend a bullet. Then read the following article: <http://www.popsoci.com/breakdown/article/2008-07/breakdown-can-you-bend-bullet>

Conclusion

What evidence supports or contradicts the myth according to Mythbusters and the article?

Based on the Mythbusters test and article what can you conclude?