Magnetic Fields of Magnets

Summary

The students will be able to compare the magnetic fields of various types of magnets (e.g., bar magnet, disk magnet, horseshoe magnet.) Also they will compare Earth's magnetic field to the magnetic field of a magnet.

Materials

Many different types of magnets such as bar, domino, horseshoe, disc, donut, cow, and ball magnets (at least 6 different types)
1 pound of iron filings
6 paper cups
6 "overhead transparency boxes" (premade)
- *Magnetic Discoveries* data chart (pdf)

Science journals/notebooks
Overhead projector or document projection camera
- *Flying Paperclip Magnet*

(See instructions to build under Activity Connected to Lesson)

Books:
- *Usborne Science Activities--Vol. 1*

, by Joan and Maurice Martin (Usborne Publishing Ltd, Usborn House, 8385 Saffron Hill, London, EC1N 8RT, England.) Copyright 1992, ISBN 0746006985
- *Usborne Science Activities--Science With Magnets*

, by Joan and Maurice Martin (Usborn Publishing Ltd, Usborne House, 8385 Saffron Hill, London, EC1N 8RT, England.) Copyright 1992; ISBN 0746012594
- *World Book, Young Scientist--Light & Electricity--Magnetic Power*

, by Hemesh Alles (World Book, Inc., 525 West Monroe Street, Chicago, IL 60661.) Copyright 1992; ISBN: 0-7166-2791-4
- *The World Book Student Discovery Encyclopedia - Vol.M*

, (World Book, Inc., 233 N. Michigan Ave., Chicago, IL 60601.) ISBN: 0-7166-7400-9

Media:
- *The Magic of Magnetism*

, (100% Educational Videos; 4921 Robert J. Matthews Pkwy, El Dorado Hills, California 95762. DVD Product #S1401.
- *Working with Electricity and Magnetism*

, by Kathy Furang (2004). ISBN: 1-4108-0438-0.
- *Magnets*

(Science Alive!), by Darlene Lauw (2002); ISBN: 0-7787-0609-5

Background for Teachers

Science language that students should use: attract, magnetic force, magnetic field, natural magnet, permanent magnet, properties, repel, temporary magnet
Magnets have special *properties, qualities or characteristics*. We know that magnets could attract, draw objects together. When we turn one magnet the other way, we are not able to keep them together. This unknown force caused the magnets to repel, *push apart*. This is a world of magnetism. This amazing magnetic force is the *push or pull of a magnet on other magnetic material*. There are unseen magnetic fields around single magnets, between two magnets attracting each other, and

between two magnets repelling each other. North and South polarized ends of magnets are where the strong pulling and repelling occurs. Bar, ring, disc, domino, and horseshoe magnets each have different, distinctly shaped magnetic fields. *The lines that form these magnetic field patterns* are called magnetic field lines. These lines seem to flow away from the north end of a magnetic field and return again to the south end.

We know that magnets have forces that will draw iron and steel objects toward them. We also know that magnets have poles usually referred to as *north and south*. Opposite poles attract each other and like poles repel. (North ends attract south ends, South ends attract north ends. North ends repel North ends and South ends repel South ends.) If they are close enough, depending upon the strength of the magnet, they will come together with great force. All magnets show properties of magnetic attraction and repulsion.

With the use of iron filings, we can see these magnetic fields. When iron filings are sprinkled on a bar magnet, you see that these magnetic field lines start at the magnet's north end and will end at the magnet's south end. The field lines that curve toward each other show attraction. You will even see these curved lines if you sprinkle iron filings on two attracting bar magnets. However, if iron filings are sprinkled between two bar magnets repelling each other, the magnetic field line will curve away from each other and even stand on edge. The magnetic field forces are pushing each other away, and this causes the curving and standing on edge. Natural magnets are *naturally magnetized by Earth's magnetic field and are made of an iron ore that is called magnetite.* A permanent magnet is an *object that keeps its magnetism after it has been magnetized*. Iron and nickel are the most common materials magnets are made from. You can make a permanent magnet from steel nail by taking a magnet and rubbing the mail the same direction several times. Now the nail will pick up pins, staples, paperclips or other small items made of iron.

Intended Learning Outcomes

1. Use science processes and thinking skills.
3. Understand the nature of science.
4. Communicate effectively using science language and reasoning.

Instructional Procedures

Invitation to Learn:

Demonstrate to the students the "flying paperclip" magnet pendulum For construction see instructions below in "Activity Connected to Lesson.) Give the pendulum magnet a push, and watch! Vary the location and poles of the magnets to develop other patterns. You can arrange the magnets so that all of them have the same pole up, or you can mix them up. Notice that a tiny change in the location of one of the fixed magnets or in the starting position of the pendulum magnet may cause the pendulum to develop a whole new pattern of swinging.

Ask questions like: Why is the paper clip suspended in midair? How many other things can you attach to a string and suspend with a magnet? Does using a circular magnet alter the experiment? How about a horseshoe magnet?

Have students put their hand between the magnet and the paperclip. Discuss whether they can see or feel the magnetic force field. Let them move the paperclip from the magnetic field. Watch how the magnetic force pulls the paperclip.

Instructional Procedures:

A. Inquiring Minds Want to KNOW About the Magnetic Field of a Bar Magnet

Instruct students to use scientific method steps to inquire about magnets. The students will begin to see that scientists are not the only ones who use scientific steps to produce credible explanations of natural phenomena that can be validated by further investigations.

Students write in their journals the first four steps to investigate questions about the magnetic fields of

different magnets.

I. Question: Are magnetic fields the same for all magnets? (Teacher can ask students to generate an investigative question about magnetic fields instead of just writing this one.)

II. Hypothesis: Students will write their own hypothesis using an "if, then" sentence. (i.e., If I sprinkle iron filings over the top of different magnets, then the magnetic fields will be different or the same.

III. Procedures: Give a list of instructions students will follow. Have them tape, glue, or staple them into their journals. You can also have them write the steps in their journal.

For example:

Write the name of the magnet you will be observing on the top line of the "Magnetic Discoveries" data chart.
Observe the station magnet and sketch a picture of that magnet in the first box.
Place the transparency premade box over the top of the magnet. Hold it level above the magnet.
One student from the group; sprinkle the iron filings on top of the transparency box.
Observe the pattern created by the iron filings.
Draw that pattern on the drawn magnet figure.
Be sure to draw accurately all the magnetic field lines and any iron filings that are standing on end. Don't draw all of the iron filings. Draw the magnetic fields as if the lines were connected.
Clean up by pouring the iron filings back into the cup.
Rotate to the next station. (Everyone should finish about the same time. Have the students prepare to rotate by cleaning up their iron filings and put them back into the paper cup. After clean up, the student groups rotate to the next station. The children will repeat procedure steps after each rotation until everyone has completed each station.)

IV. Data Collection: "Magnetic Discoveries" will be used for students to record information learned while exploring the magnetic fields of different magnets. (The data chart can be glued or taped into the student journal)

V. Conclusion: Students write a reflection about the magnetic forces of each magnet. Discuss with the students things that could be included in the conclusion. They should reflect on the concepts learned as they investigated the magnetic fields for each magnet. Encourage the usage of vocabulary words in the student reflection.

B. Inquiring Minds want to KNOW More about other Magnets

Teacher modeling of Stations The students will observe the teacher showing them how the stations will work.

Use an overhead transparency open box.
Place a bar magnet onto an overhead projector.
Place the overhead transparency box on top of the bar magnet. Hold it level above the magnet.
Sprinkle some iron filings on top of the magnet and into the transparency box.
Ask them what is happening to the filings.
Encourage them to try to explain why the filings are in the pattern they see.
After your demonstration and discussion, explain what has happened.
Provide journal pages "Magnetic Discoveries" for each student.
Instruct them to tape, glue, or staple the pages into their journal on pages side by side.
Instruct them to draw a picture of a bar magnet in the first box.
Have them draw the magnetic field pattern they see created around the bar magnet. You may need to help them by drawing it on the board. Emphasize the magnetic field lines that show attraction and the iron filings standing on end that show repulsion.
Have them write "bar magnet" on the first line and then describe the characteristics of the magnetic field in the space provided on the "Magnetic Discoveries" journal pages.

C. Inquiring Minds Want to KNOW About the Magnetic Fields of Different Magnets

The students will explore the magnetic fields of other magnets. Provide the materials in tote trays for

six different magnets.

Divide the students into six groups.

Have the six remaining magnets in plastic ziplocking bags. Place a different magnet in each of the six tote trays.

Have an overhead transparency box by the side of each tote tray.

Have a small paper cup with a small amount of iron filings in each tote tray.

Have the students name the magnet they will be observing, and write it in the next box in their journal.

Have the students draw a picture of that magnet in the box, then write the name of the magnet on the lines provided.

Have one student in each group sprinkle the iron filings on top of the transparency box.

Have the students observe the pattern created by the iron filings. Then have them draw that pattern on the magnet figure they drew. Make sure they draw accurately showing all the magnetic field lines and any iron filings that are standing on end. (Students don't have to draw all of the iron filing fragmented lines. They should draw the magnetic fields as if the lines were connected.)

Everyone should finish about the same time. Have them clean up their iron filings and put them back into the paper cup.

Have student groups rotate to the next station.

The children will repeat steps 9 through 14 after each rotation until everyone has been to each station.

While the students are working on each magnet, the teacher circulates amongst the students asking questions that will be helpful for the students to use when writing their conclusion at the end of the class period.

When groups have been to all the stations, have them clean their last station and go to their seats.

Discuss how the iron filings reacted to each kind of magnet. Give time for the students to discuss what they learned and share their drawings. Revisit questions that were answered during the student exploration time. This can be done a number of ways.

The teacher can draw the patterns on the board (or on an overhead) while the children compare what they drew with what is on the board (or overhead).

The teacher can choose six children to go to the board and draw what they have on their papers or show it on a document projection system. Each of them should tell what they think is happening. Allow the students to lead the discussions instead of the teacher.

Use the last box on the "Magnetic Discoveries" data chart for the students to predict the Earth's magnetic field by drawing the Earth, axis, labeling North Pole, South Pole, and then drawing the magnetic field. The similarities between a bar magnet's magnetic field and the Earth's magnetic field are very obvious. Have them include this information in their conclusion.

Conclusion:Students write their conclusion, addressing their hypothesis, data observations, and knowledge gained from the investigation.

Lesson and Activity Time Schedule:

10 minutes Starter Activity - The Flying Paperclip demonstration

20 minutes Teacher Model Activity - Model the Bar Magnetic Field using Iron Filings

10 minutes Experiment Preparation - Students use journals, scientific methods steps, and "Magnetic Discoveries" data chart in preparation for the Discovering Magnets Station

40 minutes Student Exploration - Students work with other magnets to discover the magnetic fields of domino,horseshoe, disc, donut, cow, and ball magnets, etc.

10 minutes debrief using the students' journal entries about the learned knowledge about magnetic fields. Compare their understanding about the magnetic fields of magnets with the

Earth's magnetic field.

Activity Connected to Lesson

Activities connected to the lesson are embedded in the lesson.

Instructions for the teacher to do before the activities are included here:

Constructing a "Flying Paperclip Magnet Pendulum"

Using string or fishing line, hang one magnet from a ring stand so that it is a swinging pendulum. You can hang the magnet in any orientation.

Arrange other magnets on the ring stand base in an equilateral triangle measuring a couple of inches on a side. Position the magnets so that they all have the same pole up.

Adjust the length of the pendulum so that the freeswinging magnet will come as close as possible to the magnets on the ring stand base without hitting them or the base itself. You can accomplish this either by changing the length of the string or by adjusting the position of the clamp.

The force of gravity and the simple pushes and pulls of the magnets act together to influence the swinging pendulum in very complex ways. It can be very difficult to predict where the pendulum is going to go next, even though you know which magnets are attracting it and which are repelling it.

Construction of an "Overhead Transparency Box" --Make one for each group to use.

The objective is to create a tray/box to hold the iron filings when the students sprinkle them over the top of the magnet. This protects the magnet from getting iron filings stuck to it which will make a terrible mess to clean up.

Use an 8.5 x 11 inch overhead transparency to create a 1 x 6.5 X 9 inch open box

To make the box, fold each edge of the transparency approximately one inch Then cut each folded corner diagonally towards the fold line created. Repeat for each corner.

After cutting, overlap the cut edges to form a corner, and tape on the outside edge to create a box.

Extensions

Additional activities with magnets:

- Students can investigate using magnets to discover how magnets will both attract and repel other magnets.
- Students can investigate the magnetic attraction and the relative strength of magnets by using more magnets connected together to increase the attraction strength.
- Give each group of students at least 2 bar magnets and 20 paperclips. Ask them to examine the magnets and note that on one end of the magnet there is the letter "N" and on the other the letter "S." (Some magnets have different colors instead of letters.) Explain that these letters refer to the poles of the magnet. One end is called the North Pole and the other the South Pole.
- A magnet is used to make a paperclip "walk" on a paper plate. Students investigate how many different materials through which the magnetic field will still pass.
- Students can discover through handson activities that magnets have the ability to push and pull iron objects without touching them.
- Students can magnetize different material (i.e., needle, scissors, or nail). They rub a nail in the same direction several times with either pole of a magnet. The nail takes on the characteristics of a magnet, and can be used to pick up a paperclip or other light object. If you drop the nail, or strike it sharply, it will lose its magnetism.

Family Connections:

- Have students teach their parents about magnetic fields.
- Students can take a library book home about magnets to read to their parents.

Assessment Plan

Students write a conclusion about the understanding and knowledge learned from the data collected on their observation. Some questions that might encourage the development of the conclusion might

include the following:

- What happens when metal filings are put on a bar magnet?
- What happens when metal filings are put on a horseshoe magnet?
- What happens when metal filings are put on a disc magnet?
- What happens when metal filings are put on a domino magnet?
- Describe what magnetic fields look like when iron filings show attraction.
- Describe what magnetic fields look like when iron filings show repulsion.
- Describe the similarities between different magnets with the Earth's magnetic field.

Authors

Janeen Graham