

## MYSTERIES OF MAGNETISM

### STANDARDS

Grade 4

IV.B.2.a. Distinguish and describe objects that are magnetic and nonmagnetic.

IV.B.2.b. Investigate and describe the properties of different magnets.

IV.B.2.c. Observe and describe the magnetic fields of various types of magnets.

IV.B.2.d. Distinguish the lines of force between like and unlike poles.

IV.B.2.e. Define electromagnetism.

IV.B.2.f. Analyze the factors that influence the strength of an electromagnet.

### BACKGROUND INFORMATION

#### Warnings

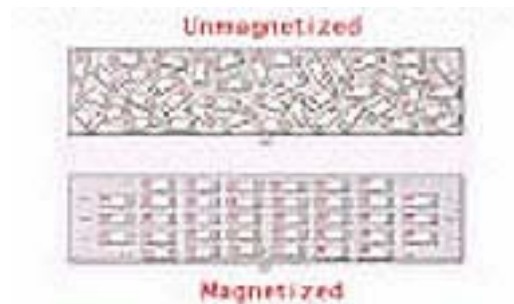
Fingers can get severely pinched between two attracting magnets. Some magnets are brittle, and can peel, crack or shatter if allowed to slam together. Eye protection should be worn when handling these magnets, because shattering magnets can launch pieces at great speeds. The strong magnetic fields of magnets can also damage magnetic media such as watches, floppy disks, credit cards, magnetic I.D. cards, cassette tapes, videotapes or other such devices. They can also damage televisions, VCRs, and computer monitors. Never place strong magnets near any of these appliances. Never allow neodymium magnets near a person with a hearing aid, pacemaker, or similar medical device. The strong magnetic fields of the magnet can affect the operation of such devices.

#### Magnets

Most people have experienced *magnetism*, or the attraction of a magnet for another object, with the magnets on their refrigerator at home. Magnets can also be found in nature. Some rocks contain a magnetic mineral called *magnetite*. These magnetic rocks are called *lodestones*. The Earth itself acts as a large magnet.

#### Magnetism

Magnetism results when the magnetic fields of the atoms that make up an object align with one another. A group of these atoms whose magnetic fields are in alignment are known as a *magnetic domain*. The entire domain acts like a magnet with a north and south pole. In a material that is not magnetized, the domains point in random directions and the magnetic fields cancel one another out.

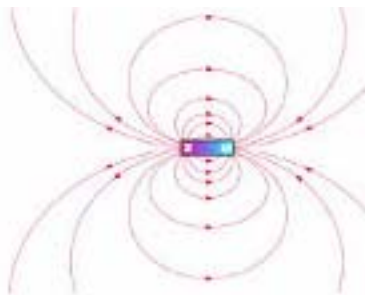


### Magnetic Poles

All magnets, no matter what their shape, have two regions called *magnetic poles*. The Earth has magnetic poles. The pole is the area of the magnet that has the greatest magnetism. One pole of a magnet will always point to the Earth's north pole. This region of the magnet is called the *north pole*. The other pole is called the *south pole*. When poles that are the same (*like poles*) interact they *repel*. When opposite poles interact they *attract*. If you break a magnet you will end up with separate magnets, each with one north and one south pole. \*As extra credit, or if there is extra time, the problem with the designation of the Earth's poles and other magnetic poles should be considered. What is the problem? If opposite poles attract, why do we designate the pole that is attracted to the Earth's north pole as the magnet's north pole?

### Magnetic Fields

In the region around the poles the *magnetic field* lines are closer together. Although the magnetic forces are strongest at the poles, magnetism is not limited to these regions because the invisible magnetic field is around the entire magnet. Although magnetic fields cannot be seen, their effects can. Magnetic fields allow magnets to interact without touching. The direction of magnetic field lines always come out of the north pole and flow in through the south pole. Each line makes a complete loop and they never cross. The three dimensional property of a magnetic field can be better seen using a magnetic field observation tube.



### Creating a Magnet

\*This section should be studied after electricity is discussed in detail.

A moving electric current can produce a magnetic field. Wire can carry electric current and when it is connected to a battery it creates a magnetic field. The stronger the current and the greater the number of coils, the stronger the magnetic field produced. The wire can be wrapped around a nail so that the number of loops can be counted and if it is an iron nail (or some other magnetic material) its magnetic properties will also intensify the strength of the magnet. In this case both the coil of wire and the iron nail act as *temporary magnets*. The magnetic domains of a temporary magnet line up while they are in contact with another magnetic field. The magnetic properties of the temporary magnets will be lost once the electric current is removed. The magnetic domains of a *permanent magnet* will always be in alignment and therefore it will retain its magnetism unless heated to a specific temperature (depending on the type of magnet), dropped, or placed in a strong magnetic field.

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### **DOES SIZE AFFECT STRENGTH?**

This is a level one lesson because the problem is given (see title) and instructing students to use paperclips to test relative strength provides the ways and means. The students are then asked to shed light on the question using their observations.

**PREDICTION** Ask each student to predict the order of strength of several magnets that range in size, shape, and type of material. Ask them to record their predictions and reasons in their scientific notebooks.

**DISCUSSION** Ask the students to share their predictions within their groups and discuss their reasoning.

**OBSERVATION** Ask the students to use paperclips to test the strength of the magnets. Ask the students to record all of their observations in a data table in their scientific notebooks. Encourage the groups to consider their predictions and make any necessary changes.

**RELATION** Ask the students to write, in their scientific notebooks, a statement relating size, shape, and strength of magnets.

**EXTENTION** Ask the groups to discuss the usefulness of this relationship. Ask them if they have any ideas about what determines strength. If not guessed, let them know that the magnets they have tested are made of different materials. Ask them to add the types of magnets to their data tables.

**EXPANSION** Ask the students what other questions they have that could be answered through further exploration of the subject of strength.

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### **WHAT KINDS OF MATERIALS ARE ATTRACTED TO MAGNETS?**

This is a level two lesson because the problem is given (see title), but the ways and means are left up to the students (although the materials are provided, a way to test them is not). Providing a response to the question is the student's responsibility.

**PREDICTION** Provide each group of students with several different types of materials and objects such as coins, bobby pins, painted, plain, and brass paperclips, toothpicks, steel wool, etc. Ask each student to predict which of the materials are magnetic and why. Remind them to record their predictions in their scientific notebooks.

**DISCUSSION** Ask the students to discuss, within their groups, their predictions and their reasoning.

**OBSERVATION** Ask each group of students to test their predictions using the materials they were given and encourage them to test any other materials they have access to. Ask them to record all observations in a data table in their scientific notebooks. Ask the groups to discuss any changes they may need to make to their predictions.

**RELATION** Ask the students to write a statement in their scientific notebook that compares/contrasts the objects that are magnetic to those that are not.

**EXTENTION** Ask the students to test other objects around them based on the observations they made and their revised predictions.

**EXPANSION** Ask each group to discuss other possible activities to relate magnetic and non-magnetic materials.

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### WHAT CAN A MAGNETIC FIELD PASS THROUGH?

This is a level two lesson because the problem is given (see title), but the ways and means are left up to the students (although the materials are provided, a way to test them is not). A response to the question is determined by the students' observations.

**ENGAGEMENT** Allow each group of students to manipulate a magnetic field observation tube. Ask why the iron filings make a pattern around the cow magnet. Ask them each to test to see if the patterns in each tube are similar.

**EXPLORATION** Provide each group of students with several magnets, different types and sizes. Also provide felt, plastic, thin pieces of wood, and encourage them to use any other materials they have access to. Ask them to use these objects to find out what determines if a magnetic field can pass through an object. Ask them to write all observations in a data table in their scientific notebooks.

**EXPLICATION** Ask the reporter in each group to explain their findings to their classmates. Ask the students if they notice any trends in the data they have collected. Provide them with the term magnetic field and ask them to draw a magnet with its magnetic fields labeled. Ask them to consider whether their drawings look like what they saw in the observation tubes.

**ELABORATION** Ask the students which poles were interacting in this experiment (like or opposite). Ask the students if they have ever been exposed to magnetic fields. If needed, prompt them to recall that the earth acts as a magnet. Also ask them to recall the warnings at the beginning of the unit.

**EVALUATION** Ask each student to draw, in their scientific notebooks, what iron filings placed around a horseshoe-shaped magnet would look like. Check each student's scientific notebook for a data table, an explanation of today's findings, and the drawing.

Ask each group to describe other objects they would like to test to see if a magnetic field could pass through.

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### **WHAT PRODUCES MAGNETIC FIELDS?**

\*This activity should be carried out after electricity is discussed in detail.

This is a level two lesson, although the problem is only partially given. The students will likely deduce that the question can be more specific (i.e. Can a battery/electricity produce a magnetic field?) once given the laboratory materials. The ways and means are not provided, nor are the answers to the question.

**ENGAGEMENT** Allow each group to manipulate a lodestone and test it for magnetism. Ask them if they can create a magnet and if so, what supplies they would need.

**EXPLORATION** Provide each student with a marked iron nail, and a battery. Give each group pre-cut copper wire in enough different lengths to allow each student in the group to have a different length (10-50 cm). Ask the recorder in each group (the student with the shortest wire) to construct a data table that includes length of wire, number of loops, and strength (number of paper clips). Ask each student to create a magnet with the given supplies and test its strength using paperclips. Remind the students to record their findings on the group data table.

**EXPLICATION** Ask the ‘data entry technician’ ☺ in each group to enter their group’s data onto a spreadsheet in Excel. Ask the students to describe any trends they noticed. Provide the students with the term electromagnet. Ask the students to draw an electromagnet in their scientific notebooks and list the components that would make it a strong magnet.

**ELABORATION** Ask the students to consider what they have learned about magnets and steer them toward the presence of poles. Ask them if they know of any way to determine the location of the poles. Provide them with compasses so they can determine the location of the North and South poles of the magnets they have created.

**EVALUATION** Ask each student to make the strongest magnet they can make with 30cm of wire. Explain that they will be graded on the strength of their magnet. The individual who picks up the most paper clips will get an A and every student who picks up within 5 will also get an A. Students who make magnets that pick up 10-6 within the highest will get a B, and so on. \*With the same length of wire, each student should create magnets of a relatively similar strength.

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## **POTENTIAL MAGNET MISCONCEPTIONS**

**by: Lloyd H. Barrow**

This article described a study by Lloyd Barrow conducted to determine which magnet concepts are found in K-8 textbooks, the format in which they are presented (written, laboratory activity, and/or illustration), and the misconceptions that may arise. This study is important because identifying misconceptions will allow authors to change/augment the contents to avoid presentations that are misleading or contain incorrect information.

The study of magnetic poles is included in the South Carolina Science Education Standards. Barrow's study found that some textbooks identify the location of the poles as the ends of the magnet. This is misleading because not all magnets are shaped the same way. For example, at which 'ends' of a cube or a spherical magnet are the poles located? He also found that some textbooks do not mention magnetic poles at all.

Another problem discussed in the article is that in all of the textbook series studied, only the electromagnet concept included a laboratory activity. Children will more easily understand magnetism if they are able to manipulate and study the properties of the magnets themselves.

Lloyd Barrow recommends that science teachers take the time to recognize the magnet concepts about which their students are already aware. He then encourages teachers to study the textbooks to determine which concepts are being taught and how they are presented. The teacher can then start at an appropriate level based on their students' previous experiences and can augment textbook lessons to include hands-on activities when appropriate.

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## **ELECTROMAGNETIC CONCEPTS IN MATHEMATICAL REPRESENTATION OF PHYSICS**

**by: Virginie Albe, Patrice Venturini, and Jean Lascours**

This article deals with misconceptions and inaccuracies held by undergraduate physics students. This article is important to this project because it demonstrates that misconceptions that elementary students have will be carried throughout their education if they are not eradicated. The researchers referred to the students' knowledge as "fragmented" (202). The goal of inquiry-based teaching is to ensure that the flow of knowledge is continuous and students are encouraged to face their misconceptions.

From their study, the researchers concluded that the undergraduate physics students have difficulty using models of magnetic fields. For this exact reason elementary and middle school students need to be exposed to the actual elements when possible. Although magnetic fields are invisible, their effects can be seen using a magnetic field observation tube or simply by using iron filings. By encouraging the students to manipulate the objects and create the models, they will more readily see the limitations inherent in a pictorial model of a magnetic field.

By allowing students to discover and study the effects of magnetism on their own in laboratory exercises, we will ensure that the foundation of their knowledge is free of

misconceptions and inaccuracies. This is critical because these same students will be the decision-makers of the future and we must ensure they are capable of understanding certain phenomena so they will be prepared to make sound decisions based on scientific data.

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## REFERENCES

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