I'M ATTRACTED

TO MAGNETS!

¡LA ATRACCION

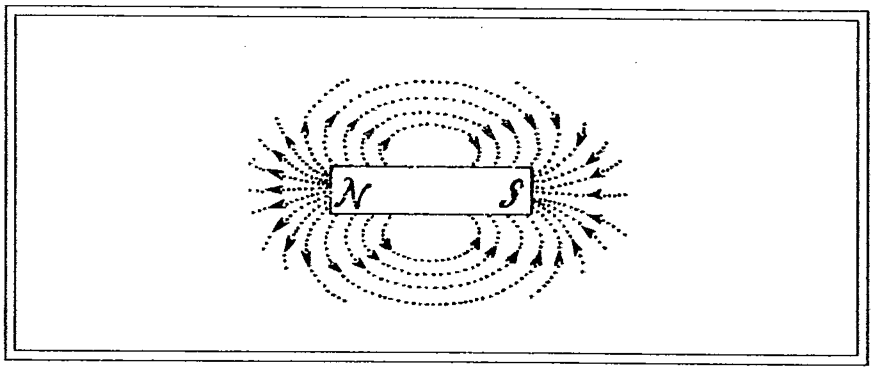
DE LOS IMANES!

BACKGROUND INFORMATION

Magnetism is the term we use to describe the attraction between certain kinds of iron ores and other metals. Magnets are used around us every day. Look at the cabinets in your home; many are held shut by magnets. You probably have a magnet or two on your refrigerator. And, although you may not be aware of it, magnets play an important role in every appliance and machine that uses an electric motor. When did humans learn about magnets? Where do they come from?

> *According to legend, the discovery of magnetism occurred about 3,000 years ago in an ancient Middle Eastern country called Magnesia. One day, the story goes, a shepherd found it difficult to lift his iron-tipped staff from certain places on the ground. After investigating, he realized that he had difficulty only when the iron tip was on a certain type of dark stone. These stones were...**lodestones,** which contain a kind of iron ore called **magnetite.***[1]

Just as electricity results from the *passing along* of negative charges (electrons) at the molecular level, magnetism results from how individual molecules want to *line up* in certain iron ores, such as magnetite. The lining up of these molecules creates an invisible force field (called the **magnetic field**) around the magnet. When an object is attracted to the magnet, it tries to *line up* with the magnetic field. This creates the **pull** you often feel when a magnet is attracted to an object. The magnetic field of a bar magnet looks something like this:



Materials that magnets are attracted to are called **magnetic**. Only a few materials are magnetic—iron, steel (because it is a mixture of iron and other metals), nickel, and cobalt. When these materials come close to a magnetic field, their individual molecules also try to line up with the lines of force of the magnetic field, resulting in the pull you feel when you bring a magnet near a piece of steel, such as the front of your refrigerator.

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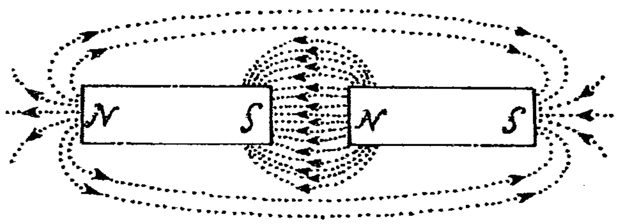
[1] Reuben, G. 1960. *Electricity experiments for children.* New York: Dover Publications, p.6.

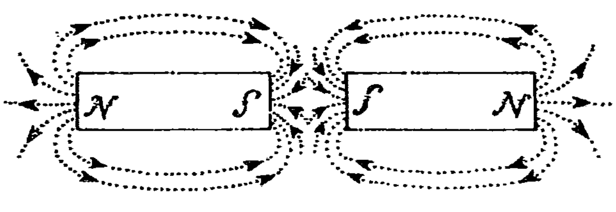
In general, any magnetic object found in your classroom will probably contain iron. Nickel and cobalt are the only other magnetic elements, but these are relatively rare. Steel also is magnetic because it is an **alloy** (that is, a mixture) of iron and other metals.

When an object is attracted to a magnet, you can feel the pull of the magnetic force when you try to separate the two. It seems as if an invisible force is trying to hold the two objects together. Magnetic force is a natural force just like gravity. We cannot see gravity but, if we let go of a glass of water, we can see the effects of gravity! Similarly, although we cannot see magnetic force or the magnetic field around a magnet, we can feel the effects (the pull of the magnet for the magnetic object) and we can actually see the effects if we use iron filings (try the activity *Exploring Magnetic Fields* in this section). The lines that appear result from the iron filings lining up with the lines of force in the magnetic field. These lines of force not only travel from side to side, but also extend upward and downward from the magnet's ends.

All magnets have two **poles.** One is called the **north-seeking pole (or north pole)** because it is attracted to the earth's north magnetic pole. The other is called the **south-seeking pole (or south pole)** because it is attracted to the earth's south magnetic pole. When magnets are brought close together, a north pole always attracts a south pole, while pairs of like poles (such as a north pole on one magnet and a north pole on another magnet) **repel** each other.

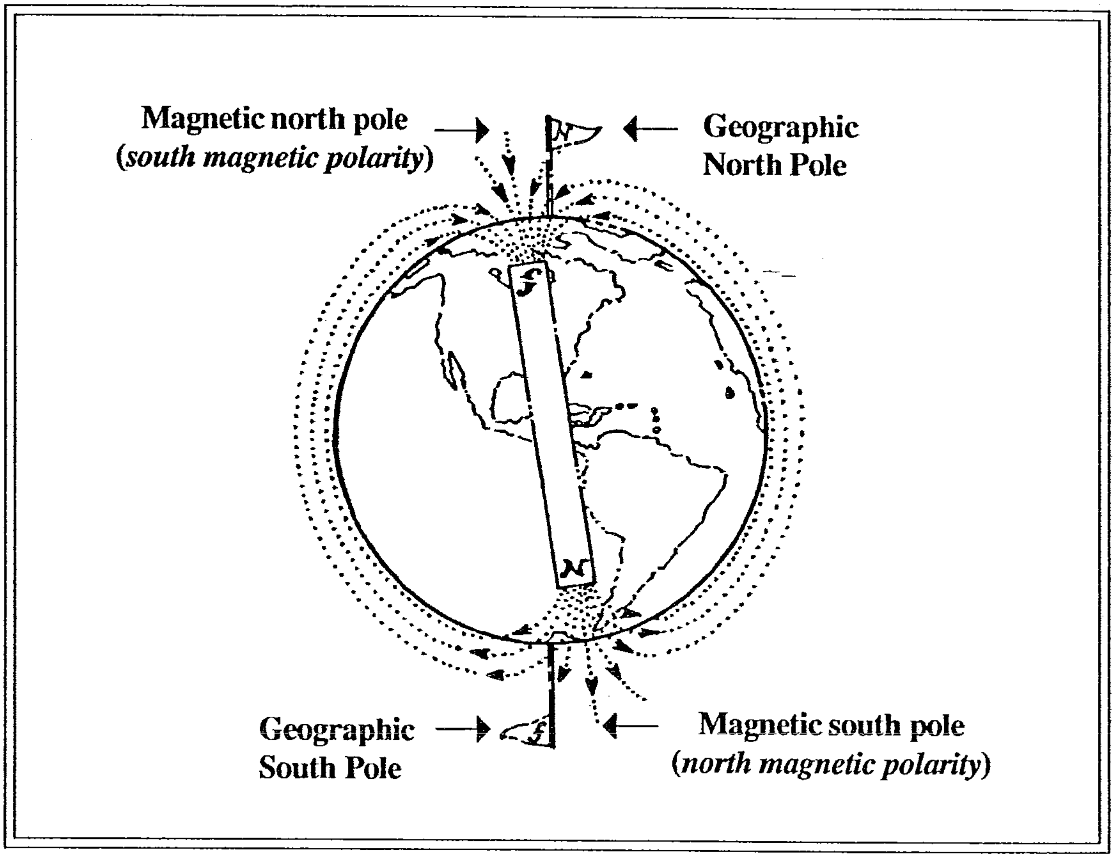


Unlike poles



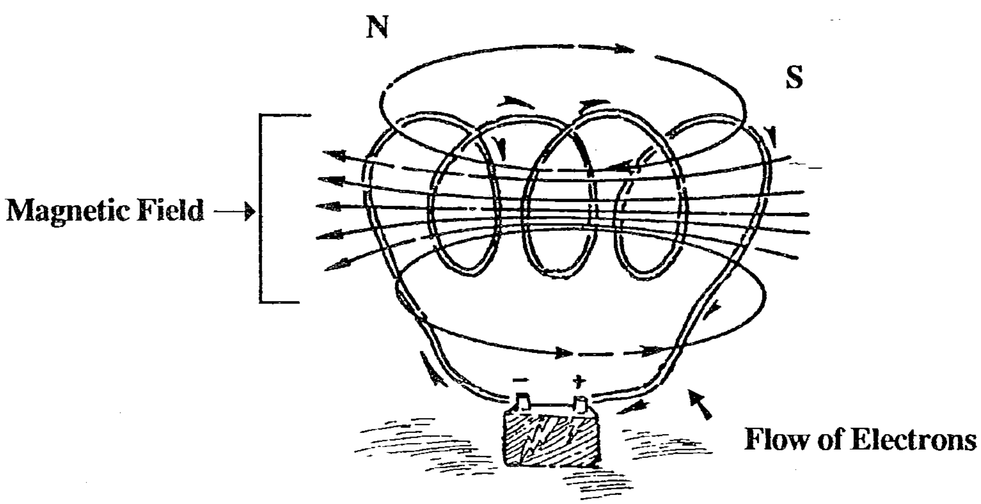
Like poles

The earth itself acts like a very large magnet. Its magnetic field acts between its magnetic north and south poles. The magnetic poles of the earth are caused by huge deposits of magnetite deep in the earth. The magnetic poles of the earth are not in exactly the same place as the *geographic* poles and they change position slightly from time to time. The geographic North Pole is the point where the imaginary axis on which the earth turns would stick out of the earth. The magnetic north pole is also in the Arctic but is many miles away from the geographic North Pole. The same is true for the magnetic south pole and the geographic South Pole.



Magnets occur naturally, but we can also **induce** certain metals to become **temporary magnets.** The most common way to do this is to rub a piece of iron with a permanent magnet. By stroking in the same direction several times, the individual molecules in the iron piece try to *line up* facing in the same direction and the iron piece can temporarily act like a magnet. Eventually, the molecules will move around a little and the iron piece will no longer act like a magnet.

The other way we can make a temporary magnet is by using electricity. When an electric current flows through a wire, a tiny magnetic field is produced around it. We call this an **electromagnet** since the magnetism is caused by the electricity flow. The magnetic field created by a single strand of wire is very weak. To increase it, the wire is wound into a coil. This concentrates the magnetic field, which has its poles at either end of the coil. The more turns of wire, the stronger the field. Also, the more current flowing through the wire, the stronger the field. Finally, placing an iron or steel rod in the middle helps to concentrate the magnetic field further. Electromagnets can be very powerful, such as those used to lift large piles of scrap iron in junkyards.



This relationship between electricity and magnetism is used in building electric motors. By placing a permanent magnet next to a temporary electromagnet (a coil of copper wire with an electric current running through it), we can cause the two magnets to either be attracted to each other or to push away (repel) from each other. By timing this push and pull just right, we can cause the coil of wire to spin around and around...eureka! An electric motor! Some motors are made to work with **direct current** where the electrons flow in one direction, as in a circuit connected to a battery. These are called **DC motors.** Others are built to operate on **alternating current** where the electrons flow first one direction and then reverse and flow the other direction, as does the current in your house wiring. These are called **AC motors.**

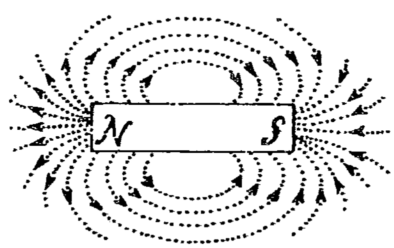
We can see, then, that magnets play a much more important role in our daily lives than simply keeping notes tacked to our refrigerators! Now how many places can you think of that use magnets?

INFORMACION BASICA

Magnetismo es el término que usamos para describir la atracción entre algunos minerales de hierro y otros metales. Los magnetos son usados todos los días. Cada vez que abre y cierra un gabinete o alacena en su casa, puede ver cómo los magnetos o imánes trabajan en muchos gabinetes para que las puertas se queden cerradas. Aunque no se dé cuenta, los magnetos están en cada artefacto y máquina que funciona con motor eléctrico. ¿Cuándo fue que el ser humano descubrió los magnetos? ¿Cuál es el origen del magneto o imán?

> *De acuerdo con la leyenda, el descubrimiento del magnetismo ocurrió hace 3000 años aproximadamente, en un país antiguo del Medio Oriente llamado Magnesia. La historia cuenta, que un día un pastor no podía levantar del suelo su varilla o bastón de punta de hierro, cuando la ponía en ciertos lugares del suelo. Después de investigar, se dió cuenta que solo tenía dificultad para levantar la varilla cuando la ponía sobre unas piedras de color oscuro. Esas piedras eran piedras imán, que contienen un mineral de hierro llamado magnetita.*[1]

De la misma manera que la electricidad se produce por el paso de los electrones a nivel molecular, así, el magnetismo se produce cuando las moléculas individuales se alinean sobre ciertos metales de hierro, como la magnetita. La alineación de esas moléculas crea un campo de fuerza invisible (llamado **campo magnético**) alrededor del magneto. Cuando un objeto es atraído por el magneto, trata de alinearse con el campo magnético. Esto crea la fuerza que a menudo se siente cuando el magneto es atraído hacia el objeto. El campo magnético de una barra magnética se asemeja a esto:



Los materiales que atraen el magneto se llaman magnéticos. Solo algunos materiales tienen propiedades magnéticas: el hierro, el acero (porque es una mezcla de hierro y otro metal), el níquel y el cobalto. Cuando esos materiales se acercan a un campo magnético, sus moléculas individuales tratan de alinearse con las líneas de fuerza de los campos magnéticos, produciendo la atracción que se siente cuando se coloca un magneto cerca de un pedazo de acero, como la puerta del refrigerador.

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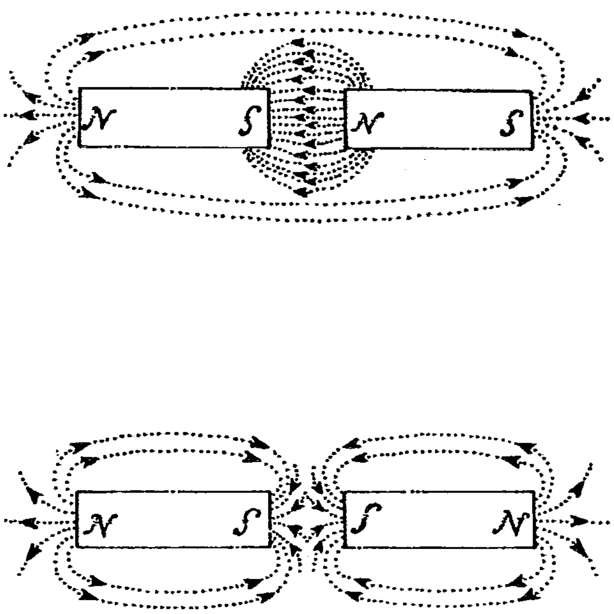
[1]Reuben, G. 1960. *Electricity experiments for children.* New York: Dover Publications, p.6.

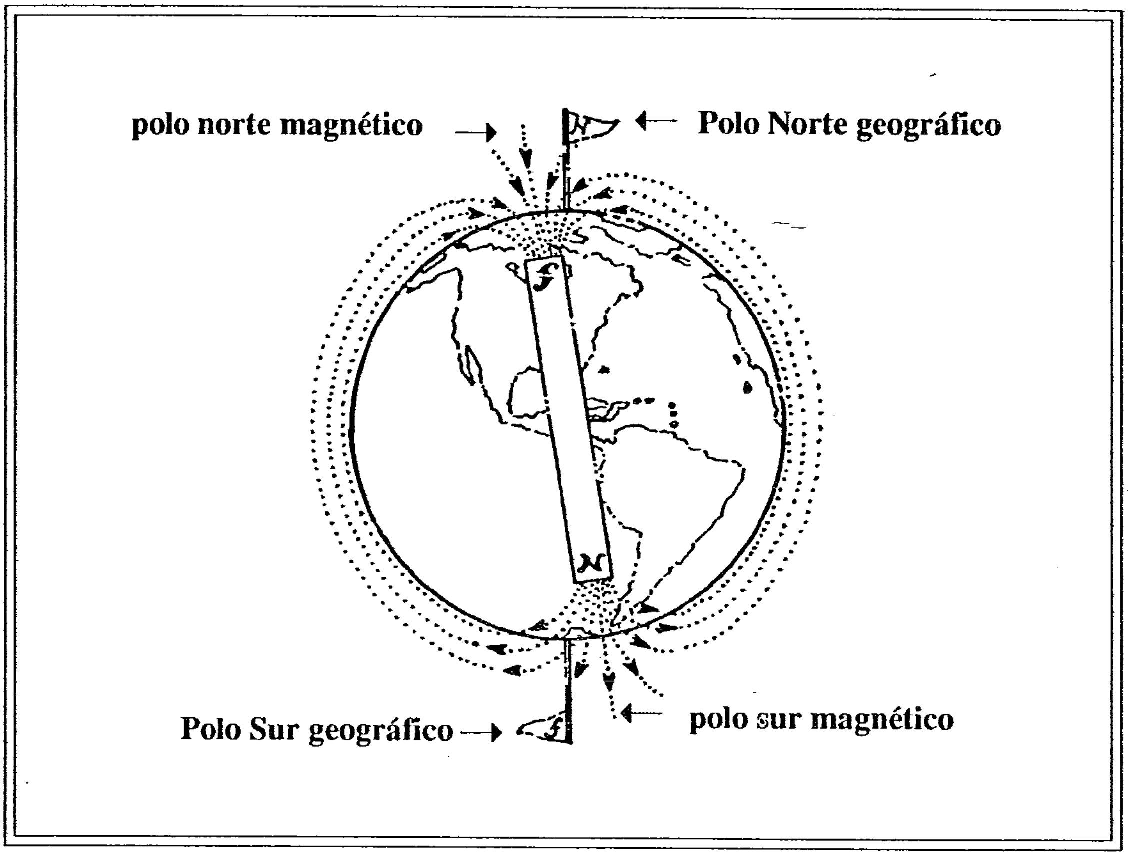
Por lo general, los objetos magnéticos en el salón de clase contienen hierro. El níquel y el cobalto son los únicos otros elementos magnéticos, pero son relativamente raros. El acero es también magnético porque es una **aleación**, es decir una mezcla de hierro y otros metales.

Cuando un objeto es atraído hacia el magneto, se puede ver y sentir la atracción de la fuerza magnética cuando se trata de separarlos. Es como una fuerza invisible que los mantiene juntos. La fuerza magnética es una fuerza natural similar a la fuerza de la gravedad. No podemos ver la fuerza de la gravedad, pero si dejamos caer un vaso de agua podemos ver sus efectos! De la misma manera, aunque no podemos ver la fuerza ni el campo magnético, podemos sentir sus efectos, la fuerza de atracción del magneto sobre el objeto magnético, y podemos ver realmente los efectos cuando utilizamos partículas de hierro (trate la actividad *Explorando campos* **magnéticos** en esta sección). Las líneas que se observan son el resultado de las partículas de hierro alineándose con las líneas de fuerza en el campo magnético. Esas líneas de fuerza no solo viajan paralelamente, sino que también se extienden hacia arriba y hacia abajo desde los extremos del magneto.

Todos los magnetos tienen dos **polos**. Uno es llamado el polo de atracción norte, o **polo norte**, porque es atraído hacia el polo norte magnético de la Tierra. El otro es el polo de atracción sur, o **polo sur**, porque es atraído por el polo sur magnético de la Tierra. Cuando los magnetos se juntan, el polo norte siempre atrae al polo sur, mientras que polos iguales se **repelen** (como el polo norte de un magneto y el polo norte de otro magneto).

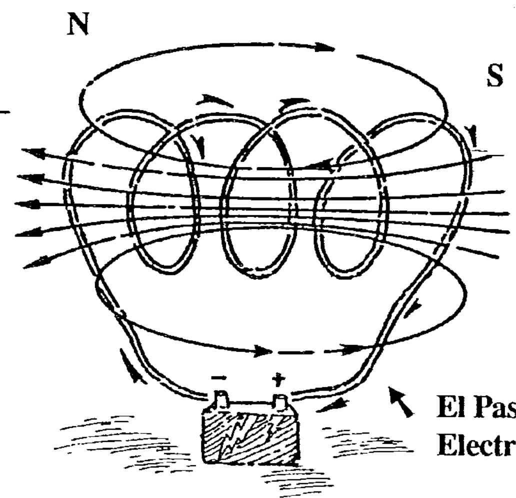


La Tierra misma tiene un magneto gigantesco. Su campo magnético actúa entre sus polos norte y sur. Los polos magnéticos de la Tierra son el resultado de grandes depósitos de magnetita en la profundidad de la Tierra. Los polos magnéticos formados por los metales de la Tierra y los polos *geográficos* estan situados en diferente posiciónes y de vez en cuando, los polos magnéticos de la Tierra cambian ligeramente de posición. El Polo Norte geográfico, es el punto donde sobresale el eje imaginario sobre el cual gira la Tierra. El polo norte magnético se encuentra también en la región Artica, pero está a muchas millas del Polo Norte geográfico. Lo mismo pasa con el polo sur magnético y el Polo Sur geográfico.



El magnetismo ocurre de manera natural, pero también podemos hacer que ciertos metales adquieran temporalmente propiedades magnéticas. La manera más frecuente de hacer esto es frotando un pedazo de hierro contra un magneto permanente. Frotando varias veces en la misma dirección, las moléculas individuales del pedazo de hierro se alinean en la misma dirección y el pedazo de hierro, adquiere temporalmente las propiedades del magneto. Eventualmente, las moléculas se desplazan y el pedazo de hierro pierde su poder magnético.

Hay otra forma de hacer un magneto temporal utilizando la electricidad. Cuando la corriente eléctrica fluye a través de un alambre se produce un pequeño campo magnético alrededor del alambre. Esto se llama **electromagneto**, debido a que el magnetismo es producido por la corriente eléctrica. El campo magnético creado por un solo alambre es muy débil, para aumentarlo, el alambre se enrolla en forma de espiral. Mientras más vueltas tenga la espiral, más fuerza tiene el campo. Por fin, una barra de hierro o acero en el medio del alambre ayuda mucho para concentrar el campo magnético. Los electromagnetos pueden ser muy fuertes, como los que se utilizan para levantar grandes cantidades de chatarra de los lugares donde se deposita hierro viejo.



Este magnetismo creado por la corriente eléctrica es usda en la construcción de los motores eléctricos. Si ubicamos un magneto permanente junto a un **electromagneto** temporal (una espiral de alambre de cobre con corriente eléctrica) podemos hacer que los dos magnetos se atraigan o se rechazen. Si coordinamos la atracción y repulsión podemos hacer que la espiral gire y gire...y EUREKA! tenemos nuestro motor eléctrico! Algunos motores son construídos para trabajar con **corriente directa** (CD) y los electrones fluyen en una sola dirección, como ocurre en un circuito conectado a una batería. Estos motores son llamados **motores DC.** Otra clase de motores se mueven con **corriente alterna** y los electrones fluyen primero en una dirección y luego en la dirección opuesta, como sucede en los circuitos electricos en el hogar. Estos motores son llamados **motores AC.**

Ahora ya sabemos que los magnetos o imánes nos ayudan mucho en nuestra vida diaria y pueden hacer más por nostros que simplemente mantener notas pegadas al refrigerado! Piensa por un momento ¿cuántos lugares hay en donde se usen los imánes o magnetos diariamente?

WHAT'S A MAGNET?

SUGGESTIONS FOR TEACHERS

WHAT'S THE POINT:
To demonstrate what a magnet does and what kinds of objects a magnet attracts.

ESTIMATED TIME:

Setting up:	Time to gather materials
Doing activity:	About 15–20 minutes
Cleaning up:	About 10 minutes

APPROPRIATE AGE GROUPS:

X K–3 X 4–6 ___ 7–8

DO ACTIVITY IN GROUPS OF: Whole group activity (demonstration)

MATERIALS NEEDED:
Bar or horseshoe magnet
Samples of as many different objects as you can find such as:

- wood
- glass
- cup
- paper clips
- needles
- mitten
- tin can
- thread
- aluminum pot
- paper
- nail
- crayon
- jewelry
- penny
- rubber band

SAFETY CONSIDERATIONS:
Since children will not be handling the objects in this activity, the only safety consideration here is to be sure to clean up all the small or sharp objects when you are finished.

ENRICHMENT FOR BILINGUAL STUDENTS:

After the demonstration, ask children to explore ways that magnets are used in other countries. Students should make a list of how magnets are used in the United States and in other countries. Are there differences?

ADAPTATIONS FOR PARTICIPANTS WITH DISABILITIES:

- Since this activity is a demonstration, students with vision or hearing impairments need to hear or see clearly what is going on. You may want to give children with visual impairments an opportunity to feel how magnetic and nonmagnetic objects interact with the magnet.
- Be sure to speak clearly and be visually explicit, that is, avoid letting your hands hide what you are doing.

BEFORE YOU BEGIN:

If it is available, watch the video *Magnetic Moments* from the National Science Teachers Association. This video gives an excellent demonstration of how this activity can be done successfully.

QUESTIONS TO ASK AS YOU DO THE ACTIVITY:

- What is a magnet? Describe it.
- What do magnets do?
- How can you tell if something is a magnet?
- What do you think magnets are made of?
- How do different things react to magnets? Give examples.

CLEAN UP:

Store magnets separately from the test objects. This is important since magnets can magnetize some objects if left in contact with them.

WHERE CAN I GO FROM HERE?

Check the following books for further activities on magnets (see the Book List): *Science on a Shoestring*; *The Whole Cosmos Catalog of Science Activities*; *The Thomas Edison Book of Easy and Incredible Experiments*; *Mr. Wizard's 400 Experiments in Science*; *The Smithsonian Institution's Science Activity Book*; *101 Science Activities*; and *TOPS Learning Systems: Magnetism*.

WHY IT HAPPENS:

First, be sure to read the background information in the introduction to this section. A magnet is an object that has the ability to attract magnetic materials such as iron, steel (which contains iron), nickel, and cobalt. The pull of the magnet is called **magnetism**, which is an invisible force that can be noticed only by the effect it has on other substances (somewhat like the wind). When you touch the magnet to items it will attract (that is, to things that are **magnetic**) you will feel the pull of the attraction—sometimes faint and sometimes strong. Try not to explain all of this to the students until they have tried the activity themselves and discovered some of this information on their own.

Any magnetic object found in your classroom probably contains iron. Nickel and cobalt are the only other magnetic substances, but they are relatively rare. You also may find magnetic things made from steel, which is an alloy (that is, a mixture) of iron and other metals. Students may ask some of the following questions:

Why is a tin can magnetic?

By itself, tin is not magnetic. A tin can is made by coating (or *plating*) an iron can with a layer of tin so that it won't rust. Therefore, a magnet is attracted not to the tin, but to the iron underneath the tin.

What is a ceramic magnet made from?

A ceramic magnet is made from a combination of clay (which is not a magnet) and from iron oxide that has been magnetized by contact with a permanent magnet.

If nickel is magnetic, why isn't my magnet attracted to the nickel coin I took from my pocket?

The substance nickel is magnetic, but U.S. nickel coins don't really contain nickel anymore. They are made from a mixture of other nonmagnetic metals. If you have a Canadian nickel, try it!

REFERENCES:

Marson, R. 1983. *TOPS learning systems: Magnetism.* Canby, OR: TOPS Learning Systems.

National Science Teachers Association (NSTA). 1990. *Magnetic moments* (videotape). Washington, DC: NSTA.

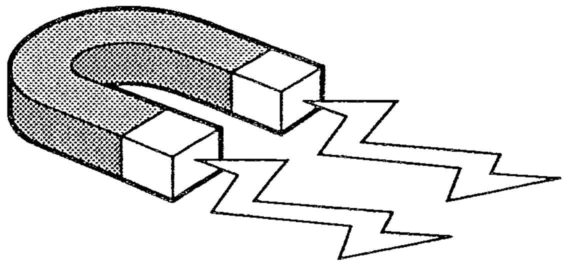
NOTES

WHAT'S A MAGNET?

TEACHER DEMONSTRATION

1. The purpose of this demonstration is to help children see that magnets are attracted to and can pick up certain kinds of objects.

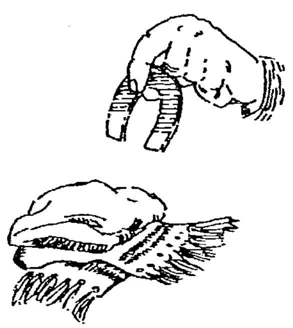
2. After showing the children the magnet, let them see that you have a pile of items to test to see if the magnet will pick each one up.

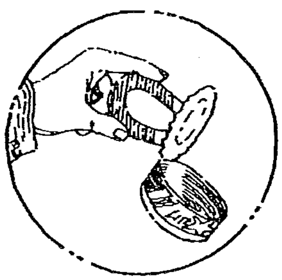


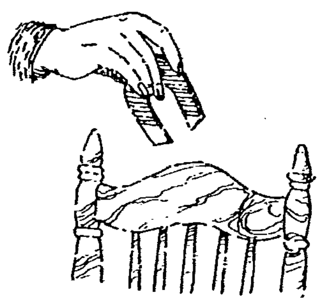
3. Hold each object up, one at a time, and ask the children to predict whether the magnet will be attracted to the object. Ask why they think that. Then bring the magnet close to the object so that they can see whether their prediction was correct.

4. You can separate the objects into two piles: those that are attracted and those that are not. Ask the students to comment on what the objects in each group have in common.

This activity is a good lead-in for the next activity, *Magnetic Pickups*.







MAGNETIC PICKUPS

SUGGESTIONS FOR TEACHERS

WHAT'S THE POINT?

To explore what types of things are and are not magnetic, that is, which things magnets are and are not attracted to. Students should make predictions, test those predictions, and discuss the results of their experiments.

ESTIMATED TIME:

Setting up:	Time to gather materials
Doing activity:	15–20 minutes
Cleaning up:	10 minutes

APPROPRIATE AGE GROUPS:

X K–3 ___ 4–6 ___ 7–8

DO ACTIVITY IN GROUPS OF: 2

MATERIALS NEEDED (per group of 2 students):

Bar or horseshoe magnet

Samples of as many different objects as you can find (you may want to make a bag or box of these for each pair of students):

- wooden toothpick
- penny
- jewelry
- crayon
- nail
- mitten
- paper
- aluminum pot or foil
- tin can
- glass
- cup
- paper clips
- needles
- thread
- rubber band

SAFETY CONSIDERATIONS:

Be sure that the materials the younger children experiment with do not have any sharp edges. Be sure that younger children know to not put objects into their mouths.

ENRICHMENT FOR BILINGUAL STUDENTS:

Students can conduct this experiment at home using the *Magnetic Pickups Data Sheet* to assist in recording their results. Students can share their results with the class and explain their results.

ADAPTIONS FOR PARTICIPANTS WITH DISABILITIES:

- Students with hearing or visual impairments should have no trouble doing this activity with appropriate modifications in communicating the instructions.
- Students with mobility impairments may need to work with a partner.

BEFORE YOU BEGIN:

- Gather the materials needed for each pair of students and place the materials in a box or plastic bag.
- Prepare the data sheet. Use the sample sheet on the following page as a guide. You also may want to reproduce this sheet on a large sheet of paper or on the chalkboard. For younger students, use the activity sheet as a quide for your verbal instructions.
- Fill in the item column, listing all the objects to be tested for magnetic attraction. When the class has completed this activity, don't throw away the data sheet—you will need the results for the next activity, *Mystery Magnets.*

QUESTIONS TO ASK AS YOU DO THE ACTIVITY:

- What is a magnet? How do you know if something is a magnet?
- How did you decide whether something was magnetic or not?
- Can you see magnetism?
- Can you feel magnetism? What does it feel like?
- What other things do you notice about the magnets and things that are magnetic?

CLEAN UP:

Ask each pair of children to replace their materials in their box or bag. Package and store the magnets separately.

WHERE CAN I GO FROM HERE?

Check the following books for further activities on magnets (see the Book List): *Science on a Shoestring*; *The Whole Cosmos Catalog of Science Activities*; *The Thomas Edison Book of Easy and Incredible Experiments*; *Mr. Wizard's 400 Experiments in Science*; *The Smithsonian Institution's Science Activity Book*; *101 Science Activities*; and *TOPS Learning Systems: Magnetism.*

WHY IT HAPPENS:

First, be sure to read the background information in the introduction to this section as well as the "Why It Happens" section of the previous activity, *What's a Magnet?*

When an object is attracted to a magnet, you can feel the pull of the magnet toward the object. When you try to separate the two, it seems as though some invisible force is trying to hold the two objects together. It is indeed a force, just as gravity is a force. You will read more about magnetic force in *Find the North and South Poles*.

After testing the different items in this experiment, your students will find, after close observation and sorting, that only materials containing certain metals—iron, steel (which contains iron), cobalt or nickel—are attracted by the magnet. None of the other items will be attracted by the magnet. When an object is magnetic, one or more of the four metals listed above is always present in the object.

NOTES

REFERENCES:

Abruscato, J., and J. Hassard. 1977. *The whole cosmos catalog of science activities*. Glenview, IL: Scott, Foresman.

Marson, R. 1983. *TOPS learning systems: Magnetism.* Canby, OR: TOPS Learning Systems.

National Science Teachers Association (NSTA). 1990. *Magnetic moments: Science teaching that works* (videotape). Washington, DC: NSTA.

Thomas Alva Edison Foundation. 1988. *The Thomas Edison book of easy and incredible experiments*. New York: Wiley.

MAGNETIC PICKUPS

ACTIVITY SHEET

A. Making your predictions

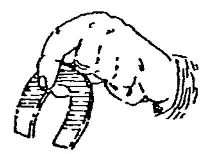
One of the things that scientists do is to make predictions about what they think will happen. Then they do experiments to test their predictions to find out whether they were right or wrong. Next, they talk about what they learned from their experiment. We can be scientists and experiment with magnets!

1. Work with a partner. To do this activity, you will need:
   - ✧ a magnet
   - ✧ some items to test with the magnet
   - ✧ a data sheet
   - ✧ a pen or pencil

2. Look at each of the things in the pile on your table. Which ones do you think will be attracted to the magnet? Place all those items into one pile. Place all of the items you think will not be attracted to the magnet into another pile. How did you decide about each item?

3. Work with your teacher to help fill in your data sheet. First, write down the name or draw a picture of each item you are going to test with your magnet. Next, write down whether you think the item will or will not be attracted to the magnet. Why do you think it will or will not?

B. Testing your predictions



1. Take turns with your partner. Bring your magnet close to one of the items. What happens? Is the item attracted to the magnet? How can you tell?

2. Write down what happened on the result part of your data sheet.

3. Now test each of the items you made predictions about, one at a time, by bringing your magnet close to the item. Write down what happens each time on your data sheet. Remember to take turns with your partner so you both get to use the magnet and write on the data sheet.

4. Do you see something special about all the items that are attracted to the magnet? How are they the same? How are they different? Write your answer below.

We call items that are attracted to the magnet **magnetic**. These items always are made of either iron, steel, nickel, or cobalt. All of these are metals. How do you know whether something is made of metal? Are all metals magnetic? Items that are not attracted to the magnet are called **nonmagnetic**.

C. Talking about your results

1. Talk with your partner about the predictions you made at the start of this activity. Which predictions were correct? Were some of your predictions wrong? Which ones? **It is all right if some of your predictions were wrong. Scientists often make predictions that turn out to be wrong. That is a part of learning!**

2. How would you decide now whether something is magnetic or not?

3. When you are done, work with your teacher and the rest of your class to do a data sheet for the whole class.

MAGNETIC PICKUPS

DATA SHEET

ITEM WHAT ARE WE TESTING?	**PREDICTION** WHAT WILL HAPPEN?	**RESULT** WHAT REALLY DID HAPPEN?

ATRACCION MAGNETICA
HOJA DE ACTIVIDADES

A. Cómo hacer predicciones

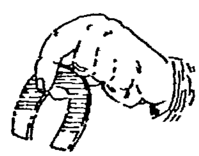
Una de las tareas de los científicos es predecir aquellas cosas que pueden ocurrir. Luego, hacen experimentos para probar sus predicciones y para saber si están o no están en lo correcto. Después, comentan lo que han aprendido en el experimento. ¡Podemos ser como los cienteificos y experimentar con imanes o magnetos!

1. Trabaje con un compañero. Para llevar a cabo esta actividad, necesita:
   - ✧ un imán
   - ✧ algunos objetos para probar el imán
   - ✧ Una hoja de datos
   - ✧ un lápiz o una pluma

2. Examine las cosas que tiene sobre la mesa. ¿Cuáles cree usted que atraen al imán? Separe los objetos que usted cree que atraen al imán. ¿Cómo hizo para decidir?

3. Ayude al maestro a llenar su hoja de datos. Primero, escriba o dibuje el nombre de cada uno de los objetos que va a utilizar para probar el imán. Después, diga por escrito si cree que el imán atraerá o no atraerá al objeto. ¿Por qué piensa que lo atraerá o que no lo atraerá?

B. Cómo probar las predicciones



1. Tome turnos con su compañero. Coloque el imán cerca de uno de los objetos. ¿Qué ocurre? ¿Atrae el imán al objeto? ¿Cómo sabe que lo atrae?

2. Escriba lo que ocurrió en la hoja de datos, en la parte de los resultados.

3. Ahora, pruebe uno por uno los objetos sobre los cuales hizo sus predicciones, colocando el imán cerca de uno. Escriba en su hoja de datos lo que ocurre con cada objeto. Recuerde tomar turnos con su compañero, de manera que los dos tengan oportunidad de utilizar el imán y de escribir en la hoja de datos.

4. ¿Ve algo especial en los objetos que son atraídos por el imán? ¿En qué se parecen? ¿En qué son diferentes?

Los objetos que son atraídos por el imán son los llamados magneticos. Estos objetos son siempre hechos de hierro, de acero, de níquel o de cobalto. Todos estos son metales. ¿Cómo sabe que un objeto es de metal? ¿Son todos los metales magnéticos? Los objetos que no son atraídos por el imán se llaman no-magneticos.

C. Comentando los resultados

1. Comente con su compañero las predicciones que hizo al comienzo de esta actividad. ¿Cuáles predicciones resultaron correctas? ¿Resultaron incorrectas algunas de sus predicciones? ¿Cuáles? Si algunas de sus predicciones no resultaron correctas, no se preocupe. Los científicos hacen a menudo predicciones que resultan incorrectas. Eso es parte del aprendizaje.

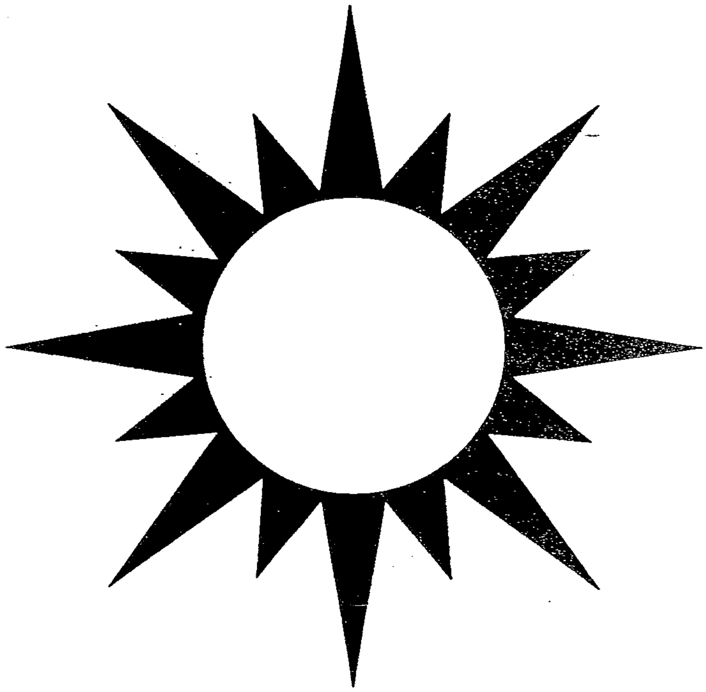
2. Ahora, ¿Cómo hace para saber si un objeto es magnético o no?

3. Cuando termine, trabaje junto con el maestro y la clase para preparar una hoja de datos para toda la clase.

ATRACCION MAGNETICA

HOJA DE DATOS

OBJETO ¿CUAL VAMOS A PROBAR?	**PREDICCION** ¿QUE VA OCURRIR?	**RESULTADO** ¿QUE OCURRIO REALMENTE?



MYSTERY MAGNETS

SUGGESTIONS FOR TEACHERS

WHAT'S THE POINT?

To design an experiment to determine whether an iron bar or washer is a magnet.

ESTIMATED TIME:

Setting up:	Time to gather materials
Doing activity:	20 minutes
Cleaning up:	10 minutes

APPROPRIATE AGE GROUPS:

X K–3 ___ 4–6 ___ 7–8

Note: For kindergarten students, try as a small group activity with the teacher.

DO ACTIVITY IN GROUPS OF: 2

MATERIALS NEEDED (per group of 2 students):

- either a plain iron or steel washer, or a bar or doughnut magnet—each pair of students should have either a plain piece of iron or a magnet
- several magnetic objects (such as those used in the previous activity)
- several nonmagnetic objects (such as those used in the previous activity, *Magnetic Pickups*)
- data sheet
- pencil

Note: Be careful to not store the magnets and plain iron bars or washers in the same bag or box, since the real magnets can magnetize the plain iron pieces.

SAFETY CONSIDERATIONS:

- Check both magnets and iron pieces for sharp or rough edges. If you find any, you can use a steel file to smooth the edges.
- Children should be warned to not place any of the test items in their mouths.

ENRICHMENT FOR BILINGUAL STUDENTS:
Students can find an object at home (for example, appliance or furniture) that could be improved by incorporating a magnet into its design.

ADAPTATIONS FOR PARTICIPANTS WITH DISABILITIES:
- Students with visual or hearing impairments should have no trouble doing this activity with appropriate modifications in communicating the instructions.
- Students with mobility impairments may need to work with a partner.

BEFORE YOU BEGIN:
- Students should first do the activity *Magnetic Pickups*.
- You can prepackage the materials into small boxes or bags for each team.
- Since you do not want the plain iron bars or washers to come in contact with the permanent magnets, you may want to distribute these before the class begins.

QUESTIONS TO ASK AS YOU DO THE ACTIVITY:
- Does your bar or washer look like a magnet? Why?
- Does it feel like a magnet? Why?
- Does it act like a magnet? That is, does it attract things as a magnet does? How can you tell?

CLEAN UP:
Ask each pair to replace their materials into the bag or box. Be sure to store the magnets separately from the other materials.

WHERE CAN I GO FROM HERE?
Check the following books for further activities on magnets (see the Book List): *Science on a Shoestring*; *The Whole Cosmos Catalog of Science Activities*; *The Thomas Edison Book of Easy and Incredible Experiments*; *Mr. Wizard's 400 Experiments in Science*; *The Smithsonian Institution's Science Activity Book*; *101 Science Activities*; and *TOPS Learning Systems: Magnetism*.

WHY IT HAPPENS:

First, be sure to read the background information in the introduction to this section as well as the "Why It Happens" section of the previous activity, *What's a Magnet?*

The bars or washers that are magnets will attract objects made of iron, steel, nickel, or cobalt. The bars or washers that are not magnets will not attract the magnetic objects (or any other object). This activity can help students understand that it is what the magnet is made of that makes it magnetic, *not* the shape of the magnet.

It is a good idea to separate the magnets from the nonmagnets for storage since the magnets can **magnetize** the nonmagnets simply by being close to them for a period of time. If this happens, the plain iron pieces can temporarily act as magnets and pick up paper clips and other magnetic objects. The nonmagnets made of iron would be affected most quickly—since iron is the softest of the four metals that are magnetic; the softer metals can become magnetized more quickly. If some of the plain iron pieces do become magnetized, simply store them in a different place and they will demagnetize in a few days. You can also demagnetize them by rapping them sharply against the floor a few times.

REFERENCES:

Abruscato, J., and J. Hassard. 1977. *The whole cosmos catalog of science activities.* Glenview, IL: Scott, Foresman.

Marson, R. 1983. *TOPS learning systems: Magnetism.* Canby, OR: TOPS Learning Systems.

National Science Teachers Association (NSTA). 1990. *Magnetic moments: Science teaching that works* (videotape). Washington, DC: NSTA.

Strongin, H. 1985. *Science on a shoestring.* Menlo Park, CA: Addison-Wesley.

Thomas Alva Edison Foundation. 1988. *The Thomas Edison book of easy and incredible experiments.* New York: Wiley.

NOTES

MYSTERY MAGNETS

ACTIVITY SHEET

Sometimes scientists act like detectives. They make observations about what they see and then try to figure out what is happening. In this activity, you will act as a scientist and a detective to decide whether you have a real magnet or a plain piece of iron or steel. Then you will make up your own experiment so that you can tell someone else how to solve this problem.

1. Work with a partner. You will need the following items to do this activity:

   - your mystery magnet
   - some items that are magnetic
   - some items that are not magnetic
   - a data sheet
   - a pencil or pen to write down your findings

2. Your job is to find out whether your bar or washer is really a magnet or is a plain piece of iron or steel. How can you do this? How can you tell whether it is really a magnet? Which items will you use to test your mystery magnet?

   Hint: Use your data sheet to help plan and do your experiment! Look back at what you learned in the last activity, *Magnetic Pickups*.

3. After you have decided whether your mystery magnet is really a magnet, write out your experiment and how you could tell a real magnet from a plain piece of iron or steel on your data sheet.

4. When you are done, compare experiments with the other teams of students. Try out each others' experiments. What did you find? Did you find something different from what the other students found?

MYSTERY MAGNETS

DATA SHEET

ITEMS TO TEST	WILL A REAL MAGNET PICK IT UP?	DOES MY MYSTERY MAGNET PICK IT UP?	IS MY MYSTERY MAGNET REALLY A MAGNET?
	YES NO	YES NO	YES NO
	YES NO	YES NO	YES NO
	YES NO	YES NO	YES NO
	YES NO	YES NO	YES NO
	YES NO	YES NO	YES NO

MY EXPERIMENT
HOW TO TELL WHETHER YOU HAVE A REAL MAGNET

____

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MAGNETOS MISTERIOSOS

HOJA DE ACTIVIDADES

Algunas veces los científicos actúan como detectives. Ellos hacen observaciones, con le que ven, y entonces tratan de imaginar lo que está ocurriendo. En esta actividad, usted va a actuar como un científico y como un detective para averiguar si tiene un verdadero imán, o solamente un pedazo de hierro o de acero. Luego hará su propio experimento de manera que pueda decirle a otro compañero cómo resolver este problema.

1. Trabaje con un compañero. Para llevar a cabo esta actividad necesita los siguientes objetos:

    - su imán misterioso
    - algunos objetos magnéticos
    - algunos objetos no magnéticos
    - una hoja de datos
    - un lápiz o una pluma para escribir los hallazgos

2. Su tarea es saber si la barra o el "washer" son realmente imanes o simplemente pedazos de hierro o de acero. ¿Cómo puede hacerlo? ¿Cómo puede saber si son realmente imanes? ¿Qué objetos va a utilizar para probar su imán misterioso?

    Una pista: utilice la hoja de datos para planificar y hacer el experimento. Recuerde lo que aprendió en la última actividad, ¿Es magnético?

3. Cuando sepa si su imán misterioso es realmente un imán, describa el experimento en la parte de abajo de la hoja de datos. Diga cómo hizo su experimento y cómo puede distinguir entre un imán verdadero y un pedazo de hierro.

4. Cuando termine, compare sus experimentos con los de otros grupos de estudiantes. Intercambie experimentos con los otros estudiantes en su grupo y pruébelos. ¿Qué encontró? ¿Halló algo diferente a lo de los otros estudiantes?

IMANES MISTERIOSOS

HOJA DE DATOS

OBJETOS PARA PROBAR	¿LO ATRAERA UN IMAN VERDADERO?	¿LO ATRAERA MI IMAN MISTERIOSO?	¿ES MI IMAN MISTERIOSO UN IMAN VERDADERO?
	SI NO	SI NO	SI NO
	SI NO	SI NO	SI NO
	SI NO	SI NO	SI NO
	SI NO	SI NO	SI NO
	SI NO	SI NO	SI NO

MI EXPERIMENTO
COMO SABER SI TIENE UN IMAN VERDADERO

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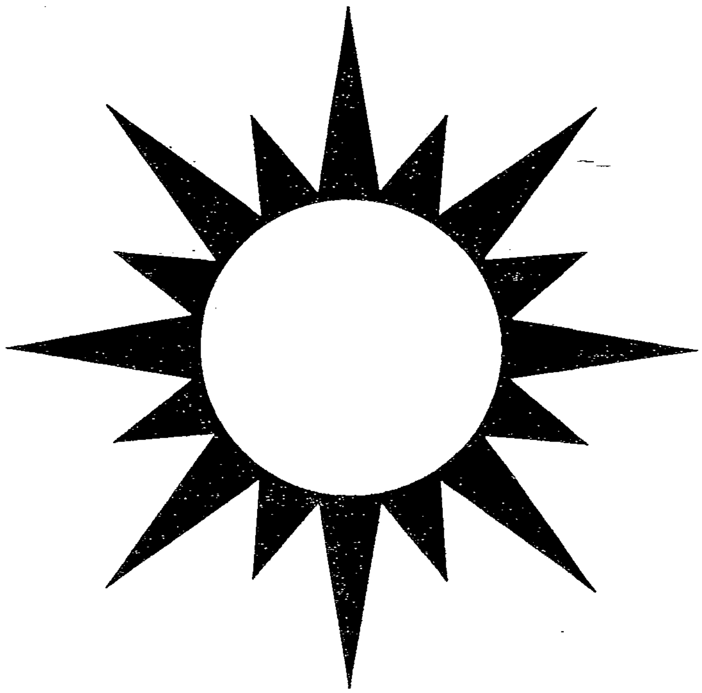


HOW STRONG IS YOUR MAGNET?

SUGGESTIONS FOR TEACHERS

WHAT'S THE POINT?

To experimentally measure the strength of a magnet and graph how the strength changes as the distance from the magnet increases, and as a barrier (masking tape) is built between the magnet and an iron object.

ESTIMATED TIME:

Setting up:	10 minutes
Doing activity:	30–40 minutes
Cleaning up:	10 minutes

APPROPRIATE AGE GROUPS:

X K–3 X 4–6 X 7–8

Note: For kindergarten level, try as a group activity led by teacher.

DO ACTIVITY IN GROUPS OF: 2

MATERIALS NEEDED (per group of 2 students):

- bar magnet
- clothespin
- masking tape (1 long strip and 21 one-inch [2.5-cm] pieces)
- ½ manila folder
- plastic or paper cup
- 20 paper clips
- data sheet
- pencil or pen

For teacher:

- graph paper diagram

SAFETY CONSIDERATIONS:

There are no specific safety considerations other than making sure children do not put paper clips into their mouths.

ENRICHMENT FOR BILINGUAL STUDENTS:

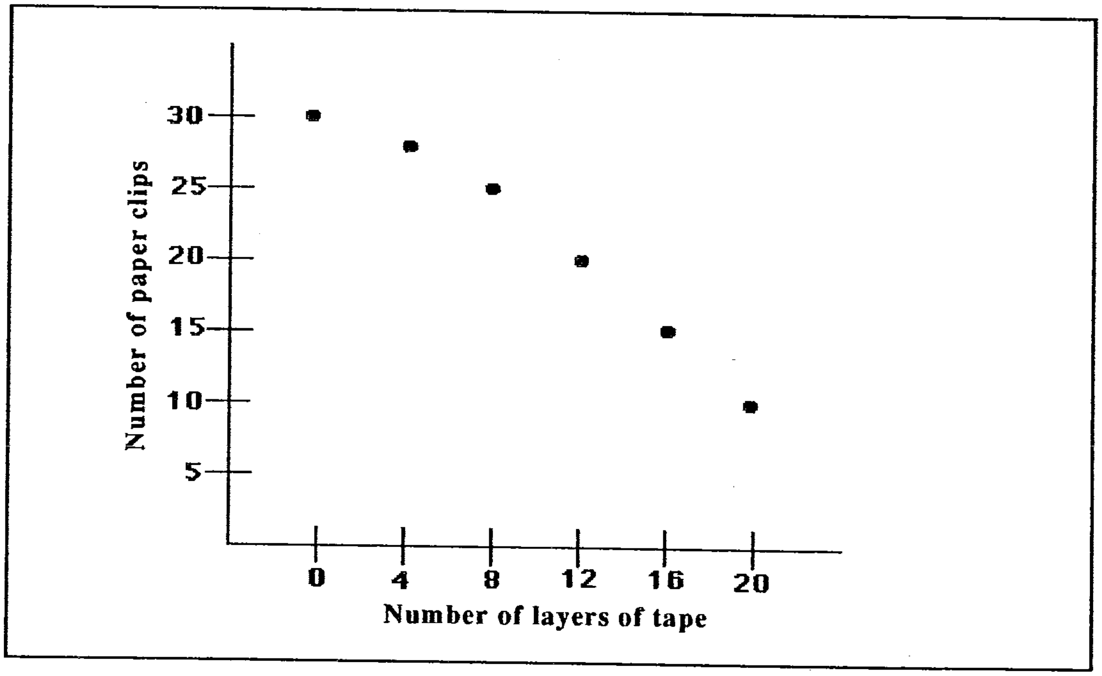
Contact your NASA regional office, local industries, or universities to locate a Hispanic scientist. Have students invite scientists to present information on how magnets are used in their work.

ADAPTATIONS FOR PARTICIPANTS WITH DISABILITIES:

- Students with hearing impairments will have no trouble in performing this activity with appropriate modifications in communicating the instructions.
- Students with vision or mobility impairments may need to work with a partner.

BEFORE YOU BEGIN:

- Make copies of the data sheet for each pair.
- Make a large graph on newsprint paper or the chalkboard. Average students' findings and graph the class findings. The x-axis (horizontal) is for the distance from the magnet (that is, the number of layers of tape beginning with zero); the y-axis (vertical) is for the strength of the magnet (number of paper clips it can hold).



- Cut the tape for each pair. One long strip will be used to tape the clothespin to the cup. Then, cut 21 one-inch (2.5-cm) pieces (small enough to fit on the magnet). Stick them to a smooth manila folder and have students number them from 1 to 21.

QUESTIONS TO ASK AS YOU DO THE ACTIVITY:

- ✧ How many paper clips can the magnet hold without any masking tape?
- ✧ As you begin adding layers of tape, what happens? Why?
- ✧ Is the masking tape a magnet? How do you know? If not, why are the paper clips attracted to it?
- ✧ What happens to the strength of the magnet as you add more layers of tape? Why?
- ✧ Is the magnetic attraction blocked by the tape, or is it just that the tape adds distance between the magnet and the paper clip?
- ✧ What does the graph tell us?

CLEAN UP:

- ✧ Dismantle the cup and clothespin apparatus.
- ✧ Discard tape.
- ✧ Store magnets separately from paper clips.

WHERE CAN I GO FROM HERE?

See the remaining magnetism activities in this unit. Check the following books for further activities on magnets (see the Book List): *Science on a Shoestring*; *The Whole Cosmos Catalog of Science Activities*; *The Thomas Edison Book of Easy and Incredible Experiments*; *Mr. Wizard's 400 Experiments in Science*; *The Smithsonian Institution's Science Activity Book*; *101 Science Activities*; and *TOPS Learning Systems: Magnetism.*

WHY IT HAPPENS:

A magnetic field (the pull of the magnet) will pass through materials like tape with almost no effect. The tape does not block the attraction of the magnet for the paper clip. Rather, each piece of tape removes the paper clip from the surface of the magnet by one more small increment of distance, equal to the thickness of the tape. The tape is just a convenient way to move the clip and the magnet apart bit by bit. The distance between the magnet and the clips, not the tape itself, lessens the attraction of the magnet. We can also describe this in terms of the magnetic field: As you move farther from the magnet's pole, the field becomes weaker and weaker.

NOTES

WHY IT HAPPENS: *continued*

You can show that the strength of the magnetic field decreases the farther you move from the magnet by a simple demonstration. Tie one end of a thread to a paper clip and tape the other end to the surface of a table. Hold a magnet above the paper clip. You can hold the clip up in the air (and keep the string taut) as long as the magnet is fairly close to the paper clip. If you move the magnet too far away from the clip, the strength of the magnetic field decreases, and the paper clip falls.

REFERENCES:

Hoffman, J. 1989. *Backyard scientist, series two.* Irvine, CA: Backyard Scientist.

Marson, R. 1983. *TOPS learning systems: Magnetism.* Canby, OR: TOPS Learning Systems.

Strongin, H. 1985. *Science on a shoestring.* Menlo Park, CA: Addison-Wesley.

HOW STRONG IS YOUR MAGNET?

ACTIVITY SHEET

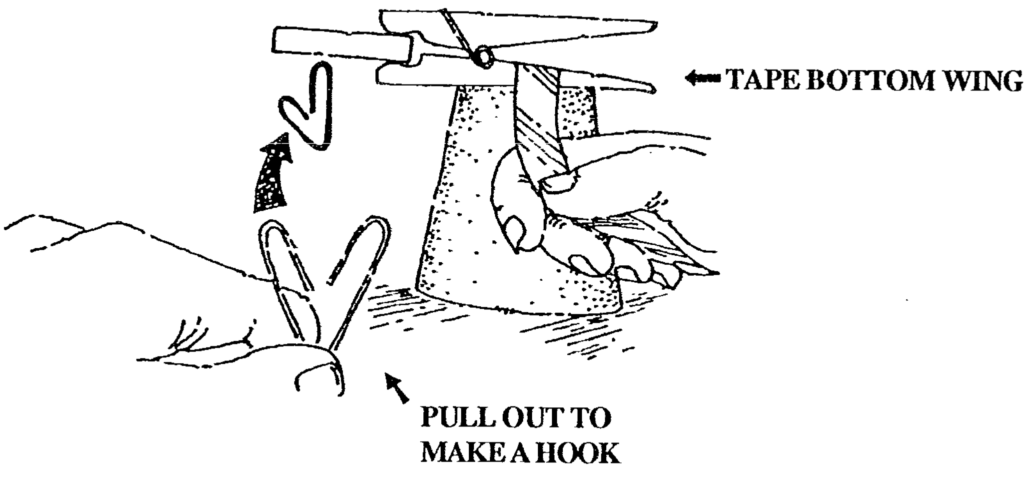
Can your small magnet attract a paper clip from across the room? From across your desk? How can you find out how strong your magnet is? This experiment will help you find out!

For this experiment, you will need:

- magnet
- clothespin
- masking tape (1 long piece and 21 short pieces)
- paper cup
- 20 paper clips
- data sheet
- pencil

1. Work with a partner. Number your small pieces of tape from 1 to 21.

2. Clamp your magnet in the clothespin. Tape it to the bottom of the cup as shown in the drawing.

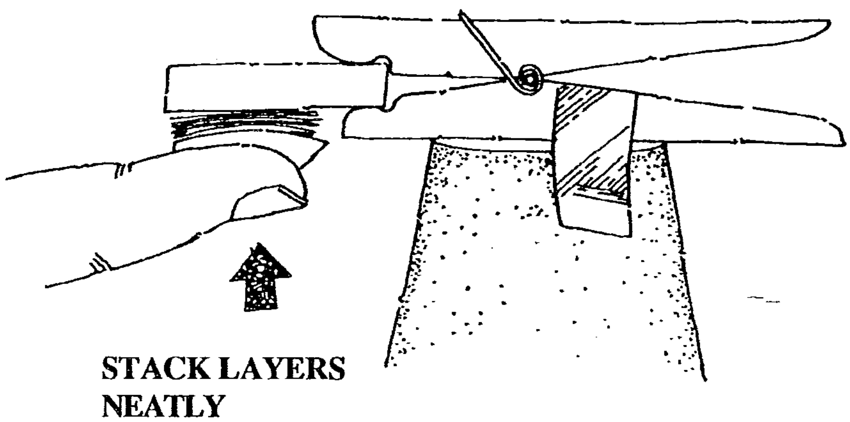


3. Pull apart one end of a paper clip to form a hook. Touch the hook to the magnet. It should stick to one pole of your magnet.

4. Take turns with your partner and carefully add paper clips to the hook, one by one. Count the total number of paper clips that you can hang onto the hook before the weight becomes too much for the magnet to hold and the paper clips fall.

5. Write this number of paper clips on your data sheet on the line for *zero pieces of tape.*

6. Next, stick three pieces of masking tape (labelled #1, #2, and #3) on the bottom of your magnet. See the picture below. Now repeat your experiment and see how many paper clips you can hang on the hook. Make sure the hook touches the tape, not the magnet itself. Write your findings on your data sheet.



7. Add three more pieces of tape and repeat your experiment. Mark your findings on your data sheet.

8. Keep adding pieces of tape, three at a time, repeat the experiment, and write down what you find. As you add more and more layers of tape, what do you notice about the number of paper clips you can add to the hook? Is the magnet able to hold more or fewer clips?
   Do you think the tape is causing this? Why?

9. Use your findings to help your teacher and class complete a graph that describes the results of your experiment.

HOW STRONG IS YOUR MAGNET?

DATA SHEET

HOW MANY LAYERS OF TAPE?	HOW MANY PAPER CLIPS?
0	
3	
6	
9	
12	
15	
18	
21	

¿QUE FUERZA TIENE SU IMAN?

HOJA DE ACTIVIDADES

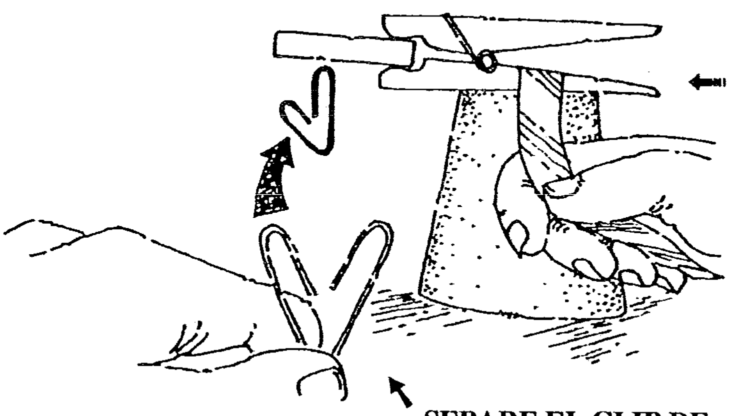
¿Puede su pequeño imán atraer el clip que se encuentra del lado opuesto del cuarto? ¿Del lado opuesto de su escritorio? ¿Cómo puede saber qué fuerza tiene su imán? Este experimento lo ayudará a determinar la fuerza que tiene su imán.

Para este experimento necesita:

- ✧ un imán
- ✧ una pinza para colgar ropa
- ✧ cinta adhesiva (un pedazo grande y 21 pedazos pequeños)
- ✧ un vaso de papel
- ✧ 20 clips
- ✧ una hoja de datos
- ✧ un lápiz

1. Trabaje junto con su compañero. Numere los pedazos pequeños de cinta adhesiva del 1 al 21.

2. Sujete el imán con la pinza de colgar ropa. Póngalo en el fondo del vaso de papel y sujételo con cinta adhesiva como se muestra en el dibujo.

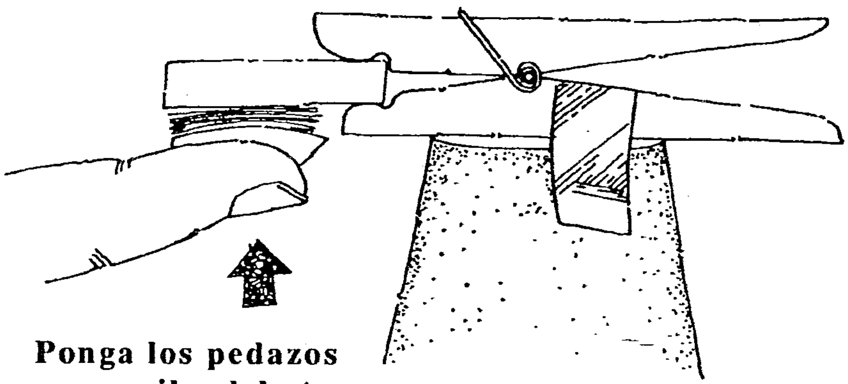


3. Separe el clip de manera que forme un gancho. Haga que el gancho toque el imán. El gancho debe pegarse o adherirse al imán.

4. Trabaje tomando turnos con su compañero, con mucho cuidado, ponga más clips en el gancho, uno por uno. Cuente el número total de clips que ha colgado en el primer gancho antes de que el peso sea muy grande para el imán y se caigan los clips.

5. Escriba el número de clips en su hoja de datos en la línea señalada para *0 cinta adhesiva.*

6. Después, ponga tres pedazos pequeños de cinta adhesiva (marque #1) en la parte inferior del imán. Vea el dibujo más abajo. Ahora repita el experimento y vea cuántos clips puede colgar del primer gancho. Escriba su respuesta en la hoja de datos.



Ponga los pedazos uno arriba del otro con cuidado

7. Ponga tres pedazos más de cinta adhesiva y repita el experimento. Escriba su respuesta en la hoja de datos.

8. Pegue tres, pedazos más de cinta adhesiva, repita el experimento y escriba su respuesta. Cuando pone más pedazos de cinta adhesiva ¿qué observa en el número de clips que puede poner en el gancho? ¿Puede el imán sostener un número más grande o un número más pequeño de clips? Termine la hoja de datos.

   ¿Cree usted que la cinta adhesiva hace que esto ocurra?
   ¿Por qué, o por qué no?

9. Utilice sus respuestas para ayudar al maestro y a la clase a completar la gráfica que muestra los resultados de su experimento.

¿QUE FUERZA TIENE SU IMAN?

HOJA DE DATOS

¿CUANTAS CAPAS DE CINTA ADHESIVA?	¿CUANTOS CLIPS?
0	
3	
6	
9	
12	
15	
18	
21	

FIND THE NORTH AND SOUTH POLES

SUGGESTIONS FOR TEACHERS

WHAT'S THE POINT?

To help students understand that magnets have two different ends, the north-seeking and south-seeking poles. And to understand that the earth acts like a giant magnet and has a magnetic field that can help us find geographic directions by using a magnet.

ESTIMATED TIME:

Setting up:	10 minutes
Doing activity:	20 minutes
Cleaning up:	10 minutes

APPROPRIATE AGE GROUPS:

_X_ K–3 _X_ 4–6 ___ 7–8

Note: For kindergarten students, focus on the first half of the activity.

DO ACTIVITY IN GROUPS OF: 2

MATERIALS NEEDED (per group of 2 students):

- ✧ 2 bar magnets
- ✧ data sheet
- ✧ pencil
- ✧ masking tape
- ✧ 2 pieces of string or thread, each 20 inches (50 cm) long

SAFETY CONSIDERATIONS:

There are no specific safety considerations.

ENRICHMENT FOR BILINGUAL STUDENTS:

- There are various scientific and technical professions utilizing magnetic fields. Students can brainstorm and list possible fields and how magnets are used.
- Arrange a visit to a science museum or a NASA regional office. Invite a Hispanic scientist come to visit the classroom and present how magnets and magnetic fields are used in his or her work.

ADAPTATIONS FOR PARTICIPANTS WITH DISABILITIES:

- Students with hearing or vision impairments will have no trouble performing this activity with appropriate modifications in communicating the instructions.
- Students with mobility impairments may need to work with a partner.

BEFORE YOU BEGIN:

- Make enough copies of the data sheet for each team.
- Cut string to 20-inch (50-cm) lengths.
- Prepare a demonstration magnet for yourself by labeling the poles. To do this, hang the magnet from some thread with the poles pointing in opposite directions. It should come to rest so the north-seeking pole faces north. Use a compass to find magnetic north in your classroom and hang a sign with a large **N** on it on the north wall or corner of your classroom.
- Have another unlabelled magnet handy to use when you demonstrate to the class how to find and label the poles.

QUESTIONS TO ASK AS YOU DO THE ACTIVITY:

- What happens when the magnetic poles *attract*?
- What happens when the magnetic poles *repel* ?
- What happens when you hang a labelled magnet? What if you push it out of place? Does it stop spinning in the same place? Does the same thing happen every time?

CLEAN UP:

Store magnets separately from other materials.

WHERE CAN I GO FROM HERE?

Check the following books for further activities on magnets (see the Book List): *Science on a Shoestring*; *The Whole Cosmos Catalog of Science Activities*; *The Thomas Edison Book of Easy and Incredible Experiments*; *Mr. Wizard's 400 Experiments in Science*; *The Smithsonian Institution's Science Activity Book*; *101 Science Activities*; and *TOPS Learning Systems: Magnetism*.

WHY IT HAPPENS:

First, be sure to read the background information in the introduction to this section as well as the "Why It Happens" section of a previous activity, *What's a Magnet?*
All magnets have a north-seeking pole (commonly called a north pole) and a south-seeking pole (commonly called a south pole). Just as with electrons and protons, opposites attract when it comes to magnets (see the introduction to the *Electricity: It's Easy* section of this manual). A north-seeking pole is attracted to a south-seeking pole, but two similar poles repel each other. You can actually feel this attraction and repulsion. The poles of the magnets result from individual atoms within the magnet lining up in the same direction. In a piece of copper, for example, individual atoms are randomly arranged. In a magnet, however, individual atoms line up all "facing" the same direction so the two ends are not exactly the same. Certain metals, such as iron, are attracted to magnets because their atoms tend to move and line up in the same direction when they are exposed to a magnetic field.

The earth acts like a very large magnet. Deep in the earth are huge deposits of **magnetite** or **lodestone.** These deposits act like a very large bar magnet, several hundred miles long, running down the middle of the earth from the north pole to the south pole. This giant magnet creates a magnetic field just as small magnets do. When you hang a small magnet suspended in the air, it tries to line up with the earth's magnetic field so that the magnet's north-seeking pole is pointed toward the earth's north pole and so the magnet's south-seeking pole is pointed toward the earth's south pole.

This is exactly what a compass does. The pointer on a compass is a small magnet. It rotates freely on a pin so that it can line up with the earth's magnetic field. The north-seeking pole of the compass magnet is traditionally painted red. If you turn so that the red end of the pointer points toward the N on the compass, you can then tell in which direction you are headed.

We think of the earth as only having one North Pole and one South Pole. It actually has two of each—two geographic poles and two magnetic poles. The geographic North Pole is where the imaginary axis that the earth turns on would stick out of the earth. The magnetic north pole is also in the Arctic, but is miles from the geographic North Pole. Likewise, there is a geographic South Pole and a magnetic south pole. The magnetic poles change slightly in position from time to time. Magnets are attracted to the magnetic poles, not the geographic ones.

NOTES

REFERENCES:

Abruscato, J., and J. Hassard. 1977. *The whole cosmos catalog of science activities.* Glenview, IL: Scott, Foresman.

National Science Teachers Association (NSTA). 1990. *Magnetic moments: Science teaching that works* (videotape). Washington, DC: NSTA.

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FIND THE NORTH AND SOUTH POLES

ACTIVITY SHEET

In this activity, you will learn that the two ends of your magnet are not the same! They look the same but they are very different. Let's find out more about magnets!

For this activity, you and your partner will need:

- 2 bar magnets
- 4 small pieces of masking tape
- a pen or pencil
- 2 pieces of string or thread
- data sheet

A. ARE THE POLES REALLY DIFFERENT?

1. Work with a partner.

2. Cover each end of both magnets with a small piece of tape.

3. Pick up both of the magnets. Bring the magnets close together, end-to-end. What do you feel? Do the ends (also called **poles**) feel like they attract or repel each other? Let your partner try it now. Does he or she feel the same thing?

4. Now turn **one** of the magnets around and try to bring them together again. Now what do you feel? Let your partner try it, too.

5. Using your pen or pencil, draw small circles on the tape of the two ends that repel each other. Your partner should draw small squares on the tape of the other ends.

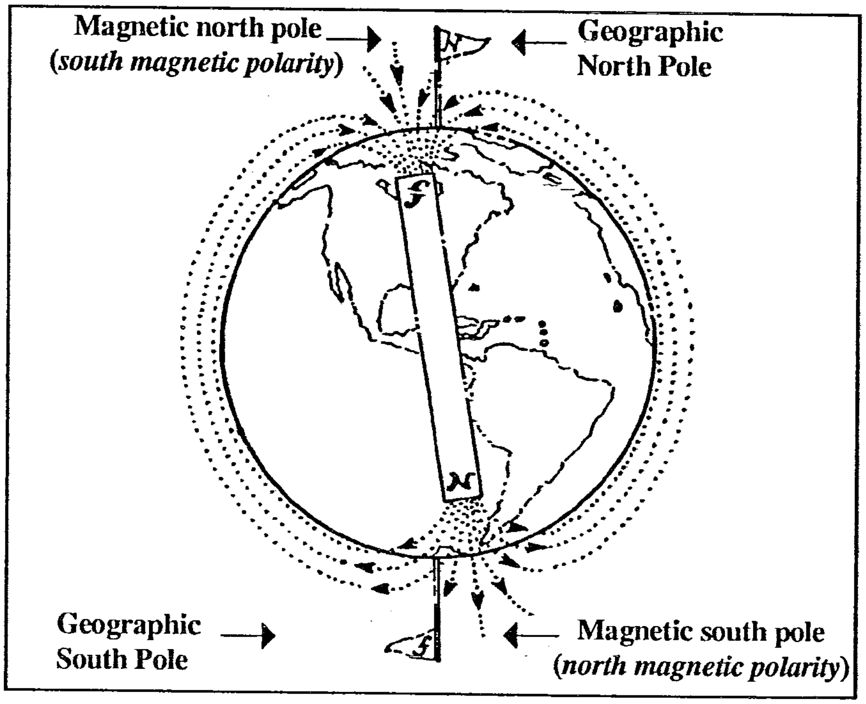
6. Use your magnets to complete your data sheet. First, make sure that when you bring the two ends with circles drawn on them, they repel. Then try all the activities on the data sheet and write down which poles of the magnets **attract** and **repel**.

7. When you are finished, show another team of students how you can tell that each magnet has two different **poles**.

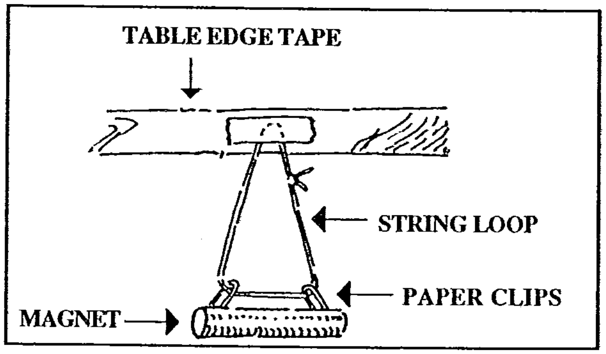
B. WHICH WAY IS NORTH?

The earth also contains a magnet that works very much like your small magnet, but it is much larger. It is many miles long and the poles of the earth's magnet are at the north pole and the south pole. These two large poles can attract and repel the poles of your small magnet. Let's find out how this happens.

1. Tape a loop of thread to your desk or table.
2. Hook two paper clips into the loop and stick one to each end of your magnet. Gently let go of the magnet so it hangs from the table edge (see picture to the right).
3. Let the magnet rest until it stops swinging. One end of your magnet should point toward the **north** sign on the wall of your classroom. **This is the north-seeking pole of your magnet because it points toward the earth's north pole. Write N on this end of your magnet.** The north-seeking pole of your magnet is attracted to the huge north pole at the top of the earth!



4. The other end of your magnet is the **south-seeking pole because it points toward the earth's south pole. Write S on this end of your magnet.** The south-seeking pole of your magnet is attracted to the huge south pole at the bottom of the earth!
5. Now work with your partner again. Try to bring the north pole of your magnet to the north pole of your partner's magnet. They should repel each other. Then try to bring the north pole of your magnet to the south pole of your partner's magnet. They should attract each other.



FIND THE NORTH AND SOUTH POLES
DATA SHEET

similar (or like) poles	○ TO ○	REPEL
different (or unlike) poles	○ TO □	
similar (or like) poles	□ TO □	
different (or unlike) poles	□ TO ○	

COMO ENCONTRAR EL POLO NORTE Y EL POLO SUR
HOJA DE ACTIVIDADES

En esta actividad va a aprender que los extremos de su imáni ¡no son iguales! Parecen iguales, pero son muy diferentes. Vamos a aprender más acerca de los magnetos o imanes.

Para esta actividad necesita:

- 2 barras magnéticas
- 4 pedazos pequeños de cinta adhesiva
- 1 lápiz o una pluma
- 2 pedazos de cuerda o de hilo
- una hoja de datos

A. ¿SON LOS POLOS REALMENTE DIFERENTES?

1. Trabaje con un compañero.

2. Cubra cada extremo de los dos imanes con un pedazo pequeño de cinta adhesiva.

3. Agarre los dos imanes. Júntelos por los extremos. ¿Qué siente? ¿Siente que los extremos (también llamados **polos**) se atraen o se repelen? Ahora, deje que su compañero haga la prueba. ¿Siente su compañero lo mismo?

4. Luego, invierta la posición de uno de los imanes y júntelos otra vez. ¿Qué siente ahora? Deje que su compañero haga también la prueba.

5. Dibuje pequeños círculos con el lápiz o con la pluma sobre la cinta adhesiva de los extremos que se repelen. Su compañero debe dibujar pequeños cuadros sobre la cinta adhesiva en los otros dos extremos.

6. Utilice esta información sobre los imanes para completar la hoja de datos. Primero, asegúrese que cuando junta los dos extremos que tienen círculos dibujados estos se repelen. Luego, pruebe todas las actividades en la hoja de datos e indique si los imanes se **atraen** o se **repelen**.

7. Cuando termine, muéstrele a los estudiantes qué hizo para saber que cada magneto tiene dos **polos** diferentes.

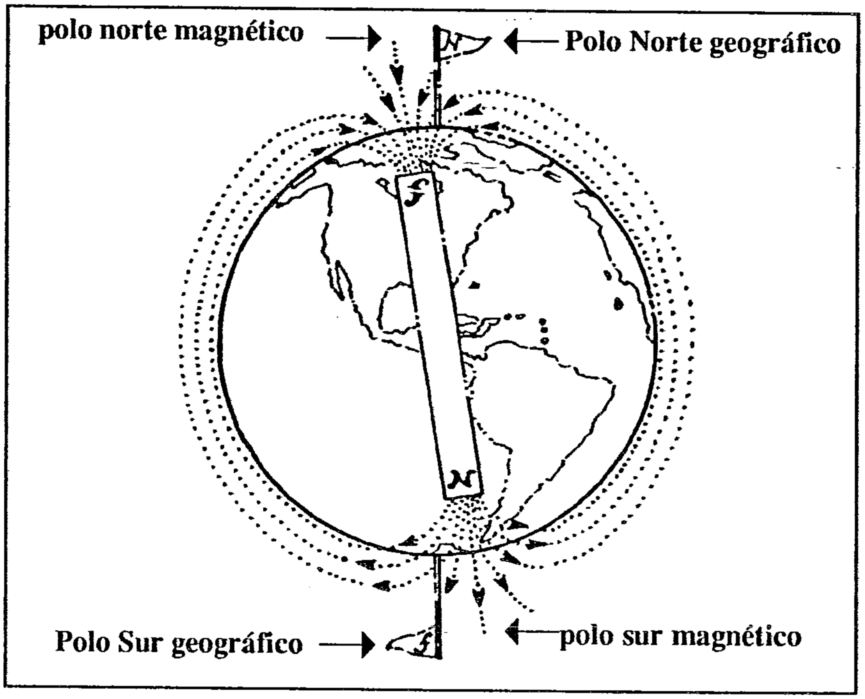
B. ¿DONDE QUEDA EL NORTE?

También la Tierra tiene un imán que trabaja de la misma manera que su pequeño imán, pero es mucho más grande; se extiende desde el polo norte hasta el polo sur cientos de millas y los polos son los extremos del imán. Estos dos grandes polos pueden atraer o repeler los polos de su pequeño imán. Vamos a ver cómo ocurre.

1. Pegue un pedazo de hilo en forma de lazo en su escritorio o en una mesa.

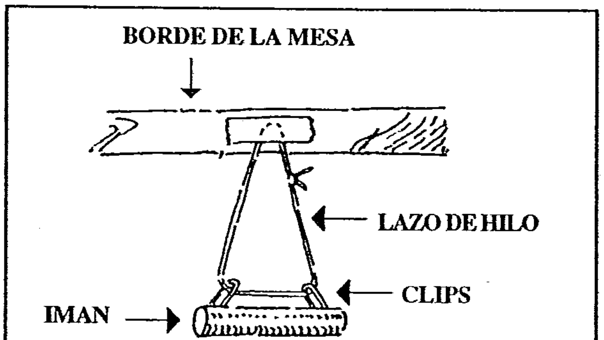
2. Cuelgue dos clips del lazo de hilo, pegando uno en cada lado (mire el dibujo más abajo).

3. Deje que el imán descanse hasta que deje de moverse. Un extremo del imán debe apuntar hasta el letrero grande que dice norte, colocado en la pared del salón de clase. **Este es el polo de su imán que busca el norte porque está apuntando hacia el polo norte de la Tierra. Escriba una N sobre este extremo de su imán.** El polo de su imán que apunta al norte es atraído por el gigantesco polo norte que se encuentra en la parte superior de la Tierra.



4. El otro extremo de su imán es **el polo que busca el sur, porque apunta hacia el polo sur de la Tierra. Escriba una S sobre este extremo de su imán.** El polo de su magneto que busca el sur es atraído por el gigantesco polo sur que se encuentra en el extremo inferior de la Tierra.

5. Ahora, trabaje con su compañero de nuevo. Trate de juntar el polo norte de su imán con el polo norte del imán de su compañero. Deben repelerse. Trate de juntar el polo norte de su imán con el polo sur del imán de su compañero, los cuales deben atraerse.



INDIQUE CUAL ES EL POLO NORTE Y EL POLO SUR
HOJA DE DATOS

polos similares (o iguales)	○ A ○	SE REPELEN
polos diferentes (o no similares)	○ A □	
polos similares (o iguales)	□ A □	
polos diferentes (o no similares)	□ A ○	

EXPLORING MAGNETIC FIELDS

SUGGESTIONS FOR TEACHERS

WHAT'S THE POINT?

To demonstrate the magnetic field formed by a small magnet and to compare it to the large magnetic field formed by the earth.

ESTIMATED TIME:

Setting up:	Time to gather materials
Doing activity:	25 minutes
Cleaning up:	10 minutes

APPROPRIATE AGE GROUPS:

__X__K–3 __X__4–6 _____7–8

Note: For kindergarten students, first do as a whole class demonstration, then allow children to explore in pairs.

DO ACTIVITY IN GROUPS OF: 2

MATERIALS NEEDED (per group of 2 students):

- ✧ 2 bar magnets
- ✧ other types of magnets such as doughnut or horseshoe
- ✧ sealed plastic case (such as a cassette tape case) or a small zipper-lock bag
- ✧ 3 inch x 5 inch (7.5 cm x 12.5 cm) index card
- ✧ teaspoonful of iron filings

Note: Presealed plastic cases with iron filings can be purchased from Discover Magnets; see *Supplies and Suppliers*.

SAFETY CONSIDERATIONS:

Make sure children know not to eat the iron filings.

ENRICHMENT FOR BILINGUAL STUDENTS:

- Contact local universities or NASA regional office to locate a Hispanic scientist.
- Students can write to invite a scientist to talk about the magnetic fields on earth and how they affect space travel.

ADAPTATIONS FOR PARTICIPANTS WITH DISABILITIES:

- Students with hearing impairments will have no trouble performing this activity with appropriate modifications in communicating the instructions.
- Students with mobility impairments may need to work with a partner.
- For students with vision impairments, you may want to build a model of the magnetic field on paper using toothpicks, yarn, or sprinkled sand glued along the lines of the magnetic field. A three-dimensional model could be constructed using toothpicks, pipe cleaners, straws, glue, and an orange, styrofoam ball or block of florist foam representing the poles of the magnet in the middle.

BEFORE YOU BEGIN:

Gather the materials for both parts of the activity and perform the experiments yourself before you do them with your students. You can make either "filing boxes" or "filing bags" for this activity. To make a filing box, remove the tape and paper liner from a clear cassette tape case. Place one level teaspoon of iron filings in the case and seal it shut by gluing or taping (use clear tape) the edges closed. To make a filing bag, place a 3 inch by 5 inch index card in a small, zipper-lock bag. Add one heaping teaspoon of iron filings to the bag and "zip" it closed.

QUESTIONS TO ASK AS YOU DO THE ACTIVITY:

- Can you see magnetism? How? What does it look like?
- Are the patterns and shapes formed by the iron filings the same no matter how many times you do the experiment?
- What happens in steps 6–10 when you use the other pole of the magnet?
- What happens in steps 6–10 when you use two magnets?

CLEAN UP:

If you are using loose iron filings, clean them up very carefully. They tend to end up everywhere! To pick up filings easily, wrap your magnet in paper or slip it inside a plastic bag. Run it over the loose filings and it will pick them up easily. To remove them from the magnet, simply turn the bag or paper inside out. Store iron filings separately from the magnets so they won't become magnetized. Please note...it is very difficult to get fine iron filings off the magnets once they are stuck on, so be careful not to get them in direct contact with the magnet. These activities also work well if you keep the magnets in plastic bags or wraps to protect them from filings.

WHERE DO I GO FROM HERE?

Check the following books for further activities on magnets (see the Book List): *Science on a Shoestring*; *The Whole Cosmos Catalog of Science Activities*; *The Thomas Edison Book of Easy and Incredible Experiments*; *Mr. Wizard's 400 Experiments in Science*; *The Smithsonian Institution's Science Activity Book*; *101 Science Activities*; and *TOPS Learning Systems: Magnetism.*

WHY IT HAPPENS:

First, be sure to read the background information in the introduction to this unit.

The area in space around a magnet where it attracts materials made of iron, nickel, or cobalt is called its **magnetic field.** You can see the lines of force in this field when you do this activity. The lines that appear in the iron filings are invisible paths over which the magnetic force from the magnet acts. The iron filings line up with these lines of force because they are attracted to the magnet.

Although the thin layer of iron filings we are using in this activity only shows the magnetic field in two dimensions, it really is three-dimensional. The lines of force in the field extend upward and downward as well as from side to side. In fact, you can see some of these lines near the poles of the magnet where some of the filings seem to stand straight up in the air. If we had a way to see it, these lines would curve upward and then back down toward the other pole of the magnet, just as those we can see in the filings do.

The earth's magnetic field looks very much the same, although it is much larger. Note the diagram on the activity sheet. It is the small magnet in the compass lining up with these lines of magnetic force that causes the compass to point north.

NOTES

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EXPLORING MAGNETIC FIELDS

ACTIVITY SHEET

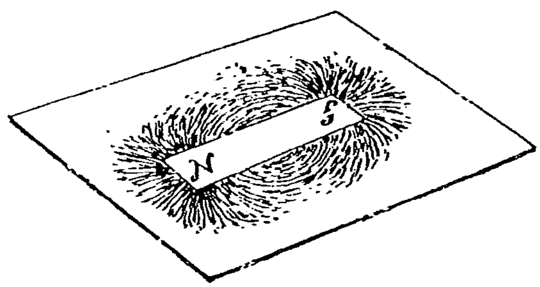
Around every magnet there is an invisible field called a **magnetic field.** This field is what attracts items such as paper clips and nails to the magnet. Although it is invisible, if we use some very small pieces of iron called **filings**, we can see the effects of this field.

1. Work with a partner. For this activity, you will need the following items:
   - 2 bar magnets
   - paper clip
   - sealed plastic box (or a plastic bag and a 3-inch x 5-inch card) with tiny iron pieces (filings) inside
   - pen or pencil for drawing pictures

2. Lay the box on a flat desk or table and shake it back and forth gently. Let your partner try it, too. With a little practice, you can get a thin layer of filings over the bottom of your box (or on top of the card in your bag). The filings should not all be in a lump at one end.

3. Lay your paper clip on the other end of your desk. When you have a nice layer of filings on the bottom of your box (or on the card in your bag), gently lift up your box and hold it right over the paper clip. What happens? Do the filings move around?

4. Now, lay your magnet on the other end of your desk. Again shake your box or bag so you have a thin layer of filings. Then gently lift up your box or bag and hold it right over the magnet. What happens? Do the filings move around? Do you see something like this?



5. Try it a few times. You can hold the magnet flat in your hand and set the box or bag down on it there, too. Draw a picture of the magnetic field that you see in your box or bag on your data sheet.

Remember—We cannot really see the magnetic field, but we can see how it moves the iron filings around. This is like the wind outside. We cannot see the wind but we can see how it moves the leaves on the trees or paper on the street.

6. Now put your other bar magnet under the filing box. Does the magnetic field of this magnet look like the first one? Try some other bar magnets and compare with other teams of students.

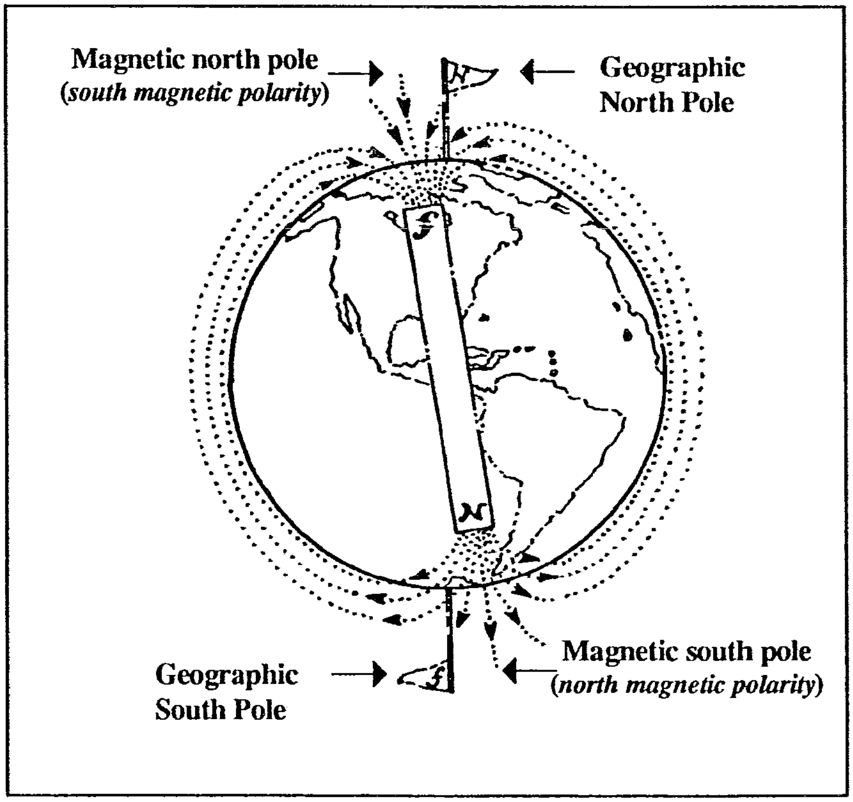
7. Now, put your two bar magnets end to end so that they are **attracted** to each other and then put your filings box on top. What do the magnetic fields of the two magnets look like now? Draw a picture on your data sheet.

8. Next, put your two magnets end to end so that they **repel** each other. Set your filing box on top and see if the fields look different. Draw a picture on your data sheet of what you see. Look at your pictures. Can one magnetic field change the shape of another magnetic field when they get close to each other? What do your drawings show you about this?

9. Now ask your teacher for another magnet with a different shape. This magnet might be shaped like a doughnut or a horseshoe. Try to see what the magnetic field looks like around this magnet. Draw a picture of it on your data sheet. Do all magnetic fields look alike? Do they change shape with the shape of the magnet?

10. Why do you think the iron filings line up along the magnetic field as they do?

Remember that the earth acts like a giant magnet. It also has a giant magnetic field! The earth's magnetic field looks something like this diagram. When you hung your magnet from a string and let it dangle in the air, it always pointed toward the north and south poles. This is because it is lining up with the earth's giant magnetic field just like the tiny pieces of iron line up along the magnetic field of your small magnet.



EXPLORING MAGNETIC FIELDS

DATA SHEET

What does the magnetic field look like around your bar magnet? Draw a picture of what you see.

What does it look like when you have two magnets under the box that are attracted to each other? Draw a picture.

What does the magnetic field look like around a horseshoe or doughnut magnet? Draw a picture of what you see.

What does it look like when the two magnets are repelling each other? Draw a picture of what you see.

EXPLORANDO LOS CAMPOS MAGNETICOS

HOJA DE ACTIVIDADES

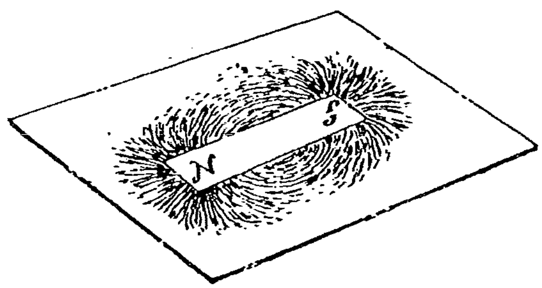
Alrededor de cada imán existe un campo invisible que se llama **campo magnético.** Este campo es el que atrae los objetos, tales como clips y clavos, hacia el imán. Aunque este campo es invisible, cuando utilizamos pequeños pedazos de hierro llamados **limaduras** podemos observar los efectos de este campo.

1. Trabaje junto con su compañero. Para esta actividad necesita los siguientes objetos:
   - ✧ dos barras magnéticas
   - ✧ presillas o clips
   - ✧ una caja plástica sellada con pedazos pequeños de hierro (limaduras) dentro de la caja
   - ✧ un lápiz o una pluma para hacer los dibujos

2. Ponga la caja sobre un escritorio o una mesa y sacuda la caja de un lado y del otro muy suavemente. Deje que su compañero lo haga también. Con un poco de práctica puede regar una capa delgada de limaduras en el fondo de la caja. Las limaduras no deben amontonarse todas en un solo extremo de la caja.

3. Ponga el clip o presilla en el otro extremo del escritorio o de la mesa. Cuando tenga una capa suficiente de limaduras en el fondo de la caja, levántela suavemente y manténgala sobre la presilla. ¿Qué ocurre? ¿Se mueven las limaduras?

4. Ahora, ponga el imán en el otro extremo del escritorio o de la mesa. Nuevamente, sacuda la caja de manera que las limaduras formen una capa delgada en el fondo de la caja. Luego, suavemente levante la caja y sosténgala derecho sobre el imán. ¿Qué ocurre? ¿Se mueven las limaduras? ¿Ocurre algo parecido?



5. Haga algunas otras pruebas. Puede sostener imán en la mano y poner la caja sobre ella. Dibuje en su hoja de datos el campo magnético que ha visto en la caja.

RECUERDE—No podemos realmente ver el campo magnético, pero si podemos ver cómo el campo magnético mueve las limaduras. El campo magnético se parece al viento. No podemos ver el viento pero podemos ver cómo mueve las hojas de los árboles y los papeles en las calles.

6. Ahora, ponga la otra barra magnética bajo la caja de limaduras. ¿Actúa el campo magnético de este imán como el primer campo magnético? Haga otras pruebas con las barras magnéticas y compare los resultados con los de otros grupos de estudiantes.

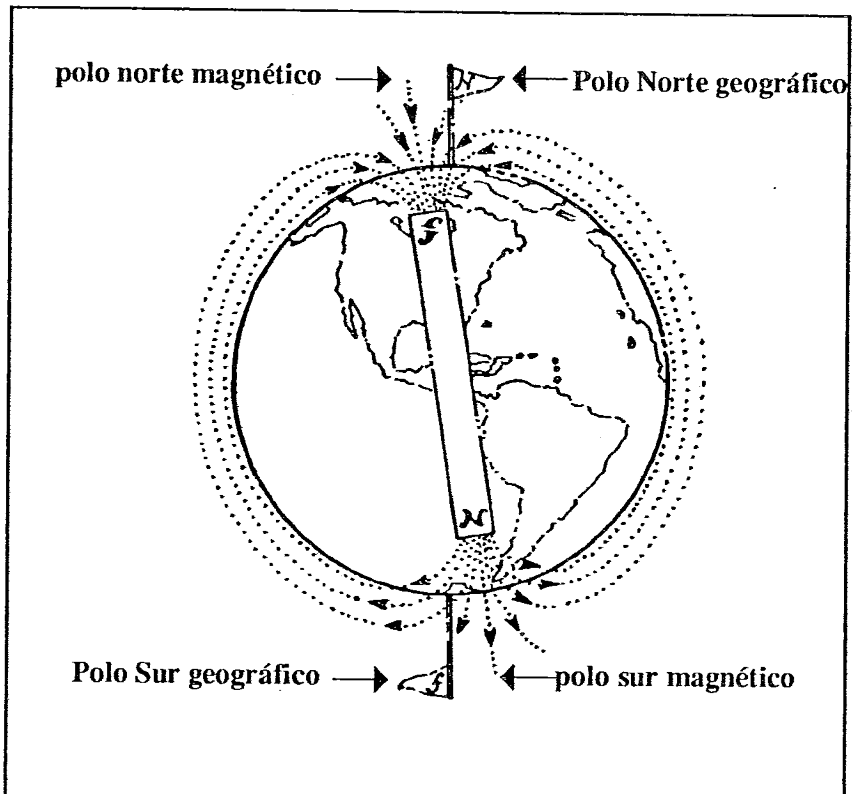
7. Luego, junte las dos barras magnéticas por los extremos, de manera que se atraigan, y entonces coloque arriba la caja con las limaduras. ¿Cómo se ven los campos magnéticos de los dos imanes? Haga un dibujo en su hoja de datos.

8. Después, junte los dos imanes por los dos extremos, de manera que se repelen. Coloque arriba la caja de limaduras y vea si los campos se ven diferentes. Haga un dibujo de lo que observa en su hoja de datos. Estudie los dibujos. ¿Puede un campo magnético cambiar la forma de otro campo magnético cuando se acercan? ¿Qué muestran los dibujos?

9. Ahora, pida al maestro otro imán de forma diferente. Este imán puede tener la forma de una rosquilla o de una herradura. Observe el campo magnético de este imán. Haga un dibujo del campo magnético en su hoja de datos. ¿Parecen iguales los campos magnéticos? ¿Cambian la forma de acuerdo con la forma del imán?

10. ¿Por qué se colocan de esa manera las limaduras en el campo magnético?

Recuerde que también la Tierra se asemeja un imán gigantesco que tiene enorme campo magnético. El campo magnético de la Tierra se asemeja a una cuerda de donde cuelga un imán que se balancea en el aire, siempre apuntando hacia el polo norte y el polo sur. Esto ocurre porque el imán se alínea con el campo magnético gigantesco de la Tierra, igual que se alínean los pequeños pedazos de hierro en el campo magnético de su imán.



EXPLORANDO LOS CAMPOS MAGNETICOS

HOJA DE DATOS

¿Cómo se ve el campo magnético alrededor de su imán? Haga un dibujo de lo que usted observa.

¿Qué observa cuando los dos imanes bajo la caja se atraen? Haga un dibujo.

¿Cómo se observa el campo magnético de su imán que tiene la forma de rosquilla o de herradura? Haga un dibujo de lo que observa.

¿Cómo se ven dos imanes cuando se repelen? Haga un dibujo de lo que observe.

MAGNETIC PICTURES

SUGGESTIONS FOR TEACHERS

WHAT'S THE POINT?

To give students a permanent picture of how the lines of force look in a magnetic field. These pictures will provide a two-dimensional view, but students should be challenged to think of magnetic fields in three dimensions.

ESTIMATED TIME:

Setting up:	Time to gather materials
Doing activity:	15–20 minutes, depending upon how many pictures you make
Cleaning up:	10 minutes

APPROPRIATE AGE GROUPS:

_X_ K–3 _X_ 4–6 ____ 7–8

Note: For kindergarten students, slip magnets into small plastic bags before starting activity to keep iron filings from sticking to magnets.

DO ACTIVITY IN GROUPS OF:

- Do painted pictures as a class.
- Do rust pictures individually.

MATERIALS NEEDED:

- dark construction paper (sheets of about 8.5 x 11 inches)
- matte-finish, quick-drying, white spray paint
- large box for spray painting (boxes that hold photocopy or computer paper work well)
- bar magnets (1 per student)
- other assorted magnets such as horseshoe or doughnut
- iron filings in a small jar or shaker
- white shelf paper or photocopy paper (sheets of about 8.5 x 11 inches or 21 x 28 cm)
- fine-mist-spray bottle of water

SAFETY CONSIDERATIONS:

We recommend that the children set up their magnetic picture and the teacher actually do the spray painting. Quick-drying spray paint should be used only in a well-ventilated area such as a gym, hallway, outdoors (on a calm day), or in a classroom designed to accommodate spray paint. The second activity has few safety considerations other than supervising children's use of filings and a spray bottle.

ENRICHMENT FOR BILINGUAL STUDENTS:

Working in small groups, students can build three-dimensional models to demonstrate how the lines of force look in a magnetic field. For the limited-English student, having the opportunity to build a model will reinforce the concept and the terminology.

ADAPTATIONS FOR PARTICIPANTS WITH DISABILITIES:

- Students with hearing impairments will have no trouble performing this activity with appropriate modifications in communicating the instructions.
- Students with mobility impairments may need to work with a partner.
- Students with visual impairments may need to manipulate alternative models of the magnetic field. See *Exploring Magnetic Fields* for ideas on how to construct these models.

BEFORE YOU BEGIN:

- Since applying the paint requires some practice, try it several times yourself before you try it with your class. You could make pictures of magnetic fields of bar, horseshoe, and doughnut magnets on poster board for display.
- Protect the surface on which you'll be painting with newspaper or use a large cardboard box with one side cut away.
- You may want to protect the magnets by slipping them into plastic bags or plastic wrap. This keeps paint and filings from accidentally getting stuck to the magnets.
- Cut pieces of shelf paper and construction paper into 8.5 x 11 inch (21 x 28 cm) pieces. If shelf paper curls, try to smooth it flat.

QUESTIONS TO ASK AS YOU DO THE ACTIVITY:

- Describe what is in your picture.
- What does your picture show?
- Why did the iron filings line up the way they did?
- If you made another picture, would it look exactly the same? Would it look similar? Why?
- How would your picture look if you used a magnet with a different shape?

CLEAN UP:

- Wait until the paint is dry to touch the pictures!
- Lift the picture off of the magnet and carefully shake the loose filings onto a piece of shelf paper. To get off the remaining filings, rub over them lightly with the blunt end of a pencil or pen. You can return the filings to the jar to be used over and over again.
- Do the same with the rust pictures. If you do this activity in the morning, they should be rusty and dry by afternoon so children can take them home or hang them up for display. If the paper is not completely dry, leave the pictures undisturbed until the next day.

WHERE DO I GO FROM HERE?

Check the following books for further activities on magnets (see the Book List): *Science on a Shoestring*; *The Whole Cosmos Catalog of Science Activities*; *The Thomas Edison Book of Easy and Incredible Experiments*; *Mr. Wizard's 400 Experiments in Science*; *The Smithsonian Institution's Science Activity Book*; *101 Science Activities*; and *TOPS Learning Systems: Magnetism*.

WHY IT HAPPENS:

Read the background information in the introduction to this section. Also read the "Why It Happens" section of *Exploring Magnetic Fields*. For the pictures made with filings and water, the color on the paper is ferric oxide or rust. This chemical results when the water and the oxygen in the air react with the iron in the filings. Since the water also touches the paper, some of the rust is washed down onto the paper and dries there.

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NOTES

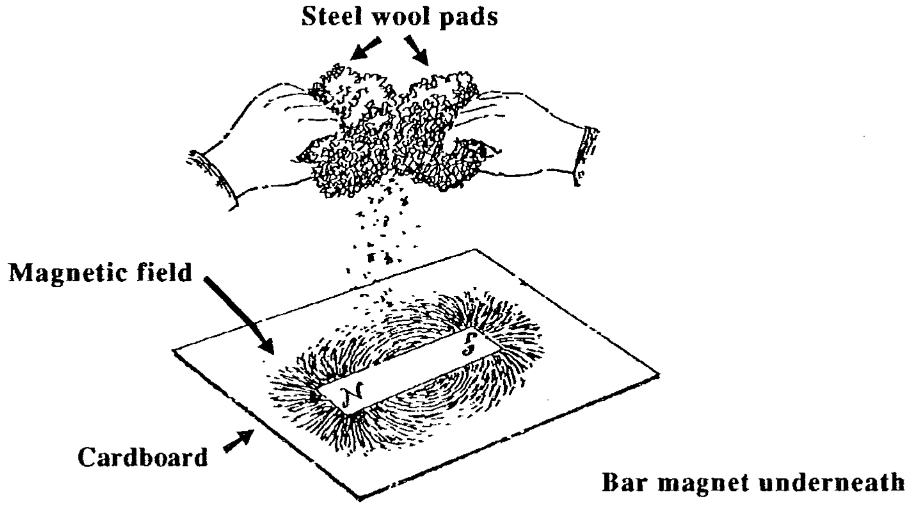
MAGNETIC PICTURES

ACTIVITY SHEET

The magnetic fields we looked at in the last activity, *Exploring Magnetic Fields,* were invisible until we used tiny iron filings to show that they were really there. Today we will make a picture of a magnetic field that you can take home with you.

1. Once you start this activity, you cannot move your picture until it dries. Be sure to listen to your teacher so you know where to set up your picture.
2. Lay down a sheet of newspaper.
3. Next lay your magnet in the middle of the sheet of newspaper.
4. Lay a sheet of white paper on top of the magnet so the magnet is just about under the middle of the paper.
5. Sprinkle a very thin layer of iron filings on the paper. If you get too many, you will hide the magnetic field.
6. With help from your teacher, spray a fine mist of water over your picture. What do you think will happen to the iron filings after they get wet?
7. **Do not touch your picture until tomorrow!**
8. After your picture is dry, your teacher will tell you how to remove the iron filings without spilling them.

When you take your picture home, see if you can tell your Mom, Dad, or a friend about magnetic fields and how you made your magnetic picture!



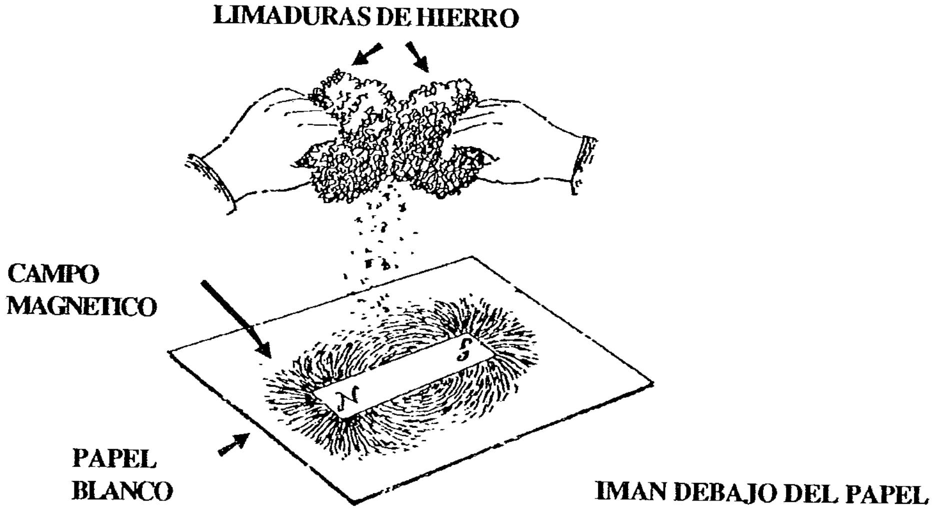
DIBUJOS DEL CAMPO MAGNETICO

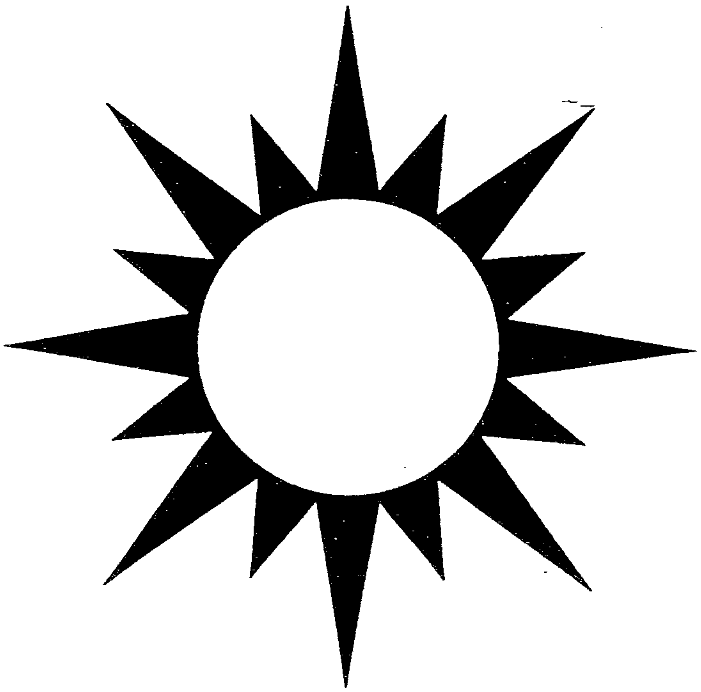
HOJA DE ACTIVIDADES

Los campos magnéticos que vimos en la última actividad, *Explorando los campos magnéticos*, eran invisibles hasta que utilizamos las pequeñas limaduras de hierro para demostrar que estaban realmente allí. Hoy, vamos a hacer un dibujo de un campo magnético, el cual se puede llevar a la casa.

1. Una vez que comience esta actividad no puede mover el dibujo hasta que se seque. Escuche atentamente al profesor, de manera que sepa cuando debe comenzar el dibujo.
2. Coloque una hoja de periódico sobre la mesa.
3. Coloque el imán en la mitad de la hoja de periódico.
4. Ponga una hoja de papel blanco sobre el imán, de manera que el imán quede colocado debajo de la mitad del papel.
5. Rocíe una capa muy delgada de limaduras de hierro sobre el papel. Si pone demasiadas limaduras puede esconder el campo magnético.
6. Con la ayuda de su maestro, rocíe una capa delgada de agua sobre el dibujo. ¿Qué ocurre a las limaduras de hierro cuando se mojan?
7. ¡No toque el dibujo hasta el día siguiente!
8. Cuando el dibujo se seque, el maestro le enseñará cómo remover las limaduras de hierro sin que estas se desparramen o se rieguen.

Cuando lleve el dibujo a la casa, explique a sus padres ó amigos lo qué es un campo magnético, y dígales cómo hizo su dibujo magnético.





WHICH WAY IS NORTH?
SUGGESTIONS FOR TEACHERS

WHAT'S THE POINT?
To understand what a compass is and how it works. To understand how a magnet responds to the earth's magnetic field.

ESTIMATED TIME:
Setting up:	10 minutes
Doing activity:	15 minutes
Cleaning up:	10 minutes

APPROPRIATE AGE GROUPS:
_X_ K–3 _____ 4–6 _____ 7–8

Note: For kindergarten students, instead of having children work with needles, use this opportunity to demonstrate what a compass is, what directions are, and how to use a compass. Play a game using a compass.

DO ACTIVITY IN GROUPS OF: 2

MATERIALS NEEDED (per group of 2 students):
- bar magnet
- needle
- paper clip
- clear plastic cup
- water
- small piece of felt, styrofoam, or waxed paper
- small piece of masking tape
- demonstration compass for teacher

SAFETY CONSIDERATIONS:
Remind children to be very careful when working with needles.

ENRICHMENT FOR BILINGUAL STUDENTS:

- Students can locate north in other rooms and areas of the school using the floating compass and a compass to check the reading.
- Discuss with class how Spanish navigators used compasses to assist them with navigation and to make world maps.

ADAPTATIONS FOR PARTICIPANTS WITH DISABILITIES:

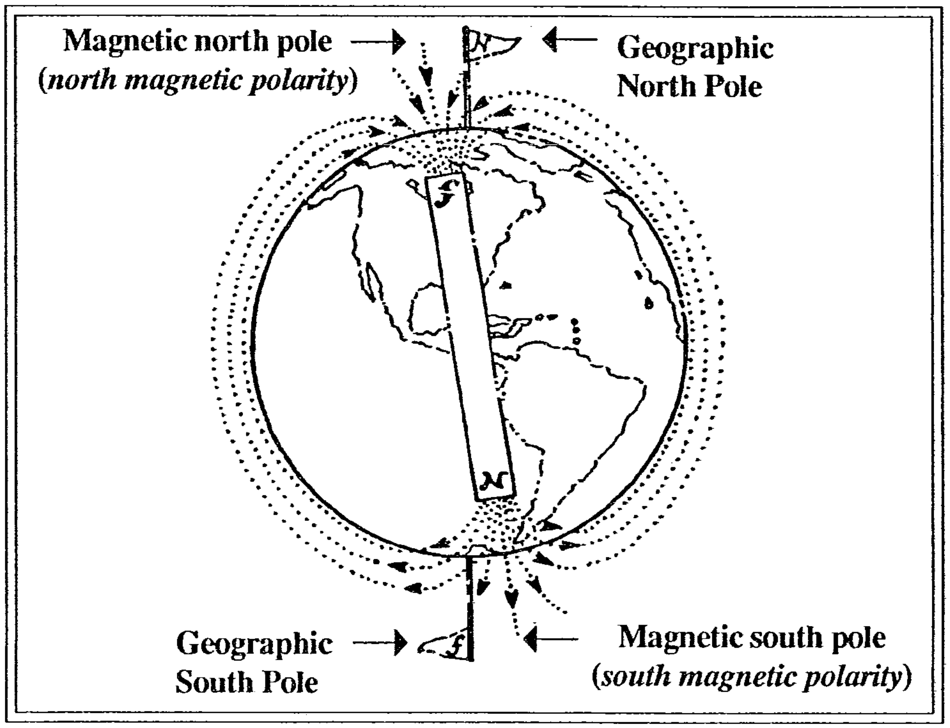
- Students with hearing disabilities will have no trouble performing this activity with appropriate modifications in communicating the instructions.
- Students with mobility and/or visual impairments may need to work with a partner.
- For children with visual impairments, have the partner mark the directions the needle is pointing with small bits of tape on the rim of the cup.

BEFORE YOU BEGIN:

- Have class do the activity *Find the North and South Poles.*
- Cut the felt or styrofoam into small (no more than 1-inch-square) pieces. The thin foam wrapping around a 16-oz. soda pop bottle works well.
- Use the demonstration compass to locate the north wall of your classroom. Place a large N on that wall or chalkboard.
- Before students do the activity, briefly introduce the class to the compass and how it works.
- Make sure you have access to water.

QUESTIONS TO ASK AS YOU DO THE ACTIVITY:

- What does a compass tell us? Why do we need that information?
- Can you think of some time when you might need a compass?
- How does the earth act like a magnet? What does the earth's magnetic field look like? (See diagram below)



CLEAN UP:

Be sure to store compasses separately from magnets.

WHERE CAN I GO FROM HERE?

Check the following books for further activities on magnets (see the Book List): *Science on a Shoestring*; *The Whole Cosmos Catalog of Science Activities*; *The Thomas Edison Book of Easy and Incredible Experiments*; *Mr. Wizard's 400 Experiments in Science*; *The Smithsonian Institution's Science Activity Book*; *101 Science Activities*; and *TOPS Learning Systems: Magnetism*.

WHY IT HAPPENS:

The earth is a tremendous magnet. Its magnetic field acts between its magnetic north and south poles. A compass works because its needle is a small magnet balanced on a pin. The compass magnet feels the pull of the earth's magnetic field. The north-seeking end of the compass magnet points toward the north pole and the south-seeking end points toward the south pole. It is very similar to the way the iron filings lined up along the magnetic field of the small magnet in the *Exploring Magnetic Fields* activity.

The magnetic poles of the earth contain huge deposits of magnetite, also called lodestone. This stone contains iron ore and other iron compounds. It is the presence of these poles that create the magnetic field around the earth and that allows us to use a compass to tell directions.

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Thomas Alva Edison Foundation. 1988. *The Thomas Edison book of easy and incredible experiments.* New York: Wiley.

NOTES

WHICH WAY IS NORTH?

ACTIVITY SHEET

In the activity *Find the North and South Poles,* you saw that your magnet would hang from a thread with its north-seeking pole pointing toward the earth's north pole. Now let's look at how we can use that information to make a floating compass.

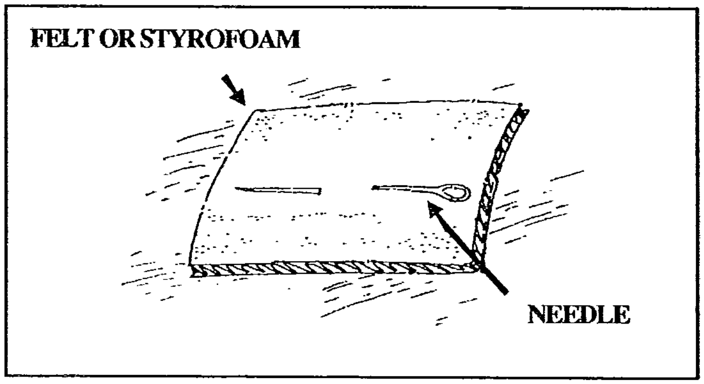
1. Work with a partner. You will need the following items:

   - bar magnet
   - needle **(Be careful)**
   - plastic cup
   - small piece of felt or styrofoam
   - small piece of tape
   - pencil

2. Rub the point of the needle gently lengthwise along one pole of the magnet. Each stroke must be in the same direction. **Do not rub back and forth.** Your teacher will demonstrate how to do this. What is happening to the needle as you do this?

3. After 10 or 11 strokes, see if the needle has become magnetized so that it will act like a magnet. See if the needle will pick up the paper clip. If not, stroke it a few more times along the pole of the magnet.

4. When your needle can pick up the paper clip, **carefully** stick the needle through the piece of felt or styrofoam as shown below.



5. Get some water in your cup. Set the cup on your desk and let it settle until the water is smooth and calm on top. Try to not bump into your desk. Gently lower the needle and felt into the cup so it floats on the surface of the water. If it sinks, ask your teacher for help. If your felt bumps into the side of the cup, you can gently push it back to the middle with your pencil tip.

6. Which way is your needle pointing? Look for the teacher's **NORTH** sign in the classroom. Is one end of your needle pointing toward the sign? If not, have your teacher check out your needle. Which end of the needle is pointing **NORTH?** This is the **north-seeking pole of your needle magnet.**

7. Place your piece of tape on the rim of the cup where the needle is pointing to **NORTH.** Now, very carefully carry your cup around to the other side of the room or the other side of your desk (or you can carry a regular compass). You must move slowly or you will spill the water and sink your compass! Hold your cup so that the piece of tape is pointed away from you.

8. Hold your compass in front of you and turn around slowly until the north-seeking end of your needle magnet is pointing toward the tape. You should now be facing toward the NORTH sign in your classroom. **You just made a floating compass!**

Compasses have been used for hundreds of years to help sailors, aircraft pilots, and explorers find their way. Some of the most famous explorers were from Portugal and Spain. You may have heard of Magallanes, Cortez, Ponce de Leon, Vasco Nuñez de Balboa, Los Hermanos Pinzón, Juan de la Cosa. These explorers all used compass magnets to travel between Europe and North and South America long before there were radios to help them navigate.

Another Hispanic sailor was Jorge Farragut. He was born on the island of Minorca, near Spain. He became a ship's captain and came to the United States to help her win the Revolutionary War. His son, David Farragut, also was a Navy captain who won battles during the Civil War. He became the very first admiral in the U.S. Navy. All these explorers and sailors used compasses just as you did today!

¿DONDE ESTA EL NORTE?

HOJA DE ACTIVIDADES

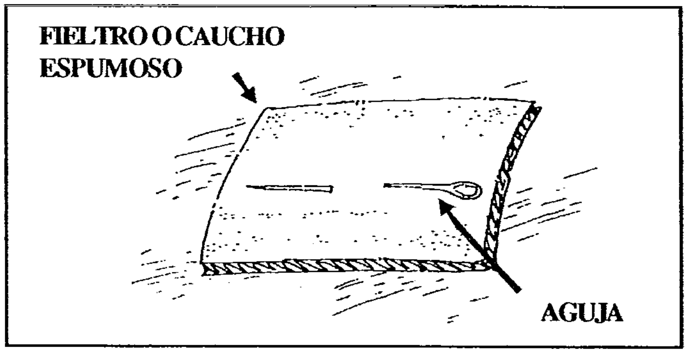
En la actividad *Como encontrar el polo norte y el polo sur*, usted vió su magneto colgando de un hilo con su polo de atracción norte buscando el polo norte de la Tierra. Ahora, vamos a usar esa información para construir un compás flotante.

1. Trabaje con un compañero. Se necesitan los siguientes objetos:
   - ✧ una barra magnética
   - ✧ una aguja (tenga cuidado)
   - ✧ una taza plástica
   - ✧ un pedazo pequeño de fieltro o de caucho espumoso
   - ✧ un pedazo pequeño de cinta adhesiva
   - ✧ un lápiz

2. Frote la punta de la aguja suavemente contra un polo del magento. Cada movimiento de frotación debe ir en la misma dirección, no hacia arriba y hacia abajo. El maestro le mostrará como hacerlo. ¿Qué ocurre?

3. Después de 10 ó 11 frotaduras, verifique si la aguja se ha **magnetizado** y actúa como un magneto. Vea si la aguja puede recoger un clip. Frótela algunas veces más contra el polo del magneto si no puede recoger el clip.

4. Cuando la aguja pueda recoger el clip, inserte la aguja **cuidadosamente** a través del pedazo de fieltro o de caucho espumoso, como se muestra más abajo.



5. Ponga un poco de agua en la taza. Ponga la taza sobre su pupitre y deje que el agua se asiente hasta que se aclare y no se mueva la superficie. Procure no mover su pupitre. Suavemente coloque la aguja y el fieltro en la taza, de manera que floten sobre la superficie del agua. Si se hunden pídale al maestro que lo ayude. Cuando el fieltro tropieze contra el lado de la taza, empújelo suavemente hacia el medio con la punta del lápiz.

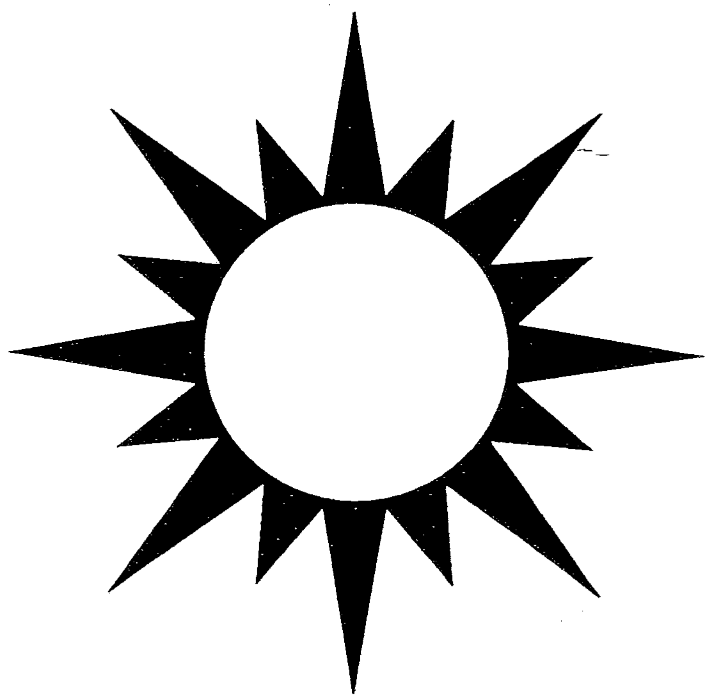
6. ¿Hacia que lado apunta la aguja? Busque el signo **norte** que ha colocado el maestro en el salón de clase. ¿Apunta la aguja hacia ese signo? Sí no lo hace, pida al maestro que pruebe la aguja que ha utilizado. ¿Cuál de los extremos de la aguja apunta hacia el **norte**? Ese es **el polo de su aguja magnética que busca el norte.**

7. Coloque un pedazo de cinta adhesiva en el borde de la taza, donde la aguja apunta hacia el **norte.** Ahora, cuidadosamente lleve la taza hacia el otro lado del salón o colóquela al otro lado del pupitre (también puede llevar un compás corriente). Muévase lentamente o puede derramar el agua y hundir el compás! Sostenga la taza de manera que el pedazo de cinta apunte opuestamente a usted.

8. Sostenga el compás frente a usted y muévalo lentamente alrededor hasta que el extremo magnético de la aguja que busca el **norte** apunte hacia el lugar donde está la cinta adhesiva. Ahora, usted debe estar frente al signo **norte** que se encuentra en el salón de clase. ¡Usted acaba de construir un compas flotante!

Por miles de años, el compás ha ayudado a los marineros, los aviadores y los exploradores a encontrar su ruta. Algunos de los exploradores más famosos nacieron en Portugal y en España. Usted ha oído hablar de Magallanes, Cortez, Ponce de León, Vasco Nuñez de Balboa, los Hermanos Pinzón, Juan de la Cosa. Todos esos exploradores utilizaron compases magnéticos para navegar entre Europa y Norte y Sur América, mucho antes de que se inventara la radio para guiar la navegación.

Otro marinero español, Jorge Farragut, nació en la Isla de Minorca, cerca de España continental. Se hizo capitán de barco y vino a los Estados Unidos a pelear en la Guerra de la Revolución. Su hijo, David Farragut, también fue capitán de barco, y ganó batallas durante la Guerra Civil. Fue el primer almirante de la Fuerza Naval de los Estados Unidos. Todos esos exploradores y navegantes utilizaron el compás, ¡como usted lo utilizó en el día de hoy!



WHAT'S AN ELECTROMAGNET?

SUGGESTIONS FOR TEACHERS

WHAT'S THE POINT?

To learn how to construct and use an electromagnet. To learn that electromagnets are temporary magnets and work only when electricity passes through the coil.

ESTIMATED TIME:

Setting time:	Time to gather materials
Doing activity:	15–25 minutes
Cleaning up:	10 minutes

APPROPRIATE AGE GROUPS:

_____K–3 __X__ 4–6 __X__ 7–8

Note: For younger children (grades K–3), you could build several demonstration models of electromagnets and let children try picking up magnetic objects with them.

DO ACTIVITY IN GROUPS OF: 2

MATERIALS NEEDED (per group of 2 students):

- ✧ iron bolt
- ✧ 2 feet (60 cm) of insulated wire (see *Supplies and Suppliers*)
- ✧ 2 size D (1.5 volt) batteries
- ✧ 20 paper clips and other magnetic objects
- ✧ masking tape and/or rubber bands to hold batteries together

SAFETY CONSIDERATIONS:

- ✧ Be careful with the sharp ends on the wires.
- ✧ Make sure children remember what a short circuit is and that the wires can become warm if they leave a short circuit connected for a minute or two.

ENRICHMENT FOR BILINGUAL STUDENTS:

Arrange a visit to a recycling plant and/or a junkyard. Children can see electromagnets in action. This will help reinforce the terminology and concepts.

ADAPTATIONS FOR PARTICIPANTS WITH DISABILITIES:

- Students with hearing impairments will have no trouble performing this activity.
- Students with visual and/or mobility impairments will need to work with partners.

BEFORE YOU BEGIN:

- Before doing this activity, students should have completed the *Simple Circuits* and *How Strong is Your Magnet?* activities.
- Build an electromagnet and try it yourself so you can assist students in wrapping the wire coil.
- Prestrip the ends of the wire for each pair of students. Use a wire stripper, scissors, or sharp knife to remove insulation.

QUESTIONS TO ASK AS YOU DO THE ACTIVITY:

- What is traveling through the wires? Where does the electricity come from?
- Describe what an electromagnet is.
- Is an electromagnet a temporary magnet or a permanent magnet? Why is it a temporary magnet?
- How can you measure the strength of your electromagnet? How can you make your electromagnet stronger?

CLEAN UP:

- Do not dismantle the electromagnets until you are finished with electromagnet activities, but be sure they are disconnected from the batteries at the end of class. A number of activities to do with the electromagnets are listed below. Students can label their electromagnets with tape and use them over and over.
- When you are finished with electromagnets activities, unwrap the wires and be sure the electromagnets are not connected to the batteries.
- Undo the battery packs.

WHERE CAN I GO FROM HERE?

Once students have built their electromagnets, you can have them explore the strength of the electromagnet (as described above or in a more formal way as described in *How Strong is Your Magnet?*) and the magnetic field of the electromagnet (see *Exploring Magnetic Fields* and *Magnetic Pictures*). These activities adapt readily to using electromagnets.

WHY IT HAPPENS:

When an electric current flows through a wire, a magnetic field is produced around it. The field produced by a single wire is very weak. To increase it, we wind the wire into a tight coil. This concentrates the magnetic field, especially if we put an iron bar in the center of the field. The poles of the magnet are at either end of the coiled wire (therefore, at the ends of the iron bolt).

There are two ways to increase the strength of an electromagnet. One is by adding more length to the wire (more coils). The other is by increasing the amount of electricity going through the wire. By increasing these two things, engineers have developed very powerful electromagnets such as the enormous ones used in junkyards to lift large piles of metal.

NOTES

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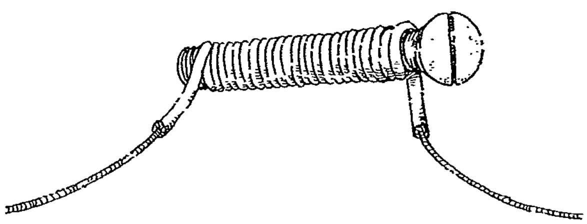
WHAT'S AN ELECTROMAGNET?

ACTIVITY SHEET

You can make a temporary magnet by stroking a piece of iron or steel (such as a needle) along a permanent magnet. There is another way that uses electricity to make a temporary magnet, called an *electromagnet*. Let's build one!

1. Work with a partner. For this activity, you will need:
   - 1 iron bolt
   - 2 feet (61 cm) of insulated wire
   - 2 size D batteries (1.5 volts each)
   - paper clips and other magnetic items.

2. Wrap the wire in a **tight, even coil** around the bolt or nail; leave 3–4 inches (7.5–10 cm) loose at each end. Keep wrapping the wire until you get to the end of the bolt. There should be one or two layers of wire all the way up and down the bolt. Your electromagnet should look something like this:



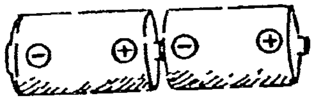
3. Attach one of the wires to the positive (+) end of your battery. Attach the other wire to the negative (-) end of your battery.

4. Try to pick up one of the paper clips with your electromagnet. What happens? Now unhook one of the wires from the battery. Will your electromagnet pick up a paper clip now? What do you need going through the wire to make the iron bolt act like a magnet?

5. Make a hook out of one of the paper clips as you did in *How Strong is Your Magnet?* and add paper clips one by one until it becomes too heavy for the electromagnet to hold.

   How many paper clips will your electromagnet hold?

6. Now, build a battery pack using two batteries as you did in *Circuits and Maps*. Connect your electromagnet to this two-battery pack.



Now how many paper clips will your electromagnet hold?

How do you think the amount of electricity going through the wire affects how strong the magnet is? Write a sentence telling what you think.

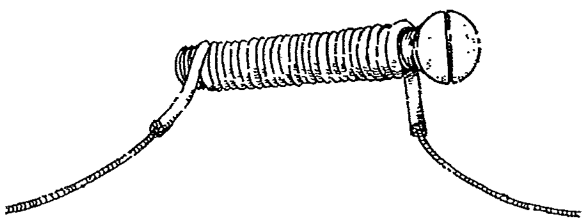
¿QUE ES UN ELECTROMAGNETO?

HOJA DE ACTIVIDADES

Se puede hacer un magneto temporal, frotando un pedazo de hierro ó de acero (como una aguja) contra un magneto permanente. Otra manera es utilizar la electricidad para hacer un magneto/ imán temporal, esto se llama electromagneto. ¡Vamos a construirlo!

1. Trabaje con un compañero. Para esta actividad se necesita:
   - ✧ un pedazo de hierro ó un clavo
   - ✧ dos pies (61 cm) de alambre aislador
   - ✧ dos baterías de células-D (1.5 voltios cada una)
   - ✧ clips de papel y otros objetos magnéticos.

2. Enrolle el alambre en una **espiral uniforme y ajustada** alrededor del clavo; deje 3–4 pulgadas (7.5–10 cm) de alambre sueltos en cada extremo. Siga enrollando el alambre hasta que llegue al final del clavo. Deben haber uno ó dos capas de alambre alrededor del clavo. El electromagneto que se construye debe ser similar a este:



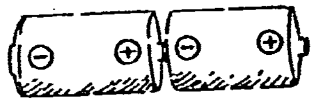
3. Conecte uno de los alambres con el polo positivo (+) de las baterías. Conecte el otro alambre con el polo negativo (-) de las baterías.

4. Trate de agarrar uno de los clips con el electromagneto. ¿Qué ocurre? Ahora desconecte uno de los alambres de la batería. ¿Puede el electromagneto agarrar el clip ahora? ¿Qué debe pasar a través del alambre para hacer que el clavo de hierro actue como magneto?

5. Haga un gancho con uno de los clips como lo hizo en la actividad *¿Que fuerza tiene su imán?* y ponga clips en el gancho, uno por uno, hasta que los ganchos se hagan muy pesados y el electromagneto no pueda sostenerlos.

   ¿Cuántos clips puede sostener el electromagneto?

6. Ahora, junte dos baterías, como lo hizo en la actividad *Circuitos y mapas*, y conecte el electromagneto a las dos baterías.



¿Cuántos clips puede sostener el electromagneto?

¿Cómo se afecta la fuerza del magneto por la cantidad de electricidad que corre a través del alambre? Escriba lo que piensa en una oración.