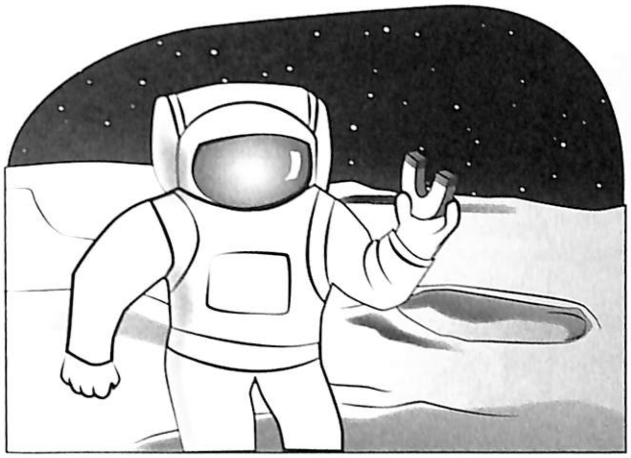
# How Would a Magnet Work on the Moon?



Four friends were wondering if gravity had an effect on magnets. They each had different ideas about how a magnet would work on the moon. Here is what they said:

**Leif:** A magnet would work the same as it does on Earth.

**Imani:** A magnet would work but it wouldn't be as strong as it is on Earth.

**Jasmine:** A magnet would work the opposite way on the Moon. It would repel rather than attract iron.

**Nate:** A magnet wouldn't work at all on the Moon.

With whom do you agree the most? ______________ Explain why you agree.

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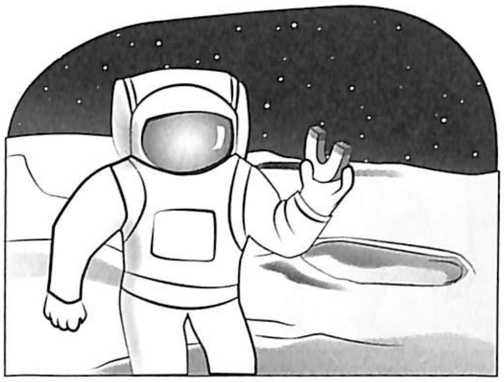
# How Would a Magnet Work on the Moon?

## Teacher Notes



### Purpose
The purpose of this assessment probe is to elicit students' ideas about magnetism. The probe is designed to reveal whether students think gravity has an effect on magnetism.

### Related Concepts
magnetic force, magnets and gravity, interaction

### Explanation
The best answer is Leif's: "A magnet would work the same as it does on Earth." Magnetism is a force that is independent of gravity. Although the gravitational force on an object on the Moon is less than the gravitational force on the object on Earth, it does not affect the magnetic attraction.

### Administering the Probe
This probe is best used with middle and high school students. Before using this probe, first make sure students know how conditions on the moon (e.g., less gravitational force, no atmosphere) are different from conditions on Earth.

### Related Research
- Researchers have found that some students link magnetism with gravity. Students sometimes describe gravity as a magnetic force drawing objects toward the Earth. Conversely, some students refer to magnetism as a type of gravity (Driver et al. 1994).
- Borges and Gilbert (1998) found that among secondary, university, and graduate students, the majority retained naïve and scientifically flawed concepts about magnetism, even after long periods of study.
- A study of students ages 9 to 14 found that 20% connected magnetism to gravity (Bar and Zinn 1989).

### Suggestions for Instruction and Assessment
- Provide additional examples to challenge students beliefs about the connection

between magnetism and gravity by including other planets, a planet in a distant galaxy, a space probe traveling to the edge of our solar system, on top of the world's tallest mountain, in a tunnel deep within the Earth, and so on.

- Counter students' beliefs with articles on objects in space that depend on magnets. For example, a large magnet is part of a cosmic ray detector that was attached to the outside of the International Space Station, which orbits in space where there is no atmosphere or air.
- Show students a YouTube video of an astronaut on the International Space Station demonstrating how magnets work in microgravity: *www.youtube.com/watch?v=NvJcrGlzGAg*
- Have students investigate how a compass works on Earth. Then have them research how Earth's magnetic field compares with the Moon's magnetic field. Challenge them to predict and explain whether a compass would work on the Moon and how using a compass is similar to and/or different from using a regular magnet.

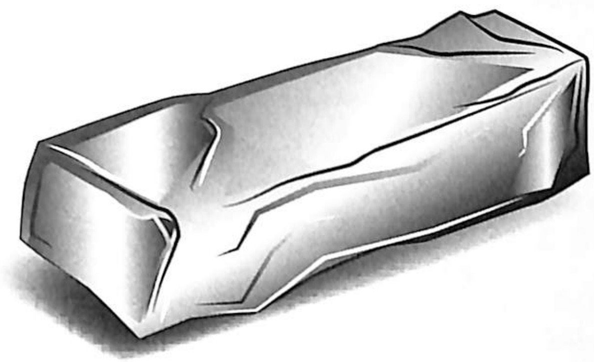
## References

Bar, V., and B. Zinn. 1989. *Does a magnet act on the moon? Scientific Report.* Jerusalem, Israel: The Amos de Shalit Teaching Centre, Hebrew University.

Borges, A., and J. Gilbert. 1998. Models of magnetism. *International Journal of Science Education* 20: 361–378.

Driver, R., A. Squires, P. Rushworth, and V. Wood-Robinson. 1994. *Making sense of secondary science: Research into children's ideas.* London: RoutledgeFalmer.

# What Happens When You Wrap a Magnet With Aluminum Foil?



A magnet is wrapped up with aluminum foil. The magnet is completely covered by the foil. What do you predict will happen when the magnet is held near a steel paper clip? Circle the prediction that best matches your thinking.

**A.** The paper clip will move toward the wrapped magnet.

**B.** The paper clip will move away from the wrapped magnet.

**C.** The paper clip will not move either toward or away from the magnet.

Explain your thinking. What rule or reasoning did you use to make your prediction?

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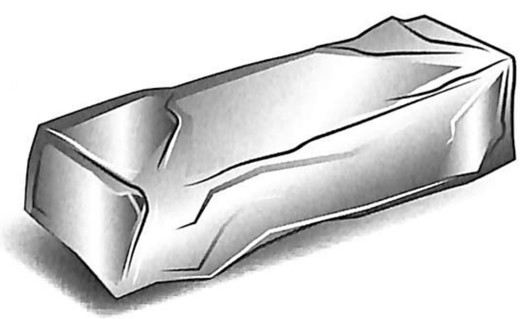
# What Happens When You Wrap a Magnet With Aluminum Foil?

## Teacher Notes



### Purpose

The purpose of this assessment probe is to elicit students' ideas about magnetic force. The probe is designed to reveal students' ideas about how magnetism passes through some materials.

### Related Concepts

magnetic force, magnetic materials, interaction

### Explanation

The best answer is "A. The paper clip will move toward the wrapped magnet." Aluminum is a non-magnetic material. Non-magnetic materials do not interact with magnets or magnetic fields. As a result, the magnetic field produced by the magnet is unaffected by the aluminum foil and will still interact with the paper clip. Plastic is also a non-magnetic material. Some magnets are covered in plastic to protect the magnet. Just like the aluminum foil, the plastic will not interfere with the magnetic properties of the magnet.

### Administering the Probe

This probe is best used with upper elementary and middle school students. If materials are available, consider demonstrating the probe scenario. First show students that the magnet interacts with the paper clip before wrapping it up with foil. This probe can be used with the P-E-O strategy described on page xii (Keeley 2008).

### Related Research

- Barrow (1987) investigated students' ideas about magnets across all age ranges. He found that students were generally aware of magnets and how they worked from their everyday experience picking up things with magnets or sticking them to a refrigerator. However, before being taught about magnets, they couldn't explain magnetism (Driver et al. 1994).
- Researchers at the University of Washington have found that students often believe materials that do not interact with a prop-

erty of matter are more effective at blocking the effect. This is also true for electric fields, where students incorrectly predict that insulators will block the electric field more effectively then conductors.

## Suggestions for Instruction and Assessment

- Ask students to predict what will happen when the magnet is wrapped with other materials such as plastic wrap, wax paper, electrical tape, wool, and so on.
- Once students observe that the magnetism passes through the foil, ask them if the thickness makes a difference. Test the magnet by wrapping it with different thicknesses of foil.
- The best way to block magnetic interactions is to wrap the magnet in a ferromagnetic material. For example, have students wrap a magnet in a steel can or in sheet metal made from an iron alloy.
- Visit *www.youtube.com/watch?v=GNizWxAD-9M* for an explanation of the Faraday Pail: An example of electrostatic shielding.

## NSTA Safety Notes for Follow-up Instructional Activities

1. Use caution in handling metals. Some have sharp edges that can cut skin.
2. Students should wash their hands with soap and water after handling all metals.
3. Lead and mercury must be avoided.
4. Some individuals are allergic to wool.

## References

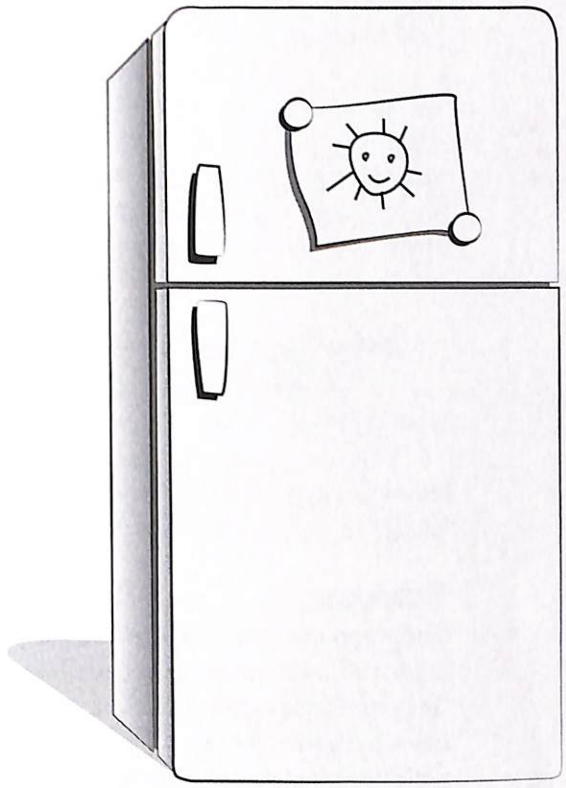

Barrow, L. 1987. Magnet concepts and elementary students' misconceptions, in *Proceedings of the Second International Seminar on Misconceptions and Educational Strategies in Science and Mathematics*, ed. J. Noval, 17–22. Ithaca, NY: Cornell University.

Driver, R., A. Squires, P. Rushworth, and V. Wood-Robinson. 1994. *Making sense of secondary science: Research into children's ideas.* London: RoutledgeFalmer.

Keeley, P. 2008. *Science formative assessment: 75 practical strategies for linking assessment, instruction, and learning.* Thousand Oaks, CA: Corwin Press.

# What Makes It Stick?

Six friends were talking about what makes a magnet stick to a refrigerator. This is what they said:



**Joaquin:** I think chemicals make it stick.

**Shantell:** I think it has to do with a type of gravity.

**Yiannis:** I think an unseen force is involved.

**Maura:** I think it is because the magnet is charged.

**Bart:** I think a type of energy is what makes it stick.

**Bernie:** I think it's only friction that makes it stick.

With whom do you agree the most? _____________ Explain your thinking.

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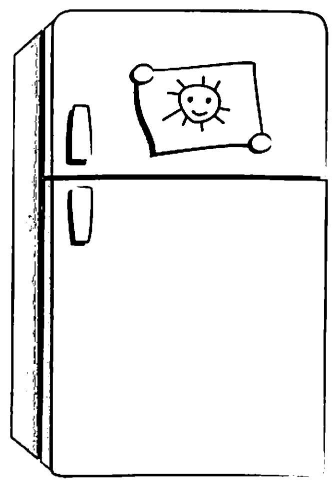
# What Makes It Stick?

## Teacher Notes



### Purpose
The purpose of this assessment probe is to elicit students' ideas about magnetic interactions. The probe is designed to find out whether students recognize that it is a force between magnetic objects that causes them to "stick."

### Related Concepts
magnetic force, interaction, magnets and gravity, electric charge

### Explanation
The best answer is Yiannis's: "I think an unseen force is involved." Magnetic interactions are caused by magnetic fields, which cannot be directly observed. Magnetic fields are produced by the atoms in the material and act at a distance and not because the magnet is touching the refrigerator. However, sticking to a refrigerator involves more than magnetic forces. There is a friction force "up" that is opposite to a gravitational force "down." This force keeps the magnet from sliding down the refrigerator. However, it is the magnetic force that pulls the magnet toward the refrigerator.

### Administering the Probe
This probe is best used with middle and high school students. If materials are available, consider demonstrating the probe scenario. (Note: magnets do not stick to stainless steel refrigerators.) This probe works well as a discussion at the start of a unit on electricity and magnetism.

### Related Research
- Elementary students are usually aware of how magnets are attracted to magnetic objects but may not recognize the force involved (Driver et al. 1994).
- Researchers have found that some students tend to link magnetism with gravity. Some account for the way magnets interact with objects by calling magnetism a "type of gravity" (Barrow 1987).
- Barrow's study also found that before teaching, most students offered no explanation

of magnetism. A few referred to "chemicals making them stick." After teaching, references were made to gravity, energies, and electrons, and protons (Driver et al. 1994).

- A study by Selman et al. (1982) of students between the ages of 3 and 9 demonstrated two levels of conceptualizing magnetism: (1) one of linking events and (2) the notion of an unseen force as magnets "pulling on things."
- In a study by Erickson (1994) of students' conceptions of magnetism in grades 4, 7, and 10, three models emerged. Common among the younger students was the "pulling model," primarily providing only a description of observation, and associated mainly with the effect of magnets on other bodies without consideration of mechanism or causality. The "emanating model" is explained in terms of the magnet emanating rays of energy toward attracted objects. The "enclosing model" is characterized by rays coming out of the magnet spreading over the area to create region of influence, analogous to the effect of gravity.
- Borges and Gilbert (1998) found that among secondary, university, and graduate students, the majority retained naïve and scientifically flawed concepts about magnetism, even after long periods of study.

## Suggestions for Instruction and Assessment

- Consider combining this probe with "What Happens When You Hold a Magnet Near a Refrigerator?" (p. 143) so students can use a representation to explain their thinking.
- The answer choices in this probe mirror the commonly held ideas in the research (see Related Research section). Your students may have other ideas and if so, add a seventh answer choice: "I don't think it is any of these things. I think it is because of something else." If they choose this answer, have them explain what the "something else" is that makes the magnet stick.
- This probe is best used for discussion at the start of a unit on magnetism. Teachers should not correct misunderstandings during these discussions, but use what they learn about student ideas to better facilitate hands-on activities that help students to test their initial models.
- Compare responses to this probe to "What Happens When You Bring a Balloon Near a Wall?" (p. 27). Results may reveal difficulty in distinguishing between electric charge interactions and magnetic interactions.

## NSTA Safety Notes for Follow-up Instructional Activities

1. Use caution in handling metals. Some have sharp edges that can cut skin.
2. Students should wash their hands with soap and water after handling all metals.

## References

Barrow, L. 1987. Magnet concepts and elementary students' misconceptions. In *Proceedings of the Second International Seminar on Misconceptions and Educational Strategies in Science and Mathematics*, ed. J. Novak, 17–22. Ithaca, NY: Cornell University.

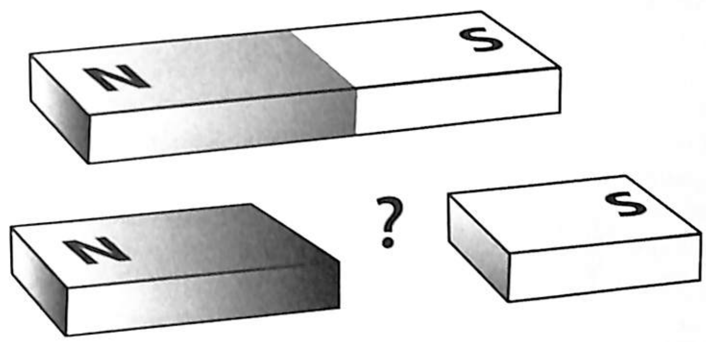
Borges, A., and J. Gilbert. 1998. Models of magnetism. *International Journal of Science Education* 20: 361–378.

Driver, R., A. Squires, P. Rushworth, and V. Wood-Robinson. 1994. *Making sense of secondary science: Research into children's ideas.* London: RoutledgeFalmer.

Erickson, G. 1994. Pupil's understanding of magnetism in a practical assessment context: The relationship between content, process and progression. In *The content of Science*, ed. P. Fehsham, R. Gunstone, and R. White, 80–96. London: Falmer.

Selman, R., M. Krupa, C. Stone, and D. Jacquette. 1982. Concrete operational thought and the emergence of the concept of unseen force in children's theories of electromagnetism and gravity. *Science Education* 66 (2): 181–194.

# What Happens When a Magnet Breaks?




Three students were asked to draw what they thought would happen to the magnet shown above if it were broken in half at the center of its length. Here is what they said:

**Sabrina:** I think one magnet will have 2 N poles at the ends and the other magnet will have 2 S poles at the ends.

**Marcus:** I think both magnets will have a N and a S pole at each end.

**Lester:** I think one magnet would have the N pole on one end and the other would have the S pole on one end, but the other ends of both magnets would have no poles.

With whom do you agree the most? _______________ Explain why you agree.

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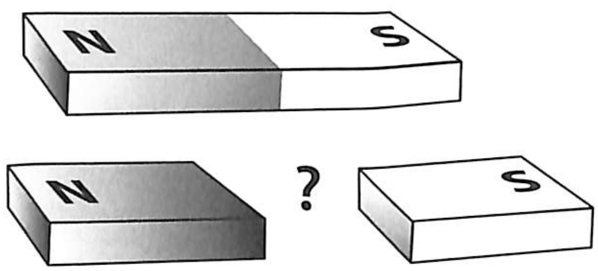
# What Happens When a Magnet Breaks?

## Teacher Notes




### Purpose

The purpose of this assessment probe is to elicit students' ideas about the properties of magnets. The probe is designed to find out how students would represent the poles of a broken magnet.

### Related Concepts

magnetic force, poles, symbolic representation, interaction

### Explanation

The best answer is Marcus's: "I think both magnets will have a N and a S pole at each end." The magnet shown in the picture is considered a bar magnet with a north pole at one end and south pole at the other. Because magnetic fields form complete loops (unlike electric fields), all magnetic poles come in pairs with both a north and a south end (called a magnetic dipole). The magnetic field comes from the north pole, around in a complete circle and back into the south pole.

Breaking a bar magnet in half will not isolate a single pole nor create the same pole at each end. If the magnet is cut in two, two bar magnets are created out of one. This halving and creation of dipoles from one magnet to two to four to eight and so on can continue to the level of an atom. This suggests that atoms themselves are magnets with both a north and a south pole.

### Administering the Probe

This probe is best used with middle and high school students. If materials are available, consider demonstrating the probe scenario. This probe works well as a discussion about the properties of magnets. Have students support their explanation with a drawing of what they think the pole-labeled magnet would look like.

### Related Research

- Barrow (1987) investigated students (of all ages) ideas about magnetism and found that few had correct ideas about poles.

- Borges and Gilbert (1998) found that among secondary, university, and graduate students, the majority retained naïve and scientifically flawed concepts about magnetism, even after long periods of study.

## Suggestions for Instruction and Assessment

- Extend the probe by asking what would happen if the magnet was cut in thirds.
- Challenge older students to think about the extent to which a magnet can be successively halved and still be a magnet.
- Challenge students with the question, "If you cut a magnet in half, will the strength of one of the magnets be reduced by half?"
- Challenge students to describe what happens when magnets of other shapes (discs, horseshoe, donut) are cut in half.

## NSTA Safety Notes for Follow-up Instructional Activities

1. Use caution in handling metals including cut magnets. Some have sharp edges that can cut skin.
2. Students should wash their hands with soap and water after handling all metals.

## References

Barrow, L. 1987. Magnet concepts and elementary students' misconceptions. In *Proceedings of the Second International Seminar on Misconceptions and Educational Strategies in Science and Mathematics*, ed. J. Novak, 17–22. Ithaca, NY: Cornell University.

Borges, A., and J. Gilbert. 1998. Models of magnetism. *International Journal of Science Education* 20: 361–378.