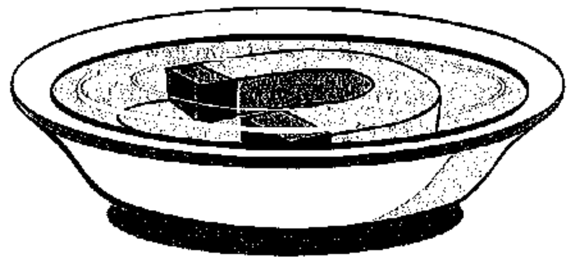
Magnets in Water



Four friends were wondering if a magnet could pick up steel paper clips in water. This is what they said:

Nate: "I think magnets and paper clips need to be in air. If both the magnets and paper clips are in water, they won't attract."

Amy: "I think magnets need to be in the air, but it doesn't matter if the paper clip is. Magnets can attract paper clips covered with water."

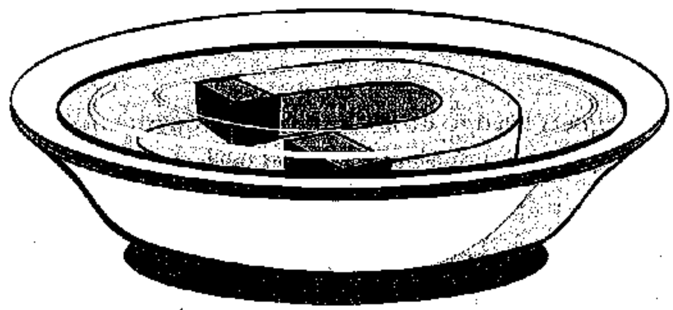
Steve: "I don't think air makes a difference. I think magnets will attract paper clips when both are underwater."

Leah: "I don't think air makes a difference. However, when magnets are in water, they work the opposite way. The paper clips will be repelled by the magnet."

Which friend do you agree with and why? Explain your thinking about how magnets work.

Magnets in Water

Teacher Notes



Purpose

The purpose of this assessment probe is to elicit students' ideas about magnetism. The probe is specifically designed to determine whether students believe air is necessary for magnets to work.

Related Concept

magnetism

Explanation

The best answer is Steve's: "I don't think air makes a difference. I think magnets will attract paper clips when both are underwater." Magnetism is a force that can work through a gas, a liquid, and even a solid (e.g., nonmagnetic materials such as paper, wood, aluminum foil, tape, and plastic). Just as electricity moves through some materials better than others, magnetism moves with ease through some materials and has more difficulty passing through other materials. Although most peoples' experiences with magnets happen in an environment in which the magnet is surrounded by air, magnets also work underwater and in other gaseous environments, such as in carbon dioxide and helium. Magnets also work in environments without an atmosphere or air. For example, a magnet on the Moon or a magnet in a bell jar with all the air removed will attract iron objects.

Curricular and Instructional Considerations

Elementary Students

In the elementary grades, magnets provide students with multiple opportunities to engage in inquiry while developing the idea that forces can act without directly touching an object. Students' experiences with magnets are mostly observational. Explaining the specifics of how magnets work should wait until students develop a deeper understanding of forces in middle school.

Middle School Students

In the middle grades, students combine their knowledge of magnets with their understanding of electric current. At this level, students have developed ideas about gravity and electric charge that may interfere with ideas about magnetism.

High School Students

At the high school level, students develop more sophisticated ideas about electromagnetism. However, early misconceptions related to magnets and their effect in air may still persist.

Administering the Probe

This probe is appropriate at all grade levels. You might consider using a prop by first showing how magnets pick up paper clips when both are in air and then putting a magnet in water and asking students what they think would happen if the paper clips were placed near the magnet. This probe can lead to a lively discussion of students' ideas.

Related Ideas in *National Science Education Standards* (NRC 1996)

K–4 Properties of Objects and Materials

- Objects have many observable properties, including size, weight, shape, color, temperature, and the ability to react with other substances.

K–4 Light, Heat, Electricity, and Magnetism

★ Magnets attract and repel each other and certain kinds of materials.

9–12 Motions and Forces

- Electricity and magnetism are two aspects of a single electromagnetic force.

Related Ideas in *Benchmarks for Science Literacy* (AAAS 1993 and 2008)

Note: Benchmarks revised in 2008 are indicated by (R). New benchmarks added in 2008 are indicated by (N).

K–2 Forces of Nature

- Magnets can be used to make some things move without being touched.

3–5 Forces of Nature

★ Without touching them, a magnet pulls on all things made of iron and either pushes or pulls on other magnets.

6–8 Forces of Nature

- Electric currents and magnets can exert a force on each other.

★ Indicates a strong match between the ideas elicited by the probe and a national standard's learning goal.

9–12 Forces of Nature

- Magnetic forces are very closely related to electric forces and are thought of as different aspects of a single electromagnetic force. Moving electrically charged objects produces magnetic forces and moving magnets produces electric forces. (R)

Related Research

- Research has shown that some students are inclined to link gravity with magnetism (Driver et al. 1994). If they believe gravity is necessary for magnets to work and also believe that gravity has no or less of an effect under water, they may believe magnets will not attract objects in water.
- Barrow (1987) investigated students' awareness of magnets and magnetism across age ranges and found that they were aware of magnets through their everyday experiences of sticking objects to refrigerators with magnets. However, before instruction, few students could offer explanations of magnetism, especially in terms of forces and how magnets work (Driver et al. 1994).
- Bar and Zinn (1989) sampled 98 students ages 9–14 and found that 40% believed that a medium (air) was necessary in order for magnets to have an effect on objects. Twenty percent of these students also made a link between gravity and magnetism (Driver et al. 1994).

Suggestions for Instruction and Assessment

- This probe can be used with the P-E-O (Predict, Explain, Observe) strategy (Keeley 2008). Have students make a prediction, explain the reasons for their prediction, and test their ideas. If their observations do not match their predictions, challenge them to construct a new explanation to fit their observations.
- Consider probing students' ideas about magnets related to their ideas about gravity. Do students believe gravity is necessary in order for magnets to work? Do they link the idea that air is necessary for gravity and thus link magnetism to gravity as well?
- Barrow's (1987) study considered that teaching about magnets might dissociate students from their everyday awareness of magnetism. Barrow suggested that teaching approaches that draw on everyday experience and focus on uses of magnets may be effective in helping students understand magnetism.
- Providing opportunities for students to test and observe how magnetism passes through solid materials such as paper, plastic, and aluminum foil may help support the notion that magnetism also passes through a liquid such as water.
- Challenge students to think about whether magnets work in the absence of air and come up with a way to test it. One way is to suspend a magnet attracted to a paper clip in a bell jar. If students think air is needed in order for the paper clip to remain

attracted to the magnet, have them observe whether the paper clip will drop.

Related NSTA Science Store Publications, NSTA Journal Articles, NSTA SciGuides, NSTA SciPacks, and NSTA Science Objects

American Association for the Advancement of Science (AAAS). 2007. *Atlas of science literacy.* Vol. 2. (See "Electricity and Magnetism" map, pp. 26–27.) Washington, DC: AAAS.

Ansberry, K., and E. Morgan. 2007. *More picture-perfect science lessons: Using children's books to guide inquiry, K–4.* (See "That Magnetic Dog," pp. 123–129.) Arlington, VA: NSTA Press.

Kur, J., and M. Heitzman. 2008. Attracting student wonderings. *Science & Children* (Jan.): 28–32.

Robertson, W. 2005. *Electricity and magnetism: Stop faking it! Finally understanding science so you can teach it.* Arlington, VA: NSTA Press.

Related Curriculum Topic Study Guide
(Keeley 2005)
"Magnetism"

References

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American Association for the Advancement of Science (AAAS). 2008. Benchmarks for science literacy online. *www.project2061.org/publications/bsl/online*

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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, 3: 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. 2005. *Science curriculum topic study: Bridging the gap between standards and practice.* Thousand Oaks, CA: Corwin Press.

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

National Research Council (NRC). 1996. *National science education standards.* Washington, DC: National Academy Press.