ASME International

Engineering Magic

TRICK #5: The Magic Playing Card

Teacher's Guide

Overview of the Trick:

The Magician holds up what appears to be a large playing card. He shows a side with 1 spot, then he reverses the card to show a side with five spots. From the way the spots are positioned and the way he holds the card, he expects the audience to assume there is a sixth spot under his hand. When he turns the card over, there are 2 visible spots and again the audience is given the impression that there is a third spot hidden under his hand. When the card is turned again, there are only 4 spots! At this point, some viewers may become suspicious that there were only 5 spots on the card initially and that the 5th spot is now hidden under his hand. Likewise, viewers may now conclude that there were actually only 2 spots on the back of the card, one of which the Magician initially hid. Finally, as if to "prove" these conclusions false, the Magician first shows all three spots, then all six, and then eight!

How the Trick Works:

(Do not reveal this to students until after they have proposed their own explanation for the trick.)

As suspected by astute viewers, there are just 2 spots painted on one side and just 5 on the other. However, the card is made of metal and there are also several black spots mounted on magnetic sheeting material that cling to the metal card. On the first side, 1 black magnetic spot initially covers one painted spot. Thus, when it is slid over, there are three spots. On the other side, 3 of the painted-on 5 spots are covered with black magnetic spots, which can be slid over to show first 6 and finally 8 spots.

Lesson Focus: **Properties of Flexible Magnets**

Lesson Synopsis: Students use magnetic sheeting and a metal surface such as a filing cabinet, metal message board, or steel cookie sheet to recreate the trick. In What's Going On Here?, they compare and contrast the properties of flexible magnetic sheeting material to metal or ceramic magnets. As a Math Connection, they graph the relationship between magnetic sheet surface area and magnetic strength. Finally, they are challenged to create a product using magnetic sheeting, such as a board game that uses magnetic game pieces or a teaching tool.

TRICK #5: The Magic Playing Card Teacher's Guide (continued)

Related National Science Education Standards:

Content Standard B (Physical Science):

As a result of their activities in **grades 5-8**, all students should develop an understanding of **Properties and Changes in Properties of Matter.**

Fundamental concepts and principles that underlie this standard include:

A substance has characteristic properties…

As a result of their activities in **grades K-4**, all students should develop an understanding of **Light, Heat, Electricity, and Magnetism**.

Fundamental concepts and principles that underlie this standard include:

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

Content Standard E (Science and Technology):

As a result of activities in **grades 5-8**, all students should develop **Abilities of Technological Design**, including the ability to **Design a Solution or Product** and to **Evaluate Completed Technological Designs and Products**.

Related Benchmarks from Benchmarks for Science Literacy:

Section IB (Scientific Inquiry):

By the end of **8th grade**, students should know that:

What people expect to observe affects what they actually do observe.

Section 3C (Issues in Technology):

By the end of **5th grade**, students should know that:

Scientific laws, engineering principles, properties of materials, and construction techniques must be taken into account in designing engineering solutions to problems.

By the end of **8th grade**, students should know that:

Once an invention exists, people are likely to think up ways of using it that were never imagined at first.

Section 8B (Materials and Manufacturing):

By the end of **8th grade**, students should know that:

The choice of materials for a job depends on their properties and how they interact with other materials.

TRICK #5: The Magic Playing Card Teacher's Guide (continued)

Section 9B (Symbolic Relationships):

By the end of **8th grade**, students should know that:

Graphs can show a variety of possible relationships between two variables.

Glossary:

- **flexible magnets** Magnets made by magnetizing sheets of material made from a mixture of rubber compounds and iron compounds. The sheets are usually magnetized on one face only. Flexible magnets are easily cut with scissors, inexpensive, and bendable, but are magnetically weak.

Important Science Concepts:

1. Magnets can be made from a variety of materials.
2. Magnets made from one material are attracted to the same objects as magnets made from other materials.
3. Magnets may differ in their strength of attraction.
4. Not all magnetic materials have a single north pole and south pole.

Materials for Each Inquiry Team:

- Steel cookie sheet (cheap one from a discount store or one borrowed from home)
- Flexible magnetic sheeting (available from craft stores in strips, sheets, or rolls)
- "Ordinary" magnets (metal or ceramic)
- Rulers
- Paper Clips
- Scissors, paper, markers, glue, etc.

Safety Precautions:

- Although the risk of damage is low, it is a good policy to keep magnets away from computer discs and computers.

Procedure:

Engagement: Show the video of the **Magic Playing Card Trick.** Have students brainstorm in their **Inquiry Journals** possible explanations for the trick.

Exploration, Explanation, and Extension: see **Student Handout**

TRICK #5: The Magic Playing Card Teacher's Guide (continued)

Evaluation:

1. Provide each student with a pair of unfamiliar magnets and have him/her determine which is "stronger". Have each explain the criteria applied and the data on which the conclusion was based.

Ideas for Further Exploration:

Pass out copies of **What's Going On Here?** and provide materials for teams to take the **Engineering Challenge**.

There are numerous student activities involving magnets. Depending on students' past experience with magnets and their interest, you may wish to consult a Physical Science text for additional magnet activities.

Additional Background Information for Teachers:

Flexible magnetic sheeting is made by mixing an iron compound with a rubbery substance to form sheets that can be magnetized on one or both sides (usually just one). The advantages of magnetic sheeting are that it is inexpensive, it can be cut with scissors, it can be applied to a curved surface, and that colored vinyl or adhesive can be added to its non-magnetic side. It is widely used for magnetic signs for use on vehicles and for promotional refrigerator magnets, magnetic business cards, etc. Its main disadvantage is that is magnetically weak.

References:

- **Auto Game for the Car**, directions available online at http://www.kidsdomain.com/craft/auto.html

TRICK #5: The Magic Playing Card

Student Handout

Materials for Each Inquiry Team:

- Steel cookie sheet (cheap one from a discount store or one borrowed from home)
- Flexible magnetic sheeting (available from craft stores in strips, sheets, or rolls)
- Scissors, paper, markers, glue, etc.

Exploration:

1. Use a coin or other round object to trace several circles on a sheet of paper and on the magnetic sheeting.
2. Cut out the magnetic circles.
3. Color in the traced circles.
4. Lay a magnetic circle on a colored circle. Note the total number of visible circles on the paper.
5. Slide the magnetic circle over to a white area on the paper. Now how many circles do you count?

Explanation:

Revise, if you wish, your explanation of how the trick was done and then watch the video segment in which the Magician reveals his secret.

Extension:

Create a pair of drawings of cards with marked black circles and use cut-out black circles to illustrate each "step" in the illusion. (Hint: You will need one drawing with 2 black circles, one with 5 black circles, and 4 extra cut-out circles.)

TRICK #5: What's Going On Here?

Student Handout

Properties of Flexible Magnets

Do you recall some past experiences with **bar magnets**? Bar magnets are man-made magnets that are made by using an **electromagnet** to magnetize a bar of steel. The bar magnet produced has a **north-seeking pole** and a **south-seeking pole**. You probably discovered that like poles repel each other and unlike poles attract each other.

Man-made magnets can be made in a variety of types (including **ceramic** and **flexible**) and shapes, but all must contain some iron, steel, cobalt, or nickel, since these are the only metals that can be magnetized. Depending on how they are made, man-made magnets may or may not have a single north pole and south pole.

The extra dots on the trick playing card were mounted on **flexible magnets** made of flexible magnetic sheeting. Flexible magnetic sheeting is made by mixing an iron compound with a rubbery substance to form sheets that can be magnetized on one or both sides. Usually just one side is magnetic. How can you test your sheeting sample to find out whether both sides are magnetic?

The advantages of magnetic sheeting are that it is inexpensive, it can be cut with scissors, it can be applied to a curved surface, and colored vinyl or adhesive can be added to its non-magnetic side. What uses of magnetic sheeting are you familiar with or can you imagine?

Comparing Flexible Magnets to Other types of Magnets

Additional Materials for Each Inquiry Team:

- "Ordinary" magnets (metal or ceramic)
- Rulers
- Paper Clips

Using cutouts from magnetic sheeting and various similar-shaped metal or ceramic magnets; compare magnetic sheeting to other magnets by answering one or more of the following questions:

1. How far can you move the magnet from a paper clip and still "grab it"?

2. How many paper clips can you chain together and lift with each magnet?

3. How many sheets of paper can you "hang" on a vertical metal surface with each of the magnets?

Based on your comparison of the properties of magnetic sheeting to ordinary magnets, can you guess what its main disadvantage is?

Math Connection:

What is the relationship between the surface area of a square of magnetic sheeting and its strength? To find out, cut squares of sheeting that are 1 cm on each side, 2 cm on each side, and 3 cm on each side. Measure the strength of each, using one of the ways you used to compare flexible magnets to other magnets. Graph your data, letting the X axis indicate the area of the magnet (1 cm^2, 4 cm^2, and 9 cm^2) and the Y axis to indicate strength, in terms of distance, number of paper clips, or number of sheets of paper.

Engineering Challenge:

Create a new product using magnetic sheeting, such as a board game that uses magnetic game pieces or a teaching tool. Be prepared to show your product and demonstrate its use to the class.

