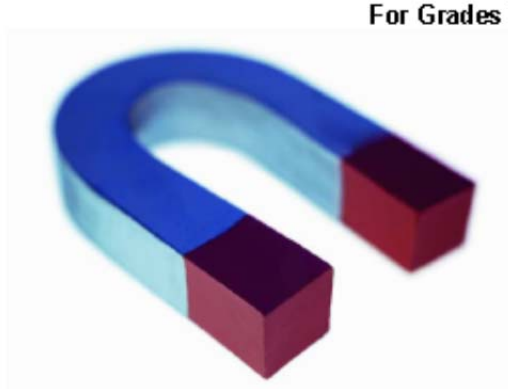
Magnet Strength (Teacher Lesson Plan)

Questioning

For Grades 3-4

Investigation Question
How does adding layers of tape alter the strength of a magnet?



Vocabulary
Magnet, attraction, magnetic field, force, barrier, anomaly

Overview

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

Learning Goals

- Learners will understand that the strength of a magnet changes as the distance between it and the iron object attracted to it changes.

Connections to K-4 Standards (NSES and Iowa Core)

By developing explanations about magnets, the children develop:
- Physical Science Content Standard B (Light, Heat, Electricity, and Magnetism): "Magnets attract and repel each other and certain kinds of other materials."
- Science as Inquiry Standard A (Ability necessary to do Scientific Inquiry): "Ask a question about objects, organisms, and events in the environment," "Plan and conduct a simple investigation," "Employ simple equipment and tools to gather data and extend the senses," "Use data to construct a reasonable explanation," and "Communicate investigations and explanations."

Materials

Item	Quantity	Notes
Paper Clips	20 per group	For data collection
Piece of thread	1 per group	For engage activity

Small bar magnet	1 per group	For engage activity
Clothespin	1 per group	For data collection
Masking tape (1 inch pieces)	21 per group	For data collection
Masking tape (long piece)	1 per group	To hold down clothespin
12 oz paper cup	1 per group	To hold magnet
"How Strong is Your Magnet" data sheet	1 per student	For data collection
Science Journals	1 per student	For data collection/analysis

Teacher Background Information

Students should carry out many investigations in order to familiarize themselves with the pushes and pulls of magnets. By exploring magnets, students are indirectly introduced to the idea that there are forces that occur on earth which cannot be seen. This idea can then be developed into an understanding that objects, such as the earth or electrically charged objects, can pull on other objects. It is important that students get a sense of electric and magnetic force fields (as well as gravity) and of some simple relations between magnetic and electric currents (*Benchmarks for Science Literacy*, p. 93.) In later years, students will learn about gravitational force and how electric currents and magnets can exert a force as well.

Students at this level should have already discovered that magnets can make an object move without touching it. What they may not have paid attention to is the type of materials that move and do not move when near a magnet.

In this lesson, students will discover how increased distance can vary the strength of a magnet. The main notion to convey in this lesson is that forces can act from a distance. 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 also can describe this in terms of the magnetic field: as you move farther from the magnet's pole, the field becomes weaker and weaker.

Predicting

Procedure

1 Begin the lesson by asking students to predict, using their prior knowledge of magnets, whether or not a magnet will exert a force on (or attract) a paper clip and why. Use this discussion as an opportunity to review what students know about magnets.

2 Discuss with the class their previous knowledge of magnets. As you facilitate group discussion, here are some potential questions to help build explanations (these also make excellent journal questions):

- How strong is a magnet?
- How far away will it work?
- Can a small magnet attract a paper clip from across the room? From across your desk?
- How can you find out how strong a magnet is?
- How can you quantify (measure) the strength of your magnet?

3 Divide the class into pairs. Distribute the student packet to each student. Distribute (or have students collect) the necessary materials for this activity.

4 Review the procedure from the student pages with students prior to the activity, then allow them to proceed with the investigation. (Students should fill out sections A,B and C, including the data table and graph, on their student pages).
There is a graph provided on the student sheet for them to fill in, however, you may need to change the y-axis numbers accordingly if you have stronger or weaker magnets.

5 Each group should fill their findings in on the class data chart. You can make a blank chart on the board/overhead/SmartBoard for students to fill in that looks like this:

Layers of Tape	Group 1	Group 2	Group 3	Group 4	AVERAGE
0					
3					
6					
9					
12					
15					
18					
21					

Data Collection and Analysis

Explanation

6 Now that students have recorded their group results, have them individually answer question D on their student pages. Have the students share their explanations within their small groups. As you facilitate small group discussion, here are some potential questions to help build explanations (these also make excellent journal questions):

- How many paper clips can the magnet hold without the 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?

Class evidence - setting the stage for alternate explanations discussions

7 Use your findings to create a class graph showing the results of the experiment. (You will have to help students make the graph at this stage of development but it is an important skill for them to learn).

- Make a large graph on newsprint paper, SmartBoard or the chalkboard.
- Average student 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).

Alternate Explanations and Communicate/Justify

Evaluate

8 Invite students to discuss differences between each group's findings and explanations. Students should fill in question E on their student pages.

- Why didn't each group get the exact same results?
- Are there any anomalies in the data? (i.e. a group had more paper clips after adding three more pieces of tape). What could that mean?
- Does this make you think differently about your explanation?

11 Read the following passage either outloud or have students read in small groups and answer the same questions as immediately above. Students fill in question F on their student pages after this passage is read.

Suppose you put a bar magnet (shaped like a rectangle, sometimes with the north and south poles painted different colors) or a horseshoe magnet (bent round into a tight U-shape) onto a table and place an iron nail nearby. If you push the magnet slowly toward the nail, there will come a point when the nail jumps across and sticks to the magnet. That's what we mean by magnets having an invisible magnetic field that extends all around them. Another way of describing this is to say that a magnet can "act at a distance": it can cause a pushing or pulling force on other objects it isn't actually touching).

Magnetic fields can penetrate through all kinds of materials, not just air. You probably have little notes stuck to the door of your refrigerator with brightly colored magnets—so you can see that magnetic fields cut through paper. You may have done the trick where you use a magnet to pick up a long chain of paperclips, with each clip magnetizing the next one along. That little experiment tells us that a magnetic field can penetrate through magnetic materials such as iron.

The strength of the field around a magnet depends on how close you get: it's strongest very near the magnet and falls off quickly as you move away. (That's why a small magnet on your table has to be quite close to things to attract them.) We measure the strength of magnetic fields in units called gauss and Tesla (the modern SI unit, named for Croatian-born US electricity pioneer Nikola Tesla, 1856–1943). It's interesting to note that the strength of Earth's magnetic field is very weak—about 1000 times weaker than that of a typical bar magnet. On Earth, gravity, not magnetism, is the force that sticks you to the floor. We'd notice Earth's magnetism much more if its gravity weren't so very strong. (http://www.explainthatstuff.com/magnetism.html)

12 To summarize the lesson and assess student understanding, ask students to reflect back on the Investigation Question in their science journal (question G on student pages).

Making the connections between "what I knew", "what I know now" and "how I know it"

Magnet Strength: Student Pages

Questioning →

Investigation Question
How does adding layers of tape alter the strength of a magnet?

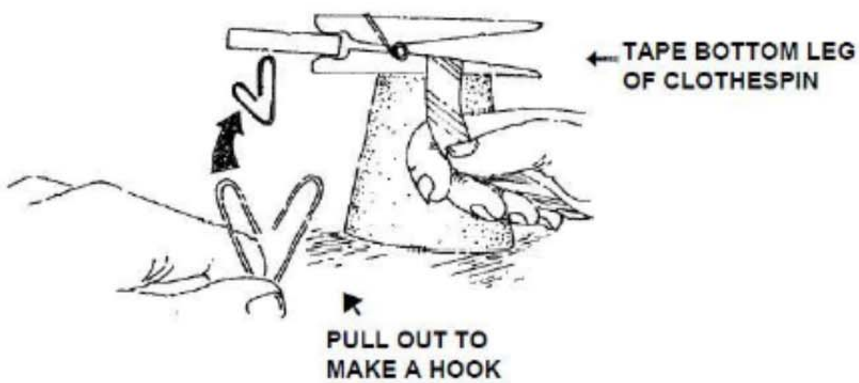
Predicting

A. I think that adding pieces of tape will / will not affect the magnet's strength

How or Why?

B. Procedure (work with a partner!)

a. Clamp your magnet to the clothespin. Tape the clothespin to the bottom of the cup as shown in the sketch.

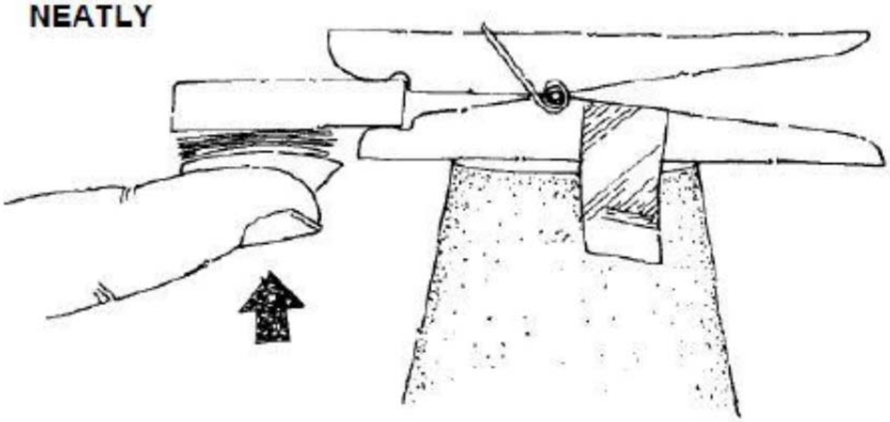


b. Pull out one end of a paperclip to form a hook. Touch the hook to the magnet. Does it stick?

c. Take turns with your partner and carefully add paperclips to the hook, one by one.

d. Count the total number of paperclips that you can hang onto the hook before the weight becomes too much for the magnet to hold and the paper clips fall. Write this number of paper clips on your data sheet on the line for *zero pieces of tape*.

e. Cut three squares of masking tape (1 inch x 1 inch). Stick the three pieces of tape on the bottom of your magnet. See the picture below.



f. Repeat your experiment and see how many paperclips you can hang on the hook. Make sure the hook touches the tape, not the magnet itself. Record the number of paperclips on your data sheet on the line for *three pieces of tape*.

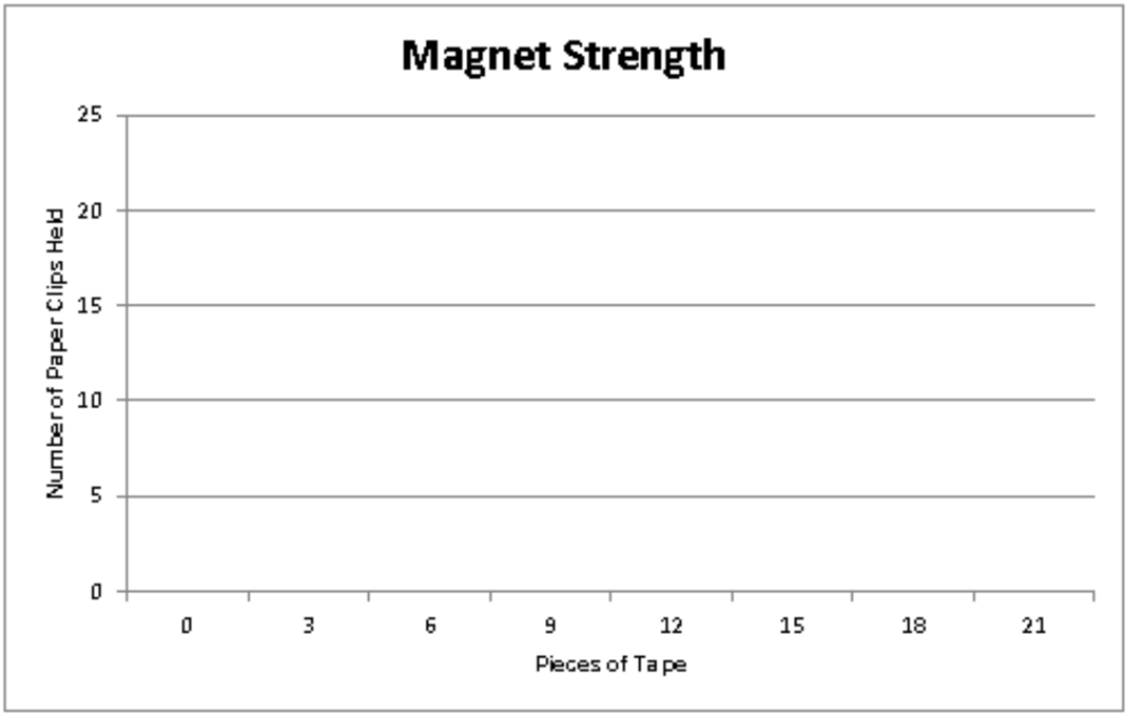
g. Cut three more squares of tape, add them to the layer already present, and repeat your experiment. Record your findings on your data sheet.

h. Keep adding pieces of tape, three at a time, repeat the experiment, and record what you find.

Data Collection

C. Summarize the results of what you observed during your experiment. Fill in both your data table and the graph below using your experiment results.

How many Layers of Tape?	How many paper clips?
0	
3	
6	
9	
12	
15	
18	
21	



i. Answer these questions in your science journal:
   i. As you add more and more layers of tape, what do you notice about the number of paperclips you can add to the hook?
   ii. Is the magnet able to hold more or fewer paperclips?
   iii. Do you think the tape is causing this? How?
   iv. What experiment could you do to test your idea?

Explanation Building and communicate and justify

D. How do you explain your experiment's results? Be sure to use your data in your explanation.

Alternate Explanations

Communicate and Justify

E. After hearing other groups' results and explanations, do you think differently about your explanation?

F. After reading the scientific explanation, do you think differently about your explanation?

G. Our investigation question was "How does adding layers of tape alter the strength of a magnet". Based on your results, explain your answer to this question.

Making the connections between "what I knew", "what I know now" and "how I know it"