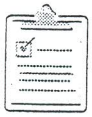
6. How Strong is Your Magnet?

Measure the strength of a magnet and graph how the strength changes as the distance from the magnet increases.

Life Skills: cooperating
Science Process Skills: observing, comparing, relating

Time Frame

- Helper Preparation: 20 min. plus the time to gather materials and review the *Background Information* and *Youth Activity*
- Youth Activity: 30 min.



Materials

Grabber (for the leader/helper only)

- ☐ bar or horseshoe magnet
- ☐ clear plastic cup
- ☐ metal paper clip
- ☐ water to fill the cup- 1/2 to 3/4 full

Activity (for each youth or pair)

- ☐ smooth manila folder, or 30x10-cm (12x4-in.) strips of wax paper
- ☐ bar magnet
- ☐ clothespin, spring type
- ☐ masking tape, 2.5 cm (1 in.) wide and about 75 cm (30 in.) long
- ☐ plastic or paper cup, at least 8 oz. size
- ☐ 20 metal paper clips, #1 size
- ☐ pencil or pen

Expanded Activity

- ☐ materials for the activity
- ☐ large piece of paper, such as newsprint (alternatively, use a chalkboard)
- ☐ marking pen or piece of chalk

More Challenges

- ☐ materials for the activity
- ☐ 30-cm (12-in.) ruler
- ☐ nail

Safety Considerations

- There are no specific safety concerns in this activity other than making sure the youth do not put the paper clips in their mouths.
- Be sure to keep magnets away from computers and computer disks! Magnets can damage these.
- Magnets can lose their magnetism. Avoid dropping magnets and keep them out of hot places. To increase the life of bar magnets, store them in pairs, side by side with the north pole of one magnet next to the south pole of the other magnet. Store horseshoe magnets with the "keeper," a metal bar placed across the ends of the magnet.

Getting Started

Helpful Hints

1. Have the youth work in pairs at tables.
2. The youth may have trouble with the cup tipping over as more paper clips are added to the hook. Suggest that they secure the cup by taping it to the table.

Before the Activity

1. Cut the tape for each pair:
   a) One long strip (about 10-cm or 4-in. long) will be used to tape the clothespin to the cup.
   b) Cut 21 pieces, each about 2.5-cm (1-in.) or small enough to fit on the magnet. Stick each of these on a smooth manila folder or 30x10 cm (12x4 in.) strip of wax paper.
2. Label the small pieces of masking tape 1 through 21. Alternatively, have the youth number the pieces of tape between steps 2 and 3 of the "Do This" section.
3. Put 20 paper clips in each of the plastic cups.
4. For the expanded activity, make a large graph on newsprint, other oversized paper, or a chalkboard. Refer to the sample graph on p. 52 of this activity guide.
5. Label the x-axis (horizontal axis) of your graph as "distance from magnet." This will be the number of layers of tape between the magnet and the paper clips—start with zero.
6. Label the y-axis (vertical axis) as "magnet strength." Along this axis the youth will record the number of paper clips their magnet could hold for each increase in pieces of tape. Start with two pieces of tape.

Grabber

1. Place the metal paper clip in an empty, clear plastic cup.
2. Keeping the magnet outside of the cup, move the bar magnet around so as to cause the paper clip in the cup to follow the magnet. Use the magnet to make the paper clip slide up and down the sides of the cup.
3. Ask the youth to explain what is going on.

   (The magnetic field can penetrate the sides of the cup and attract the paper clip.)
4. Fill the cup half or three-quarters with water.
5. Repeat step 2 and 3.

   The paper clip will still follow the magnet because the magnet's magnetic field can pass through both the plastic cup and the water. The field can only affect magnetic objects that come within its range. Thus, the magnet has less effect, or weakens with increased distance from the magnet.

Doing the Activity

Make This

See picture at the end of the packet.

1. Give, or have each pair get, a cup containing the paper clips, clothespin, tape, and pencil or pen.
2. Tell the youth to first tape the clothespin to the bottom of the cup as shown in their activity books.
3. Then, have them clamp the magnet in the clothespin.
4. To make a hook, have them pull apart one of their paper clips, as shown in the illustration in their books.
5. Remind the youth to observe what happens when they touch the hook to the magnet.

   The hook will "stick" to the bottom of the bar magnet.

Do This

Help Students create a chart to record their data in.

1. Taking turns and keeping count, the partners each carefully and gently add paper clips to the hook, one by one, until the hook falls off of the magnet.
2. When the hook falls off the magnet, the youth should write on their data sheet, in the column next to the zero, the number of paper clips that their magnet was able to hold. Remember to include the hook in the count!
3. Next, the youth will find out about the magnet's magnetic field by adding layers of tape to its end.
4. If the pieces of tape have not been numbered, instruct the youth to number them 1 through 21 before they begin sticking them on the magnet.

Depending on how much time you have, you may need to have the students put on 7 pieces at a time.

5. Have them stick tape pieces numbered 1, 2, and 3 on to the underside of the end of the magnet as shown in the illustration on p. 16 of their activity books.
6. Next they should repeat steps 1 and 2 above (or step 1 and 2 in the youth books), making sure that the hook touches the tape and not the magnet itself. When the magnet can hold no more paper clips, the number held is to be recorded in the column next to the number of pieces of tape between the hook and the magnet.
7. The youth will continue to add pieces of tape, in increments of three, and repeating the experiment until all 21 pieces of tape have been added. Be sure to remind them to record their data.

Why It Happens

A magnetic field—the pull of the magnet—will pass through materials like tape, plastic, fabric, or glass with almost no effect. The tape used in this activity does not block the attraction of the magnet for the paper clip hook. Each layer of tape keeps the hook further away from the surface of the magnet by one more small increment of distance, a distance equal to the thickness of the tape. Tape is used in this activity because it is simply a convenient way to separate the hook and magnet bit by bit. It is the distance between the magnet and the hook, not the tape itself, that reduces the attraction of the magnet. As you move further away from the magnet's pole, the magnetic field becomes weaker and weaker. Try the *More Challenges* to demonstrate the effect of distance from the poles on magnetic field strength.

Talking It Over

Sharing

Q: How many paper clips can the magnet hold without using any masking tape?

A: The responses from the youth will vary, but most should be at or close to 20 paper clips.

Q: Did you and your partner always agree on how to do the experiment? How did you reach an agreement?

A: Answers will vary. Encourage the youth to show respect for their partner's suggestions. A discussion on the different ways each pair reached agreement will be beneficial to all the youth in the group.

Q: As you began adding layers of tape, what did you observe? Why?

A: As the tape layer gets thicker and thicker, the magnet can hold fewer and fewer paper clips. This happens because the tape layers gradually increase the distance between the paper clips and the magnet's pole. The magnetic field is strongest near the pole and gets weaker further from the pole. Thus, the pull of the magnet on the paper clips gets weaker as more layers of tape are added.

Processing

Q: Is the masking tape a magnet?

A: No.

Q: If not, why are the paper clips attracted to it (the tape)?

A: The paper clips are not attracted to the tape. Rather, they are attracted to the magnetic field of the magnet. The magnetic field can pass through the tape.

Generalizing

Q: Can you think of other ways to measure the strength of your magnet?

A: Responses to this question will vary. Any ideas that have to do with how much weight a magnet can hold is on the right track. Also, how hard it is to pull objects away from a magnet.

Applying

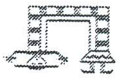
Q: Can you think of situations where you might need a very strong magnet? A magnet that is not as strong?

A: There are many situations in which a very strong magnet would be useful. For example, very strong magnets are used to lift and move heavy piles of scrap metal in junkyards and reclamation centers. They can also be used to lift heavy beams for the construction of buildings or bridges. Magnets that are not so strong are handy for picking up things like pins, needles, nails, and other small magnetic items, and for tacking notes, school papers, art, pictures, and other light items on to the refrigerator. Compasses also use magnets.

Frequently Asked Questions

Q: Why do compasses always point north?

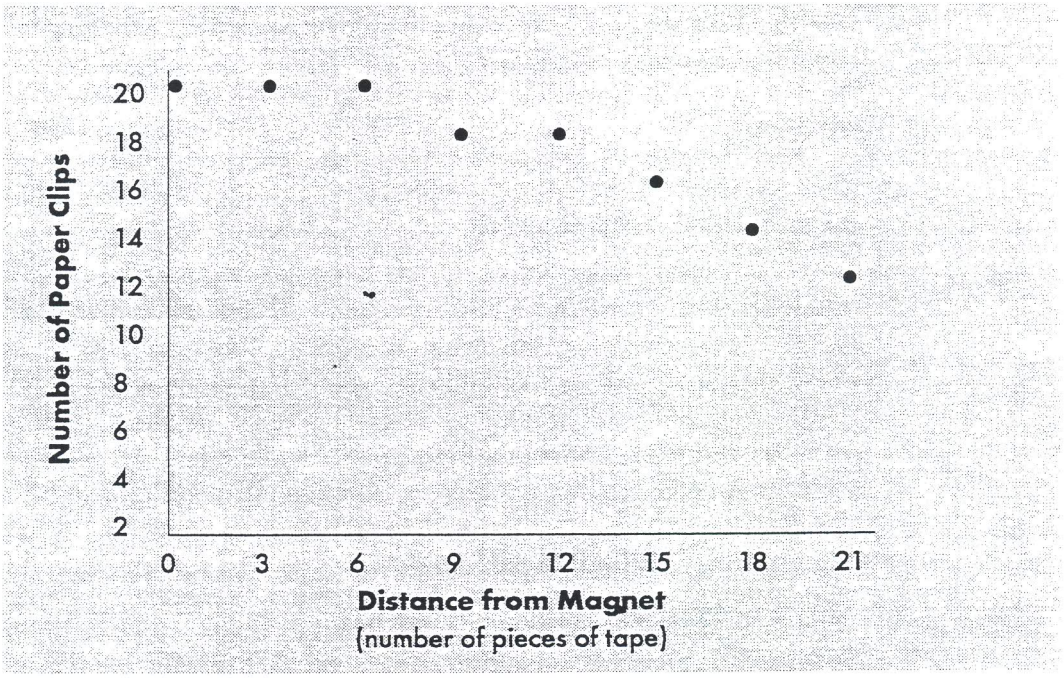
A: They point north because ends of the compass needle are attracted to the magnetic field of the Earth's poles. The Earth is like a giant magnet. The Earth's magnetic field is caused by its enormous iron core.



Expanded Activity

1. After every pair has completed the activity, have each pair show their results on the large graph you made earlier. For each data point—the number of tape layers and the number of paper clips held with that number of tape layers—have each pair put a mark on the graph that lines up with the corresponding numbers on each axis. The graph on the next page illustrates this for the sample data shown.

Layers of Tape	Number of Paper Clips
0	20
3	20
6	20
9	18
12	18
15	15
18	13
21	12



2. Ask the youth if they notice any pattern on the graph.

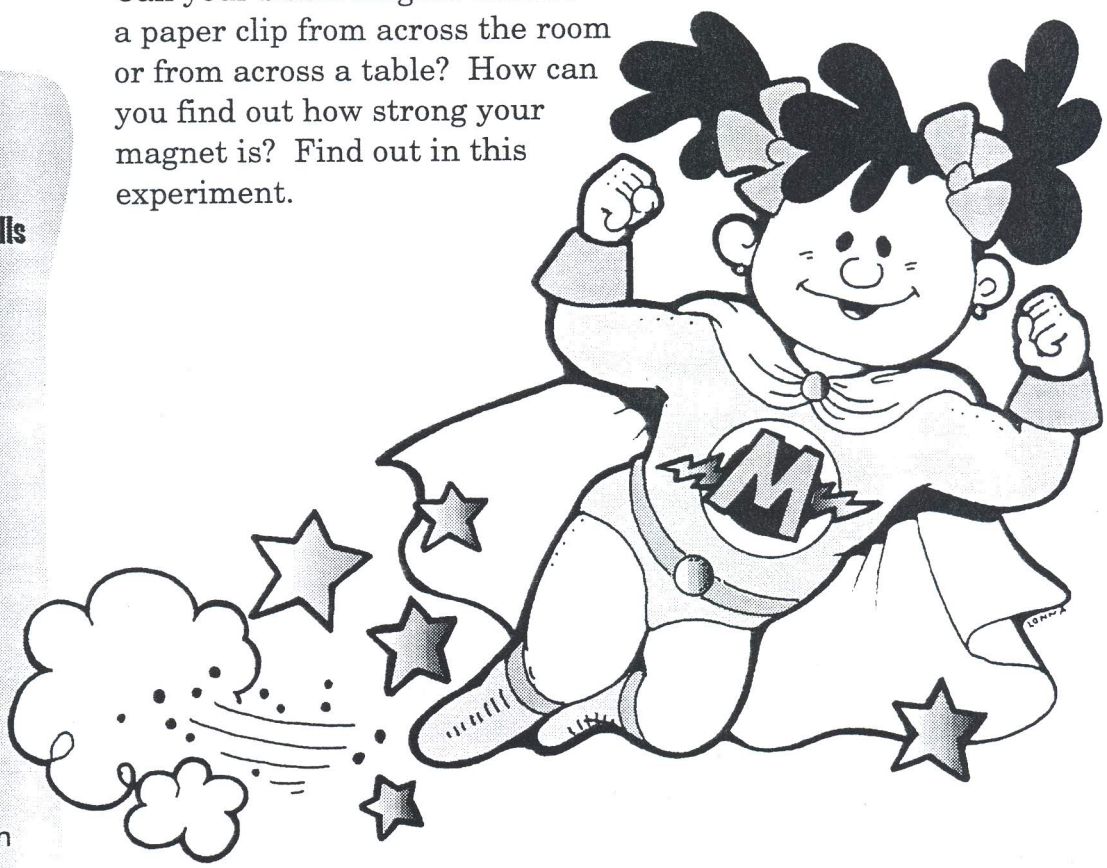
   The data points will likely cluster in along the upper part of the graph and then decline or slope downward. The actual data and pattern on the graph will depend on the strength of the magnets used in this activity.

More Challenges

1. Place a ruler flat on the table.
2. Lay a nail at one end of the ruler, with the nail pointing to the last mark on the ruler.
3. Put the magnet at the other end of the ruler.
4. Very slowly, move the magnet along the edge of the ruler towards the nail. Observe what happens!

How Strong is Your Magnet?

Can your small magnet attract a paper clip from across the room or from across a table? How can you find out how strong your magnet is? Find out in this experiment.



Life Skill
cooperation

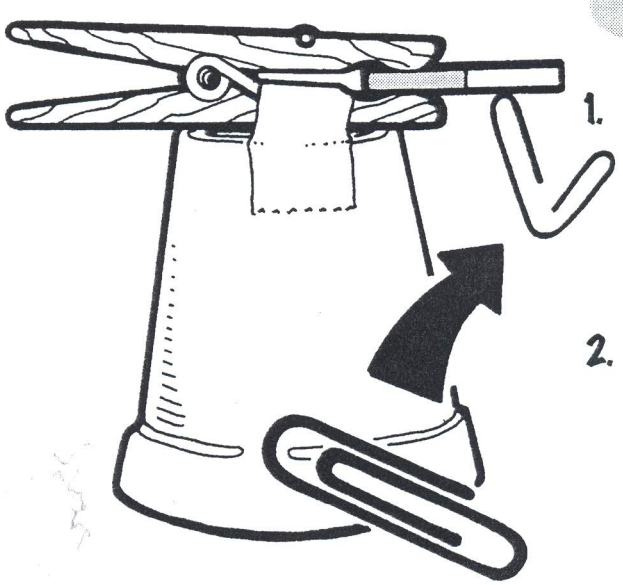
Science Process Skills
- observing
- comparing
- relating

Materials
- bar magnet
- clothespin
- masking tape
- plastic or paper cup
- 20 paper clips

What To Do
Measure the strength of a magnet and graph how the strength changes as the distance from the magnet increases.

Vocabulary Words
- compass
- lodestone
- pivot

Make This



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

2. Pull apart one end of a paper clip to form a hook. Touch the hook to the magnet. What happens?

Continued ☞