Squeaky Clean Magnets

Home Connection

Dear Family,
During the last few days, the students designed a prototype tool that could be used to clean a fish tank. They acted just like engineers! They . . .

- identified and learned about a problem
- planned ways to solve the problem
- made and tested a prototype
- revised their design to make it even better

In this challenge, students developed an understanding of the properties of magnets and magnetic fields, how magnets interact with each other, and how distance affects magnetic forces. They also learned about the engineering design process, including developing and using prototypes, analyzing data, making claims based on evidence, and communicating technical information.

Let your child tell you in his or her own words about what the team did in this engineering project and how the team used magnets. Prompt your child if he or she needs help.

- What was the problem you were solving?
- What were the criteria (goals or conditions) that your design had to meet?
- What constraints (limits) to materials did you have to work with?
- How did you know if your design was successful?
- How did you improve your design? Why did you make those improvements?

On the back of this sheet, work with your child to extend his or her work in the challenge.

This STEM project has been developed in partnership with Texas A&M University.

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About Magnets

Magnets are objects that can attract iron or certain other metals. Magnets are surrounded by an area of force called a magnetic field. Although the magnetic field is invisible, its effects can be felt. Iron, steel, and some other metal objects are pulled toward the magnet if they are in the magnetic field. Ask your child to describe how magnets act. Prompt your child, if needed:

- What materials do magnets attract?
- How can magnets attract objects without touching them?
- Where is the force of a magnet strongest?
- How do the poles of different magnets interact with each other?
- Where are the poles of a disc magnet and a ring magnet?

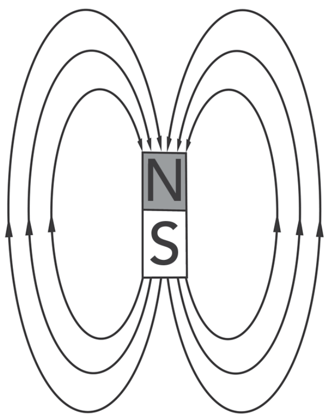

Diagram of a magnetic field

Try It!

Engineers have found a surprising variety of practical uses for magnets. With your child, see how many magnets you can find in your home. When you find one, have your child observe what material the magnet is attracted to. Ask your child to identify the problem that the magnet helps solve.

If you have a compass, you can use it to find more magnets. Be sure to have your child hold the compass so it is level. (A compass is helpful because the needle in it is attracted to magnetic fields.)

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Explore Magnets

Name ___________________________________

Follow these steps.

1. **Predict** Will the magnet attract the material? Write Yes or No.

Object	Material	Predict: Will the magnet attract the material? (Yes/No)	Observe: Did the magnet attract the material? (Yes/No)
Bolt	Iron		
Ball	Plastic		
Index card	Paper		
Paperclip	Steel		
Glass marble	Glass		
Steel marble	Steel		
String	Cotton		
Wood cube	Wood		
Foam cube	Plastic		
Aluminum cube	Aluminum		

2. **Observe** Hold the magnet close to the object, but not touching.
3. **Record** Did the magnet attract the object? Write Yes or No.
4. **Draw conclusions** What type of materials does a magnet attract?

____

Attract or Repel?

Name ______________________________

Follow these steps.

1. Place two bar magnets so they are flat, like this:

N	**S**	**N**	**S**

2. **Observe** Slowly push the ends of the two magnets together.
   Did the magnets *attract* or *repel* each other? ________

3. Now place the bar magnets like this.

N	**S**	**S**	**N**

4. **Observe** Slowly push the ends of the two magnets together.
   Did the magnets *attract* or *repel* each other? ________

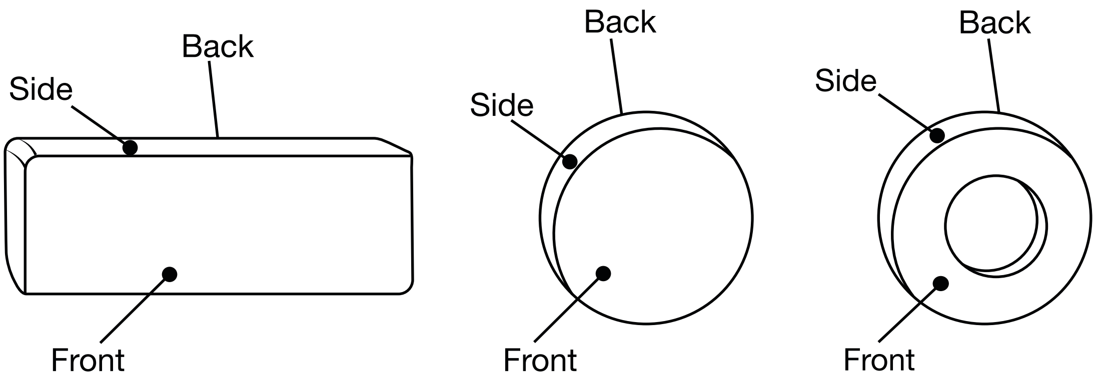
Draw conclusions

5. The north pole of a magnet attracts the ________ pole of another magnet.

6. The north pole of a magnet repels the ________ pole of another magnet.

Observe other magnets

7. **Predict** Observe the rectangular, disc, and ring magnets. For each, circle where you think the north pole will be.



8. **Test** Use the bar magnet to find the north pole of the rectangular, disc, and ring magnets. Use dot stickers to mark the north poles of all of your team's magnets.

How Many Paperclips?

Name ___________________________________

Follow these steps.

1. Pour 100 paperclips in a plastic cup.
2. **Test** Use one rectangular magnet. See how many paperclips it holds.
3. **Count** How many paperclips does the magnet hold?
4. **Record** Write your results in the chart.

Magnet	Number of Paperclips Held	
	1 Magnet	4 Magnets
Rectangular		
Disc		
Ring		

5. **Test** Stack 4 rectangular magnets together and repeat the test.
6. **Test** Repeat Steps 2–5 with the disc and ring magnets.
7. **Compare** How did adding more magnets change the number of paperclips the magnet held?____

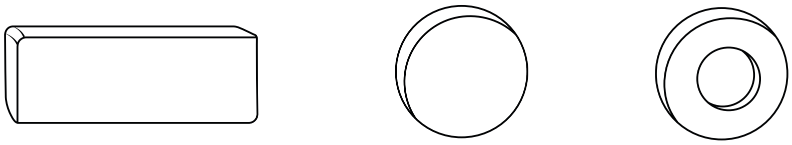
   ____
8. **Conclude** Which magnet was strongest?______________________________

   ____

Distance of Attraction

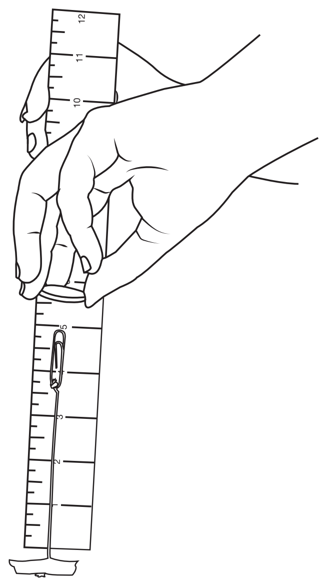
Name ______________________________________

Magnet tested (circle one):



Rectangular **Disc** **Ring**

1. Tie one end of a string to a paperclip.
   Tape the other end of the string to a desk.
2. Hold a ruler, as shown, near the tape.
3. Use one magnet. Touch it to the paperclip.
   Pull the paperclip up the ruler until the string and paperclip are straight up.
4. **Measure** the height at the top of the paperclip.
   Record it in row 2 of the chart in Step 7.
5. **Test** Slowly move the magnet up away from the paperclip.
   In row 1 of the chart, record the height of the magnet when the paperclip falls.
6. **Subtract** to find the magnet's greatest distance of attraction.
7. Repeat the test using 4 stacked magnets.



	Number of magnets	
	1	**4**
Height of magnet when the paperclip fell		
Height at the top of the paperclip		
Magnet's greatest distance of attraction		

Distance of Attraction
(continued)

Name ___________________________________

8. **Share** your data with other teams.

9. **Analyze Data** Use your data and data from other teams to make a bar graph.

Greatest Distance of Attraction		▭	○	◎	▭	○	◎
	2 inches						
	$1\frac{3}{4}$ inches						
	$1\frac{1}{2}$ inches						
	$1\frac{1}{4}$ inches						
	1 inch						
	$\frac{3}{4}$ inch						
	$\frac{1}{2}$ inch						
	$\frac{1}{4}$ inch						
		1 magnet			**4 magnets**		

10. **Compare** What was the greatest distance of attraction? ____________________

11. **Conclude** How did adding magnets change the distance of attraction?

____

12. **Draw conclusions** Why were the magnets able to hold up the paperclip without touching it?

____

13. **Infer** Do you think magnets can work through solids, such as paper, plastic, or glass? Why?

____

Float or Sink?

Name ___________________________________

Follow these steps.

1. Slowly pour 4 cups of water into the fish tank.
2. **Observe** Examine the objects.
3. **Predict** Will each object float or sink? Record your prediction.

Objects	Predict	Observe	
	Float or sink?	Float or sink?	Did it float high or low?
Ball			
Wood cube			
Foam cube			
Aluminum cube			

4. **Test** Place each object in the fish tank.
5. **Observe** and record your observations.
6. **Compare** Which objects would make your scrubber float? Which would not?

   ____

7. **Predict** Which object might help you clean the side of the tank? Why?

   ____

   ____

8. **Predict** Which object might help you clean below the gravel? Why?

   ____

   ____

Cleaning Tool Design Plan

Name ___________________________________

Follow these steps.

1. **Think** about the test results. What materials will you use? Fill in the chart.

Materials	Reason for choosing
Shape of magnets:	
Float for your scrubber:	
Handle for your polisher:	

2. **Draw your prototype** Draw your cleaning tool. Show all the parts.
   - Scrubber with float
   - Polisher with handle
   - Cleaning cloths attached to both the scrubber and the polisher

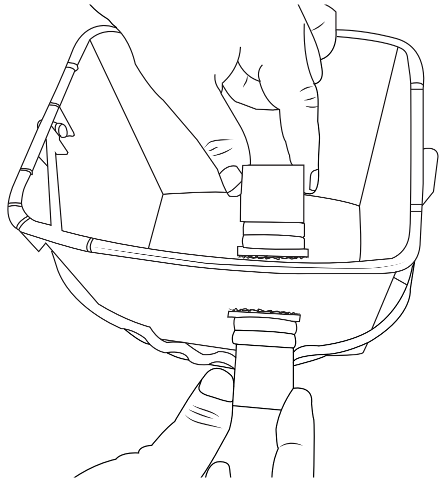
   Label the parts.

Cleaning Tool Test

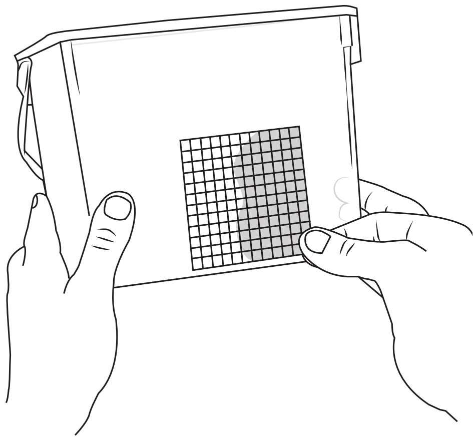
Name ___________________________________

Follow these steps.

1. Place the scrubber in water. Does it float? **Yes** **No**
2. Get your cleaning tool ready.
   Begin cleaning when the timer says, “start.”
   - Use your tool to clean as much of the fish tank as you can in 30 seconds.
   - Try to clean below the edge of the gravel.
   - Do not put your hands in the water.



3. Stop cleaning when the timer says, “stop.”
4. Replace the cleaning cloth on the scrubber only.
5. Repeat Steps 2–4 on the other side of the tank.
6. Slowly pour the water out of the tank.



7. **Measure Area** Find the area cleaned. On each side of the tank:
   - Line up the grid over the square.
   - Count how many squares you cleaned.
   - If only part of a square was cleaned, estimate how much.

   Record the total number of squares cleaned.

   Side 1: Number of squares cleaned __________

   Side 2: Number of squares cleaned __________

8. Did your tool clean below the gravel? **Yes** **No**

Reflect On It

Name ___________________________________

Use your design, prototype, and test results to finish these sentences.

Cleaning Tool Plan

1. We used this many magnets: ______ ring ______ ______ rectangular
2. We chose these magnets because ______________________________________

____

____

Prototype

3. Put a check next to the criteria your plan met.
   - ☐ Float to the top of the tank if dropped inside.
   - ☐ Clean one side of the tank in 30 seconds.
   - ☐ Clean below the edge of the gravel at the bottom of the tank.
4. One part of our prototype that worked well was ___________________________

   because ____

   ____
5. One part of our prototype that did not work well was ______________________

   because ____

   ____

Compare Prototypes

6. We compared our prototype to Group ________. We observed that ____________

   ____
7. The most successful prototype was made by Group ________________. It was

   successful because ____

   ____