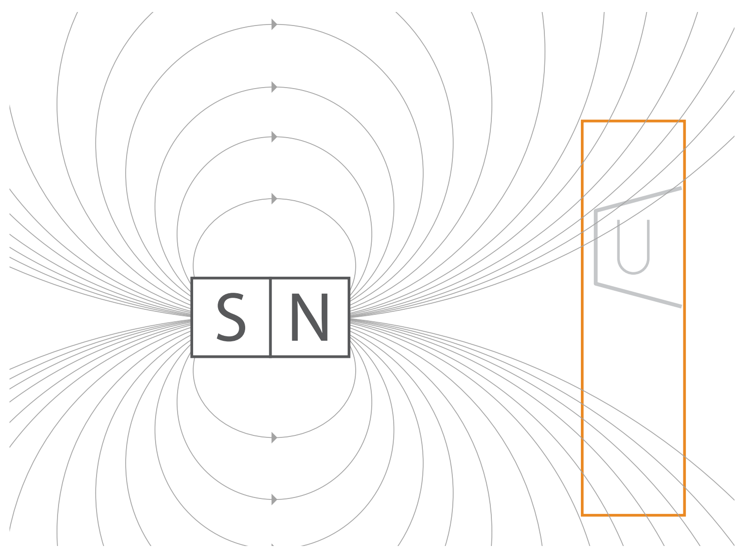
How Does Distance Affect The Strength of a Magnetic Field?

Exploration

Can you throw a baseball without touching it? No, your hand needs to push the baseball forward as your throw it. Objects often interact like this, through contact. The baseball will then stop moving after contacting the ground or a catcher's mit. But can two objects interact when they aren't in contact, when they are instead, at a distance from each other? Using PocketLab, you can explore how this might be possible.

Materials

- Pocketlab
- Two dipole magnets
- Two sheets of blank paper
- Ruler or meter stick.



Objective

In this experiment, students will:

1. Draw a conclusion, supported by data collected in your investigation, about whether objects can exert forces on each other at a distance.
2. Use the magnetometer to determine the relationship between the magnetic field stength and its distance from a dipole magnet.

Part 1: Interaction through contact

1. Place one magnet at the center of one end of a sheet of paper. Draw a circle around it. Use the ruler to draw a line from the circle to the other side of the paper. From the circle, measure out and mark 1 cm, 2 cm, 3 cm, 4 cm, etc. along the line, all the way to the other end of the paper.
2. Without touchng the magnet, try using your mind to move the magnet out of the circle to the 2 cm mark. Does it work? Why not?
3. Now, use the ruler to push the magnet out of the circle to the 2 cm, mark, then the 4cm, 6 cm, 8 cm, etc. mark. Does it work? Why? Explain your answer thinking about the paragraph from the “Exploration” section on the first page.

Part 2: Interaction at a distance

1. Take both magnets and play around with them. Observe why sometimes they come together and sometimes they push apart. Write down every observation you and your group make while playing with the magnets.
2. Place one magnet in the circle on the sheet of paper. Can you use the other magnet to move magnet on the paper to the 2 cm mark, then the 4 cm, 6 cm, 8 cm, etc. mark? Why? Compare to when you tried to move the magnet using your mind. What is different now? Explain your answer thinking about the paragraph from the “Exploration” section on the first page.
3. Try to come up with at least two methods to move the magnet on the sheet of the paper using the other magnet. Explain the two methods your group came up with.

Part 3: Predict and Investigate

Predict: You previously observed that when two magnets interact, sometimes they repel, or push each other apart, and sometimes the attract, or pull each other together. Each magnet is made of two poles, a North (positive) and South (negative). See the diagram on the previous page. When the two positive sides come together do you think they will attract or repel? What about the two negative sides? What about when a positive side interacts with a negative side? Write a prediction that explains when magnets repel and when they attract.

Investigate: Connect the PocketLab to the PocketLab app. Open the Magnetic Field graph. Hold the magnets away from the PocketLab and zero the graph. Using the PocketLab, the Magnetic Field graph, and the two magnets, come up with a method to test your prediction. Explain the method for testing your prediction and draw a conclusion that either supports or refutes your prediction.

Part 4: Measuring interaction at a distance

1. Place the PocketLab inside the circle on the sheet of paper so the front of the PocketLab (white side with the axis logo) is facing the distance markings on the paper.
2. Begin by connecting the PocketLab sensor and app and selecting the Magnetic Field Magnitude graph. Then move the PocketLab far from the magnet and "Zero" the magnetometer.
3. Next, hold the magnet at the 1cm mark with the North (positive) pole facing the PocketLab.
4. Begin a data recording. Record data at 1 cm for a few seconds.
5. Without stopping the recording, move the magnet to the 2 cm mark. Leave it there for a few seconds.
6. Repeat step 6 for the 3-10 cm marks.
7. Stop your recording. Take a screen shot or draw a picture of the graph. Label the approximate average values for the magnetic field at the different changes in distance.
8. Optional: Export the data as .csv file and use Excel or Google Sheets to create a Magnetic Field versus Distance graph, and if you can, find a regression line and equation for the data collected. (Note: You can also plot a Magnetic Field verusus Distance graph by hand. For the Magnetic Field data, use the graph from the recording and either find or approximate the average value at each distance).

Data Analysis and Observations/Conclusions:

- After examining the data, what can you conclude about the relationship between magnetic field strength and distance? If a magnet is twice as close, is the magnetic field twice as strong? How do you know? Explain your answers and support them with evidence collected from the lab.
- Optional: After drawing your own conclusions about the relationship between magnetic field strength and distance, research the relationship online or in a textbook. Is there a law that describes this relationship? How closely did your conclusion and data support/verify this law? Explain.
- Write a conclusion that explains whether objects can interact and exert forces on each other at a distance. Provide direct evidence from all parts of the lab to support your conclusion.