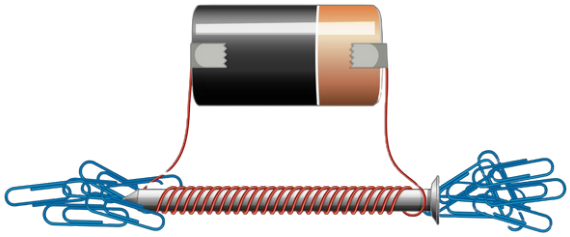


Magnetometer

Electromagnets

Overview

This lesson builds on the knowledge gained in previous studies of magnetism, focusing on how electronics influence magnetic fields and how to create and test an electromagnet. Students will use databot™ to detect changes in magnetic fields caused by electronics and observe the properties of an electromagnet.

Grades: Middle School
Time: 45 Minutes
Subject: Physical Science
Topics: Magnetic Fields, Electronics, Electromagnets

Background

Magnetic fields are invisible forces surrounding magnetic materials and influencing other objects sensitive to magnetism. We interact with magnetic fields daily without even noticing—from fridge magnets to complex components inside our phones and computers.

The connection between electricity and magnetism was first discovered by Hans Christian Oersted in 1820. He observed that an electric current flowing through a wire caused the needle of a compass to deflect, providing the first evidence of the electromagnetic interaction.

Electromagnets are a pivotal invention demonstrating how electric current generates magnetic fields. When electricity flows through a wire, it creates a magnetic field around it. Wrapping the wire around an iron core amplifies the field's strength. Electromagnets have countless applications, from motors and relays to magnetic cranes and medical devices like MRI scanners.

Magnetic fields also surround electronic devices. Every functioning gadget—from chargers to electric motors—generates a weak magnetic field.

What You Will Need/Prep

- databot
- IOS/Android Smart Device
- Install Vizeey™ on your Smart device.
- Electronic devices (e.g., phone, charger, fan)
- Ruler or measuring tape
- Insulated copper wire (1–2 m)
- Iron nail (at least 10 cm long)
- AA battery and battery holder
- Small metallic objects (e.g., paper clips)
- Test your databot™ connection.
- You will be prompted to select and connect to databot™ each time you launch an experiment.
- If there are two or more databot's listed, the one closest to your device will be highlighted in blue.
- Study the background information and terms and prepare to explore!

Magnetometer

Through hands-on activities with the databot magnetometer, you will investigate the relationship between electricity and magnetism and how electronics impact our environment.

Learning Objectives

By completing this lab, students will:

- Measure and analyze the impact of electronic devices on magnetic fields.
- Discover how electromagnetic fields are generated.
- Construct a simple electromagnet and observe its behavior.
- Enhance skills in using databot™ for scientific investigation.

Important Terms

Magnet: an object that produces a magnetic field, which exerts a force on certain materials such as iron and other metals. Magnets have two poles, called the north pole and the south pole, and they can attract or repel other magnets or magnetic materials.

Magnetic Field: A region around a magnetic material within which the force of magnetism acts.

Electromagnet: A type of magnet in which the magnetic field is produced by an electric current.

Magnetometer: A device that measures the strength and direction of magnetic fields.

Magnetic Interference: Disturbance in a magnetic field caused by nearby electronics or other magnetic sources.

Interesting Facts

Electromagnets in Everyday Life: Electromagnets are used in numerous everyday devices, including doorbells, electric locks, and relays. They're also crucial in more complex systems like maglev trains, which use powerful electromagnets to levitate and propel trains without friction.

Strength of Electromagnets: The strength of an electromagnet can be adjusted by changing the current passing through the wire or increasing the number of coils. This makes them highly versatile for different applications, from lifting scrap metal in junkyards to delicate medical instruments.

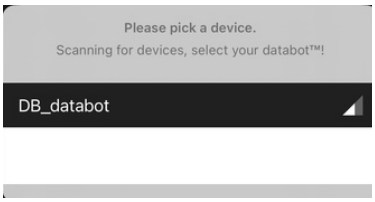
Magnetic Interference: Strong magnetic fields from electronics can interfere with other devices. For example, a running microwave oven may disrupt Wi-Fi signals due to electromagnetic interference.

Magnetometer

Using Vizeey

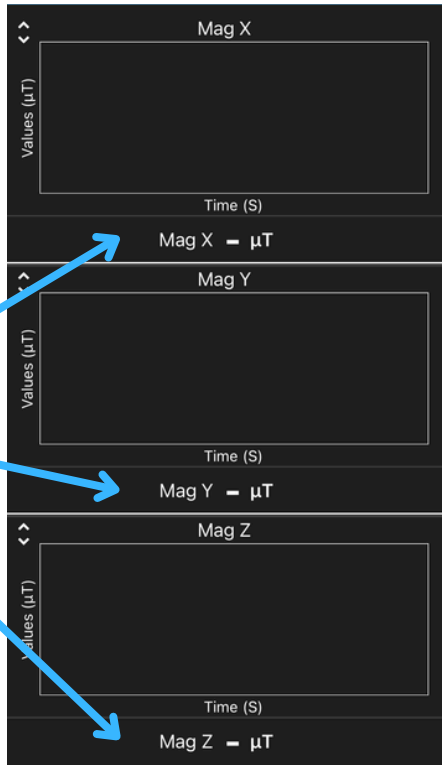
In order to work with the experiment you need to launch the Vizeey application and click on + in the upper right corner.

Then select “Add experiment from QR code” and scan the QR code prepared for this experiment. Your experiment will appear in the list.



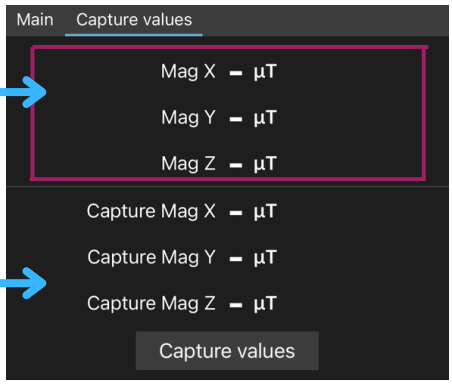
Once in the Experiment

In this experiment we will use the magnetic field sensor (magnetometer) which is built into databot.The sensor is very sensitive and notices even the smallest changes in the magnetic field.



Depending on which side of the magnet is brought closer to the databot and the pole of the magnet (north or south), the databot’s sensors will detect changes in the magnetic field along three axes: X, Y, and Z. These changes will be displayed in real time, showing the direction and strength of the magnetic field.

There are 2 tabs available for analyzing and capturing data in this experiment. You can see them here and use any of them.



This block shows data from the databot sensor in real time.

By clicking on the “Capture values” button you capture the data at the moment.
After pressing the “Capture values” button again, the previous values are deleted.

Magnetometer

Part 1: Initial Observations and Discussion Questions

How could the ability to detect magnetic fields from electronics be useful in real-life scenarios? _____

_____

What challenges might arise from magnetic interference caused by electronics, and how can these be mitigated?

_____

_____

What real-world examples can you think of where electromagnets or electromagnetic fields play a critical role?

_____

_____

Part 2: Hypothesis

Do you think all electronic devices will produce magnetic fields of the same strength? Why or why not?_____

_____

_____

Why do you think an electromagnet can be turned on and off, while a permanent magnet cannot? _____

_____

_____

Part 3: Experiment Procedure

Investigating Electronics and Magnetic Fields

In this experiment, we investigate how electronic devices generate and alter magnetic fields, using databot™ to measure magnetic field strength at different distances. We will record changes in the magnetic field to understand the impact of distance and device operation.

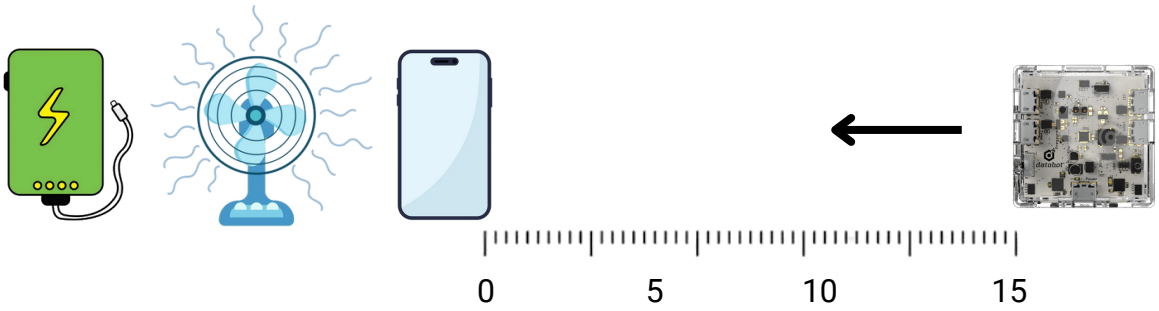
Materials Needed:

- databot
- Electronic devices (e.g., phone, charger, fan)
- Ruler or measuring tape

Magnetometer

Part 3: Experiment Procedure

- Ensure your databot™ is fully charged or connected to a power source.
- Place databot™ in an area free of electronic devices or other magnetic sources.
- Tap on "**Electromagnets**" in Vizeey to load the experiment.
- You will be prompted to connect to databot.
  - Hint- if there is more than one databot in use, the one closest to you will be in blue!
  - A solid blue light on databot means you are connected.
- Start your experiment using: ▶
- Use these icons ▶ ⏸ at the top of the screen in Vizeey to start and to pause the experiment.
- Select an electronic device (e.g., a phone, charger, or small fan) and place it approximately 15 cm away from databot™ while the device is powered on. Observe and record the magnetic field readings displayed in the app.



- Gradually move the electronic device closer to databot™ in increments of 5 cm (15 cm → 10 cm → 5 cm).
- Click on the "Fix values" button to fix the magnetic field values in all axes. These values need to be entered into the table
- Repeat the process with other electronic devices, ensuring consistent distances and conditions for each test.

Specify the name of the device _____

Distance	Mag X (μT)	Mag Y (μT)	Mag Z (μT)
15			
10			
5			
0			

Specify the name of the device _____

Distance	Mag X (μT)	Mag Y (μT)	Mag Z (μT)
15			
10			
5			
0			

Specify the name of the device _____

Distance	Mag X (μT)	Mag Y (μT)	Mag Z (μT)
15			
10			
5			
0			

Which devices produced the strongest magnetic fields? _____

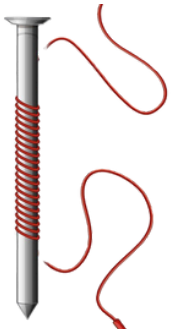
Part 5: Experiment Procedure

Building and Testing an Electromagnet

In this section of the lesson, you will construct an electromagnet and test its ability to attract metal objects. You will also measure its magnetic field strength using a databot™. Additionally, you will explore how factors such as the number of wire turns and battery charge influence its performance.

Materials Needed:

- Insulated copper wire (1–2 meters)
- Iron nail (at least 10 cm long)
- AA battery and battery holder
- databot™ with magnetometer
- Small metallic objects (e.g., paper clips)



- Take a long piece of insulated copper wire (approximately 1–2 meters).
- Begin wrapping the wire tightly around an iron nail (at least 10 cm long), ensuring the coils are close together without overlapping. Leave 5–10 cm of wire free at each end for connections.
- Secure the ends of the wire to the terminals of an AA battery. Use a battery holder for added safety and to prevent accidental short circuits. Make sure the connections are secure.

When the wire contacts on the battery are short-circuited, the wire or the battery may get hot, so the contacts can be short-circuited for a short time of 2-3 seconds.

When you connect 2 wires to the battery, a magnetic field will be created, and you will measure it using databot.

- Turn on databot.
- Tap on "**Electromagnets**" in Vizeey to load the experiment.
- You will be prompted to connect to databot.
  - Hint- if there is more than one databot in use, the one closest to you will be in blue!
  - A solid blue light on databot means you are connected.
- Start your experiment using: ▶
- Use these icons ▶ ⏸ at the top of the screen in Vizeey to start and to pause the experiment.

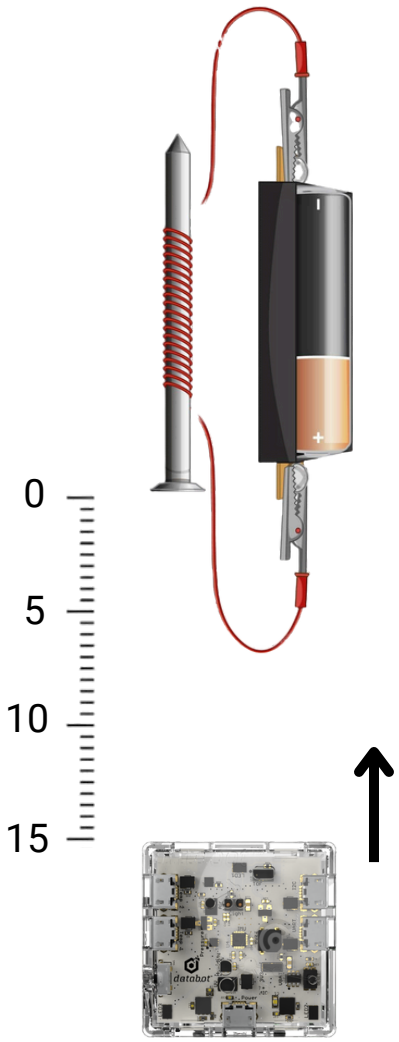
Magnetometer

- Place databot™ at different distances (5 cm, 10 cm, 15 cm) from the nail and record the field readings.
- Click on the "Fix values" button to fix the magnetic field values in all axes. These values need to be entered into the table.

Distance	Mag X (μT)	Mag Y (μT)	Mag Z (μT)
15			
10			
5			
0			

- Take a longer wire and make more turns around the nail. Repeat the tests and observe how the number of turns affects the strength of the electromagnet's magnetic field.

Distance	Mag X (μT)	Mag Y (μT)	Mag Z (μT)
15			
10			
5			
0			



If you have extra time, expand the experiment.

1. Connect multiple AA batteries in series to increase the current through the wire. Test the electromagnet again with databot™ and metallic objects, noting any changes in magnetic strength and range.
2. Replace the iron nail with other materials (e.g., a wooden stick, steel rod) and observe how the core material affects the electromagnet's performance.
3. Record all observations

_____

_____

_____

_____

Magnetometer

Part 6: Concept Questions

How does the distance from an electronic device affect the strength of the magnetic field detected by databot™?

Why do different devices produce varying magnetic field strengths?

What are the key differences between a permanent magnet and an electromagnet?

Part 7: Reflection

1. Which experiment—measuring magnetic fields from electronics or creating an electromagnet—did you find more surprising or engaging? Why?

2. What challenges did you encounter during the experiments, and how did you address them?

3. If you could modify your electromagnet to make it stronger or more efficient, what would you change, and why?