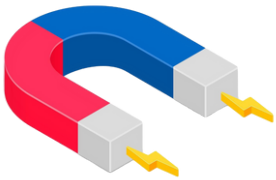
Magnetometer



Material-Magnet Interaction

Overview

Today, you will explore the fascinating world of magnetism through the study of magnetometers, which are essential tools for measuring magnetic fields. Have you ever wondered why some objects attract or repel each other? This lesson will uncover the mysteries of magnetic materials and their invisible forces.

Grades: Middle School
Time: 45 Minutes
Subject: Physical Science
Topics: Magnetic fields

Background

We are surrounded by an invisible but powerful force: the Earth's **magnetic field**. This field acts like a giant **magnet**, with its magnetic poles located near the Earth's North and South Poles. It helps protect us from harmful solar radiation and even guides animals, like birds and sea turtles, as they travel long distances.

To understand magnetism, we first need to look at **magnets**. **Magnets** are objects that create their own **magnetic fields**. These fields are invisible but can be felt as forces of attraction or repulsion. Magnets have two poles — north and south. Opposite poles attract, while similar poles repel. The **magnetic field** around a **magnet** extends outward in lines, showing the direction and strength of the magnetic force.

Scientists use special tools called **magnetometer**s to study and measure **magnetic fields.** A **magnetometer** detects the strength and direction of **magnetic field**s and can be used to study fields produced by the Earth or other objects.

The databot's **magnetometer** operates by detecting changes in the magnetic environment and providing accurate measurements in microteslas (μT). Using this device, you can observe how **magnetic field**s behave and interact with different materials, helping you uncover the invisible forces that shape our world.

What You Will Need/Prep

- databot
- IOS/Android Smart Device
- Install Vizeey™ on your Smart device.
- Ferrite magnets
- Ruler or measuring tape
- Neodymium magnets
- Various materials for testing

- 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

Learning Objectives

By completing this lab, students will:

- Visualize, collect, and interpret live sensor data.
- Analyze data and draw conclusions about magnetic fields.
- Understand the purpose and operation of a magnetometer, including how it works and the units it uses.
- Measure and record magnetic field strength in microteslas (μT).

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.

Magnetism: a natural force that causes certain materials to attract or repel each other.

Microtesla: Teslas are the units used to describe the strength of magnetic field. The magnetic field of one Tesla is relatively strong, so magnetic fields are typically expressed in Microteslas (μT).

Interesting Facts

Natural Magnets: The first magnets were naturally occurring minerals like magnetite, also known as lodestone. Ancient sailors used these stones as early compasses to navigate.

Earth is a Magnet: The Earth itself is a giant magnet, with a magnetic field that protects us from harmful solar radiation. The magnetic field is generated by the movement of molten iron in Earth's outer core.

Animal Magnetism: Some animals, like birds, turtles, and bees, can sense Earth's magnetic field. They use it to navigate during migration or travel.

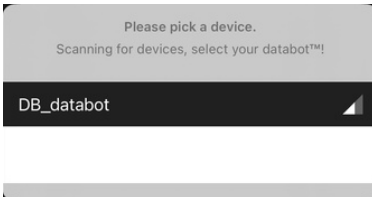
Magnetometer

Using Vizeey

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

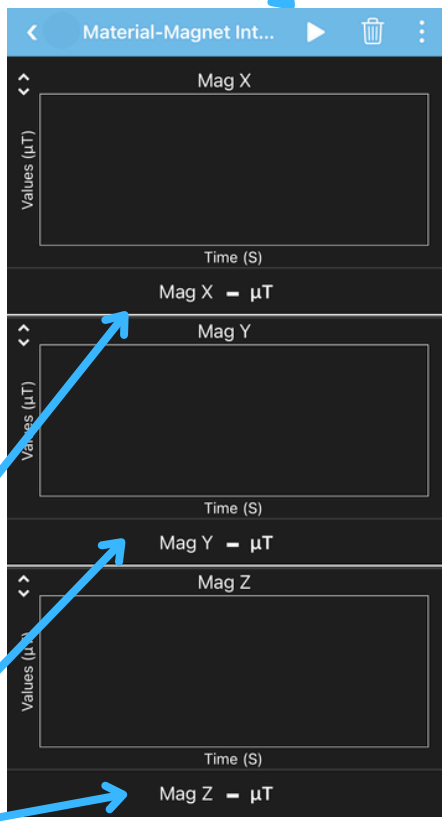
Then select “Add experiment from QR code” and scan the QR code prepared for this experiment. Your experiment will appear in the list.

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.

Press this button to start the experiment.



Safety Guidelines for Working with Magnets
Avoid Powerful Magnets:

- Do not use extremely strong magnets, as they can damage electronic devices, including databot and mobile devices.
- Keep Magnets Away from Electronics
- Magnets should not be placed near devices like phones, laptops, or credit cards, as they can interfere with their operation or erase stored data.

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.

Magnetometer

Part 1: Initial Observations and Discussion Questions

- Which materials are affected by the magnet?

- What do you think causes some materials to be attracted to a magnet while others are not?

- How do you think distance affects the strength of the field?

Part 2: Hypothesis

Predict whether different types of magnets (e.g., bar magnets, neodymium magnets) will produce varying readings on the databot.

As you might imagine, if databot moves around a stationary magnet, the detected magnetic field will change depending on its position and orientation relative to the magnet.

Part 3: Experiment Procedure

Magnetic Field Strength by Magnet Type

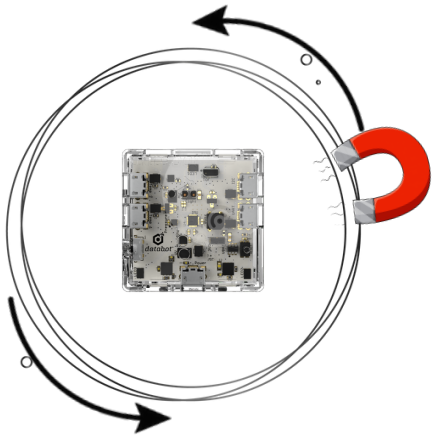
In this experiment, you will focus on two types of magnets: ferrite magnets, which are commonly used and relatively weaker, and neodymium magnets, known for their exceptional strength. Using databot's magnetometer, you will measure and compare the magnetic field strength of these magnets.

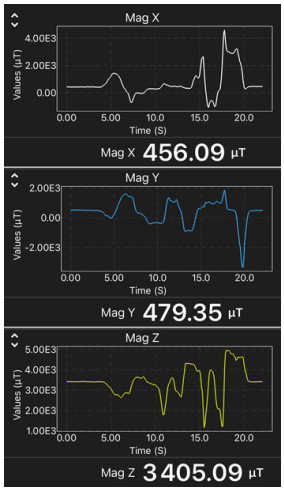
Materials Needed:

- databot with magnetometer.
- Ferrite magnets.
- Neodymium magnets.
- Ruler or measuring tape

Part 3: Experiment Procedure

- Prepare a clean and uncluttered work area, away from other magnetic or electronic objects.
- Turn on your databot and ensure it is fully charged or connected to a power source.
- Tap on "**Material-Magnet Interaction**" 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.
- Place databot in the middle of the table. Take one of the magnets and move it around databot. Observe how the magnetic field values change. Explore all 3 axes of the magnetic field.





- Stop the experiment

Describe your observations. Why are there 3 axis displays on the databot? How do the positive and negative poles of the magnet affect databot.

Part 4: Experiment Procedure

- Choose one magnet (e.g., ferrite, or neodymium magnet) for measurement.
- Restart the experiment.
- Place databot in the middle of the table.
- Set the wooden or plastic ruler near databot.
  (Do not use a metal ruler, it can affect the readings)
- Bring the magnet closer to databot and measure the distance at which the magnet field readings begin to change.

- Write down the reading in the Data Table
- Repeat the experiment with a different type of magnet

Specify the type of magnet here

_____

Distance to databot	Magnetic field strength (μT)

Specify the type of magnet here

_____

Distance to databot	Magnetic field strength (μT)

Construct a histogram from the obtained data.

Write down your observations

_____

_____

_____

_____

Magnetometer

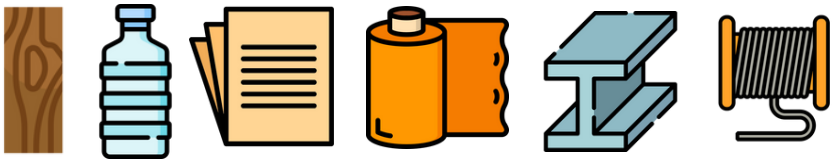
Part 5: Experiment Procedure

Exploring How Different Materials Affect Magnetic Fields

Investigate how various materials influence the readings of the databot™'s magnetometer. Determine which material in the classroom has the greatest impact.

- Prepare a clean and uncluttered work area, away from other magnetic or electronic objects.
- Turn on your databot and ensure it is fully charged or connected to a power source.
- Tap on **"Material-Magnet Interaction"** 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.
- Record the initial reading of the magnetic field displayed by the magnetometer in an empty space without nearby objects. Note this value as the baseline.

  _____
- Gather various materials (e.g., wood, plastic, paper, aluminum foil, steel, copper, etc.).
- One at a time, slowly bring each material close to the databot's magnetic field sensor without touching it.
- Observe the changes in the magnetic field strength displayed on the app.



- Write down the name of the material and the highest reading observed in the Data Table.
- If no change is detected, record "No Effect."
- Continue testing each material and recording the results.

Avoid using magnets or magnetized objects during this part of the experiment.

Material	Magnetic field strength (μT)

Magnetometer

Part 6: Concept Questions

- How does the magnetic field strength vary between ferrite magnets and neodymium magnets? Why do you think this difference exists?

_____

- How does distance from the magnet affect the magnetic field readings? Can you describe the relationship?

_____

- Which materials had the greatest impact on the magnetic field sensor? Why do you think they influenced the readings?

_____

- Did any materials surprise you by having no effect? Why do you think some materials are unaffected by magnetic fields?

_____

Part 7: Reflection

1. How do you think the ability of materials to affect magnetic fields is applied in real-world technologies (e.g., shielding, sensors)?

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2. How has this experiment helped you understand the properties of magnets and their fields?

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3. If given more time, what other materials would you like to test, and what do you predict would happen?

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