Sensor Starters

Grades: 4 & Up
Time: 15 Minutes -PDQ 1 & 2

Subject: Physics, Technology, STEM
Topics: Magnetic Field, Micro Tesla , Conductors

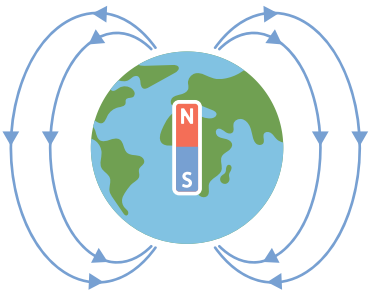
Meet the Magnetometer

The magnetometer is a device that measures the strength and direction of a magnetic field. One of the best examples of a magnetometer is a compass which works by detecting the Earth's natural magnetic field. Magnetometers are used in many ways - on magnetic surveys to find iron deposits, identify archaeological sites, and even in the ocean to find submerged objects.

Background

The magnetometer measures magnetic fields, the region around a magnetic material. You can experience the magnetic field when you bring two magnets closer to each other where the effect of magnetism (attraction /repulsion) is felt. On Earth, magnetism varies from place to place because of differences in Earth's magnetic field.

The magnetometer consists of a material that conducts electricity. When the sensor detects a magnetic field perpendicular to the flow of electrons, a voltage difference is produced. The value of the magnetic field is calculated based on the voltage difference detected.

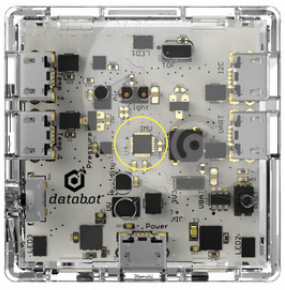


The magnetometer is one sensor in a module called an inertial measurement unit (IMU) located in the center of the databot. PCB. Look for the label IMU on your databot!

What You Will Need/Prep

- databot™ & Vizeey™
- IOS/Android Smart Device
- Use Vizeey™ to scan the QR Code for Magnetometer
- Various materials to test for magnetic properties/shielding properties (metal, cloth, batteries, etc.)
- Magnets

Magnetometer
Behold magnetic forces displaye



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Important Terms

Conductor: Materials through which heat and electricity can be passed easily. *Example: Copper, aluminum, iron.*

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

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).

What are the Units to Express Magnetism?

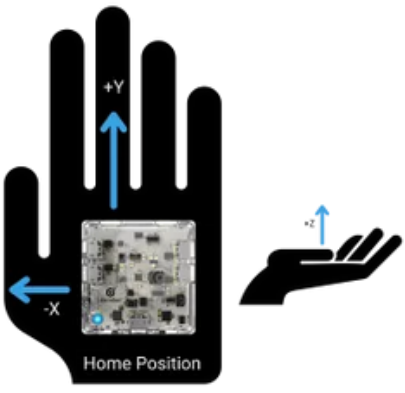
Magnetic fields, the regions around a magnetic material, are measured in Microteslas (µT). Here are some typical values for static magnetic fields.

Surface	µT
Earth's magnetic field at surface	35 - 70
Refrigerator (30 cm distance)	0.012 - 0.299
MRI	1,500,000

Exploration Preparation!

In the coming activities you will be exploring your local environment and identifying magnetic levels using databot. databot is loaded with sensors and capabilities and it helps to have a common orientation for holding it and conducting experiments. That way if you are communicating with a partner you can communicate clearly - moving left, moving right, etc.

"Home position," shown here, is holding databot flat in the palm of your hand with the power and programming port oriented to the back of your palm. In this position sensors are facing up and you can move freely in any direction.



databot in "home position"

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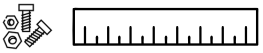
PDQ1 : Magnetic Materials

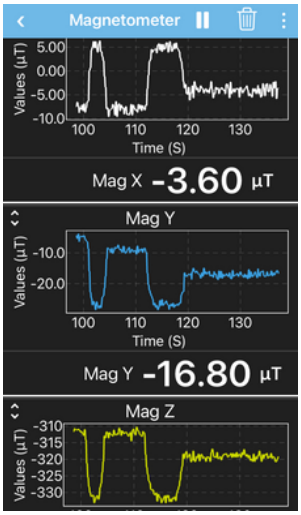
Various materials exhibit different magnetic properties depending on their atomic and molecular structure. For instance, ferromagnetic materials like iron and nickel possess spontaneous magnetic moments and can be strongly magnetized when exposed to a magnetic field. Diamagnetic materials such as water and boron are repelled by magnetic fields and have low magnetic susceptibility. Using the databot **magnetometer** it is possible to investigate and compare the magnetic properties of different materials.

**Before the experiment, prepare various materials to test, including metals (e.g., iron, copper, aluminum), non-metals (e.g., wood, plastic, paper), and any other interesting items you'd like to test (e.g., magnets, coins, toys or even batteries).*

- Open the Vizeey App on your smart device
- Turn on databot
- Tap on "Magnetometer" *in* Vizeey™ to load the experiment.
- Place databot on the table away from the objects being tested.
- Start and pause your experiments using :
  - Vizeey™ displays three graphs. Each graph measures the magnetic property along the x,y,z axes.
- One by one, place different objects near databot. Observe the changes in the graph.
- If the object has magnetic properties you will immediately see it on the graph.
- Move the objects closer and further away
  - use a ruler to measure how distance affects the magnetic field.
  - Record your observations in a data table like this one:
- Add notes to your observations - did any of the objects surprise you?



Test your materials for magnetism at various distances from databot.



Material	Magnetic Y/N
Battery	*Yes*
Necktie	*No*

Important! If you are working with a magnet, do not place it too close to databot or other electronic devices. This may cause damage.

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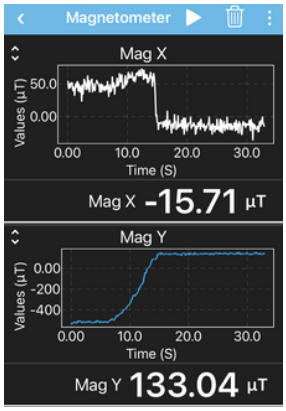
PDQ2 : Shields to Maximum Strength!

Magnetic fields can be shielded using special materials and methods. Shielding magnetic fields is especially important when it is necessary to prevent electronics or other sensitive devices from being affected.

Metallic materials such as iron, nickel, and copper can shield magnetic fields. Typically, metal shields or sheaths that surround sensitive devices are used for this purpose. Let's experiment to shield databot from a powerful magnet!

- Open the Vizeey App on your smart device
- Turn on databot
- Tap on "Magnetometer" in Vizeey™ to load the experiment.
- Place databot on a surface away from the objects being tested.
- Start and pause your magnetometer experiment using:
- Place a magnet several feet (1m) away from databot
  - gradually move the magnet towards databot until you are clearly reading a magnetic field.
    - There should be a sufficient distance between the magnet and databot to place items for testing.



Magnetic field detected!

- Prepare a material to shield the electromagnetic field. (This can be cloth, water, metal or other materials).
  - Place this material between the databot and the magnet.
- If the values of the magnetic field decrease, it means that the material shields the magnetic field emitted by the magnet.
- If the values increase, the material adds magnetic field.
- Experiment with different materials, placing the shielding material at different distances from databot.
  - Record your observations in a data table similar to the one below.

Material	Shield Y/N
Toothbrush	*No*
Necktie	*No*

Important! Use care with magnets near databot as you can damage sensitive electronics with magnetic fields!

Check for Understanding

1. In your own words, explain magnetism.
2. What are the units used for expressing the strength of a magnetic field.
3. What happens to magnetic field strength as you move away from a source of magnetism?

Standards & Alignment

NGSS Standards

- 4-PS4-2: Developing and Using Models
- 3-5-ETS1-3: Planning and Carrying Out Investigations
- MS-PS4-2/HS-PS4-3: Waves and Their Applications in Technologies for Information Transfer
- MS-ETS1-3: Analyzing Data
- HS-ETS1-3: Analyzing Data

Science and Engineering Practices

- 1st Practice: Asking Questions and Defining Problems
- 3rd Practice: Planning and Carrying Out Investigations
- 4th Practice: Analyzing and Interpreting Data
- 6th Practice: Constructing Explanations and Designing Solutions
- 7th Practice: Engaging in Argument from Evidence

TEKS -Texas Essential Knowledge and Skills

Elementary Process TEKS

- 5.2C Scientific investigation and Reasoning: Collect and record information
- 5.2D Scientific investigation and Reasoning: Analyze and interpret information to construct reasonable explanations.

Crosscutting Concepts

- Patterns
- Cause and Effect
- Scale, Proportion, and Quantity
- Systems and System Models
- Energy and Matter

Disciplinary Core Ideas

- Wave Properties (PS4.A)
- Engineering, Technology, and Applications of Science (ETS1.B)
- Earth and Space Sciences (ESS3.B)

ISTE Standards

- 1.1 Empowered Learner (1.1.d)
- 1.3 Knowledge Constructor (1.3.a) (1.3.b)(1.3.d)
- 1.4 Innovative Designer (1.4.a) (1.4.b)
- 1.5 Computational Thinker (1.5.a) (1.5.b)
- 1.6 Creative Communicator (1.6.a) (1.6.b)