NATIONAL GEOGRAPHIC

RESOURCE LIBRARY
ACTIVITY : 55 MINS

Build a Magnetometer

Students construct a simple magnetometer in order to monitor and measure changes in Earth's magnetic field from inside the classroom.

GRADES

6 - 8

SUBJECTS

Astronomy, Mathematics

CONTENTS

1 Video, 2 Images, 2 PDFs, 1 Link

OVERVIEW

Students construct a simple magnetometer in order to monitor and measure changes in Earth's magnetic field from inside the classroom.

For the complete activity with media resources, visit:
http://www.nationalgeographic.org/activity/build-a-magnetometer/

Program

WILDEST WEATHER IN THE SOLAR SYSTEM

DIRECTIONS

1. Activate students' prior knowledge.
Ask: *What do you already know about magnetic fields? What everyday object can you think of that measures magnetic fields?* Elicit from students that a compass uses Earth's magnetic

field to give information about direction. Then show students the NASA video "Magnetometry 101." Ask them to restate in their own words how magnetic fields can be measured and drawn. Tell students that, in this activity, they will build their own magnetometer to monitor and measure magnetic fields.

2. Analyze an illustration and discuss magnetic storm prediction via magnetometers.
Display for students the NASA illustration "Electromagnetic Radiation into the Atmosphere." Explain to students that Earth's magnetic field is shaped and controlled by the sun. Ask students to describe what they observe in the image. Point out how the solar flare produces a solar wind. The solar wind pushes the ions around Earth's magnetosphere. Solar wind will push the magnetosphere to a dynamic state called a magnetic storm. A temporary buildup of energy in the portion of Earth's magnetic field farthest from the sun is suddenly released through a partial collapse of a small part of the magnetosphere and redirected toward the poles. Ask: *How do you think scientists track changes in the magnetic field? How does that give them information about magnetic storms?* Explain to students that magnetic storms are caused by temporary changes in the magnetic field. Scientists measure the strength and direction of Earth's magnetic field with magnetometers placed all over the world. Most are placed near the polar regions, where the magnetic field is known to change quickly.

3. Divide students into small groups and have them select roles.
Divide students into small groups of four. Have students choose from the following roles:

- Recorder—reads directions, records data
- Materials handler—gathers, organizes, measures, and glues materials needed for task
- Engineer—assembles parts as instructed by materials handler
- Project Manager—coordinates and ensures job is on track for completion and all duties are being completed; enlists assistance of other team members as needed; completes checklist as steps are completed

4. Have groups build magnetometers.
Distribute two sets of handout Build a Magnetometer and worksheet Magnetometer Data Collection to each group. One set is for the recorder and the other is for the project manager. Project the step-by-step illustration showing how to build the magnetometer for students to refer to as they assemble theirs. Caution students to take their time and be careful during the construction period. Allow ample time for groups to construct their magnetometers. Rotate around the room and support students in fulfilling their roles, as needed.

5. Provide opportunities for students to gather data fifteen times.
If possible, set up the magnetometers in a place where they will not be disturbed. Determine the best method for data collection, making sure students have the opportunity to gather data a total of at least fifteen times, and record it in Part 1 of the worksheet Magnetometer Data Collection. Then have students graph their data in Part 2 of the worksheet.

6. After students have gathered enough data, have groups compare their data.
Have a whole-class discussion in which groups compare and contrast their data. Ask:

- *What similarities and differences do you see between the data sets?*
- *What are some possible explanations for any similarities or differences?*

Note that students should see similar data if data is collected at the same time from the same magnetometer, or if the magnetometers are close in proximity. If the magnetometers are in very different locations, students may see a fluctuation in data. There may also be differences in the data sets if measurements are not taken precisely or if students round measurements.

7. Have groups compare their data to USGS data.
Display the USGS: National Geomagnetism Program real-time page, or print the data. Have students select the site that is closest to your location. Note that data is displayed for a 6-day period. The data unit is recorded in nanotesla (nT), but you can use the data to make general observations. Have groups compare their graphed data to real-time USGS data. Ask:

- *What similarities and differences do you see between the data sets?*
- *What are some possible explanations for any similarities or differences?*
- *What modifications to the experiment would be beneficial? Why?*

Students should see similarities in the data. If they see differences, it may be due to the differences in locations or their methodology for data gathering. Depending on initial data gathering, students may want to change their methodology and see if they get similar results.

TipSafety

If students are using laser pointers, stress the importance of not pointing them at another student or at their own eyes. Lasers can cause permanent damage to the retina of the eye.

Modification

Demonstrate electromagnetic interferences so students can observe how the assembled magnetometer behaves. Turn on and off computers, a television, or radio.

Informal Assessment

Check groups' completed data collection worksheets for completeness and accuracy. Then ask students to answer the guiding questions, either orally or in writing:

- *How can changes in Earth's magnetic field be monitored and measured?* (Scientists use instruments called magnetometers, placed all over the globe, to monitor and measure Earth's magnetic field. Most magnetometers are placed near the Poles, where magnetic changes are more frequent.)
- *How can those changes provide information about magnetic storms?* (Changes in the magnetic fields indicate magnetic storms.)

Extending the Learning

Have students read the NOAA Space Weather Scale for Geomagnetic Storms. Then ask them to monitor the news and share any articles on geomagnetic storms that fall into any of the categories from minor to extreme. If needed, remind students to only refer to reliable news sources.

OBJECTIVES

Subjects & Disciplines

Earth Science

- Astronomy

- Mathematics

Learning Objectives

Students will:

- describe geomagnetism using their magnetometers
- demonstrate understanding of measurement using comparable USGS data

Teaching Approach

- Learning-for-use

Teaching Methods

- Cooperative learning
- Discussions
- Hands-on learning
- Lab procedures

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Learning and Innovation Skills
    - Communication and Collaboration
  - Life and Career Skills
    - Productivity and Accountability
- Critical Thinking Skills
  - Analyzing
  - Creating
  - Understanding

National Standards, Principles, and Practices

NCTM PRINCIPLES AND STANDARDS FOR SCHOOL MATHEMATICS

• **Algebra (6-8) Standard 3:**
Use mathematical models to represent and understand quantitative relationships

NATIONAL SCIENCE EDUCATION STANDARDS

• **(5-8) Standard B-3:**

Transfer of energy

ISTE STANDARDS FOR STUDENTS (ISTE STANDARDS*S)

- **Standard 2:**

Communication and Collaboration

Preparation

What You'll Need

MATERIALS YOU PROVIDE

- 2-liter plastic soda bottles
- Clear packing tape
- Index cards
- Laser pointer or gooseneck lamp
- Low-melt glue or superglue
- Meter sticks
- Pencils
- Plastic straws
- Quart-sized glass jars with lids
- Rulers
- Sand
- Scissors
- Small bar magnets (not refrigerator magnets)
- Small craft mirrors
- String
- Thread
- White paper

REQUIRED TECHNOLOGY

- Internet Access: Required
- Tech Setup: 1 computer per classroom, Projector, Speakers
- Plug-Ins: Flash

PHYSICAL SPACE

- Classroom

GROUPING

- Large-group instruction
- Small-group instruction

OTHER NOTES

Ideally, students will collect data by taking 15 different measurements, or 2-3 measurements each day over 5-7 days or longer.

BACKGROUND & VOCABULARY

Background Information

Scientists measure solar storms using a variety of tools. One of the measurements they use to determine the intensity of solar storms is changes in magnetic fields. Scientists use magnetometers to monitor the Earth's environment in space for signs of bad space weather caused by solar activity. Solar storms can affect the Earth's magnetic field causing small changes in its direction at the surface, which are called magnetic storms. A magnetometer operates like a sensitive compass and reads the slight changes.

Prior Knowledge

["basic understanding of magnets and solar activity"]

Recommended Prior Activities

- Magnetic Fields Lab
- Our Active Sun

Vocabulary

Term	Part of Speech	Definition
magnetic field	*noun*	area around and affected by a magnet or charged particle.
magnetic storm	*noun*	interaction between the Earth's atmosphere and charged particles from solar wind.

Term	Part of Speech	Definition
magnetometer	*noun*	scientific instrument used to measure the presence, strength, and direction of Earth's magnetic field.
magnetosphere	*noun*	teardrop-shaped area, with the flat area facing the sun, around the Earth controlled by the Earth's magnetic field.
nanotesla	*noun*	(nT) unit of measurement for magnetic flux density (magnetic field B), which is magnetic force on a moving charge.
solar flare	*noun*	explosion in the sun's atmosphere, which releases a burst of energy and charged particles into the solar system.
solar wind	*noun*	flow of charged particles, mainly protons and electrons, from the sun to the edge of the solar system.
space weather	*noun*	changes in the environment outside the Earth's atmosphere, usually influenced by the sun.

For Further Exploration

Websites

- Nat Geo Movies: Wildest Weather in the Solar System
- National Geographic Science: Space
- USGS: Geomagnetism—FAQ
- National Geographic News: Why Does Earth's Magnetic Field Flip?

FUNDER

LOCKHEED MARTIN

NATIONAL GEOGRAPHIC