

Introduction to the THEMIS Magnetism Series

This is one of four magnetism activity guides—plus a background guide for teachers—that provide students with the opportunity to build on science concepts related to Earth’s magnetism and its changes. If your students engage in the activities in these four guides, they will have the skills, language and conceptual understandings of magnetism— one-half of the four fundamental forces of nature (the whole force is known as electromagnetism).

All of these guides have been:

- Classroom tested
- Checked for science accuracy by NASA and THEMIS scientists
- Designed to utilize math and writing

The goal of these guides is to give students an appreciation of the major role magnetism plays on Earth and in space, and ultimately enable them to use NASA data as “scientists” researching our magnetic connection to the Sun. We achieve this goal through sequential activities in the four teachers’ guides, from basic explorations with magnets, compasses and galvanometers to scientific discoveries using data from instruments called magnetometers. These magnetometers are located in schools across the U.S, as part of the THEMIS education project.

The four activity guides have been used in different types of classes, from physical science and physics classes, to geology and astronomy classes. The excitement of actually participating in the THEMIS project helps motivate the students to learn challenging physical science concepts.

1. **Magnetism and Electromagnetism** is a review of basic magnetism, similar to what is encountered in most grade-level physical science texts. Students map field lines around bar magnets to visualize the magnetic dipole field, and create their own electromagnet using copper wire, battery and a pencil to learn that electric currents create magnetic fields. Two activities introduce generators and Lenz’s law, in one case using Earth’s magnetic field and a large conducting wire. These materials can be used by teachers presenting Earth and Physical Science courses in grades 6-9, and would fit well into a lab at the end of a high school physics class. These activities are a classroom-ready prerequisite to understanding magnetism on Earth and in space.

2. **Exploring Magnetism on Earth** is intended to help students explore Earth’s magnetic field through a variety of math-based activities. This guide contains problems focusing on Earth’s changing magnetic field in time and space. Students use compasses to discover how these changes can impact navigation on Earth’s surface. They use basic math skills to interpret graphical information showing polar wander and magnetic changes, and answer questions about quantitative aspects of these changes. These lessons can be used in geology and astronomy classes.

3. **Magnetic Mysteries of the Aurora** is a prerequisite to using magnetometer data as students will in the next guide, **Earth’s Magnetic Personality**. **Magnetic Mysteries of the Aurora** introduces

students to Earth's magnetic field and Northern and Southern Lights (aurora) within the context of the Sun and space weather. Using worksheets, globes, and a single light source, students review time-keeping on Earth—time zones and Universal Time. Students then go through a series of activities to discover the causes of the aurora and their relation to Earth's magnetosphere and solar storms. Students classify images of aurora by shape and color, create a model of Earth's magnetosphere, forecast magnetic storms using geomagnetic indices, and engage in a presentation about space weather. These lessons have been used in physics and astronomy classes as well.

4. **Earth's Magnetic Personality** is the culmination of all the previous guides. It was developed with the goal that students can now work directly with the THEMIS magnetometer data. Students review vectors through calculations, learn to interpret x-y-z magnetometer plots, predict auroral activity using the x-y-z magnetometer data, calculate the total magnetic field strength and observe it over months, and discover that waves in Earth's magnetic field are excited by large magnetic storms by comparing spectrograms with magnetic indices.

5. The background guide for teachers, the **THEMIS GEONS Users Guide**, describes the important role that terrestrial magnetism plays in shaping a number of important Earth systems. It also explains the basic operating principles behind magnetometers—particularly the system you are now in the process of using to investigate magnetic storms at your school.