National Aeronautics and Space Administration

ACTIVITY MANUAL

IT'S MAGNETIC

This scalable activity teaches magnetism at various learning levels and contextualizes the content through a space communications lens. Students learn about space navigation through orienteering and how interactions between space weather and Earth's magnetic field can impact communications.

AGE: 5-13

COST: <$20

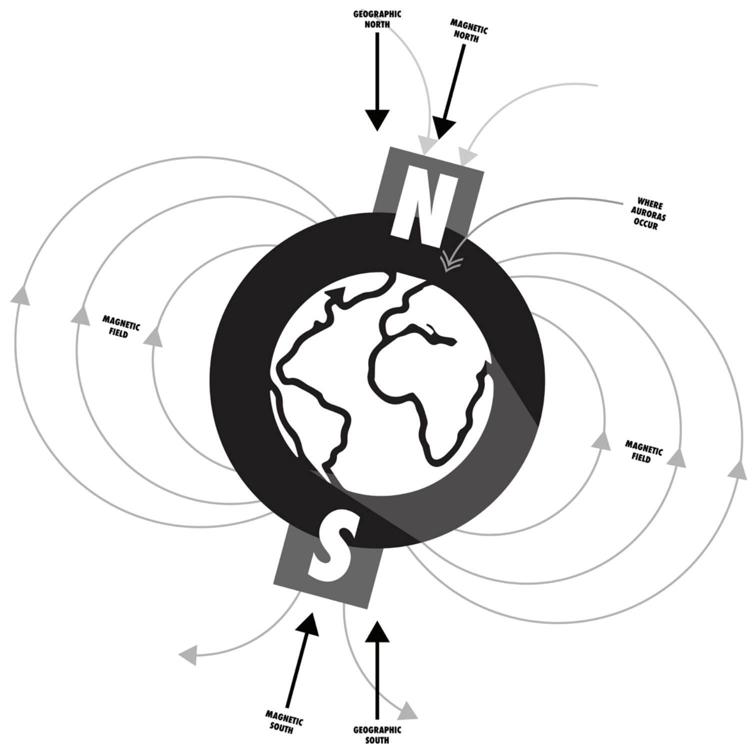
TIME: 20-45 MIN

PREPARATION

MATERIALS

1. One donut shaped magnet. Ideally, obtain one whose center hole can fit a pencil.
   a. If this is not available, most simple disc or bar magnets will do.
   b. Flexible 'sheet' magnets are not strong enough for this activity.
   c. Magnets with decorative elements will be difficult to manage.
   d. U-shaped magnets will not work for this activity.
2. String *(about three feet long)*
3. A pencil
4. Tape *(masking tape is ideal)*
5. Compass *(to check accuracy)*

EARTH AS MAGNET



Molten iron in the Earth's core generates a magnetic field surrounding the planet. This magnetic field exerts an aligning force on magnetic materials, which is why a compass needle points towards the North Pole. The field also protects us from much of the Sun's radiation, or solar winds. Magnetic field lines extend out from Earth in loops, drawing radiation away from the surface. When the radiation is drawn into the atmosphere by the poles, auroras can occur.

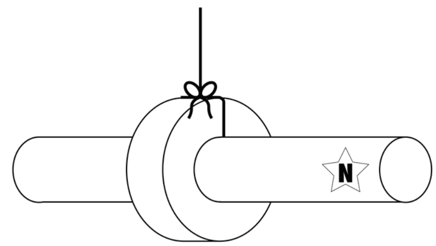
Fun fact: Earth's magnetic poles aren't at the geographic 'top' and 'bottom' of the planet. In fact, the geographic and magnetic poles are about 300 miles apart!

INSTRUCTIONS

CONSTRUCTION

1. Tie a piece of string to the magnet. If your magnet does not have a hole, you can tape the magnet to the string, or sandwich the string between a second, matching magnet.
2. Mark one side of the magnet to differentiate it. If you have a donut-shaped magnet, you can put a pencil or similar through the hole to help it 'point'.

EXAMPLE



1. Hold the string so the magnet dangles freely. Let it settle until any twisting in the string has spun out and the magnet points in a consistent direction.
2. Slowly rotate your hand to test; the magnet should stay pointed in the same direction regardless of your movement. (At a certain point, twisting in the string may overcome the magnet's desire to align with the earth's magnetic field; when this happens, wait for your compass to re-stabilize.)
3. Confirm that your compass is not being influenced by any electricity-using devices or large metal objects. Move slowly around your house or yard until you're reasonably sure that you have a sense of the two directions the compass points. (One is north and the other is, naturally, south.)

Is the way the dangling magnets line up an accident? To remove any doubt, try hanging nonmagnetic stainless steel, zinc, or aluminum washers and compare their alignments to that of the magnets. Move different pieces of metal near your home-made compass and watch it spin in response.

4. Confirm with a manufactured compass or smartphone compass app.
5. Once you know which side of your homemade compass is north, mark it with masking tape (or a pointing pencil.)
6. Using simple directions (north, south, east, and west), make sets of instructions to help you navigate from one place to another. Can you make a 'treasure map' to navigate from your bed to the bathroom sink?
7. Have other members of your family test out your treasure map. If they follow your instructions, do they reach the same place?
8. How do you communicate distance? Discuss the challenges of making standard units. Have your child measure the length of your step and compare it to the length of one of their steps.

WARNINGS

If students participate in the orienteering component of this lesson, ensure that any course is well-lit and free of obstacles. If taking the lesson outside, ensure that students are appropriately supervised.

Powerful magnets can pinch the skin. Metal objects can splinter or poke. Exercise caution when purchasing materials for this lesson.

FURTHER INVESTIGATION

THE COMPASS: CULTURAL & GEOLOGICAL ORIGINS

As far back as 200 BC, Chinese peoples used the mineral magnetite to develop north to south pointing devices for navigation. They reffered to the mineral as tzuh shih, or the "loving stone" for its attractive properties. It is also referred to as "lodestone," with "lode" meaning 'to lead.'

Geologists have long sought the geological origins of lodestones. Only a fraction of Earth's magnetite is unearthed with naturally occurring magnetic properties. Analysis of lodestones shows that their magnetite has a unique crystalline structure which allows them to remain magnetized longer. As to how these stones are magnetized in the first place, many scientists think the strong magnetic forces around lightning may play a role.

THE AURORAS IN SCIENCE AND LEGEND

Both the North and South Poles experience auroras, beautiful lights in the sky that result from the complex interactions between solar weather (radiation from the sun), Earth's magnetic fields and Earth's atmosphere. Their coloring depends on the gases present when high energy particles from the sun hit the atmosphere. While we're most familiar with auroras on Earth, many planets experience the phenomenon, including Jupiter and Saturn.

Today, scientists study the interactions of solar weather and Earth's magnetic fields to better understand how the sun impacts vital infrastructure like communications networks and power grids. Additionally, many native cultures near the North and South poles have legends, myths and traditional knowledge of these phenomena.

"In general, the aurora borealis was feared. To some extent, the uneasiness occasioned by it survived. Children were told to go into the house when the lights appeared. The phenomenon was personified and the child was told that it would take his head to use for football. Adults likewise were frightened by the aurora. It was believed to bring headache and pains in the neck. One turned one's back to it and waved a knife behind one to ward off the influence. Songs were also sung to prevent harm from the aurora."

– Robert F. Spencer, The North Alaskan Eskimo: A Study in Ecology and Society

NASA'S SEARCH AND RESCUE OFFICE

When hiking through the woods, mountain or tundra near your home, having a compass can come in handy. With a map and a compass you can orient yourself and guide yourself home. But, what if you're lost without a compass? What if you need someone to find you? NASA can help.

NASA's Search and Rescue office develops technology that can help find you anywhere in the world. They design emergency beacons for personal use, and for use on boats and planes. To learn more about NASA's contributions to the international satellite-aided search and rescue effort, visit:

esc.gsfc.nasa.gov/SAR

DIVE DEEPER

BUILD-YOUR-OWN ORIENTEERING COURSE

1. Hand students a blank map of the activity space.
2. Have students identify the cardinal directions on the map using their compasses, then draw and label a compass rose at the corner of the map.
3. Each group can then build their own orienteering course to challenge their classmates. Instruct them to create directions that will guide their classmates to a secret spot on the map.
4. Have teams take turns leading the class through the orienteering courses they've built.

ALTERNATE COMPASS CONSTRUCTION

1. Magnetize a small, metal object like a sewing needle. Do this by placing one end of a magnet against one end of the metal object. *(Note: this requires a strong magnet and repeated contact.)*
2. Fill a bowl with water.
3. Carefully float the magnetized needle on the surface of the water using a light, buoyant piece of foam.
4. There are multiple solutions possible for this activity. Any magnetized object that is floating can become a compass. Give your students some options and see what they come up with.

PLACE-BASED LEARNING AND CULTURAL RELEVANCY

When building your lesson plan, this activity can be enhanced though place-based learning. Questions to ask yourself about your students:

- *What cultural or historical references will best suit your students? Many cultures have different histories of and relationships to orienteering, magnetism and space weather phenomenas like auroras.*
- *When building your orienteering course: What sorts of landmarks will your students be most familiar with? Can the course be built to promote exploration of spaces with particular significance to their communities?*

> ***For example:*** *At NASA's Goddard Space Flight Center's Visitor Center in Greenbelt, Maryland, an orienteering course could be built that directs students to various exhibits within the building. At each exhibit, students could learn about Maryland's contributions to the space program.*

EXPLORATION AND SPACE COMMUNICATIONS PROJECTS DIVISION
NASA'S GODDARD SPACE FLIGHT CENTER

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