Magnetic Globe

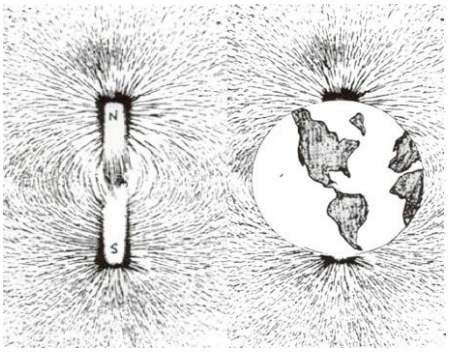
P8-1130

INSTRUCTIONAL GUIDE

Background

The magnetic globe was invented by Dr. Paul Doherty, director of The Exploratorium in San Francisco. The Magnetic Globe consists of a powerful magnet inserted into a “squesh” globe. Since the earth behaves like it has a giant bar magnet at its center, the Magnetic Globe offers a unique opportunity to view the earth’s magnetism from the “outside.”

> “The earth acts like there is a large bar magnet placed near its center. However, the earth is not a magnetized chunk of iron like a bar magnet. It is too hot for individual atoms to remain aligned. Currents in the molten part of the earth beneath the crust provide a better explanation for the earth’s magnetic field. Most earth scientists think that moving charges looping around within the earth create its magnetic field. Because of the earth’s great size, the speed of moving charges would have to be less than one millimeter per second to account for the field. Another candidate for the earth’s magnetic fields is convection current that result from heat rising from the earth’s core. Earth’s heat comes from the release of nuclear energy C radioactive decay. Perhaps such convection currents combined with the rotational effects of the earth produce the earth’s magnetic field” (Hewitt, 562-563).



Whatever the cause, the magnetic field of the earth is not stable, but rather has been wandering around throughout geological time. Geologists know this by studying rock containing iron. Just before the rock solidified, its iron content lined up with the earth’s magnetic field. Geologists can now date the rock and analyze what direction the iron is pointing in. That’s where the north and south magnetic poles of the earth were at the time the rock was formed. Right now, the magnetic poles are somewhere over the Hudson Bay region of northern Canada and just south of Australia.

Activities

To help conceptualize it, visualize the magnetic field lines created by a bar magnet. Now place a globe in the center of the magnetic field. We exist on the outside surface of the earth, where the field is curved. It helps to visualize yourself with a compass standing on the globe in the picture. What direction would the compass point in? When you think about it from this vantage point, compasses behave quite understandably.

What would a compass do at the Equator, North Pole, and South Pole?

Place a **Magnaprobe** (P8-8006) at the Equator of the Magnetic Globe.

Q: Is the gimbal-mounted bar magnet dipping north, south or perpendicular?

A: The gimbal-mounted bar magnet is perpendicular to the Equator.

Move the **Magnaprobe** from the Equator towards the North Pole.

Q: As you move the 3D Magnetic Compass from the Equator towards the North Pole what happens to the tilt of the magnet?

A: The magnet begins to tilt until the red end of the magnet is pointing down towards the earth.

Continue your journey around the Globe resting at the South Pole.

Q: How is the magnet pointing now?

A: The magnet should tilt until the blue end is pointing straight down.

What is "Magnetic inclination"?

The **Magnaprobe** points up and down at certain angles depending on where you are at on the Magnetic Globe

Q: why don't compasses do that?

A: Compasses are restricted to 2 dimensions and therefore can't show tilt.

To demonstrate the inclination of the earth's field you need a three-dimensional compass and a Magnetic Globe. The **Magnaprobe** is a gimbal-mounted bar magnet that floats freely enough to line up with any magnetic field in three dimensions.

The angle at which the magnet leans is called the field's "Magnetic inclination."

What are the Van Allen radiation belts?

1. Use Arbor Scientific's **Magnaprobe** to map out the Magnetic Globe's surrounding magnetic field.
2. The Van Allen radiation belts are charged particles that get trapped in the earth's magnetic field. They move back and forth between the magnetic north and south Polar Regions. These trapped particles interact with the earth's atmosphere to produce the dazzling spectacle of the aurora.

Related Products

The Magnaprobe (P8-8006) is a gimbal-mounted bar magnet that acts as a three-dimensional compass.

Bibliography

Conceptual Physics by Paul G. Hewitt. Pearson Education, Inc.