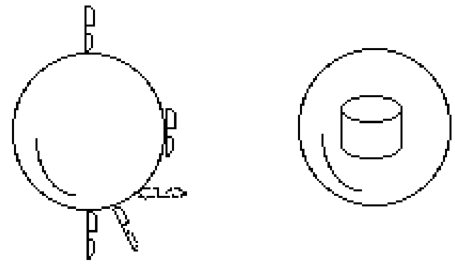
# Magnetic Globe

This can be fun&emdash; if you have the inclination.



Staples cling to a sphere with a strong magnet at its center.

**Introduction**

With this activity you can make a 3 dimensional model of the magnetic fields of planets by inserting a small yet strong magnet into a sphere. Then you can show the magnetic field by sprinkling used staples onto the sphere. The orientation of the staples changes with latitude.

**Materials**

- You can buy a preassembled earth globe with a magnet already inside from Arbor Scientific, P.O. Box 2750, Ann Arbor, Michigan 48106 (1-800-367-6695) for about $15 (in 2000)
- Used staples
- Here's what you'll need to build your own magnetic earth globe.
    - Otherwise you can make your own from:
    - A Sqeeshball$^{TM,}$ a soft toy ball with an earth globe printed on it, available in toystores, distributed by Toysmith, Kent WA
    - A Neodymium magnet: a cylinder 1 cm in diameter and 1 cm high can be assembled from two standard sized 1cm x 1/2 cm disks.
      You can use other sizes as long as you adjust the diameter of the sphere to be 2 to 4 times the length of the neodymium magnet. [ Only neodymium magnets are strong enough for this activity. They are available from Dowling Miner, P.O. Box 1829, Sonoma, CA 95476 (1-800-MAGNET1) ; All Magnetics, 930 S. Placentia Ave. Placentia, CA, 92670 (1-800-AMAGNET)
    - Hot melt Glue, or silicone seal
    - Utility Knife or Scissors

Compass (or optional, a Magnaprobe, a 3-dimensional compass from Arbor Scientific.)

**Assembly**

If you're assembling your own magnetic earth, cut a slit in the Squeeshball$^{TM}$, and insert the magnet into the center. Point one of the flat ends of the magnet toward the north pole of the earth. Reseal the ball with silicone seal or hot melt glue.

**Try This!**

Explore the magnetic field of the ball. If you place a used staple on the ball, the staple will stick to the ball and line up with the ball's magnetic field. Add more staples to the ball. Notice that the staples lie flat against the ball along a circle, this is the "magnetic equator. " At the "magnetic poles," the staples stand up vertically. Between the poles and the equator the staples stand up at different angles with respect to a plane tangent to the ball. The angle between the staple and the tangent plane is known as the "magnetic inclination" or the "dip of the magnetic field."

The Magnaprobe (optional) is a compass that is free to rotate in three dimensions. Use it or a compass to explore the magnetic field surrounding the sphere. The field stretches away from the sphere; in the same way, the earth's magnetic field stretches far out into space. The earth's field traps charged particles from the sun making the Van Allen radiation belts.

If the compass or magnaprobe is held far from the magnetic sphere it will align itself with the magnetic field of the real earth rather than your earth model. Notice that in North America the north pole of the magnaprobe (red) points north and down.

**What's Going On?**

The earth is a magnet with magnetic north and south poles. Because it has only two poles, two places where the staples stand up vertically, its magnetic field is modeled by what is called a "dipole field."

A sphere with a magnet inside creates a magnetic dipole like that of the earth. The staples will line up with this magnetic field. As the staples align, they show field lines that run between the north and south poles, they also show that the field over most of the sphere is not tangent to its surface.
Although the magnetic field of this experiment is created by a permanent magnet, the earth is actually an electromagnet. The earth's magnetic

field is created by electric currents which flow in the rotating and convecting liquid metal of the earth's outer core.

A compass lines up with the earth's magnetic field, however, the pivot of the compass does not allow it to rotate up or down so it only shows the horizontal component of the field.

**Etc.**

The magnetic poles move
Explorers who search for the place where a compass aligns itself straight up-and-down find the magnetic poles of the earth. One magnetic pole is currently in Canada more than 15 degrees of latitude from the geographic North Pole. Because of the way magnetic poles were originally named that pole is actually a magnetic south pole. Today, the other magnetic pole is off the coast of Antarctica. In 1913 the Australian Antarctic Expedition commanded by Douglas Mawson found the Antarctic magnetic pole on land. The magnetic poles of the earth move with time.

**Etc.**

The magnetic poles reverse.
Besides moving around, the poles of the earth occasionally reverse. The last major reversal was 700,000 years ago; the previous one was 1.1 million years before that. So if we are patient enough the poles of the earth will flip and the magnetic north pole will actually be near the north geographic pole. The flips take less than a thousand years and during a flip the strength of the earth's field decreases to 10% or so of its maximum value.

A moberg is a volcanic mountain erupted under the ice. The top half of the lavas in this Icelandic Moberg, named Ingolfsfjall, record the same magnetic direction we have today, the lower half records reversed magnetism.

**Etc.**

The naming of the magnetic poles
When needles of magnetite were found to point toward the north pole star no one knew that the needles were magnets or that the earth itself was a magnet so the end that pointed toward the north pole was called the "north seeking pole." Today that name has been shortened to the "north pole" of the magnet. Since opposite magnetic poles attract, when the earth itself was discovered to be a magnet , this naming convention meant that the pole of the earth's magnet nearest the geographic North Pole had to be a magnetic south pole. This has led to hundreds of years of confusion. Only a future flip of the magnetic poles of the earth can save us from our current state.

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