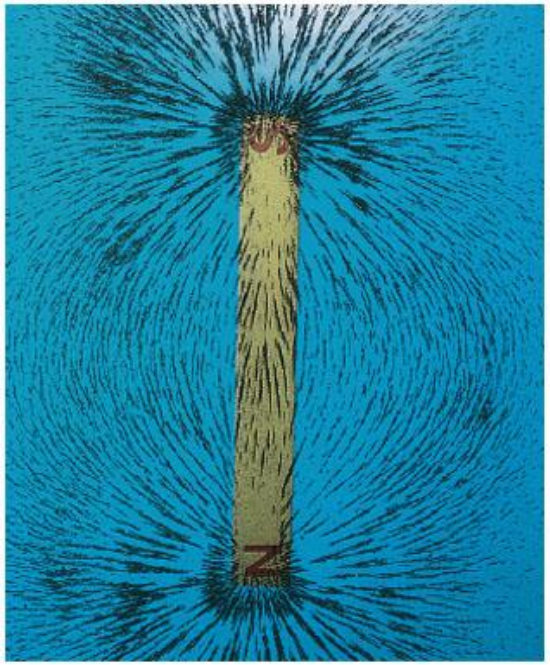
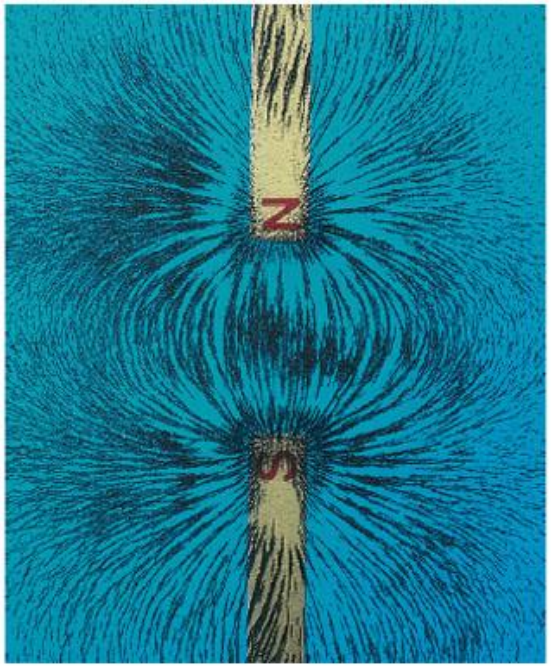
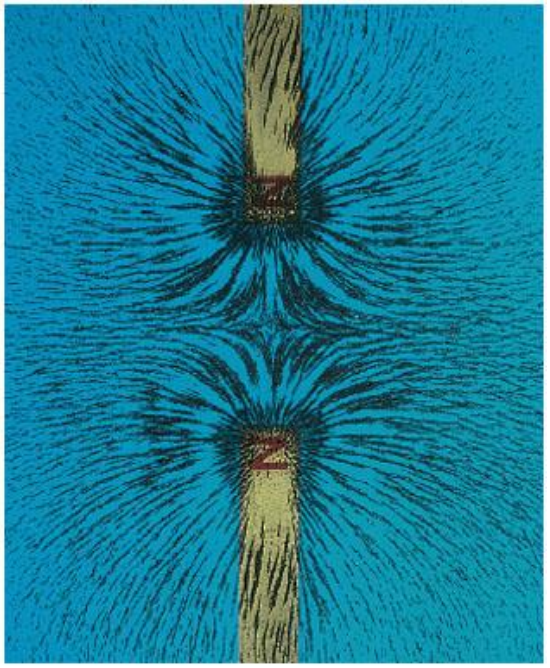
Magnetism – Part 1







Some observations…

A horizontal magnet is aligned in an approximate North-South direction—actually it points about 3º to the west of geographic north.

But—in the Chicago area—the "North-seeking" end also "dips" at an angle of about 70º below the horizontal.

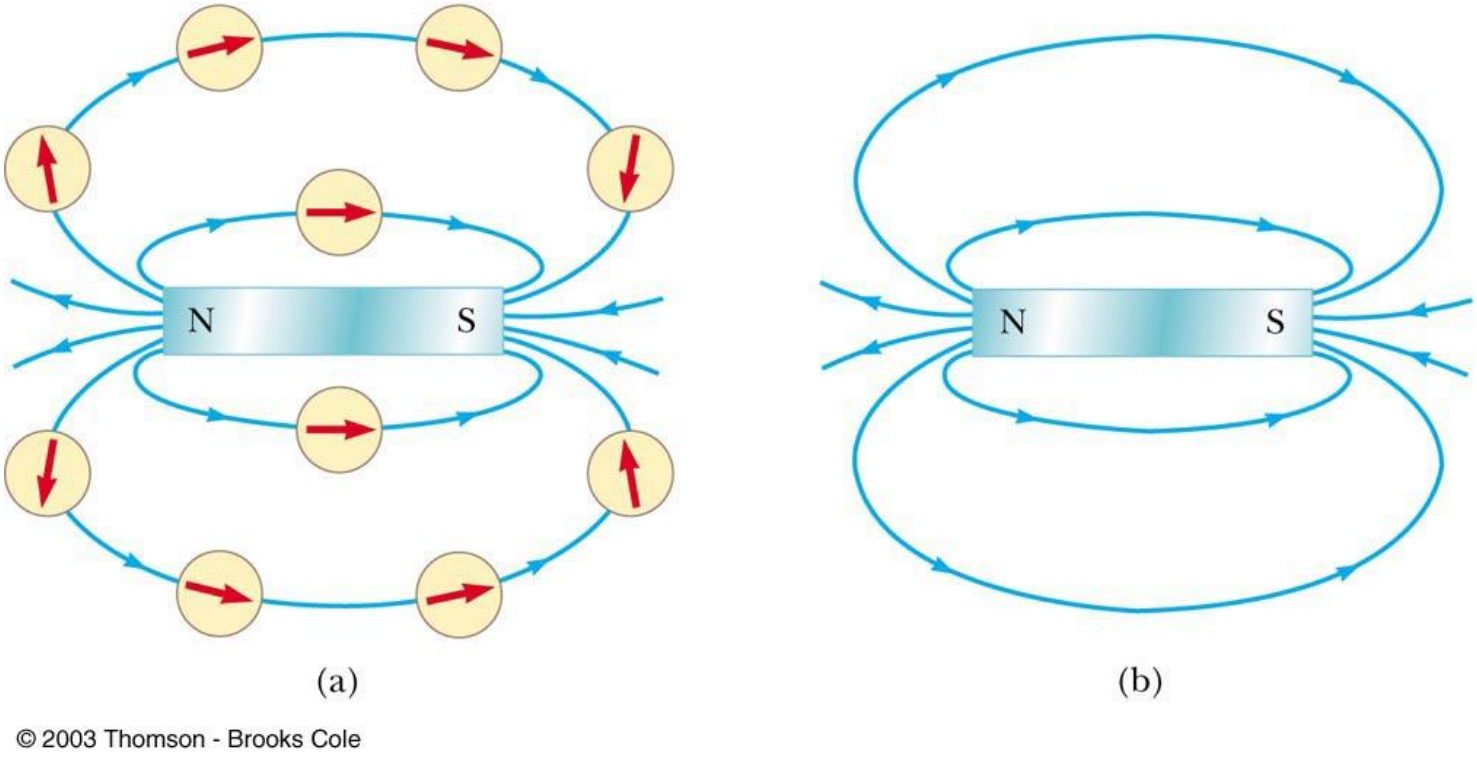
***Poles* of a magnet are the ends where objects are most strongly attracted.**

Some other observations…

Like magnetic poles repel each other, unlike poles attract each other.

Are the poles of a magnet electrically charged? Observe and note your observations.

The *field* concept applied to magnets.



A compass can be used to show the direction of the magnetic field lines (a).
A sketch of the magnetic field lines (b).
The field is really 3-dimensional (observe).

Types of Magnetic Materials

Soft magnetic **materials, such as iron, are easily magnetized.**

They also tend to lose their magnetism easily.

Hard magnetic **materials, such as cobalt and nickel, are difficult to magnetize**

They tend to retain their magnetism

Response of Materials to Magnetic Fields

1. Diamagnetism is a property of all materials, due to magnetic properties of atoms and molecules. Diamagnetic materials tend to oppose external magnetic fields. The effect is usually quite small and may be overridden by other magnetic properties. Water, graphite, mercury, silver, lead and copper are examples of diamagnetic materials.

Response of Materials to Magnetic Fields

Diamagnetism makes *magnetic levitation* possible. Here, a very strong magnet is placed between two carbon blocks in the field of a magnet at the top of the apparatus.

The diamagnetic force opposes the gravitational pull on the magnet and it "floats" between the carbon blocks.

Here is the famous levitating frog video from the Nijmegen High Field Magnet Laboratory.

Response of Materials to Magnetic Fields

2. **Paramagnetism is a property of some materials that are magnetized in proportion to the strength of the magnetic field in which they are placed. This property will override the diamagnetism of these materials. Uranium, platinum, tungsten, cesium and aluminum are paramagnetic materials. The response of a paramagnetic material to an external magnetic field is usually quite small.**

BUT…

Response of Materials to Magnetic Fields

3. Ferromagnetism is a property of some parmagnetic materials to respond strongly to an external magnetic field. Iron, iron oxide, nickel and cobalt are examples of ferromagnetic materials. Strong permanent magnets are made of alloys of samarium, neodymium, cobalt, iron and boron.

Earth's Magnetic Field

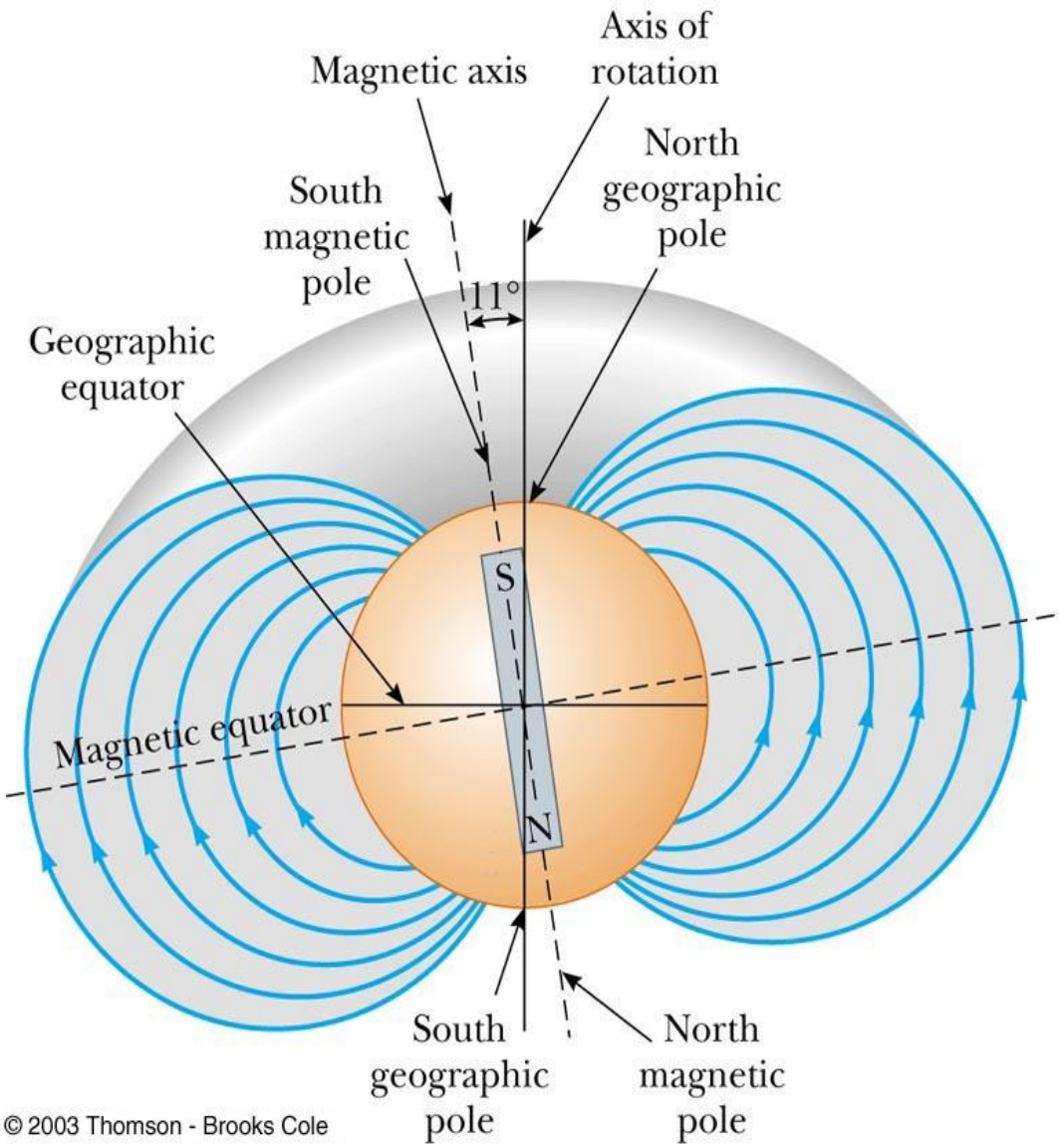
The Earth's geographic north pole corresponds to a magnetic south pole

The Earth's geographic south pole corresponds to a magnetic north pole.

Strictly speaking, a north pole should be a "north-seeking" pole and a south pole a "south-seeking" pole.

Earth's Magnetic Field

The Earth's magnetic field resembles that achieved by burying a huge bar magnet deep in the Earth's interior



Dip Angle of Earth's Magnetic Field

The angle between the horizontal and the direction of the magnetic field is called the *dip angle.*

The farther north the device is moved, the farther from horizontal the compass needle would be.