Magnetism

An overview of the activities in the kit

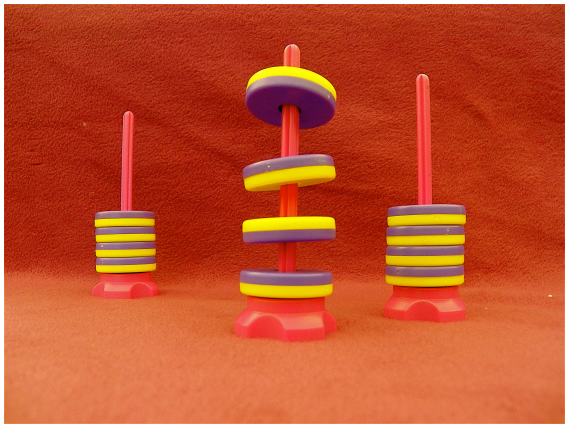
Updates

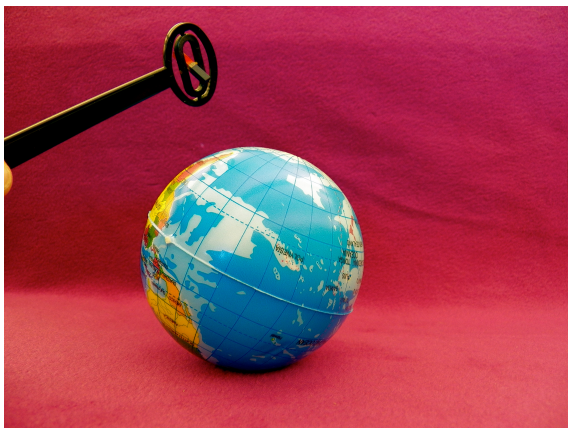
We regularly update the detailed documents for the activities described here. You can get updated versions at the Little Shop web site:

http://littleshop.physics.colostate.edu/magnet

Central Points: Whole-Class Activities

For the central principles, we have enough materials for you to have students work in groups to perform investigations as a class.

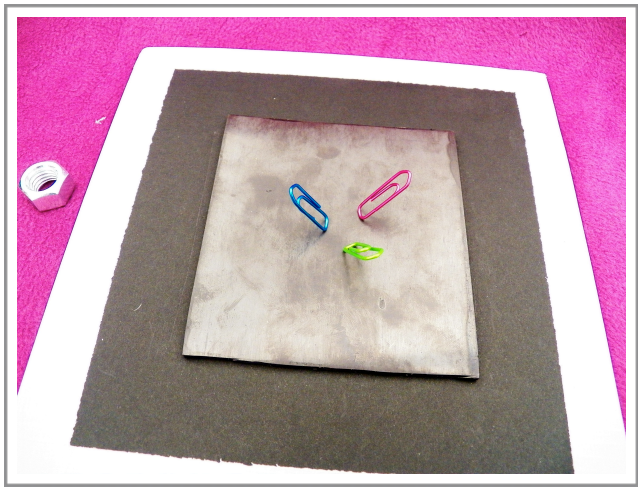
Magnetic Fields	Overview
	The first thing everyone learns about magnets is this: Magnets stick to things. We'll treat this principle later. The second thing is that magnets have north poles and south poles, and that opposite poles attract and like poles repel. The levitating magnet stand is a great way to let your students experiment with this principle.

Magnetic Fields	Overview
	There is a magnet inside the globe model that makes a magnetic field that extends well beyond the globe. You can detect it by using the magnet probe, which lines up with the field. You can use this as a model of the earth's field. In North America, what is the direction of the earth's field? You might be tempted to say north, and that's partly true. But, more than north, the field points down. This *dip angle* is important for many animals that use the earth's field to navigate.

Applications: Stations

The kit contains materials for you to provide a set of 7 stations for your students to explore that illustrate some of the basic principles of magnetism.

Nature of Magnetism



Overview

Magnets do exert forces, but understanding magnetism is more about understanding alignment. The *spins* inside a magnetic material like to line up with an applied magnetic field; this magnetizes the material.

The rubbery black material is a strong magnet with the entire top surface a single pole. You'll find that paper clips line up with the field but don't stick to the magnet, though they stick to each other. Understanding this lining up is more interesting, more fundamental, than understanding the forces between magnets.

Magnetic Surprises

Overview

Ferromagnetic materials (iron, nickel, cobalt, and a few other metals, along with a number of alloys) are attracted to magnets.

There are many things in the world that have iron in them that you can detect or pull out with a strong magnet—and some are quite surprising.

Sand in Fort Collins has a good deal of iron it in. But so does cereal! When cereal is fortified with iron, it is fortified with, literally, iron! Paper money has magnetic ink, with small iron particles, that helps with security.

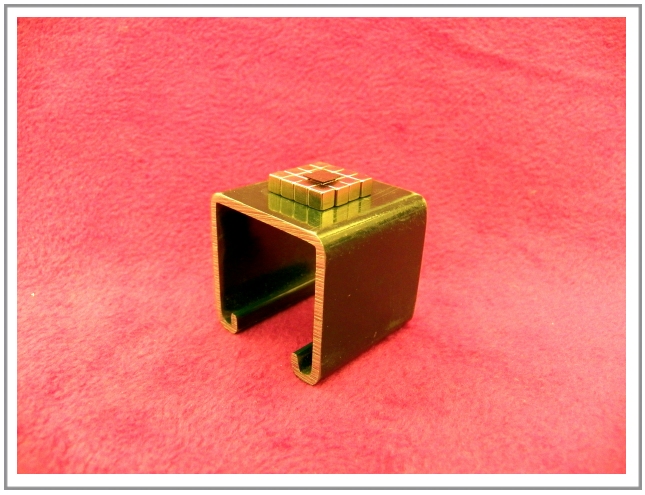
Writing with Magnetism

Overview

A rectangle of magnetic material can be magnetized with a magnetic “pencil.” And a magnetic viewer (which has its own interesting physics!) shows the resulting “writing”.

The magnetic material is easily magnetized; it’s soft refrigerator magnet material. The strong magnet on the pencil can be used to magnetize it; locations under the pencil tip get lined up with the north pole facing up. The viewer, when placed over a magnet pole, appears black—and the magnetic message appears.

Levitating Graphite

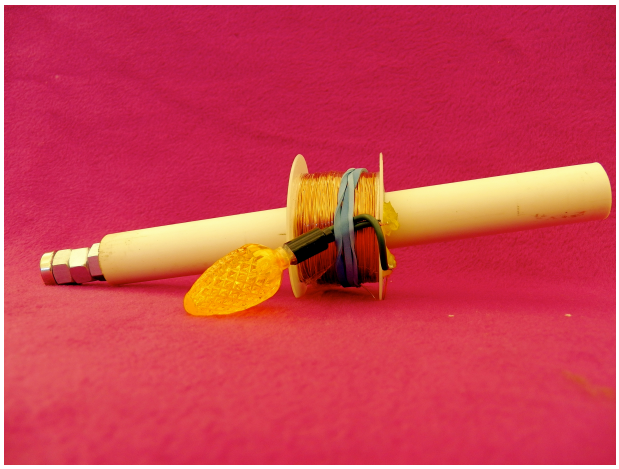


Overview

Ferromagnetic materials are attracted to a magnet, but *diamagnetic* materials are repelled by a magnet. A square of diamagnetic graphite is repelled by an array of strong magnets, and floats above it.

It’s a pretty magical effect, but it also teaches an important point: Magnets interact with materials at an atomic level. It’s the interaction of magnetic fields with the electron spins and orbits in the graphite that is responsible for the diamagnetism and therefore the levitation. This only happens with a very special type of graphite called *pyrolytic* graphite.

Generating Electricity

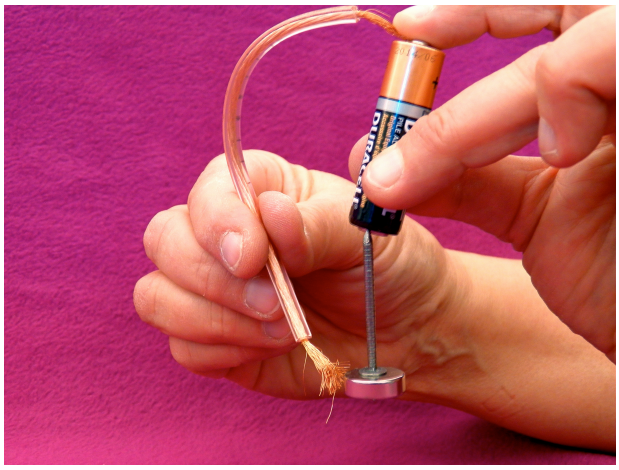


Overview

All the electricity you've ever used (except for that which comes from batteries) was created this way: A changing magnetic field inside a coil of wire *induces* a small voltage, creating an electric current.

You'll make a small device to show this effect that consists of a coil of wire and an LED light bulb from a string of holiday lights. When a strong magnet moves through the coil, the resulting electricity lights the bulb!

World's Simplest Motor



Overview

A magnetic field exerts a force on a current in a wire. So a magnet will push on a current-carrying wire. By Newton's 3rd Law, the wire thus pushes on the current as well.

This is the basis for the world's simplest motor, a so-called *homopolar* motor. This isn't something your students will understand in great detail, but they'll get the basic principle that motors involve magnets and electricity. And they can, themselves, make a motor that spins at a pretty furious clip!

Magnetic Braking

Overview

As a magnet moves down a copper tube, the changing magnetic field causes a current in the copper. And magnetic fields exert forces on currents.... The net result is a magnetic braking effect—the magnet falls with glacial slowness through the tube.

This isn't something you'll teach about in detail, but it is something that it's great to let your students experience.