Magnetism

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Derivation: From Greek magnes (lithos) *literally "stone of Magnesia," an ancient city in Asia Minor where lodestones were found.*

Magnetism is critical if you're trying to make a generator or motor, design electronic devices, or get things to stick on your refrigerator. Magnets do a surprising amount of work in our technological society. They're also a lot of fun.

Where does magnetism come from? All magnetism comes from the movement of charges. When charges flow through a wire, a magnetic field is generated around the wire.

You've tried holding two magnets together north pole to north pole, right? They try to push each other away. Hold the south pole next to the north pole and they snap together. These repelling and attracting forces of magnetic fields are key to motor and generator function. A motor is essentially one set of magnets rotating inside or beside another. Depending on the type of motor, these can be "permanent magnets," materials that hold their magnetism, or "electromagnets," coils of wire that generate a magnetic field when there is a current through them.

In a motor, electrons flow through the electromagnetic coils, causing a magnetic force. The force is enhanced by providing steel pathways for the magnetism, and manipulated by the structure of the motor to attract or repel the magnets in the other set, causing a rotating motion that drives the motor. So an electric current is used to create a spinning motor shaft. Electricity in; mechanical energy out.

With a generator, the exact opposite happens. We drive the spinning shaft with an engine, a hydro runner, blades in the wind, pedals, or some other source of rotating motion. The motion spins the magnets past the coils, causing an electrical current in the wires of the coils. Mechanical energy in; electricity out. Without magnetism, we'd have to dream up a whole new way to design motors and generators.

The earth is like a big magnet. Scientists theorize that the motion of liquid metal in the earth's molten core is the source of the earth's magnetic field. Just like the currents in wires, the currents in the earth's core—billions of amperes—have a magnetic field.

People have been aware of some effects of the earth's magnetic field for hundreds of years. Early transoceanic explorers used bits of metal suspended or floating to guide their ships. These ferromagnetic ("ferrous" means "iron") compass needles aligned themselves with the earth's magnetic field, pointing north/south. Nowadays we know that the earth's magnetic pole is not exactly aligned with the earth's rotational pole. So we have what is called "magnetic declination," the difference between "true north" and "magnetic north."

Magnets and magnetism are used in a surprising variety of tools and toys that we use every day. Motors, sensors, medical diagnostic equipment, relays, latches, audio and videotape—the list goes on and on. Once you're aware of how they are used, you notice every day how dependent we are on magnets.

Magnets are also fascinating and fun. I recently hosted Hugh Piggott's Homebuilt Wind Generators workshop here in the Pacific Northwest for SEI. We spent a week building wind generators from scratch, including winding the coils for the alternator stators and casting the magnet rotors. We got to see firsthand the effects of magnetism as we pinched our fingers between neodymium (rare earth) magnets and learned why not to use steel tools around them. At the end of the workshop, we saw their more practical effects, generating electricity from the wind generators we'd built.

Close-up of students casting magnets in resin during SEI's Homebuilt Wind Generators workshop.

There is a magnet below this dish full of ferrofluid—what we're "seeing" is the magnet's field.

One highlight of the week was an evening presentation by Dan Bartmann and Dan Fink from Wondermagnet.com (authors of an article in *HP88*.) The Dans showed us lots of neat tricks with magnets. Try dropping a neodymium magnet down a heavy-wall copper tube. The copper acts as an electric brake, slowing the fall of the magnet. We also got to see "ferrofluid" in action. This is an oily substance with magnetic material ground into it. It lets you "see" a magnetic field in three dimensions. We poured some in a Petri dish and put a magnet underneath the dish. The fluid is attracted to the magnet, and shows the lines of magnetic force with little spikes—it's wild!

I'm drawn to the idea of ending my column with a magnet joke, but that would probably just repel you. The discovery and use of magnetism is one of the unsung heroes of human history. We acknowledge the contributions of fire, the wheel, and the computer chip, among others. But we too often overlook the contribution magnetism makes. Electricity, fun tricks, and spelling words on the fridge—what more can we ask?

Access

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ForceField, 614 South Mason St., Fort Collins, CO 80524 • 877-944-6247 or 970-484-7257 • Fax: 970-493-7243 • ff@wondermagnet.com • www.wondermagnet.com • Lots of neodymium magnets and other fun stuff

Driving Force: The Natural Magic of Magnets, James D. Livingston, ISBN 0-674-21645-8, paper, 311 pages, 1996. US$16.95 from Harvard University Press, 79 Garden St., Cambridge, MA 02138 • 800-405-1619 or 401-531-2800 • Fax: 800-406-9145 or 401-531-2801 • Contact_HUP@harvard.edu • www.hup.harvard.edu • Good overview of magnetism and magnets