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Needle Compass

How to Make a Needle Compass from Your Own Household Materials

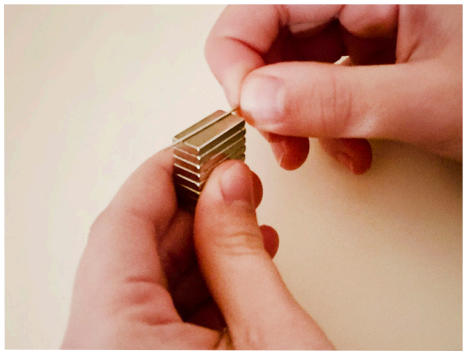
Supplies

- *Shallow dish*
- *One-inch diameter paper circle*
- *Iron or steel sewing needle*
- *Magnet*
- *Water*

Since the invention of the compass in China more than 2000 years ago, we no longer have to navigate using landmarks, the position of the sun in the sky, or the direction that trees grow. We can use the science of magnetism to figure out which direction to travel, even at night or on a cloudy day.

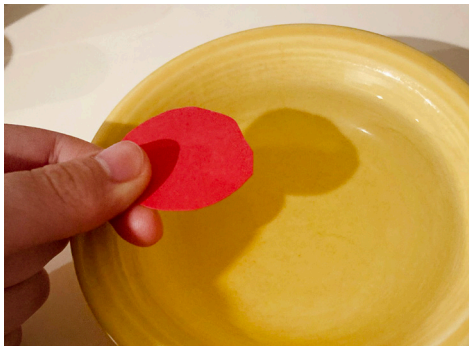
A conventional plastic compass.

1. Fill a shallow dish with water.



2. Take a sewing needle and run a magnet along it at least 20 times.

3. Cut out a paper circle one inch in diameter.



4. Gently place the circle in the water, then place the needle on top of it.

5. Watch it turn. You can use a compass to test accuracy.

6. As a challenge, place the needle with no paper, just using surface tension.

How Compasses Work

The iron needle of your compass is a human-made, permanent magnet. Like all magnets, it has two ends called "poles," a north pole and a south pole, with a magnetic field that loops between them. The poles were created when the electrons in the needle lined themselves up in one direction as you stroked the needle on another magnet. The north pole of your needle magnet attracts the south pole of a second magnet, and the north pole of the needle magnet repels the north pole of the second magnet.

When you are navigating with your compass, the Earth itself is that second magnet—a natural, giant, spherical magnet, with its own magnetic north and south poles. You float the compass needle on water so that its south pole is free to turn toward the Earth's north pole. Once you see which way is north, you can figure out all of the other compass directions as well.

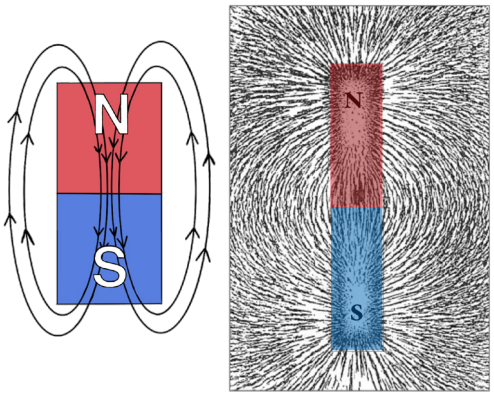
Electromagnetism as a Universal Force

Magnetism is a force created by electric currents in objects as small as single atoms and as big as the power lines bringing electricity to a city. Whenever electricity moves around, it creates magnetism. Magnetism is one side of a larger phenomenon called "electromagnetism," which is one of the four basic physical forces of the universe. (The others are gravity, and the strong and weak atomic forces.) Because of the way they interact with each other, electricity and magnetism can be thought of as "two sides of the same coin."

Permanent Magnets

Magnets come in two varieties, permanent and temporary. Permanent magnets occur naturally in the earth, but they can also be created artificially, just as you did in this activity, by bringing a "ferromagnetic" material such as iron, cobalt, or nickel close to an existing magnet. Human-made permanent magnets come in many different shapes, including bars, horseshoes, rings, spheres, disks and cylinders. The needle in this activity becomes a bar magnet.

Amazingly, you can keep breaking a magnet in two, all the way to the level of one atom, and each resulting piece will still be a complete magnet, with a north and south pole and a magnetic field created by the electron in that atom!



Left: diagram of the magnetic field of a bar magnet. Right: the magnetic field of a bar magnet revealed by iron filings on paper.

Electromagnets

Human-made, temporary electromagnets retain their magnetism only while electricity is running through them. The starter in your car, your microwave, and your washing machine all have motors with electromagnets in them.

To make an electromagnet you send electricity through a coil of material that conducts electricity. The moving electricity creates a temporary magnetic field in the center of the coil.

If you combine the powers of a permanent magnet and an electromagnet you can make a motor! In one type of motor, the electromagnet coil surrounds a permanent magnet. The poles of the electromagnet repel the poles of the permanent magnet, causing the permanent magnet to spin. You can harness the spinning motion to run other parts of a machine.

Fun Facts About the Earth's Magnetism

- *Movement of the molten metal in the earth's core creates electric currents that generate the Earth's magnetic field.*
- *Earth's geomagnetic poles are not the same as its geographic North and South poles. The geomagnetic poles actually move around, due to activity in the core's molten metal.*
- *The strength of Earth's magnetic field is very weak—about 100–1000 times weaker than that of a typical bar or fridge magnet—but it's strong enough to make your compass work!*
- *The Earth's magnetic field is not perfectly parallel to its surface! Some of its magnetic "lines" erupt through the Earth's surface near the south pole, go into the sky across the equator, and dive back into the ground before they reach the north pole. At the equator the magnetic field is parallel to the ground, so a compass needle floats parallel to the ground. But, the closer the compass is to the Earth's north pole, the more the compass' own south pole points downward, as it follows the Earth's magnetic field into the ground.*