Do batteries radiate?

We tested several batteries to see if they radiate in any way. We found that they do not radiate electric or magnetic waves, but those with steel casing are often magnetized. We also tested two basic shielding methods.

Keywords: battery, alkaline, lithium-ion, li-ion, radiation, magnetic field, electric field, EMF, magnetic, magnet, shielding, electrical sensitivity

Batteries affecting people?

In the third season of the television series *Better Call Saul,* the fictional character Chuck McGill is shown having great difficulty holding an ordinary D cell battery in his hand while changing the batteries in a cassette player. This is fiction intended to mimic the illness electrical hypersensitivity, EHS, but is it accurate?

Some people do claim ordinary batteries affect them. We try to find an explanation by testing several batteries.

Results in brief

We tested eleven batteries of different sizes, brands and technologies. None of them emitted any kind of electrical or magnetic waves. None were expected, given that the batteries were not being charged or discharged. (A battery connected to most electronics, such as portable electronics, will radiate because of the pulses.)

We did find that many of the batteries had steel casings that were magnetized. One sample was slightly more powerful than a typical refrigerator magnet, though it was still quite weak and could barely be detected 12 centimeters (5 inches) away. Some people are reported sensitive to even such weak magnets, so they may be affected if holding magnetized steel-cased batteries in their hands.

The tested batteries

We selected a wide variety of alkaline and lithium-ion batteries to test.

Type	Brand	Voltage	Technology
D	Duracell	1.5	alkaline
C	Rayovac	1.5	alkaline
C	Energizer	1.5	alkaline
AAA	Rayovac	1.5	alkaline
9 volt	Energizer	9	alkaline
9 volt	Rayovac	9	alkaline
SNNSS88A	Motorola	3.6	li-ion
RAYCGAS007A	Rayovac	3.6	li-ion
NB-6LH	Canon	3.7	li-ion
T720	unknown	3.7	li-ion
L-VX3200	unknown	3.7	li-ion

The low-frequency test

We first tested to see if there were any low-frequency magnetic or electric fields around the batteries. We did test with a sensitive meter (ME 3951A from Gigahertz Solutions in Germany) in a rural off-grid house with exceptionally low ambient levels.

We measured the ambient level for three frequency bands:

frequency band	magnetic nanotesla	magnetic milligauss	electric V/m
5 – 400 KHz	2.3	0.023	1.6
50 – 400 KHz	0.2	0.002	1.6
2K – 400 KHz	0.2	0.002	0.1

The typical suburban home in North America has levels ten to a hundred times higher.

We then measured each of our battery samples, and none of them gave a higher reading.

The instrument with some of the tested batteries.
the reading shown is 0.2 nanotesla (0.002 milligauss).

The radio-frequency test

We repeated the test with an RF meter (a TENMARS TM-195). The ambient RF level in the house was 0.005 uW/m^2 (0.002 V/m), which is several orders of magnitude below the typical suburban home.

Again, none of the sample batteries were able to create a higher reading. We take that to mean they do not emit radio-frequencies, as expected.

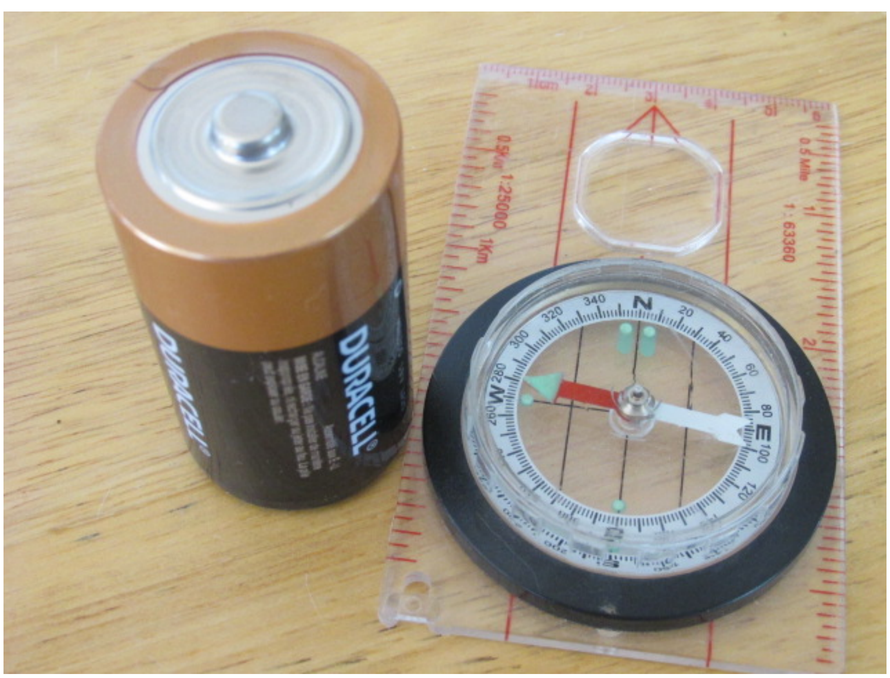
Static magnetic field tests

We tested to see if batteries have a static (DC) magnetic field, like magnets. We used a compass, as it is very sensitive to weak magnetic fields. We placed the compass with the needle lined up with North on its scale and watched if any of the batteries could turn the needle. If the needle turned that meant the battery provided a stronger magnetic field than the earth's natural field.

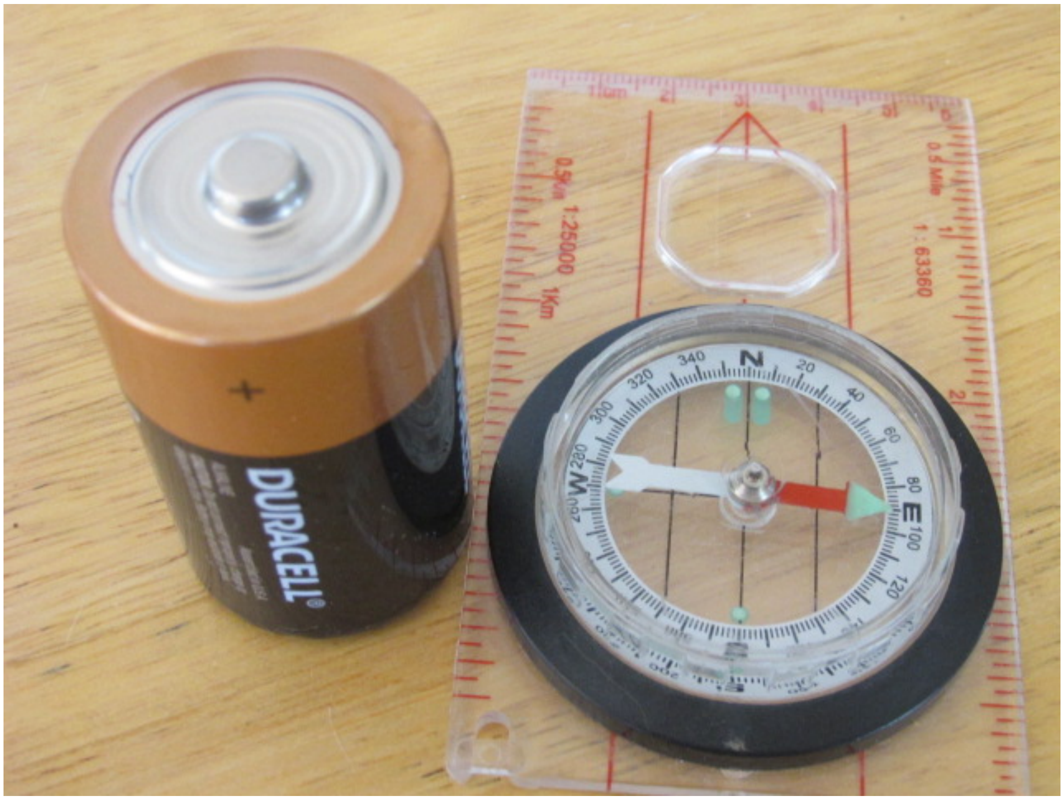
The tests took place on a wooden stool that was glued together. It had no screws or nails that might affect the tests.

The D-cell test

We placed a D-cell next to the compass and turned it around 360 degrees. The compass needle turned between plus and minus 90 degrees from north, depending on which side of the D-cell was closest.



D-cell battery turns the compass needle 90 degrees.



Same D-cell battery, when turned 180 degrees. The needle now points the other way.

We tried four batteries of the same brand and had the same result.

Magnetic fields get weaker with distance. When we moved the battery 12 centimeters (5 inches) away from the compass, it no longer affected the needle noticeably, i.e. the earth's natural field dominated.

We compared with five different refrigerator magnets and found the D-cell battery to be a stronger magnet than all of them. However, it was not strong enough to lift a steel paper clip.

The D-cell was a stronger magnet than the five refrigerator magnets we tested. The one shown was the strongest. (We are not affiliated with the university.)

Since turning the battery dramatically alters the direction of the compass needle, we conclude that the steel casing must be magnetized. This likely happened during production, as it is commonly seen with other steel products. If the contents of the battery were magnetic, we would expect a more uniform magnetism.

Testing C cells

We repeated the compass test with the smaller size C cells of two other brands. We tested four cells of one brand and eight cells of the other.

We found they were all magnetized as well. One brand was consistently more magnetic than the other, and the two brands each had a consistent pattern in how the needle reacted to the turning battery.

Testing C cell battery.

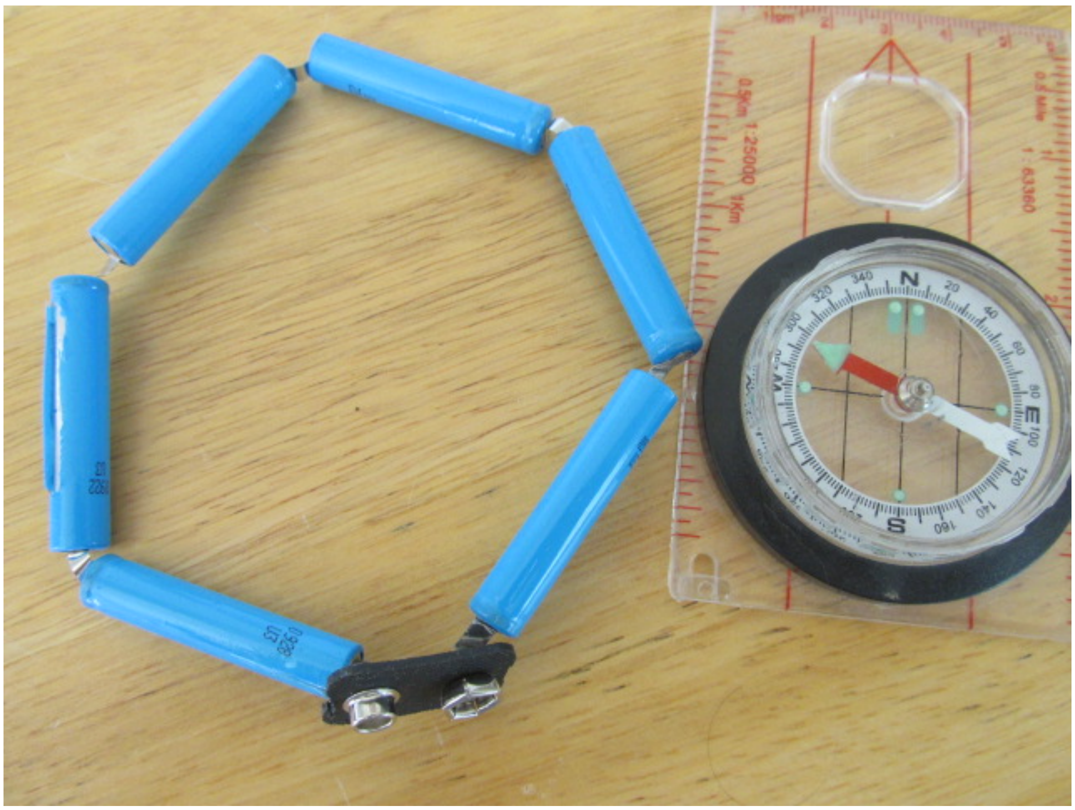
This brand of C cells was much less magnetized.

Testing 9 volt batteries

Nine-volt batteries are more complex than the 1.5 volt batteries, as they have six miniature 1.5 volt batteries inside.

We tested three batteries of the same brand. Two of the batteries were barely able to move the compass needle at all. The third battery moved the needle more.

We took this battery apart to test each of the six smaller batteries inside. We found some did not move the needle, while some did.



We also tested the metal cap of the disassembled battery alone, and found it didn't move the needle. It was not magnetized.

Testing lithium-ion batteries

We tested five different small lithium-ion batteries intended for portable electronics.

None of them moved the compass needle at all. This was as expected, as the batteries were all housed in plastic cases that could not become magnetized.

Shielding magnetic fields

Shielding static (DC) magnetic fields is exceedingly difficult. That would require thick steel or special alloys. Metals used for radio-frequency shielding, such as aluminum and copper, have virtually no effect.

To verify, we wrapped the same D-cell we tested before in three layers of heavy duty (1 mil) aluminum foil (with plastic cling wrap underneath to prevent a short).

The battery turned the compass needle as before, proving aluminum foil has no shielding effect for static magnetic fields.

We also tested a steel flashlight with two D-cell batteries inside. We could not detect any shielding effect by the thin steel walls of the flashlight.

D-cell battery wrapped in three layers of foil. The foil had no shielding effect.

Steel flashlight provides no magnetic shielding of D-cells inside.

Discussion

Disposable and rechargeable batteries are mostly just a chemical cocktail inside so it was no surprise that none of the batteries emit any low-frequency or radio-frequency waves when not actively used.

The lithium batteries do have simple voltage-monitoring electronics inside to tell the battery charger when the battery is full, but this apparently is dormant when the battery is not connected to anything.

When batteries are powering something, they can radiate, depending on how the current is drawn. If powering digital electronics, the transients (dirty electricity) will backfeed into the battery. This includes some modern flash lights which have DC converters to make the batteries last longer. If the battery just powers an incandescent light bulb, then there are no transients and thus no radiation.

We found that the steel casing on some batteries was magnetized. This was likely caused on the production line since we could see consistent patterns in batteries of the same brand, and different patterns for other brands of the same type.

We found no magnetized rechargeable lithium-ion batteries. They were all in plastic casings with some also wrapped in aluminized plastic foil. Plastic and aluminum cannot be magnetized. We did not test any disposable lithium batteries, which usually are in steel casings.

Magnets are used by some alternative health practitioners to treat people, though these magnets are at least a thousand times stronger than the magnets tested here.

The magnets we found were all very weak and unable to even lift a paper clip, but up close they are stronger than the earth's natural magnetic field. Moving a battery away just 12 centimeters (5 inches) was enough to eliminate its effect compared to the earth's natural field.

It is possible that these weak magnets are the cause of the discomfort some people report while holding a battery in their hand. This problem does appear to be exceedingly rare, even among people with severe electrical sensitivities.

Other technical reports

We have other technical studies of relevance to people with electrical sensitivities at www.eiwellspring.org/technical.html.

2019