Application No. 229: Measuring a magnetic field

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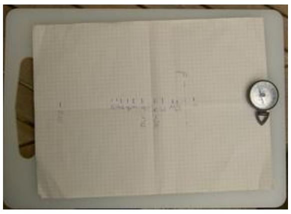
Do you know how much magnetic force your credit card can withstand?

It all started with a simple question: "How close could the magnet get to my credit card without jeopardising it?"

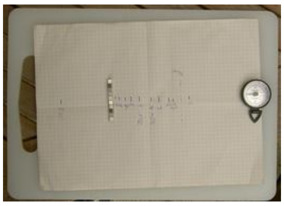
As it turns out, the answer wasn't easy to come by. After some searching on the internet, I estimated that the credit card could probably withstand a magnetic field of up to approx. 10 mT (Milli-Tesla, i.e. a thousandth of a Tesla – the field inside the magnet is about 1 T!). In a different unit: 1 mT = 10 Gauss; 10 mT = 100 Gauss.

Note from the supermagnete team: In our FAQ "What is the safe distance that I need to keep to my devices?" (www.supermagnete.de/eng/faq/distance) we believe that a credit card can withstand a magnetic field of up to 40 mT.

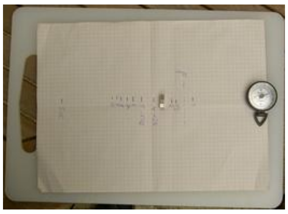
But how far does the magnetic field extend? Magnets can be rather well described as dipoles. Without delving too far into the subject matter: The field of one dipole (www.supermagnete.de/eng/magnetismus/monopol) decreases by $1/R^3$(R denotes distance), and dipoles can be added together. I wanted to test this theory with a simple experiment at home to estimate a "safe distance" to the credit card.



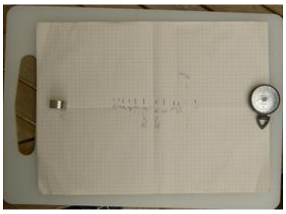
Setting up the experiment is very easy. You need a sheet of paper, a compass and a set of magnets (here 10 W-05-N (www.supermagnete.de/eng/W-05-N)). I placed the compass on one edge of the sheet with the needle positioned parallel to the edge.



Next, I stacked the 10 cube magnets and oriented them on the sheet in such a way that they would affect the compass needle. I then tested at which magnet distance the compass needle would turn 90 degrees towards the magnets. At that point, I made a mark on the paper and also noted the number of magnets.

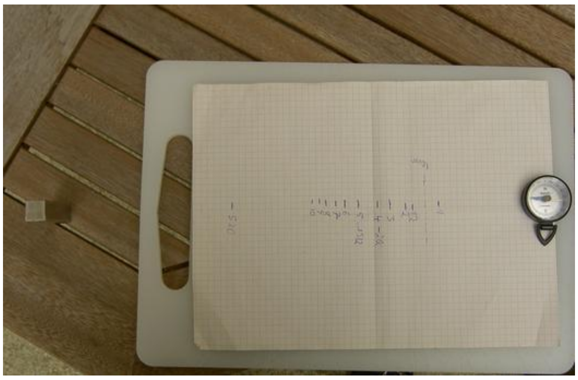


As a second step, I did the same with nine magnets, then with eight and so on, until only a single magnet turned the compass by 90 degrees.

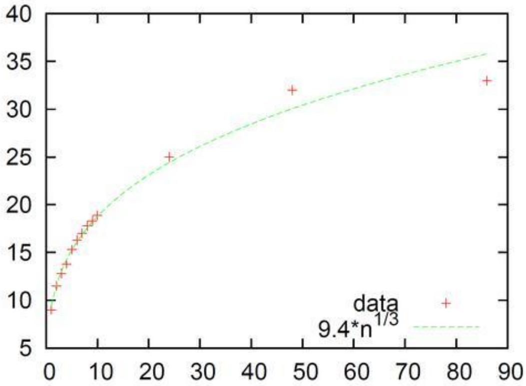


Afterwards, and playing around a little, I tested stronger magnets:

This one is a S-20-10-N (www.supermagnete.de/eng/S-20-10-N)...



... and even a Q-50-15-15-N (www.supermagnete.de/eng/Q-50-15-15-N). In doing so, the distance to the compass is increasing.



If you plot the mass of the magnets (x-axis) against the distance in centimetres (y-axis), it is consistent with our $1/R^3$law. The cube magnets weigh 1 gram, the large magnets 24 and 48 grams, respectively. The data is not entirely accurate because I didn't measure as precisely off the paper. However, the trend is consistent.

So what did the experiment show? I measured at what distance the magnetic field is roughly equivalent to the earth's magnetic field (0,05mT). Since the total dipole moment is the sum of their combined values, the number of magnets is proportional to the total dipole moment. Because the field is proportional to the dipole moment, the measurement is equivalent, although "reversed".

When it comes to the credit card: It is fortunate for the card (and its owner), that the magnetic field decreases by $1/R^3$and the mass of the cube increases by L^3(L= side length). Both those principles cancel each other out.

During the experiment, I found that a distance of 10 cm, which is equivalent to 20-times the cube length, the magnetic field reduced to the strength of earth's magnetic field (0.05 mT). At a distance of 7-times the cube length, the strength of the magnetic field still measures approximately 1mT. That is the safe limit for the credit card; it should not get any closer to the magnet.

Therefore, I would recommend as a rule of thumb for the credit card: Measure the longest side of a magnet, multiply this number by 7 and you will get the minimum distance that should be kept to a magnet.

Of course, I do not give any guarantees – if in doubt, the following applies: Preferably, credit cards and magnets should never cross paths at all!

Articles used

10 x W-05-N: Cube magnet 5 mm (www.supermagnete.de/eng/W-05-N)
1 x S-20-10-N: Disc magnet Ø 20 mm, height 10 mm (www.supermagnete.de/eng/S-20-10-N)
1 x Q-50-15-15-N: Block magnet 50 x 15 x 15 mm (www.supermagnete.de/eng/Q-50-15-15-N)

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