Magnetism

This seems like a good time to think about magnetism, because it shares characteristics that look a lot like charge.
So, you ask what causes magnetism?
Isn't it odd that we can accept without curiosity, that atomic particles have positive and negative charges? Nobody ever asks what is charge? Where does that come from? But, when observing the effects of magnetism, we're usually left scratching our heads ... hmm, wonder what actually causes that? There are lots of things in the physical universe that are not well understood.

They include charge, magnetism, heat, light, and gravity.
There are theories of course.

When it comes to magnetism, it turns out that in addition to orbiting a nucleus, electrons also have spin, and that spin is thought to give rise to magnetic phenomena.

Have a physicist attempt to explain that to you, and you'll soon become snowed in a blizzard of quantum theory and relativity technospeak. As a rule of thumb,
I always just think that when a person isn't able to explain things in an easily understood way, it's because they don't really know what they're talking about.
Somebody who didn't know what he was talking about, once said ... 'there are known knowns; there are things we know we know. There are known unknowns ... that is to say, there are things that we know we don't know.

But, there are also unknown unknowns.

There are things we don't know we don't know.'

We don't need to understand what exactly causes magnetism to put the ferromagnetic effects to good use in electronics.

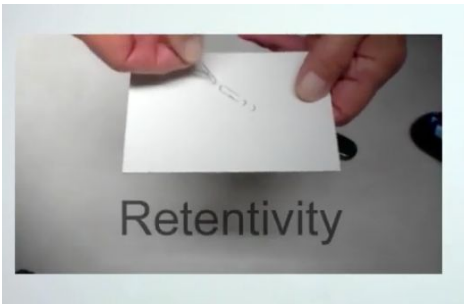
The only naturally occurring magnetic material, is lodestone.

This is a naturally magnetised form of magnetite, first mentioned by the Greek mathematician Thales (thay-lees)

about twenty-six-hundred years ago.

We still don't know how it becomes magnetized.

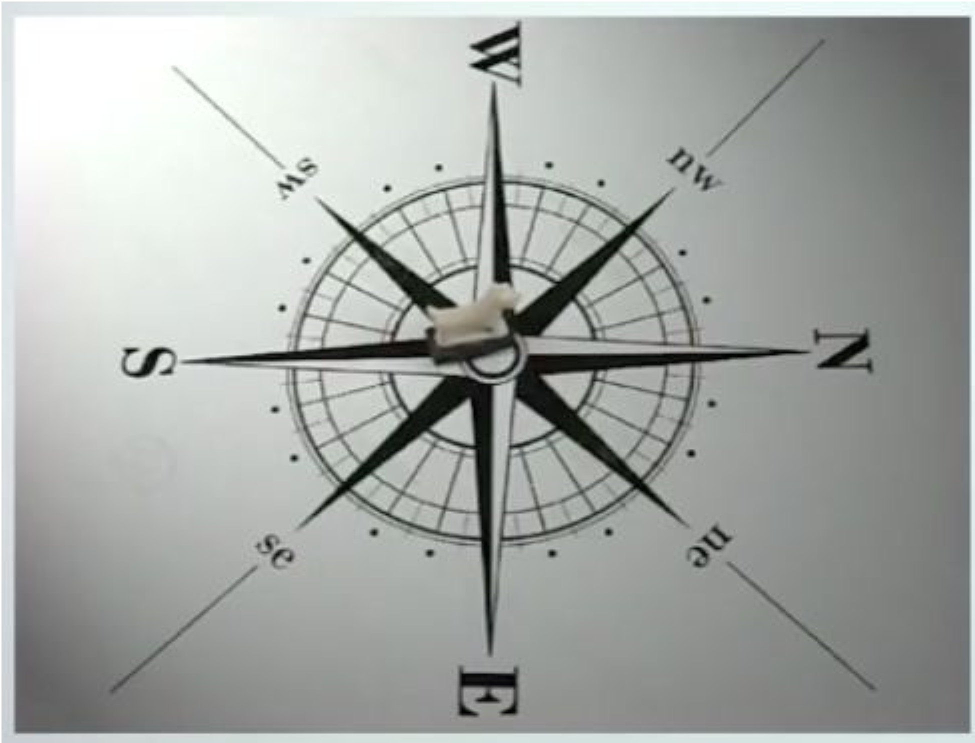
The leading theory is that lodestones are magnetized by the strong magnetic fields surrounding bolts.



A receptive material, normally, but not always, a metal alloy containing iron, can be artificially magnetized by passing it through a strong magnetic field. If the magnetism is retained after the field is removed, the material is said to have a high degree of retentivity, and it's called a permanent magnet. Materials with a very low degree of retentivity, such as soft iron, lose their magnetismwhen the field is removed, and are useful as temporary magnets. Examples are relays, which come in all

shapes and sizes, and are used all over the place and electrical and electronic applications ... and the junkyard crane, which is used for loading scrap metal.

Getting back to the Scottie dogs ...



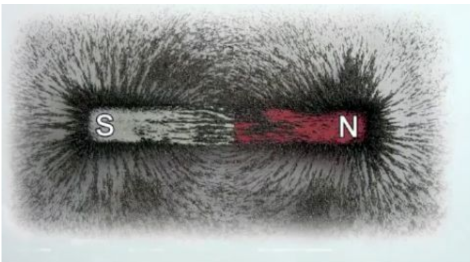
they are glued to the top of a two bar magnets. We can use these to observe a couple of things about magnets.

First, that they have a polarity, and second, that they're surrounded by fields of force. If we suspend one of these bar magnets so that it can pivot freely, it will always come to rest with one end pointing north. This is how the polarity of magnets came to be named North and South, which are also sometimes designated positive and negative. This can be handy for navigation purposes, provided that you know which end of the bar is its north pole. So they're often marked north or south, or plus and minus. Like poles repel each other, and unlike poles attract.That should sound familiar to you. The forces of attraction and repulsion can be calculated,

and there's a lot for that. The force of attraction or repulsion between two magnetic poles, varies directly as the product of the strength of the poles, and the square of the distance between them.

Can you guess who determined that?
Clue: He was a Frenchman.

If we lay a piece of paper over the bars and sprinkle some iron filings over it , we can see what the



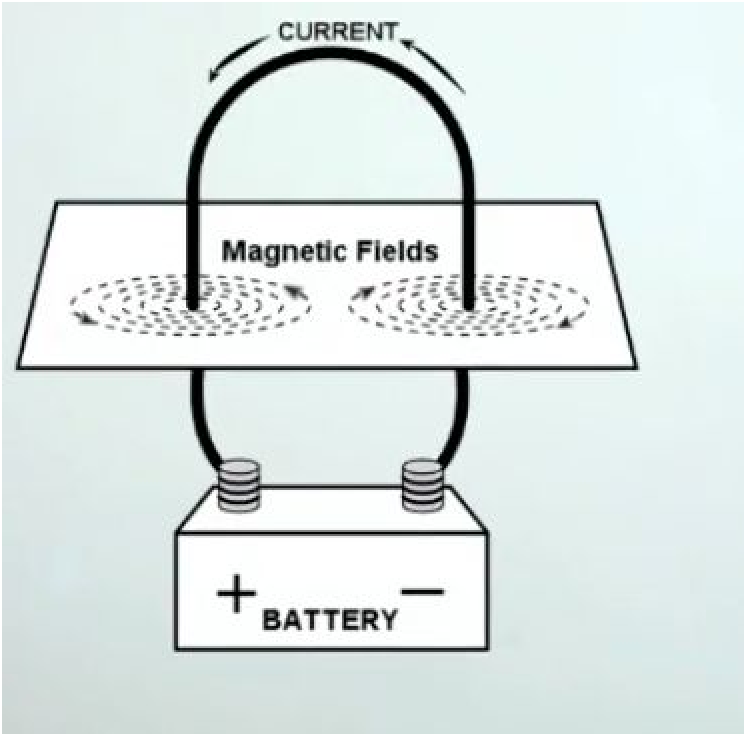
field surrounding them looks like.

As a practical matter, we can think of these fields as consisting of lines which form a complete loop, traveling from north to south outside the bar, and south the north internally. They never cross, and they expand or contract when influenced by some other magnetic field. They pass more easily through magnetic materials, but no material is actually impervious to them. So, we've had some fun playing with our toys.

What's more interesting and useful, is the relationship between electricity and magnetism, called

electromagnetism.

About 200 years ago, a Danish guy named Oersted, discovered that a conductor carrying an electric



current was surrounded by a circular magnetic field.

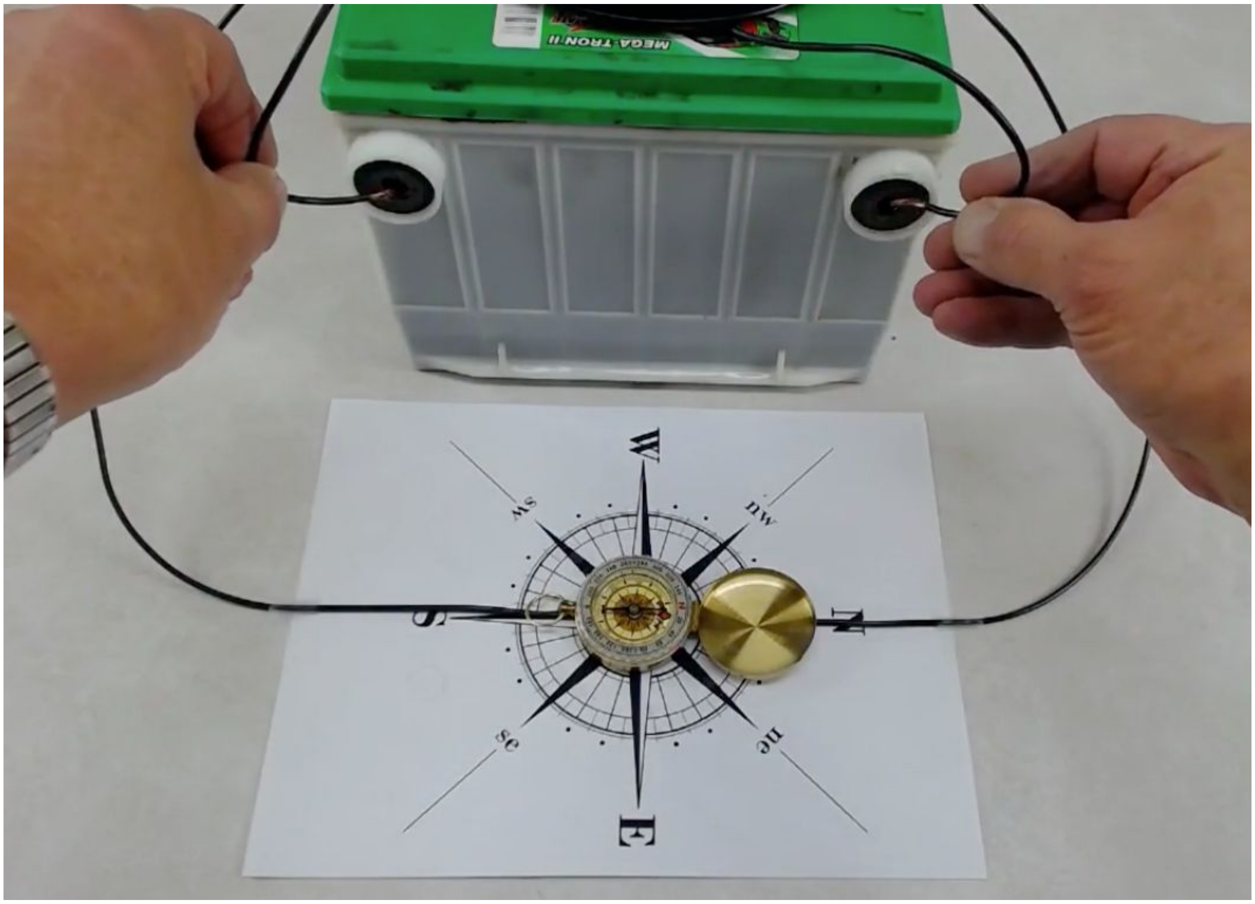
He observed that the strength of the field was directly proportional to the current flowing through

the conductor, and inversely proportional to the distance from it. Even more interesting,he found that the polarity of the field reversed when the direction of the current was reversed.

Using my nifty little compass, which I had imported from the Orient expressly for this purpose,

we too can see what Hans Christian Oersted saw.

(Incidentally, he was, in fact, a close friend of his neighbor, Hans Christian Andersen.)
Now, if I place the compass by this current carrying wire, the needle deflects from the north, indicating the presence of a magnetic field. If I reverse the polarity of the currents in the wire, the compass needle points in the opposite direction, indicating that the polarity of the field is also reversed.



If I decrease the current, or move the compass farther away from the wire, its needle position will be

less firmly held.

If I switch the current off, the needle returns to the north.

You might wonder, if current flowing through a conductor gives rise to a magnetic field, would the reverse also be true? Would a passing magnetic field induces a current into a conductor?

Aha! ... Good thinking! We'll be thinking about this again when we get into discussions about inductors, relays, motors, and that sort of thing,