

Background Material

Important Questions about Magnetism:

1) What is Magnetism? Magnetism is a force of nature, like gravity. But it is quite different from gravity in many respects. Gravity is a force of attraction between all objects with mass. Matter can be defined as objects in the universe that have mass. Therefore, all matter attracts other matter to it through gravity. Much of the fundamental matter in the Universe also has charge. Whereas there is only one kind of mass, there are two kinds of charge: positive or negative. Objects may contain equal numbers of positive and negative charges and therefore have no net charge overall. Objects with different charges will attract one another very much like how mass attracts mass through gravity. But objects with the same charge will repel one another. This force of attraction or repulsion due to charge is called the electric force. But what about magnetism, is there a fundamental property of some matter that makes things magnetic? The answer is: "sort of." Electric current is the source of magnetism. Electric current is charge in motion. Anywhere there is an electric current there is a magnetic force field present, just as anywhere there is charge there is an electric force field present, and anywhere there is mass there is a gravitational force field present. If an object has no net electric current flowing through it, there will be no magnetic field overall.

2) Why are some objects magnetic and others are not? All atoms are magnetic; they have charges moving around within them. For a macroscopic object made of atoms to be a magnet, the atoms' magnetic fields in it have to align with each other. This will create a large scale magnetic field around the object. In order for the atoms' magnetic fields to line up within the material, they have to be able to move freely. In many materials the atoms are held too rigidly in place to be able to line up with any external magnetic field. If the magnetic fields of all those atoms are randomly oriented then they would cancel each other out and the material would have no net magnetic field.

For example, a bar magnet's atoms are lined up so that their north and south magnetic poles align with one another, as shown in Figure BEM.1. This gives an overall very large magnetic field. However, a pencil's atoms are arranged in such a way that their north and south magnetic poles are lined up randomly, also shown in Figure BEM.1.

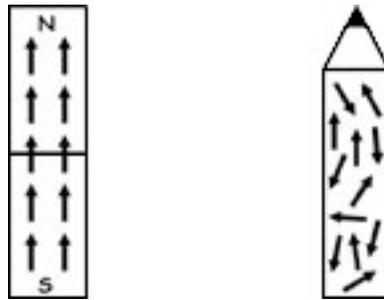


Figure BEM.1 Cartoon of atom's magnetic dipole fields in a bar magnet and in a pencil.

3) What's the deal with the whole compass pointing North thing? The needle of a compass points North, and the part of the compass pointing North is a north magnetic pole. But like magnetic poles repel and opposite magnetic poles attract. What's the deal?

The deal is that the magnetic pole located in the Northern Hemisphere is actually a south magnetic pole. Likewise the magnetic north pole is located in the Southern Hemisphere. So why do we call it North if that's where a south magnetic pole is located?

It's really just an accident of history, which we are stuck with. But it turns out not to be so bad. Nowadays, scientists define North by using what they call a "right-hand rule." If you take your right hand and curl your fingers in the direction that Earth spins while keeping your thumb extended, then your thumb points North. Likewise, magnetic north is defined the same way. If you take your right hand and curl your fingers in the direction that positive current flows (i.e. the direction that positive charges are moving — or opposite the direction that negative charges are moving) then again your thumb points north. You can verify this for yourself in Session 2, Activity 3 of this guide. Check which direction the positive current flows through the coil of wire and which direction is north for the magnetic field that is mapped out around the coil. Even though it is confusing, it all turns out to be consistent.