

# DEMOS

Magnetic fields can be powerful. To give an idea of how powerful they can be, you can do your own little demonstration at home. This demonstrates the interplay between charges and magnetic fields.

**You need:** two tubes – one plastic, one copper (or some other metal that is not magnetic) – and 2 strong magnets (rare earth or neodymium).

**What to do:** have a race dropping the magnets down the tubes.

## What happens?

The magnet dropped down the plastic tube will win the race. This is because it just falls under gravity, so falls very fast. The magnet travelling down the copper tube goes a lot slower. Look down the tube and you'll see the magnet falling in slow motion – it looks like it's floating.

This effect is due to something called electromagnetic induction, which was discovered by Michael Faraday around 1830. A changing magnetic field across a conductor causes an electromotive force, or a voltage, to be set up across the conductor. The changing magnetic field motivates the free electrons in the metal to move and causes a current. Electric fields and magnetic fields are intimately connected – moving charged particles (currents) generate magnetic fields and changing magnetic fields generate currents.

So in our metal tube, the falling magnet creates a changing magnetic field, which generates eddy currents flowing in the tube. Now, charged particles moving in magnetic fields feel a force. Current is a flow of charged particles (electrons) in a particular direction, so the current flowing in a magnetic field generates a force. The direction of this force obeys Lenz's law, which states that the force will act to oppose the change creating it. In other words, in the case of our tube and magnet, the falling magnet generates eddy currents, which themselves generate a force pushing back up on the magnet and slowing its fall.

**Variation:** Try with a narrow (~1cm diameter) copper tube and a ring-shaped neodymium magnet that fits around the outside. Drop the ring-magnet down over the tube and watch it fall slowly.

