

Magnetism and Electromagnetism

Rail Gun

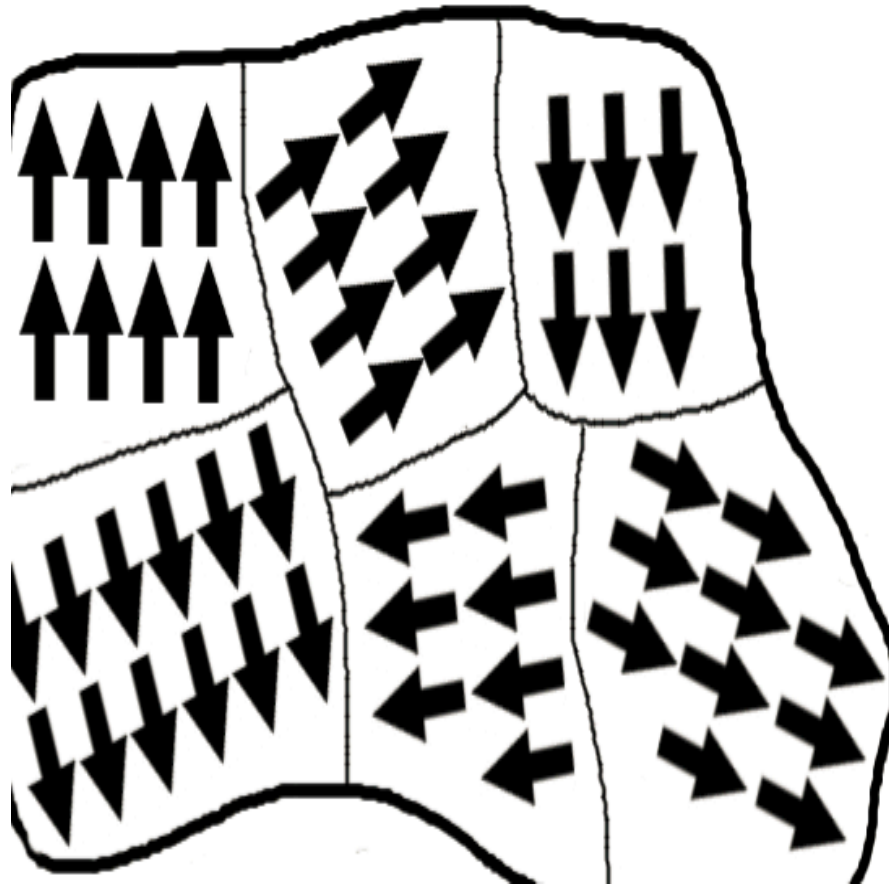
What is a magnet?

- Object with opposite “north” and “south” poles that attract or repel ferromagnetic objects (objects that can be magnetized).

THE LAW OF MAGNETIC POLES

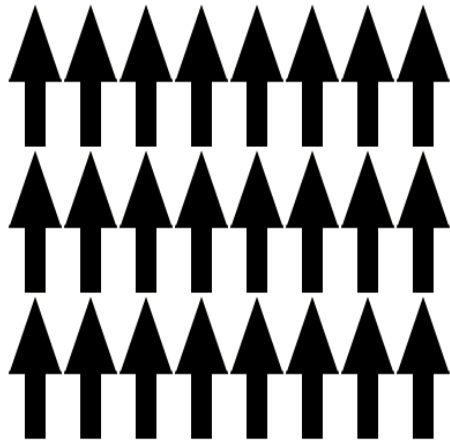
“Like” poles repel, “unlike” or “opposite” poles attract.

Magnetization



Ferromagnetic and Paramagnetic Objects

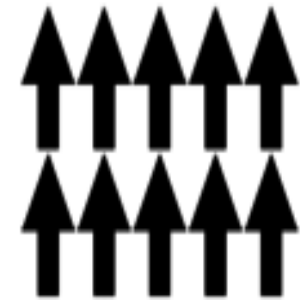
Ferromagnetic Materials



Paramagnetic Materials



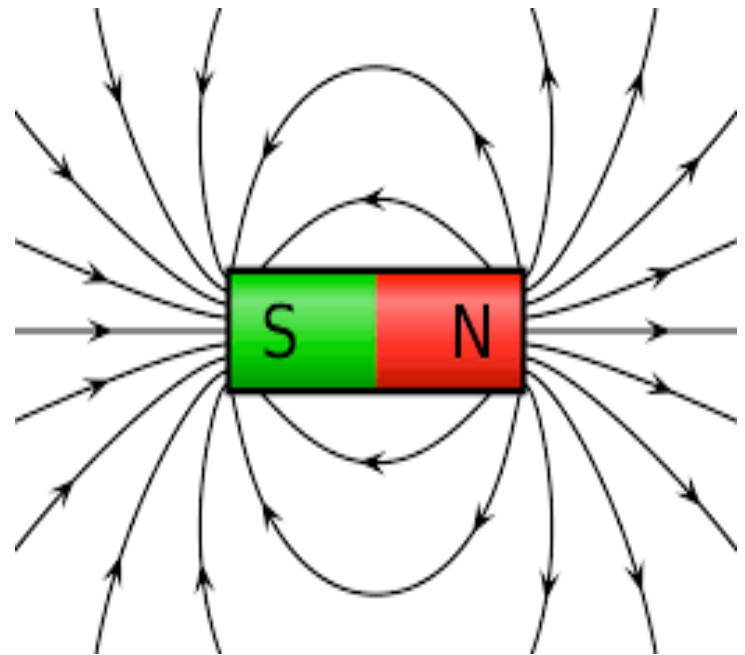
Applied Magnetic
Field Absent



Applied Magnetic
Field Present

Magnetic Fields

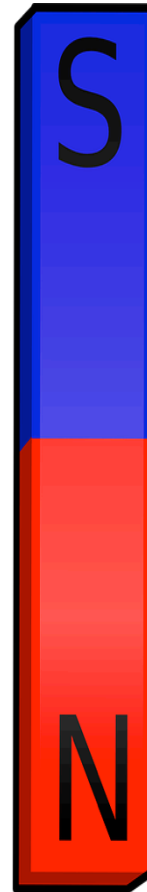
1. Magnetic field lines point from North to South on the outside of the magnet and from South to North on the inside of the magnet (they form a closed loop).
2. There are more magnetic field lines where the magnetic field is stronger.
3. Magnetic field lines start and end at infinity.



Examples of Magnetic Fields

Draw the magnetic fields surrounding these magnets.

a)



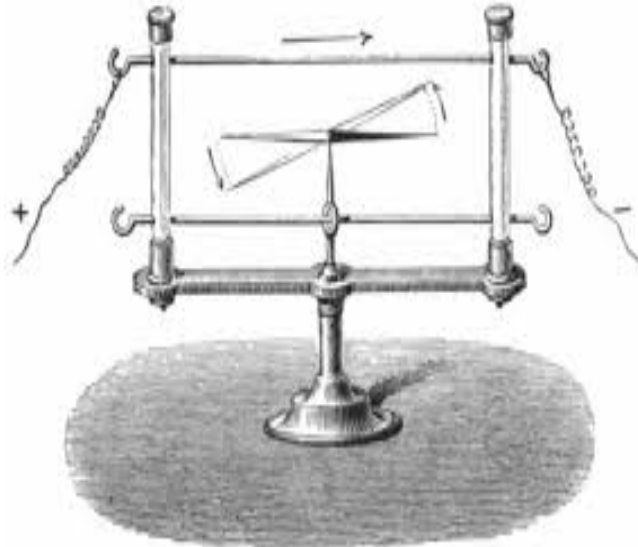
b)



By Sav vas, Francesco Rollandin (<http://www.openclipart.org/detail/27331>) [Public domain], via Wikimedia Commons

Electromagnetism

- Discovered by Oersted in 1820
- He found that an electric current could produce a magnetic

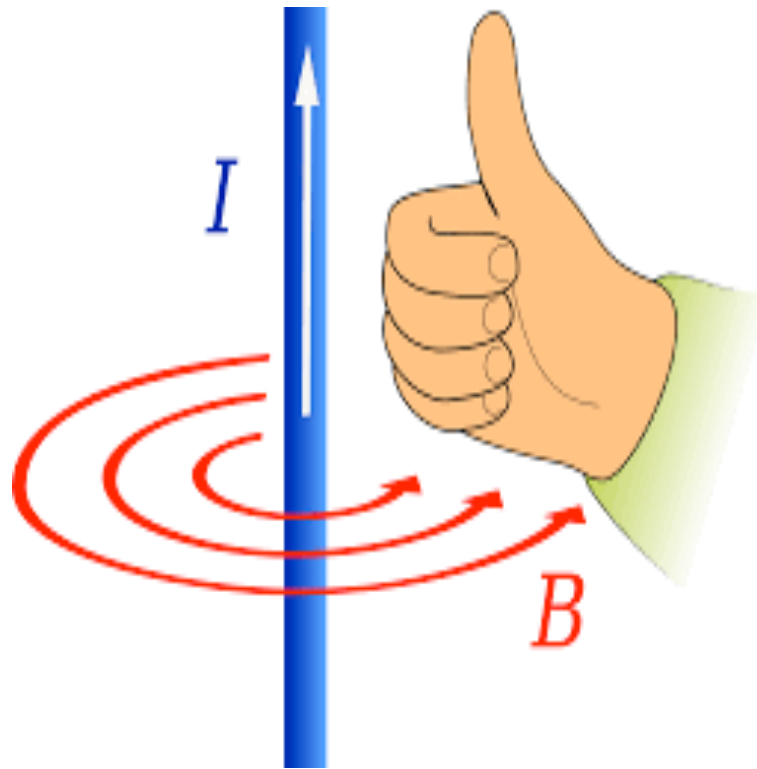


Oersted's Law

In a current carrying wire, the field is:

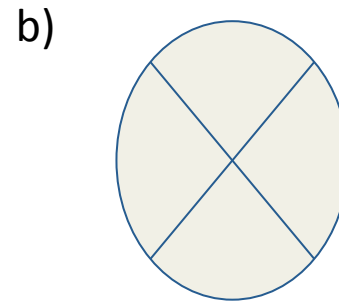
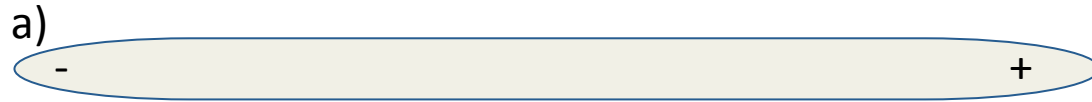
- A. Perpendicular to the wire.
- B. Inversely proportional to the distance away from the wire.
- C. Proportional to the magnitude of the current.
- D. Reversed if the current direction is reversed.

Right Hand Rule For a Straight Current Carrying Wire

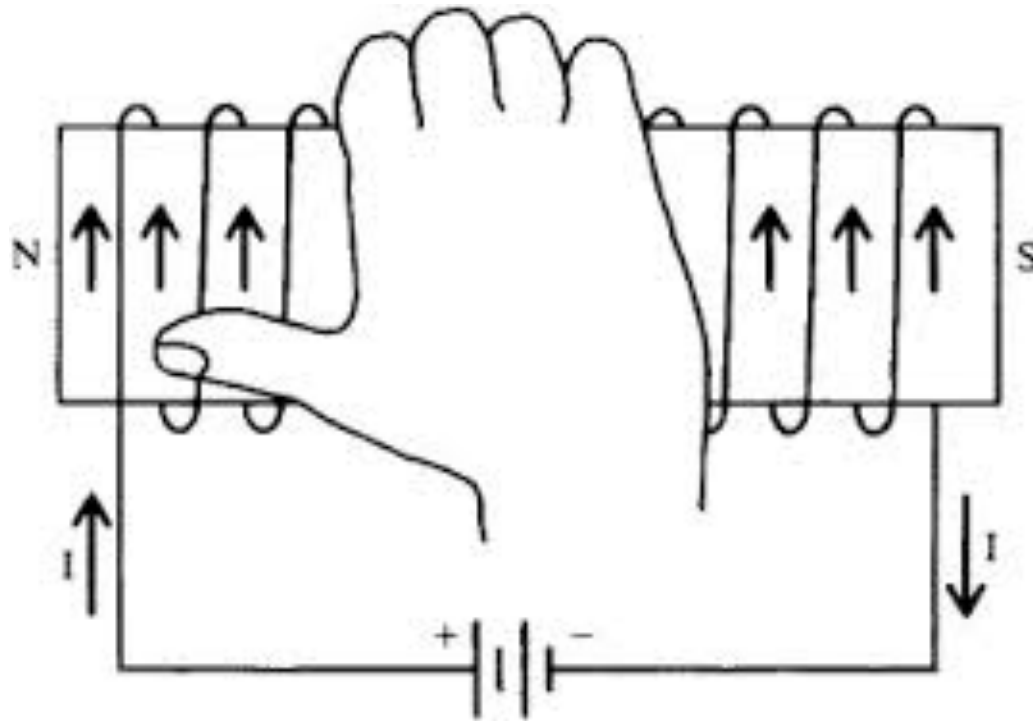


Examples of RHR For a Long Straight Conductor

Draw the magnetic fields surrounding these current-carrying wires.



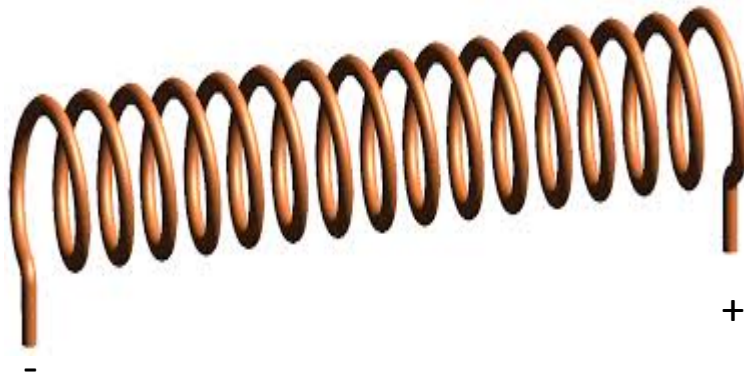
Right Hand Rule for a Solenoid



Examples of RHR For a Solenoid

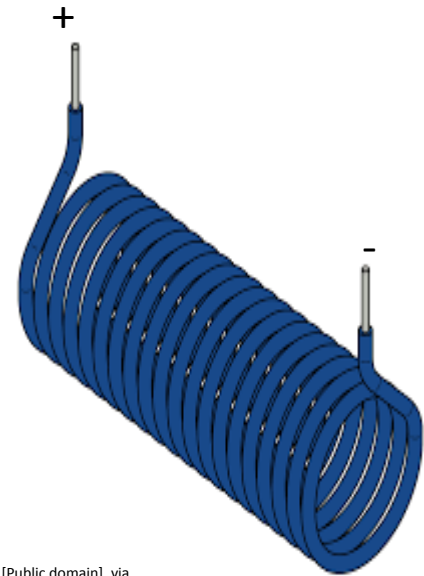
Draw the magnetic fields surrounding these current-carrying solenoids.

a)



By Zureks (Own work) [Public domain], via Wikimedia Commons

b)



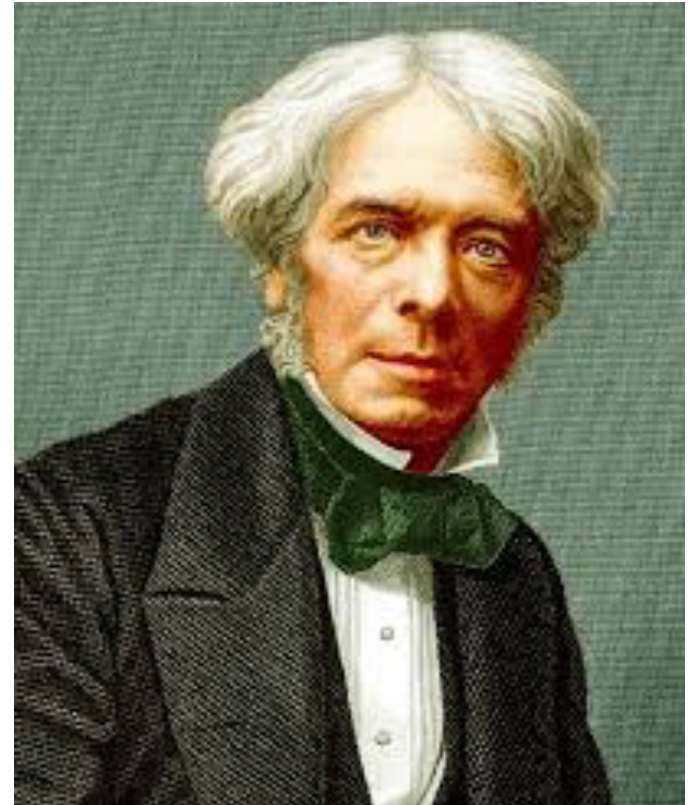
By Inductiveload (Own work, created with Solid Edge and Inkscape) [Public domain], via Wikimedia Commons

Electromagnets



Faraday's Law

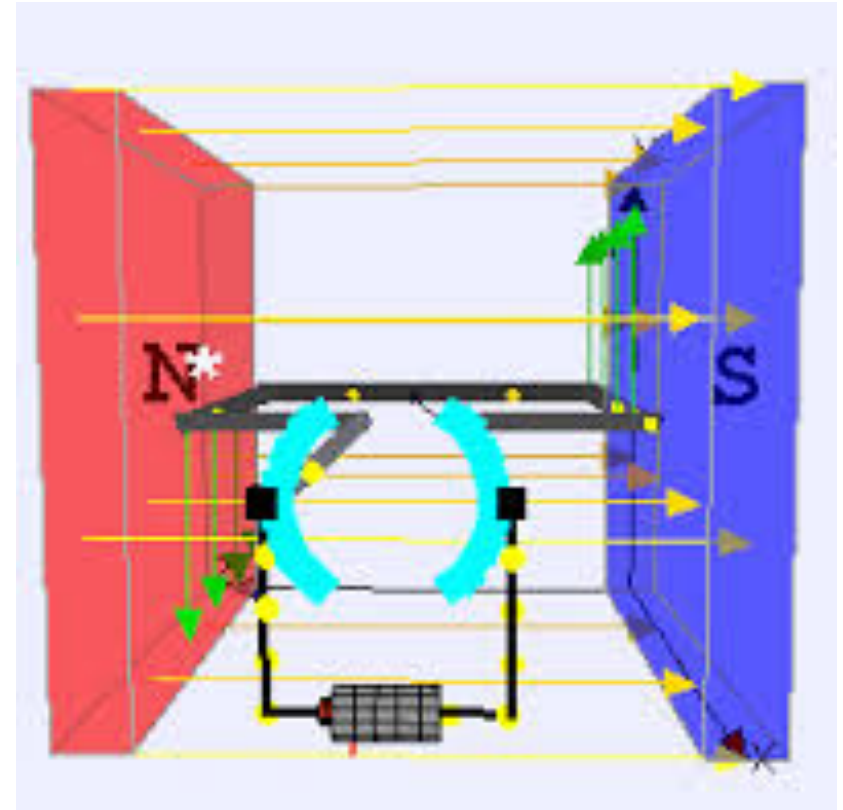
In 1831, Faraday determined that changing a magnetic field could induce a current. This is called **electromagnetic induction**.



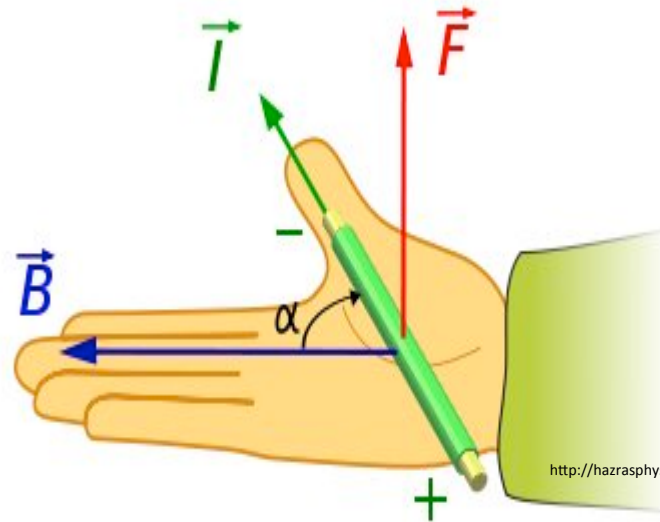
The Lorentz Force and the Motor Principle

The Motor Principle

A current-carrying conductor in an external magnetic field experiences a force that is perpendicular to the plane formed by both the current and the field .



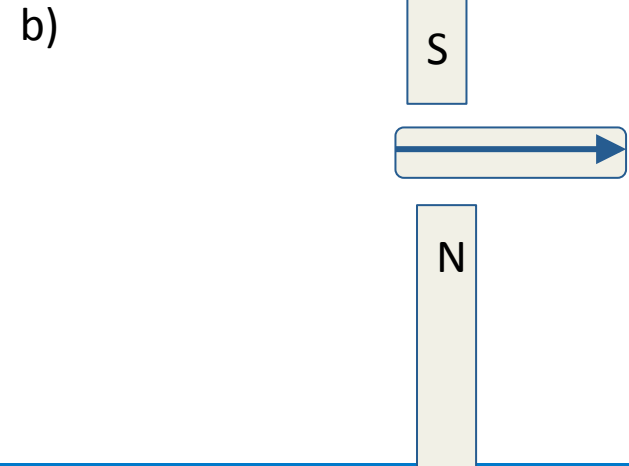
The Right Hand Rule for the Force on a Current Carrying a Conductor in an External Magnetic Field



<http://hazrasphysics.blogspot.ca/2010/11/right-hand-rules.html>

Examples of RHR for the Force on a Current Carrying Conductor in an External Magnetic Field

Indicate the direction of the force acting on the conductor in the external magnetic field.



Railgun



How does a railgun work?

- The current runs up through one rail, through the axle, and down the other rail down to the negative terminal of the battery.
- The magnetic fields that are set up around each rail are in opposite directions.
- The net magnetic field is vertical.
- The force is directed parallel to the rails and perpendicular to the axle.