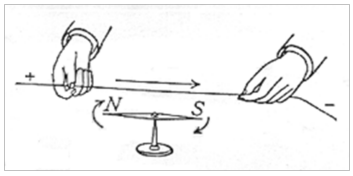
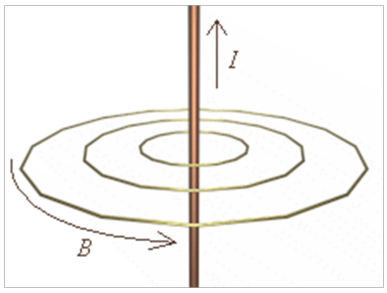
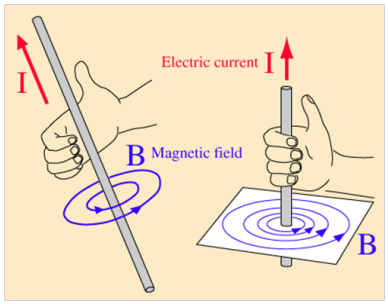
Recall Oersted's Discovery:



moving charges create a magnetic field

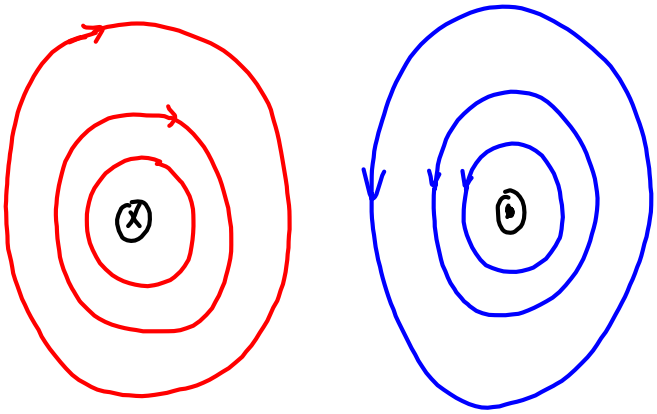




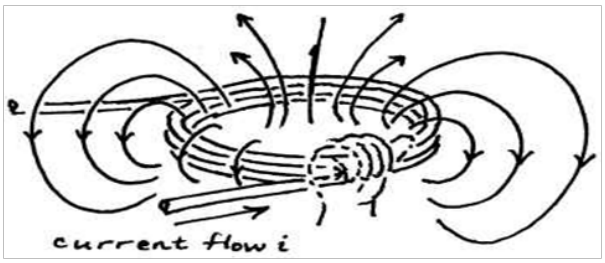
Consider a wire perpendicular to the page:

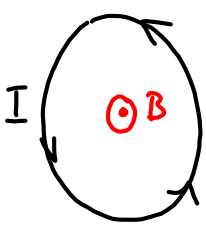
⊗ into page

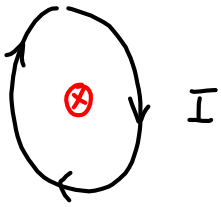
⊙ out of page



Consider a flat circular coil







Magnetic Field due to Electrons in an atom:

Since electrons are constantly moving within an atom, they create a magnetic field. (very small). Most substances have the atoms randomly oriented and the magnetic fields cancel out.

Iron - small groups of atoms that align themselves (domain)

If the domains are randomly oriented → non magnetic

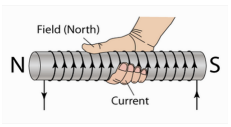
If the domains are oriented in the same direction → magnetic.

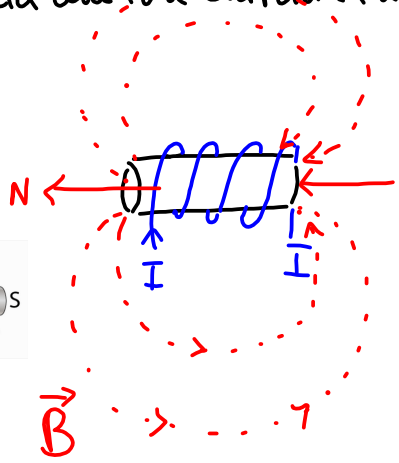
Cobalt and Nickel also behave in the same way.

Iron, Cobalt + Nickel → ferromagnetic materials.

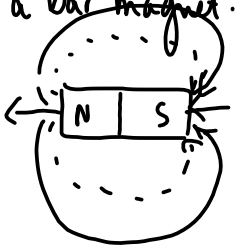
Magnetism is really due to the movement of electrons in wires (i.e. current) and in atoms. Magnetic fields also result due to the motion of freely moving charged particles (electrons, protons, α particles)

Magnetic field due to a current in a solenoid:



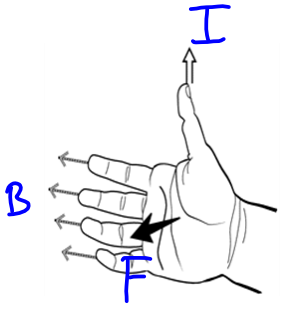


The solenoid is essentially like a bar magnet.



Force on a current-carrying conductor in a magnetic field:

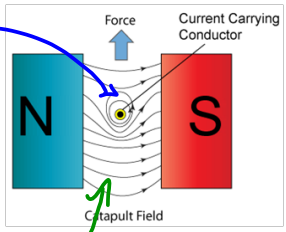
1831 -> Faraday -> discovered that when a current carrying conductor was placed at right angles through a magnetic field that there is a force acting on it which is perpendicular to both the conductor and the field.



Use the right hand rule to find the direction of the force (keep hand flat)

"Catapult" Effect

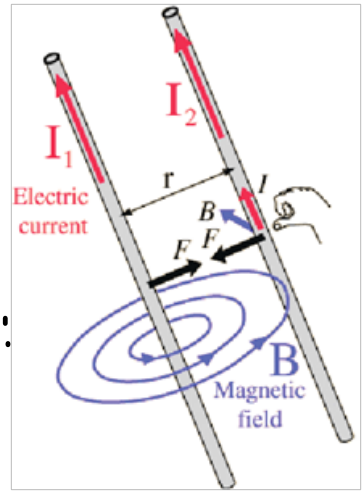
the field from the current in the wire distorts the external magnetic field



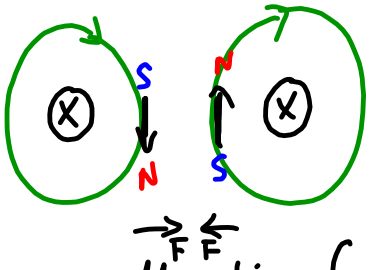
(current is out of the page, field is counter-clockwise)

these field lines want to back to normal

Force between two parallel current-carrying wires:

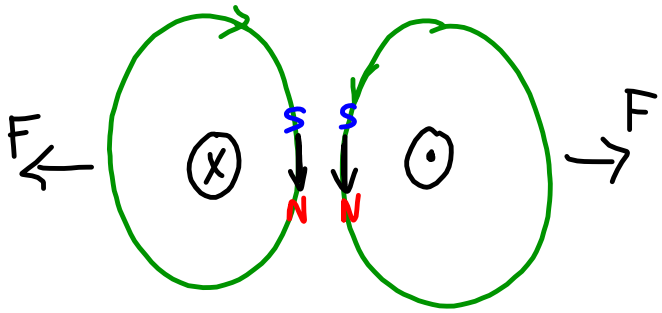


Consider the current flowing in same direction:



attractive force when the currents are in the same direction.

Consider the currents flowing in the opposite direction:



The wires repel when the current flow in opposite directions.

Current is defined in terms of the force per unit length between two parallel current carrying conductors.