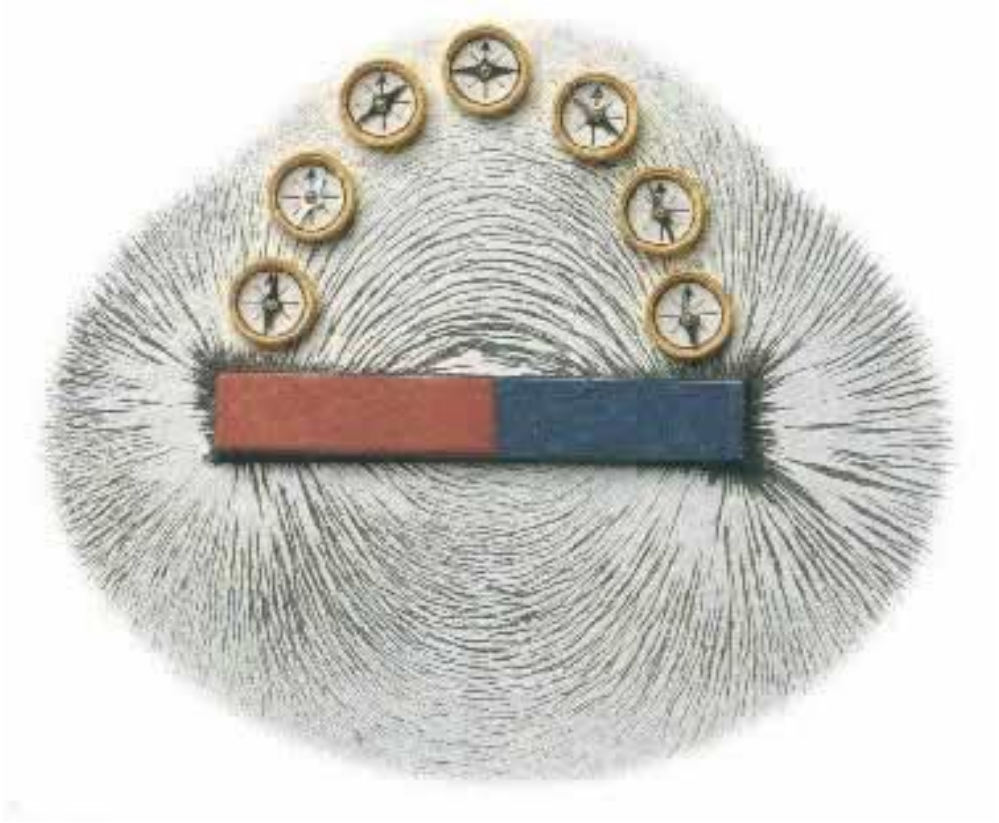
Chapter 24

Magnetism



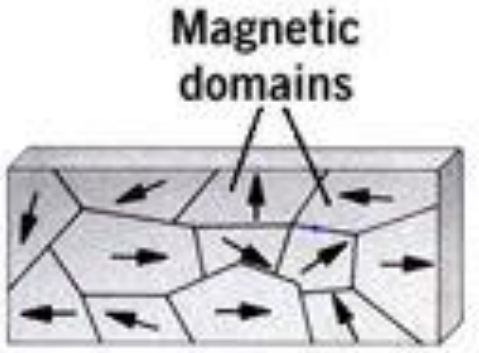
Magnetic Forces

- Behave in a similar way as electric forces.
  - "Opposites" attract & "likes" repel.
  - Between "poles" the magnetic force obeys an "inverse-square law."
- Depend in a complicated way on the MOTION of electric charges.
- Magnetic poles always come in pairs. (No isolated poles have ever be discovered.)
- If there is no motion of the electric charges, there is no magnetic force.

What Makes a Magnet?

Every atom contains electrons that are constantly moving about the nucleus. These moving electrons create tiny magnetic fields that can make an atom behave like a tiny magnet.

Interactions among adjacent atoms can cause large clusters of atoms to "line up" their internal magnets. The regions where this occurs are called *magnetic domains*.

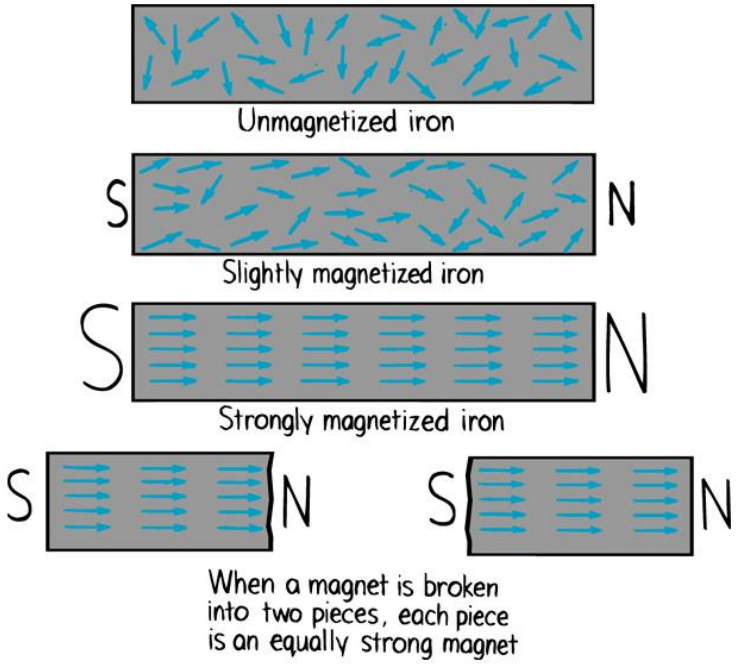


What Makes a Magnet?

An ordinary piece of iron is not a magnet because all the magnetic domain a randomly oriented giving no overall magnetism.

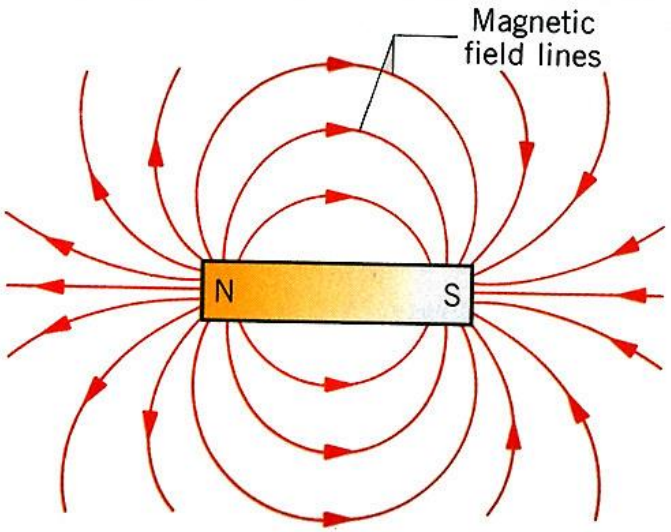
Placing the piece of iron in a magnetic field can align the domains giving rise to an overall magnetic field.

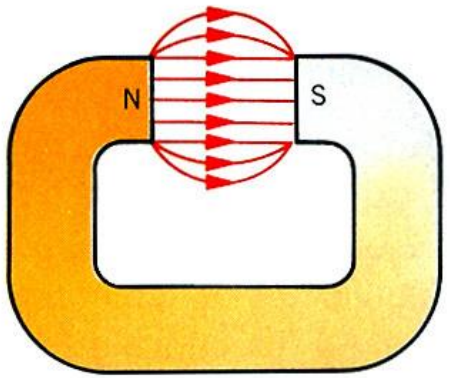
When broken, you have two individual magnets, each with their own North and South poles.



Properties of Magnetic Forces & Fields

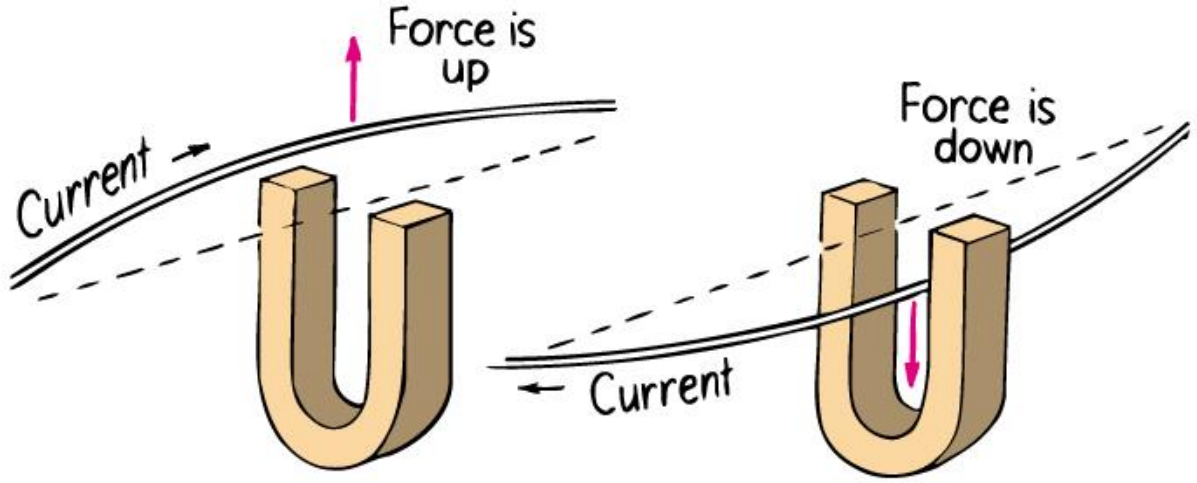
The field emanates from a “North” pole and terminates on a “South” pole. Outside of a magnet, the magnetic field points from North to South.





Properties of Magnetic Forces & Fields

The magnetic force is perpendicular to the velocity of the electric charge and is perpendicular to the magnetic field.

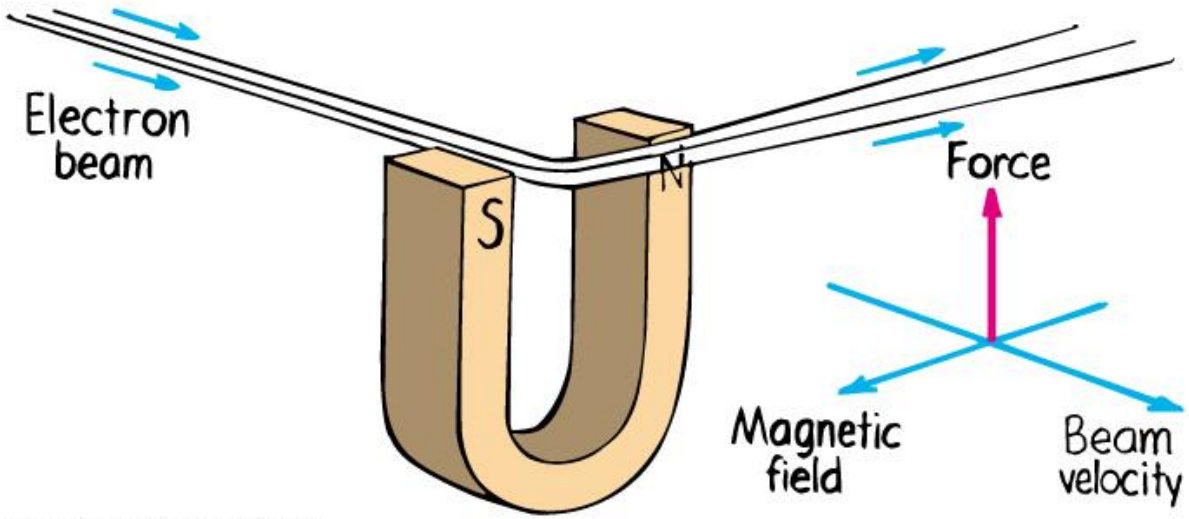


Properties of Magnetic Forces & Fields

The magnetic force obeys the "right-hand-rule" for (+) charges:

Using your right hand, point your hand in the direction of the moving charge, then curl your fingers toward the direction of the magnetic field. Your thumb will point in the direction of the magnetic force.

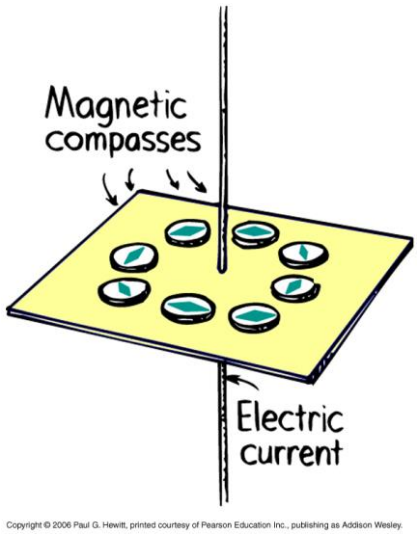
However, if the moving charges are negative (as with electrons), then the magnetic force is in the opposite direction as shown in the figure below.

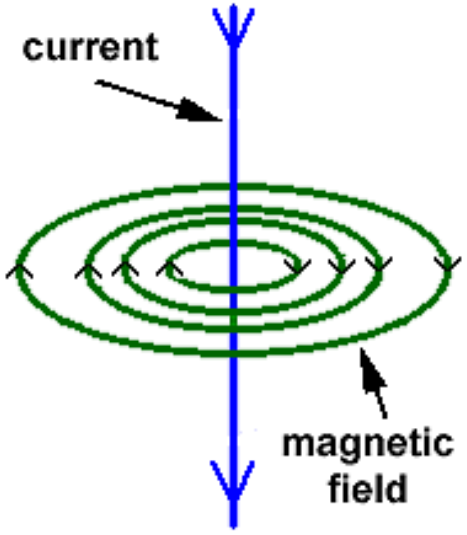


Electric Currents & Magnetic Fields

Moving charges (current) create magnetic fields.

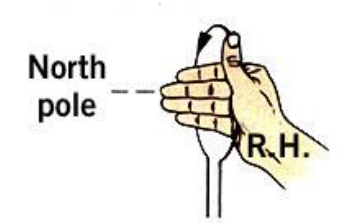
The direction of the field can be determined by places compass needles all around the conductor.

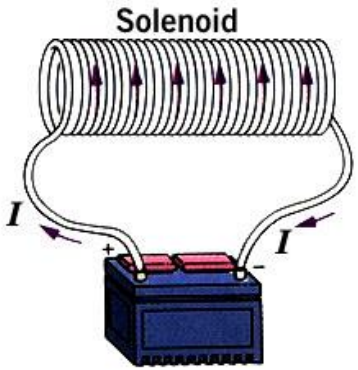


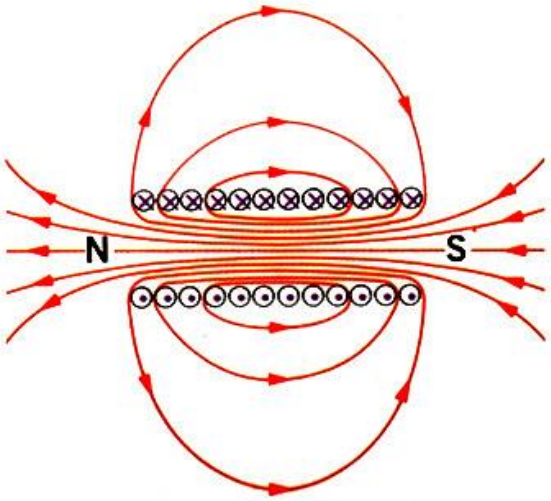


Electric Currents & Magnetic Fields

If the current carrying wire is bent in a loop or several loops, the magnetic field bunches up inside the loop giving rise to a strong magnetic field:

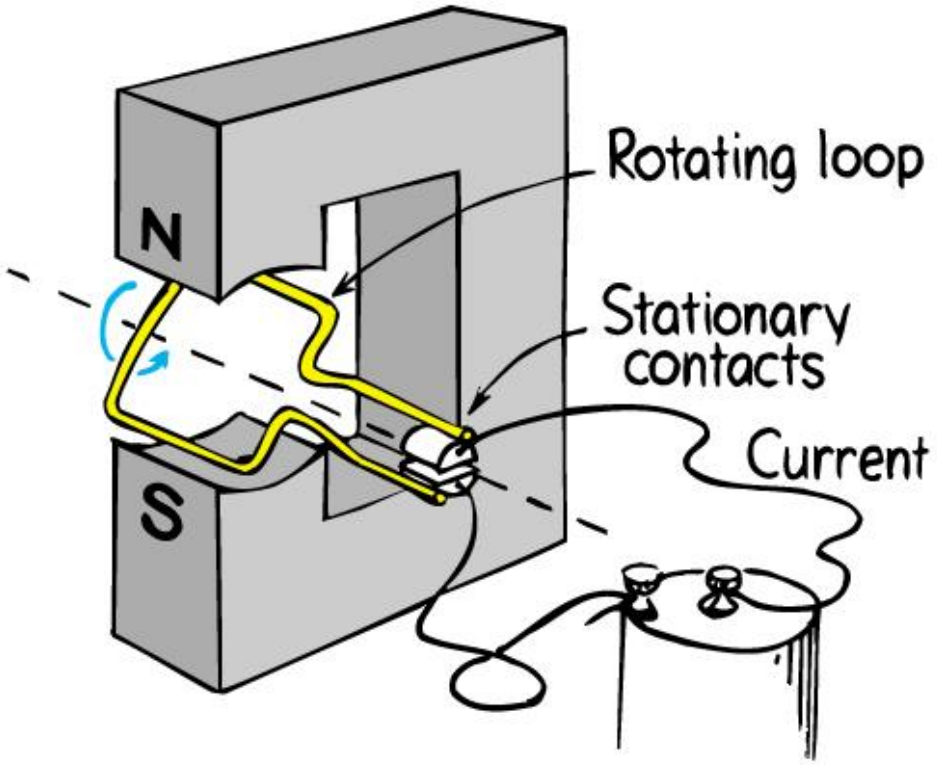






Electric Motors

A current-carrying wire placed in a magnetic field will experience a force. Careful design can allow the wire to be pushed into a continuous circular motion. This is the basis of an *electric motor*.



Hewitt, *Conceptual Physics*, Ninth Edition.