

**Magnetism:** a class of phenomena resulting in attractive and repulsive forces between objects and relating to motions of electric charge.

**Magnetic field lines:** arrows flowing away from a magnet's north pole and toward a magnet's south pole.

**Symbol for Magnetic Field Vector** = \_\_\_\_\_

**North Pole:** the pole of a magnet that tends to point itself toward the Earth's (current) North Pole. This is because, if you think of the Earth as a magnet, the North Pole is really its magnetic south pole. We call it the North Pole because magnets' north poles point toward it.

**South Pole:** the pole of a magnet that points toward the Earth's south pole.

### Moving Charges Create Magnetic Fields:

**Current (I) in a wire creates a magnetic field (B), according to the right hand rule.**

**Right hand rule:** If you point your right thumb in the direction of current flow, and you curl your fingers on that hand, your fingers point in the direction of the magnetic field lines.

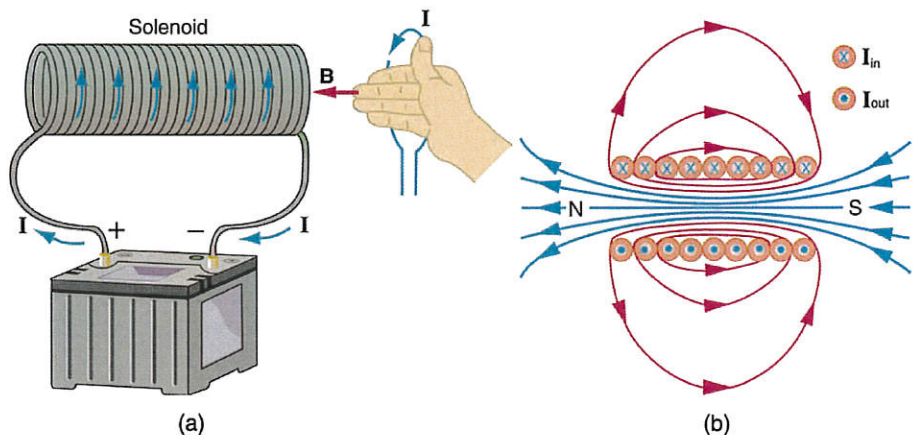
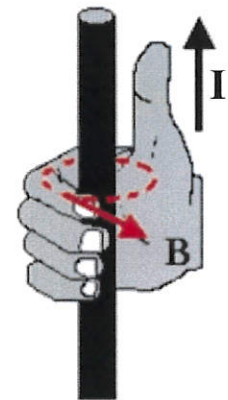
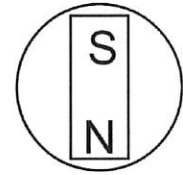
[Image on the right from <http://physiczed.buffalostate.edu/SeatExpts/resource/rhr/CNB.JPG>]

**Electrons in atoms create magnetic fields:**

- Most atoms have paired electrons. Electrons in pairs have opposite spin, so they cancel one another's magnetic fields.
- Iron, however, has unpaired spinning electrons that create magnetic fields. In groups of iron atoms, called **domains**, the unpaired electrons align with one another's magnetic fields. However, throughout the iron, the aligned domains are randomly oriented, so the iron has no overall magnetic field. When a strong magnet is brought near a piece of iron, the iron's domains align with the magnet's magnetic field. The iron becomes "magnetized," and it sticks to the other magnet. When the magnet is taken away, the iron's domains usually return to their normal orientations, so the iron does not become a permanent magnet.

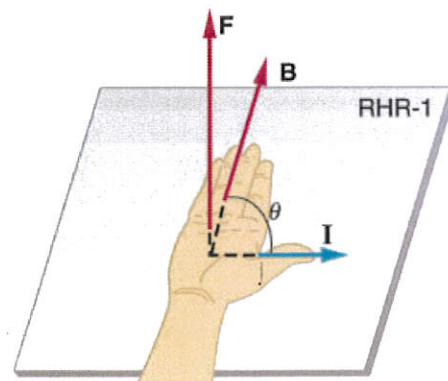
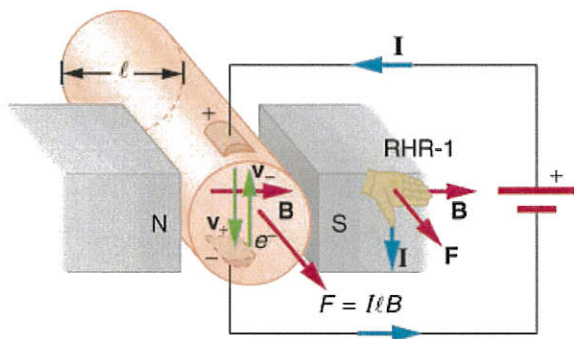
**Solenoid (electromagnet):**

A solenoid is a coil of wire through which current is flowing. The right hand rule can be used to understand the direction of the magnetic field, B. In the diagram on the far right, X represents current flowing into the page. A dot represents current flowing out of the page.



**Another Right Hand Rule** (concerning the force exerted on a current-carrying conductor in a magnetic field)

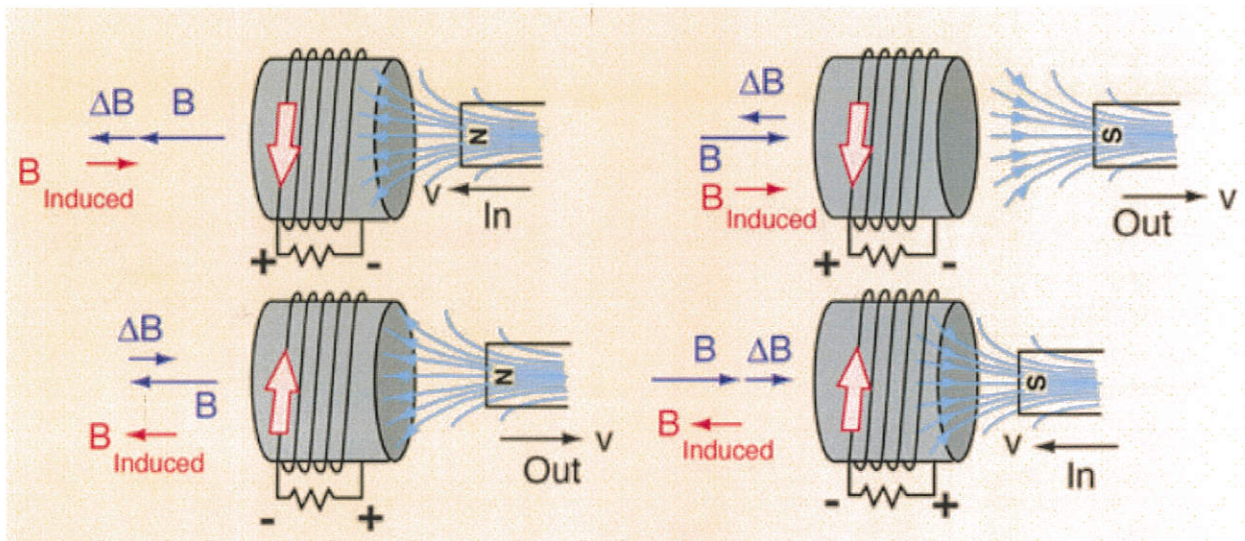
Example:



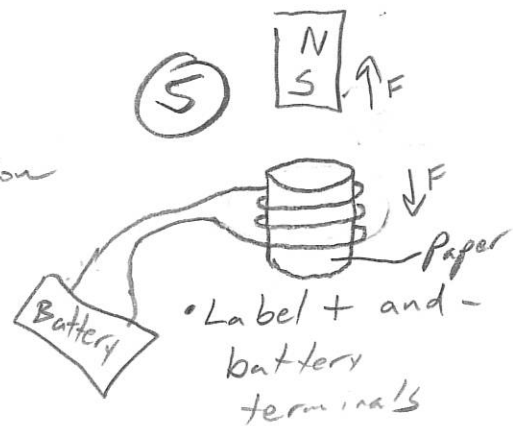
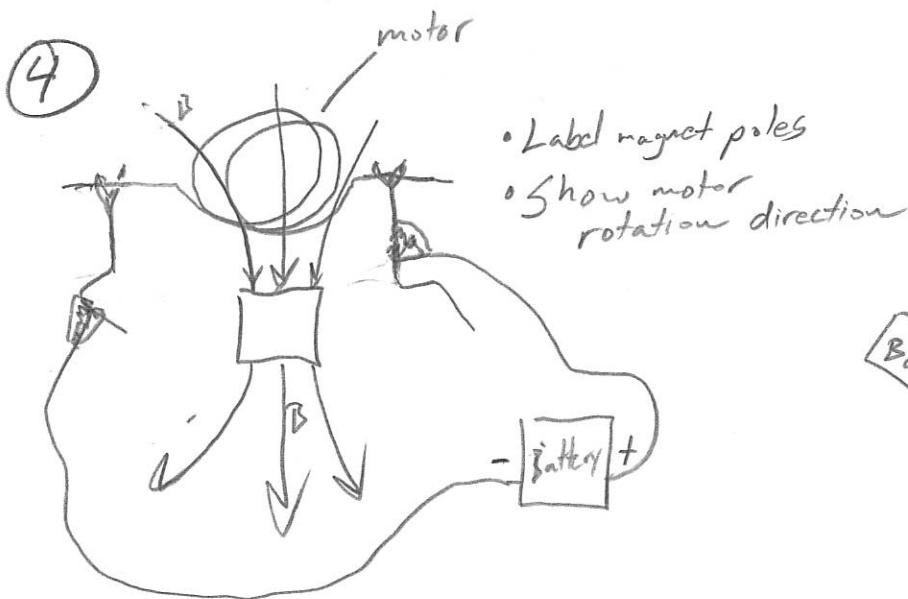
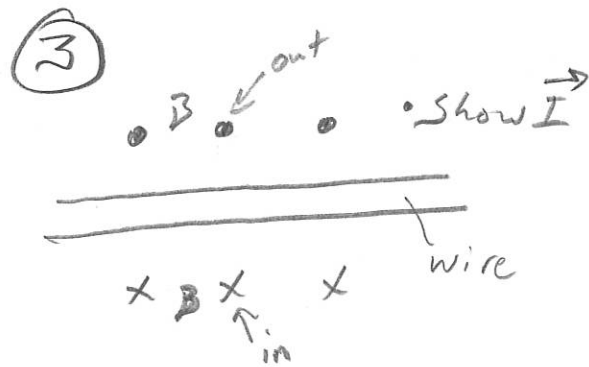
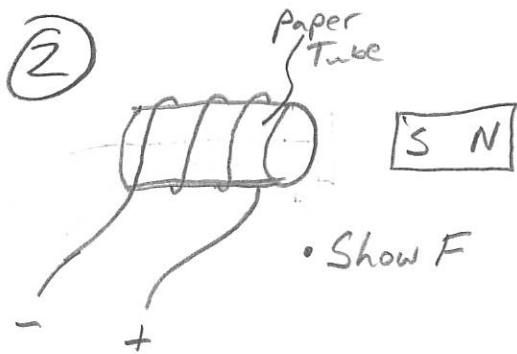
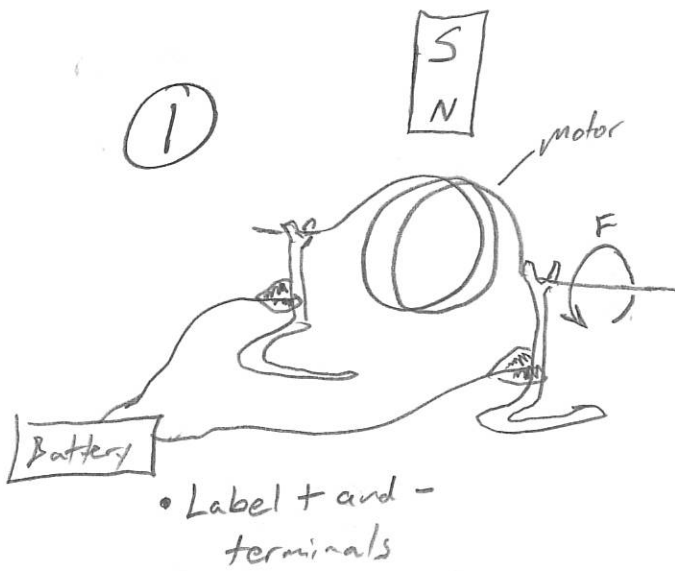
$$F = I\ell B \sin \theta$$

$F \perp$  plane of  $I$  and  $B$

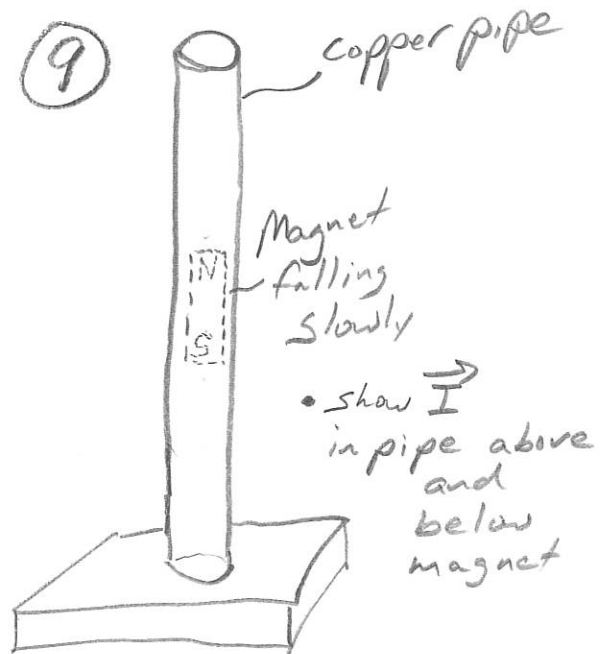
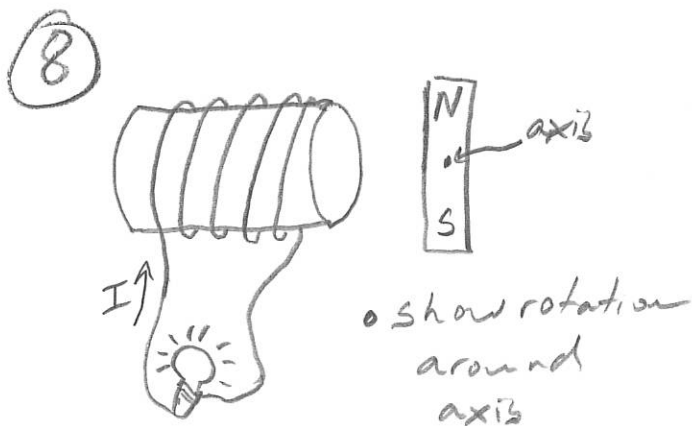
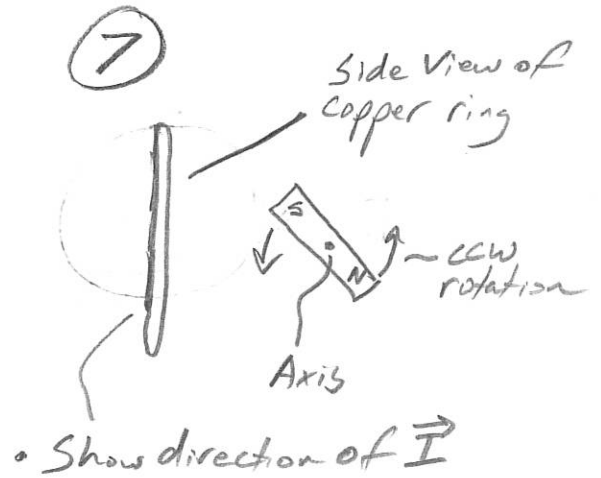
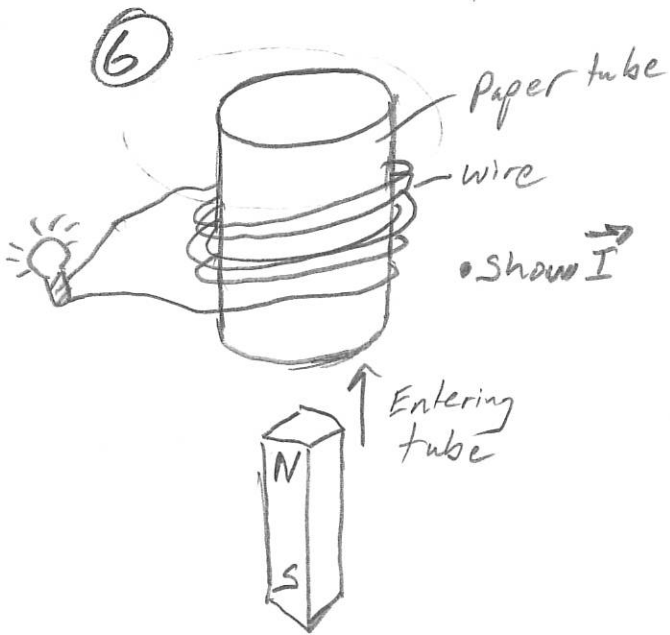
**Lenz' Law:** A change in magnetic flux through a conductive coil induces a current in the coil, such that the induced current's magnetic field opposes the first change in magnetic flux.



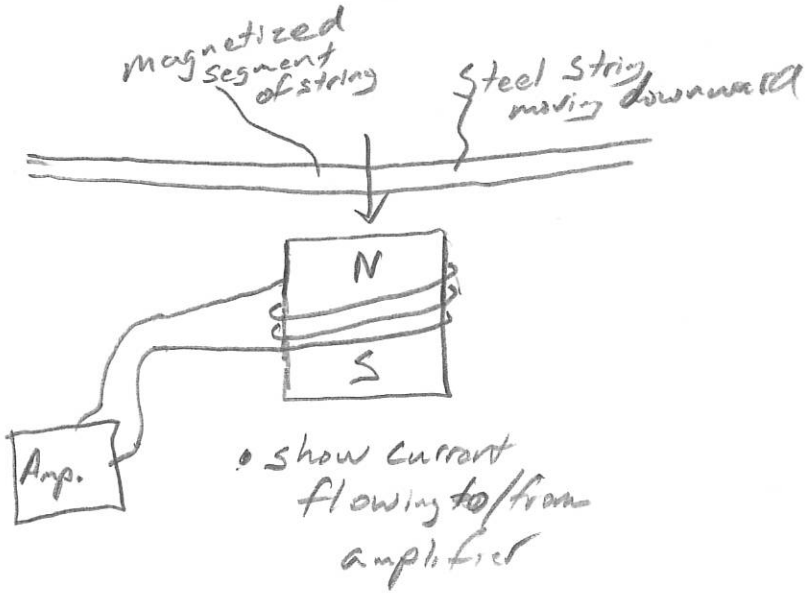
# #1-5: Magnets and Right Hand Rule



# #6-11: Lenz's Law



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