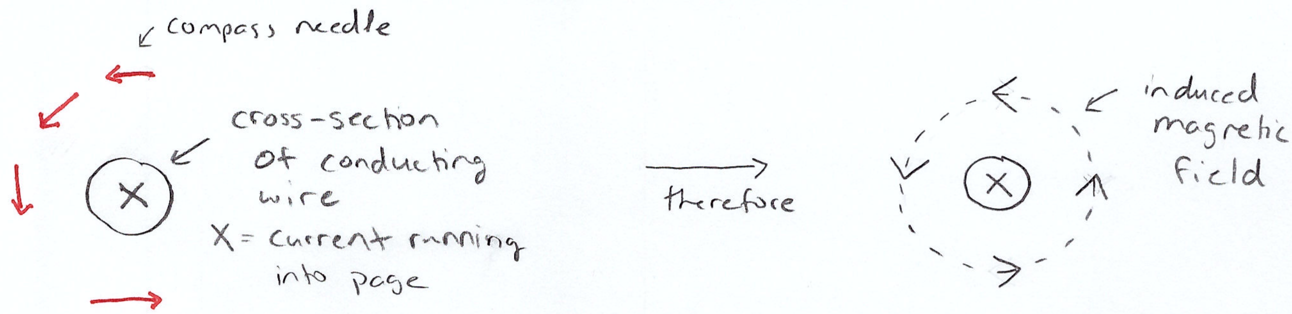
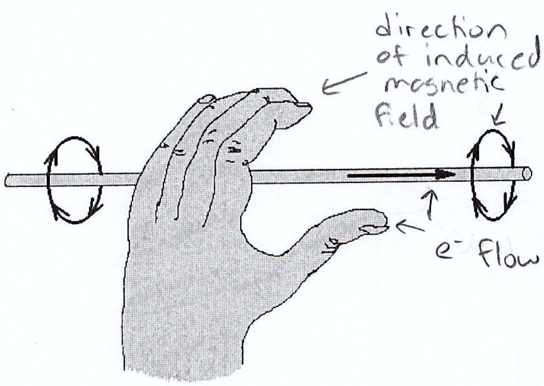
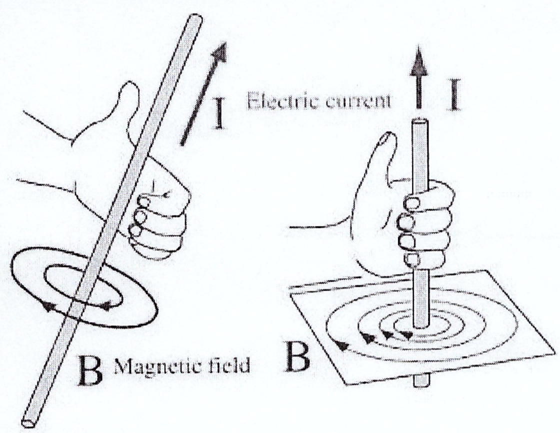
Electromagnetism

- Oersted discovered that a *current* running through a *conducting wire* will produce/induce a *magnetic field* around the wire
    - To determine the direction of the magnetic field around a conducting wire, compasses were placed in various locations around the conducting wire and the north end of the compass needle was observed to determine the magnetic field direction
    - We use the symbol • to represent a direction out of the page and we use the symbol **X** to represent a direction into the page



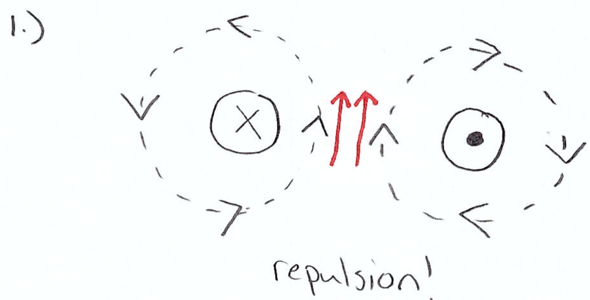
- The **first left hand rule** is a general rule developed to determine the *direction of the induced magnetic field lines* produce around a *conducting wire* based off the *direction the current* moving through the conducting wire

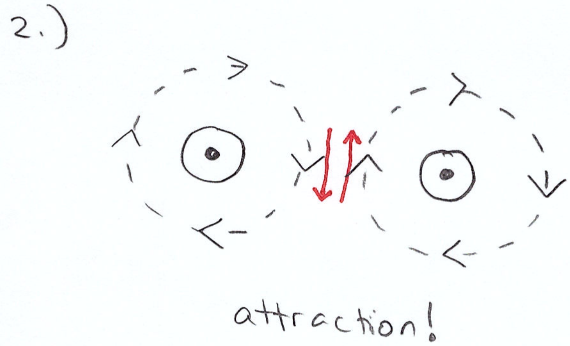




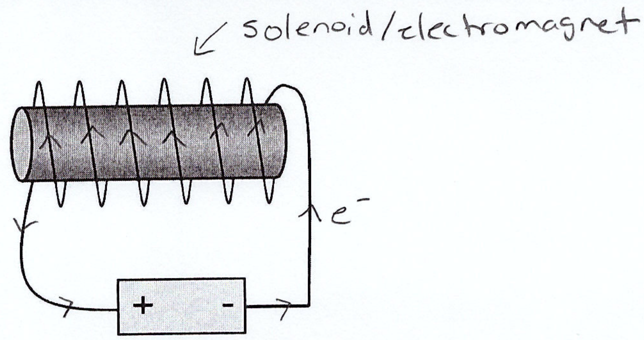
- Thumb of the left hand points in the direction of electron flow or any "–" particle
- Fingers will circle/wrap around the wire in the same direction as the magnetic field lines
- ✳ The left hand rule only works for the flow of electrons or negative charges! Use the right hand for the flow of positive charges (ie. **conventional current**)
- You need to know one direction first (ie. current or induced magnetic field) to be able to apply the first left hand rule and determine the unknown

- Conducting wires with currents running though, can interact with each other due to their induced magnetic fields and can either repel or attract each other
  - Examples:

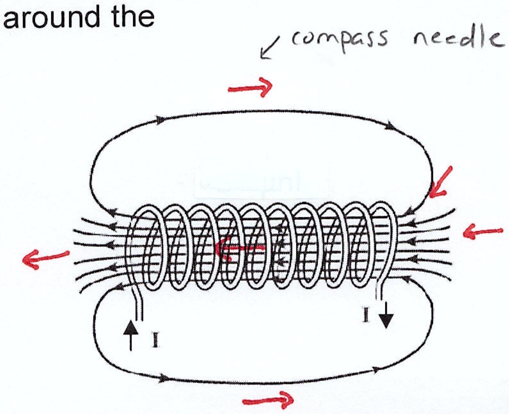




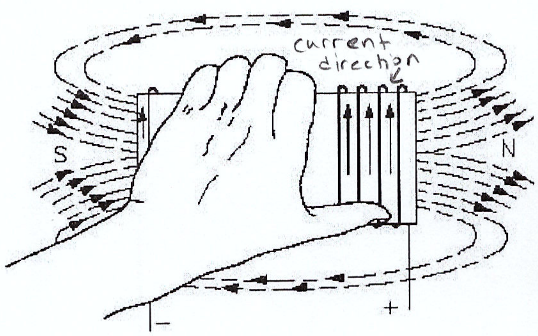
- When a conductor wire is wrapped into many loops this is now called a **solenoid** or **electromagnet**
  - A solenoid has a hollow center, while an electromagnet has a solid metal center

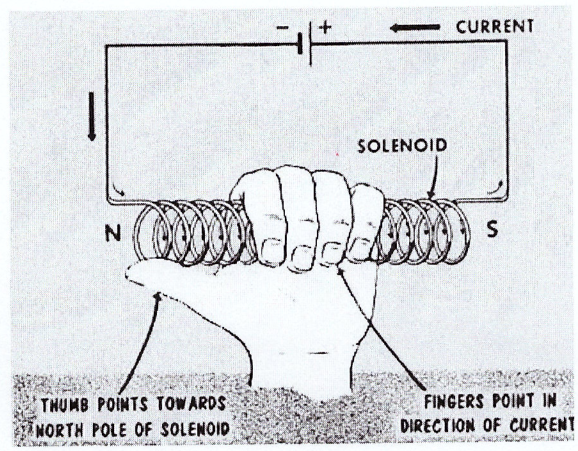


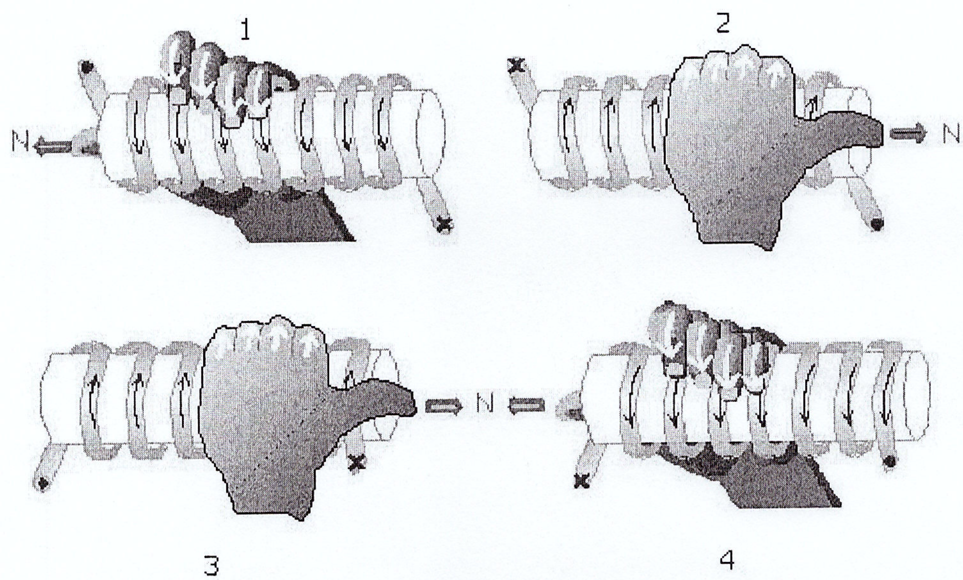
- When a current is running through the conductor wire, the solenoid/ electromagnet will produce/induce an magnetic field around the solenoid/electromagnetic
  - Compasses were used to determine the direction of magnetic field lines around a solenoid/ electromagnet
  - The magnetic field inside the solenoid is *strong* and *uniform* compared to the magnetic field strength outside the solenoid, which is weak and non-uniform
  - The magnetic field lines around a solenoid/electromagnet are similar to that of a bar magnet



- The **second left hand rule** is a general rule developed to determine the *direction of the induced magnetic field lines* produce around a *solenoid/electromagnet* based off the *direction the current* moving through the conducting wire





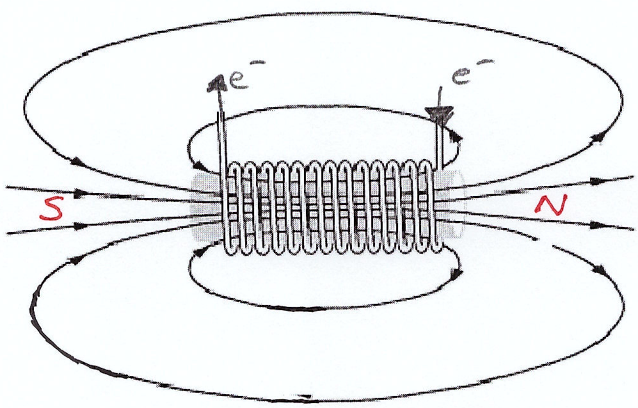


  - Curl your fingers of your left hand in the direction the electron flow/current in the coiled wire
  - Keep your thumb straight; it will be pointing the same direction as the north pole of a compass (ie. in the direction of the magnetic field lines) *inside* the solenoid/electromagnet or points to north pole of solenoid!
  - A word of caution: when we talk about the *magnetic poles,* we are referring to them being just *outside* the solenoid/electromagnet.
  - You need to know one direction first (ie. current or induced magnetic field) to be able to apply the second left hand rule and determine the unknown
  - * The left hand rule only works for the flow of electrons or negative charges! Use the right hand for the flow of positive charges (ie. **conventional current**)

- A solenoid/electromagnet has many applications because its magnetic properties can be turned off and on as the current is turned off and on
    - Examples:

-cranes
- bells
-magnetic locks

EXAMPLE: Determine the direction of electron flow through the solenoid. Label the ends of the solenoid with the correct polarity.



Now try pg. 139 #1-11a (acceptable)