

Magnetism

10-04

Force notes

Magnetic Forces

- Two kinds of force you need to know about
 - Force on moving charges
 - Force on wires (on “conductors”)

Force on moving charges

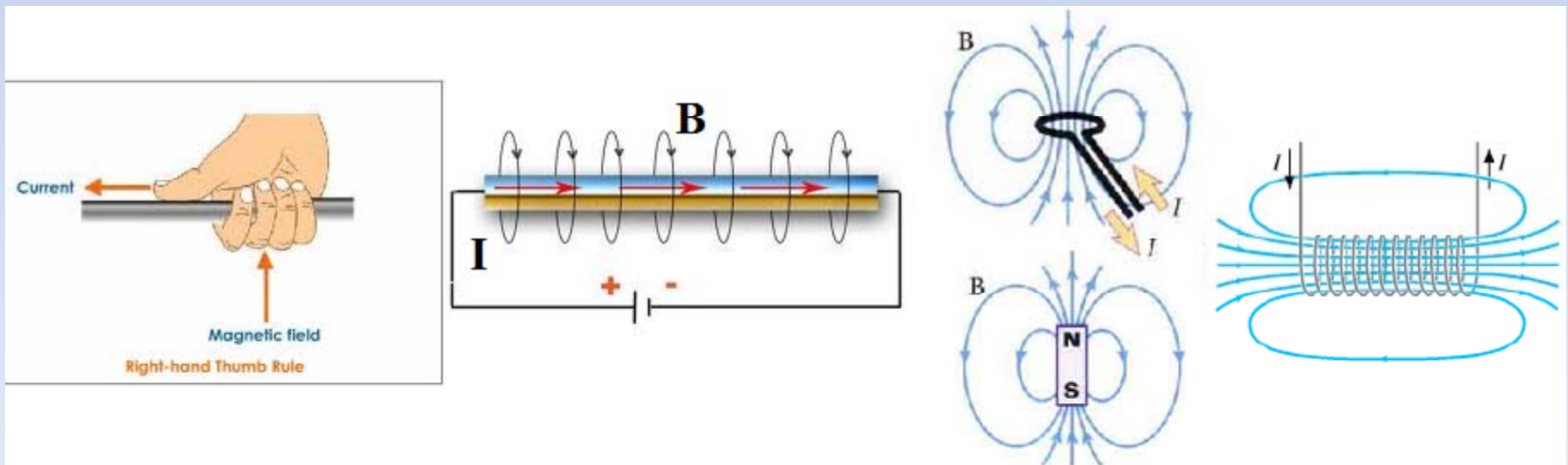
- $F = qvB$
 - q is the charge in coulombs
 - Remember, $e = 1.6 \times 10^{-19} \text{ C}$
 - V is the speed of the moving charge (m/s)
 - B is the external magnetic field the charge moves within (T, for tesla)
 - B is directed away from a magnet's N pole and into a magnet's S pole (outside the magnet)
 - F is the force the charge experiences (must be moving within a magnetic field) (N, newtons)

Force on wires

- $F = ilB$
 - i is the magnitude of current (A, amps)
 - L is the length of the wire (or other conductor) (m, meters)
 - B is the external magnetic field on the wire (T, for tesla)
 - F is the force on the wire (N)

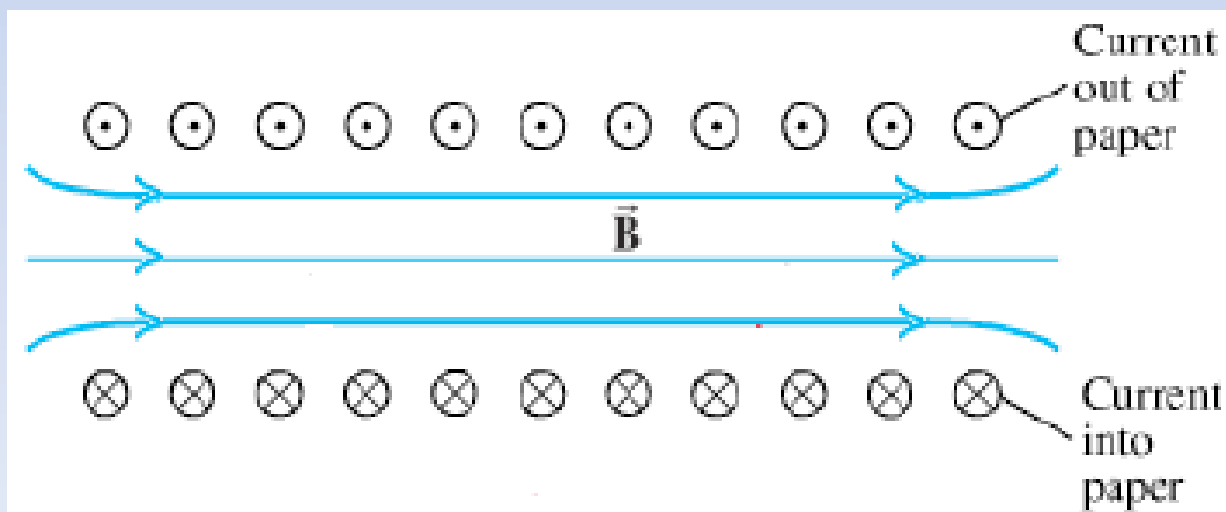
Direction - right hand rule #1

- The easy rule
- Relates I and B **directions** produced BY moving charges
- Doesn't consider
 - Any external magnetic field
 - Any forces (takes TWO magnetic fields to create a force anyway)
- Align CONVENTIONAL current (I) with your thumb, direction curled fingers point is direction of B (yes, curled fingers point in a CIRCLE!)
- NOTE: Works the opposite too: Align curled fingers with conventional current direction (I), thumb points in B 's direction



3D convention rules

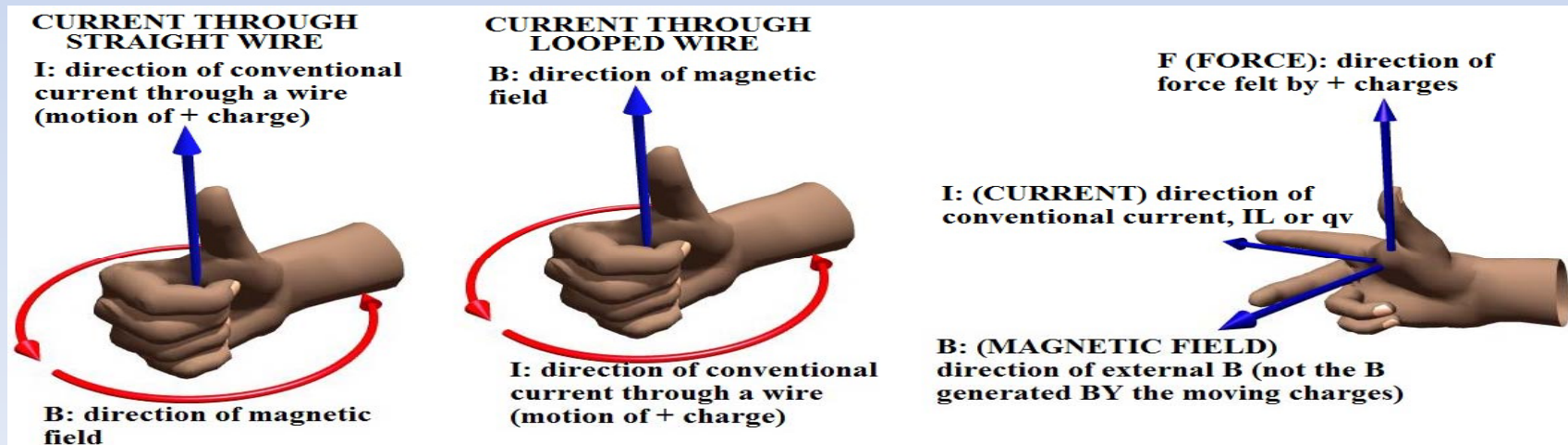
- Drawing 2D is easy, your paper is 2D (flat)
- To show 3D for F , I or B , etc. use “arrow notation”
 - Arrow away from you, you see feather from behind, looks like an X
 - Pointy arrow tip heading toward you, you see dot (point)
- Use rule #1 to make sense of example below!



Direction - right hand rule #2 (hard rule)

(Master this or Lenz' law will be impossible!)

- F, I, B: at right angles to each other
 - If one is North, another East the last must be perpendicular to North and East (up or down)
 - F: direction of force on + charge
 - Neg. charge feels force in OPPOSITE direction
 - I: direction of positive charge's motion (no motion = no force!)
 - OPPOSITE direction of Electrons
 - B: direction of EXTERNAL magnetic field
 - NOT the magnetic field produced by the moving charge
 - Two magnetic fields interact to make force: External and that produced by moving charge
 - FYI: Direction of Earth's magnetic field points roughly toward NORTH (from Geographic S pole (penguin's home) to Geographic N pole (Santa's home))



Making a “FIB”

- A. Take two stiff insulated copper wires (electrical wire)
- B. Bend the middle part of the wire
- C. Rotate the outer wires (1 and 3) each by 45° so wires 1, 2 and 3 are all 90° from each other to make a base
 - Take three popsicle sticks and tape them to two bases such each stick is connected to BOTH an inner and out base
 - Label with arrows each stick as F, I and B appropriately

