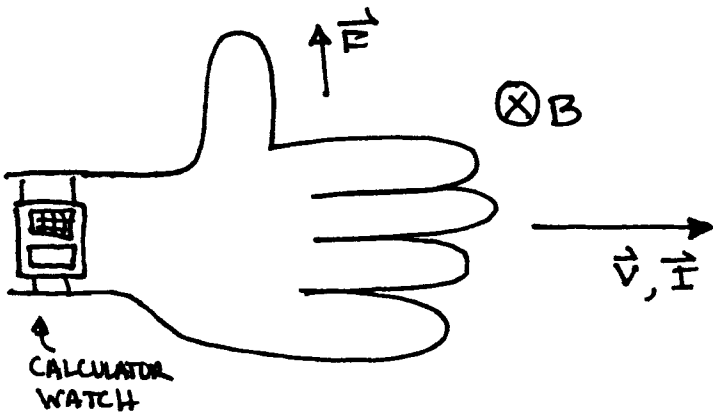
MANIC MONDAY #4: RIGHT HAND RULE FAIRY TALES

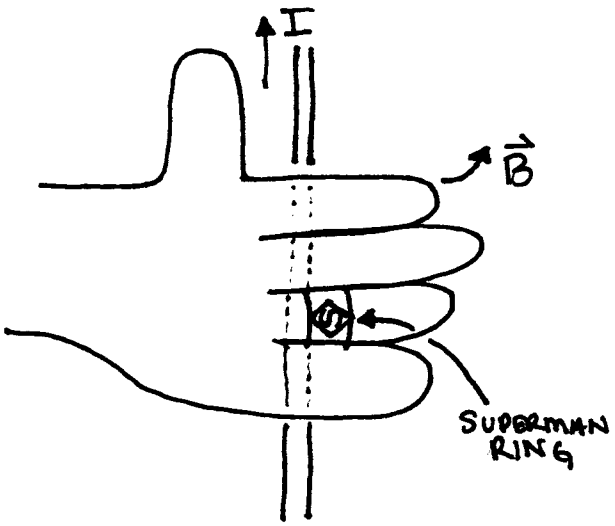
(A) RHR #1: Forces



- Fingers along $\vec{I}$ or $\vec{v}$
- Palm toward $\vec{B}$
- Curl fingers into $\vec{B}$
- Thumb along $\vec{F}$

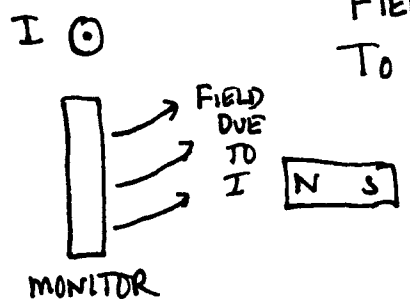
(B) If charge is (−) instead of (+) the force is in <u>OPPOSITE DIRECTION</u>.

(C) RHR #2: FIELDS & CURRENTS



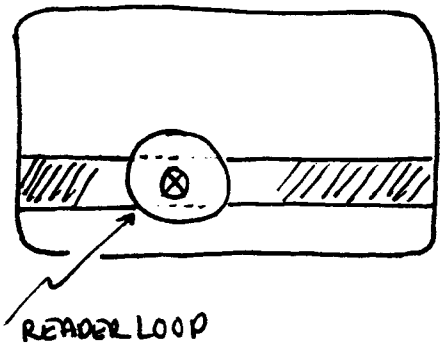
- Thumb along current
- Palm toward wire
- Fingers curl around wire
- B field along fingers

(D)



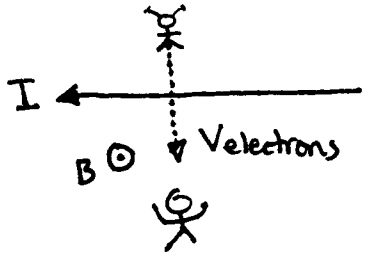
FIELD due to I is OUT of my monitor (RHR2). To cancel it, I point the N end of the bar magnet (lines coming out) toward monitor.

(E)



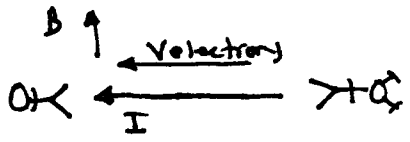
Looking thru Loop at the magnetic stripe, I see S POLE, so the B field is ⊗. When the S POLE goes by, the loop sees flux increasing and doesn't like that, so the field from the induced current must <u>OPPOSE</u> the S (or in other words, come <u>out</u> of the page). Using RHR2 the field induced in the center of the loop pts out, so current <u>CCW</u>.

(F) VIEW FROM ABOVE (INITIAL)



The case at the start of the problem is shown. If I stay put, the force will deflect the electrons to the right. (by RHR #1).

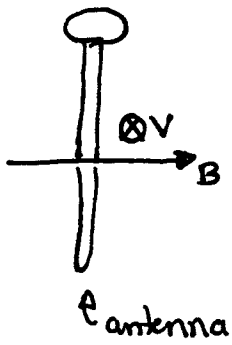
If I walk so I am facing the direction the current comes from, RHR1 gives an <u>UPWARD</u> deflection for electrons. I know this because RHR2 gives current above the wire that the electrons see.

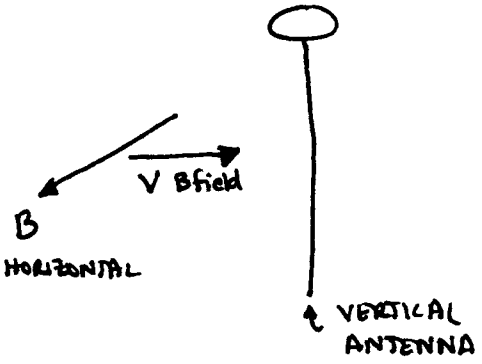


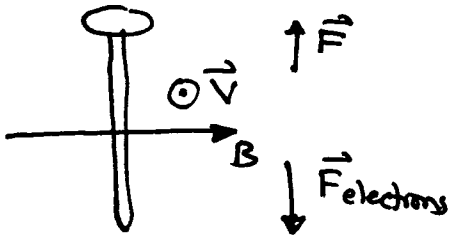
(G)

The loop is shown to the right. An induced CCW current gives $B_{INDUCED}$ <u>UP</u> in loop center. Before the car arrived there was <u>NO</u> field, so the induced current creates a field to get back to that state (or "try"). Thus it wants ZERO B and car's B points <u>DOWN</u> thru loop.

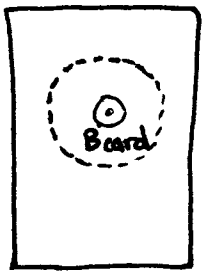
(H) The setup is shown in 2 sketches to the right. The antenna hangs vertically, and a horizontal B field is travelling toward the antenna ($\vec{v}$ is the velocity of the B field). If I think of the B field holding still and the antenna moving (completely equivalent) I get a diagram like at right with $\vec{v}$ OUT of page. RHR 1 then gives $\vec{F}$ UP, or for electrons (negative particles) DOWN, as indicated.



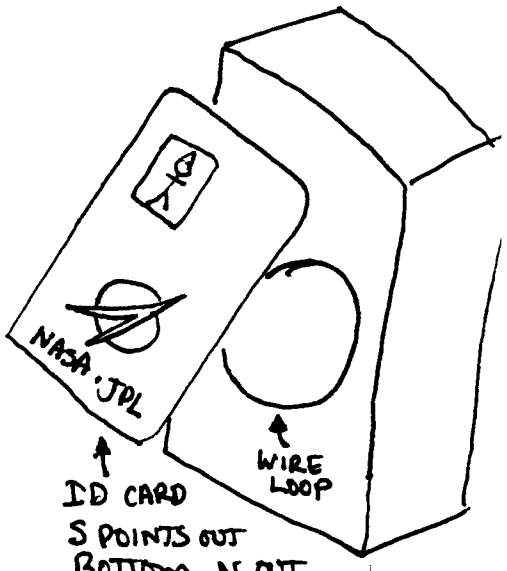




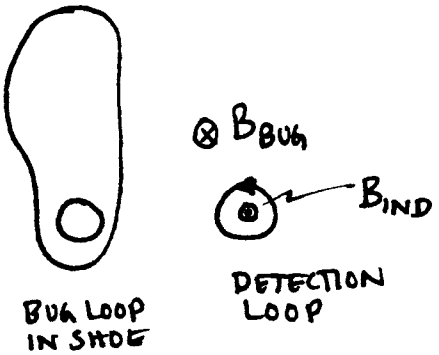
(I) The setup is shown to the right. The side of the card near the reader is a S pole that field lines go INTO. Before I get to the reader, it sees NO FIELD and NO FLUX. When I hold my card up there is suddenly field pointing thru it. It does not like the increase in flux, so induces a current to OPPOSE it (B ind INTO page). Thus by RHR 2 to make B ind IN thru middle of loop, current is CW viewed from my perspective (front face of card)



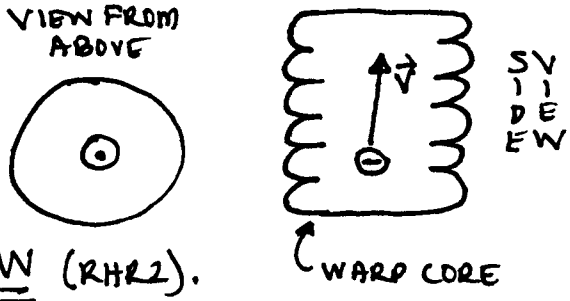
Looking THRU CARD AT READER LOOP



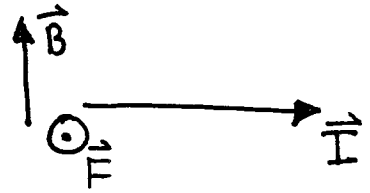
(J) I see a CCW current in the detection loop. That means the induced B, in the middle of my DETECTION LOOP is UP thru the middle (RHR2). Before I was near the bug, flux was ZERO so this induced field is an attempt to cancel the field from the bug and get back to ZERO. Thus the B_{BUG} must POINT DOWN everywhere outside the bug loop. Thus BUG CURRENT is CCW viewed from above (RHR2).



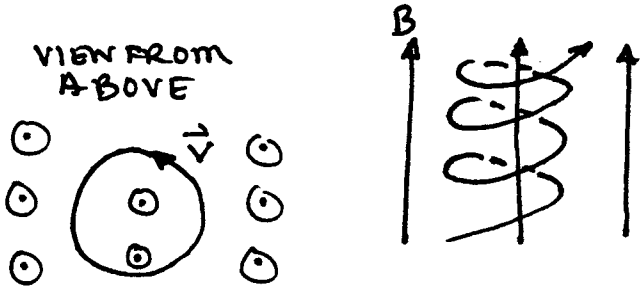
(K) The velocity is upward (out) of page from above. RHR2 gives CCW B field, but the matter is NEGATIVE so B field is CW (RHR2).



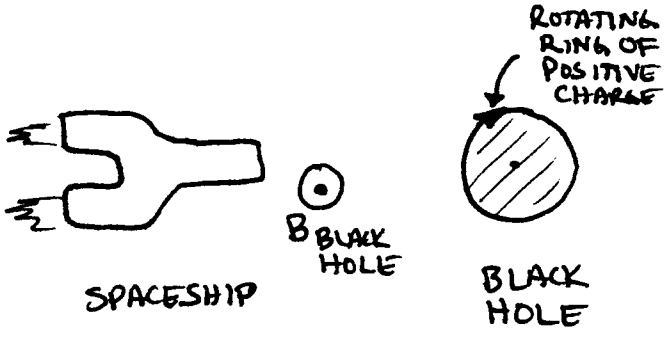
(L) When standing amidships on RED OCTOBER the situation is shown to the right. $\vec{I}$ points port to starboard and to move the submarine I want $\vec{F}$ to the BACK of the submarine (out of page in this picture). So RHR1, knowing $\vec{F}$ and $\vec{I}$, tells me $\vec{B}$ points UPWARD.



(M) The setup is shown to the right. As viewed from above, the plasma moves in a circle, so the magnetic force must point to the CENTER to keep it moving in a circle. For the $\vec{v}$ and $\vec{B}$, RHR1 gives an OUTWARD pointing force, not INWARD. So the particles must be NEGATIVE.



(N) The situation (dire though it is) shown at right as seen from ABOVE. The black hole looks like a loop of current so RHR2 says at the spaceship the B field is UP.



(O) The situation is shown at right. The $\vec{v}$ on electrons is OUT of page. The scan lines are the FORCE felt by electrons. RHR1 says if they were positive the force would be to RIGHT; if so then B field must point DOWN.