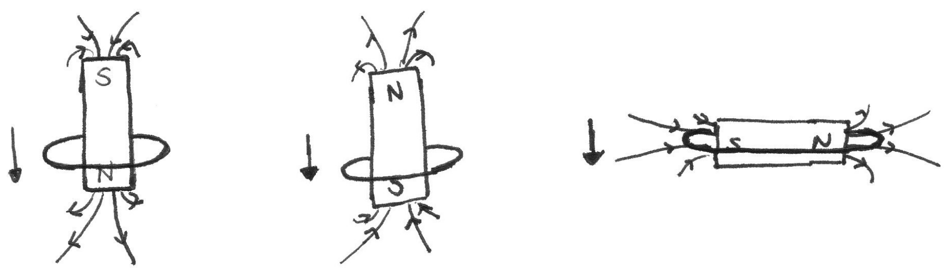
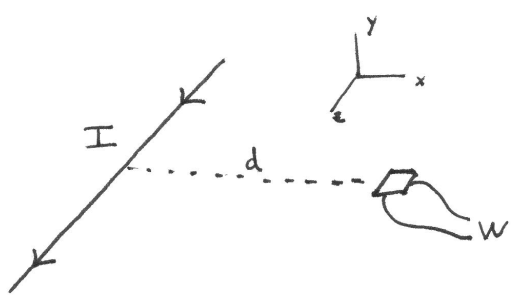
# PHY 122 HW 9

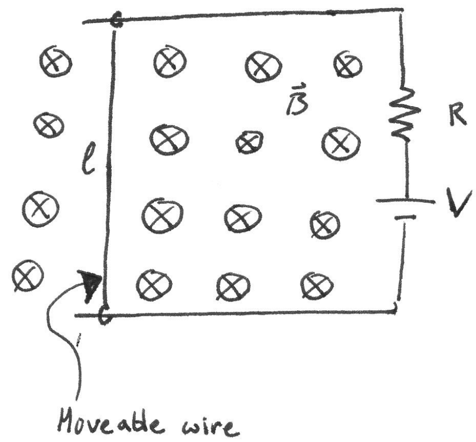
1. Describe the difference (in any) in the induced current in a wire loop when a magnet goes through the loop north side first, south side first, and sideways.




2. A long straight wire oriented in the $\hat{z}$ direction carries a current $I$. A square loop with sides of length $w$ is in the $x$-$z$ plane with its nearest edge a distance $d$ from the wire. At time $t$, the square loop moves a distance of $l$ closer to the wire. What is the emf induced in the loop while it is moving? Ignore the variation in the wire's magnetic field across the loop.




3. A circuit with a movable cross wire is shown below. The resistor has a resistance of $R$, the battery has a voltage $V$, and the length of the movable wire is $l$. There is also a uniform, constant magnetic field into the plane of the circuit with a magnitude of $B$.

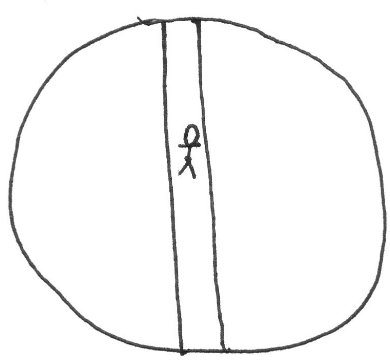



(a) What is the current if the movable wire is locked into position?

(b) What is the force on the movable wire at the moment it is released from the locked position?

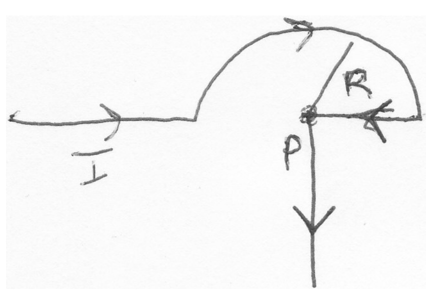
(c) At what velocity $\vec{v}$ would the wire need to move to feel no force on it?

4. The man with the charged roller skates from last week has since purchased new roller skates with highly magnetic wheels. After leaving the store, he accidentally skates into a bottomless pit which goes through a diameter of the Earth as shown below (drawing not to scale):



The sides of the pit are made of a conducting material. If we neglect the effects of air resistance, the rotation of the Earth, and take the Earth to be a perfect sphere, will the man ever make it back to the planet surface? Explain why or why not. It may help to cast your mind back to PHY 121 and compare with the situation where the man has no magnetic roller skates.

5. Using the image below, calculate the magnetic field at point P.




6. The diagram below shows two separate current carrying loops of wire in the $x$-$z$ plane, one at $y = 0$ and one at $y = L$. Each loop carries a current $I$, in the same direction.


Calculate the magnetic field along the y-axis in the region $0 < y < L$. How would the problem be different if instead of one loop at $y = 0$ and $y = L$, we had $n$ loops at each? This arrangement is known as a Helmholtz coil, and is often used to generate uniform magnetic fields for experiments.