PHYS 1512: Week 5

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Equations

$$F = ILBsin(\theta) \quad \text{(Magnetic force on a wire)} \tag{1}$$

$$\tau = NIABsin(\phi) \quad \text{(Torque on current coil)} \tag{2}$$

$$\sum B_{||} \Delta L = \mu_o I_{enc} \quad \text{(Ampere's Law)} \tag{3}$$

$$B = \mu_o NI \quad \text{(Magnetic Field in Solenoid)} \tag{4}$$

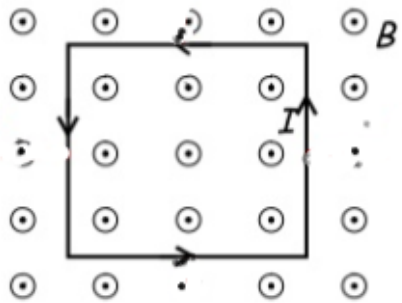
$$\mathcal{E} = -N\frac{\Delta \Phi}{\Delta t} \quad \text{(Lenz's Law)} \tag{5}$$

$$\mu_o = 4\pi * 10^{-7} \frac{Vs}{Am}$$

Question #1

Fundamentals of force

For the figure below:
1) What is the net magnetic force acting on the square loop?
2) If the magnetic field was pointing into the page?
3) If the loop is turned clockwise so that it was aligned with the B-Field, what direction will it begin rotating? (B-Field goes left to right)
4) Repeat 3) but now the B-Field goes left to right



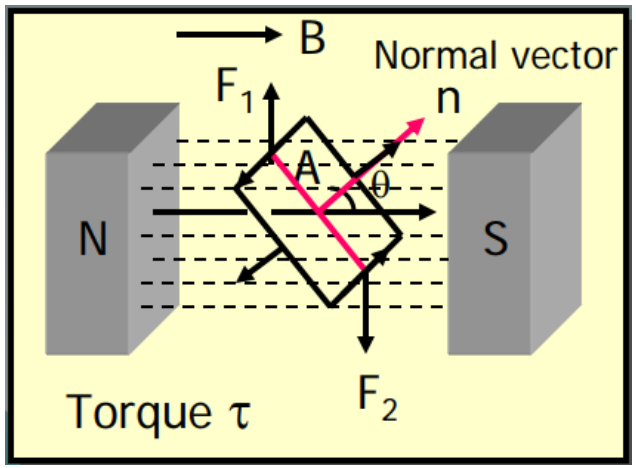
Question #2

Wires

Wire 1 and Wire 2 are singular loop wires. They are placed in the same perpendicular uniform magnetic field. The same current is passed through both wires. Wire 1 is a square with side length L and Wire 2 is circular in shape with radius $\frac{L}{4}$.

1) Find an expression for the amount of torque Wire 1 experiences as compared to wire 2.

2) If wire 2 is rotated $\Phi = -45^\circ$ and its current is doubled, repeat part 1).



Question #3

Quick Proof

Wire 1 has a current that goes toward the top of the page. Use Ampere's Law to determine the B-Field at some point "r" away from the center of the wire.

Question #4

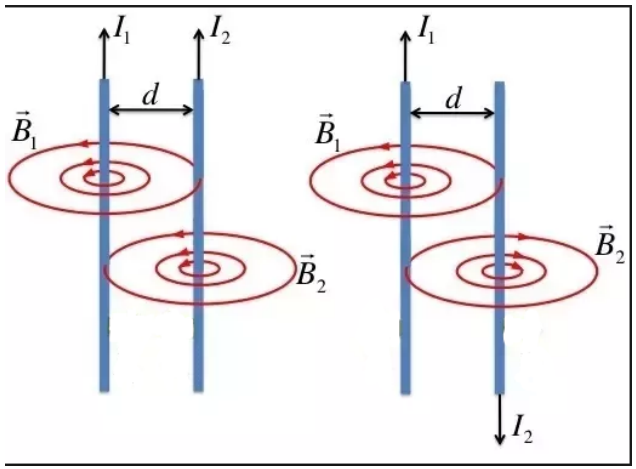
Motion in B-Field

We placed a two wires d=0.5m apart as shown below, labelling the left one Wire 1 and the right one Wire 2.

1) If $I_1 = 1A$ **going up** and $I_2 = 2A$ **going up**, what is the magnitude and direction of the **Force per unit length** that Wire 1 puts onto Wire 2?

2) What is the magnitude of **Force per unit length** that Wire 2 puts on Wire 1?

3) Repeat part 1) and 2) if now $I_1 = 1A$ is **up** while $I_2 = 2A$ is **down**.

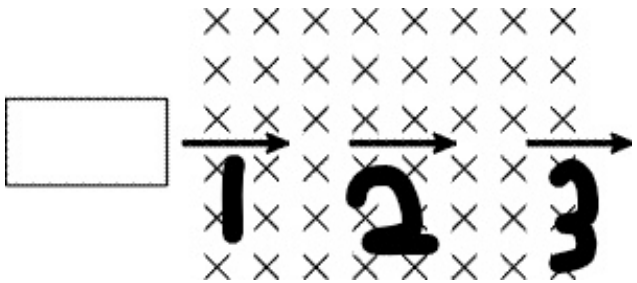


Question #5

Lenz's principles!

A square wire with a small resistance passes through a magnetic field going into the page. What is the direction of the current going through the wire at the following points:

1) When the loop is halfway into the field
2) When the loop is entirely in the field
3) When the loop is halfway out of the field



Question #6

Final Boss

A Metal rod (yellow bar in the figure) is moving with a speed v=0.7 $\frac{m}{s}$ on conducting rails towards a resistor. The rod and resistor are within a uniform magnetic field pointing out of the page. The rod has length L=0.5m.
1) What is the direction of the current running through the system?
2) If the resistor can be thought of as a cylinder with Length L=10cm, radius r=5mm, and resistivity $\rho = 9.7 * 10^{-8} m\Omega$, what is the strength of the magnetic field given that the induced current is 1.1A? (Ignore any Resistance of the rod)