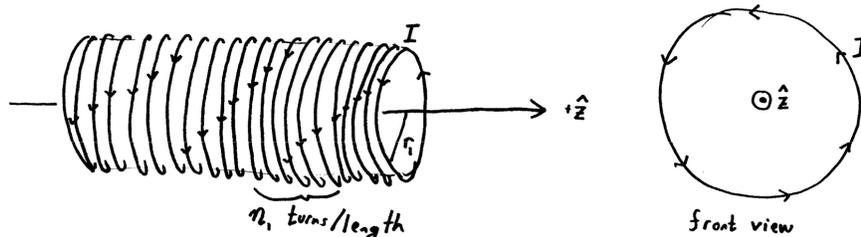


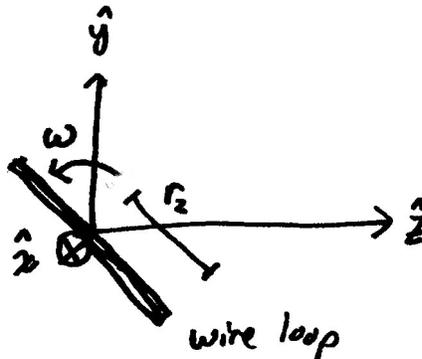
Physics 8B - Midterm 2 Review Problems - Summer 2011
Austin Hedeman

1. A long solenoid of radius r_1 and n turns per unit length lies along the z -axis. When looking from the $+z$ -direction, a current I flows through the solenoid in a counterclockwise fashion, as shown.



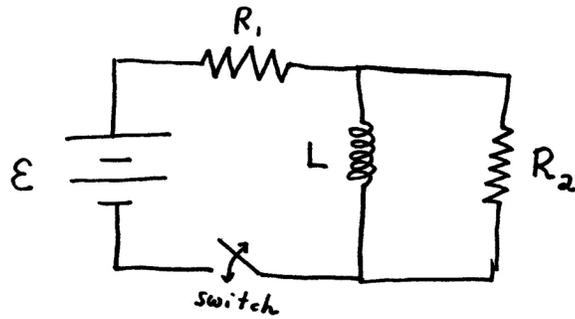
- a) What is the magnetic field inside the solenoid (magnitude and direction)?

A small loop of wire of radius $r_2 < r_1$ and resistance R is placed inside the solenoid. Initially, the loop lies in the xy -plane ($\theta = 0$). An external torque is applied such that the loop rotates about the x -axis with a constant angular speed ω , so $\theta = \omega t$.



- b) What is the maximum current $I_{\text{loop,max}}$ through the loop?
- c) What is the maximum value of the external torque, τ_{max} , that is applied to the loop? (Trigonometry hint! The maximum value of $(\sin\theta \cos\theta)$ is $1/2$).
- d) At what orientations do the maximum values from part (c) occur?

2. Consider the following circuit, with the switch initially open.

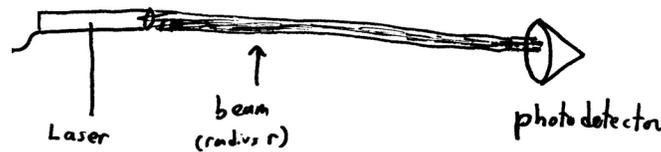


- a) What is the current through resistor R_2 in the following cases (indicate direction of current as well!):
- Just after the switch closes?
 - A long time after the switch closes?
 - Just after the switch reopens?
 - A long time after the switch reopens?
- b) Starting from the time the switch reopens, how much total energy is dissipated by the resistor?

3. Consider a monochromatic laser beam. The electric field from the light is found to be $\vec{E} = E_0 \sin(ky - \omega t) \hat{x}$.

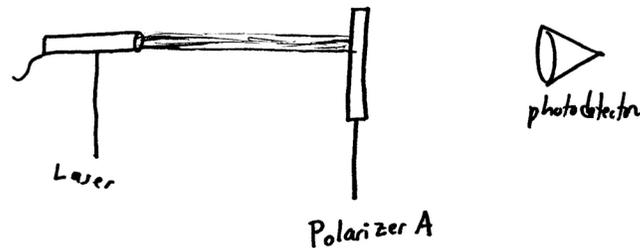
a) What is the magnetic field for this wave (magnitude and direction)?

A photodetector is placed somewhere along the path of the beam. This detector will only show a reading if the power entering the detector is at least P_0 .



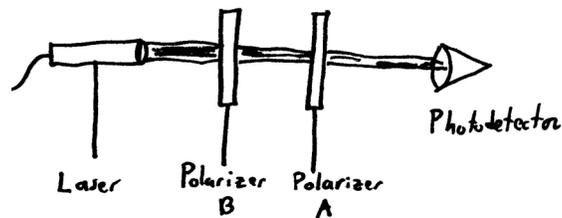
b) What is the minimum radius the laser beam must have for the detector to show a reading?

The actual laser beam is twice this radius (yey!). Now a polarizer (labeled polarizer *A*) is placed between the laser and the photodetector, as shown. The polarizer *completely* blocks the laser beam.



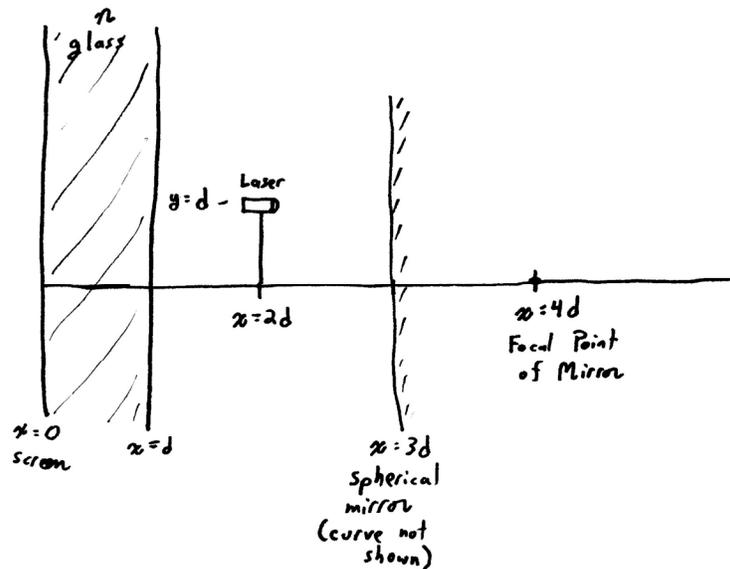
c) What is the axis of polarization for this polarizer?

Now an *additional* polarizer (labeled polarizer *B*) is placed between the laser beam and polarizer *A*. Polarizer *B*'s axis is oriented at an angle θ relative to polarizer *A*'s axis.



d) Does the photodetector show a reading if $\theta = 30^\circ$? If $\theta = 45^\circ$?

4. A laser at position $x = 2d$ shoots a beam of light parallel to the x -axis from a height of $y = d$. At $x = 3d$ is a spherical mirror whose focal point is located on the x -axis at $x = 4d$. At $x = 0$, there is a screen and filling the space between $x = 0$ and $x = d$ is a slab of glass ($n = 1.5$). At what height on the screen will the laser dot appear?



5. Student X is farsighted. The nearest point that X can focus on is 100 cm away from the eye. However, X can only comfortably hold a book (or, more realistically, a cell phone) so that the screen is 25 cm from the eye. Luckily, X has contact lenses and can read or text in comfort.

- a) What is the focal length of one of X's contact lenses? Is this contact lens a converging or a diverging lens?

Oh, no! Student X lost their contacts! However, Student Y claims that poking a small hole in a piece of paper and placing that hole next to the eye will make the blurry text 25 cm away a little sharper and easier to read. Student X is unconvinced.

- b) Using a ray diagram, draw a picture showing X why Y's idea may work. (Of course, we will show X this picture from a comfortable distance of at least 100 cm...)