Physics 8B, Section 2 (Speliotopoulos)
Second Midterm, Fall 2013
Berkeley, CA

Rules: *This midterm is closed book and closed notes. You are allowed two sides of one sheet of 8.5" x 11" paper on which you can write whatever notes you wish. You are* **not** *allowed to use calculators of any type, and any cellular phones must remain off and in your bags for the duration of the exam.* ***Any violation of these rules constitutes an act of academic dishonesty, and will be treated as such.***

Numerical calculations: *This exam consists of four problems, and each one is worth 25 points. All four problems require numerical answers. I have tried to choose the values in the problems so that the calculations will not be too onerous.* ***I have also included a math info sheet at the end of the exam to which you will want to refer.*** *However, if you find that in your calculation of these problems you end up with an expression which you cannot evaluate, simplify the expression as much as you can and leave it.*

We will give partial credit on this midterm*, so if you are not altogether sure how to do a problem, or if you do not have time to complete a problem, be sure to write down as much information as you can on the problem. This includes any or all of the following: Drawing a clear diagram of the problem, telling us how you would do the problem if you had the time, telling us why you believe (in terms of physics) the answer you got to a problem is incorrect, and telling us how you would mathematically solve an equation or set of equations once the physics is given and the equations have been derived. Don't get too bogged down in the mathematics; we are looking to see how much physics you know, not how well you can solve math problems.*

If at any point in the exam you have any problems, just raise your hand, and we will see if we are able to answer it.

Before the exam begins, fill in the following information:

Name: ________________________________ *Disc Sec Number:* ________________________

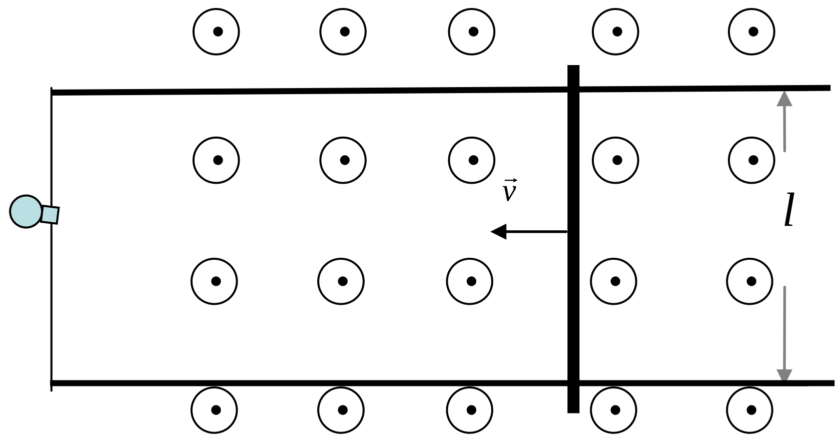
Signature: _____________________________ *Disc Sec GSI:* ____________________________

Student ID Number: ____________________ *Disc Sec Time:* ___________________________

You must show your student ID when you hand in your exam!

1	
2	
3	
4	
Total	

1. The A rod is resting on two rails inside a magnetic field with B = 2.0 T (see below). The two rails is connected to a 4.0W light bulb on the end in such a way that any induced current can cause the bulb to glow. The length, l, between the two rails is 25 cm.

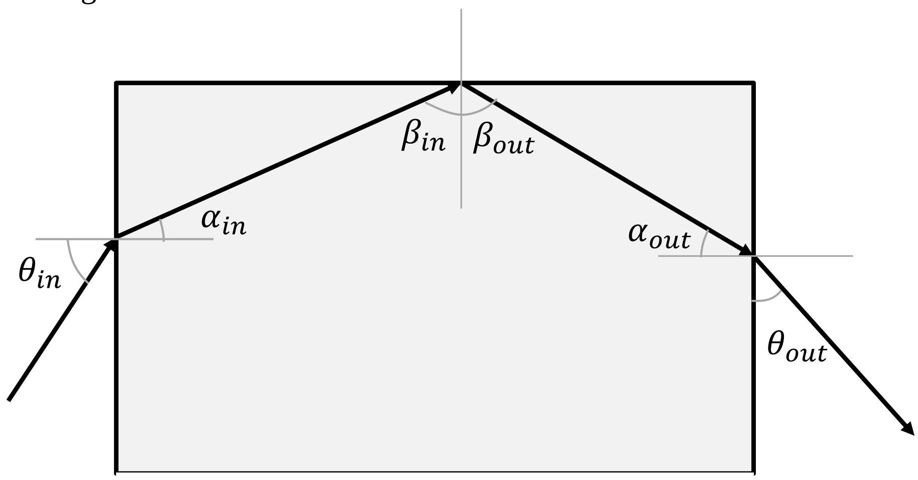


   a. The rod is pushed at a constant velocity, v, so that the light bulb glows at 4.0 W. What is this velocity? You can neglect the resistance of the rails, and the resistance of the light bulb is 4.0 Ω.

b. What is the force (direction and magnitude) that must be applied to the rod for it to maintain this velocity?

c. Suppose that you only push the rod fast enough so that 2.0 W is generated in the light bulb. By what multiplicative factor is this velocity smaller than when the bulb was putting out 4.0 W?

2. The figure to the below shows the end of a slab of glass with index of refraction, $n = \sqrt{3}$. A light beam incidents on the left side of the slab with an angle, $\theta_{in} = 60°$. Make sure that you give reasons for your answers to the questions below. The angles drawn in the figure need not be accurate.



a. What is α_{in}?

b. What is β_{in}?

c. What is β_{out}?

d. What is α_{out}?

\

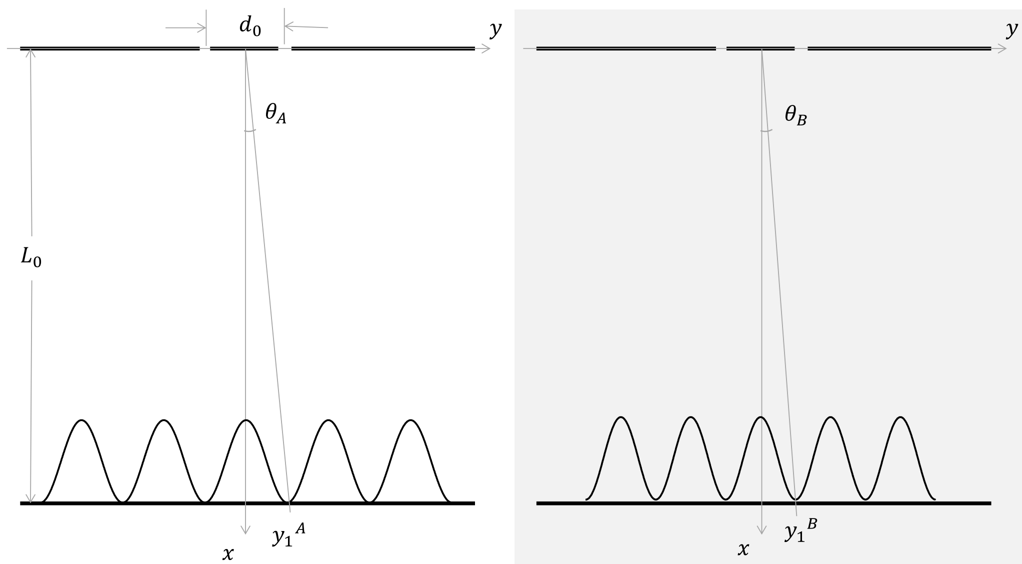
e. What is θ_{out}?

3. A candle is separated from a screen by a distance, $L_0 = 90\ cm$. A convex, reflective lens with focal length, $f = 20\ cm$, is placed between the candle and the screen. I strongly recommend drawing a picture.

   a. If the lens is placed so that a focused image is shown on the screen, where should it be placed? There are two possible positions. What are they? Give these positions as the distance, s, between the candle and the lens.

b. The screen is then slowly moved closer to the candle, so that the distance from the candle to the screen is now L. The lens is then moved so that once again we try to focus an image on the screen. If, however, $L < L_{min}$, no focused image of the candle can be formed on the screen. What is this minimum distance, L_{min}?

4. Experiment A in the figure below is a Young's double-slit experiment that is done in air. The separation between the two slits is d_0, and the distance between the slits and a screen is L_0. The intensity of the interference pattern form by the slits on the screen is sketched in. Experiment B shown in the figure uses the same double slits and the same distance between the slits and the screen. It is just done in a fluid with index of refraction, n. Visible light with wavelength, λ, in air is used in both experiments. The distance L_0 is large, and you can use small angle approximations.



Experiment A Experiment B

a. The location of the first minima in Experiment A is at $y_1^A = 4.0$ cm. The location of the first minima in Experiment B is at $y_1^B = 3.0$ cm. What is n?

b. If we want to make the interference pattern in Experiment B look like that of Experiment A, one way of doing so is to change the location of the screen in Experiment B so that the distance between the slits and the screen is now, L. The location of the first maxima in Experiment B is then changed to $y_1^B = y_1^A = 4.0$ cm. We keep the slit separation, d_0, the same in this approach and the wavelength of light does not change. What is the fractional change in screen distance

$$\frac{L - L_0}{L_0},$$

so that this happens?

c. A different way of making the interference pattern in Experiment B look like that of Experiment A is to change the distance between the slits to d so that once again $y_1^B = y_1^A = 4.0$ cm. In this approach, we keep the distance from the slits to the screen the same at L_0. The wavelength of light does not change. What is the fractional change in slit separation

$$\frac{d - d_0}{d_0},$$

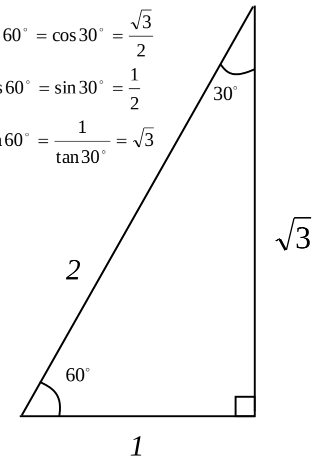
so that this happens?

Physics 8B Math Info Sheet

$\sin 60^\circ = \cos 30^\circ = \frac{\sqrt{3}}{2}$

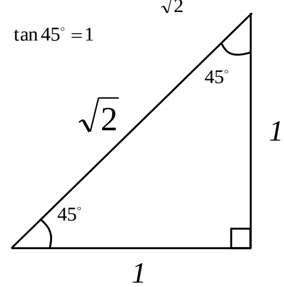
$\cos 60^\circ = \sin 30^\circ = \frac{1}{2}$

$\tan 60^\circ = \frac{1}{\tan 30^\circ} = \sqrt{3}$



$\sin 45^\circ = \cos 45^\circ = \frac{1}{\sqrt{2}}$

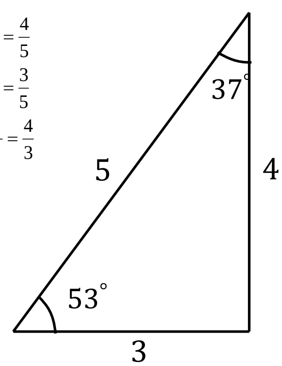
$\tan 45^\circ = 1$



$\sin 53^\circ = \cos 37^\circ = \frac{4}{5}$

$\cos 53^\circ = \sin 37^\circ = \frac{3}{5}$

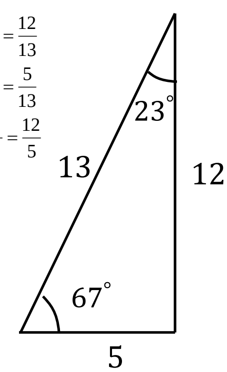
$\tan 53^\circ = \frac{1}{\tan 37^\circ} = \frac{4}{3}$



$\sin 67^\circ = \cos 23^\circ = \frac{12}{13}$

$\cos 67^\circ = \sin 23^\circ = \frac{5}{13}$

$\tan 67^\circ = \frac{1}{\tan 23^\circ} = \frac{12}{5}$



Small Angle Approximations:

$$\sin x \approx x, \qquad \tan x \approx x, \qquad \cos x \approx 1$$

for $x \ll 1$ rad.

Quadratic Equations:

The solution of the quadratic equation $ax^2 + bx + c = 0$ is

$$x = \frac{1}{2a}\left(-b \pm \sqrt{b^2 - 4ac}\right)$$