Physics 8B, Section 2 (Speliotopoulos)
Second Midterm, Spring 2014
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 five problems, and each one is worth 20 points. Two of the problems ask you to calculate numbers. I have chosen the parameters in these two problems so that the answers can be expressed in terms of rational numbers. 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:

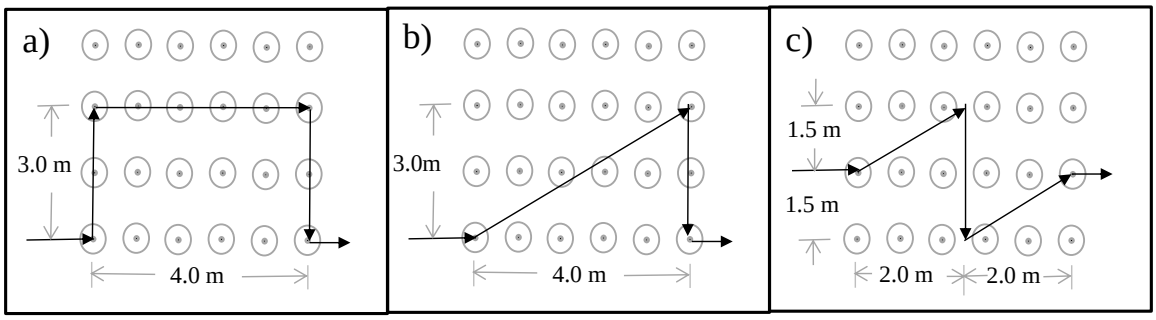
Name: _____ *Disc Sec Number:* _____

Signature: _____ *Disc Sec GSI:* _____

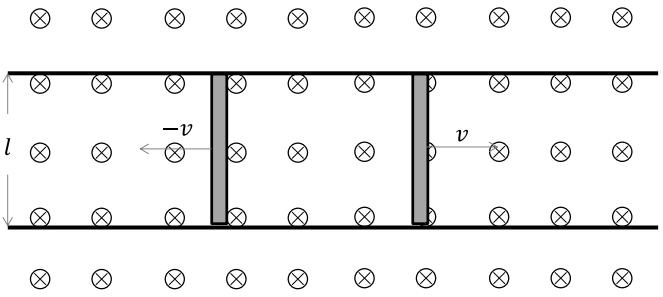
Student ID Number: _____ *Disc Sec Time:*_____

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

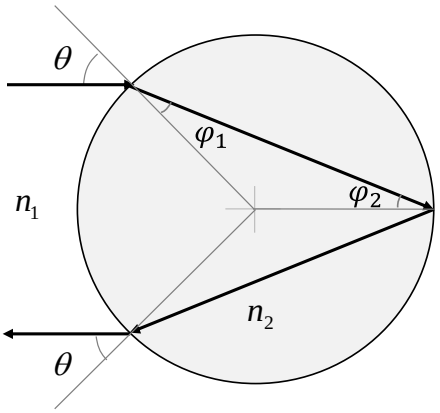
1. The figures below show wires with different shapes in a magnetic field, $B = 2.0$ T. The current through each is 2.5 A. Find the force on each wire.



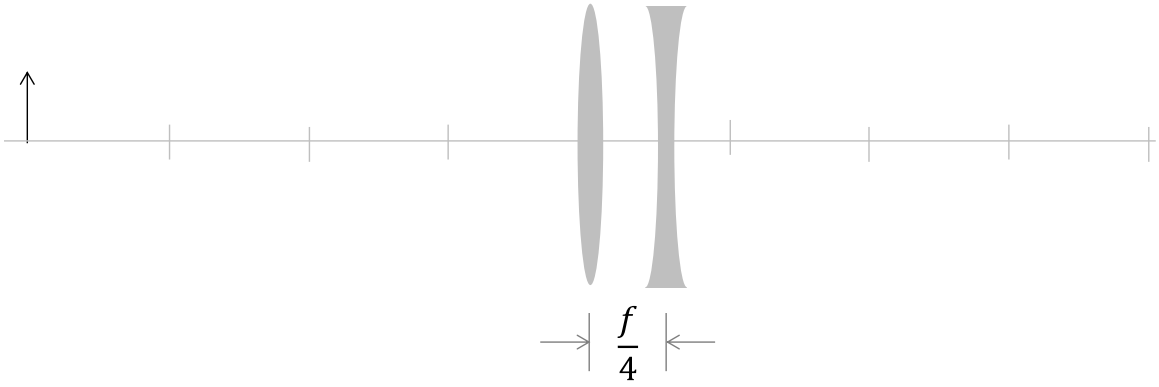
2. The figure below shows two rails with negligible resistance in a constant magnetic field, B, pointing into the page. The separation between the two rails is, l, and two rods, each with resistance, R, lies on top of the rails. They move away from each other with the same speed, v. Express your answers in terms of any of the variables given.
   a. What is the current, I, in the circuit? Does it flow clockwise, or counter-clockwise?
   b. What is the external force, $\vec{F}$, that must be applied to each rod (direction and magnitude)?
   c. What is the total power, P, that the external force must apply to the system?



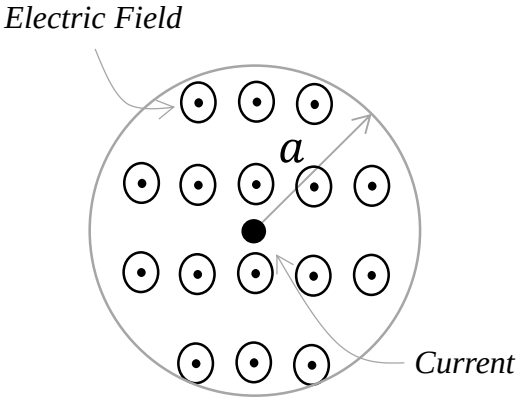
3. The figure to the right shows a sphere with index of refraction n_2 embedded in a medium with an index of refraction n_1. Incident on the sphere is a beam of light traveling horizontally which incidents the sphere with angle, θ, from the centerline of the sphere. This beam reflects off the back of the sphere, and leaves the sphere at the same angle, θ Take $\theta \ll 1$, and use small angle approximations (see math info sheet) throughout the problem.
   a. Using only geometry, determine the ratio φ_2/φ_1.
   b. Using only geometry again, find the ratio θ/φ_1.
   c. What, then, must n_2/n_1 be?



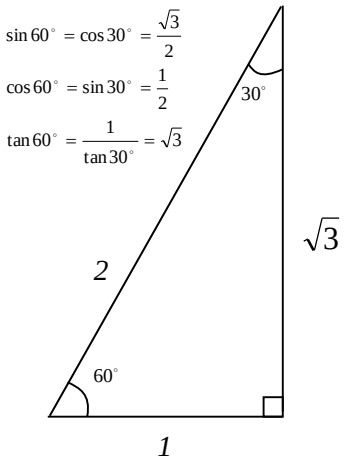
4. A converging, refractive lens with focal length, f, is placed to the left of a diverging, refractive lens with focal length, $-f/2$. The two lenses are separated by a distance, $f/4$. An object is placed at a distance of $2f$ to the left of the converging lens.
   a. Sketch the ray diagram for the lens.
   b. Find the final position of the image in terms of d, the distance between the image ***and the converging lens***. Express d in terms of f. Is the image to the right, or to the left of the converging lens?
   c. If the two lenses are replaced by a single lens placed at the converging lens, what must its focal length, f_C, be if the position of the object and the final image remains the same? Express it in terms of f.

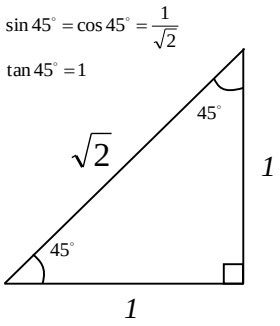


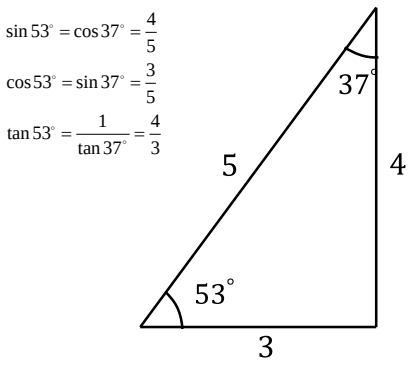
5. The figure below shows an ***electric field***, $E(t)$, coming out of the page, and restricted to be within a circle with radius, a. In the center of the circle is a wire that has a constant current, I, ***flowing out of the page***. The magnetic field, $B(r)$, is ***zero*** outside of the electric field (where $r > a$).
   a. What is the rate, $\frac{dE}{dt}$, the electric field is changing? Is it positive or negative? Express the rate in terms of $I,\ a,\ \epsilon_0$, and π.
   b. What is $B(r)$ for $r < a$? Express it in terms of $I,\ a,\ \mu_0,\ r$, and π.

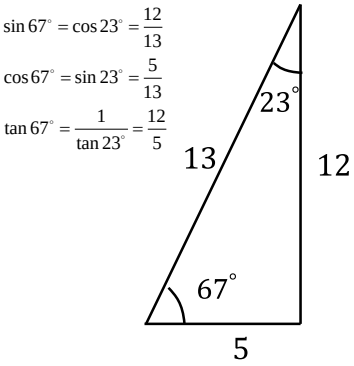


Physics 8B Math Info Sheet









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

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