Physics 8B, Lecture 1 (Speliotopoulos)
Second Midterm, Spring 2017
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. 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 and irrational numbers. If you find that in your calculation of these problems you end up with an expression which you cannot evaluate numerically—such as one containing an irrational number—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.

Name: _____ *Disc Sec Number:*_____

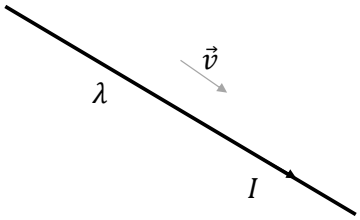
Signature: _____ *Disc Sec GSI:*_____

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

1	
2	
3	
4	
Total	

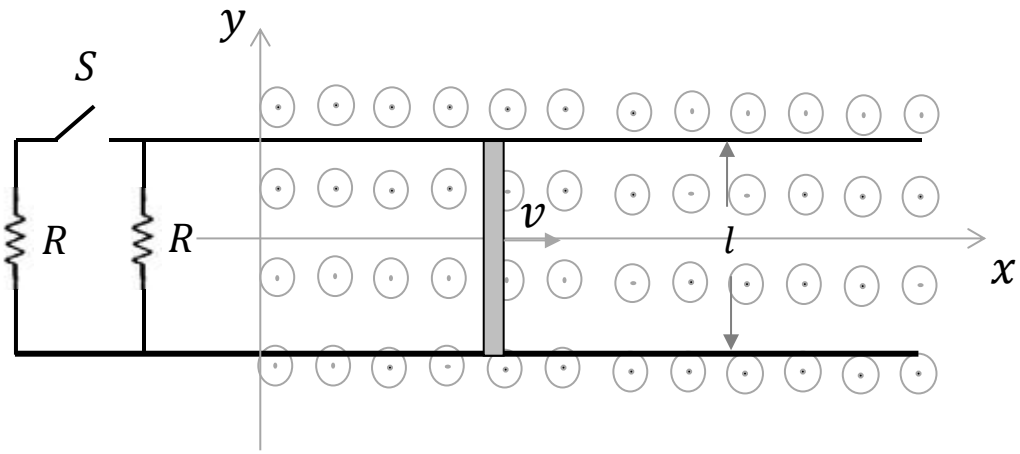
You must show your student ID when you hand in your exam!

1. The figure on the right shows an infinitely long wire with a plastic coating on top of it. A current I runs through the wire in the direction shown, and positive charges with a linear charge density λ have been deposited on the surface of the plastic coating. A charge q moves with a ***constant velocity*** v parallel to the wire. What is λ/I? (Yes, I know that I did not tell you how far above the wire the charge is.) If you know the electric field for an infinitely long line of charge, you can use it. If not, remember Gauss's Law,



$$\oint \vec{E} \cdot d\vec{A} = \frac{Q_{encl}}{\epsilon_0}.$$

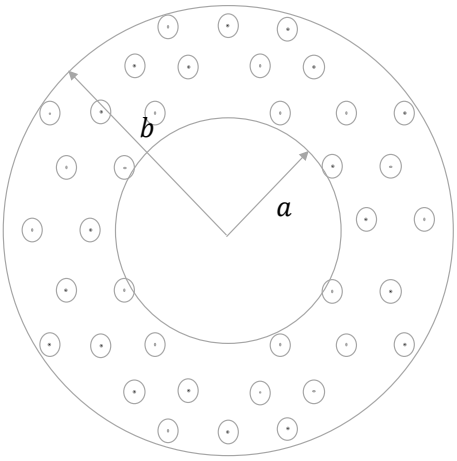
2. The figure below shows two resisters, both with resistance $R = 10\ \Omega$, connected to an open switch S, and two frictionless metal rails that are separated by a distance $l = 0.25$ m. The rails are in a region with constant magnetic field $B = 2.0$ T, and a rod is moving with a *constant* velocity $v = 10$ m/s to the right on the rails.



a. Since the velocity is constant, an external force F_H must act on the rod. Determine the magnitude and direction of this force.

b. The switch is now closed. What is this force F_H now?

3. In the figure on the right a spatially constant electric field E coming out of the page fills the region of space between a radius a and a radius b. The magnitude of the electric field decreases with time. Express your answers in terms of any of the following variables: a, b, dE/dt, ϵ_0, and μ_0.



   a. What is the magnetic field B (direction and magnitude) for $0 \leq r < a$?

   b. What is the magnetic field B (direction and magnitude) for $a < r < b$?

c. What is the magnetic field B (direction and magnitude) for $b < r$?

4. When an object is place at a distance $d = 1.0$ m in front of a refractive lens, the image is also at $s' = d$.
   a. Is the lens converging or diverging?

   b. What is the focal length f of the lens?

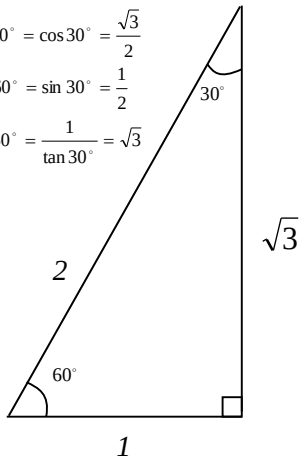
c. The object is now moved to a distance $d/4$ from the lens. Where is the image and what is its' lateral magnification? Is it a real or virtual image?

Physics 8B Math Info Sheet

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

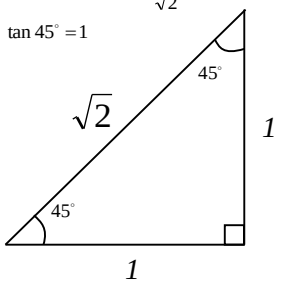
$\cos 60^\circ = \sin 30^\circ = \frac{1}{2}$

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



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

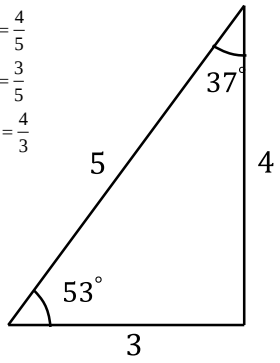
$\tan 45^\circ = 1$



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

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

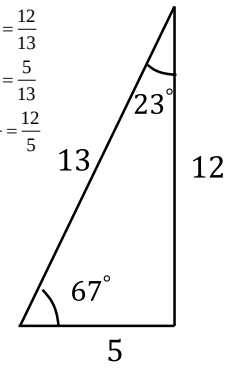
$\tan 53^\circ = \frac{1}{\tan 37^\circ} = \frac{4}{3}$



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

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

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



Quadratic Equations:

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

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

Derivatives:

$$\frac{d(x^n)}{dx} = nx^{n-1}$$

Integrals:

$$\int x^n \, dx = \frac{x^{n+1}}{n+1} + C, n \neq -1, \qquad \int \frac{dx}{x} = \ln x + C$$