

**Physics 7C, Speliotopoulos
Second Midterm, Spring 2012
Berkeley, CA**

Rules: *This midterm is closed book and closed notes. You are allowed two sides of one sheet of 8.5" x 11" of paper on which you may write whatever you wish. You are also allowed to use scientific calculators in general, but not ones which can communicate with other calculators through any means, nor ones that can do symbolic integration. **Anyone who does use a wireless-capable device will automatically receive a zero for this midterm.** Cell phones must be turned off during the exam, and placed in your backpacks. **In particular, cell-phone-based calculators cannot be used.***

Please make sure that you do the following during the midterm:

- Show all your work in your blue book

- Write your name, discussion number, ID number on all documents you hand in.
- Make sure that the grader knows what s/he should grade by circling your final answer.
- Cross out any parts of the your solutions that you do not want the grader to grade.

Each problem is worth 20 points. 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.

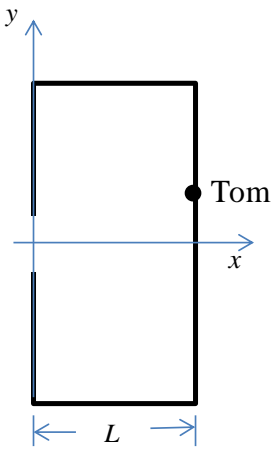
If at any point in the exam you have any questions, just raise your hand, and we will see if we are able to answer them.

Copy and fill in the following information on the front of your bluebook:

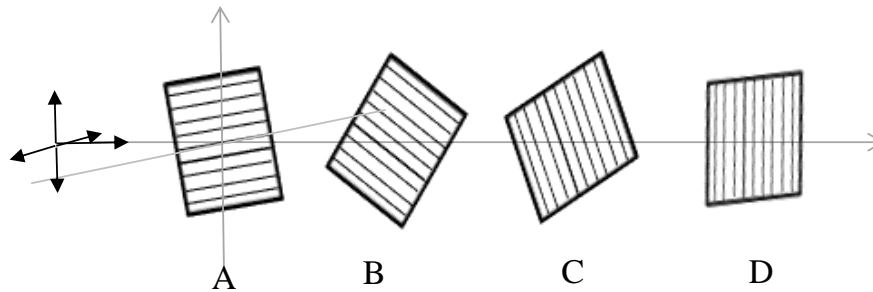
Name: _____ Disc Sec Number: _____

Signature: _____ Disc Sec GSI: _____

Student ID Number: _____



- Tom stands on the back wall of a room that is designed to prevent electromagnetic waves from entering through the walls. To make a phone call on his cell, Tom opens the door to the room, which is on the opposite wall from Tom (see figure). The initial door opening is D_0 , the back wall is a distance, L , from the wall, and his cell uses electromagnetic waves with frequency, f . Assume that the walls of the room absorbs electromagnetic waves. *Do not use small angle approximations when calculating positions.*
 - If Tom stands at positions, y_m , along the wall, he will not be able to receive any signals all. What are these y_m ?
 - Tom stands at the $m = 3$ diffraction minimum. He asks his friend to slide the door close a little. What is the approximate minimum amount, ΔD , that the door should be closed if Tom is now is able to receive the maximum possible signal?
- The figure below shows four polarizers with the first at $\theta_A = 0^\circ$, the second at $\theta_B = 30^\circ$, the third at $\theta_C = 60^\circ$, and the fourth at $\theta_D = 90^\circ$. Unpolarized light with intensity, I_0 , is incident on polarizer A from the left.



- What is the intensity of the light, I_4 , after it passes through all four polarizers?
 - One of the polarizers is removed. If the intensity of light through the remaining three is increased, which ones could have been removed? (There is more than one answer.)
- Atomic hydrogen is able to absorb and emit light with a wavelength, $\lambda = 656.3$ nm in the rest frame of the atom. The spectrum of this atom is not observed in its rest frame, however. In practice, they are observed for a gas of hydrogen atoms at a temperature, $T=35000$ K, and as such, they have a rms velocity of $v = \sqrt{\frac{3k_B T}{m}}$ with $k_B = 1.38 \times 10^{-23}$ J/K and $m = 1.66 \times 10^{-27}$. Because of this velocity, there is there is a corresponding range frequencies, $\Delta f = f - f_0$, that will be seen in the stationary frame. What is $|\Delta f|$? Here, f , is the frequency of light in the stationary frame, and f_0 is the frequency of the emitted light in the rest frame of the atom.
 - The pion (π) has a finite lifetime, and will decay into a muon (μ) and an anti neutrino ($\bar{\nu}_\mu$): $\pi \rightarrow \mu + \bar{\nu}_\mu$. Using the rest frame of the pion, determine the energy, E_ν , of the neutrino, and the momentum, p_μ , of the muon after the decay in terms of the masses, m_π and m_μ , of the pion and the muon, respectively. Make the approximation that the neutrino is massless: $m_\nu = 0$.
 - A spaceship is traveling towards Earth at $u_s = c/2$. When it is at a distance, L , from the Earth in the Earth's frame, it shoots a missile at the planet. The speed of the missile in the spaceship's frame is $u'_m = c/2$.
 - If $c\Delta T$ is the time difference between the missile reaching the Earth and the spaceship reaching Earth as measured in the Earth's frame, what is $c\Delta T/L$ assuming neither slows down?
 - What is, $c\Delta T'/L$, in the spaceship's frame?