

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

Rules: *This midterm is closed book and closed notes. You are allowed two sides of one-half 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 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: _____

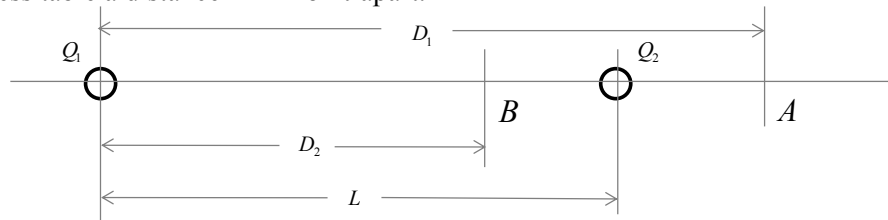
Signature: _____ Disc Sec GSI: _____

Student ID Number: _____ Disc Sec Time: _____

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

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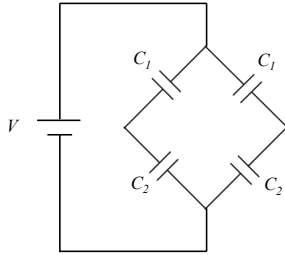
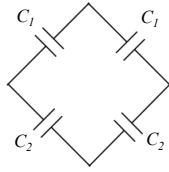
1. The figure below shows two charges, $Q_1 = 4.0 \mu\text{C}$ and $Q_2 = -1.0 \mu\text{C}$ anchored to a frictionless table a distance $L = 2.0 \text{ m}$ apart.



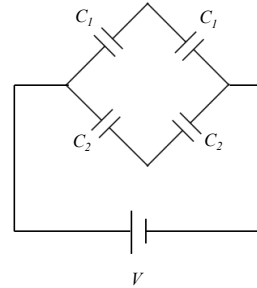
- a. When a third charge, $q < 0$, is placed on the table at point A , the charge does not move. What is D_1 ?

- b. When this charge is placed at point B, it is found that its potential energy is zero. What is D_2 ? Take the zero of potential for a point charge to be at infinity.

2. Four capacitors are arranged in the square shown below with $C_2 = 3 F$. It can be connected to a voltage supply, $V = 10 V$, in the two different ways shown in Configuration A and Configuration B, below.



Configuration A



Configuration B

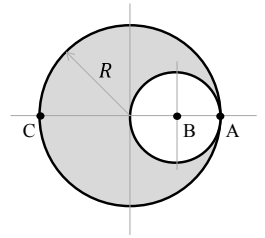
- a. You are told that $C_{EqA}C_{EqB} = 6 F^2$, where C_{EqA} is the equivalent capacitance of Configuration A, and C_{EqB} is the equivalent capacitance of Configuration B. What is C_1 ?

- b. Calculate the energy stored in Configuration A, U_A , and the energy stored in Configuration B, U_B . Which configuration stores more energy?

3. The figure to the right shows an insulating, infinitely long cylinder with a constant charge density, ρ , and radius, R . Inside the cylinder is a cylindrical pocket with no charge and a radius, $R/2$. What is the electric field at the points A, B and C shown?

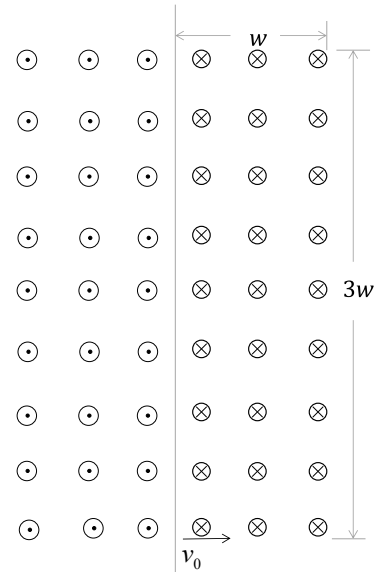


Side View



End View

4. The figure to the right shows two regions of space. The magnetic field in each region has the same *magnitude*, B , but points in opposite directions in each. Each region has width, w , and length, $3w$. A proton with charge, e , and mass, m , is shown moving with a horizontal velocity just inside the bottom of magnetic field. The proton eventually reaches the top edge of the two regions.



- a. If the proton is to stay within the regions while it moves upward, what is the smallest that w can be? Express it in terms of B , v_0 , m and e . (I strongly recommend that you sketch the path of the proton through the field.)
- b. Take w to be equal to the smallest w that you obtained in part a. How much time, T , does it take the proton to travel to the top edge of the regions? Express it in terms of B , m and e . (If you cannot get part a, you can express your answer in terms of w as well for partial credit.)
- c. What is the velocity (magnitude and direction) of the proton when it leaves the field?