Phys 251 Sample Test 1

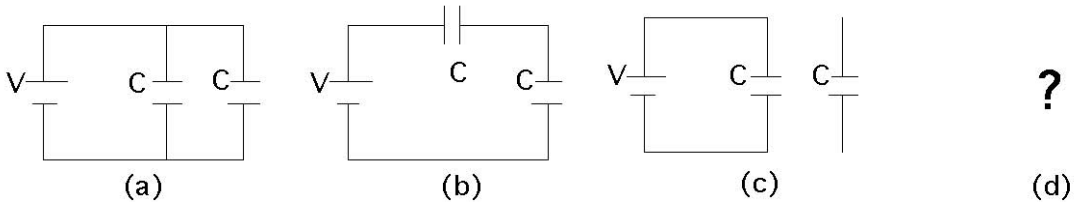
Please print your name_____

Questions (5 points each) Please blacken the letter of the best answer for each question.

Question 1: Positive charges of value Q = 1 nC are placed on the x-axis at the points (1,0,0) and (–1,0,0). Negative charges of value $-Q$ are placed on the y-axis at (0,–1,0) and (0,1,0). At which of the following points is the electric field strongest?

a) The origin (0,0,0)
b) On the z-axis at (0,0,1)
c) At the point (1,1,0)
d) The field is zero at all of those points
e) There is not enough information to tell

Question 2: Which of the following arrangements of a battery and two identical capacitors will have the **least** stored energy.



parallel | series | one capacitor not used | cannot be determined from the given information

This exam contains four problems. You may choose to solve any three. Please use the form below to indicate which three problems you would like us to grade.

Question 1	/5
Question 2	/5
Problem ___	/30
Problem ___	/30
Problem ___	/30
Total	/100

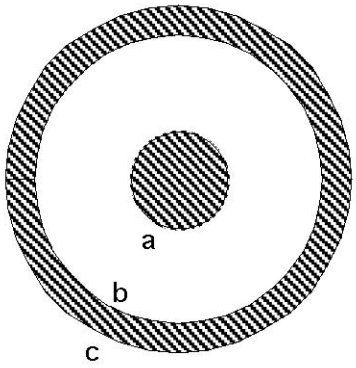
Problem 1: A coaxial cable is made of two infinitely long cylindrical conductors with radii *a, b, and c,* as shown. The inner conductor carries a linear charge density λ. The outer conductor carries a linear charge density –λ Please determine

a) The linear charge density on each surface of the outer conductor

b) The electric field in each of the regions:

$r < a$, $a < r < b$, $b < r < c$, $r > c$.

c) The potential difference between the cylinders

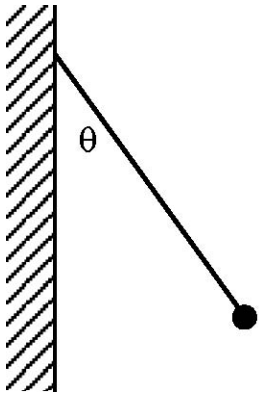


Problem 2: A parallel plate air capacitor is made by using two plates 0.18 m square spaced 0.58
cm apart. It is connected to a 50 V battery. Please answer each of the following questions.
a) What is the capacitance?
b) What is the charge on each plate?
c) What is the electric field between the plates?
d) If the region between the plates were filled with a dielectric material of constant $K = 2.5$ instead of air, what is the energy stored?

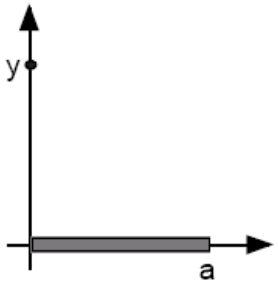
Problem 3: A small sphere of mass *m*, and charge +*q* is attached to a vertical wall by a massless string, as shown. An electric field $\vec{E} = E_o \hat{i}$ (perpendicular to the wall) holds the sphere away from the wall.
Please answer each of the following questions

a) Draw a free body diagram for the sphere

b) Determine the angle theta indicated in the diagram.



Problem 4: Charge Q is distributed uniformly over a thin rod of length L as shown. Please answer each of the following questions.



a) What is the charge per unit length?
b) What is the electric field at a point (0, y)?
c) What is the electric potential at point (0,y)?
(Assume the electric potential to be 0 at infinity)

Note: One of the following integrals may be useful.

$$\int \frac{dx}{\sqrt{x^2+y^2}} = \ln\left(x+\sqrt{x^2+y^2}\right) \qquad \int \frac{dx}{\left(x^2+y^2\right)^{3/2}} = \frac{1}{y^2}\frac{x}{\sqrt{x^2+y^2}}$$

$$\int \frac{dx}{x^2+y^2} = \frac{1}{y}\arctan\frac{x}{y} \qquad \int \frac{xdx}{\left(x^2+y^2\right)^{3/2}} = -\frac{1}{\sqrt{x^2+y^2}}$$