Physics 2212G/J — Test form **422** — Name ____________________

Fall 2016

Test 2 — Recitation Section (see back of test):__________

A

1) Print your name, test form number (above), and nine-digit student number in the section of the answer card labeled "STUDENT IDENTIFICATION".

2) Bubble your test form number (**ABOVE**) in columns 1-3, skip column 4, then bubble in your student number in columns 5-13.

3) For each free-response question, show all relevant work supporting your answer. **Clearly box or underline your final answer.** "Correct" answers which are not supported by adequate calculations and/or reasoning will be counted wrong.

4) For each multiple-choice question, select the answer most nearly correct, **circle this answer on your test**, and bubble it in on your answer card. **Show all relevant work on your quiz.**

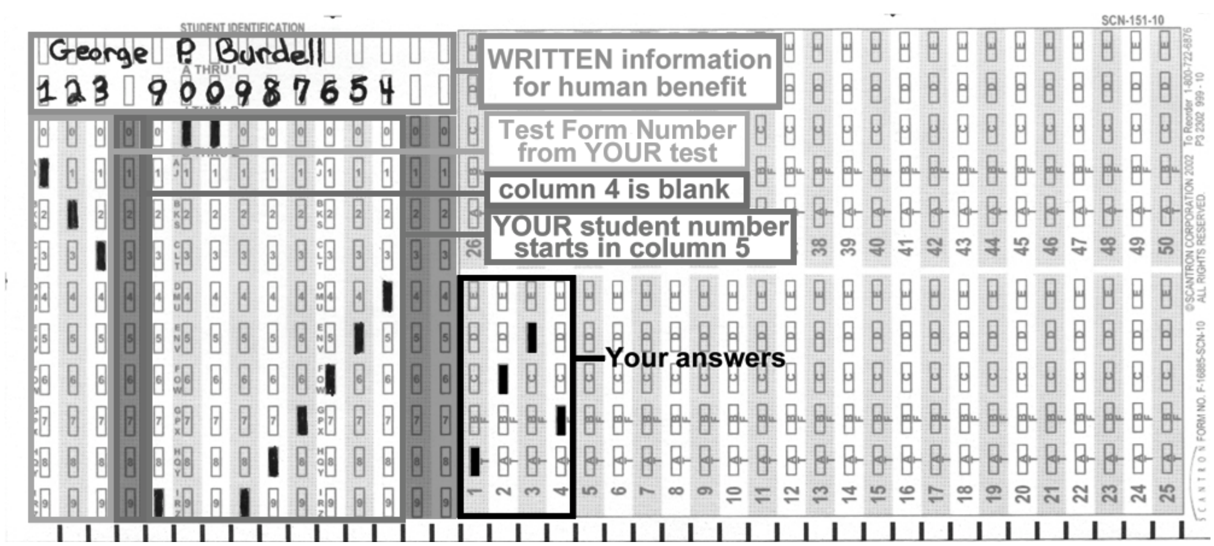
5) Be prepared to present your Buzzcard as you turn in your test. Scores will be posted to WebAssign after they have been been graded. **Quiz grades become final when the next quiz is given.**

6) You may use a simple scientific calculator capable of logarithms, exponentials, and trigonometric functions. **Programmable engineering calculators with text or graphical capabilities are not allowed. Wireless devices are prohibited.**

Numerical Constants:

$k = 8.99\times10^{9}\ \mathrm{N\cdot m^2/C^2}$	$e = 1.60\times10^{-19}\ \mathrm{C}$	$m_e = 9.11\times10^{-31}\ \mathrm{kg}$
$\varepsilon_0 = 8.85\times10^{-12}\ \mathrm{C^2/N\cdot m^2}$	$g = 9.81\ \mathrm{m/s^2}$	$m_p = 1.67\times10^{-27}\ \mathrm{kg}$

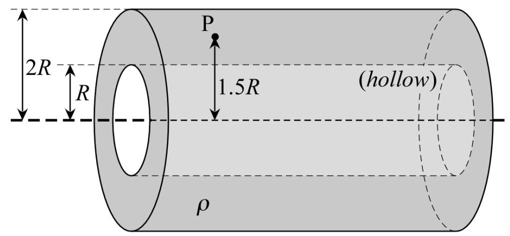
Your test form is: 422



Our next test will be on Tuesday, November 1

The following problem will be hand-graded. Show all your work for this problem. Make no marks and leave no space on your answer card for it.

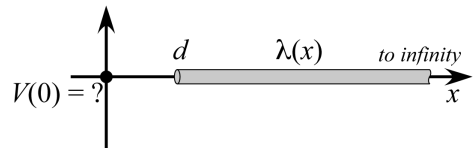
[I] *(20 points)* The figure at right shows a cutaway view of a finite sub-length of a very long cylindrical non-conducting pipe (inner radius R, outer radius $2R$) A uniform charge per unit volume ρ has been placed on the pipe.



Use Gauss' Law to calculate the magnitude of the electric field at the point P, which is a distance $1.5R$ from the central axis of the pipe. Be sure to specifiy the direction of the field.

The following problem will be hand-graded. Show all your work for this problem. Make no marks and leave no space on your answer card for it.

[II] *(20 points)* A *half-infinite* rod lies along the x-axis, extending from the finite position $x = +d$ to the infinite position $x = +\infty$. Charge is distributed non-uniformly along the rod, with a linear density given by the expression:



$$\lambda(x) = \frac{A}{x^2}$$

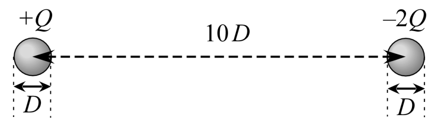
where A is a positive constant having units of [charge]×[length].

(i) Find an algebraic expression for the total charge Q on the rod. (Yes, Q is finite, despite the rod's infinite length!) Express your answer for Q in terms of A and d.

(ii) Find an algebraic expression for the electric potential V at the origin ($x = 0$), relative to the value $V = 0$ at infinity. Express your answer in terms of Q (that you just found), d, and the permittivity constant, ε_0.

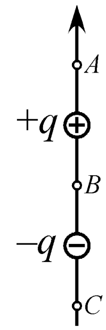
The following problem will be hand-graded. Show all your work for this problem. Make no marks and leave no space on your answer card for it.

[III] *(20 points)* A pair of identical small spheres having mass m and diameter D are given charges $+Q$ and $-2Q$, respectively. They are separated by a center-to-center separation distance $10D$, and released from rest. Determine the speeds of each of the two spheres when they impact one another. You may assume that the electric charge remains uniformly distributed on the spheres as they move.



Question value 8 points

(1) Two point charges having equal magnitudes but opposite signs are placed as shown at right. Compare the electric potentials at positions *A*, *B*, and *C*.



(a) $V_A = V_B = V_C$

(b) $V_C > V_B > V_A$

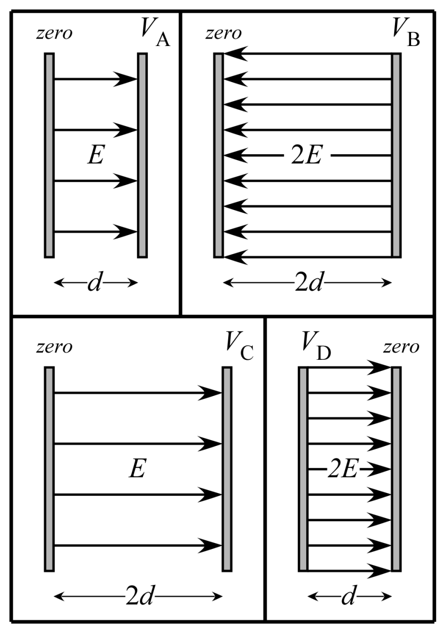
(c) $V_A > V_B > V_C$

(d) $V_A = V_C > V_B$

(e) $V_B > V_A = V_C$

Question value 8 points

(2) In the diagrams at right, four charged capacitors each have one plate specified as being at “zero volts”. The field strength and plate separation within each capacitor is indicated. Rank, from highest (most positive) to lowest (most negative), the potentials V_A through V_D at the second plate of each capacitor.



(a) $V_B = V_D > V_A = V_C$

(b) $V_B > V_D > V_A > V_C$

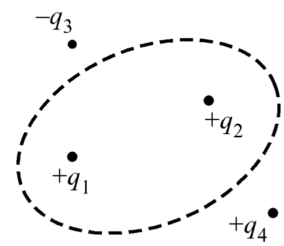
(c) $V_B > V_C = V_D > V_A$

(d) $V_C > V_A > V_D > V_B$

(e) $V_B > V_A > V_D = V_C$

Question value 8 points

(3) In the figure shown, the dashed line represents the cross-section of a three-dimentional Gaussian Surface. The four charges shown have magnitudes given by the symbols q_i, and signs as indicated explicitly in the figure. Thus, charge 3 is negative, while charges 1, 2, and 4 are positive. Let Φ_i represent the flux through the indicated Gaussian Surface due to charge "i" *only*. Which of the following flux comparisons is valid?



(a) $\Phi_4 > \Phi_3$

(b) $\Phi_1 + \Phi_2 > \Phi_3 + \Phi_4$

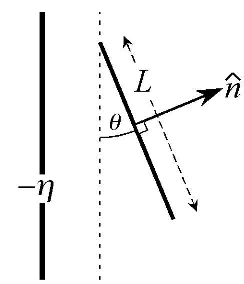
(c) $\Phi_1 + \Phi_2 + \Phi_4 = \Phi_3$

(d) $\Phi_4 > 0$

(e) $\Phi_1 + \Phi_2 = \Phi_4 - \Phi_3$

Question value 8 points

(4) A very large charged surface has a uniform area charge density $-\eta$. A small, square plastic sheet of length L on a side is held near the surface as shown at right. (In the figure, we send an *edge view* of the plastic sheet; it extends a distance L directly <u>into the page</u>.) The sheet is oriented with its surface tilted at angle θ away from being parallel with the larger surface. The normal direction for the plastic sheet is chosen to be "up and to the right", as indicated in the figure. What is the electric flux through the plastic sheet?



(a) $\Phi = 0$, because plastic is an insulating material.

(b) $\Phi = -\frac{\eta L^2}{2\varepsilon_0}\sin\theta$

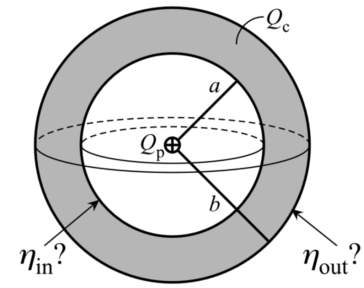
(c) $\Phi = +\frac{\eta L^2}{2\varepsilon_0}\sin\theta$

(d) $\Phi = -\frac{\eta L^2}{2\varepsilon_0}\cos\theta$

(e) $\Phi = +\frac{\eta L^2}{2\varepsilon_0}\cos\theta$

The next two questions both involve the following situation:

A point charge Q_p = +2.4 nC is placed at the center of a thick conducting shell with inner radius a = 12.0 cm and outer radius b = 18.0 cm. The conductor carries a net charge Q_c = +3.6 nC. What is the charge density on the outer surface of the conductor?



Question value 4 points

(5) What is the charge density on the inner surface of the conductor?

(a) $\eta_{in} = -13$ nC/m^2

(b) $\eta_{in} = +2.4$ nC/m^2

(c) $\eta_{in} = 0$

(d) $\eta_{in} = -19$ nC/m^2

(e) $\eta_{in} = +5.9$ nC/m^2

Question value 4 points

(6) What is the charge density on the outer surface of the conductor?

(a) $\eta_{out} = +5.9$ nC/m^2

(b) $\eta_{out} = +8.8$ nC/m^2

(c) $\eta_{out} = +2.9$ nC/m^2

(d) $\eta_{out} = +15$ nC/m^2

(e) $\eta_{out} = +11$ nC/m^2

PHYS 2212 G/J Recitation TA and Room Assignments

	Howey S-104	Howey S-106	Howey S-107
Wednesday			
1:05 pm		J01 Zhou, Boli	
2:05 pm		G01 Zhou, Boli	G02 Daum, Marcus
3:05 pm		G06 Zhou, Boli	J02/J05 Daum, Marcus
4:05 pm		G08 Kim, Sirwoo	
5:05 pm	J09 Daum, Marcus	G03/J06 Kim, Sirwoo	
Thursday			
12:05 pm			G04 Daum, Marcus
1:05 pm			J10 Daum, Marcus
2:05 pm		G09 Zhou, Boli	J03/J08 Daum, Marcus
3:05 pm		G10/J07 Zhou, Boli	
4:05 pm		J04 Thoreson, Megan	
5:05 pm		G05 Zhou, Boli	G07 Bernardes, Sarah

Tests will be returned in recitation, in the week *after* the test. In order to ensure that you receive your test back as soon as possible, please enter your recitation section from the table above (G01–G10) on the front of this test.