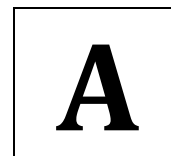


Test 2

Recitation Section (see back of test): _____

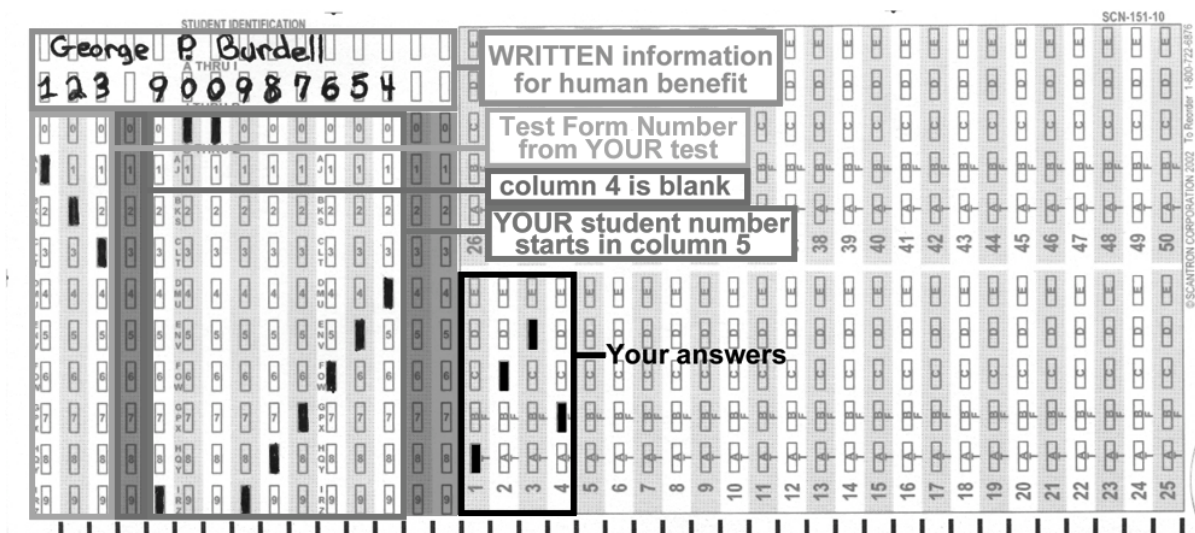
- 1) Print your name, test form number (above), and nine-digit student number in the section of the answer card labeled "STUDENT IDENTIFICATION".
- 2) Bubble your test form number (**ABOVE**) in columns 1-3, skip column 4, then bubble in your student number in columns 5-13.
- 3) For each free-response 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 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:

$k = 8.99 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2$	$e = 1.60 \times 10^{-19} \text{ C}$	$m_e = 9.11 \times 10^{-31} \text{ kg}$
$\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{N}\cdot\text{m}^2$	$g = 9.81 \text{ m/s}^2$	$m_p = 1.67 \times 10^{-27} \text{ kg}$

Your test form is: **726**

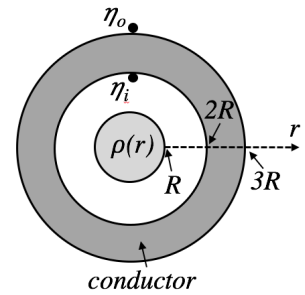


Our next test will be on Tuesday, March 14

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) An insulating sphere of radius R carries a non-uniform volume charge density $\rho(r) = C/r^2$, where C is a positively-valued constant. The sphere is placed in the exact center uncharged hollow conducting sphere of inner radius $2R$ and outer radius $3R$.

- (i) Calculate the surface charge density on the inner and outer walls of the hollow sphere.

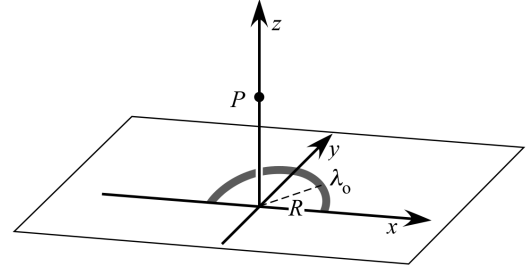


(4 points EXTRA CREDIT)

- (ii) Apply Gauss's Law to find an expression for the electric field *within* the insulating sphere, at a distance d from the center of the sphere (*i.e.*, for $d < R$). Express your answer symbolically in terms of ϵ_0 , C , d and/or R .

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 thin insulating rod is bent into a semicircle of radius R . It is placed in the xy -plane as shown at right, with its center of curvature at the origin. Positive charge is distributed uniformly along the rod, with a linear density $+\lambda_0$.



(i) Use integration methods (i.e. *not* a memorized formula) to derive an expression for the electric potential at point P on the z -axis, a distance $z = 2R$ from the origin. Express your answer in terms of λ_0 , R , and ϵ_0 .

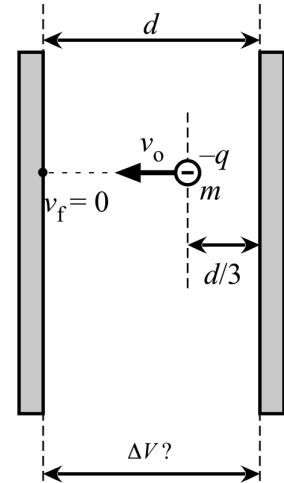
(ii) Suppose you tried to approximate the potential at $z = 2R$, by treating the entire rod as if it were a point particle (with the same total charge as the rod) located at the origin. What percent error would this approximation generate?

[Recall that %error = $100\% \times (\text{approx} - \text{exact}) / \text{exact}$]

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.

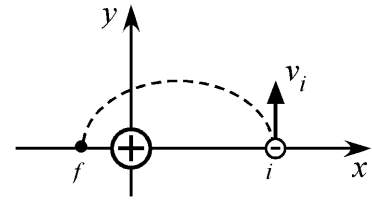
- [III] (20 points) In the figure at right, a charged capacitor has plates separated by a distance d . A particle of mass m and charge $-q$ is initially held at a distance $d/3$ from the right plate. (Note that the symbol “ q ” is inherently positive, so the particle itself has negative charge!) The particle is launched directly toward the *left* plate with an initial speed v_o . It is observed to slow down, stopping *just* as it reaches the left plate.

Determine the electric potential difference ΔV between the two capacitor plates. Express your answer symbolically in terms of the parameters given in this problem. **Also, be sure to indicate which of the plates is at high potential and which is at low potential!**



The next two questions both involve the following situation:

In the figure at right, a positive source charge is held fixed at the origin, and a negative test charge is initially at location i , moving vertically with speed v_i . The test charge follows the dotted trajectory, reaching position f —at which point it is moving vertically *downward*.



Question value 4 points

(1) What can you say about the energy changes of the test charge, as it moves from i to f ?

- (a) The charge has lost kinetic energy and lost potential energy.
- (b) The charge has gained kinetic energy and lost potential energy.
- (c) The kinetic and potential energies of the charge have remained unchanged.
- (d) The charge has gained kinetic energy and gained potential energy.
- (e) The charge has lost kinetic energy and gained potential energy.

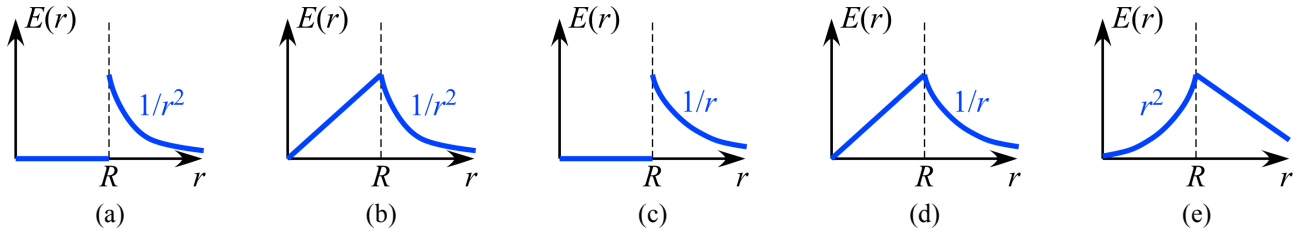
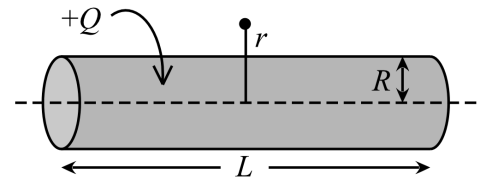
Question value 4 points

(2) What can you say about the work done by the electric field of the (positive) source charge, and the electric potential difference moved through by the (negative) test charge, as the test charge moves from i to f ?

- (a) The field has done positive work and the charge has moved to higher electric potential.
- (b) The field has done zero work and the charge has moved to lower electric potential.
- (c) The field has done negative work and the charge has moved to higher electric potential.
- (d) The field has done negative work and the charge has moved to lower electric potential.
- (e) The field has done positive work and the charge has moved to lower electric potential.

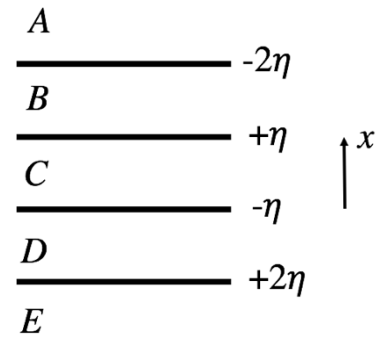
Question value 8 points

- (3) A cylindrical conductor of length L and radius R carries a total charge $+Q$. Which graph below best represents the magnitude of the electric field $E(r)$ as a function of the distance r from the cylinder's axis. *Hint:* You may assume that $L \gg r$, and that the conductor has been allowed to reach electrostatic equilibrium.



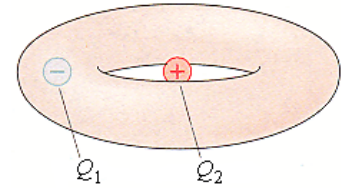
- (4) Question value 8 points
 Four very large, uniformly-charged sheets are arranged as shown at right. Rank the magnitude of the electric field in regions A to E, from the greatest to the least.

- (a) $E_C > E_D = E_B > E_A = E_E$
- (b) $E_B = E_D > E_C > E_A = E_E$
- (c) $E_A = E_E > E_D = E_B = E_C$
- (d) $E_C > E_A = E_E > E_B = E_D$
- (e) $E_B = E_D = E_C = E_A = E_E$



Question value 8 points

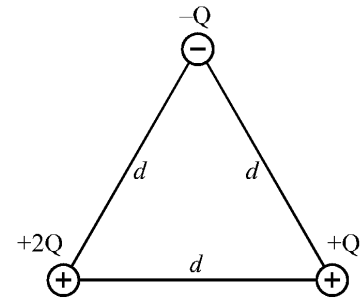
- (5) What is the net flux through the torus of the figure at right, if $Q_1 = -2.2 \text{ nC}$ and $Q_2 = +4.4 \text{ nC}$?



- (a) $+750 \text{ N}\cdot\text{m}^2/\text{C}$
 (b) $-250 \text{ N}\cdot\text{m}^2/\text{C}$
 (c) $+250 \text{ N}\cdot\text{m}^2/\text{C}$
 (d) $-750 \text{ N}\cdot\text{m}^2/\text{C}$
 (e) $+500 \text{ N}\cdot\text{m}^2/\text{C}$

Question value 8 points

- (6) Three charges are initially placed at the corners of an equilateral triangle having sides of length d , as shown at right. How much work must be done by an external agent in order to remove charge $-Q$ to a distant location? Assume all charges begin and end at rest.



- (a) $-\frac{2kQ^2}{d}$
 (b) $+\frac{kQ^2}{d}$
 (c) $+\frac{3kQ^2}{d}$
 (d) $+\frac{2kQ^2}{d}$
 (e) $-\frac{kQ^2}{d}$

PHYS 2212 G/J Recitation TA and Room Assignments

	Clough 127	Clough 131	Clough 323
WEDNESDAY			
1:05 pm		G01 Zhou, Boli	
2:05 pm	G06/H01 Zhou, Boli		
3:05 pm	G05/H05 Daum, Marcus		
4:05 pm	G02 Daum, Marcus	H02 Zhou, Boli	
5:05 pm	G09/H06/H09 Daum, Marcus		
THURSDAY			
12:05 pm			H07 Zhou, Boli
1:05 pm			
2:05 pm			
3:05 pm		G07/H03 Daum, Marcus	G03 Zhou, Boli
4:05 pm		G04 Daum, Marcus	
5:05 pm		G08/H04/H08 Daum, Marcus	

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.