Instructor(s): *F. Rojas*

PHYSICS DEPARTMENT

PHY 2049 Exam 1 June 13, 2012

Name (print): ______________________ Signature: ______________________

On my honor, I have neither given nor received unauthorized aid on this examination.

YOUR TEST NUMBER IS THE 5-DIGIT NUMBER AT THE TOP OF EACH PAGE.

DIRECTIONS

(1) <u>Code your test number</u> **on your answer sheet (use 76–80 for the 5-digit number)**. Code your name on your answer sheet. **Darken circles completely (errors can occur if too light)**. Code your student number on your answer sheet.
(2) Print your name on this sheet and sign it also.
(3) Do all scratch work anywhere <u>on this exam</u> that you like. At the end of the test, this exam printout is to be turned in. No credit will be given without both answer sheet and printout with scratch work.
(4) Work the questions in any order. Incorrect answers are not taken into account in any way; you may guess at answers you don't know.
(5) If you think that none of the answers is correct, please choose the answer given that is closest to your answer.
(6) **Blacken the circle of your intended answer completely, using a number 2 pencil**. Do not make any stray marks or the answer sheet may not read properly. Completely erase all incorrect answers, or take a new answer sheet.
(7) As an aid to the examiner (and yourself), in case of poorly marked answer sheets, please circle your selected answer on the examination sheet. Please remember, however, that in the case of a disagreement, the answers on the bubble sheet count, <u>NOT</u> what you circle here. Good luck!!!

>>>>>>>>**WHEN YOU FINISH** <<<<<<<<
Hand in the answer sheet separately.

Constants: $e = 1.6 \times 10^{-19}$ C $\quad m_p = 1.67 \times 10^{-27}$ kg $\quad m_e = 9.1 \times 10^{-31} kg \quad \epsilon_o = 8.85 \times 10^{-12} C^2/N \cdot m^2$

$k = 1/(4\pi\epsilon_o) = 9 \times 10^9\, N \cdot m^2/C^2 \quad$ nano $= 10^{-9} \quad$ micro $= 10^{-6} \quad$ pico $= 10^{-12} \quad \int \frac{z}{\sqrt{z^2+a^2}}\, dz = \sqrt{z^2+a^2}$

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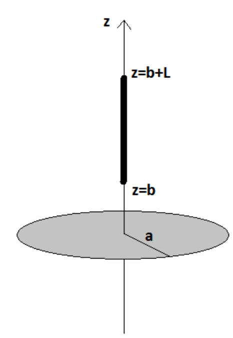
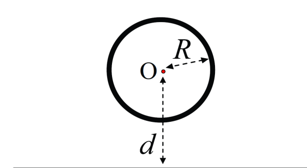
1. A uniformly charged (thin) non-conducting rod is located on the central axis a distance b from the center of an uniformly charged non-conducting disk. The length of the rod is L and has a linear charge density λ. The disk has radius a and a surface charge density σ. The total force among these two objects is



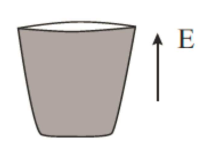
(1) $\vec{F} = \frac{\lambda\sigma}{2\epsilon_0}\left(L + \sqrt{a^2+b^2} - \sqrt{(b+L)^2+a^2}\right)\hat{k}$
(2) $\vec{F} = \frac{\lambda\sigma a^2 L}{4\epsilon_0 b^2}\hat{k}$
(3) $\vec{F} = \frac{\lambda\sigma a^2 L}{8\epsilon_0 b^2}\hat{k}$
(4) $\vec{F} = \frac{\sigma}{2\epsilon_0}\left(1 - \frac{L}{\sqrt{L^2+a^2}}\right)\hat{k}$
(5) $\vec{F} = \frac{\lambda\sigma L^2}{2\epsilon_0\sqrt{L^2+a^2}}\hat{k}$

2. A uniformly charged (thin) non-conducting shell (hollow sphere) of radius R with the total positive charge Q is placed at a distance d away from an infinite non-conducting sheet carrying a uniformly distributed positive charge with a density σ. The distance d is measured from shell's center (point O). What is the magnitude of the total electric field at the center of the shell?



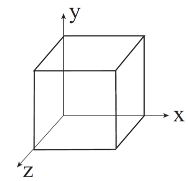
(1) $\frac{\sigma}{2\epsilon_0}$ (2) $\frac{Q}{4\pi\epsilon_0 R^2} + \frac{\sigma}{2\epsilon_0}$ (3) $\frac{Q}{4\pi\epsilon_0 R^2} + \frac{\sigma}{\epsilon_0}$ (4) $\frac{Q}{4\pi\epsilon_0 R^2}$ (5) $\frac{Q}{4\pi\epsilon_0 R} + \frac{\sigma}{\epsilon_0}$

3. A round wastepaper basket with a 0.15 m radius opening is in a uniform electric field of 300 N/C, perpendicular to the opening. The total flux through the sides and bottom, in $N \cdot m^2/C$, is:



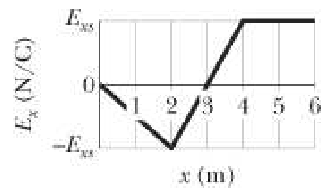
(1) −21 (2) 4.2 (3) 0 (4) 280 (5) can't tell without knowing the areas of the sides and bottom

4. An electric field given by $\vec{E} = 10\hat{\imath} - 5(y^2 + 5)\hat{\jmath}$ pierces the Gaussian cube of the figure, where the cube is 2 m on a side. (E is in newtons per coulomb and y is in meters.) What is the net electric flux through the entire cube?



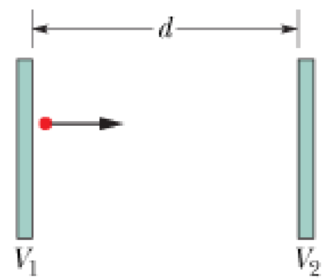
(1) -80 N/C m^2 (2) 80 N/C m^2 (3) 0 (4) 20 N/C m^2 (5) -20 N/c m^2

5. A graph of the x component of the electric field as a function of x in a region of space is shown in the figure. The scale of the vertical axis is set by $E_{xs} = 16.0$ N/C. The y and z components of the electric field are zero in this region. If the electric potential at the origin is 10 V, what is the electric potential (in V) at $x = 4.0$ m?



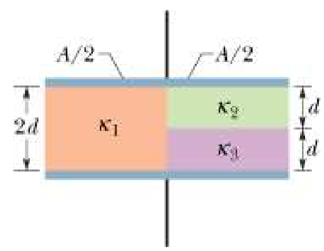
(1) 26 (2) -6 (3) 36 (4) 0 (5) 42

6. In the figure, a charged particle (either an electron or a proton; you need to find out which it is) is moving rightward between two parallel charged plates. The plate potentials are $V_1 = -25$V and $V_2 = -35$V. The particle is slowing down from an initial speed of 3×10^6 m/s at the left plate. What is its speed, in m/s, just as it reaches plate 2?



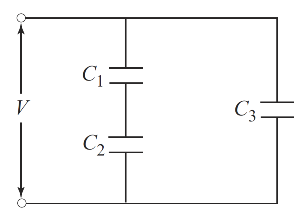
(1) 2.4×10^6
(2) 1.6×10^6
(3) not possible to know without knowing the plates separation
(4) 2.4×10^{12}
(5) 3.5×10^{12}

7. The figure shows a parallel-plate capacitor of plate area A and plate separation $2d$. The left half of the gap is filled with material of dielectric constant $\kappa_1 = 12$; the top of the right half is filled with material of dielectric constant $\kappa_2 = 20$; the bottom of the right half is filled with material of dielectric constant $\kappa_3 = 30$. What is the capacitance in terms of ϵ_0, A, and d?



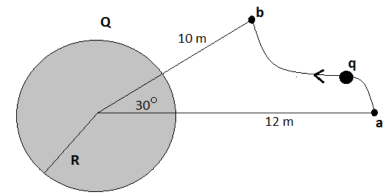
(1) $9\frac{\epsilon_0 A}{d}$ (2) $62\frac{\epsilon_0 A}{d}$ (3) $18\frac{\epsilon_0 A}{d}$ (4) $31\frac{\epsilon_0 A}{d}$ (5) none of these

8. In the figure shown, a potential diference of $V = 10$ V is applied across the arrangement of capacitors with capacitances of $C_1 = C_2 = 4\mu$F, and $C_3 = 6\mu$F. What is the charge q_2 on capacitor C_2?



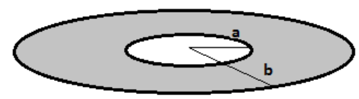
(1) $20\mu C$ (2) $40\mu C$ (3) $60\mu C$ (4) $80\mu C$ (5) $10\mu C$

9. What is the minimum mechanical work that has to be done on the charge $q = 1\mu C$ in order to bring it from point a to point b? In figure, the solid sphere of charge $Q = 2\mu C$ with a radius $R = 2$m is held fixed in space. Point a is located at 12m from the center of the sphere and point b at 10m as shown.



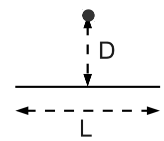
(1) 3×10^{-4} J (2) 1.5×10^{-4} J (3) -3×10^{-4} J (4) -1.5×10^{-4} J (5) 5.51×10^{-5} J

10. The figure shows a non-conducting (thin) disk with a hole. The radius of the disk is b and the radius of the hole is a. A total charge Q is uniformly distributed on its surface. Assuming that the electric potential at infinity is zero, what is the electric potential at the center of the disk?



(1) $\dfrac{2kQ}{b+a}$ (2) $\dfrac{2kQ}{b-a}$ (3) $\dfrac{2kQ}{b^2-a^2}$ (4) 0 (5) $\dfrac{kQ}{b^2}$

11. A wire segment of length L has constant linear charge density $\lambda > 0$. Which of the following expressions gives the magnitude of the electric field a distance D from the center of the wire (see figure)?

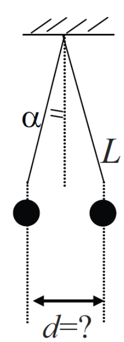


(1) $k\lambda D \int_{-L/2}^{L/2} \frac{dx}{(D^2+x^2)^{3/2}}$ (2) $k\lambda D \int_0^L \frac{dx}{\sqrt{D^2+x^2}}$ (3) $k\lambda D \int_0^L \frac{dx}{D^2+x^2}$ (4) 0 (5) $k\lambda D \int_{-L/2}^{L/2} \frac{dx}{D+x}$

12. A charge Q is placed in the center of a shell of radius R. The flux of electric field through the shell surface is Φ_0. What is the new flux through the shell surface, if its radius is doubled?

(1) Φ_0 (2) $2\Phi_0$ (3) $4\Phi_0$ (4) $\Phi_0/2$ (5) $\Phi_0/4$

13. Two very small spheres have equal masses m, carry charges of the same sign and value q, and hang on strings of length L as shown in figure. Due to the repulsive force, the spheres are separated by some distance d. Find this distance. Assume that $d \ll L$ so that you can use the approximation $\tan\alpha \approx \sin\alpha \approx \alpha$



(1) $\sqrt[3]{2L\frac{q^2k}{mg}}$

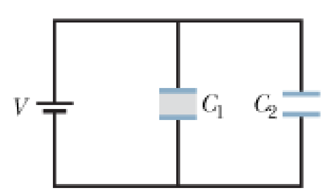
(2) $\sqrt[3]{L\frac{q^2k}{mg}}$

(3) $\sqrt{2L\frac{q^2k}{mg}}$

(4) $\sqrt{L\frac{q^2k}{mg}}$

(5) $\sqrt{\frac{Lq^2k}{2mg}}$

14. In figure, how much charge is stored on the parallel-plate capacitors by the 10 V battery? One is filled with air, and the other is filled with a dielectric for which $\kappa = 2.0$; both capacitors have a plate area of $2.00 \times 10^{-3}\, m^2$ and a plate separation of 1.00 mm.



(1) 0.53 nC (2) 0.35 nC (3) 1.06 nC (4) 0.53 μC (5) 0.35 μC

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