PHYSICS 211
Quiz I
TIME: 60 minutes

November 18, 2012

DO NOT OPEN THIS EXAM BEFORE YOU ARE TOLD TO BEGIN

NAME_____

ID Number _____

Useful information
$\varepsilon_0=8.85\text{x}10^{-12}\ C^2/N.m^2$.
$\mu_0=4\pi\ \text{x}\ 10^{-7}$ Tm/A.
$q = 1.6 \times 10^{-19}$ C
$m_e= 9.1\text{x}10^{-31}$ kg. $m_p= 1.67\times10^{-27}$ kg.
$k_e=8.9875\text{x}10^9\ Nm^2/C^2$

Grading

A	
B	
TOTAL	

Score:_____

☐ Check if solution is continued on the back.

Part A: Multiple choice questions (12)

1. (3) If a = 3.0 mm, b = 4.0 mm, Q_1 = 60 nC, Q_2 = –80 nC, and q = 36 nC in the figure, what is the magnitude of the total electric force on q?

a. 5.0 N
b. 4.4 N
c. 3.8 N
d. 5.7 N
e. 0.60 N

2. (3) Charge Q is distributed uniformly along a semicircle of radius a. Which formula below gives the correct magnitude of the electric field at the center of the circle?

a. $E = \frac{1}{4\pi\varepsilon_0}\frac{Q}{\pi a}$.
b. $E = \frac{1}{4\pi\varepsilon_0}\frac{Q}{\pi a^2}$.
c. $E = \frac{1}{4\pi\varepsilon_0}\frac{2Q}{\pi a}$.
d. $E = \frac{1}{4\pi\varepsilon_0}\frac{2Q}{\pi a^2}$.
e. $E = \frac{1}{4\pi\varepsilon_0}\frac{2Q}{a^2}$.

3. (5) Which one of the following cannot be a statement of Gauss's Law for some physical situation?

a. $4\pi r^2 \varepsilon_0 E = Q$.
b. $2\pi r L \varepsilon_0 E = Q$.
c. $\varepsilon_0 \oint \mathbf{E}\cdot d\mathbf{A} = \int \rho\, dV$.
d. $\varepsilon_0 \oint \mathbf{E}\cdot d\mathbf{A} = \rho$.
e. $2\varepsilon_0 EA = \int \sigma\, dA$.

4. (3) A hemispherical surface (half of a spherical surface) of radius R is located in a uniform electric field of magnitude E that is parallel to the axis of the hemisphere. What is the magnitude of the electric flux through the hemisphere surface?

a. $\pi R^2 E$
b. $4\pi R^2 E/3$
c. $2\pi R^2 E/3$
d. $\pi R^2 E/2$
e. $\pi R^2 E/3$

Score:_____

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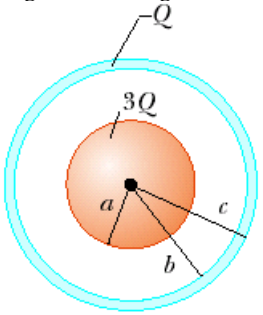
Part B: Problems (88)

2. (44%) Gauss's law

A solid **insulating** sphere of radius a carries a net positive charge $+3Q$, uniformly distributed throughout its volume. Concentric with this sphere, is a **conducting** spherical shell with inner radius b and outer radius c, and having a net charge $-Q$, as shown in the figure below.



(a) (10) Show (in details) that the electric field in the region $r < a$ is $E=3k_eQr/a^3$

(b) (7) Find the electric field in the region $b > r > a$.

(c) (5) Find the electric field in the region $c > r > b$.

Score:_____

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(d) (6) Determine the charge on the inner surface of the conducting shell (at $r=b$).

(e) (6) Find the electric field at $r > c$.

(f) (5) Make a plot of the magnitude of the electric field versus r.

(g) (5) What is the flux across a cube concentric to the two spheres with side $l>2c$?

Score:_____

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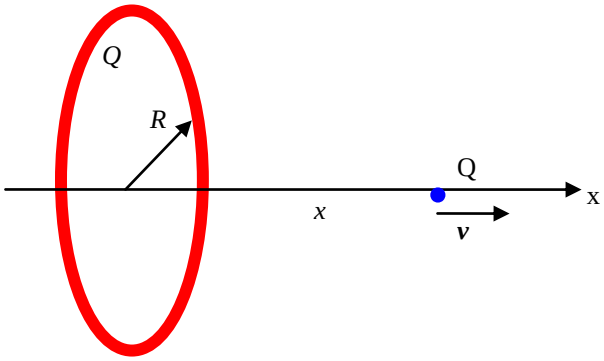
3.(24%) The **x**-axis is the symmetry axis of a stationary uniformly charged ring of radius R and charge Q. A point charge Q of mass M is initially at rest at the center of the ring. When it is displaced slightly, the point charge accelerates from the center along the x axis to infinity.



(a) (8) Show that the electric potential at a point on the axis of the ring at a position x from the center is given by $V=k_eQ/(x^2+R^2)^{1/2}$.

(b) (4) Find the potential energy at the particle at the initial and final positions.

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(c) (7)Show that the ultimate speed of the point charge is $v = \left(\frac{2k_e Q^2}{MR} \right)^{1/2}$

(d) (5) Determine the three components of the electric field at distance *x* from the ring center.

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1. (20%) In 1911 Rutherford, Geiger and Marsden conducted an experiment in which they had an alpha particle, having charge +2e and mass 6.64×10^{-27} kg hits a gold sheet (+79e).

a) (7) An electric field E = 1 V/m is applied on the alpha particle. How long must E be applied so that, starting from rest, the alpha particle reaches a velocity of v=10^7 m/s.

b) **(7)** Determine the analytical expression of the minimum distance the alpha particle can get to the gold.

c) **(6)** Use the numerical values in order compare d it to the radius of an atom which is about 10^{-9} m. What is d?

Score:_____

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SCRATCH PAPER

Nothing on this page will be graded

Score:_____

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