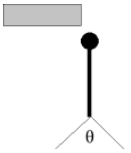
AP Physics C Name: _____

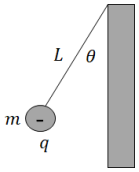
Unit 1 Test: Electrostatics

Directions: You must show all steps required to arrive at the correct answer for the problem below, including any diagrams.

1. A rubber rod is rubbed with a conducting cloth, giving it a net charge. It is brought to a charged electroscope. The leaves of the electroscope make an angle of θ with each other as shown. The rod is brought into contact with the electroscope, and the leaves of the electroscope get further apart as a result such that they know make an angle of 2θ with each other. What was the initial charge (if any) of the electroscope? Justify your answer.



2. As is tradition, a charged object with mass $m = .02\ kg$ and charge $q = -6\ \mu C$ is attached to a string of length $L = 2\ cm$. The other end of the string is fixed to a wall, $\theta = 20°$. The wall causes a constant, uniform electric field. Determine the magnitude AND direction of the electric field of the wall.



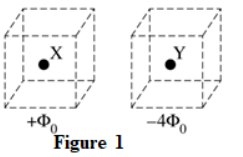


Figure 1

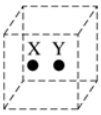
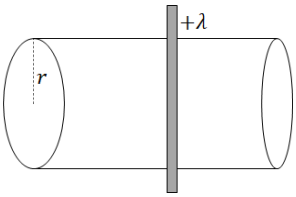


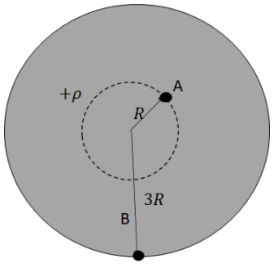
Figure 2

3.Figure 1 above shows two charged spherical conductors, X and Y, which are equal in size. When each conductor is isolated and surrounded by a closed cubical surface, the total electric flux through the surfaces is $+\Phi_0$ for conductor X and $-4\Phi_0$ for conductor Y. Conductor Y is brought into contact with conductor X and then separated, as shown in Figure 2. If the separation is small so that both conductors are inside the same closed cubical surface, as shown above, what is the total electric flux through the surface? Justify your answer.

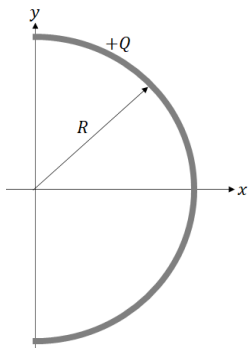
4. A line of charge of linear charge density $\lambda = 0.5\ \mu C/m$ runs through lateral surface of a sphere of cylinder $R = 1\ mm$ as shown (perpendicular to the axis of the cylinder). Calculate the electric flux through the cylinder.



5. A non-conducting sphere has uniform charge density. Point A is a distance of R from the center of the sphere and point B is 3R from the center of the sphere. Determine the value of the ratio of the electric field at A to the electric field at B, E_A/E_B.



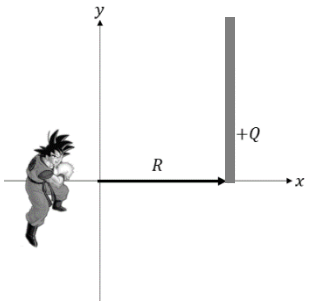
6. A conducting semicircle of charge has total charge of +Q and radius R and is distributed in the 1st and 4th quadrants on the Cartesian plane as shown on the right.



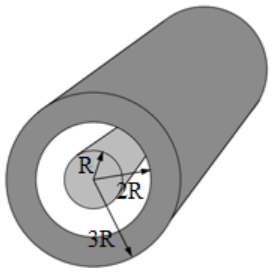
a) Using integral Calculus, derive an expression for the electric field at the origin. Show your work.

b) A positive charge is place at the origin and released from rest. Qualitatively plot the acceleration and velocity of the charge as a function of time. Take right as the positive direction.

c) KAMEHAMEHA! Goku bends the arc into a straight bar. It has the same total length and charge as part a), is placed with one end on the x-axis, a distance of R from the origin. The bar is placed parallel to the y-axis. Write a differential equation that could be used to find x-component of the electric field at the origin due to the bar. Ensure to include bounds in the integral and put the function to be integrated in simplest form.



7. A solid non-conducting cylinder has a volume density of $+\rho$ and radius R as shown. It is surrounded by a conducting shell of inner radius 2R and outer radius 3R. The cylinder and conducting shell each have a length of L, where L >>> R.



a) Using Gauss's Law determine an expression for the electric field as a function of distance from the center of the cylinders, E(r), in each of the following regions. For each region, draw and identify the Gaussian surface you are using.

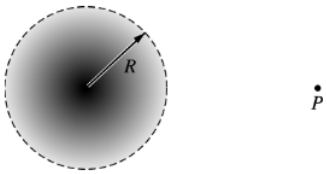
i. r < R
ii. R < r < 2R
iii. 2R < R < 3R

b) At any point outside of the conducting shell, it is observed that the magnitude of the electric field is zero.

i. Determine the charge density on the inner surface of the conducting shell. Justify your answer.
ii. Determine the charge on the outer charge of the conducting shell.

c) Graph the electric field as a function of distance from the center of cylinder. Label any relative maxima.

8. A sphere charge of radius R=0.2 m total radius has a charge density that varies with distance to the center of the sphere given by:



$\rho(r) = 0.4r$ for $\leq R$

a) Determine the electric field as a function of r within the cloud.

b) Determine the electric field at point P, which is 0.6 m from the center of the cloud.

c) Graph the electric field as a function of distance from the center of the cloud from r =0 to point P. Label any relative maxima.