Electromagnetism & Light **Name** :_____

Exam #1: Electrostatics & Waves

1: Consider a column of charge of infinite height with uniform density $\rho = 3.0\ \frac{nC}{m^3}$ and radius $R = 2.0$ cm.

a. Determine the electric field $E(r)$ as a function of distance, r, from the central axis of the column of charge.

Include $E(r)$ outside the column, $r > R$ and inside the column, $r < R$. Graph the function $E(r)$.

b. Explain why an electron released from the edge of the column of charge would undergo harmonic oscillation.

Determine the period of the oscillation.

c. Determine the work required to move an electron from the central axis to the outer edge of the column at $r = 2.0$ cm.

2: A capacitor consists of two parallel conducting plates. One plate is held at 0.0 V while the other is held at 5.0 V. The plates are separated by a distance of 50cm. Consider the plates to have infinite area for the following analysis.

a. Determine the electric field between the plates.

b. Determine the charge per unit area, σ on each of the plates assuming they are equal in magnitude but of opposite charge.

c. If a proton where released from rest half way between the two plates determine the electrostatic force on it and it's acceleration.

d. Which plate would the proton eventually crash into and what would be it's velocity at the instant of striking the plate.

3: Consider a static charge distribution consisting of 8 C at a position $(1, 1)$ and 16 C at a position $(-2, -2)$.

Units of position are in meters.

a. Draw the charge distribution and electric field lines representing the electric field in space.

b. Determine the potential energy of the configuration. Explain the meaning of the sign of the potential energy in your answer.

c. Calculate the electric field along the x-axis as a function of x, $\vec{E}(x, y = 0)$.

d. Calculate the electric potential along the x-axis as a function of x, $V(x, y = 0)$.

4: Consider a 2.00 meter long string with a mass of 50.0 grams. It is held taught at both ends and tuned to a fundamental frequency of 500 Hertz. It is plucked to vibrate with an amplitude of 1 millimeter.

a. Determine the tension in the string.

b. Determine the speed of the wave propagating through the string.

c. Determine the power of the oscillation in the string.

d. Determine a mathematical function $f(x,t)$ which describes the string's oscillation.