PRE-AP REVIEW ASSIGNMENT #13

Name:____________________________

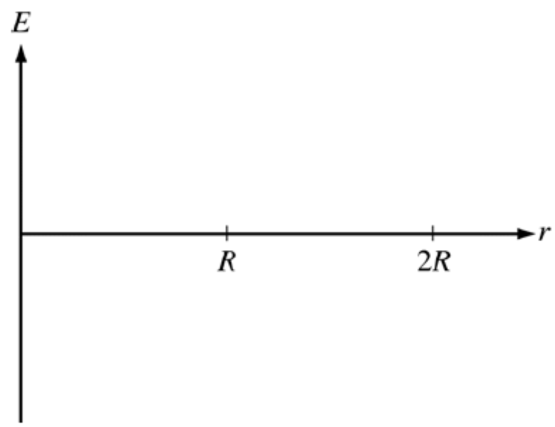
E&M 1.

A very long, solid, nonconducting cylinder of radius R has a positive charge of uniform volume density ρ. A section of the cylinder far from its ends is shown in the diagram above. Let r represent the radial distance from the axis of the cylinder. Express all answers in terms of r, R, ρ, and fundamental constants, as appropriate.

(a) Using Gauss's law, derive an expression for the magnitude of the electric field at a radius $r < R$. Draw an appropriate Gaussian surface on the diagram.

(b) Using Gauss's law, derive an expression for the magnitude of the electric field at a radius $r > R$.

(c) On the axes below, sketch the graph of electric field E as a function of radial distance r for $r = 0$ to $r = 2R$. Explicitly label any intercepts, asymptotes, maxima, or minima with numerical values or algebraic expressions, as appropriate.

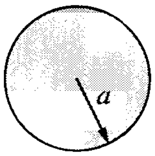


(d)

i. Derive an expression for the magnitude of the potential difference between $r = 0$ and $r = R$.

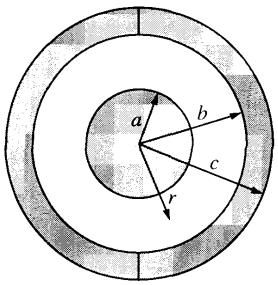
ii. Is the potential higher at $r = 0$ or $r = R$?

____ $r = 0$ ____ $r = R$



An isolated conducting sphere of radius a = 0.20 m is at a potential of -2,000 V.

a. Determine the charge Q_0 on the sphere.



The charged sphere is then concentrically surrounded by two uncharged conducting hemispheres of inner radius b = 0.40 m and outer radius c = 0.50 m, which are joined together as shown above, forming a spherical capacitor. A wire is connected from the outer sphere to ground, and then removed.

b. Determine the magnitude of the electric field in the following regions as a function of the distance r from the center of the inner sphere.

i. $r < a$

ii. $a < r < b$

iii. $b < r < c$

iv. $r > c$

c. Determine the magnitude of the potential difference between the sphere and the conducting shell.

d. Determine the capacitance of the spherical capacitor.