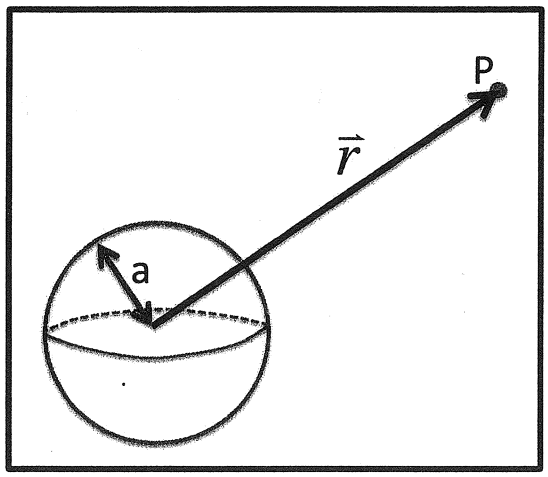
Quiz #1

Name: SOLUTION

PID #:

Problem 1

Given a uniformly charged sphere with radius a with volume charge density of ρ (C/m³). We are observing electric fields at point P with a position vector **r** away with respect to the center of the charged sphere. Give the answers using the constants given in the problem, π or ε_0.



(a) Calculate electric field when r > a.

$$Q_{ENCLOSED} = \frac{4\pi a^3}{3}\rho$$

$$\Phi = E \cdot A = E \cdot 4\pi r^2 = \frac{4\pi a^3 \rho}{3\varepsilon_0}$$

$$\boxed{E = \frac{\rho a^3}{3r^2\varepsilon_0}}$$

(b) Calculate electric field when r < a

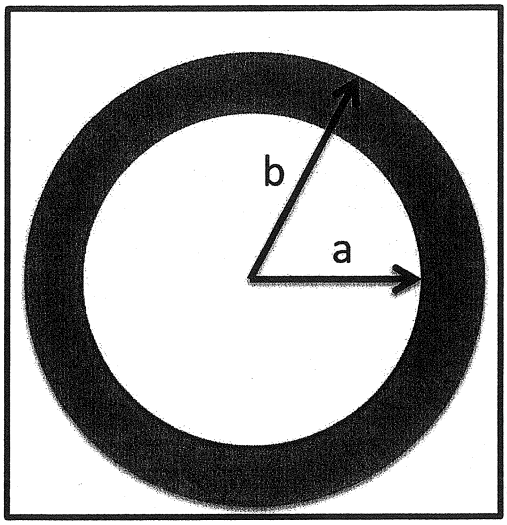
$$Q_{ENCLOSED} = \frac{4\pi r^3}{3}\rho$$

$$\Phi = E \cdot A = E \cdot 4\pi r^2 = \frac{4\pi r^3}{3\varepsilon_0}\rho$$

$$\boxed{E = \frac{\rho r}{3\varepsilon_0}}$$

Problem 2

Consider a uniformly charged hollow cylinder with cross section as depicted below. The volume charge density is ρ (C/m^3). Give the answers using the constants given in the problem, π or ε_0.



Calculate electric field (as a function of r: radial position with respect to the center of the hollow sphere) for

(a) r > b

$$Q_{ENC} = \pi (b^2 - a^2) \rho L$$

$$\Phi = E \cdot A = E \cdot 2\pi r L = \frac{\pi (b^2 - a^2) \rho L}{\varepsilon_0}$$

$$E = \frac{(b^2 - a^2)\rho}{2\varepsilon_0 r}$$

(b) a<r<b

$$E = \frac{(r^2 - a^2)\rho}{2\varepsilon_0 r}$$

(c) r<a

$$E = 0$$