

Quiz 4 - PH242

Name \_\_\_\_\_

Pledged

A long wire, comprised of two charge carrying thin shells (with  $-\lambda$  and  $+2\lambda$  line charge densities respectively) are shown in the figure below. Your task is to calculate the electric field at various points using Gauss' Law

(A) Explain using English and math why if you choose a cylindrical gaussian surface  $\int \vec{E} \cdot d\vec{A} \rightarrow EA$

(B) Calculate the electric field as a function of  $r$ : (1) inside the inner shell ( $r < R$ ), (2) between the two shells ( $R < r < 2R$ ), and (3) outside both shells ( $r > 2R$ )

(C) Draw the  $E$  field on the figure below, remember that the  $E$  field shows the path of a small positive test charge.

Equations

$$\int \vec{E} \cdot d\vec{A} = \frac{Q_{enc}}{\epsilon_0} \quad V_{cyl} = \pi r^2 L \quad A_{cyl} = 2\pi r L \quad Q = \lambda L$$

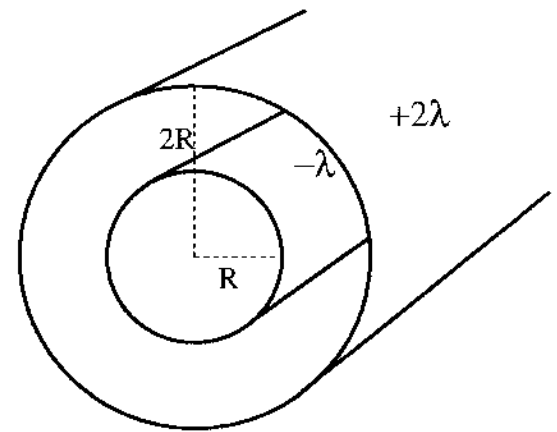
(A) with a cylinder gaussian surface

$d\vec{A} \parallel E$  along surface so

$$\int \vec{E} \cdot d\vec{a} = \int E da$$

if  $E$  is const along surface then

$$\int E da = EA$$



A long wire comprised of two thin shells

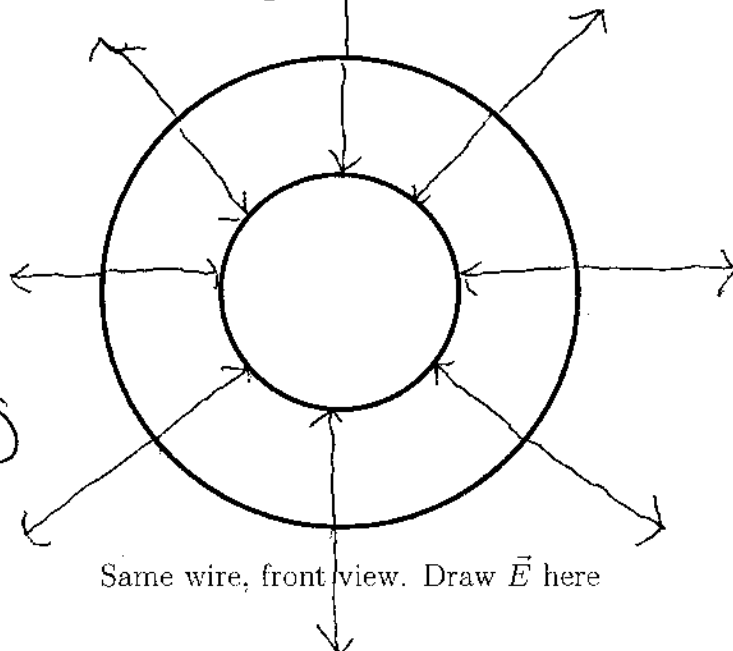
(B)  $r < R \Rightarrow E = 0$  (no  $Q_{enc}$ ) ①

$r > 2R \Rightarrow E 2\pi r L = \frac{(-\lambda + 2\lambda)L}{\epsilon_0} \Rightarrow E = \frac{+\lambda}{2\pi\epsilon_0 r}$  ③

$R < r < 2R$

$$E 2\pi r L = \frac{-\lambda L}{\epsilon_0}$$

so  $E = \frac{-\lambda}{2\pi\epsilon_0 r}$  ②



Same wire, front view. Draw  $\vec{E}$  here