Short Exam/Physics (2) **Name:**

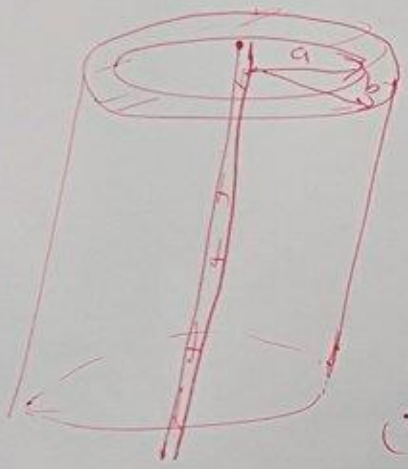
An infinitely long cylindrical insulating shell of inner radius a and outer radius b has a uniform volume charge density ρ. A line of uniform linear charge density λ is placed along the axis of the shell.

Determine the electric field for: (1) $r < a$ (2) $a < r < b$ (3) $r > b$

(1) $2k_e\frac{\lambda}{r}$, outward;

(2) $\frac{2k_e}{r}\left[\lambda+\rho\pi\left(r^2-a^2\right)\right]$, outward;

(3) $\frac{2k_e}{r}\left[\lambda+\rho\pi\left(b^2-a^2\right)\right]$, outward



(1) same as in Ex 24.4

$E = 2k_e\frac{\lambda}{r}$ $r < a$

(2) for $a < r < b$ / $q_{in} = q_{line} + q_{shell}$

$E(2\pi rl) = \frac{q_{in}}{\varepsilon_0}$

$q_{in} = ?$ $\Rightarrow \rho_{shell} = \frac{q_{shell}}{V} \Rightarrow q = \rho\pi(r^2-a^2)l$

$\Rightarrow E(2\pi rl) = \frac{\rho\pi(r^2-a^2)l + \lambda l}{\varepsilon_0}$

$E = \frac{2k_e}{r}\left[\lambda+\rho\pi(r^2-a^2)\right]$

(3) $r \geq b$

$E(2\pi rl) = \frac{q_{in}}{\varepsilon_0}$ / $q_{in} = q_{line} + q_{shell}$

$q_{shell} = \rho_{shell} V = \rho\pi(b^2-a^2)l$

$\Rightarrow$ same $\Rightarrow E = \frac{2k_e}{r}\left[\lambda+\rho\pi(b^2-a^2)\right]$