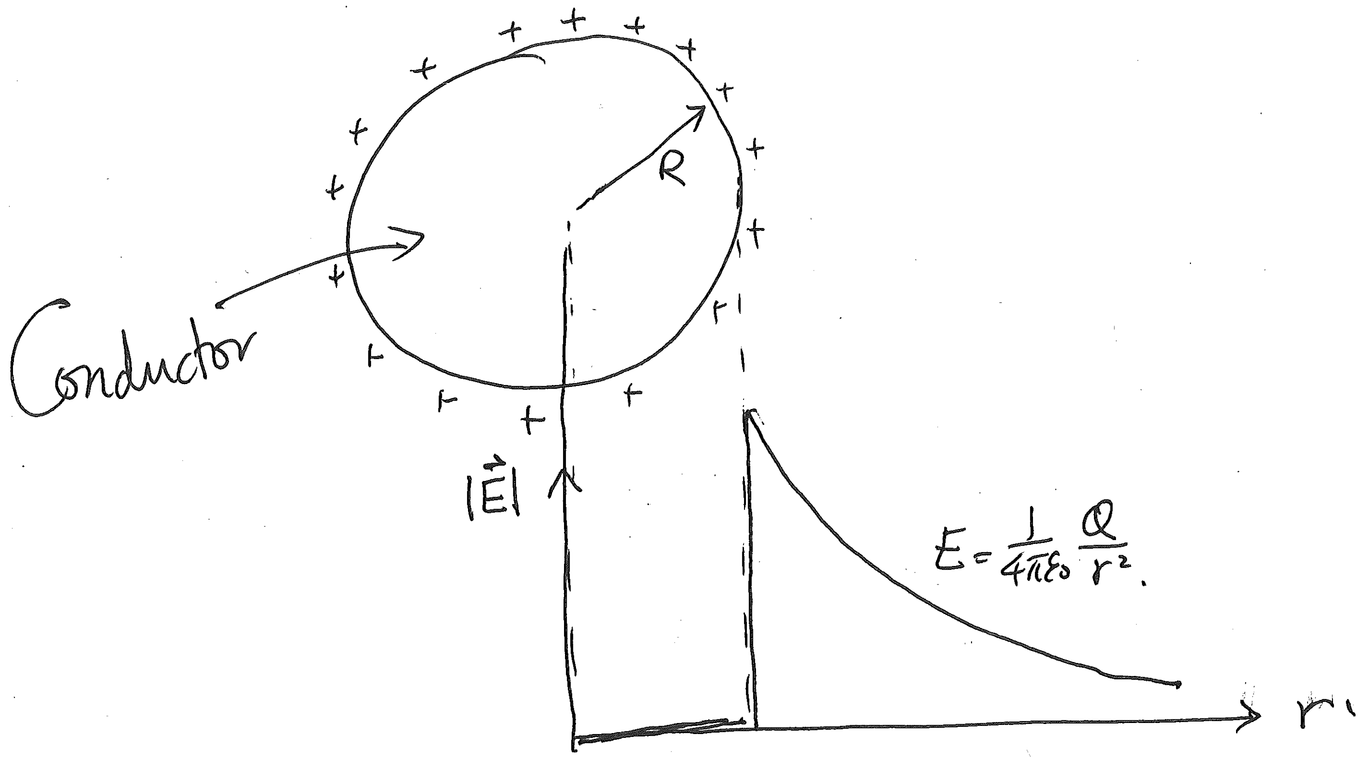
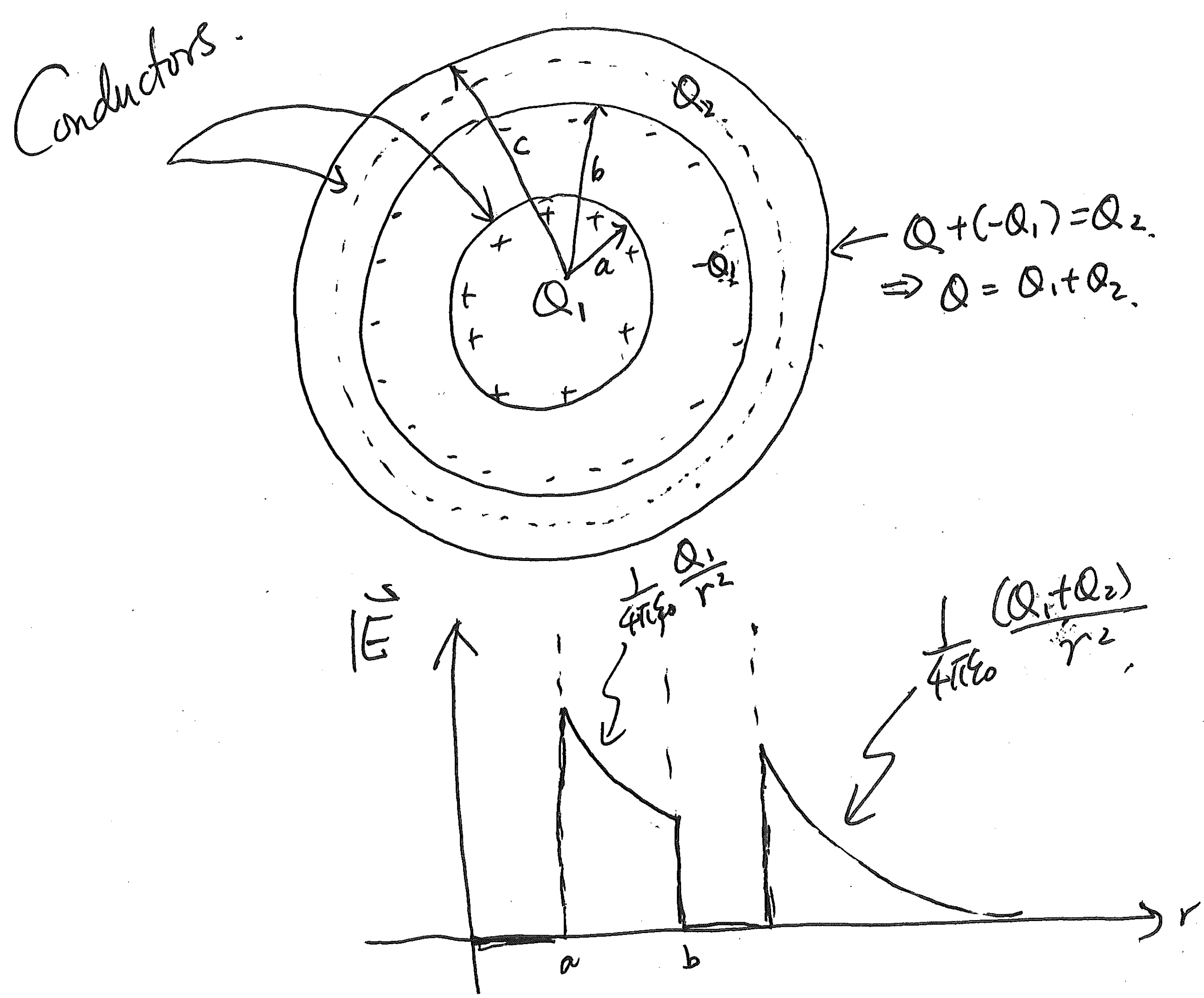
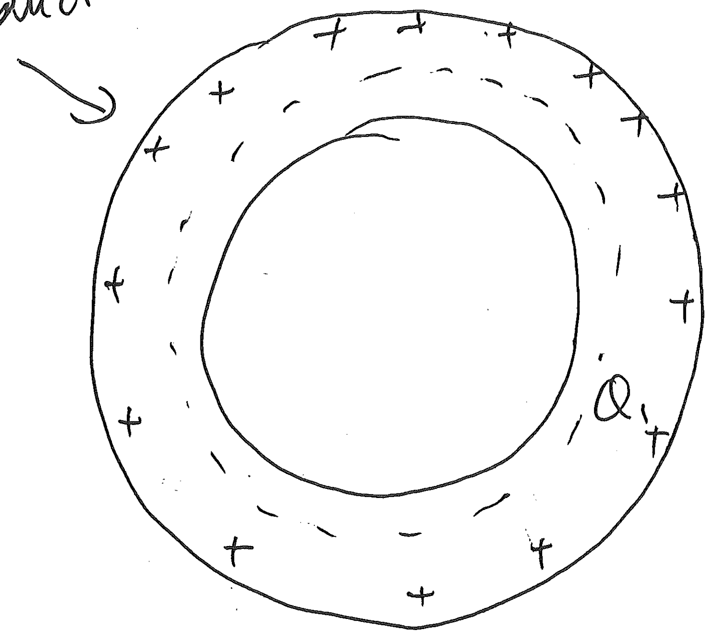

Conductor
R
|E|
E = 1/(4πε₀) Q/r²
r

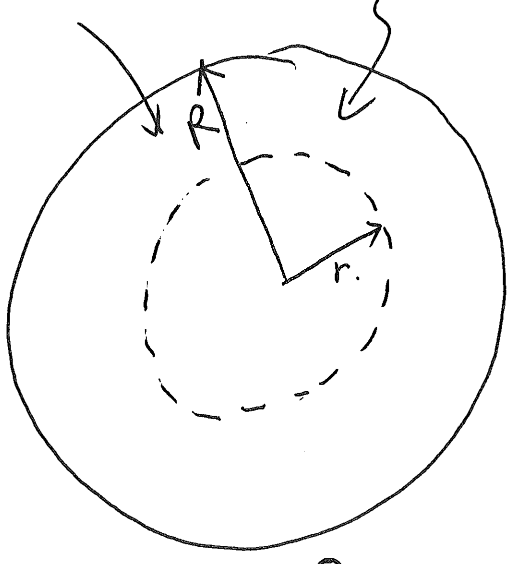

Conductors.
Q₂
c
b
a
Q₁
−Q₁
Q + (−Q₁) = Q₂
⇒ Q = Q₁ + Q₂
E
1/(4πε₀) Q₁/r²
1/(4πε₀) (Q₁+Q₂)/r²
a
b
r

Conductor



Insulator.

Uniform charge distribution.
Total charge = Q.



Charge density $\rho = \dfrac{Q}{\frac{4}{3}\pi R^3}$.

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

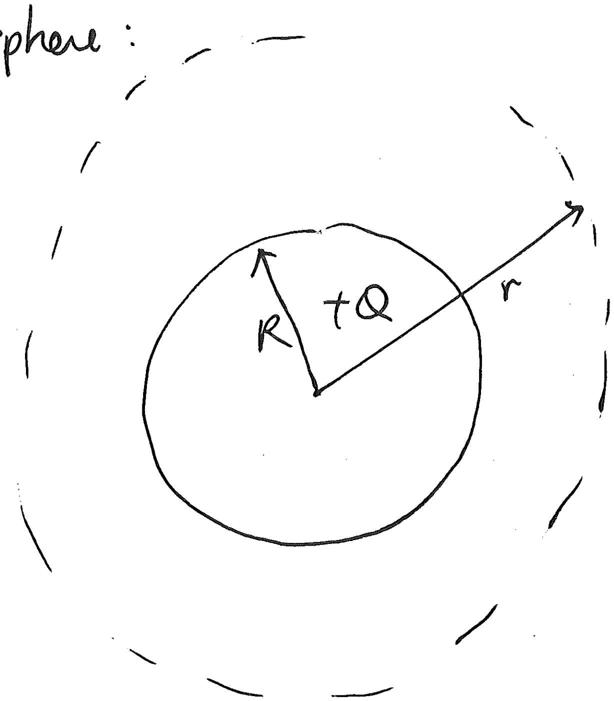
$$\Rightarrow \varepsilon_0 E \cdot 4\pi r^2 = \frac{Q}{\frac{4}{3}\pi R^3} \cdot \frac{4}{3}\pi r^3$$

$$\varepsilon_0 \cdot E \cdot 4\pi r^2 = \frac{r^3}{R^3} Q.$$

Inside ~~Out side~~

$$\Rightarrow E = \cancel{\frac{Q}{4\pi\varepsilon_0} r} \; \frac{Q}{4\pi\varepsilon_0 R^3}\cdot r \leftarrow$$

Outside sphere:



$$\varepsilon_0 \Phi = Q_{in} \Rightarrow \varepsilon_0 \cdot 4\pi r^2 E = Q.$$

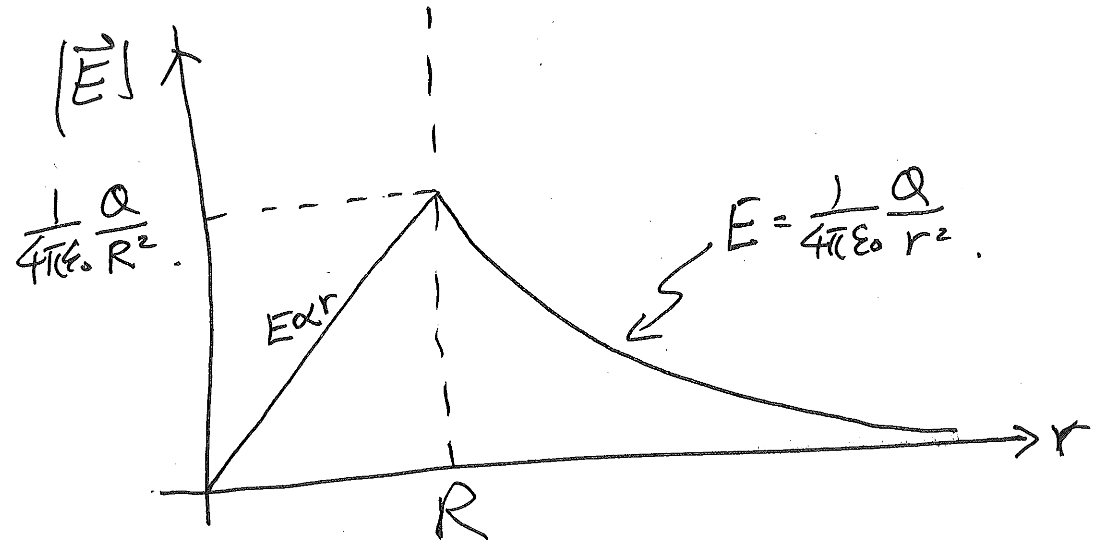
$$\Rightarrow E = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}.$$

Outside.

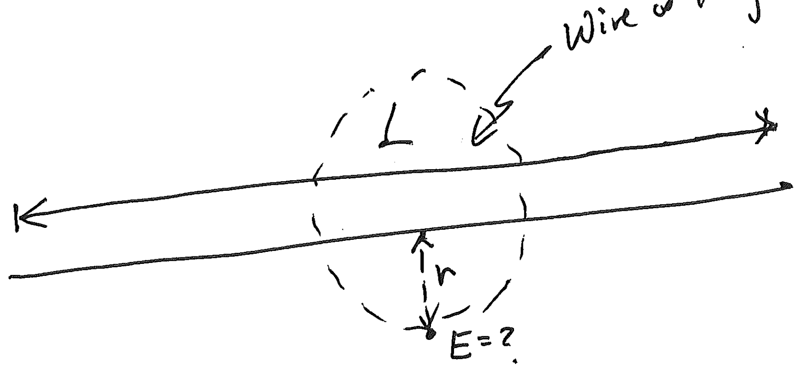
Agree!

At the surface, $r = R$.

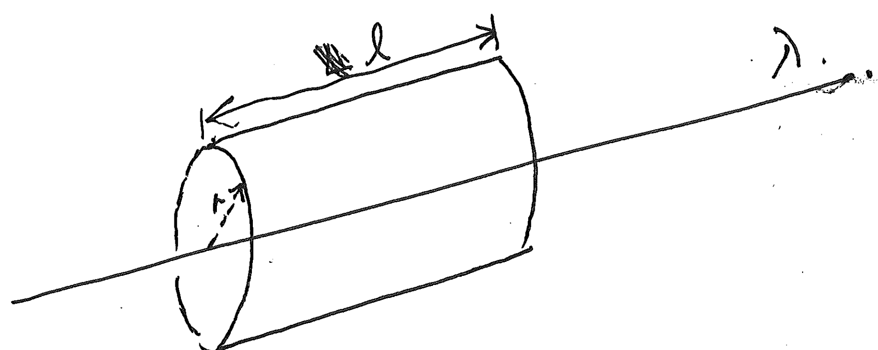
when $r=R$: $E = \dfrac{Q}{4\pi\varepsilon_0 R^3}\cdot R = \dfrac{1}{4\pi\varepsilon_0}\dfrac{Q}{R^2}$



"Long" wire

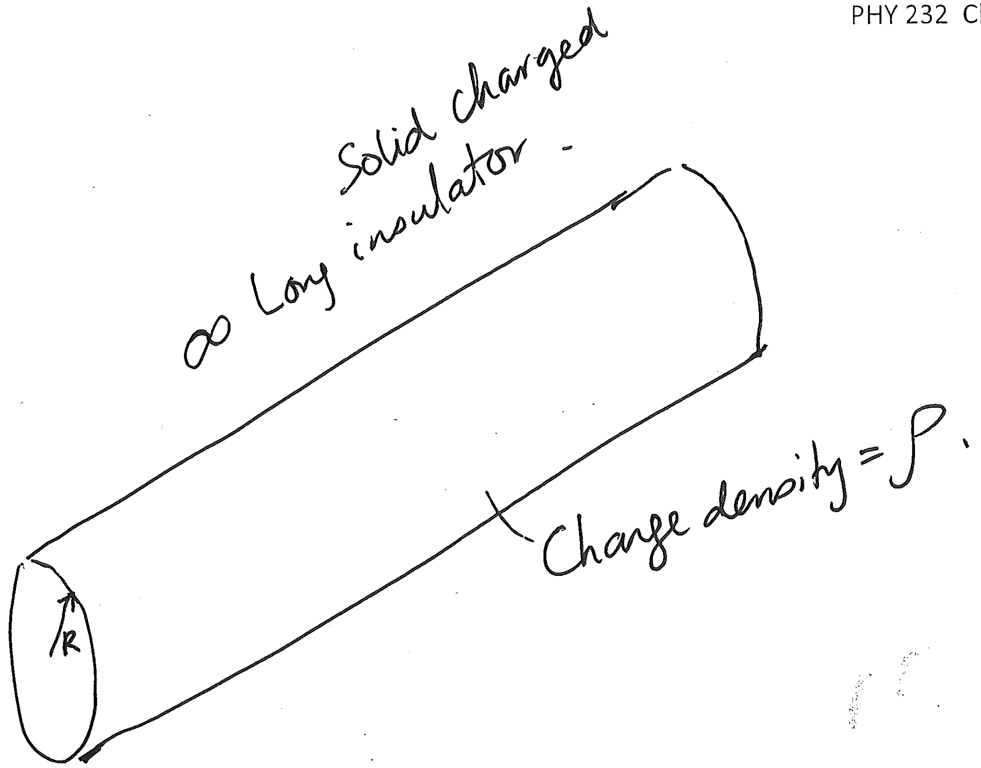


$r \ll L$



$$\varepsilon_0 \Phi = Q_{in} \Rightarrow \varepsilon_0 E \cdot 2\pi r l = \lambda l$$

$$\Rightarrow E = \frac{\lambda}{2\pi\varepsilon_0 r}.$$



Calculate E at r:

$r < R$. $\varepsilon_0 \Phi = Q_{in}$

$\varepsilon_0 \cdot 2\pi r \cancel{l} E = \rho \cdot \pi r^2 \cancel{l}$.

$\Rightarrow E = \dfrac{\rho}{2\varepsilon_0} r$.

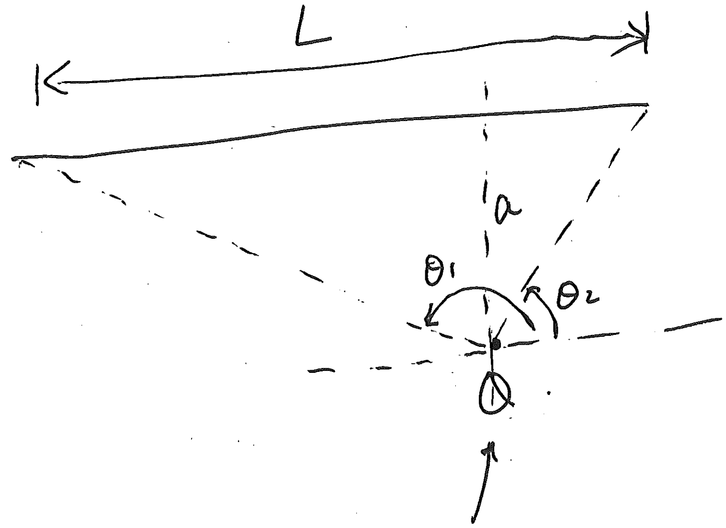
When $r = R$

$E = \dfrac{\rho R}{2\varepsilon_0}$.

$r > R$. $\varepsilon_0 \Phi = Q_{in}$

$\varepsilon_0 \cdot 2\pi r \cancel{l} E = \rho \cdot \pi R^2 \cancel{l}$.

$E = \dfrac{\rho R^2}{2\varepsilon_0} \cdot \dfrac{1}{r}$.



$$F_x = \frac{Q\lambda}{4\pi\varepsilon_0 a}\left[\sin\theta_1 - \sin\theta_2\right]$$

$$F_y = \frac{Q\lambda}{4\pi\varepsilon_0 a}\left[\cos\theta_1 - \cos\theta_2\right].$$

$$E_x = \frac{F_x}{Q} = \frac{\lambda}{4\pi\varepsilon_0 a}\left[\sin\theta_1 - \sin\theta_2\right]$$

$$E_y = \frac{\lambda}{4\pi\varepsilon_0 a}\left[\cos\theta_1 - \cos\theta_2\right].$$

when $L \to \infty$. $\theta_1 = 180°$. $\theta_2 = 0°$

$$E_x = \frac{\lambda}{4\pi\varepsilon_0 a}\left[0 - 0\right] = 0.$$

$$E_y = \frac{\lambda}{4\pi\varepsilon_0 a}\left[-1 - 1\right] = -\frac{\lambda}{2\pi\varepsilon_0 a}$$

pointing downward.