20221241
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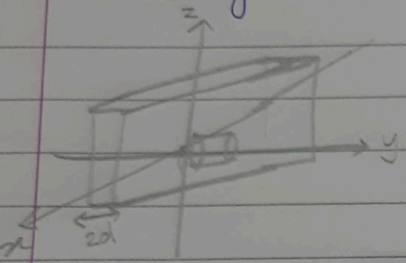
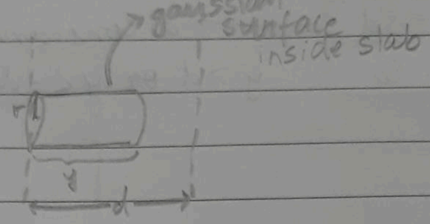
BATCH 6

PH1213 PRESENTATION

An infinite plane slab of thickness 2d carries a uniform volume charge density ρ. We will find electric field as a function of y, where y=0 at centre. We will also call the electric field positive in +y direction and negative when it is in −y direction.





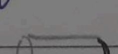
Imagine a gaussian surface from the origin, inside the slab.

Gauss' law $\oint \bar{E}\cdot d\bar{a} = \frac{Q_{enc}}{\varepsilon_0}$

Uniform charge density $\therefore Q_{enc} = \frac{\rho \pi r^2 y}{\varepsilon_0}$

For any distance y horizontally away from centre of slab, it should be a constant electric field along x-z plane. Which means E can be pulled out of integral.
Also, the electric field lines are coming just horizontally out in y and -y direction away from slab. So basically, electric field lines are not going through surface of cylinder, but just through surfaces of ends of our cylinder.

$$E\pi r^2 = \frac{\rho \pi r^2}{\varepsilon_0} y$$

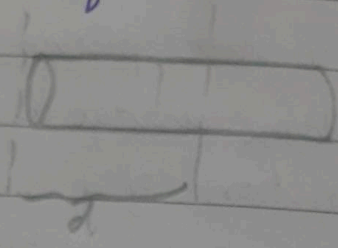


$$\therefore \boxed{E = \left(\frac{\rho y}{\varepsilon_0}\right) \pm \hat{y}} \quad (-d < y < d)$$

INSIDE THE SLAB

- OUTSIDE SLAB

For this, we simply extend our gaussian surface.



We will just replace y with d because now the gaussian surface takes up volume of length d here.

$Q_{enc} = \rho \pi r^2 d$

$\therefore \boxed{\bar{E} = \frac{\rho d}{\varepsilon_0}} \longrightarrow$ a constant

$y > d$ or $y < -d$