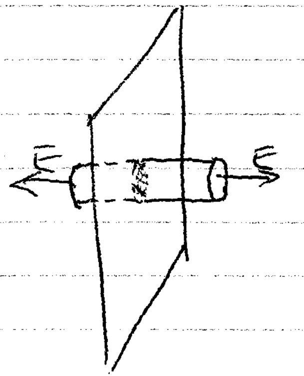
Phy 132 – HW VII–VIII

1)



Flux at each end: $E \cdot 2A$ ← cross-sectional area of cylinder (end)

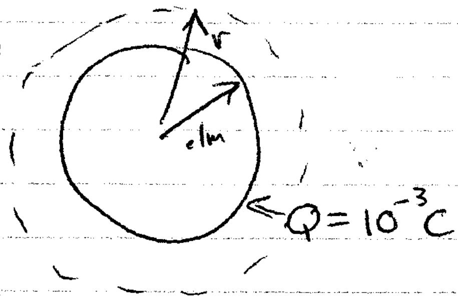
$q_{enc} = \sigma \cdot A$

so $E \cdot 2A = \frac{q_{enc}}{\epsilon_0} = \frac{\sigma A}{\epsilon_0}$

$$\boxed{E = \frac{\sigma}{2\epsilon_0}}$$

No dependence on distance – qualitatively as seen in E-field program

2)

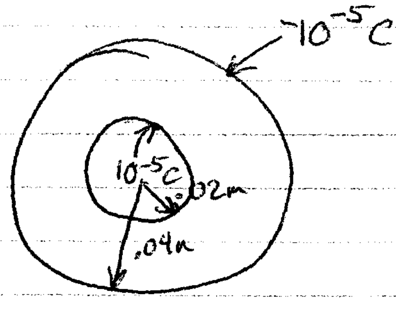


$E \cdot A = \frac{q_{enc}}{\epsilon_0}$

$E \cdot 4\pi r^2 = \frac{Q}{\epsilon_0}$

$E = \frac{Q}{4\pi\epsilon_0 r^2}$ ⇐ same as for point charge

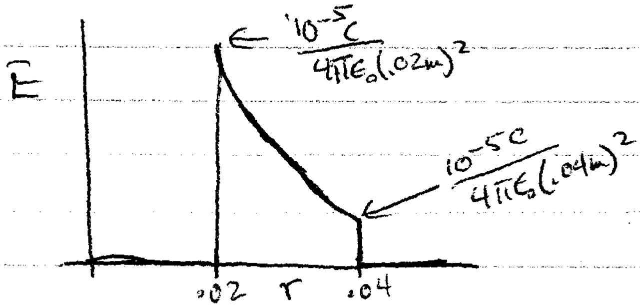
3)



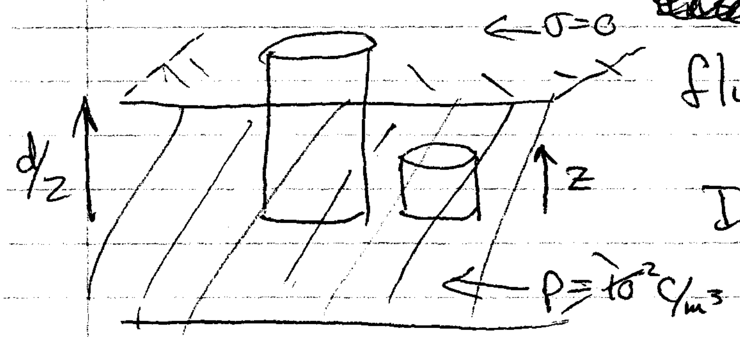
$r < .02m$: $E \cdot A = \frac{q_{enc}}{\epsilon_0} = 0 \Rightarrow E = 0$

$.02m < r < .04m$: $E \cdot A = \frac{10^{-5}C}{\epsilon_0} \Rightarrow E = \frac{10^{-5}C}{4\pi\epsilon_0 r^2}$

$r > .04m$: $E \cdot A = \frac{10^{-5} + (-10^{-5})C}{\epsilon_0} = 0 \Rightarrow E = 0$



4)



~~[illegible]~~ Since $E=0$ @ center, flux is only at top end

Inside: $E \cdot A = \frac{q_{enc}}{\epsilon_0} = \frac{\rho \cdot Vol}{\epsilon_0}$

$$= \frac{\rho \cdot A \cdot z}{\epsilon_0} \Rightarrow \boxed{E = \frac{\rho z}{\epsilon_0}}$$

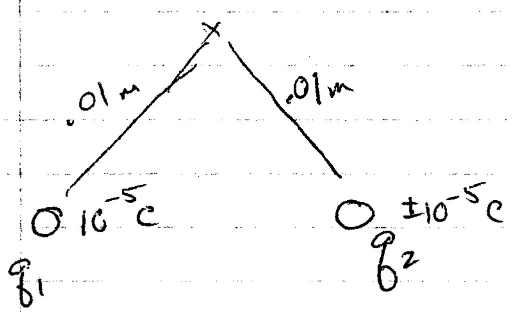
Outside — thickness of charge layer inside Gaussian volume is constant $d/2$, so

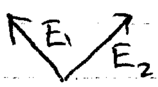
$$E \cdot A = \frac{\rho \cdot A \cdot d/2}{\epsilon_0} \Rightarrow \boxed{E = \frac{\rho d}{2\epsilon_0}}$$

[Note - could also make Gaussian volume a box, & could also make it symmetric on either side of slab, as in Prob. 1]

5) Here we must add as vectors:

a) both +





$$\uparrow E_{net} = E_1 \cos 45^\circ + E_2 \cos 45^\circ$$

$$= \frac{E_1 + E_2}{\sqrt{2}}$$

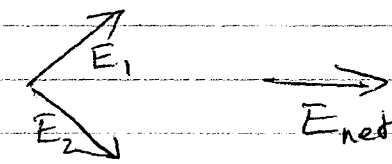
$$= \frac{2q}{\sqrt{2}\, 4\pi\epsilon_0 (.01m)^2}$$

$$= \frac{10^{-5}}{2\sqrt{2}\,\pi (8.85\times10^{-12})\, 10^{-4} m^2} = 1.27\times10^{9}\, N/C$$

Big forces! Big charges!

Directed up ↑

5b) If q_2 is negative:



$$E_{net} = E_1 \sin 45^\circ + E_2 \sin 45^\circ$$

$$= \frac{E_1 + E_2}{\sqrt{2}} \leftarrow \text{same magnitude}$$

as a), except now to right

6) $P = VI$

a) In terms of V & R, substitute $I = V/R$ to find

$$P = V \cdot \frac{V}{R} = \boxed{V^2/R}$$

b) in terms of I & R, substitute $V = IR$ to find

$$P = IR \cdot I = \boxed{I^2 R}$$

7) To maximize $P = IV$, must maximize I & V,

so $V = V_{max} = 30V$, $I = I_{max} = 0.5A$, so

$$R = V/I = \frac{30V}{.5A} = 60\Omega$$

$$P = V \cdot I = 15 \text{ watts}$$

8) $U_{capac} = \frac{1}{2}QV$, so combine w/ $C = Q/V$ to find

a) in terms of Q & C, use $V = Q/C \Rightarrow \boxed{U = \frac{1}{2} Q^2/C}$

b) in terms of C & V, use $Q = CV \Rightarrow \boxed{U = \frac{1}{2}CV^2}$

9) $C = .5F$, $V = 5V \Rightarrow Q = CV = \boxed{2.5C}$

$U = \frac{1}{2}QV = \frac{1}{2} 2.5C \cdot 5V = \boxed{6.25J}$

For raising 1kg, $U = mgh \Rightarrow h = \frac{6.25J}{mg} = \boxed{62cm}$