Ch 6 / HW 6 solutions

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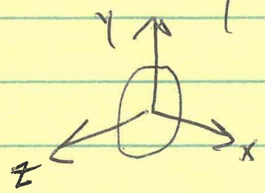

$$\vec{A} = \pi r^2 \hat{k}$$

$$\phi = \vec{E}\cdot\vec{A} = (4.0\hat{j} + 3.0\hat{k})10^3 \tfrac{N}{C} \cdot \pi r^2 \hat{k}$$

$$= 3.0\cdot 10^3 \tfrac{N}{C}\hat{k} \cdot \pi r^2 \hat{k} = \boxed{3.77\cdot 10^4 \tfrac{N\cdot m}{C}}$$

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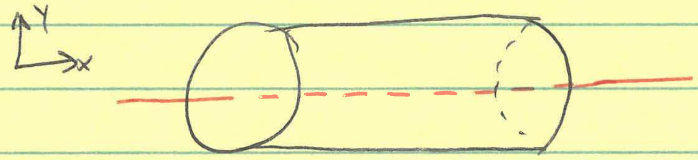

p. 255 of openstax

$$\rightarrow \vec{E}(r) = \frac{\lambda}{2\pi\epsilon_0 r}\hat{r}$$

There is no flux through either left or right faces since $\hat{r}\cdot\hat{\imath} = 0$ and $\hat{r}\cdot(-\hat{\imath}) = 0$

Also, the surface area of the tube portion of the cylinder: $\vec{A} = 2\pi r l \hat{r}$

$$\rightarrow \phi = \vec{E}\cdot\vec{A} = \frac{\lambda}{2\pi\epsilon_0 r}\hat{r} \cdot 2\pi r l \hat{r} = \boxed{\lambda l/\epsilon_0}$$

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$$\boxed{\phi_{S_1} = 0 \qquad \phi_{S_2} = \frac{-2q}{\epsilon_0} \qquad \phi_{S_3} = +q/\epsilon_0 \qquad \phi_{S_4} = \frac{-4q}{\epsilon_0} \qquad \phi_{S_5} = \frac{-2q}{\epsilon_0} \qquad \phi_{S_6} = \frac{+3q}{\epsilon_0}}$$

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$$\phi = q_{enclosed}/\epsilon_0 = 10\mu C / 8.85\cdot 10^{-12}\tfrac{C^2}{N\cdot m^2} = \boxed{1.13\cdot 10^6 \tfrac{Nm^2}{C}}$$

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$$q(r) = \int_0^r \rho(r')dV = \int_0^r \rho_0 \frac{r'}{R} 4\pi r'^2 dr' = \frac{4\pi\rho_0}{R}\int_0^r r'^3 dr' = \frac{4\pi\rho_0 r^4}{R\,4}$$

$$= \pi\rho_0 r^4/R$$

$\underline{r \le R}$: $\phi = \int \vec{E}\cdot d\vec{A} = EA = q_{enclosed}/\epsilon_0$ where $A = 4\pi r^2$

$$\rightarrow \vec{E}(r) = \frac{\pi\rho_0 r^4/R}{4\pi r^2\epsilon_0}\hat{r} = \boxed{\frac{\rho_0 r^2}{4\epsilon_0 R}\hat{r}}$$

$\underline{r > R}$ $q_{enclosed} = \pi\rho_0 R^3$

$$\rightarrow \phi = \int \vec{E}\cdot d\vec{A} = EA = q_{encl}/\epsilon_0$$

$$\rightarrow \vec{E}(r) = \frac{\pi\rho_0 R^3}{4\pi r^2\epsilon_0}\hat{r} = \boxed{\frac{\rho_0 R^3}{4\epsilon_0 r^2}\hat{r}}$$

44 $q(r) = Q_{tot}\frac{r^3}{R^3}$

a) $E(r) = \frac{Q_{encl}}{\epsilon_0}/4\pi r^2 = \frac{Q_{tot}\, r^3/R^3}{4\pi\epsilon_0 r^2} = \frac{Q_{tot}}{4\pi\epsilon_0}\frac{r}{R^3} = \boxed{5.4\cdot10^6 \frac{N}{C}(-\hat{r})}$

b) $E(r) = \frac{Q_{tot}}{4\pi\epsilon_0}\frac{r}{R^3} = \boxed{1.35\cdot10^7 \frac{N}{C}(-\hat{r})}$

c) $E(r) = \frac{Q_{tot}}{4\pi\epsilon_0 r^2} = \boxed{6.74\cdot10^6 \frac{N}{C}(-\hat{r})}$

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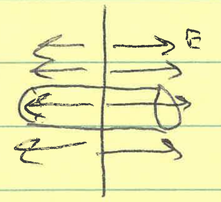
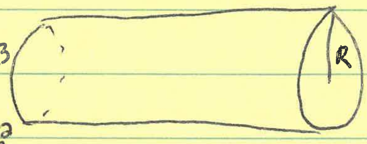


$\phi = \int \vec{E}\cdot d\vec{A} = E\,2\pi r^2$
$= Q_{enclosed}/\epsilon_0 = \sigma\pi r^2/\epsilon_0$
$\Big\}\ E = \frac{\sigma}{2\epsilon_0} = \boxed{5.65\cdot10^5 \frac{N}{C}}$

50 Given: charge per length λ

Needed: charge per area $\sigma = \frac{\lambda}{2\pi R} = 2.65\cdot10^{-3} \frac{C}{m^2}$



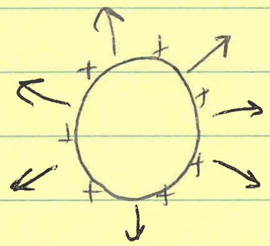
a) $\vec{E} = \frac{R}{r}\frac{\sigma}{\epsilon_0}(\hat{r}) = \frac{0.03}{0.05}\,\frac{2.65\cdot10^{-3}}{8.85\cdot10^{-12}} = \boxed{1.8\cdot10^8 \frac{N}{C}(\hat{r})}$

(p.255)

b) $\boxed{\vec{E} = 0}$ in a conductor

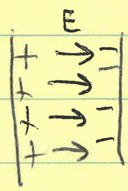
63 $E(r) = \frac{\lambda}{2\pi\epsilon_0 r}$ (p.255)

for $r > R$



E=0 inside

68 $\sigma = \pm\frac{10^{+12}\cdot1.6\cdot10^{-19}}{400\cdot10^{-4}} = \boxed{\pm 4\cdot10^{-6} \frac{C}{m^2}}$



$E = \frac{\sigma}{\epsilon_0} = \boxed{4.52\cdot10^5 \frac{N}{C}}$