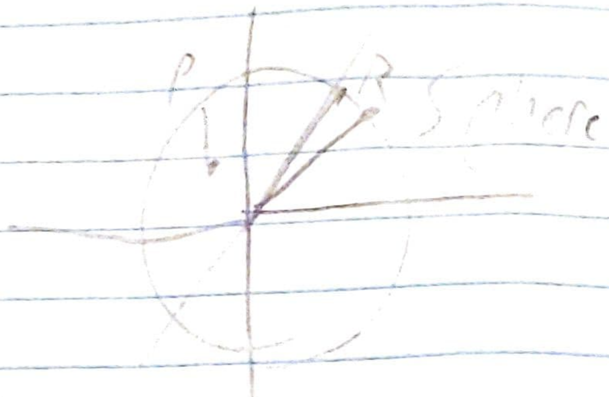
2.12 $\oint \vec{E}\cdot d\vec{a} = \frac{1}{\epsilon_0} Q_{enc}$



$E \parallel da \therefore \oint E\,da$

$\therefore = E\oint da = \frac{1}{\epsilon_0} Q_{enc}$

$E \int_0^{2\pi}\int_0^{\pi} r^2 \sin\theta \, d\theta \, d\phi = \frac{Q_{enc}}{\epsilon_0}$

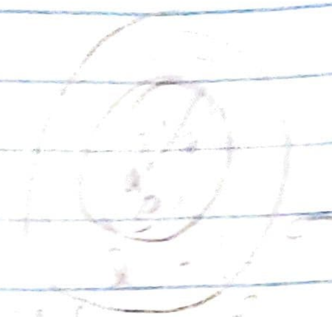
$= E\cdot 2\pi\cdot r^2 (2) = \frac{Q_{enc}}{\epsilon_0} \Rightarrow E = \frac{Q_{enc}}{4\pi r^2 \epsilon_0}$

$Q_{enc} = \int_0^R\int_0^{\pi}\int_0^{2\pi} \rho r^2 \sin\theta \, dr \, d\theta \, d\phi$

$= \frac{\rho R^3}{3}\cdot 4\pi$

$\Rightarrow E = \frac{\rho R^3 \cdot 4\pi}{3 r^2 \epsilon_0 4\pi} = \boxed{\frac{\rho R^3}{3 r^2 \epsilon_0}}$

2.16 For $r > a$ ...



E_a

$\oint q$

$\oint E \cdot da$ ...

$= E \int_0^L \int_0^{2\pi} s \, dz \, d\phi = \frac{\cdots}{\epsilon_0}$

$E \, 2\pi L s = \frac{s^2 \pi L \rho}{\epsilon_0}$

$$\boxed{E = \frac{\rho s}{2\epsilon_0} \hat{s}}$$

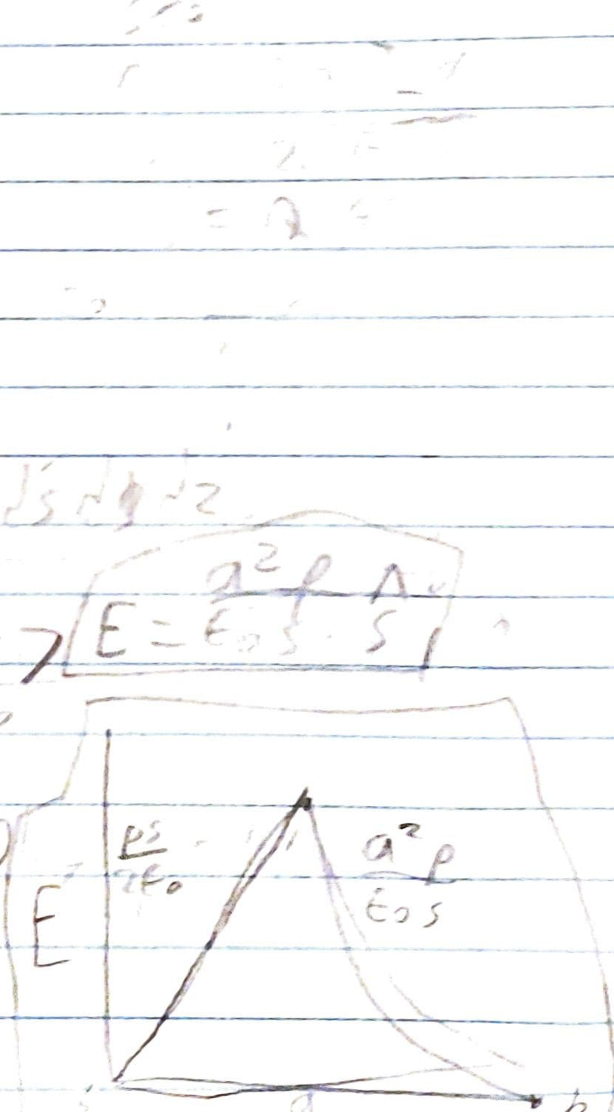
$a < s < b$

$E \, 2\pi L s = \int_0^L \int_0^{2\pi} \int_0^a \rho s' \, ds' \, d\phi \, dz$

$E \, 2\pi L s = \frac{a^2 \rho 2\pi L}{2\epsilon_0} \rightarrow \boxed{E = \frac{a^2 \rho}{\epsilon_0 s} \hat{s}}$

$b < s$

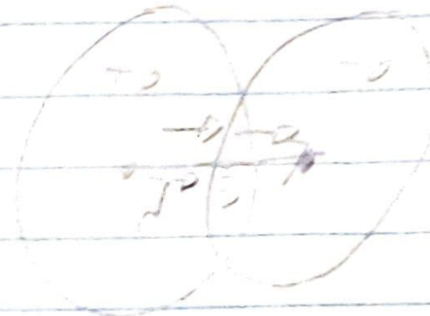
$\oint E \cdot da = \frac{Q}{\epsilon_0} = 0$



2.18) $E_{sphere} = \frac{\rho R^3}{3r^2\epsilon_0}$

$E_+ = \frac{\rho R^3}{3r^2\epsilon_0}$

$E_- = \frac{\rho R^3}{3r^2\epsilon_0}$

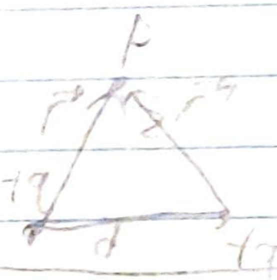


$E_{tot}\frac{\vec{d}}{2} = \frac{\rho R^3}{3r^2\epsilon_0}\hat{r} \quad \frac{\rho R^3}{(\frac{d}{2})^2\epsilon_0}\vec{d}$

$\frac{\rho R^3}{3\frac{d^2}{4}\epsilon_0} + \frac{\rho R^3}{3\frac{d^2}{4}\epsilon_0} = \boxed{\frac{2\rho R^3}{3d^2\epsilon_0}\vec{d}}$

2.25) a) $V(\vec{r}) = \frac{1}{4\pi\epsilon_0}\sum \frac{q_i}{r_i}$

$r_i = \sqrt{(\frac{d}{2})^2 + z^2}$



$\boxed{\frac{1}{4\pi\epsilon_0}\frac{2q}{\sqrt{(\frac{d}{2})^2+z^2}} = V(\vec{r})}$

$E = -\nabla V = \frac{2q}{4\pi\epsilon_0}\frac{-1 \cdot 2z}{2\sqrt{((\frac{d}{2})^2+z^2)^3}} = \boxed{\frac{-q}{2\pi\epsilon_0}\frac{z}{\sqrt{[\quad]^3}}\hat{z}}$

b) $\frac{1}{4\pi\epsilon_0}\int_{-L}^{L}\frac{\lambda\, dl}{\sqrt{l^2+z^2}}$ by thoerton substitution then z

$= \frac{1}{4\pi\epsilon_0}\left[\lambda \ln\left(\sqrt{l^2+z^2}+l\right)\right]_{-L}^{L}$

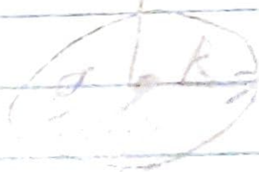
$\frac{\lambda}{2L}$

$= \boxed{\frac{\lambda}{4\pi\epsilon_0}\ln\left(\frac{\sqrt{L^2+z^2}+L}{\sqrt{(-L)^2+z^2}-L}\right)}$

$$E = -\nabla V = \frac{-\lambda}{4\pi\epsilon_0} \cdot \frac{-2\sqrt{\ }\ \hat{z}}{([illegible])}$$

$$= \boxed{\frac{\lambda 2L}{4\pi\epsilon_0 [illegible]}\hat{z}}$$

(c) $\frac{\sigma}{4\pi\epsilon_0} \cdot \int_0^{R} \int \frac{r\,dr}{[illegible]} \, dr\, d\phi$



$$= \boxed{\frac{\sigma}{2\epsilon_0}\sqrt{R^2+z^2}}$$

$$E = -\nabla V = \frac{-\sigma \cdot -2z}{4\epsilon_0\sqrt{R^2+z^2}} = \boxed{\frac{\sigma\, 2z\, \hat{z}}{4\epsilon_0\sqrt{R^2+z^2}}}$$

for (a), if $+q$ was a $+q$ was $-q$ then $V(\vec{r}) = 0$ and the field would terminate.

2.29 $V(\vec{r}) = \frac{1}{4\pi\epsilon_0}\int \frac{\rho(\vec{r}')}{r} d\tau'$ 2.29

$\nabla^2 \frac{1}{r} = -4\pi\,\delta^3(\vec{r})$ 1.102

$$\nabla^2(V) = \nabla^2 \frac{1}{4\pi\epsilon_0}\int \frac{\rho(\vec{r}')}{r} = \frac{-4\pi}{4\pi\epsilon_0}\int \delta^3(\vec{r})\,\rho(\vec{r}')\,d\tau'$$

$$= \boxed{\frac{-\rho}{\epsilon_0}}$$