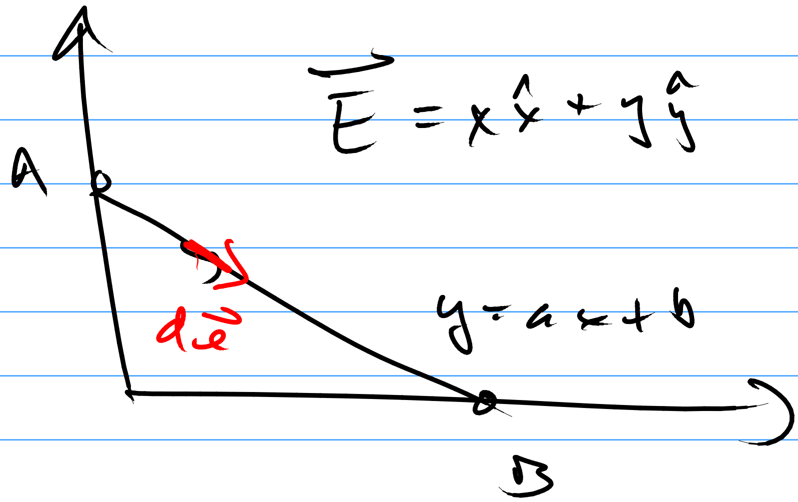
$$\oint \vec{E}_{coul} \cdot d\vec{l} = \phi$$



$$\vec{E} = x\hat{x} + y\hat{y}$$

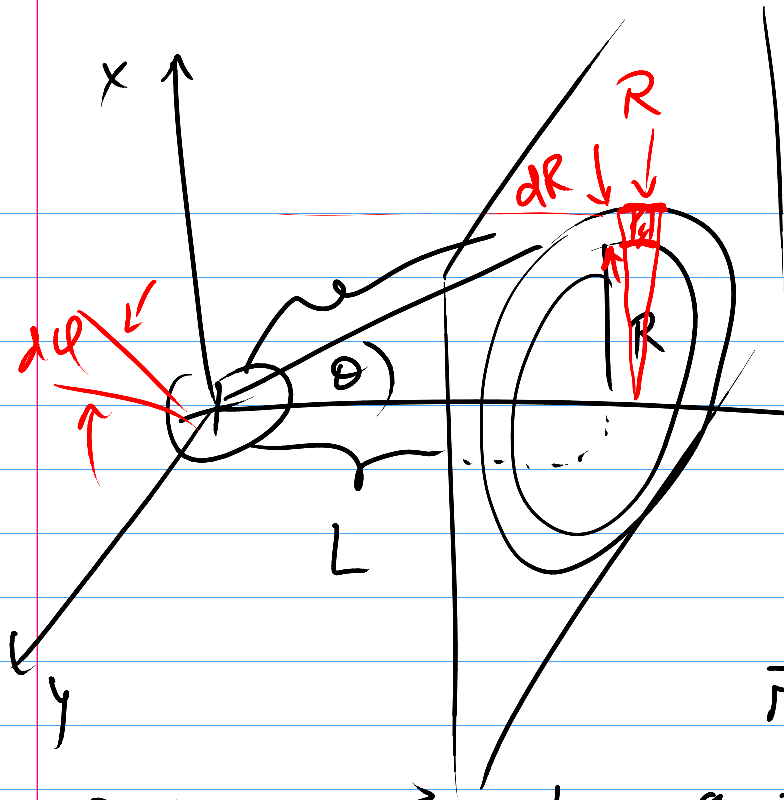
$$\vec{r} = x\hat{x} + y\hat{y}$$

$$d\vec{l} = d\vec{r} = dx\,\hat{x} + dy\,\hat{y} = dx\,\hat{x} + a\,dx\,\hat{y}$$

$$\vec{E} \cdot d\vec{l} = x\,dx + y\,a\,dx$$

$$\int_A^B \vec{E} \cdot d\vec{l} = \int_0^L x\,dx + y\,a\,dx$$

$y = ax + b$



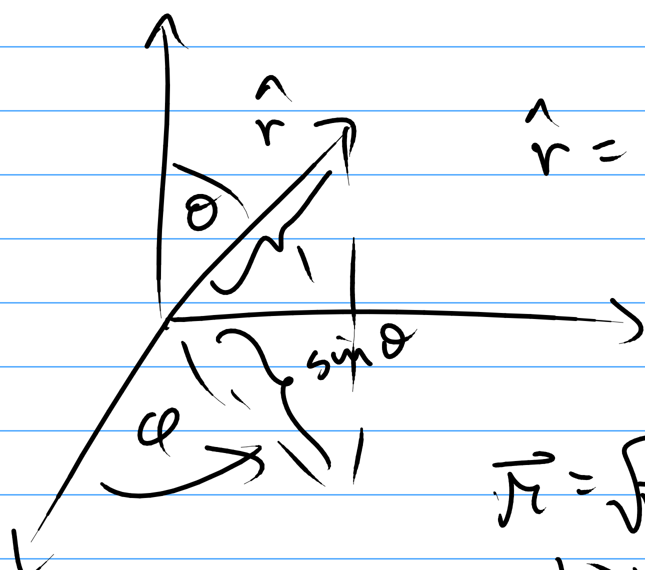
$$d\vec{a} = R\,d\varphi\,dR\,\hat{z}$$

$$= R\,dR \underbrace{\int^{2\pi} d\varphi}_{2\pi}\,\hat{z}$$

$$d\vec{a} = 2\pi R\,dR\,\hat{z}$$

$$\vec{\mathfrak{r}} = \vec{r} - \underset{0}{\underset{\shortparallel}{\vec{r}'}} = \vec{r} = \sqrt{R^2+L^2}\,\hat{r}$$

$\vec{E}\cdot d\vec{a}$ $\qquad \vec{E} = \frac{1}{4\pi\epsilon_0}\,\frac{q}{\mathfrak{r}^2}\,\frac{\vec{\mathfrak{r}}}{|\vec{\mathfrak{r}}|}$



$$\hat{r} = 1\sin\theta\cos\varphi\,\hat{x} + \sin\theta\sin\varphi\,\hat{y} + \cos\theta\,\hat{z}$$

$$\vec{\mathfrak{r}} = \sqrt{R^2+L^2}\,\Big(\underbrace{\qquad\qquad}_{\hat{r}}\Big)$$

$$|\vec{\mathfrak{r}}| = \sqrt{\vec{\mathfrak{r}}\cdot\vec{\mathfrak{r}}}$$

$$|\vec{\mathfrak{r}}| = \sqrt{\sqrt{R^2+L^2}\,\hat{r}\cdot\sqrt{R^2+L^2}\,\hat{r}} = \sqrt{R^2+L^2}$$

$$\int \vec{E}\cdot d\vec{a} = \int \frac{1}{4\pi\epsilon_0}\,\frac{q}{\mathfrak{r}^2}\,\frac{\vec{\mathfrak{r}}}{|\vec{\mathfrak{r}}|}\cdot 2\pi R\,dR\,\hat{z}$$

$$\cos\theta = \frac{L}{\sqrt{L^2+R^2}}$$

Bndry conditions

$$\nabla^2 V = -\rho/\epsilon_0$$

$$\boxed{\vec{\nabla}\cdot\vec{E} = \rho/\epsilon_0}$$