↳ Electric field at centre O of semicircle of radius a having linear charge density $\lambda$, given as

(a) $\frac{2\lambda}{\varepsilon_0 a}$

(b) $\frac{\lambda\pi}{\varepsilon_0 a}$

(c) $\frac{\lambda}{2\pi\varepsilon_0 a}$ ✓

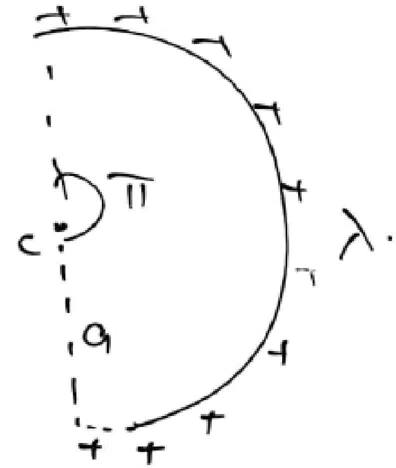
(d) $\frac{\lambda}{\pi\varepsilon_0 a}$

$$E = \frac{2k\lambda}{a}\sin\left(\frac{\theta}{2}\right)$$

$$= \frac{2k\lambda}{a}\sin\left(\frac{\pi}{2}\right)$$

$$= \frac{2k\lambda}{a}$$

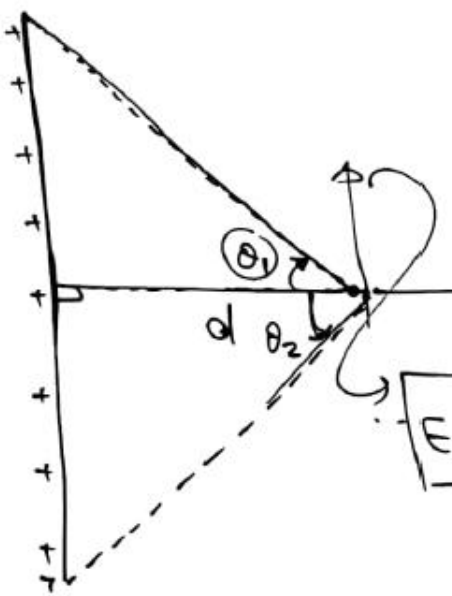
$$= \frac{2\lambda}{4\pi\varepsilon_0 a} = \boxed{\frac{\lambda}{2\pi\varepsilon_0 a}}$$



## Electric field due to finite rod having linear charge density ($\lambda$)

$\boxed{\theta_1 > \theta_2}$

$\theta_1 < \theta_2$



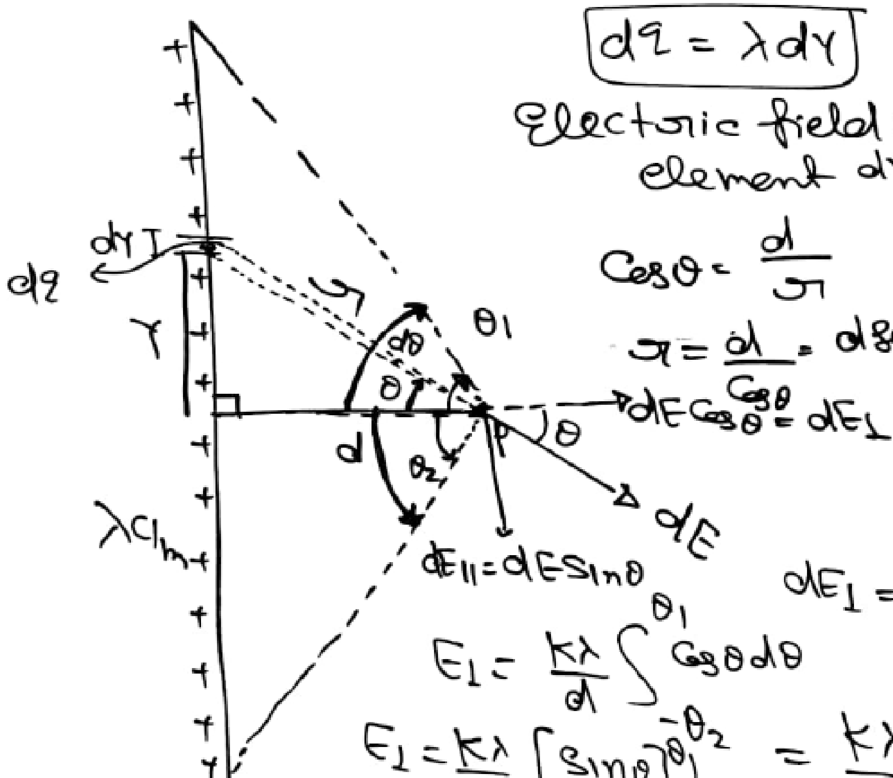

$$\boxed{E_\perp = \frac{k\lambda}{d}\left(\sin\theta_1 + \sin\theta_2\right)}$$

$$\boxed{E_{\parallel} = \frac{k\lambda}{d}\left[\cos\theta_2 - \cos\theta_1\right]}$$

## Electric field due to finite rod having linear charge density ($\lambda$)

$$\boxed{dq = \lambda dr}$$

$\sin(-\theta) = -\sin\theta$




Electric field at Point P due to small charge element dr.

$$dE = \frac{K\,dq}{r^2} = \frac{K\lambda\,dr}{r^2} = \frac{K\lambda\,dr}{d^2\sec^2\theta}$$

$$\cos\theta = \frac{d}{r}$$

$$r = \frac{d}{\cos\theta} = d\sec\theta$$

$$dE_\perp = dE\cos\theta = \frac{K\lambda\,dr\cos\theta}{d^2\sec^2\theta}$$

$$\boxed{\begin{aligned}&\tan\theta = \frac{r}{d} \Rightarrow r = d\tan\theta\\ &dr = d\sec^2\theta\,d\theta\end{aligned}}$$

$$\boxed{E_\perp = \frac{K\lambda}{d}\left[\sin\theta_1 + \sin\theta_2\right]}$$

$$dE_\perp = \frac{K\lambda\,\cancel{d}\,\cancel{\sec^2\theta}\,d\theta\cos\theta}{d^{\cancel{2}}\,\cancel{\sec^2\theta}} = \frac{K\lambda}{d}\cos\theta\,d\theta$$

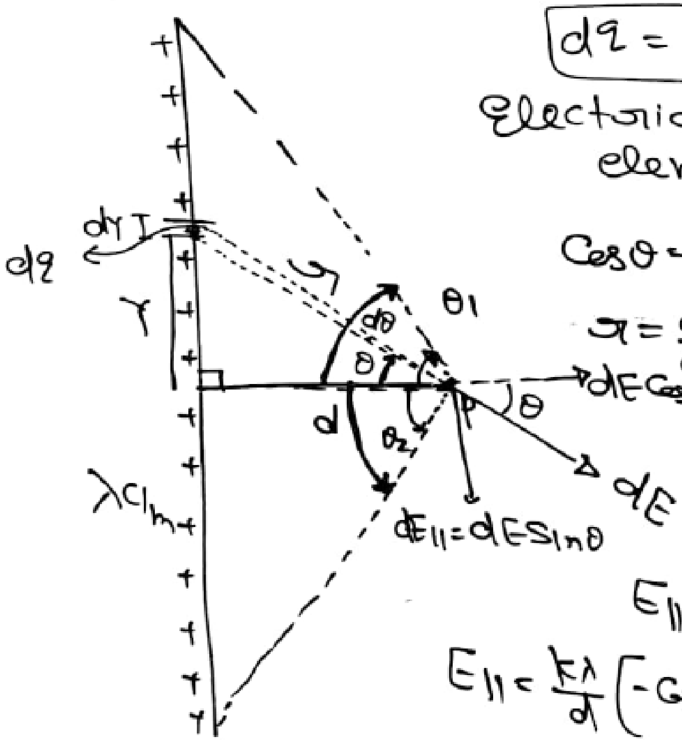
$$E_\perp = \frac{K\lambda}{d}\int_{-\theta_2}^{\theta_1}\cos\theta\,d\theta$$

$$E_\perp = \frac{K\lambda}{d}\left[\sin\theta\right]_{-\theta_2}^{\theta_1} = \frac{K\lambda}{d}\left[\sin\theta_1 - (\sin(-\theta_2))\right] = \boxed{\frac{K\lambda}{d}\left[\sin\theta_1 + \sin\theta_2\right]}$$

## Electric field due to finite rod having linear charge density ($\lambda$)

$$\boxed{dq = \lambda dy}$$

$\sin(-\theta) = -\sin\theta$




Electric field at Point P due to small charge element dy.

$$dE = \frac{K\,dq}{r^2} = \frac{K\lambda dy}{r^2} = \frac{K\lambda dy}{d^2\sec^2\theta}$$

$$\cos\theta = \frac{d}{r}$$

$$r = \frac{d}{\cos\theta} = d\sec\theta$$

$$dE_{\parallel} = \frac{K\lambda dy}{d^2\sec^2\theta}\sin\theta$$

$$\tan\theta = \frac{y}{d} \qquad y = d\tan\theta$$

$$dy = d\sec^2\theta\, d\theta$$

$$dE_{\parallel} = \frac{K\lambda\, \cancel{d}\,\cancel{\sec^2\theta}\, d\theta \sin\theta}{d^{\cancel{2}}\,\cancel{\sec^2\theta}}$$

$$\int dE_{\parallel} = \frac{K\lambda}{d}\int_{-\theta_2}^{\theta_1} \sin\theta\, d\theta$$

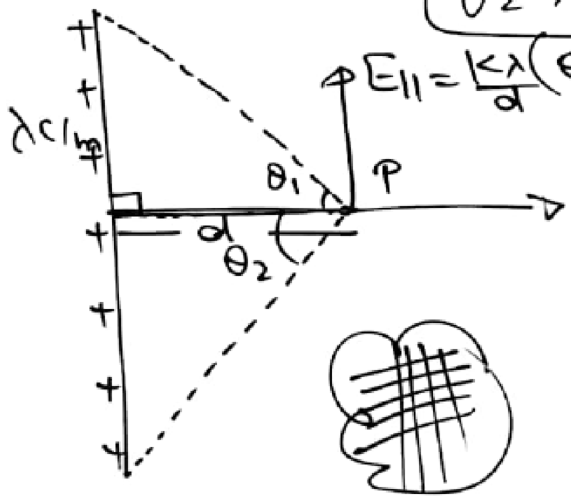
$$E_{\parallel} = \frac{K\lambda}{d}\left[-\cos\theta\right]_{-\theta_2}^{\theta_1}$$

$$E_{\parallel} = \frac{K\lambda}{d}\left[-\cos\theta_1 - (\cos(-\theta_2))\right]$$

$$\boxed{E_{\parallel} = \frac{K\lambda}{d}\left[\cos\theta_2 - \cos\theta_1\right]}$$

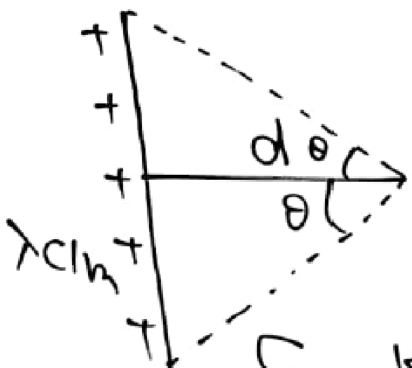
## Electric field due to finite rod having linear charge density ($\lambda$)

$$\boxed{\theta_2 > \theta_1}$$




$$E_{\parallel} = \frac{K\lambda}{d}\left(\cos\theta_2 - \cos\theta_1\right)$$

$$E_{\perp} = \frac{K\lambda}{d}\left[\sin\theta_1 + \sin\theta_2\right]$$

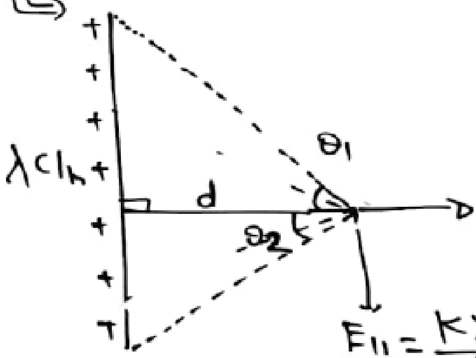



$$E_{\perp} = \frac{K\lambda}{d}\left[\sin\theta + \sin\theta\right]$$

$$= \frac{2K\lambda}{d}\sin\theta.$$

$$E_{\parallel} = \frac{K\lambda}{d}\left[\cos\theta - \cos\theta\right] = \underline{\underline{0}}$$

## Electric field due to finite rod having linear charge density ($\lambda$)




$$E_\perp = \frac{K\lambda}{d}\left[\sin\theta_1 + \sin\theta_2\right]$$

$$E_{\parallel} = \frac{K\lambda}{d}\left(\cos\theta_2 - \cos\theta_1\right)$$

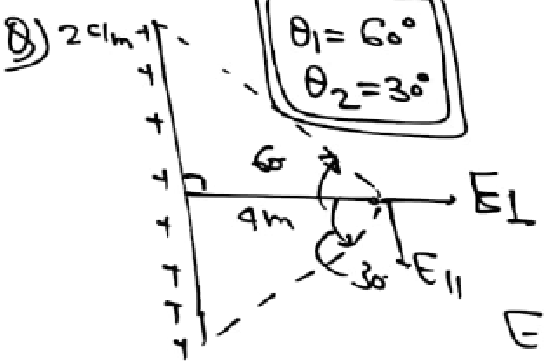
$$E_{\parallel} = \frac{K\lambda}{d}\left[\cos\theta_2 - \cos\theta_1\right]$$

$$E_{\parallel} = \frac{9\times10^9 \times \cancel{2}}{\cancel{4}_2}\left[\cos 30 - \cos 60\right]$$

$$E_{\parallel} = 4.5\times10^9\left[\frac{\sqrt{3}}{2} - \frac{1}{2}\right]$$

$$E_{\parallel} = \frac{4.5}{2}\times10^9\left[\sqrt{3}-1\right]\ \text{N/C}$$

Q)




$$\boxed{\begin{aligned}\theta_1 &= 60^\circ \\ \theta_2 &= 30^\circ\end{aligned}}$$

$$E_\perp = \frac{K\lambda}{d}\left[\sin\theta_1 + \sin\theta_2\right]$$

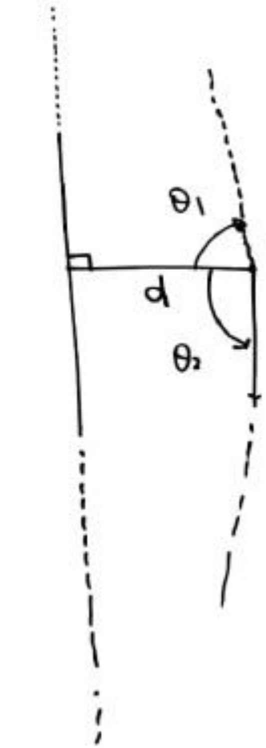
$$= \frac{9\times10^9\times\cancel{2}}{\cancel{4}\cancel{2}}\left[\sin 60^\circ + \sin 30^\circ\right]$$

$$= 4.5\times10^9\left[\frac{\sqrt{3}}{2} + \frac{1}{2}\right]$$

$$E_\perp = \cancel{4.5}\times10^9\frac{(\sqrt{3}+1)}{2}$$

$$E_\perp = 2.25\times10^9(\sqrt{3}+1)\ \text{N/C}$$

## Electric field due to Infinite wire:




$$\theta_1 = 90$$

$$\theta_2 = 90$$

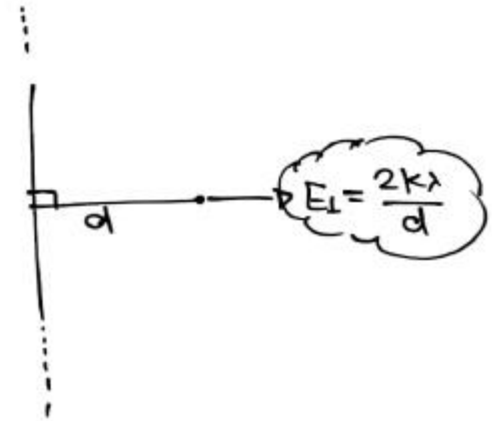
$$E_{\perp} = \frac{2k\lambda}{d} \qquad E_{\perp} = \frac{K\lambda}{d}\left[\sin 90 + \sin 90\right]$$

$$= \frac{K\lambda}{d}\left[1+1\right] = \frac{2K\lambda}{d}$$

$$E_{\parallel} = 0$$

$$E_{\parallel} = \frac{K\lambda}{d}\left(\cos 90 - \cos 90\right)$$

$$E_{\parallel} = 0$$

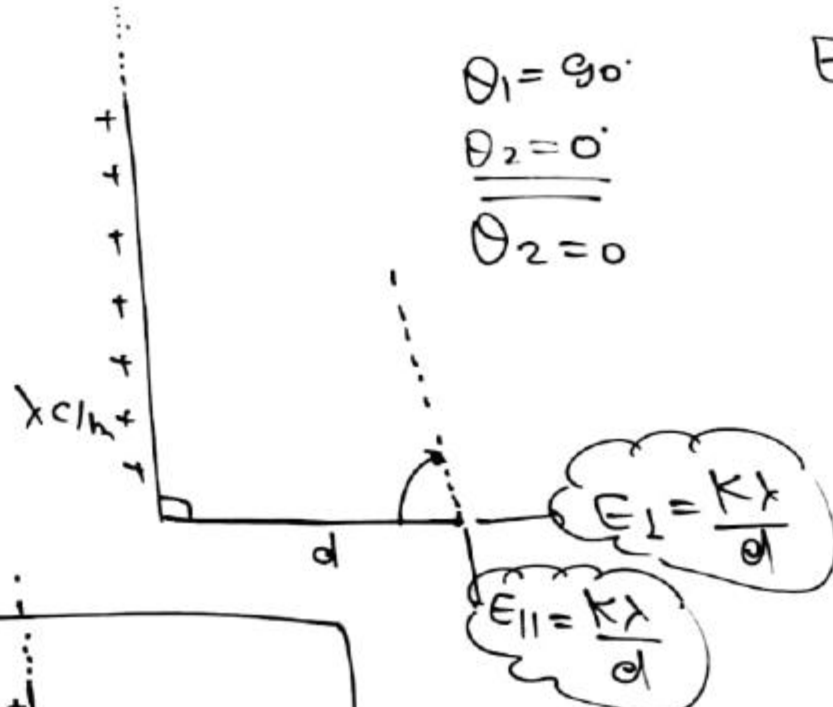


# Electric field due to semi-infinite wire :-

$\theta_1 = 90^\circ$

$\theta_2 = 0^\circ$

$\theta_2 = 0$



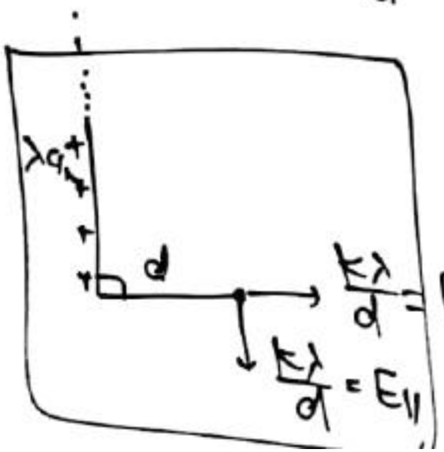

$$E_\perp = \frac{k\lambda}{d}\left[\sin 90 + \sin 0\right]$$

$$= \frac{k\lambda}{d}\left[1 + 0\right] = \frac{k\lambda}{d}$$

$$E_{\parallel} = \frac{k\lambda}{d}\left[\cos 0 - \cos 90^\circ\right]$$

$$= \frac{k\lambda}{d}\left[1 - 0\right]$$

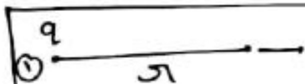
$$E_{\parallel} = \frac{k\lambda}{d}$$



# Electric field due to Semi-Infinite wire:

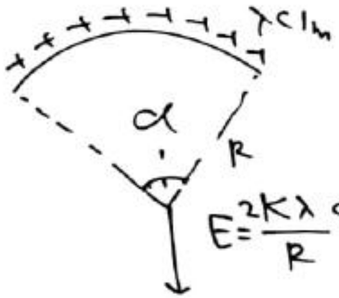
#

(i)




$E = \frac{Kq}{r^2}$

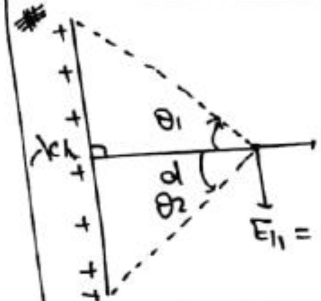
(ii)




$E = \frac{2K\lambda}{R} \sin\left(\frac{\alpha}{2}\right)$

Special problem

#



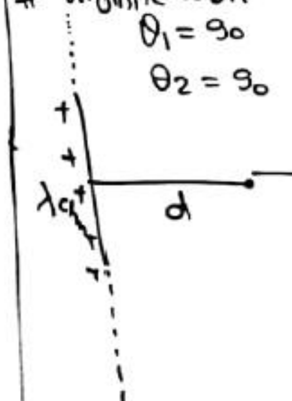

$E_\perp = \frac{K\lambda}{d} [\sin\theta_1 + \sin\theta_2]$

$E_{\parallel} = \frac{K\lambda}{d} [\cos\theta_2 - \cos\theta_1]$

# Infinite wire

$\theta_1 = 90$

$\theta_2 = 90$

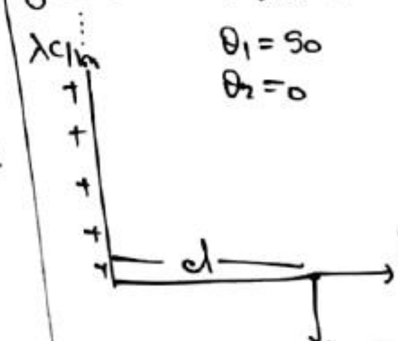



$E_{11} = \frac{2K\lambda}{d}$

For Semi-Infinite

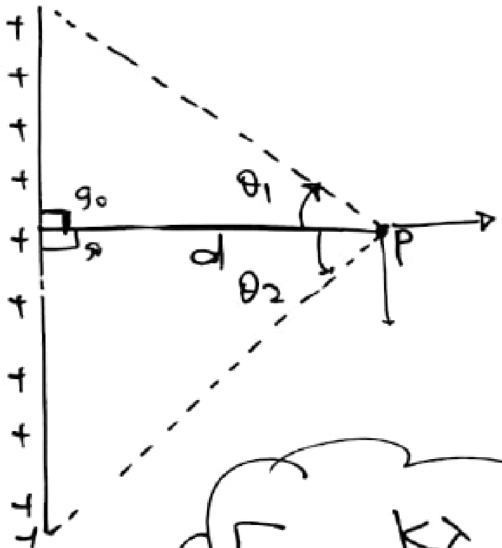
$\theta_1 = 90$

$\theta_2 = 0$




$E_1 = \frac{K\lambda}{d}$

$E_{11} = \frac{K\lambda}{d}$



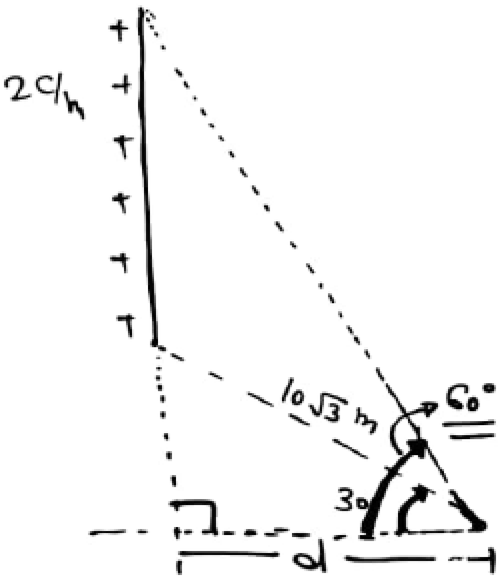

$d \rightarrow$ Perpendicular distance on point [where we find Electric field] to wire]

$\theta_1 \rightarrow$ Angle of upper part of wire from Perpendicular line [In Clockwise sense [+ive]]

$\theta_2 \rightarrow$ Angle of lower part of wire from Perpendicular line [ ACW]

$$E_{\perp} = \frac{K\lambda}{d}\left[\sin\theta_1 + \sin\theta_2\right]$$

$$E_{\parallel} = \frac{K\lambda}{d}\left[\cos\theta_2 - \cos\theta_1\right]$$

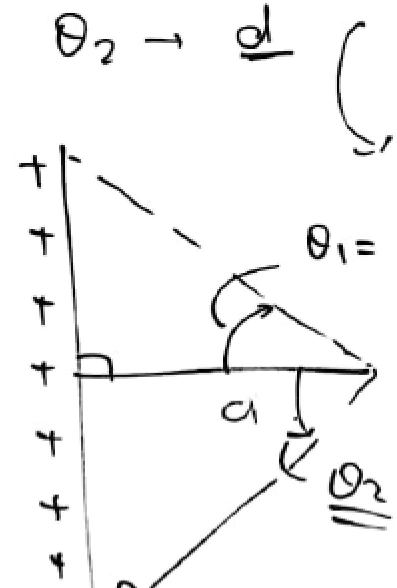



$$d = 15\,m$$

$$\theta_1 = 60^\circ$$

$$\theta_2 = -30^\circ$$

$$\boxed{E_\perp = \frac{K\lambda}{d}(\sin\theta_1 + \sin\theta_2) \qquad E_\parallel = \frac{K\lambda}{d}(\cos\theta_2 - \cos\theta_1)}$$




$$\cos 30 = \frac{d}{10\sqrt{3}}$$

$$d = \cos 30 \times 10\sqrt{3}$$

$$d = \frac{\sqrt{3}}{\cancel{2}} \times \cancel{10}\,5 \times \sqrt{3}$$

$$d = 15\,m$$

$$E_\perp = \frac{9\times 10^9 \times 2}{15}\left(\sin 60 + \sin(-30)\right)$$

$$= \frac{3\cancel{9}\times 2\times 10^9}{\cancel{15}\,5}\left(\frac{\sqrt{3}}{2} - \frac{1}{2}\right)$$

$$= \frac{6}{5}\times 10^9\left(\frac{\sqrt{3}-1}{2}\right)\,N/C$$