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$$Y_{(y)} = \sum_{n=1}^{\infty} C_n \sin\left(\frac{n\pi}{a} y\right) = V_0$$

$$\int_0^a \sum_{n=1}^{\infty} C_n \sin\left(\frac{n\pi}{a} y\right) \sin\left(\frac{n'\pi}{a} y\right) dy = \int_0^a V_0 \sin\left(\frac{n\pi}{a} y\right) dy$$

bring C_n out of integral

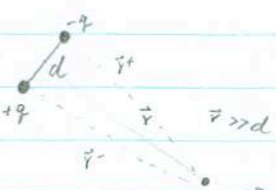
$$\int_0^a \sin\left(\frac{n\pi}{a} y\right) \sin\left(\frac{n'\pi}{a} y\right) dy = \begin{cases} 0 & \text{if } n \neq n' \\ \frac{a}{2} & \text{if } n = n' \end{cases} \rightarrow \frac{a}{2} \delta_{n,n'}$$

$$C_{n'} = \frac{2}{a} \int_0^a V_0 \sin\left(\frac{n'\pi}{a} y\right) dy = \frac{2V_0}{a} \; -\cos\left(\frac{n'\pi}{a} y\right) \frac{a}{n'\pi} \Big|_0^a$$

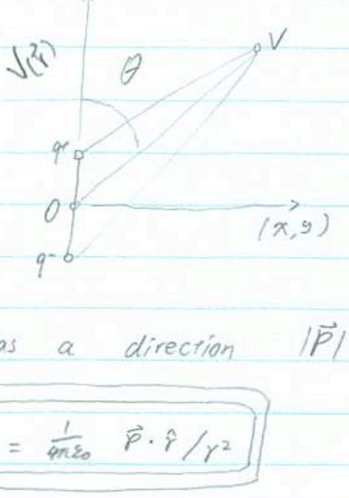
$$= \frac{2V_0}{n'\pi} \left[1 - \cos(n'\pi)\right] = \frac{4V_0}{n'\pi} \text{ for } n' = 1, 3, 5 \quad \text{and } 0 \text{ for } n = 0, 2, 4$$

$$V_{(x,y,z)} = \sum_{n=1,3,5}^{\infty} \frac{4V_0}{n\pi} e^{-\frac{n\pi x}{a}} \sin\left(\frac{n\pi y}{a}\right)$$

The Dipole



$$V_{(\vec{r})} = \frac{1}{4\pi\varepsilon_0} \left(\frac{q^+}{r_+} + \frac{q^-}{r_-}\right) = \frac{q}{4\pi\varepsilon_0} \left(\frac{1}{r_+} - \frac{1}{r_-}\right)$$



must define a coordinate

then we have $V_{(r)} = \frac{q}{4\pi\varepsilon_0} \frac{d}{r^2} \cos\theta$

a dipole has a direction $|\vec{P}| = q d$

soo $\boxed{V_{(r)} = \frac{1}{4\pi\varepsilon_0} \vec{P} \cdot \hat{r} / r^2}$

$$\vec{E}_{(r)} = -\vec{\nabla} \vec{V}_{(r)} = -\left[\frac{\partial}{\partial r}\hat{r} + \frac{1}{r}\frac{\partial}{\partial \theta}\hat{\theta} + \frac{1}{r\sin\theta}\frac{\partial}{\partial \phi}\hat{\phi}\right] \frac{1}{4\pi\varepsilon_0} \frac{P\cos\theta}{r^2}$$

$$= \frac{P}{4\pi\varepsilon_0 r^3} \left(2\cos\theta\,\hat{r} + \sin\theta\,\hat{\theta}\right)$$