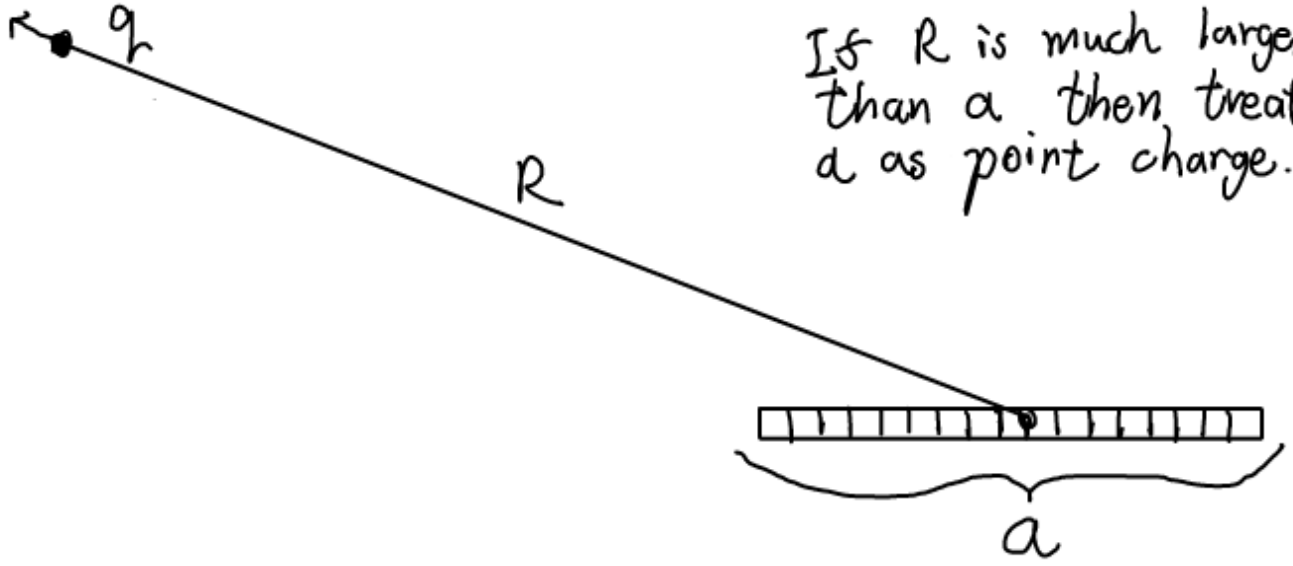
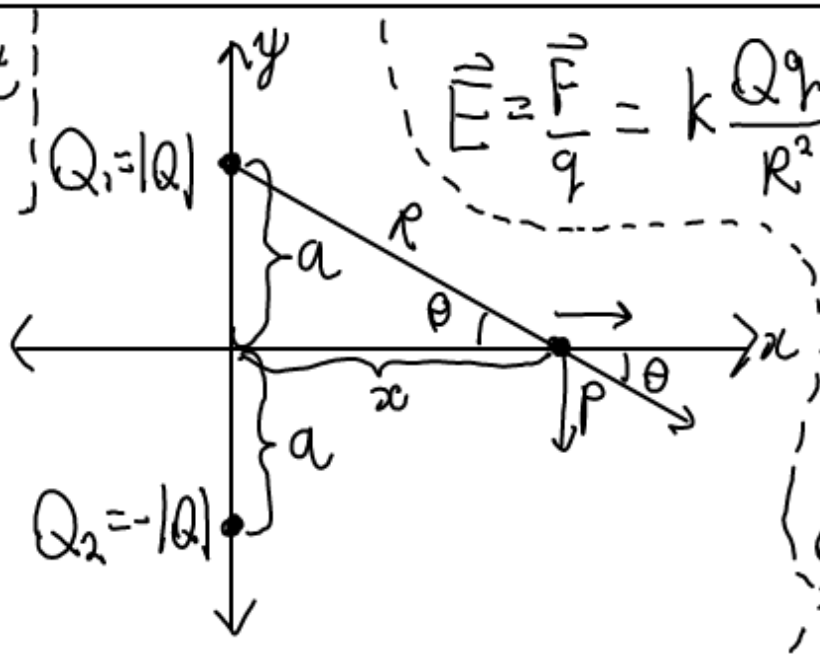
Electrostatic Field

Charge Distribution — point / line / surface / volume

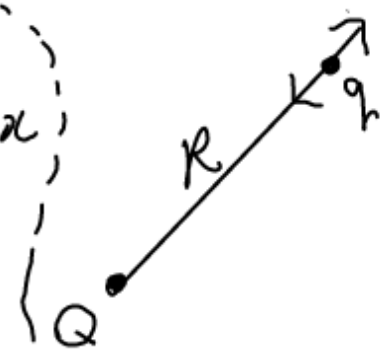


If R is much larger than a then treat a as point charge.

Find E at Point P

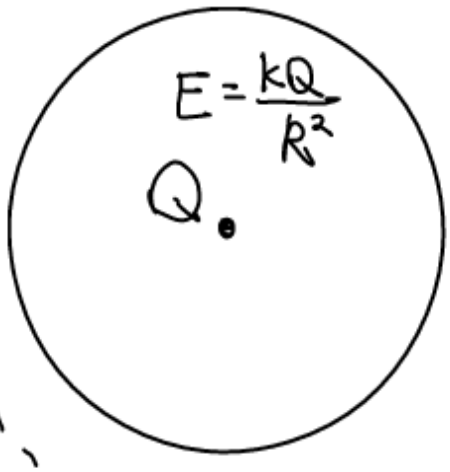


$$\vec{E}=\frac{\vec{F}}{q}=k\frac{Qq}{R^2}\left(\frac{1}{q}\right)=\frac{kQ}{R^2}$$



$$\vec{E}_{Q_1}=\frac{k|Q|}{R^2}\left(\cos\theta\,\hat{x}-\sin\theta\,\hat{y}\right)$$

$$=\frac{k|Q|}{R^2}\left(\frac{x}{R}\hat{x}-\frac{a}{R}\hat{y}\right)$$

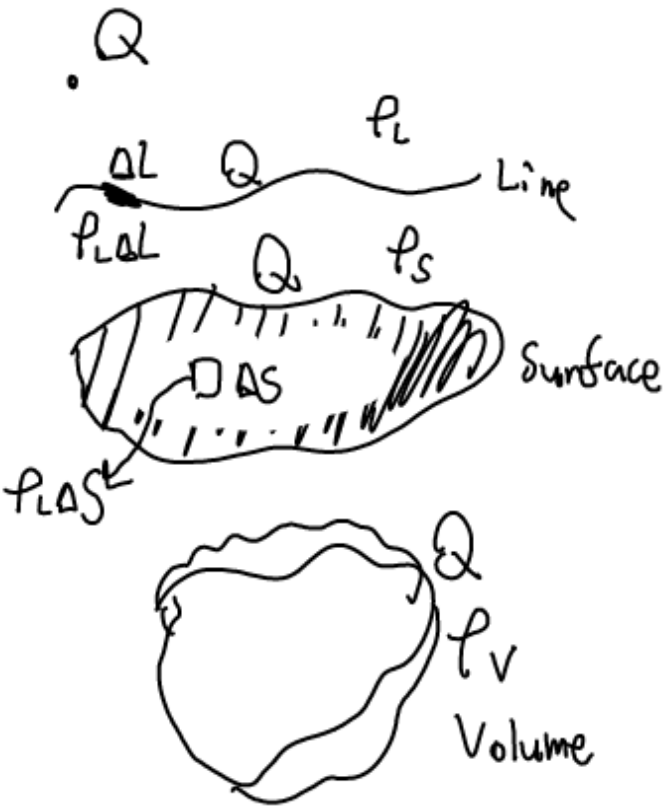


$$\vec{E}_{Q2} = \frac{k|Q|}{R^2}\left(-\frac{x}{R}\hat{x} - \frac{a}{R}\hat{y}\right)$$

$$\vec{E} = \vec{E}_{Q1} + \vec{E}_{Q2} = \frac{k|Q|}{R^2}\left(-\frac{2a}{R}\right)\hat{y} = \frac{2k|Q|a}{R^3}(-\hat{y})$$

if x is much greater than a. $= \frac{2k|Q|a}{\left(\sqrt{x^2+a^2}\right)^3}(-\hat{y})$

$$\vec{E} \to \frac{2ak|Q|}{x^3}(-\hat{y})$$



$$\rho_L = \frac{C}{m}$$

$$\rho_S = \frac{C}{m^2}$$

$$\rho_V = \frac{C}{m^3}$$