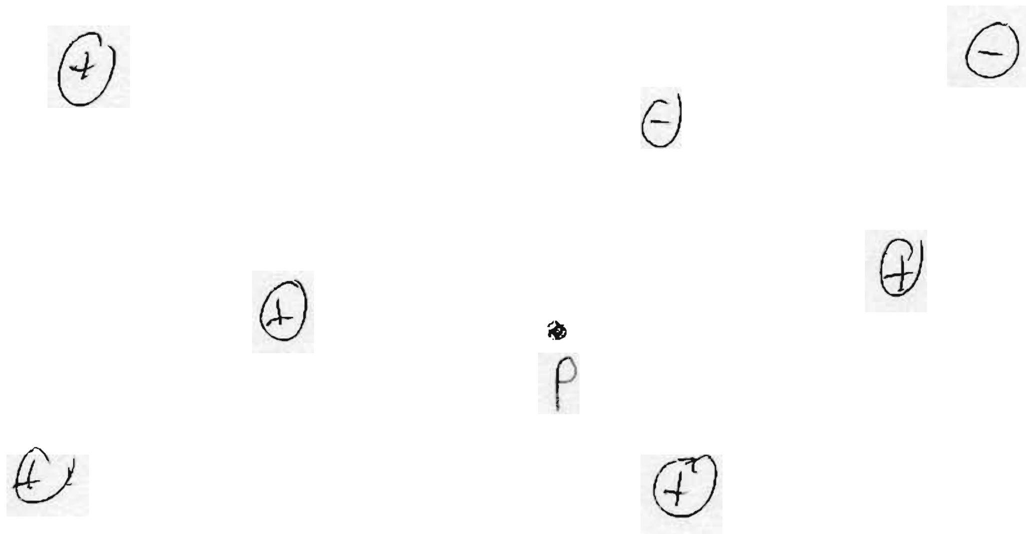
PHY 1122 LECTURE 11

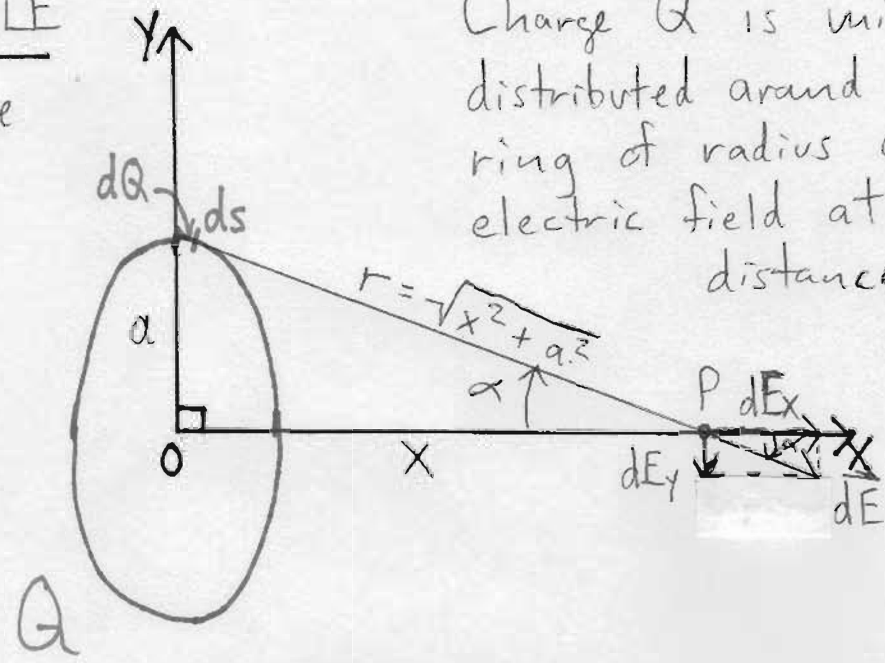


$$\vec{E} = \sum_{i=1}^{n} \frac{k q_i}{r_{ip}^2} \hat{r} \qquad k = \frac{1}{4\pi\epsilon_0}$$

EXAMPLE

See example 21.9 in textbook.

Charge Q is uniformly distributed around a conducting ring of radius a. Find the electric field at point P at distance x from its center.



$$dE = \frac{1}{4\pi\epsilon_0} \frac{dQ}{x^2 + a^2}$$

linear charge density $\lambda = \dfrac{Q}{2\pi a}$

$s = r\theta$

charge for segment of length ds

$$dQ = \lambda \, ds$$

x - component of field is

$$dE_x = dE \cos\alpha$$

$$\cos\alpha = \frac{x}{r} = \frac{x}{(x^2 + a^2)^{1/2}}$$

$$dE_x = dE\cos\alpha = \frac{1}{4\pi\epsilon_0}\frac{\lambda}{x^2+a^2}\frac{x}{\sqrt{x^2+a^2}}\,ds$$

$$= \frac{1}{4\pi\epsilon_0}\frac{\lambda x}{(x^2+a^2)^{3/2}}\,ds$$

$$E_x = \int dE_x = \frac{1}{4\pi\epsilon_0}\frac{\lambda x}{(x^2+a^2)^{3/2}}\int_0^{2\pi a} ds$$

$$= \frac{1}{4\pi\epsilon_0}\frac{\lambda x}{(x^2+a^2)^{3/2}}\,2\pi a$$

$$\vec{E} = E_x\,\hat{i}$$

$$\boxed{\vec{E} = \frac{1}{4\pi\epsilon_0}\frac{Qx}{(x^2+a^2)^{3/2}}\,\hat{i}}$$

$$x \gg a$$

$$\vec{E} = \frac{1}{4\pi\epsilon_0}\frac{Q}{x^2}\,\hat{i}$$