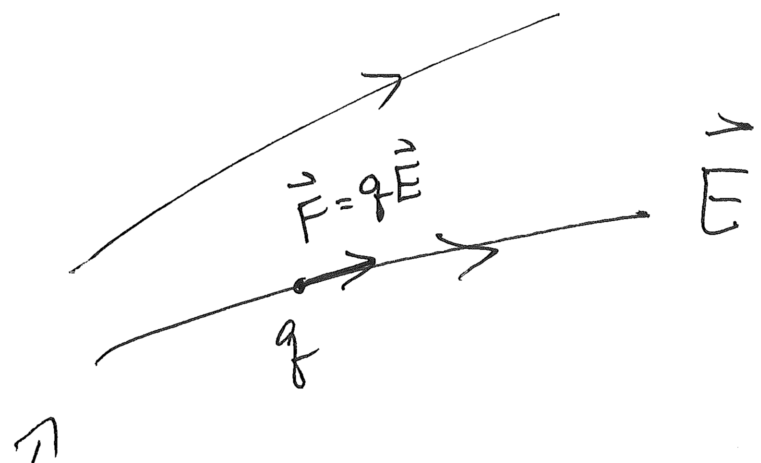
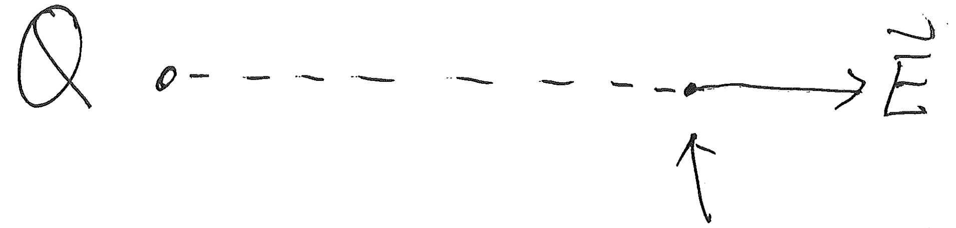


Electric field from other charges.

$$F = \frac{1}{4\pi\varepsilon_0}\frac{Qq}{r^2}$$

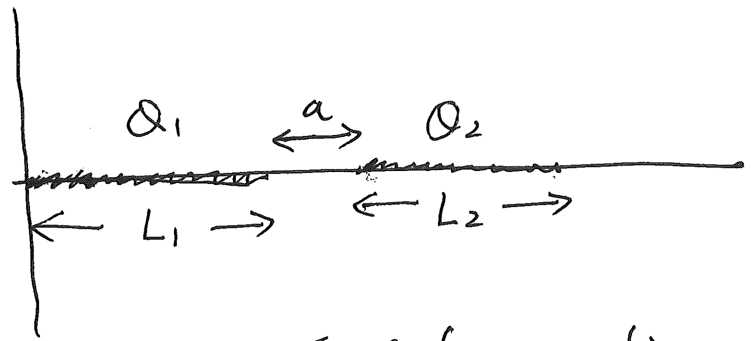
$$= qE$$

$$E \text{ due to } Q = E = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}$$



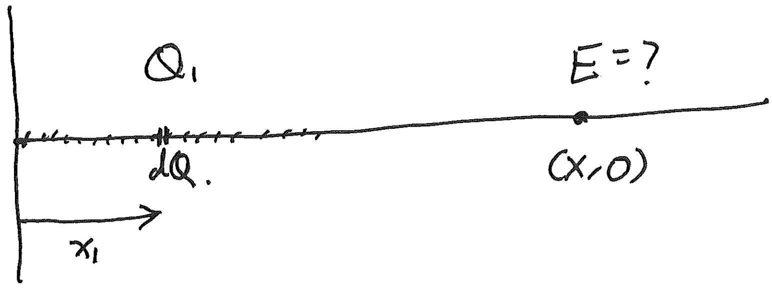
$$E = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}.$$

(negative charge)



Total force acting on $Q_2 = ?$

Electric field due to Q_1 :



$$dE = \frac{1}{4\pi\varepsilon_0}\frac{dQ}{(x-x_1)^2}$$

$$E = \frac{1}{4\pi\varepsilon_0}\int\frac{dQ}{(x-x_1)^2}$$

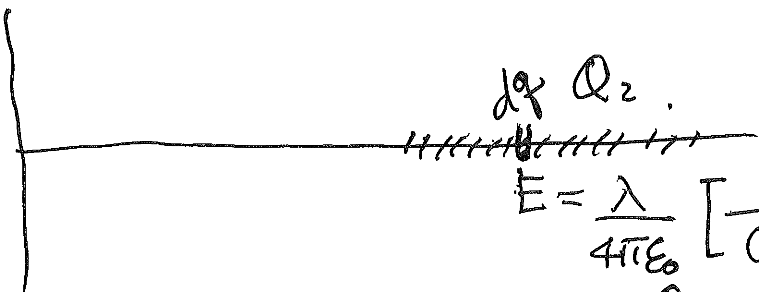
$dQ = \lambda\, dx_1 \quad \left(\lambda = \frac{Q_1}{L_1}\right)$

$$= \frac{1}{4\pi\varepsilon_0}\int_0^{L_1}\frac{\lambda\, dx_1}{(x-x_1)^2}$$

$$E = \frac{1}{4\pi\varepsilon_0}\left[\frac{\lambda}{(x-x_1)}\right]_0^{L_1}$$

$$= \frac{\lambda}{4\pi\varepsilon_0}\left[\frac{1}{(x-L_1)} - \frac{\cancel{\lambda}1}{x\cancel{L_1}}\right] //.$$

$$=$$



$$E = \frac{\lambda}{4\pi\varepsilon_0}\left[\frac{1}{(x-L_1)} - \frac{1}{x}\right].$$

$$= \frac{Q_1}{4\pi\varepsilon_0 L_1}\left[\frac{1}{(x-L_1)} - \frac{1}{x}\right].$$

dF = Force acting on dq

$$= E\,dq.$$

$$= \frac{Q_1}{L_1 4\pi\varepsilon_0}\left[\frac{1}{(x-L_1)} - \frac{1}{x}\right] dq$$

$$dF = \int dF$$

$$= \frac{Q_1}{4\pi\varepsilon_0 L_1} \int \left[\frac{1}{x-L_1} - \frac{1}{x} \right] dq.$$

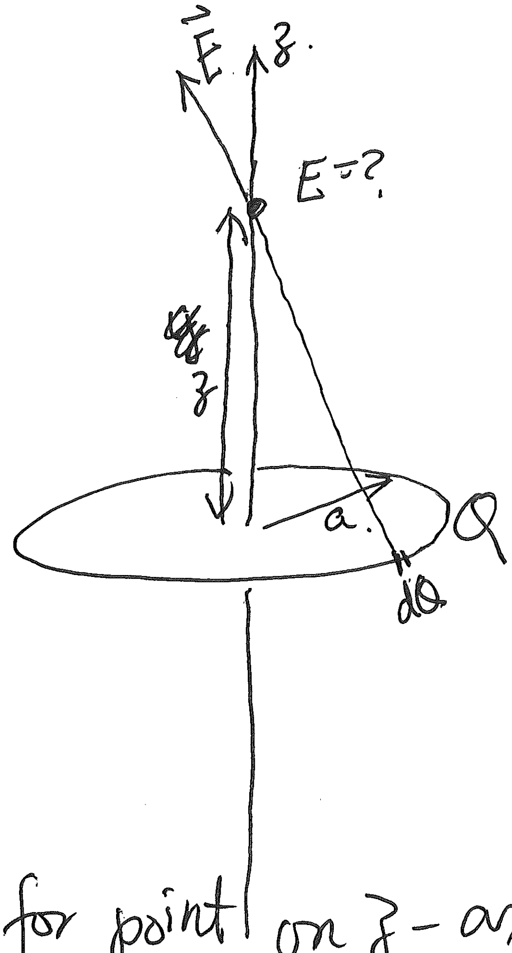
$$dq = \lambda' \, dx. \quad \left(\lambda' = \frac{Q_2}{L_2} \right).$$

$$dF = \frac{Q_1}{4\pi\varepsilon_0 L_1} \int_{a+L_1}^{a+L_1+L_2} \left[\frac{1}{x-L_1} - \frac{1}{x} \right] \lambda' \, dx.$$

$$= \frac{Q_1 Q_2}{4\pi\varepsilon_0 L_1 L_2} \left[\ln \left[\frac{x-L_1}{x} \right] \right]_{a+L_1}^{a+L_1+L_2}.$$

$$= \frac{Q_1 Q_2}{4\pi\varepsilon_0 L_1 L_2} \left[\left(\ln \frac{a+L_2}{a+L_1+L_2} \right) - \left(\ln \frac{a}{a+L_1} \right) \right]$$

$$= \frac{Q_1 Q_2}{4\pi\varepsilon_0 L_1 L_2} \ln \frac{(a+L_1)(a+L_2)}{a(a+L_1+L_2)} \quad //$$



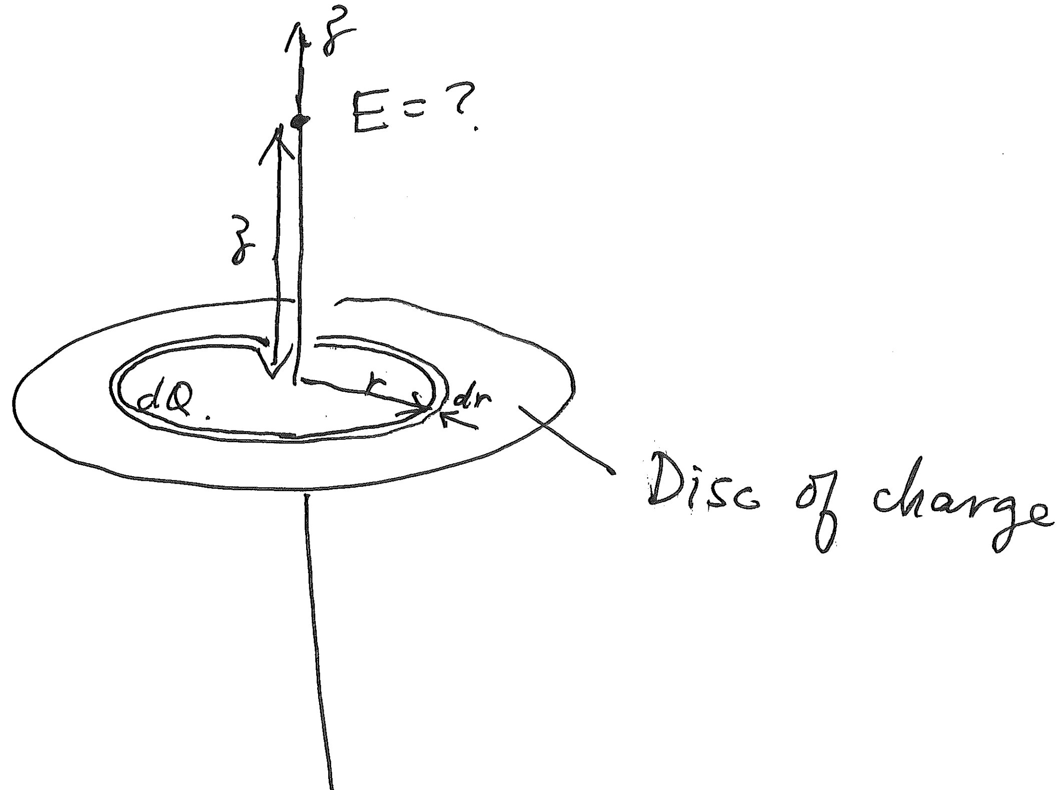
ONLY for point on z-axis:

$$E_x = E_y = 0$$

$$dE_z = \frac{1}{4\pi\varepsilon_0}\frac{dQ}{a^2+z^2} \qquad (r^2 = a^2+z^2).$$

$$\therefore E_z = \int dE_z = \frac{1}{4\pi\varepsilon_0 (a^2+z^2)}\int dQ.$$

$$= \frac{Q}{4\pi\varepsilon_0 (a^2+z^2)}.$$



dE due to the infinitesimal ring

$$= \frac{1}{4\pi\varepsilon_0} \frac{dQ}{(z^2+r^2)}$$

$$\cancel{\text{To}}\ E = \frac{1}{4\pi\varepsilon_0} \int \frac{dQ}{(z^2+r^2)}$$

$$dQ = \sigma\, dA$$

$$= \sigma\, 2\pi r\, dr \leftarrow$$

(to be continued)