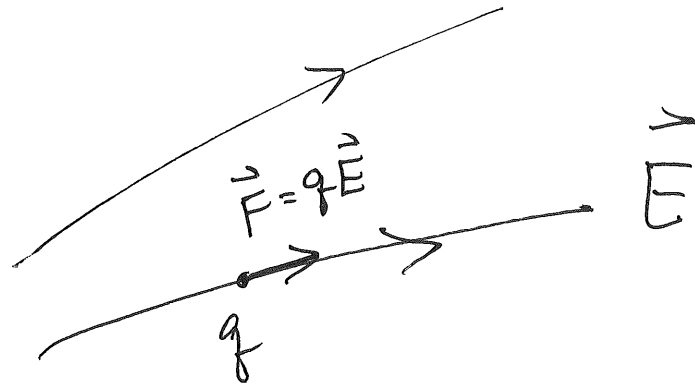




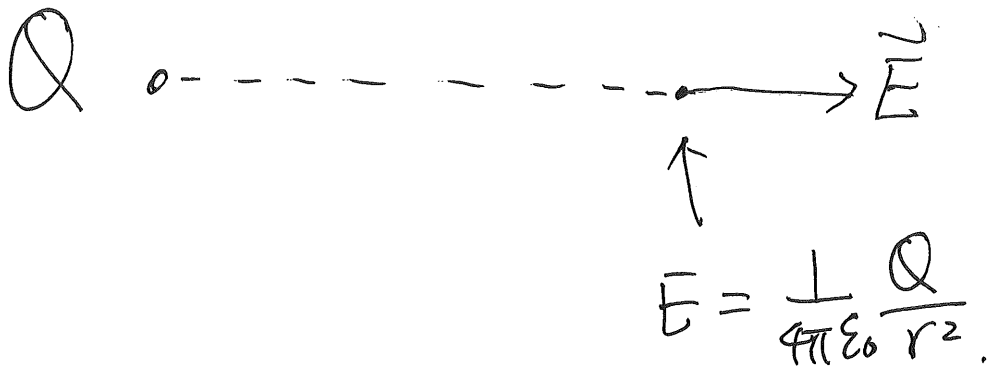
↑
Electric field from other
charges.

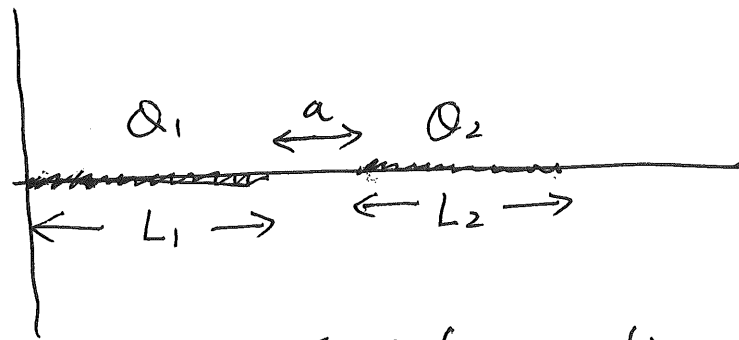
A diagram showing two point charges. On the left is a charge labeled $+Q$. On the right is a charge labeled $+q$. A horizontal line with arrows at both ends connects them, with the letter r in the middle representing the distance. To the right of the diagram, the following equations are written:

$$F = \frac{1}{4\pi\epsilon_0} \frac{Qq}{r^2}$$

$$= qE$$

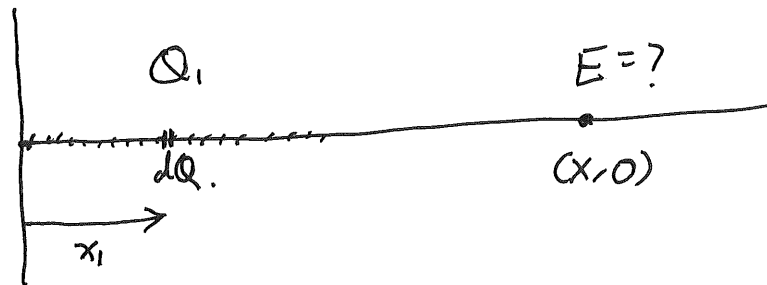
$$E \text{ due to } Q = E = \frac{1}{4\pi\epsilon_0} \frac{Q}{r^2}$$





Total force acting on $Q_2 = ?$

Electric field due to Q_1 :



$$dE = \frac{1}{4\pi\epsilon_0} \frac{dQ}{(x-x_1)^2}$$

$$E = \frac{1}{4\pi\epsilon_0} \int \frac{dQ}{(x-x_1)^2}$$

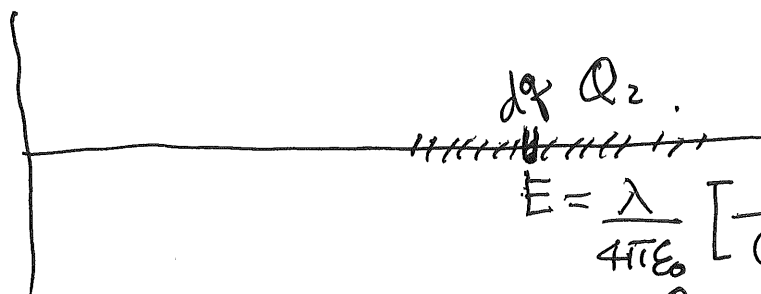
$$= \frac{1}{4\pi\epsilon_0} \int_0^{L_1} \frac{\lambda dx_1}{(x-x_1)^2}$$

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

$$E = \frac{1}{4\pi\epsilon_0} \left[\frac{\lambda}{(x-x_1)} \right]_0^{L_1}$$

$$= \frac{\lambda}{4\pi\epsilon_0} \left[\frac{1}{(x-L_1)} - \frac{1}{x} \right] //$$

$$= \frac{\lambda}{4\pi\epsilon_0}$$



$$E = \frac{\lambda}{4\pi\epsilon_0} \left[\frac{1}{(x-L_1)} - \frac{1}{x} \right],$$

$$= \frac{Q_1}{4\pi\epsilon_0 L_1} \left[\frac{1}{(x-L_1)} - \frac{1}{x} \right],$$

$dF =$ Force acting on dq

$$= E dq.$$

$$= \frac{Q_1}{L_1 4\pi\epsilon_0} \left[\frac{1}{(x-L_1)} - \frac{1}{x} \right] dq$$

$$dF = \int dF$$

$$= \frac{Q_1}{4\pi\epsilon_0 L_1} \int \left[\frac{1}{x-L_1} - \frac{1}{x} \right] dq.$$

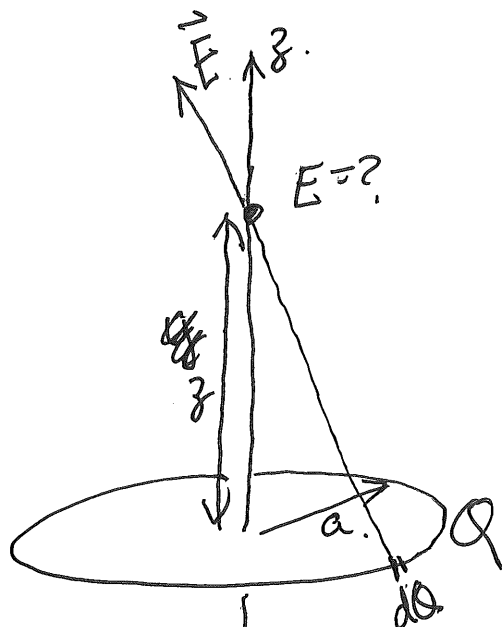
$$dq = \lambda' dx. \quad (\lambda' = \frac{Q_2}{L_2}).$$

$$dF = \frac{Q_1}{4\pi\epsilon_0 L_1} \int_{a+L_1}^{a+L_1+L_2} \left[\frac{1}{x-L_1} - \frac{1}{x} \right] \lambda' dx.$$

$$= \frac{Q_1 Q_2}{4\pi\epsilon_0 L_1 L_2} \left[\ln \left[\frac{x-L_1}{x} \right] \right]_{a+L_1}^{a+L_1+L_2}.$$

$$= \frac{Q_1 Q_2}{4\pi\epsilon_0 L_1 L_2} \left[\ln \frac{a+L_2}{a+L_1+L_2} - \ln \frac{a}{a+L_1} \right]$$

$$= \frac{Q_1 Q_2}{4\pi\epsilon_0 L_1 L_2} \ln \frac{(a+L_1)(a+L_2)}{a(a+L_1+L_2)} //$$

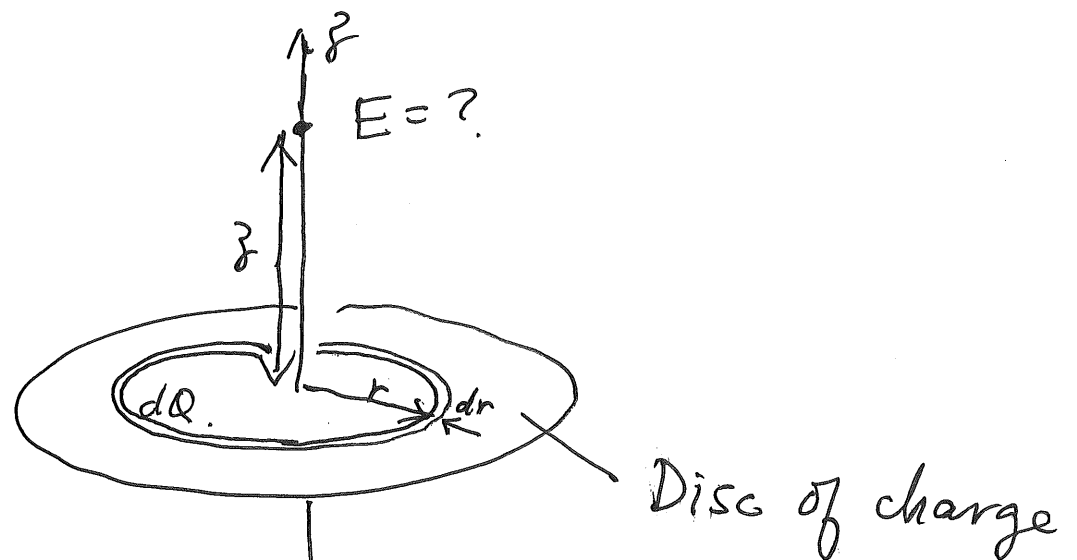


ONLY for point on z -axis:

$$E_x = E_y = 0$$

$$dE_z = \frac{1}{4\pi\epsilon_0} \frac{dQ}{a^2 + z^2} \quad (r^2 = a^2 + z^2).$$

$$\begin{aligned} \therefore E_z &= \int dE_z = \frac{1}{4\pi\epsilon_0 (a^2 + z^2)} \int dQ \\ &= \frac{Q}{4\pi\epsilon_0 (a^2 + z^2)}. \end{aligned}$$



dE due to the infinitesimal ring

$$= \frac{1}{4\pi\epsilon_0} \frac{dQ}{(z^2 + r^2)}$$

$$\therefore E = \frac{1}{4\pi\epsilon_0} \int \frac{dQ}{(z^2 + r^2)}$$

$$dQ = \sigma dA$$

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

(to be continued)