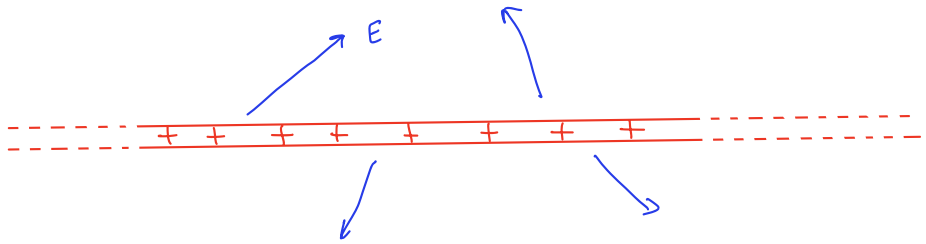
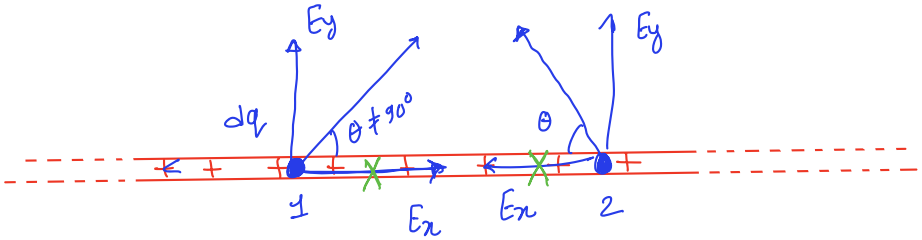
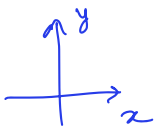
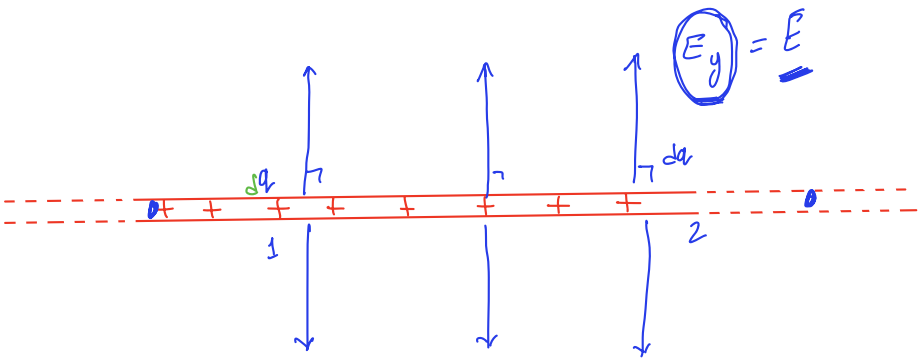
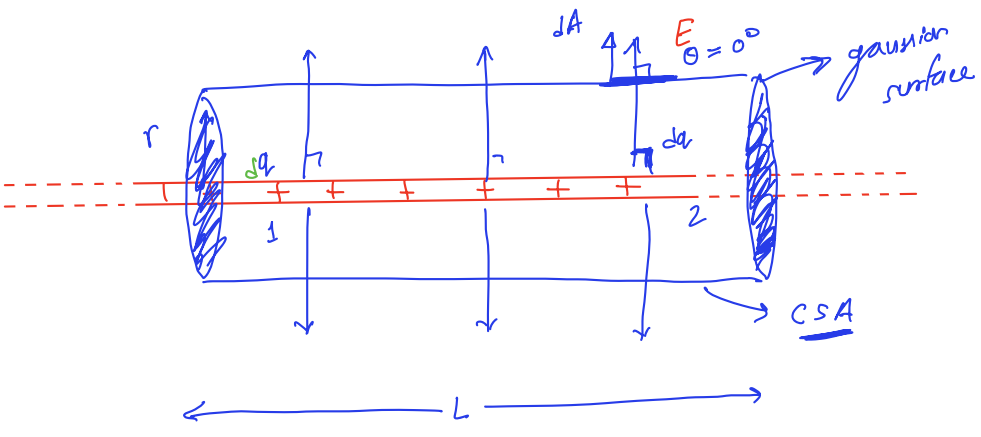
Example 2: What is the electric field from an infinitely long line of charge with charge per unit length λ (uniform).











$$\Phi_E = \frac{q_{enc}}{\varepsilon_0} \Rightarrow \oint \vec{E} \cdot d\vec{A} = \frac{q_{enc}}{\varepsilon_0}$$

$$\oint E\, dA \cos\theta = E \oint dA = \frac{q_{enc}}{\varepsilon_0}$$

$$E \text{ Area (Curved surface)} = \frac{q_{enc}}{\varepsilon_0}$$

$$E\, 2\pi r L = \frac{q_{enc}}{\varepsilon_0}$$

$$\lambda = \frac{\text{charge}}{\text{length}} = \frac{q_{enc}}{L} \Rightarrow \boxed{L\lambda = q_{enc}}$$

$$E \cdot 2\pi r L = \frac{L\lambda}{\varepsilon_0}$$

$$\Rightarrow \boxed{E = \frac{\lambda}{2\pi r \varepsilon_0}}$$