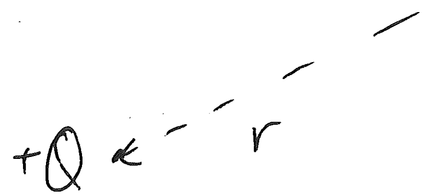
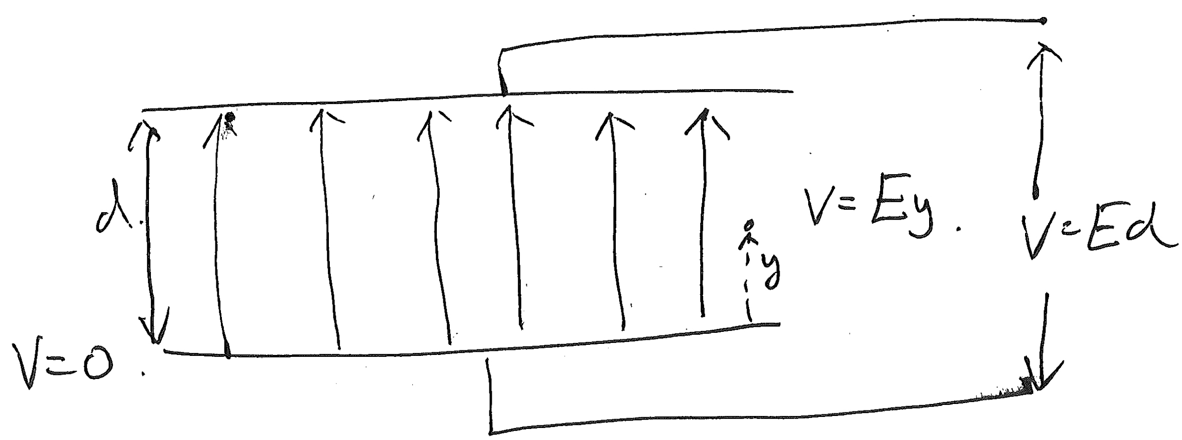
V of a point charge.

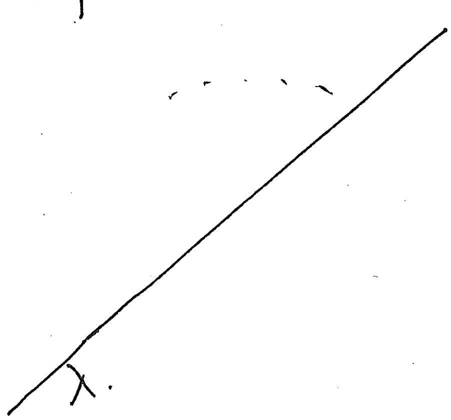
$$\Rightarrow V = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r}.$$



V of a uniform field.



V for E field of a long wire.



$$\varepsilon_0 \cdot E \cdot 2\pi r L = \lambda L$$

$$\Rightarrow E = \frac{\lambda}{2\pi\varepsilon_0}\cdot\frac{1}{r}.$$

$$V = -\int E\,dr = -\frac{\lambda}{2\pi\varepsilon_0}\ln r + C.$$

To be determined by the r at V=0.

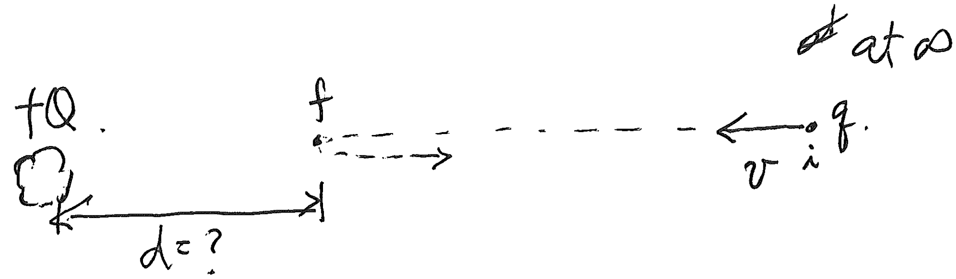
Conservation of Energy

$$\Delta KE + \Delta PE = 0.$$

$$\frac{1}{2}m(v_f^2 - v_i^2) + (V_f - V_i)q = 0$$

$$\frac{1}{2}m(v_f^2 - v_i^2) + q(V_f - V_i) = 0.$$

e.g.

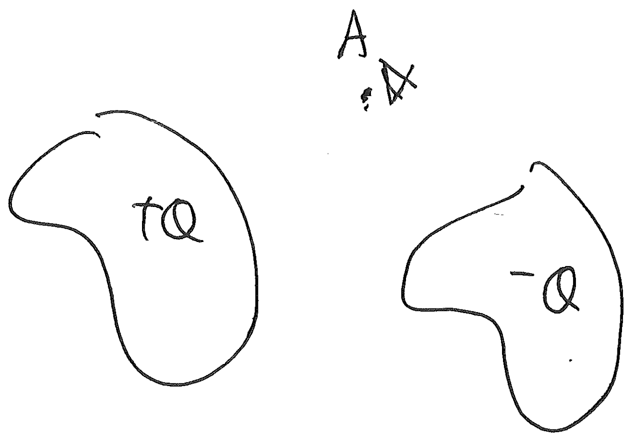


$$(KE_f - KE_i) + (PE_f - PE_i) = 0.$$

$$\left(0 - \frac{1}{2}mv^2\right) + \left(\frac{1}{4\pi\varepsilon_0}\frac{Q}{d} - 0\right) = 0.$$

$$\frac{1}{4\pi\varepsilon_0}\frac{Q}{d} = \frac{1}{2}mv^2.$$

$$\Rightarrow d = \frac{Q}{2\pi\varepsilon_0 mv^2}$$



Q is always positive by choice

For the same charge distribution,

$$V \propto Q.$$

e.g. V at point A is 3V when $Q = 2\mu C$.

V at point A will be $3 \times \frac{3}{2} = 4.5V$ when $Q = 3\mu C$.

⋮

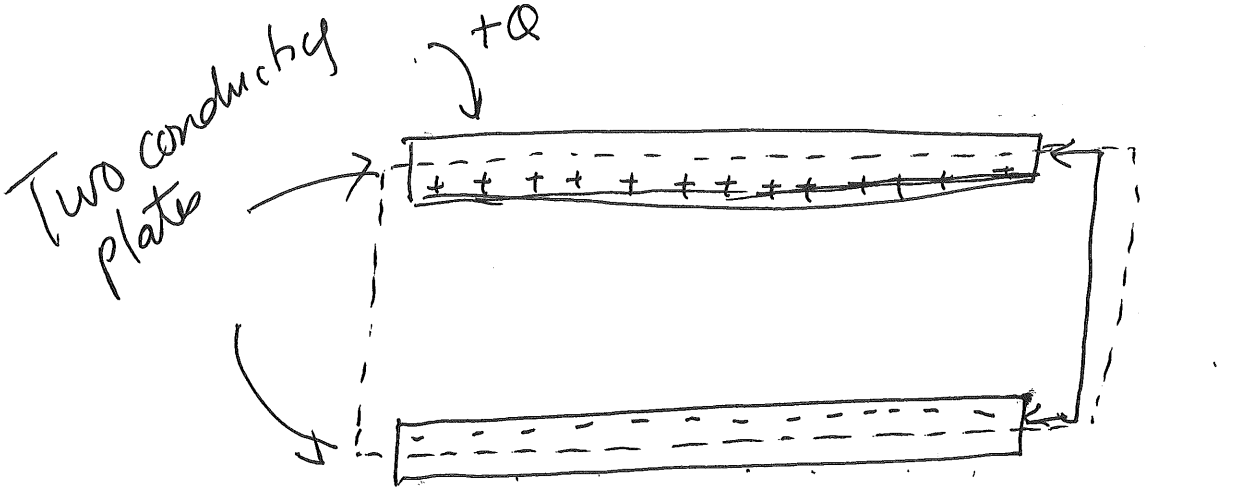
Proportional constant = C.

$$C = \frac{Q}{V}.$$

$$\boxed{Q = CV}$$

Hiding all the complicated integration in C!

① Units of capacitance = Farad (F) ≡ C/V.



Just one plate