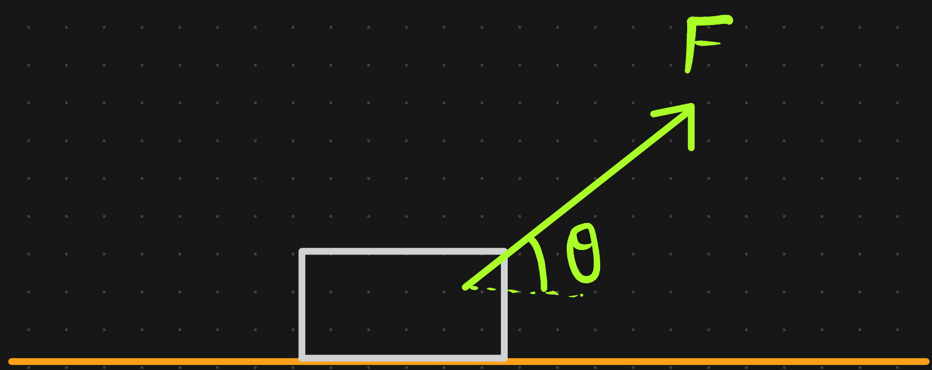
setup:

- both
- just +ve charge
- just -ve charge
- both w/ equipotential

# EQUATIONS:

- $W = F \cdot s \cdot \cos\theta$ (J)




'test' charge

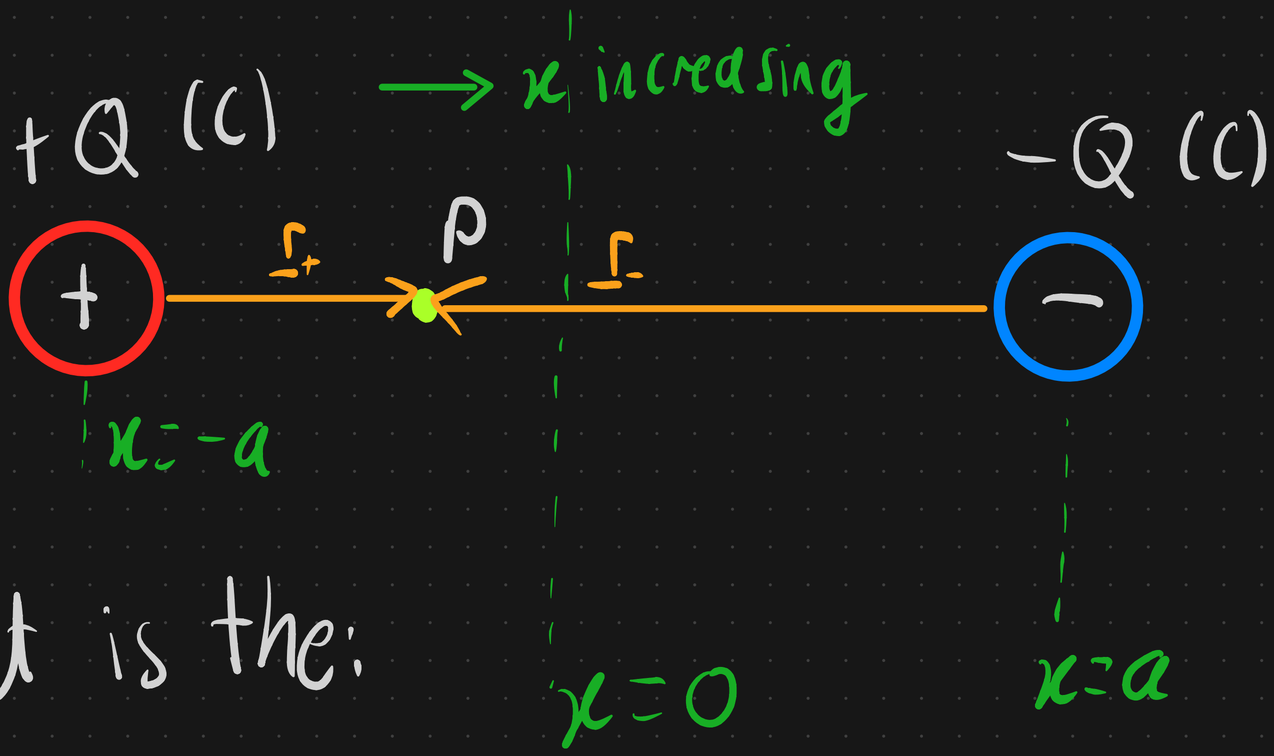
- $\underline{F} = \dfrac{1}{4\pi\varepsilon_0} \cdot \dfrac{Q \cdot q}{r^2} \, \underline{\hat{r}} = \underline{E} q$ (N)

From Q to q

  ↳ $\underline{E} = \dfrac{1}{4\pi\varepsilon_0} \dfrac{Q}{r^2} \underline{\hat{r}}$ (V/m)

- $V = \dfrac{1}{4\pi\varepsilon_0} \dfrac{Q}{r}$ (V)

  $= \dfrac{W}{Q}$




what is the:

a) Force a particle of charge $q$ experiences at point P, as P varies along the x-axis?

b) Potential at point P (if V at infinity = 0), as P varies along the x axis

a) $\underline{E}_+ = \frac{1}{4\pi\epsilon_0} \frac{(+Q)}{r_+^2} \hat{\underline{r}}_+$

but, only on x axis:

$\underline{E}_+ = \frac{1}{4\pi\epsilon_0} \frac{Q}{r_+^2} \hat{\underline{x}}$ $\left( \underline{E}_+ = \frac{1}{4\pi\epsilon_0} \frac{Qa}{r_+^2} \hat{\underline{x}} \right)$

$\underline{E}_- = \frac{1}{4\pi\epsilon_0} \frac{(-Q)}{r_-^2} \hat{\underline{r}}_-$ where does this point?


$\hookrightarrow \hat{\underline{r}}_- = -\hat{\underline{x}}$

SO:

$$\underline{E}_- = \frac{1}{4\pi\epsilon_0}\frac{(-Q)}{r_-^2}(-\hat{\underline{x}})$$

$$\underline{E}_- = \frac{1}{4\pi\epsilon_0}\frac{Q}{r_-^2}\hat{\underline{x}} \quad \left(\underline{F}_- = \frac{1}{4\pi\epsilon_0}\frac{Qq}{r_-^2}\hat{\underline{x}}\right)$$

$$\underline{F}_{total} = \underline{F}_+ + \underline{F}_- = \frac{Qq}{4\pi\epsilon_0}\left(\frac{1}{r_+^2} + \frac{1}{r_-^2}\right)\hat{\underline{x}}\ N$$

eg, when $r_+ = r_- = a$ (i.e. at origin)

$$\underline{F}_{total}\ (\text{at origin}) = \frac{2 \cdot Qq}{4\pi\epsilon_0 a^2}\hat{\underline{x}}\ N$$

b)

$$V_+ = \frac{1}{4\pi\epsilon_0}\frac{(+Q)}{r_+}$$

$$V_- = \frac{1}{4\pi\epsilon_0}\frac{(-Q)}{r_-}$$

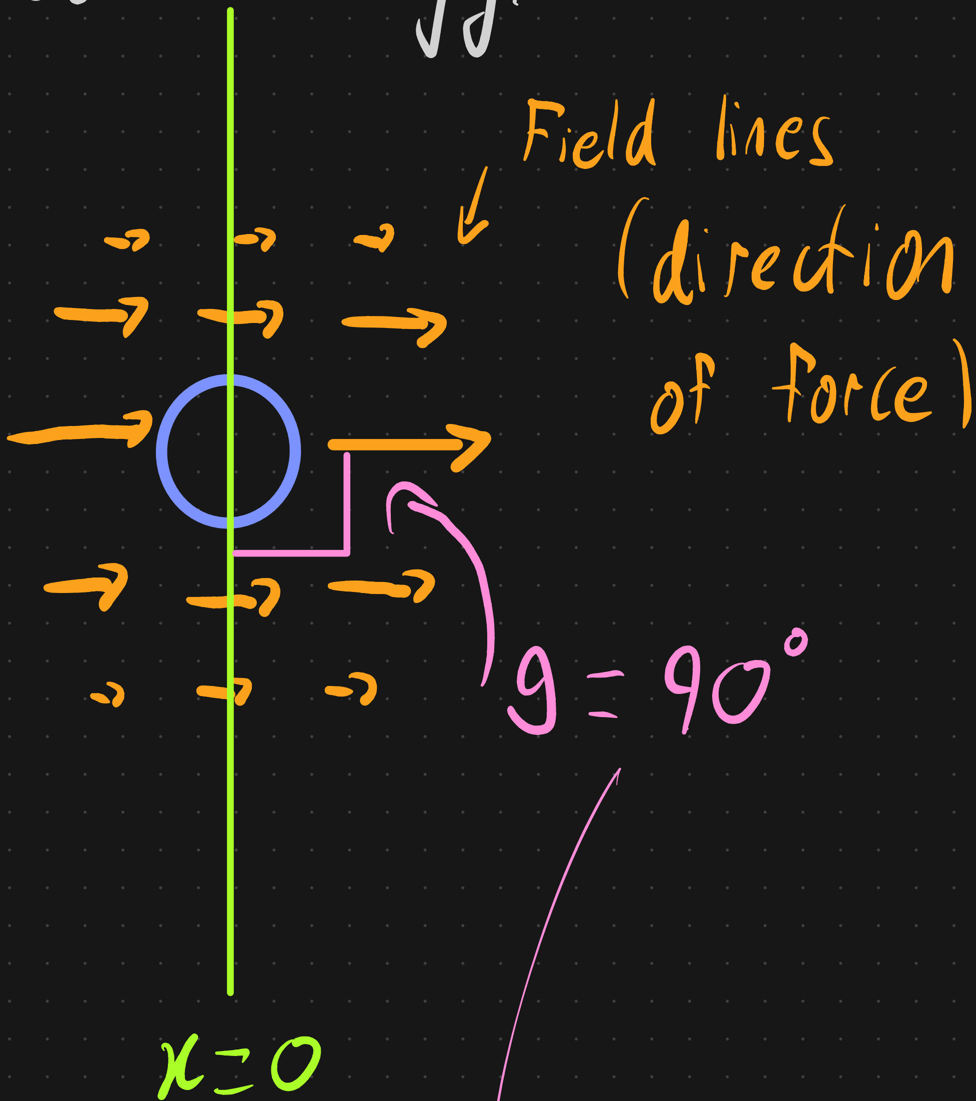
$$V_{tot} = V_+ + V_- = \frac{Q}{4\pi\epsilon_0}\left(\frac{1}{r_+} - \frac{1}{r_-}\right) V$$

so, eg

$V_{tot}$ (at origin, $r_+ = r_- = a$) $= 0$!

↳ why is potential 0, but force non-zero?

Think about energy!




$\hookrightarrow W = F \cdot s \cdot \cos 90 = 0\,J$

$\hookrightarrow V = \dfrac{W}{Q} = 0\,V$