2. Electric Potential :-

$\vec{F} \to \vec{E} \to V$ (Scalar)

G : Attractive

why not zero?

$R \to \infty$ $\quad W_{me} = \int_R^\infty \cdots = +ve$ $\quad \}\ W_g = -ve$

$\infty \to R$ $\quad W_g = +ve$ $\quad \}\ W_{me} = -ve$

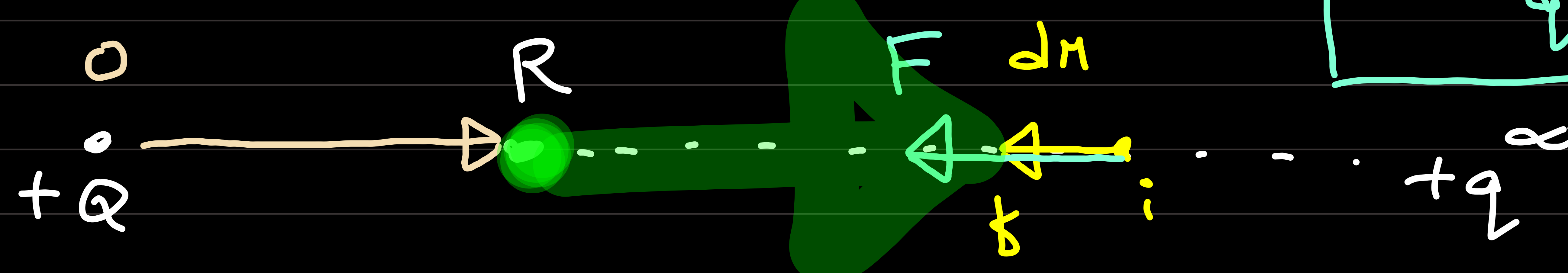
Electric potential

- Work done per unit charge (against electric force)

Test = $+q$

$$\boxed{V = \frac{W}{q}}$$

I) Source = $+Q$

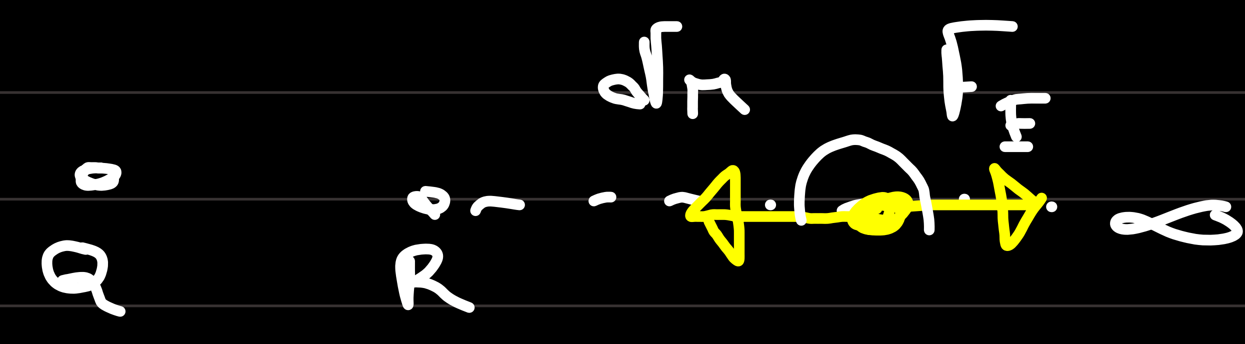


$$W = \int \vec{F}\cdot d\vec{r} = \int |\vec{F}|\,|d\vec{r}| \underbrace{\cos 0^\circ} = \int F\,dr$$

$$W = \int_\infty^R \frac{1}{4\pi\varepsilon_0}\frac{Qq}{r^2}\,dr = \frac{Qq}{4\pi\varepsilon_0}\int_\infty^R \frac{1}{r^2}\,dr$$

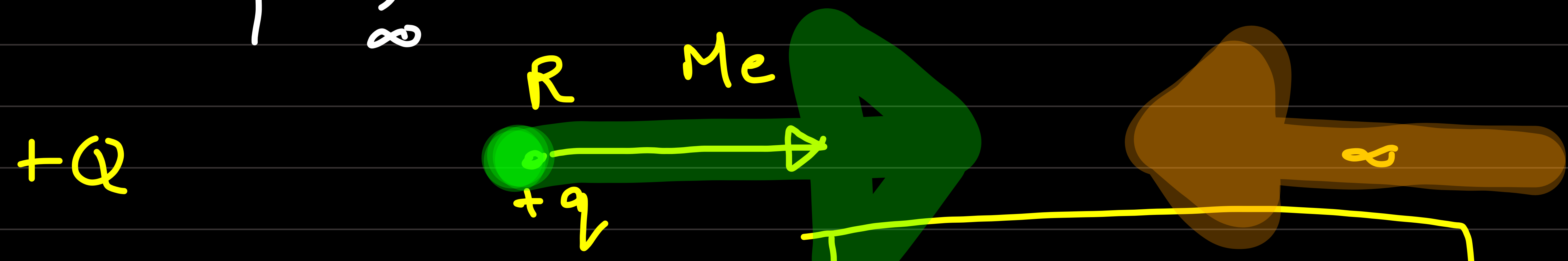
$$= \frac{Qq}{4\pi\varepsilon_0}\left[-\frac{1}{r}\right]_\infty^R = \frac{Qq}{4\pi\varepsilon_0}\left[-\frac{1}{R} - \left(\overset{\nearrow 0}{-\frac{1}{\infty}}\right)\right]$$

$$W = -\frac{1}{4\pi\varepsilon_0}\frac{Qq}{R}$$



$$W_{me} = \int_{\infty}^{R} \vec{F}_{me}\cdot d\vec{r} = \int_{\infty}^{R} -\underbrace{\vec{F}_E\cdot d\vec{r}}_{0}$$

$$= -\int_{\infty}^{R} F_E\, dr \cos 180^\circ$$



$$W_{me}\Big|_{R}^{\infty} = -ve \qquad \boxed{W_{field}\Big|_{R}^{\infty} = +ve}$$

$$\boxed{W_{field}}\Big|_{R}^{\infty} = \int_{R}^{\infty} \vec{F}_E\cdot d\vec{r} = \int_{R}^{\infty} F\, dr = \int_{R}^{\infty} \frac{1}{4\pi\varepsilon_0}\frac{Qq}{r^2}\,dr$$

$$= \frac{Qq}{4\pi\varepsilon_0}\left[-\frac{1}{r}\right]_{R}^{\infty} = \frac{Qq}{4\pi\varepsilon_0}\left[-\frac{1}{\infty}-\left(-\frac{1}{R}\right)\right]$$

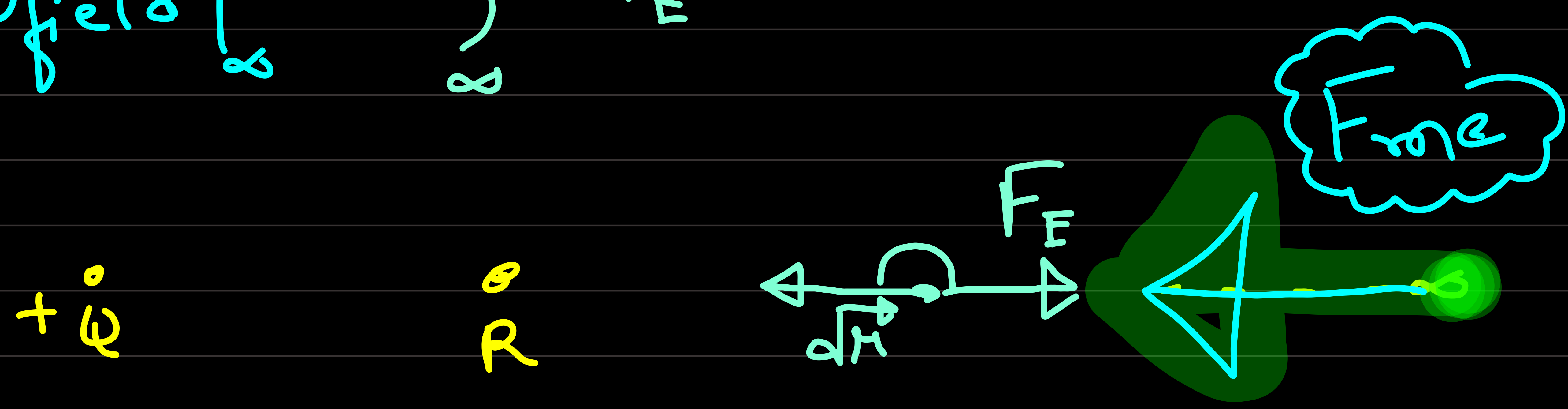
$$= +\frac{Qq}{4\pi\varepsilon_0 R}$$ Happy!

$$\boxed{W_{me}}\Big|_{\infty}^{R} = \int_{\infty}^{R} \vec{F}_{me}\cdot d\vec{r}$$

$$W_{me}\Big|_{R}^{\infty} = -\frac{Qq}{4\pi\varepsilon_0 R}$$

$$W_{field}\Big|_{\infty}^{R} = -\underbrace{W_{me}\Big|_{\infty}^{R}}$$

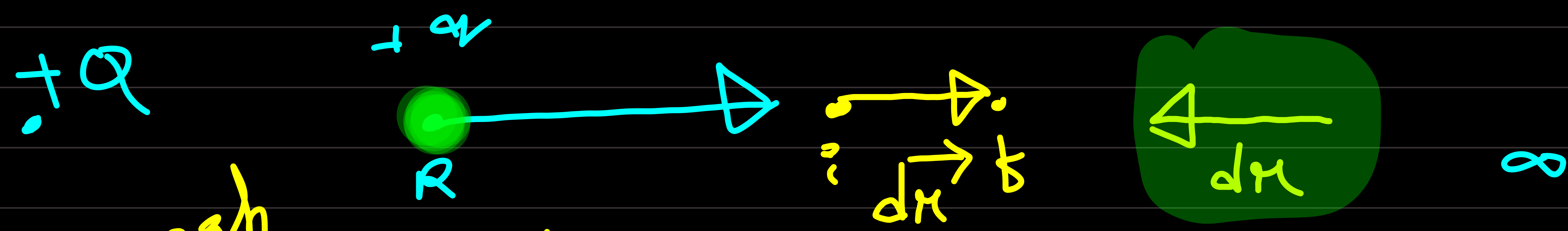
$$W_{field}\Big|_{\infty}^{R} = \int_{\infty}^{R} \vec{F_E}\cdot d\vec{r}$$



$$= -\int_{\infty}^{R} \frac{1}{4\pi\varepsilon_0}\frac{Qq}{r^2}\,dr = -\frac{Qq}{4\pi\varepsilon_0}\left[-\frac{1}{r}\right]_{\infty}^{R}$$

$$= -\frac{Qq}{4\pi\varepsilon_0}\left[-\frac{1}{R}-\left(-\frac{1}{\infty}\right)\right]$$

$$W_{field}\Big|_{\infty}^{R} = +\frac{Qq}{4\pi\varepsilon_0 R} \quad \langle \text{Sad!} \rangle$$



$W_{me} = +mgh$ $PE = mgh$

F_{me}

Happy!

I) $R \to \infty$

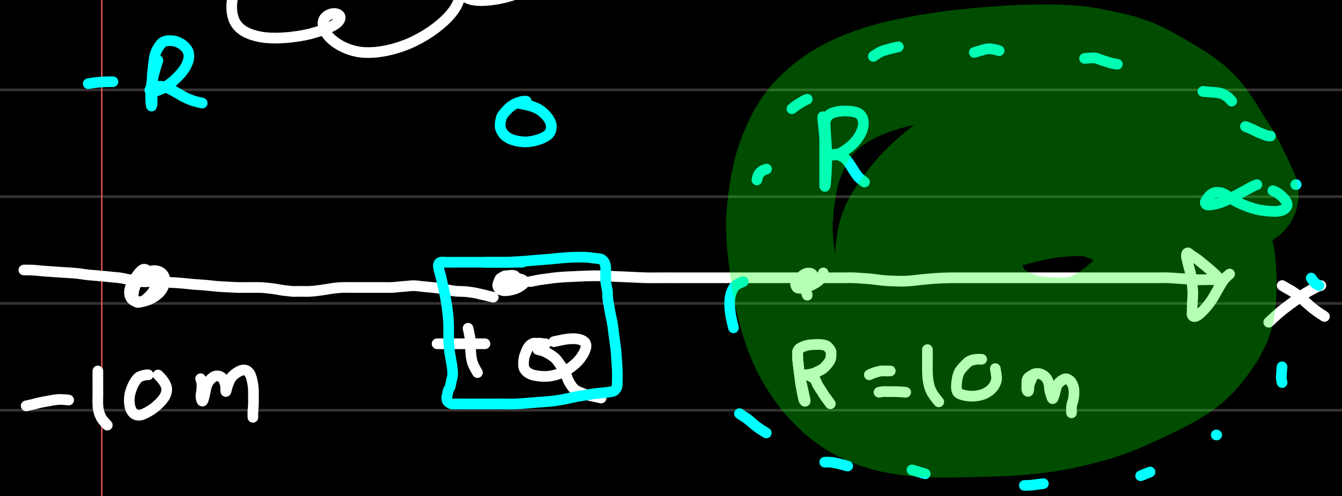
$$W_{field}\Big|_{R}^{\infty} = +ve, \quad W_{me}\Big|_{R}^{\infty} = -ve$$

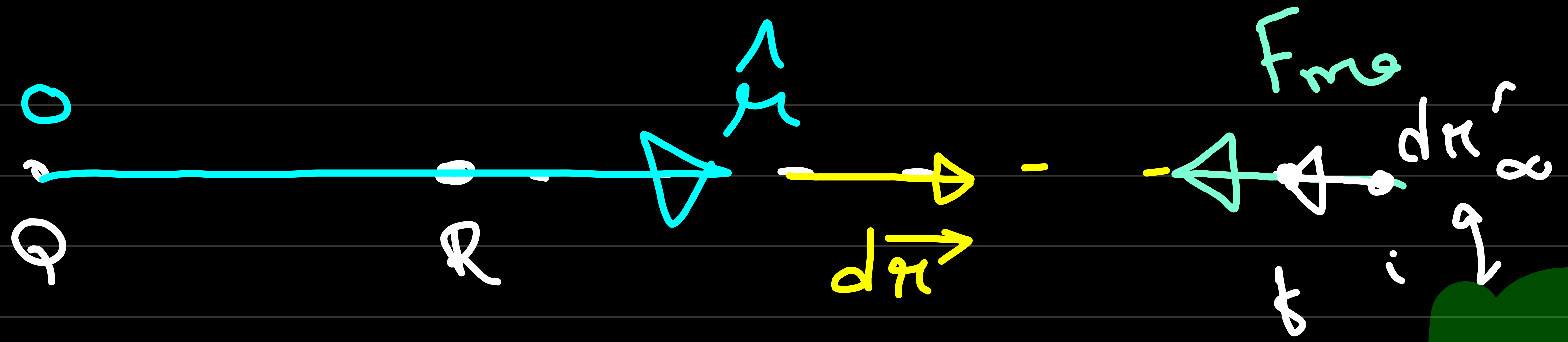
II) $\infty \to R$

$$W_{me}\Big|_{\infty}^{R} = +ve \quad \langle \text{Sad!} \rangle$$

$$W_{field}\Big|_{\infty}^{R} = -ve \quad \langle \text{Sad!} \rangle$$

HW





$*\quad W_{me}\Big|_{\infty}^{R} = \int_{\infty}^{R} \vec{F}_{me} \cdot d\vec{r}\,' = +ve\ ?$ (Sad)

$d\vec{r}$

$d\vec{r}\,'$

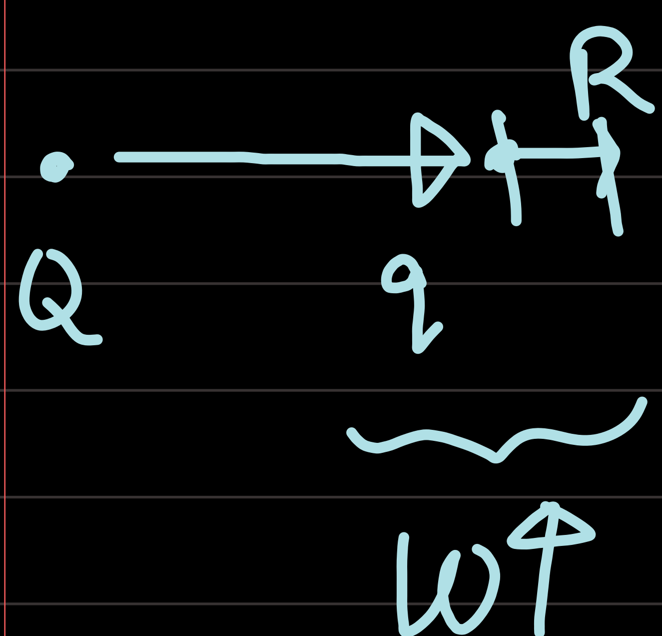
$\boxed{d\vec{r} = -d\vec{r}\,'}$

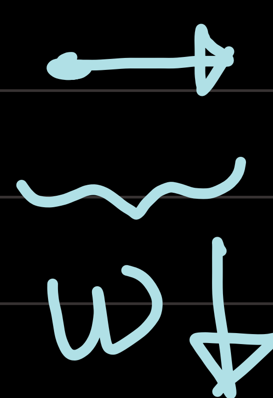
$W_{field}\Big|_{\infty}^{R} = -ve\ ?$ (Sad)

$*\quad W_{field}\Big|_{R}^{\infty} = \frac{1}{4\pi\varepsilon_0}\frac{Qq}{R} = +ve$ <Happy>

$W_{me}\Big|_{R}^{\infty} = -\left(\frac{1}{4\pi\varepsilon_0}\frac{Qq}{R}\right) = -ve$ <Happy>

$*\quad \boxed{W_{me}\Big|_{\infty}^{R} = W_{field}\Big|_{R}^{\infty} = +\frac{1}{4\pi\varepsilon_0}\frac{Qq}{R}}$.





Sequence & series.

$*\quad \frac{1}{1^2} + \frac{1}{2^2} + \frac{1}{3^2} + \frac{1}{4^2} + \frac{1}{5^2} + \ldots$

2.00 . . . . .

$= 1 + 0.25 + 0.11 + 0.0625$

$+ 0.04 + 0.027$

$+ 0.020 + 0.01$

$0.00\boxed{82}\quad + 0.0123 + 0.01$

* $-Q$ R - - - - - - - - - - q ∞

$W_{me}\Big|_{\infty}^{R} = -ve$ $W_{field}\Big|_{\infty}^{R} = +ve$

$W_{field}\Big|_{R}^{\infty} = -ve$ $W_{me}\Big|_{R}^{\infty} = +ve$

$+Q$ $W_{field}\Big|_{R}^{\infty} = +\frac{1}{4\pi\varepsilon_0}\frac{Qq}{R}$

$-Q$ $W_{field}\Big|_{R}^{\infty} = \frac{1}{4\pi\varepsilon_0}\frac{(-Q)q}{R}$

Electric Pot:(V) $= \dfrac{W_{me}\Big|_{\infty}^{R}}{q} = \dfrac{W_{field}\Big|_{R}^{\infty}}{q}$

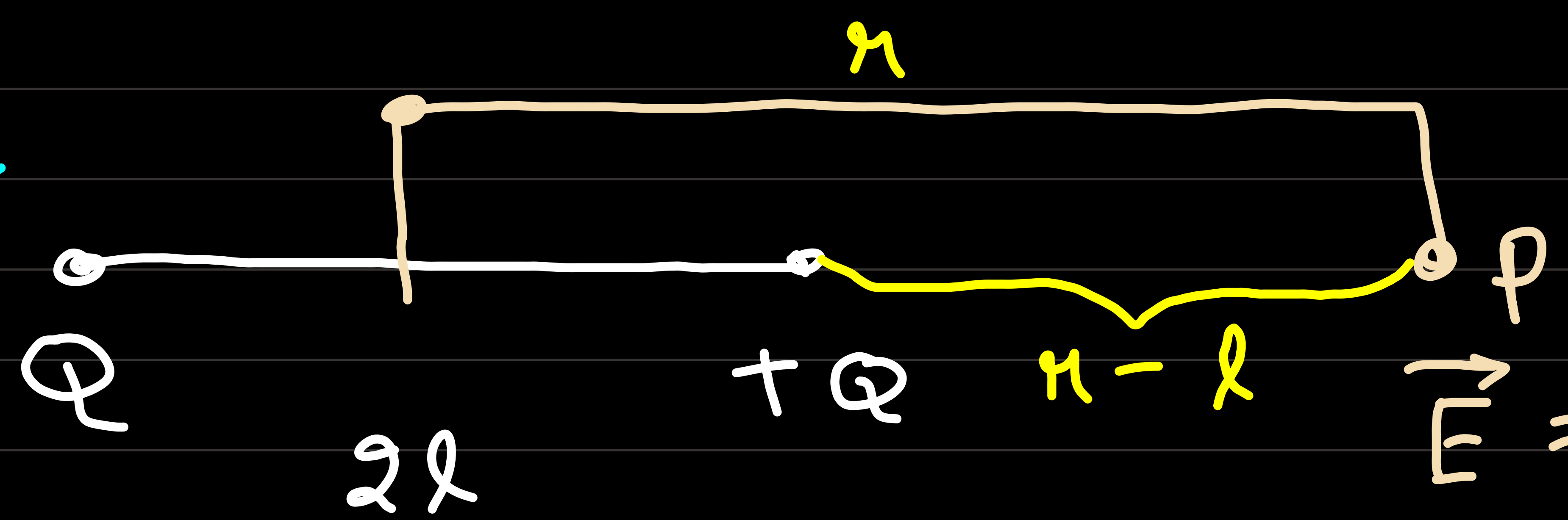
$+Q$ q

✓ $$\boxed{V = \frac{1}{4\pi\varepsilon_0}\frac{Q}{R}}$$

* $$|\vec{E}| = -\frac{\partial V}{\partial r} = -\frac{\partial}{\partial r}\left(\frac{Q}{4\pi\varepsilon_0}\frac{1}{r}\right) = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}$$

System V_{tot} $|\vec{E}_{tot}| = -\dfrac{\partial V_{tot}}{\partial r}$

discrete charge dist



$$\vec{E} = \frac{1}{4\pi\varepsilon_0} \frac{2pr}{(r^2-l^2)^2}$$

P :
$$V_{+Q} = \frac{1}{4\pi\varepsilon_0} \frac{Q}{(r-l)} \quad \text{scalar}$$

$$V_{-Q} = \frac{1}{4\pi\varepsilon_0} \frac{(-Q)}{r+l} \quad \text{scalar}$$

$$V_{tot} = V_p = V_{+Q} + V_{-Q} = \frac{Q}{4\pi\varepsilon_0}\left[\frac{1}{r-l} - \frac{1}{r+l}\right]$$

$$\boxed{Q \cdot 2l = p} \qquad = \frac{Q}{4\pi\varepsilon_0} \frac{2l}{(r^2-l^2)}$$

$$|\vec{E_t}| = -\frac{\partial V_{tot}}{\partial r} = \frac{1}{4\pi\varepsilon_0}\frac{2pr}{(r^2-l^2)^2}$$

$$-\frac{\partial V_t}{\partial r} = -\frac{\partial}{\partial r}\left[\frac{Q}{4\pi\varepsilon_0} \cdot \frac{2l}{(r^2-l^2)}\right]$$

$$= -\frac{Q \cdot 2l}{4\pi\varepsilon_0} \frac{\partial}{\partial r} \frac{1}{(r^2-l^2)}$$

$$= -\frac{Q \cdot 2l}{4\pi\varepsilon_0} \frac{-1}{(r^2-l^2)^2} \times \frac{\partial}{\partial r}(r^2-l^2)$$

$$= +\frac{p}{4\pi\varepsilon_0} \frac{2r}{(r^2-l^2)^2} \quad \text{Ans}$$

H.W

$\cdot P$

$V = 0$

$$|\vec{E}_p| = -\frac{\partial V_p}{\partial x}$$

$-Q \qquad +Q$

$V = 0$

$|\vec{E}| \neq 0$

$-Q$

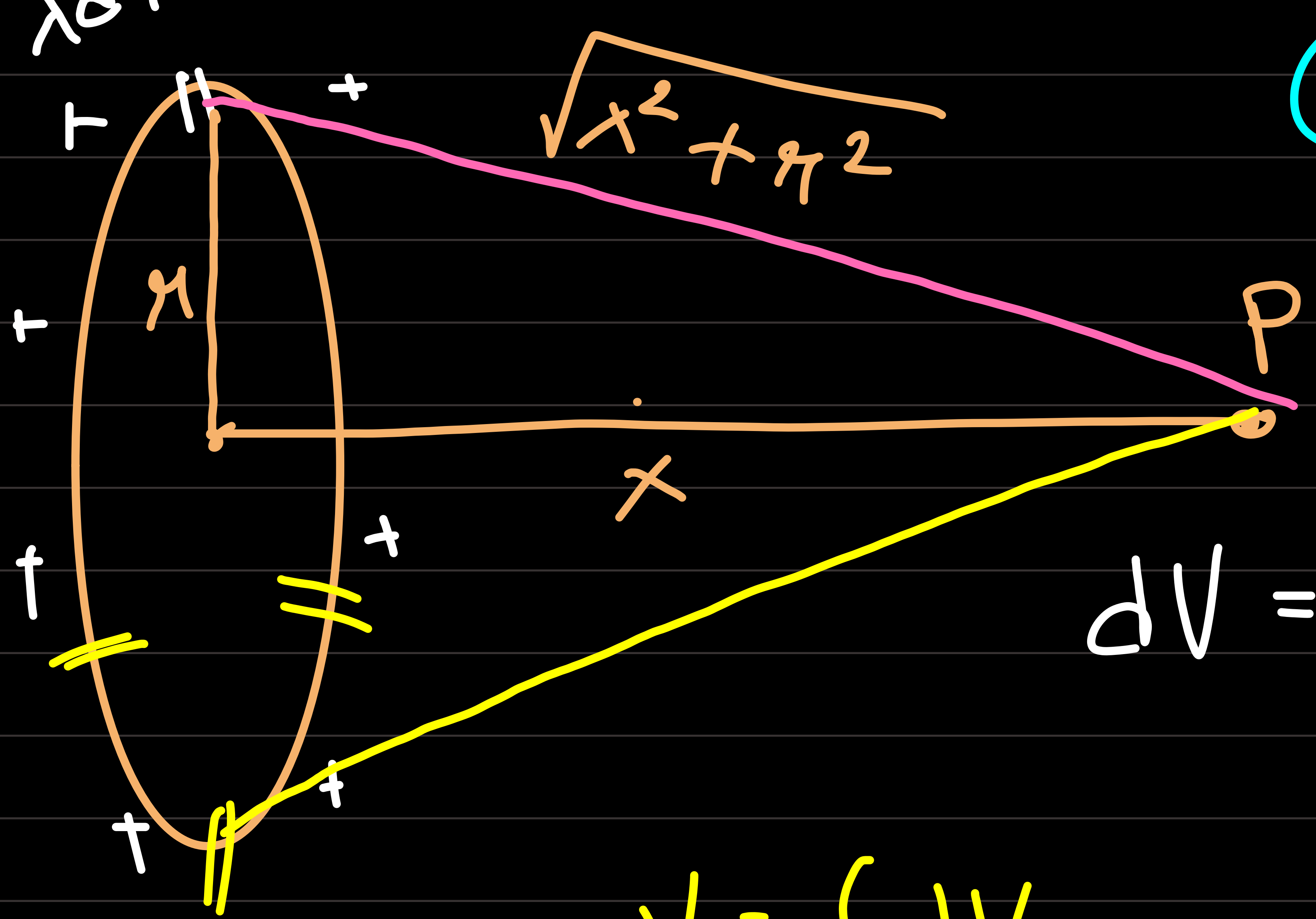
$+Q$

$V = 0$

R

q^{∞}

$dq = \lambda dl$



Continuous charge

$$dV = \frac{1}{4\pi\varepsilon_0}\frac{dq}{(\sqrt{x^2+r^2})}$$

$$\underbrace{V = \int dV} = \frac{1}{4\pi\varepsilon_0}\int\frac{\lambda\, d\lambda}{\sqrt{x^2+r^2}}$$

$$\frac{Q}{2\pi r} = \lambda$$

$$= \frac{1}{4\pi\varepsilon_0}\frac{\lambda}{\sqrt{x^2+r^2}} \times 2\pi r$$

$$= \frac{1}{4\pi\varepsilon_0}\frac{Q}{\sqrt{x^2+r^2}}$$

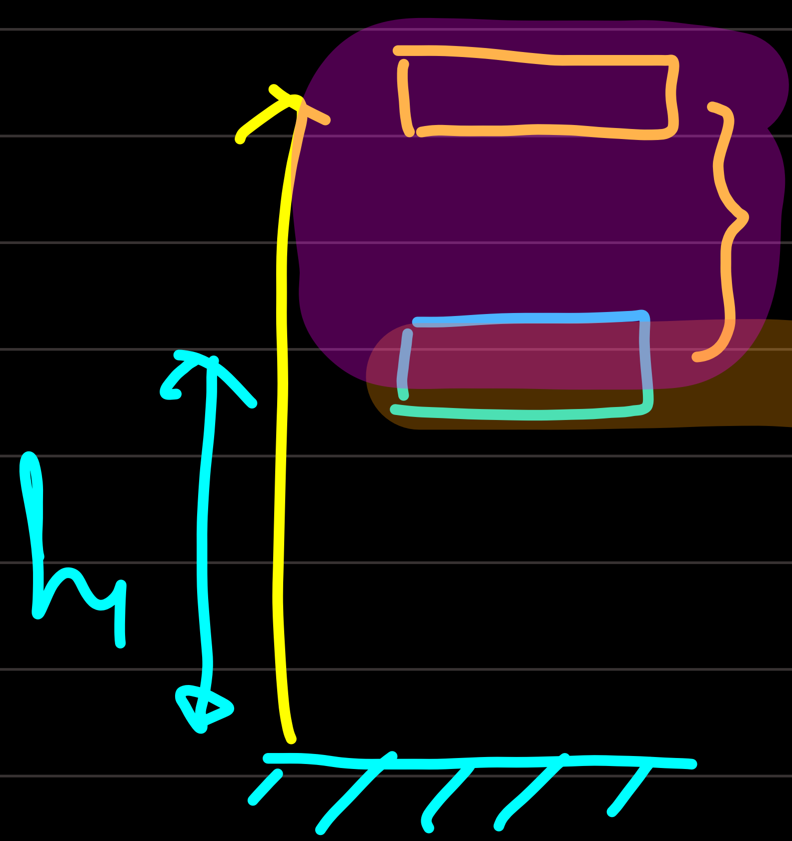
$$|\vec{E}| = -\frac{\partial V}{\partial x} = \ ? \ \text{(Ans)}$$

$$\frac{\partial}{\partial x}\frac{1}{\sqrt{x^2+r^2}} = -\frac{1}{2}\underbrace{(x^2+r^2)}^{3/2}\frac{\partial}{\partial x}(x^2+r^2)$$

$$= -\frac{x}{(x^2+r^2)^{3/2}}$$

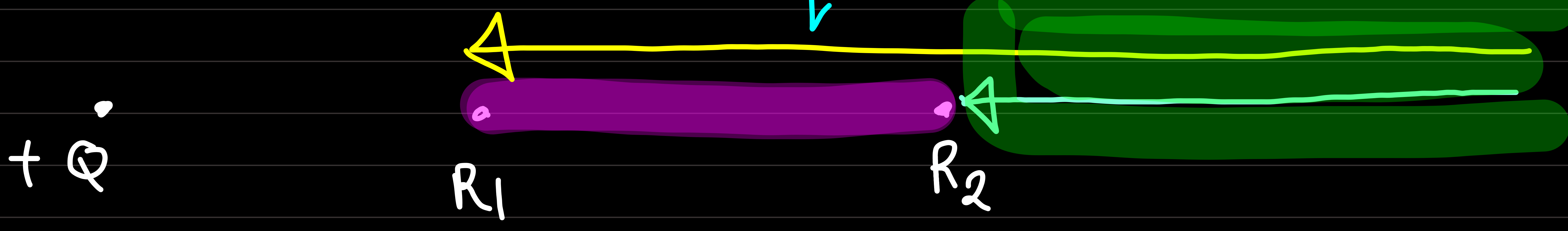
$\Delta PE = \Delta W = mg(h_2) - mgh_1$

$W = mgh_1$



Potential Difference.

$$\Delta V = \frac{\Delta W_{R_2}^{R_1}}{q}$$



$$k\frac{Q}{R_1} > \frac{kQ}{R_2}$$

$$\Delta W = \frac{kQq}{R_1} - \frac{kQq}{R_2}$$

$$\Delta V = kQ\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

Puzzle