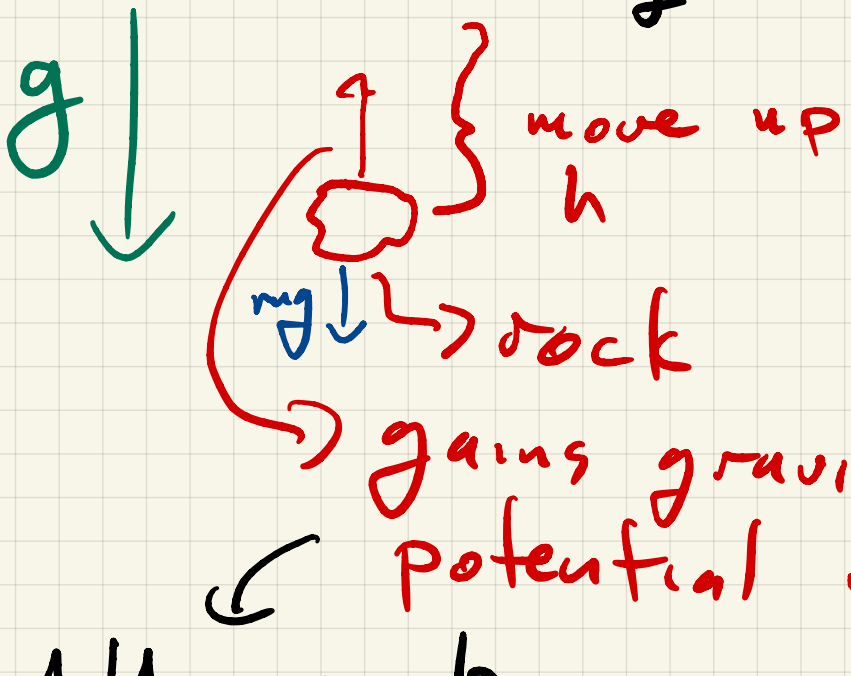
Physics 212 lecture 23 f01

3/15/21 Physics 212 Lecture 23

- record
- Quiz Friday
- HW due Friday → HW session Weds
- no Lab this week
- read chapter 25 (start chapter 26)
- on line this week

Today: Electric potential energy ↔ work, constant Field, point charges, conservative Force, electric potential

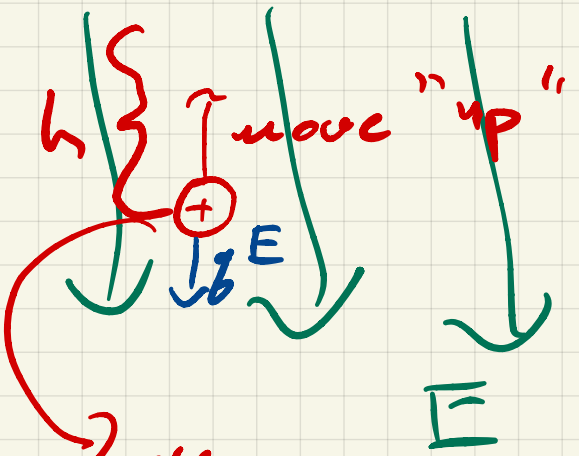
Gravity



gains gravitational potential moving up

$$\Delta U_g = mgh$$

Electric force

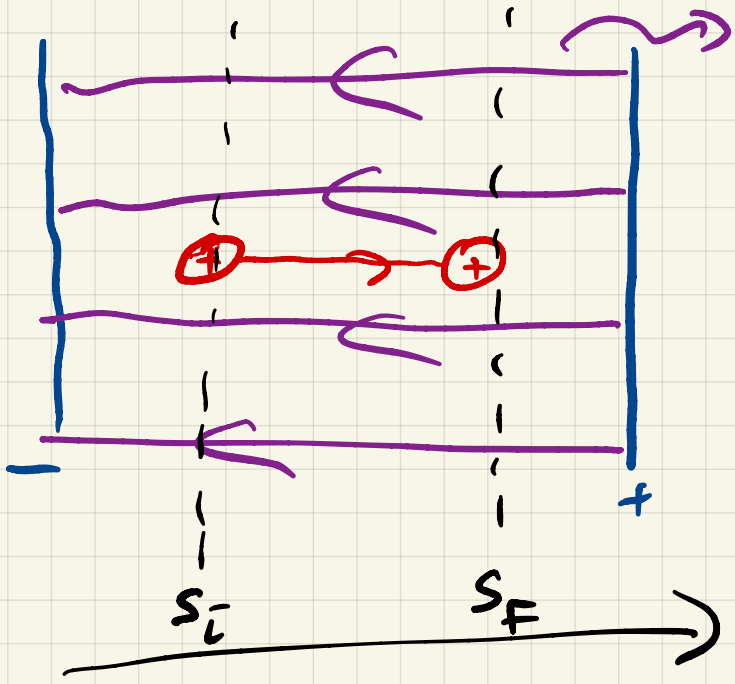


moving charge against E field gains electric potential energy

$$\Delta U = -W$$

$$W = \vec{F} \cdot \vec{s} = F s \cos\theta$$

$$\Rightarrow W = \int \vec{F} \cdot d\vec{s}$$



$$W = \vec{F} \cdot \vec{d} = qE|s_f - s_i|$$

$$F_E = qE$$

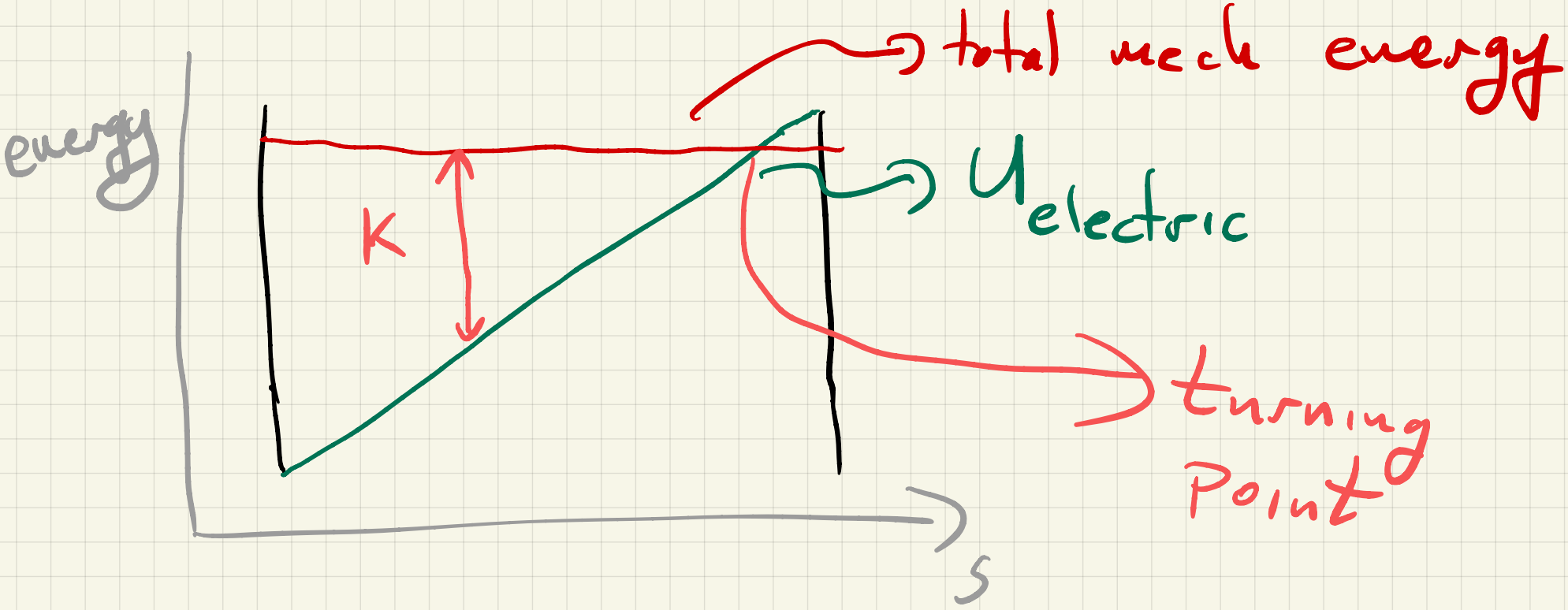
$$\Delta U_{electric} = U_f - U_i = -W = -[qEs_i - qEs_f]$$

$$\Delta U_{electric} = qEs_f - qEs_i$$

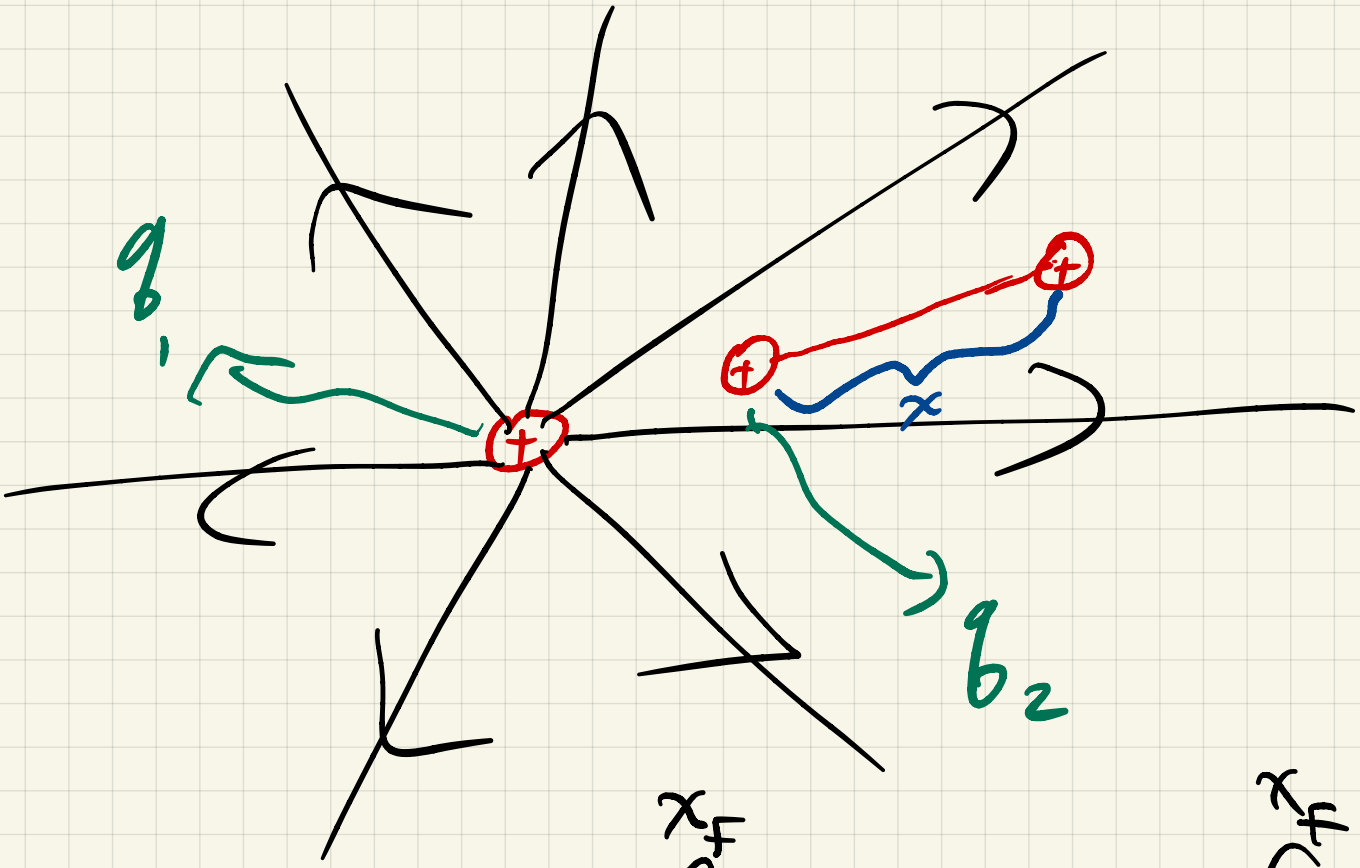
$$U_{electric} = U_0 + qEs$$

$$\Delta E_{mech} = \Delta K + \Delta U = 0 \quad \text{for conservative system}$$

$$\Rightarrow \frac{1}{2} m v_i^2 + U_i = \frac{1}{2} m v_f^2 + U_f$$



Electric potential energy for point charges



$$W_{electric} = \int_{x_i}^{x_f} F_{12}\, dx = \int_{x_i}^{x_f} \frac{k q_1 q_2}{x^2}\, dx = -\frac{k q_1 q_2}{x}\Big|_{x_i}^{x_f}$$

$$W_{electric} = -\frac{k q_1 q_2}{x_f} + \frac{k q_1 q_2}{x_i}$$

$$\Rightarrow \Delta U = -W_{ele} = \frac{k q_1 q_2}{x_f} - \frac{k q_1 q_2}{x_i}$$

$$\Rightarrow U_{electric} = \frac{k q_1 q_2}{x} \quad \text{or} \quad \boxed{U_{elect} = \frac{1}{4\pi\epsilon_0}\frac{q_1 q_2}{r}}$$

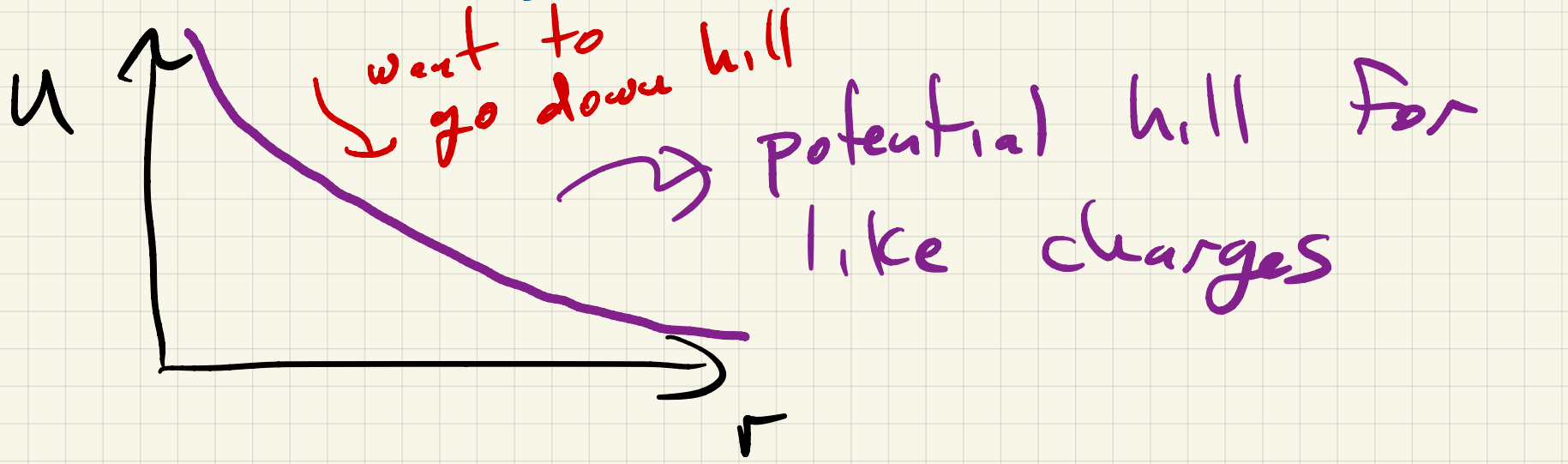
using U_0 arbitrarily

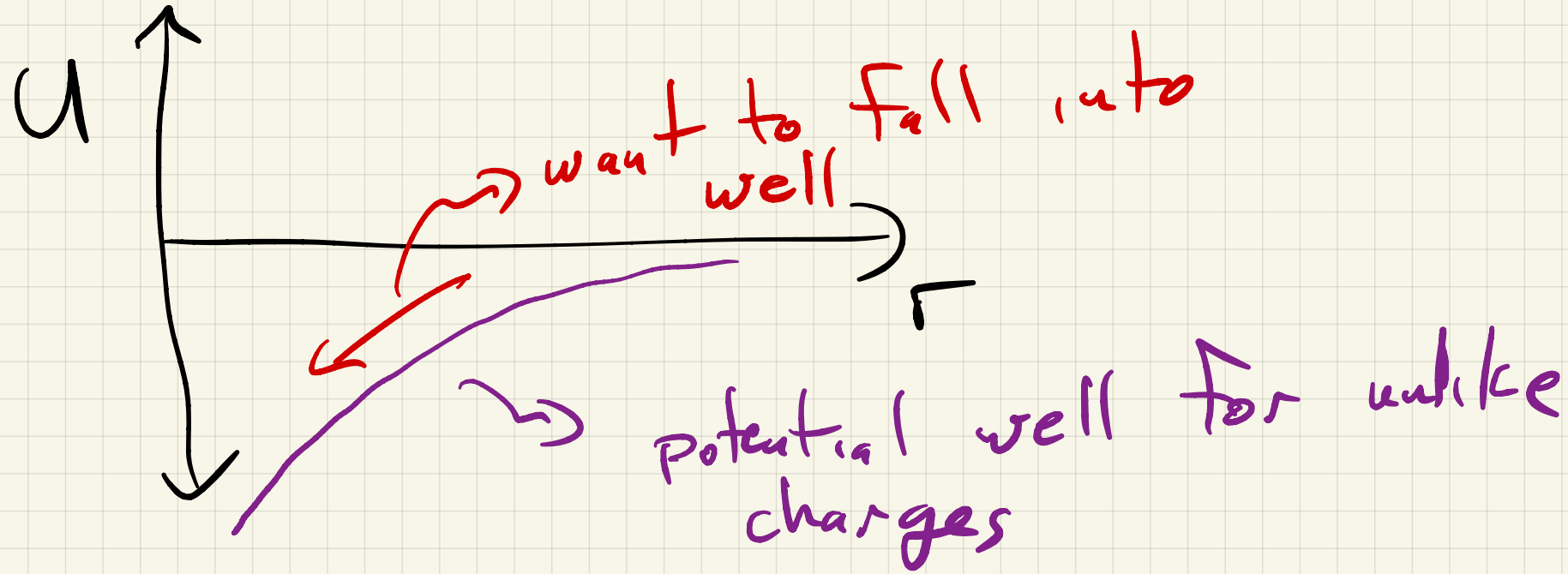
note this is a scalar not a vector

often take $U_0 = 0$ as $r \to \infty$

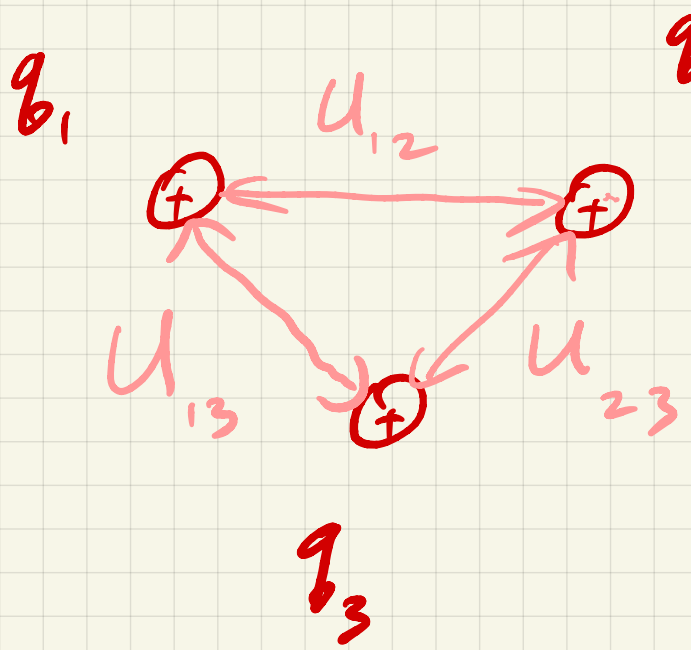
U is positive for like charges

& U is negative for unlike charges





potential energy for "group" of charges



$$U_{tot} = \sum U_i$$

$$U_{electric\ tot} = \sum_{i<j} \frac{k q_i q_j}{r_{ij}}$$

don't double count

Electric potential

$$\vec{F} = q\vec{E} \Rightarrow \vec{E} = \frac{\vec{F}}{q_{test}}$$

same thing for potential $\hookrightarrow$ potential energy

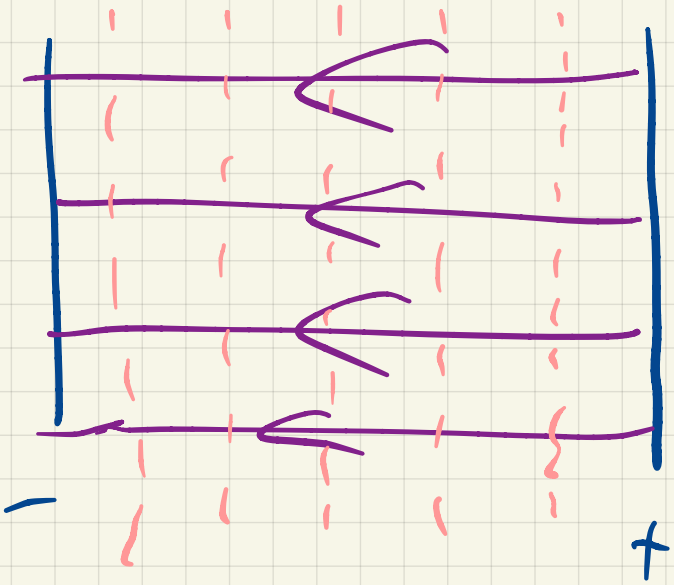
electric potential $\equiv V$

$$V = \frac{U}{q}$$

units are volts

$$1\,V = 1\,\frac{J}{C}$$

$\hookrightarrow$ independant of q_{test}



$$U = qEs$$

$$\Rightarrow V = Es$$

→ equipotential surfaces

note $E \perp V$ → equipotential