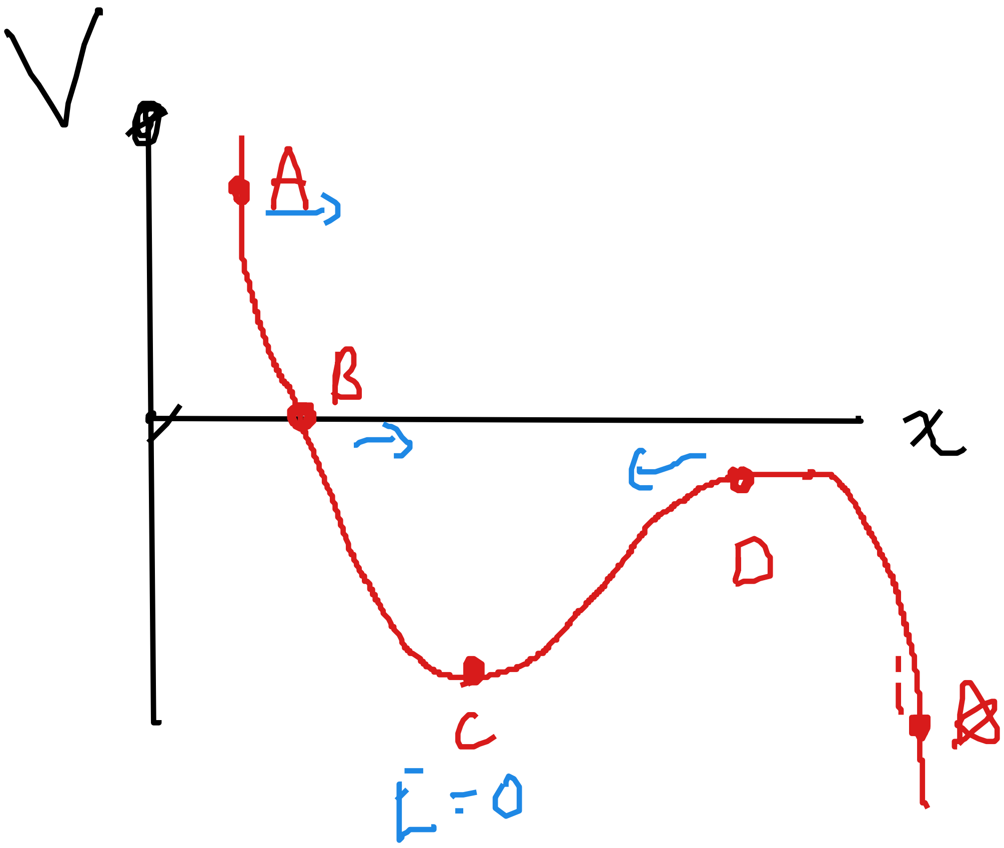
$\vec{E}$ points "downhill"

- towards lower potential



Electric field is the negative derivative of the potential in 1D

$$E_x = -\frac{dV}{dx}$$

$$V = -\int E_x \, dx$$ arbitrary constant! (V_∞)

$$\Delta V = V(x_f) - V(x_i) = -\int_{x_i}^{x_f} E_x \, dx$$

e.g.

$$\vec{E} = k\frac{q_s}{d^2}\hat{d}$$

$$= k\frac{q_s}{x^2}(+\hat{x})$$

$$E_x = k\frac{q_s}{x^2}$$

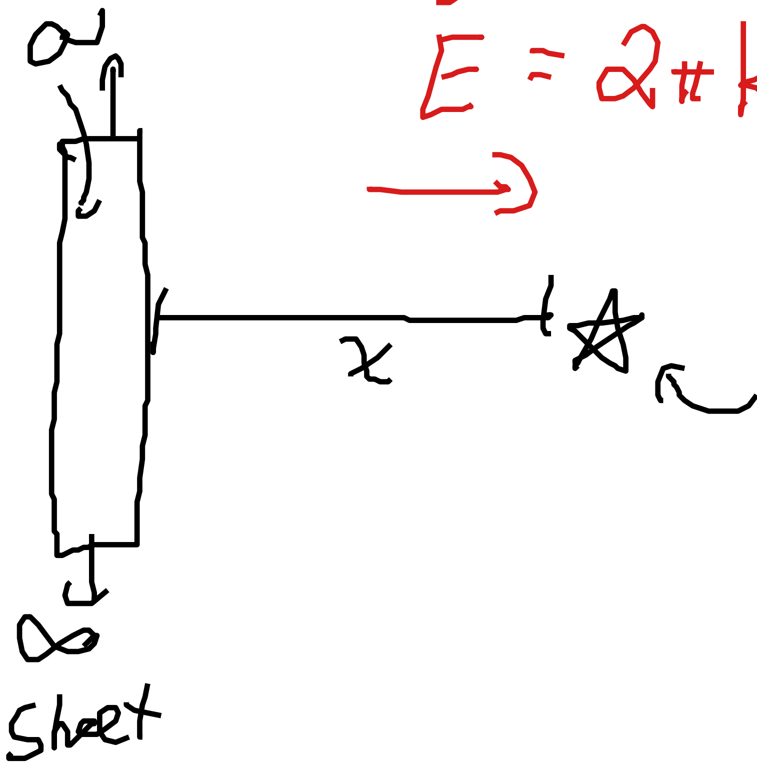
$$V = -\int k\frac{q_s}{x^2}\,dx$$

$$= -kq_s\int x^{-2}\,dx$$

$$= -kq_s\left[-x^{-1}\right] + C$$

$$= \frac{kq_s}{x} + C$$

$\vec{E} = 2\pi k\sigma$



What is V?

$$V = -\int E_x \, dx$$

$$= -\int 2\pi k\sigma \, dx$$

$$= -2\pi k\sigma \int dx$$

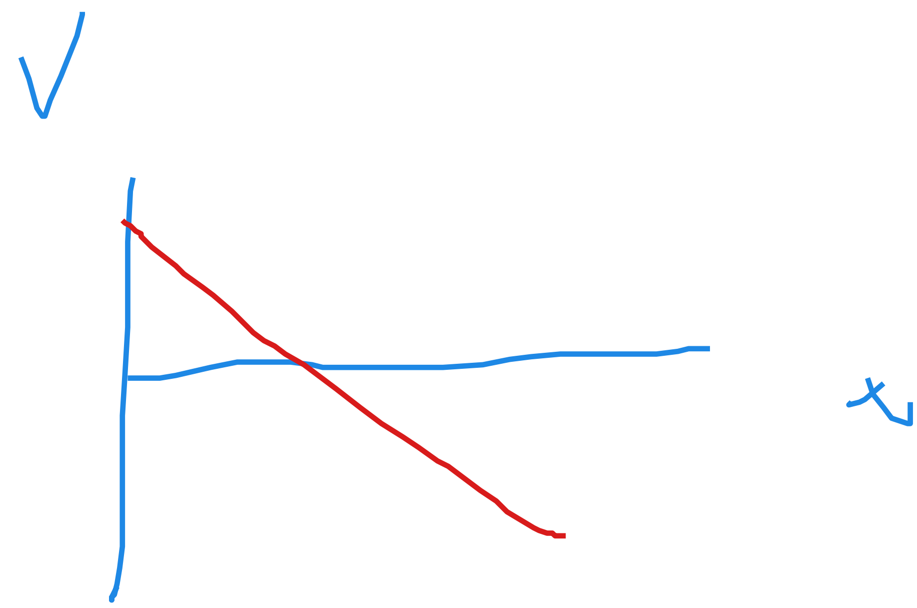
$$V(x) = -2\pi k\sigma x + C$$

$V(0) = C \leftarrow$ C is potential at the sheet

$$V(\infty) = -2\pi k\sigma(\infty) + V_0$$

$$= -\infty + V_0$$

$$= -\infty$$



We can't set $V_\infty = 0$ for an infinite sheet, or else the potential near the sheet will be infinite.

In 3D,

partial derivatives w/ ∂

$$E_x = -\frac{\partial V}{\partial x} \qquad E_y = -\frac{\partial V}{\partial y} \qquad E_z = -\frac{\partial V}{\partial z}$$

$$\vec{E} = -\nabla V$$

∇ upside-down triangle "del"

$$\Delta V = -\int_i^f \vec{E} \cdot d\vec{r}$$

path integral

integrate along a path

e.g.