# An Infinite Charge Plane

Say that we have a **very large** charge disk. So large, in fact, that its radius $a$ approaches **infinity** !

**Q:** *What electric field is created by this infinite plane?*

**A:** We **already** know! Just evaluate the charge disk solution for the case where the disk **radius** $a$ is **infinity**.

In other words:

$$\lim_{a\to\infty}\mathbf{E}(x=0,y=0,z)=\begin{cases}\hat{a}_z\dfrac{\rho_s}{2\varepsilon_0}\left[1-\dfrac{z}{\sqrt{z^2+a^2}}\right] & \text{if } z>0\\[2ex] \hat{a}_z\dfrac{\rho_s}{2\varepsilon_0}\left[-1-\dfrac{z}{\sqrt{z^2+a^2}}\right] & \text{if } z<0\end{cases}$$

$$=\begin{cases}\dfrac{\rho_s}{2\varepsilon_0}\,\hat{a}_z & \text{if } z>0\\[2ex] \dfrac{-\rho_s}{2\varepsilon_0}\,\hat{a}_z & \text{if } z<0\end{cases}$$

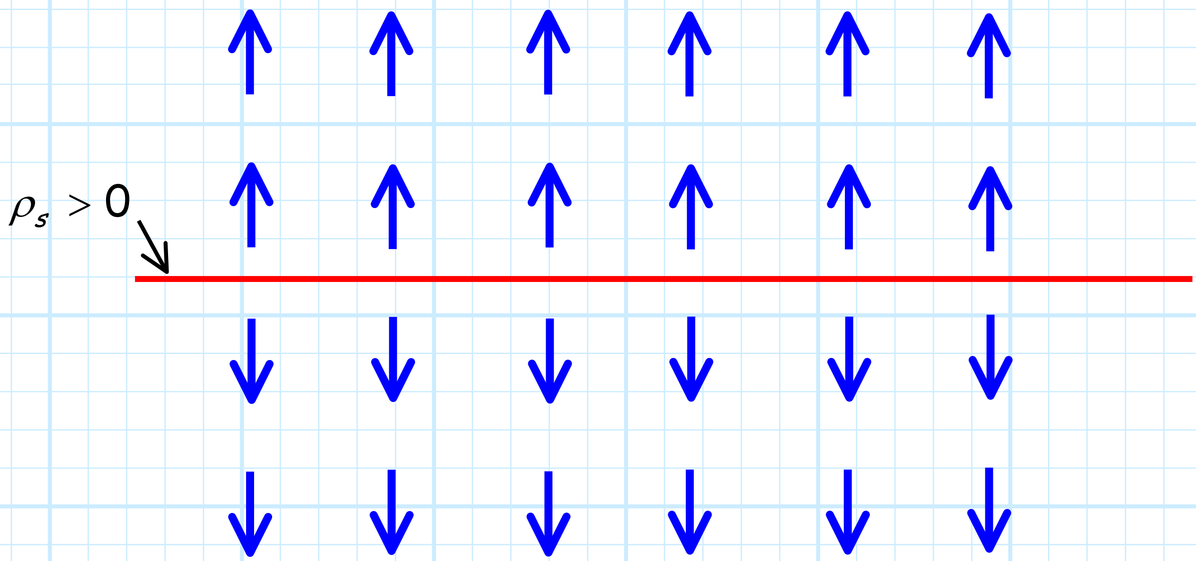
Therefore, the electric field produced by an **infinite charge plane**, with surface charge density $\rho_s$, is:

$$\mathbf{E}(\bar{r}) = \begin{cases} \dfrac{\rho_s}{2\varepsilon_0}\,\hat{a}_z & \text{if} \quad z > 0 \\[2ex] \dfrac{-\rho_s}{2\varepsilon_0}\,\hat{a}_z & \text{if} \quad z < 0 \end{cases}$$

**Think** about what **this** says!

* First, we note that the electric field **points away** from the plane if $\rho_s$ is positive, and toward the plane if $\rho_s$ is negative.

* Second, we notice that the magnitude of the electric field is a **constant**—the magnitude is **independent** of the distance from the infinite plane!



The reason for this result is, that no matter how far you are (i.e., $|z|$) from the infinite charge plane, you remain **infinitely close** to plane, when **compared** to its radius $a$.

We will find these results are useful when we study the behavior of a parallel plate **capacitor**.