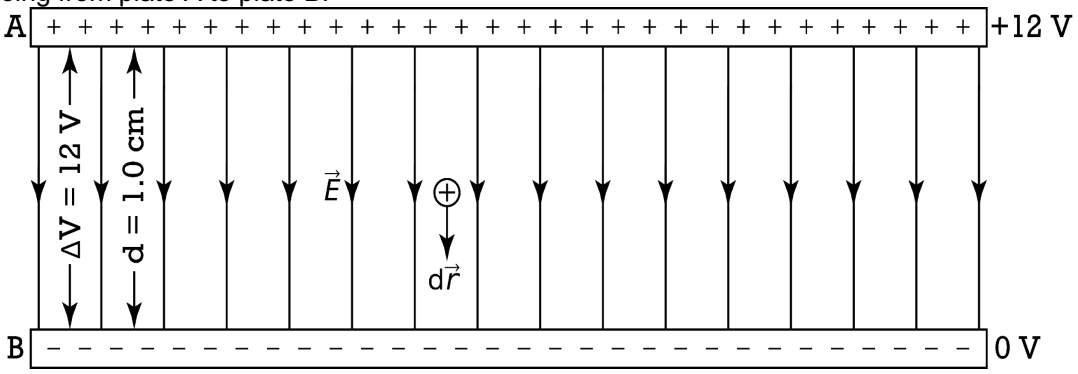
Flipping Physics Lecture Notes:
Parallel Plates Electric Potential Difference using an Integral
http://www.flippingphysics.com/parallel-plates-potential-difference.html

Let's say we have two, large, equal magnitude charged parallel plates, the top plate has a positive charge, and the bottom plate has a negative charge. We have shown the electric field is constant in this case and will be directed downward. Let's say the electric potential difference between the two plates is 12 volts and the distance between the two plates is 1.0 cm. Let's define the top plate as plate A, and the bottom plate as plate B. Let's start by determining the general equation for the electric potential difference when going from plate A to plate B.



$$\Delta V = -\int_A^B \vec{E} \cdot d\vec{r} = -\int_A^B E \cos\theta \, dr$$

$$\Rightarrow \Delta V = -\int_A^B E \cos(0°) \, dr = -E\int_A^B dr \Rightarrow \Delta V_{\text{constant E}} = -Ed$$

This is a good time to discuss the negative sign in the electric potential equation. In other words, a charge moving in the direction of the electric field will go through a negative potential difference and a charge moving opposite the direction of the electric field will go through a positive electric potential difference.