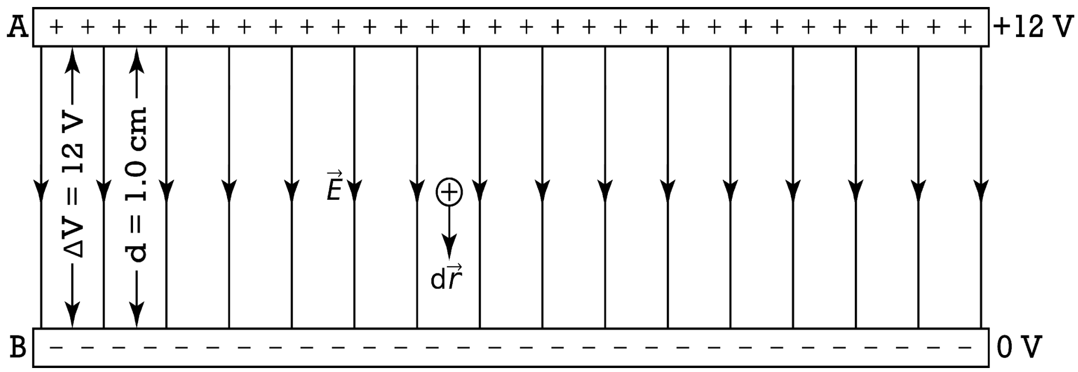
Flipping Physics Lecture Notes:
Speed of a Proton in a Uniform Electric Field
http://www.flippingphysics.com/proton-speed-electric-field.html

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. We have already determined that the electric potential difference between the two plates: $\Delta V_{\text{constant E}} = -Ed$



If we release a proton from the inside surface of plate A, what will the speed of the proton be right before it runs into plate B?

Set initial point at A and final point at B. Do not need a horizontal zero line because gravitational potential energy for subatomic particles is usually negligible and it is in this case. We do not actually know the electric potential energy initial or electric potential energy final; however, we do know the change in the electric potential energy. Also, the charge and mass of a proton are given in the Table of Information provided on the AP Physics C exam.

$$ME_i = ME_f \Rightarrow ME_A = ME_B \Rightarrow U_{\text{elec}A} = KE_B + U_{\text{elec}B}$$

$$\Rightarrow -KE_B = U_{\text{elec}B} - U_{\text{elec}A} = \Delta U_{\text{elec}} \Rightarrow -\frac{1}{2}mv_B^2 = q\Delta V$$

$$\& \ \ \Delta V = \frac{\Delta U_{\text{elec}}}{q} \Rightarrow \Delta U_{\text{elec}} = q\Delta V \ \ \& \ \ \Delta V_{A\to B} = -12V$$

$$\Rightarrow v_B = \sqrt{-\frac{2q\Delta V}{m}} = \sqrt{-\frac{(2)\left(1.6\times10^{-19}\right)(-12)}{1.67\times10^{-27}}} = 47952\frac{m}{s} \approx 48\frac{km}{s}$$

$$v_B = 47952\frac{m}{s}\left(\frac{3600\ s}{1\ \text{hr}}\right)\left(\frac{1\ \text{mi}}{1609\ m}\right) = 107288\frac{\text{mi}}{\text{hr}} \approx 1.1\times10^5\frac{\text{mi}}{\text{hr}}$$