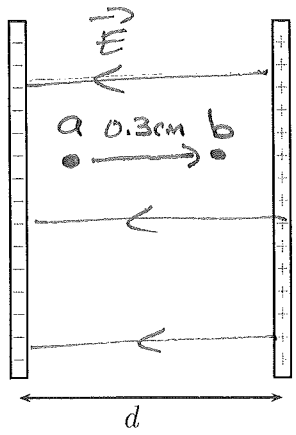
Physics 161 Test 3

(a) A parallel-plate capacitor has plates separated by a distance $d = 1\,cm$ and an electric field $E = 500\,V/m$. Pick any two points in the region between the two plates, a and b, such that $V_{ab} = -1.5\,V$. For full points, you must clearly label a and b, show the distance between them, and provide an explanation for your choice. *(5pts)*



Parallel-Plate Capacitor ⇒ Uniform Field so $V_{ab} = Er\cos\phi$.

To make $V_{ab} < 0$ (it's easiest to make) $\cos\phi = -1 \Rightarrow \phi = 180°$

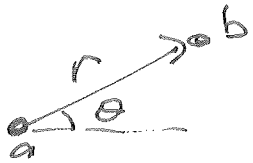
So Vector From a to b must be opposite $\vec{E}$. (Equivalently, Potential INCREASES opposite to $\vec{E}$ so b will be at higher Potential than a)

For this Capacitor, $\vec{E}$ is Right to Left so a has to be to left of b

for $\phi = 180°$ $\quad V_{ab} = Er\cos\phi \Rightarrow -1.5V = (500V/m)\,r\cos 180° \Rightarrow r = \frac{1.5V}{500V/m}$

$\Rightarrow r = 0.003m = \underline{0.3cm}$

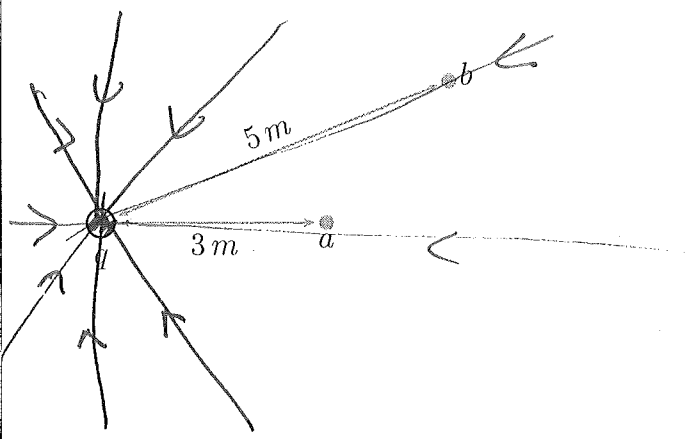
If you get more exotic, any



will make $V_{ab} < 0$

To make $V_{ab} = -1.5V$, your distance would be: $r = \frac{1.5V}{500V/m\cos\theta} = \frac{0.003m}{\cos\theta} = \frac{0.3cm}{\cos\theta}$

(b) For a point charge $q = -75\,nC$ and the points a and b shown, should a voltmeter be connected to read V_{ab} or V_{ba} in order to get a positive number? For full points, your answer must include an explanation. What would the voltmeter's reading be? *(5pts)*



q is Negative $\Rightarrow \vec{E}$ is inward

Potential Decreases in the direction of $\vec{E}$ $\Rightarrow$ a is at lower potential than b

So we would want to find $V_{ba} = V_b - V_a$.

Point charge $\Rightarrow V = \frac{kq}{r} \Rightarrow V_b = \frac{(9\times10^9\,N\cdot m^2/C^2)(-75\times10^{-9}\,C)}{5m} = -135V$

$$V_a = \frac{(9\times10^9\,N\cdot m^2/C^2)(-75\times10^{-9}\,C)}{3m} = -225V$$

↑ MORE Negative, so SMALLER

$$V_{ba} = V_b - V_a = -135V - (-225V) = -135V + 225V$$

$$\Rightarrow \boxed{V_{ba} = 90V}$$