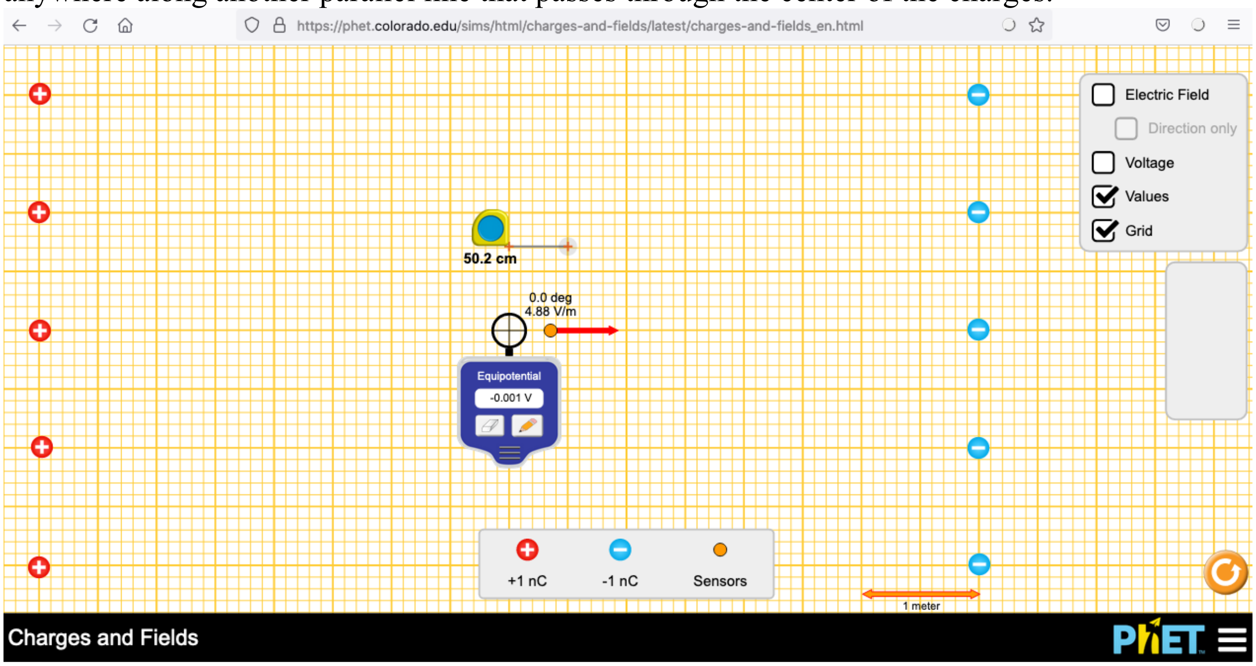
Electric Potential vs. Electric Field

Set up the following experiment in PhET Charges and Fields. Turn on Values and Grid and create a line of five 1 nC charges separated by 1 meter increments. Create a parallel line 8 meters away with five –1 nC charges separated by 1 meter increments. It does not have to be perfect, but you should find that the equipotential sensor indicates very close to 0.00 volts anywhere along another parallel line that passes through the center of the charges.



1. Temporarily turn on the Electric Field option. Looking at the arrows how can you tell that the field is fairly uniform (*i.e.* constant)? It is not *perfectly* uniform anywhere in the diagram, but where is it *most* uniform? *least* uniform? Turn off the Electric Field Option.
2. Use a field sensor to measure the electric field along a horizontal line that connects the center positive charge and the center negative charge. Measure along a 0.50 m piece of this line and determine the mean field strength. Apply the formula $|\Delta V| = |E \cdot \Delta r|$ to this 0.50 m line segment. Then use the Equipotential Tool to determine the potential at each end of the segment, calculate $\Delta V = V_2 - V_1$ and compare. Repeat this process several times with different line segments. Show your work and record the results:

	Trial 1	Trial 2	Trial 3
$\lvert\Delta V\rvert = \lvert E \cdot \Delta r\rvert$			
$\Delta V = V_2 - V_1$			

3. Now try the reverse process. Use the Equipotential tool and click on the Draw button to create a series of equipotential lines (isolines). Pick any two adjacent isolines and calculate $|E| = \left|\frac{\Delta V}{\Delta r}\right|$ where ΔV is found by subtracting the potential of each isoline and Δr is the perpendicular distance between the isolines. Use a field sensor to measure and determine the mean electric field strength between the isolines. Compare the results. Repeat the process with different equipotential isolines. Show your work and record the results:

	Trial 1	Trial 2	Trial 3
$\|E\| = \left\|\frac{\Delta V}{\Delta r}\right\|$			
E_{mean}			

4. The formulas being used are based on a constant uniform electric field. Are the results of the multiple trials most accurate where the field is most uniform? Explain.

5. The same formulas without the absolute value signs might be written as: $\Delta V = -E \cdot \Delta r$ and $E_x = -\frac{\Delta V}{\Delta x}$ or $E_y = -\frac{\Delta V}{\Delta y}$. How does the negative sign make sense considering your observations, calculations, and results?