Charges and Fields: **Grade: 11th - 12th**
https://phet.colorado.edu/sims/html/charges-and-fields/latest/charges-and-fields_en.html

Brief Concepts:

Electric field is a vector quantity. For point charge, at a point, it depends upon the magnitude of charge and distance of that point from charge.

It is given as: $$E = \frac{kq}{r^2}$$ (for charge placed in vacuum)

Electric potential (or voltage) is a scalar quantity. For point charge, at a point, it depends upon the value of charge and distance of that point from charge.

It is given as: $$V = \frac{kq}{r}$$ (for charge placed in vacuum)

Equipotential lines indicate that at all the points on such line, value of potential will be the same.

Explore:

Electric Field:

1. Select +1nC charge. De-select Electric Field. Click on Values and Grid. And select Sensors from bottom.

2. Keep Sensor at a distance of 2 meter from charge. What is the value of electric field at this point? Calculate the value by using formula of electric field.
   Do both values match?

3. As sensor is moved away from charge, how does the magnitude of electric field change?

4. Keep sensor at one point. Take +1nC more charge and keep it above earlier +1nC charge. How does the magnitude and direction of electric field change?

5. Can you predict the value of electric field at this point when charge becomes +5nC?

6. Remove all positive charges. Let the sensor be at same point. Now take -1nC charge. What is the value of electric field? Do you observe any change?

7. Click on Electric Field. For a positive point charge, what is the pattern of electric field lines?

- Radially outward
- Radially inwards
- Along tangent

8. For a negative point charge, what is the pattern of electric field lines?

- Radially outward
- Radially inwards
- Along tangent

Electric Potential:

1. Refresh simulation. Select +1nC charge. De-select Electric field. Click on Voltage, Values and Grid. Select Voltmeter.

2. Keep voltmeter at a distance of 2 meter away from charge. What is the value of potential at this point? Calculate potential using formula of electric potential.
   Do both values match?

3. As voltmeter is moved away from charge, how does the value of potential change?

4. Keep voltmeter at one point. Take +1nC more charge and keep it on earlier +1nC charge. How does the potential change?

5. Keep voltmeter at same point. Remove all positive charges. Now take -1nC charge. What is the value of potential? Do you observe any change?

6. Click on pencil symbol of Voltmeter for equipotential line. What is the shape of this line? Click on several points on this line to check if the values of potential are same at all points.

Think:

1. If two point charges of same magnitude but opposite polarities are kept on each other, what will be the value of electric field and voltage at a point?

2. What is the angle made by electric field with equipotential surface at a given point?

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