Coulomb's Law & Electric Potential

Experiment #5

PHYSIC 182 - Summer 2020

Dept. of Physics

UMASS Boston

Goals:

- Introduce charges, electric potential energy, and electrostatic force
- Use simulations to explore how force between two charged particles change as a function of distance
- Explore how the electric field will vary at different locations around a charged particle

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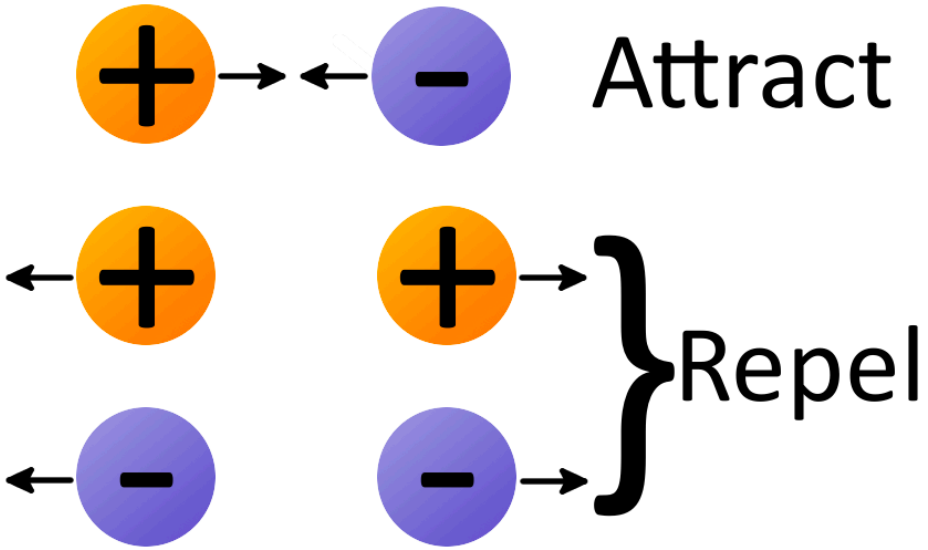
Introduction:

Protons and electrons are subatomic particles that have equal and opposite charge, *q*

Therefore, the charge of an electron is denoted as –q, and the charge of a proton is denoted as +q

Particles with similar charges will repel, whereas particles with different charges will attract



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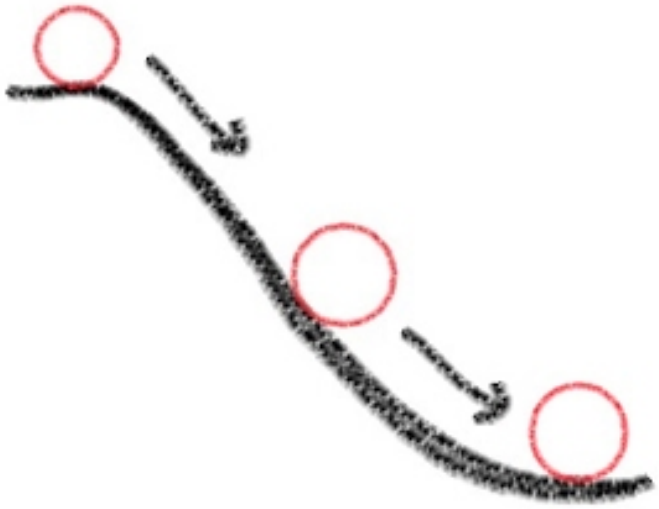
Introduction (cont):

How does electric charge flow? First, consider a ball on top of a hill

The force of gravity will move the ball from a point of high potential energy, *U*, (top of hill) to a point of lower potential energy (bottom of hill)



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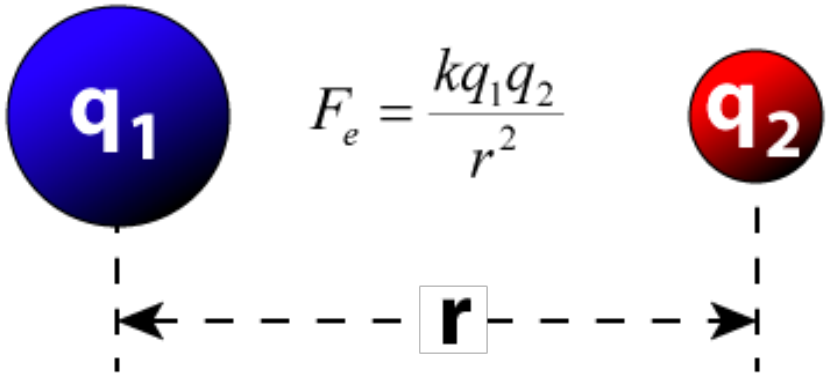
Introduction (cont):

This is analogous to how electric charges move. A difference in electric potential energy (U_E) brought about by a difference in potential (V) causes an electrostatic force (F_e) to be exerted on a charge

$$U_E = qV$$

If two particles, q_1 and q_2, are separated by some distance r, the electrostatic force is given by the following equation

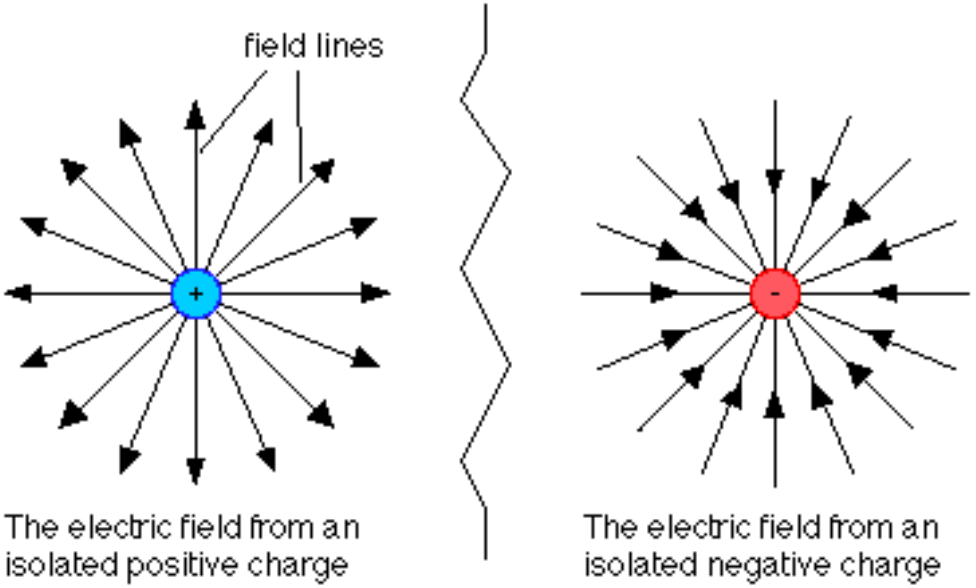


Where

$$k = \frac{1}{4\pi\varepsilon_0} = 8.99 \times 10^9\ \text{Nm}^2/\text{C}^2$$

Introduction (cont):

A charge exerts a force on its surroundings known as an electric field (*E*)



The electric field from an isolated positive charge

The electric field from an isolated negative charge

The electric field is a vector field, holding both magnitude and direction

The electric field can be related to the electrostatic force

$$E = \frac{F_e}{q_0}$$

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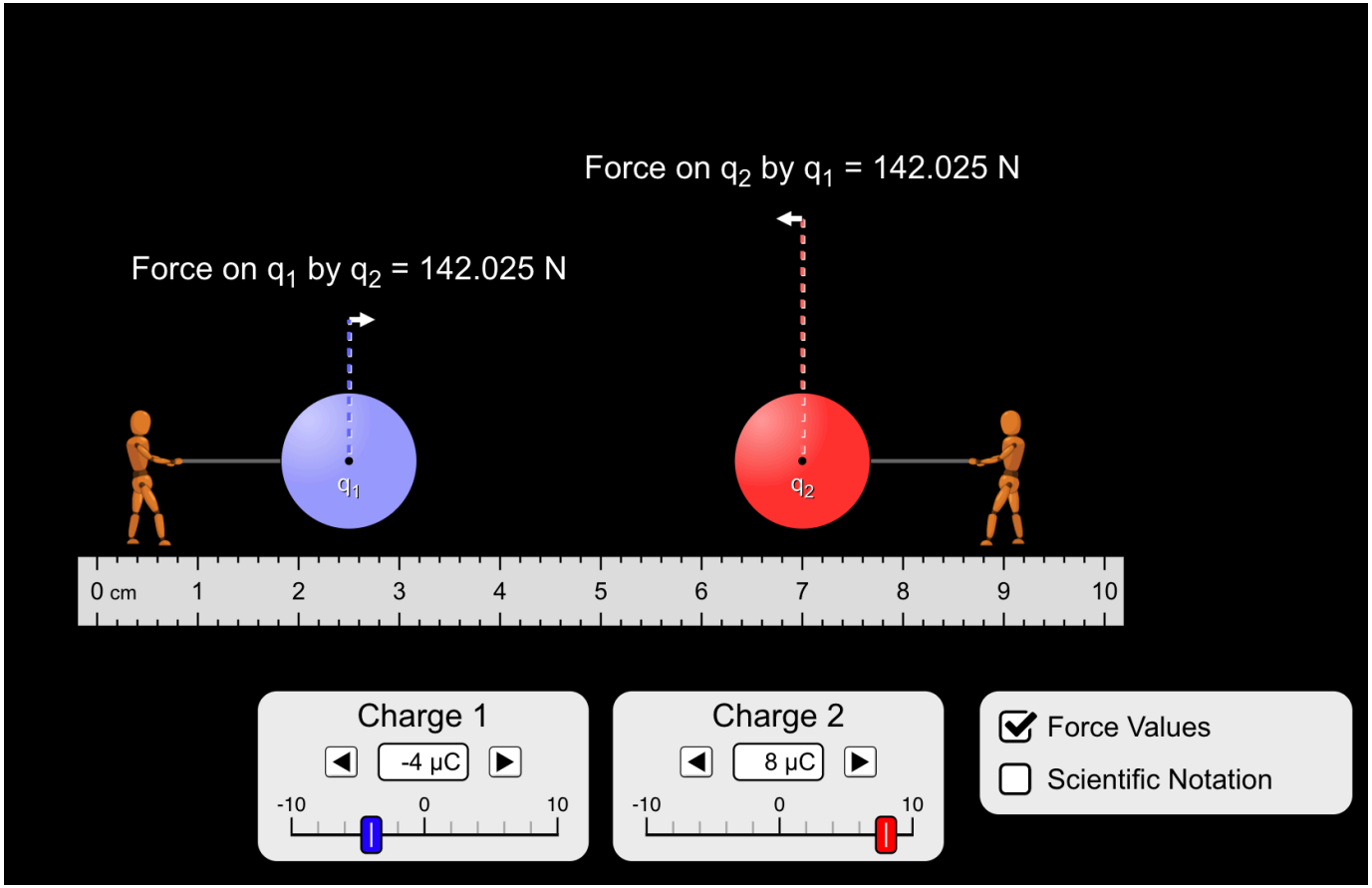
Data - Part 1:

Find the simulation at https://phet.colorado.edu/sims/html/coulombs-law/latest/coulombs-law_en.html



Data – Part 1 (cont):

1.) Fix the values of charges
2.) Change the distance between charges according to the table. Fill out remaining columns

q_1=_____		q_2=_____	
r (cm)	**r^2 (m^2)**	**$1/r^2$ ($1/m^2$)**	**F_E (N)**
10			
9			
8			
7			
6			
5			
4			
3			

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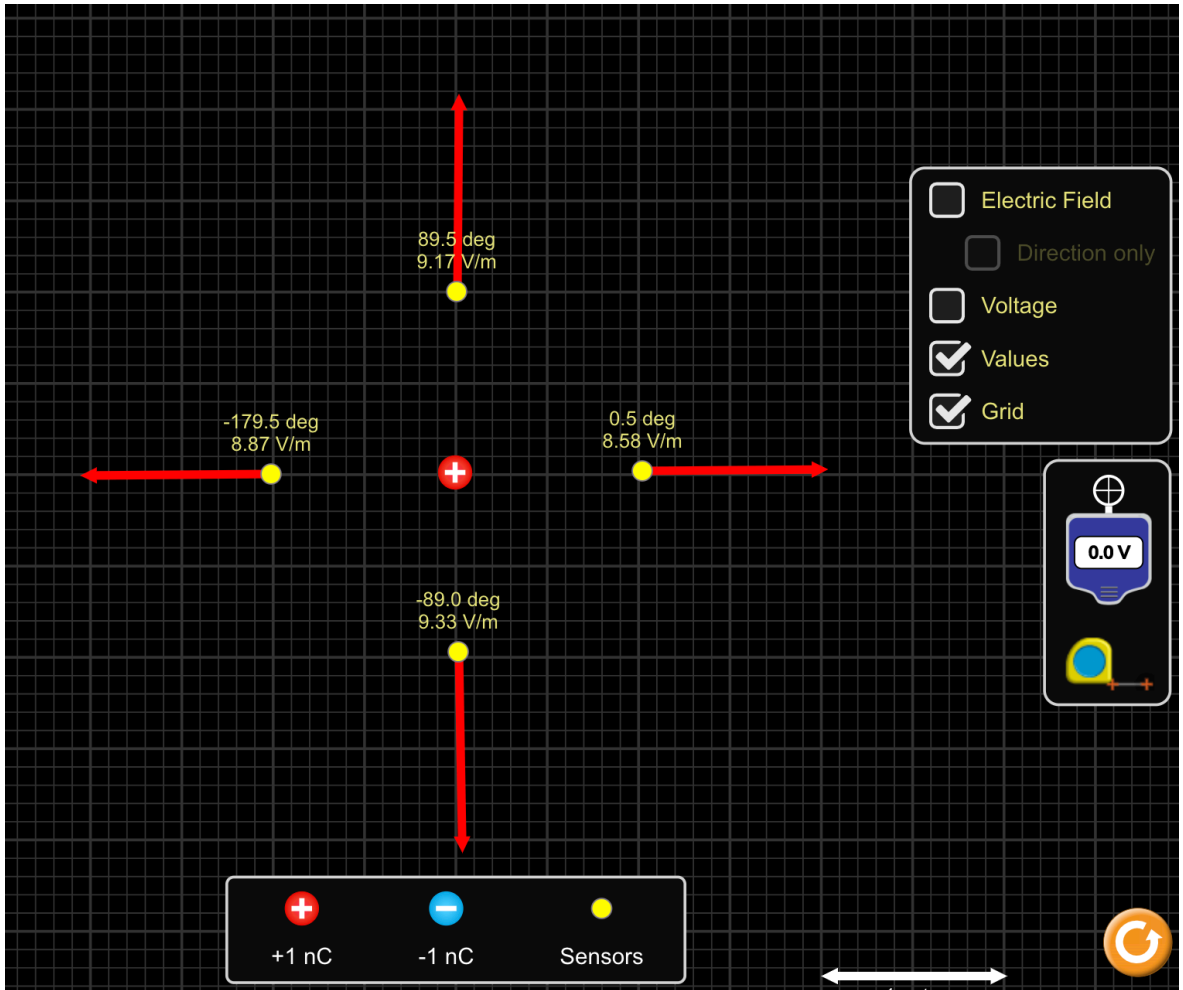
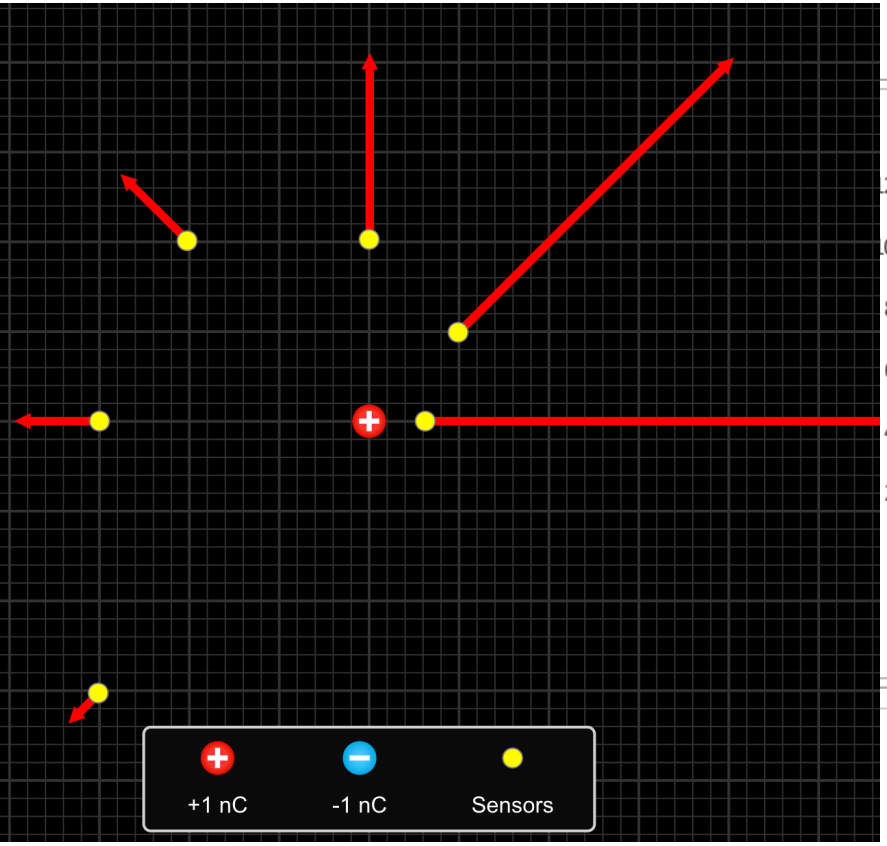
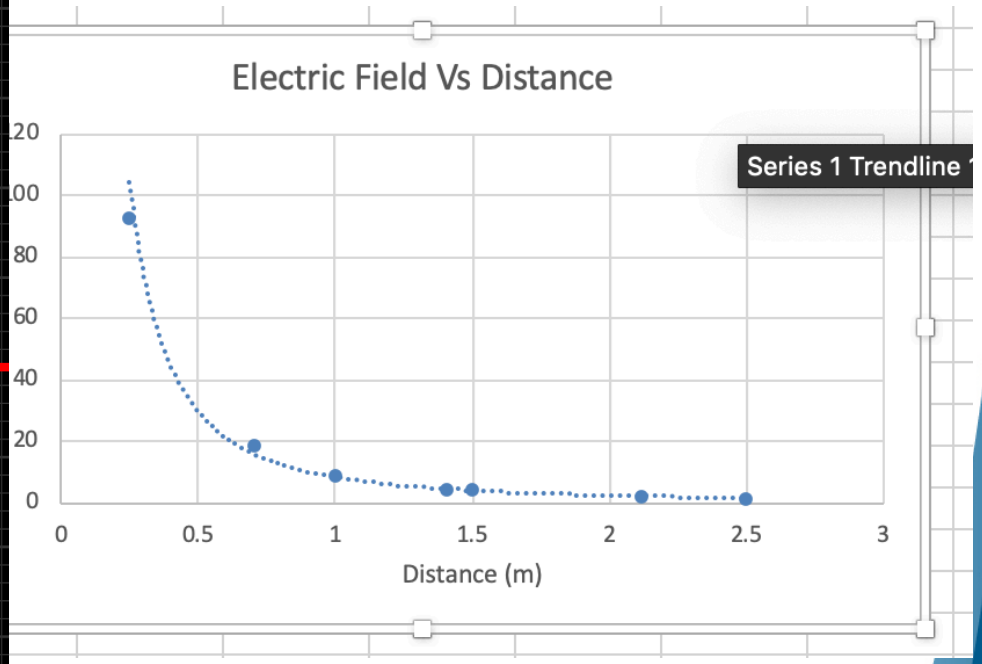
Data - Part 2:

Find the simulation at https://phet.colorado.edu/sims/html/charges-and-fields/latest/charges-and-fields_en.html



Data for Part 3





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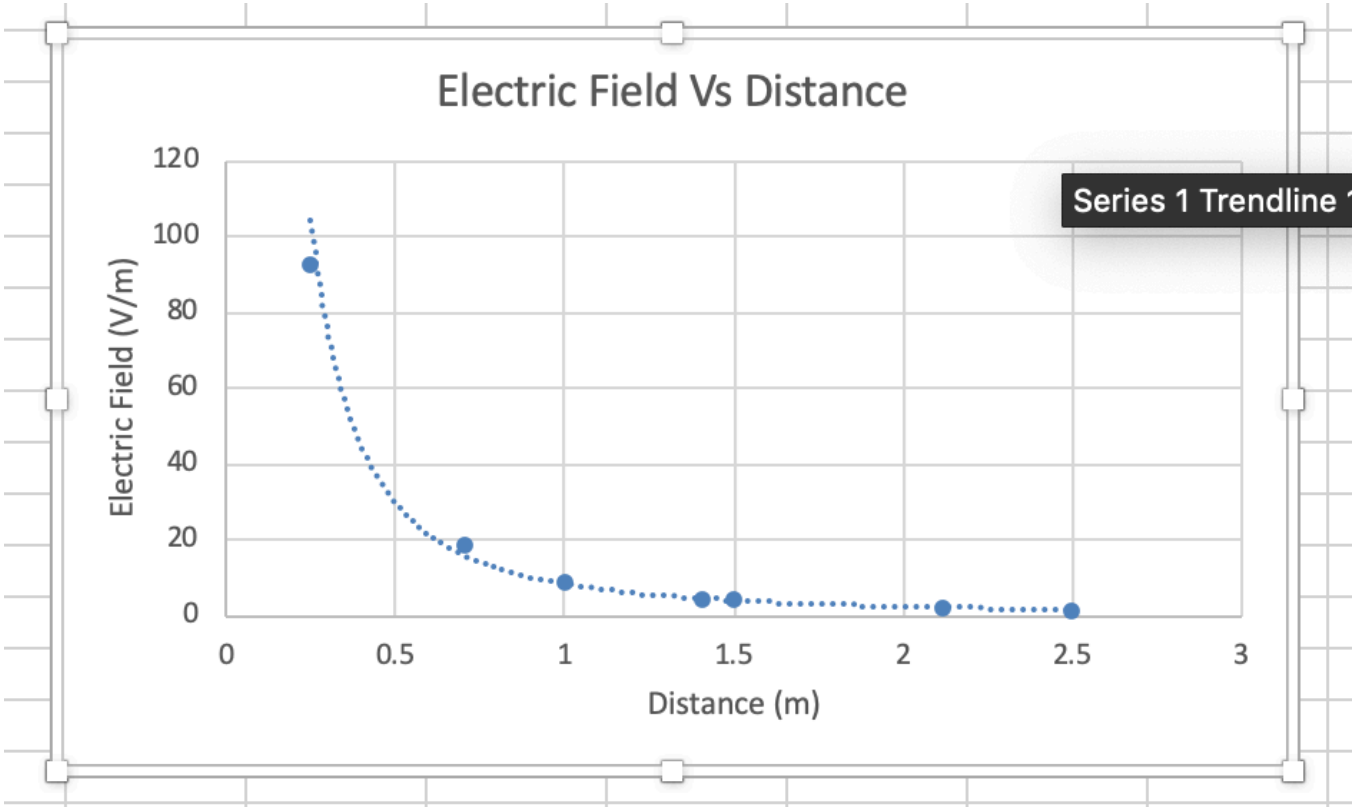
Final Notes:



$$PFE = \left(\frac{Value_1 - Value_2}{Value_1}\right) * 100\%$$

Data - Part 2 (cont):

- Place a positive charge around the center of the screen
- Place four sensors around the particle at 0,90,180,270 degrees
- Record the values for the electric field at these four locations
- Reset the simulation and repeat with a negative charge