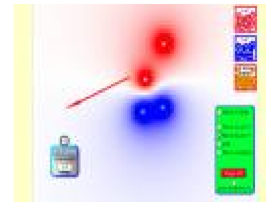
Name: ______________________

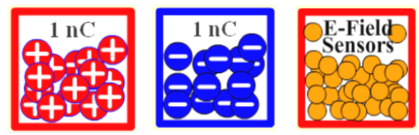
## E-Fields PhET Lab,

**Introduction:** It can be rationalized that the most important concept in physical science is like things _____________ while opposite things _____________. When working with static electric charges, like charges _____________ while opposite charges _____________. These charges can be as large as clouds of ionized gas in a nebula one million times the size of the earth, or as small as protons and electrons. The rule remains the same. In this lab, you will investigate how a charge creates a field around itself and how test charges behave when placed in that field.



Charges and Fields

**Important Formulas:** $F = Eq$ $F = k\frac{q_1 q_2}{d^2}$ $E = V/d$




k = 9.00 x $10^9$ $Nm^2/C^2$

**Procedure Part I:** *http://phet.colorado.edu/en/simulation/legacy/charges-and-fields* Run Now!

- Place a 1 nC (nanoCoulomb) positive charge and E-Field sensor in the test area. Click ☑ Show E-field to observe the field lines in the E-field. Observe the sensor's arrow as you drag it around the in the field.
- The sensor's arrow illustrates the **force** of attraction or repulsion at a point in an electric field.
- Replace the positive charge with a negative point charge. To remove charges, drag them back into their box.

By convention, field arrows point ______________ a positive charge and ______________ a negative charge.

As the sensor gets closer to a point charge, the field strength created by that field __________________

Set up positive charge and a negative charge in the test area, along with an E-field sensor (Show E-field still on).

- Describe the electric field around this two-charge configuration (i.e. what would the electric field line configuration look like? Include references to direction and strength).
- What happens if you move the charges closer together?
- What happens if you move the charges farther apart?
- Put another negative charge directly on top of the one that is already in the test area. How does this change the electric field in the test area?
- The basic law of electrostatics states that opposite charges will _____________. How might this be supported by the electric field in the test area?

Set up positive charge and a positive charge in the test area, along with an E-field sensor (Show E-field still on).

- Describe the electric field around this two-charge configuration (i.e. what would the electric field line configuration look like? Include references to direction and strength).
- What happens if you move the charges closer together?
- What happens if you move the charges farther apart?
- Put another positive charge directly on top of one that is already in the test area. How does this change the electric field in the test area?

- How would this electric field change if you replaced all of the positive charges with negative charges?

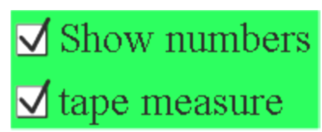
- The basic law of electrostatics states that like charges will _____________. How might this be supported by the electric field in the test area?

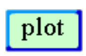
- Set up a configuration in the test area with at least 3 charges of any sign combination, along with an E-field sensor (Show E-field still on).

- Describe the configuration that you set up. (Sketch below)

- Describe the electric field of this configuration (i.e. what would the electric field line configuration look like? Include references to direction and strength).

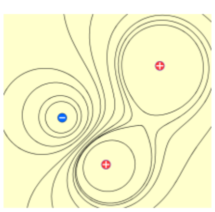
- Click on *show numbers* and *tape measure* to measure the distances from a a field-creating charge to a test charge. The tape measure can be dragged to a specific distance and placed anywhere on the field.




- When measuring field strength, click 

to show **lines of equipotential**.
- Complete the table below using a single positive or negative charge:

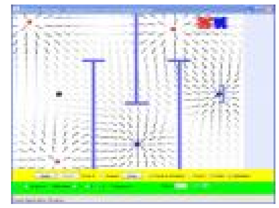
| Test charge distance, m | Field strength, V/m | Potential at location, V |
|---|---|---|
| 1.0 m | | |
| 2.5 m | | |
| | 1.1 V/m | |
| 4.0 m | | |



- Add at least three charges, using both positive and negative charges. Move the voltage meter around and *plot* the lines of equipotential. Plot at least ten lines.
- Sketch the multi-charge system here:
- Show the value of the potential on each line of equipotential.

**Procedure Part II:** *Electricity, Magnets, and Circuits → Electric Field Hockey* Run Now!

- So, using that wonderful principle that opposite charges __________ while like charges _________ play a little *Electric Field Hockey*.
- Setup your charges and go for the goal.
- Turning on the *Field* and *Trace* may make things a little easier.
- *Reset* the simulation to try again, with your charges in place.
- Challenge the other members of your lab group to duels.
- Challenge other lab groups. (no hockey fights please.)
- Try to use less than 12 charges total. (how few can you use?)



Electric Field Hockey

**Conclusion Questions and Calculations:**

1. Closer to a point charge, the electrostatic field created is *stronger / weaker*.

2. Placed exactly between two **oppositely** charged point charges, a test charge (the sensor) will show *zero / minimum / maximum* force (N) or field strength (N/C).

3. Placed exactly on a point charge, the sensor will show *zero / minimum / maximum* field strength.

4. The point charges used in the simulation are $\pm 1.0\text{x}10^{-9}$ C (**n**ano**C**oulomb). If two such positive charges are placed 2.0 m away from each other, the force between them would be... (use formula) __________________

   *SHOW WORK HERE:*

5. What is the magnitude of the electric field produced 2.0m away from **one** of the charges? __________________

   *WORK HERE:*

6. A test charge of 4.5 C in a field of strength 2.2 N/C would feel what force? __________________

   *WORK:*

7. What is the value of the electric field when a -9.6 V potential is found 1.4 m from its center? __________________

   *WORK:*

8. What is the electrostatic potential found .68 m from the center of a 2.3 V/m field? __________________

   *WORK:*

9. A balloon is electrostatically charged with 3.4 μC (microcoulombs) of charge. A second balloon 23 cm away is charged with -5.1 μC of charge. The force of *attraction / repulsion* between the two charges will be:

   *WORK:* __________________

10. If one of the balloons has a mass of 0.084 kg, with what acceleration does it move toward or away from the other balloon?

    *WORK:* __________________