Name: ____________________

Period: ____________________

Electric Field

9.3

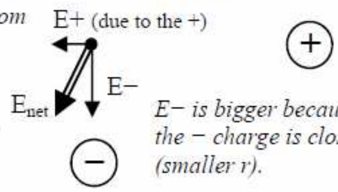
Electric Field

The potential for an electric force OR the area where F_e is possible.

Around a planet, objects are pulled by gravity. This pull decreases with distance. This area where gravity exists is called the gravitational field, g. Likewise, charges put out an electric field, E, where other charges can feel an electric force.

Like electric force, electric fields are created by charges, decrease with greater distance, and increase with more charge. Unlike electric forces, an electric field requires only one charge. **Electric fields are vectors and require direction.**

E's points away from +s and toward −s.



The total electric field at any point is the vector sum of all the individual E's.

E− is bigger because the − charge is closer (smaller r).

Electric Field (magnitude)

$$E = k_c \frac{q}{r^2}$$

- Electric Field (*in N/C*) → E
- Charge that is "r" distance away (*in C*) → q
- Coulomb's Constant $= 9\times10^9\ Nm^2/C^2$ → k_c
- Distance from this q (*in m*) → r

Since $E = k_c \frac{q}{r^2}$ and $F_e = k_c \frac{q_1 q_2}{r^2}$, then $F_e = Eq_2$.

If you already know E, then calculate the electric force by multiplying by the second charge (q_2, where q_1 is the charge making the field). Also, since electric field is in N/C, multiplying by the charge (in C) gives the force (in N).

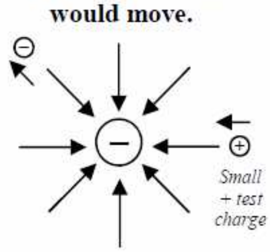
Example 1: What is the electric field strength 5 cm from a 2.6μC charge ?	
Variables: $k_c = 9\times10^9$ $q = 2.6\times10^{-6}C$ $r = .05$ m	$E = k_c\frac{q}{r^2} = 9\times10^9\frac{(2.6\times10^{-6})}{(.05)^2}$ $= 9\times10^9\frac{2.6\times10^{-6}}{.0025} = 9.36\times10^6 N/C$

Example 2: Given the electric field from Example 1, what force would a 9.4μC charge experience at that point?	
Variables: $E = 9.36\times10^6 N/C$ $q_2 = 9.4\times10^{-6}C$	$F_e = E q_2$ $(9.36\times10^6 N/C)(9.4\times10^{-6} C)$ $= 88N$ and repulsive (+s repel)

Drawing E

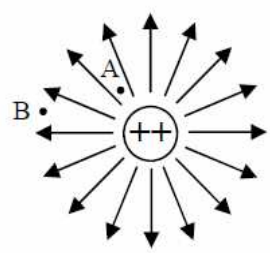
We use arrows to show the direction and strength of electric fields. The following diagrams visually demonstrate the rules for drawing electric field lines.

E points the direction a positive charge would move.



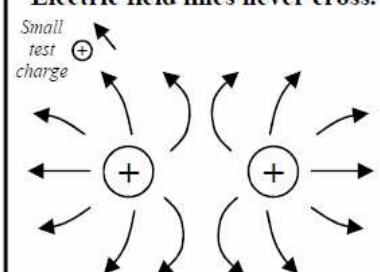
E points toward negatives because negatives attract positives. Electrons move the opposite direction of E.

More lines = stronger E.



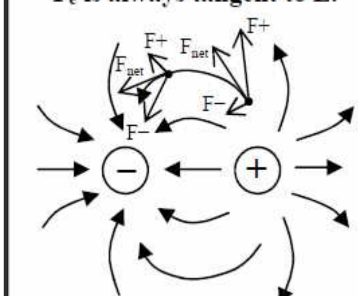
The electric field is stronger at point A because the lines are closer.

Electric field lines never cross.



Field lines point away from + charges, because a + test charge would be repelled and move away.

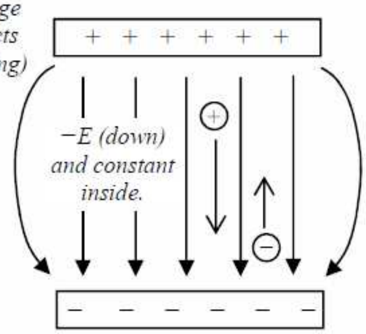
F_e is always tangent to E.



F_{net} is tangent to E at any point. F+ is the component due to the + charge and F− is due to the − charge.

Constant E

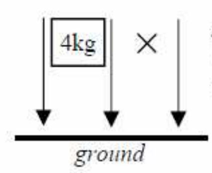
There are instances where E is constant and the lines are parallel. One is VERY close to a large charge (*like being close to the earth, where g is constant*). Another is between parallel charged plates. E still points from + to −. In constant E equations E is + if to the right or up.



Notice that the + charge moves with the field and the − moves opposite.

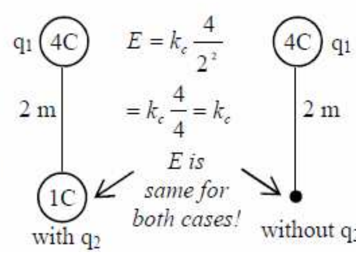
E is about the position

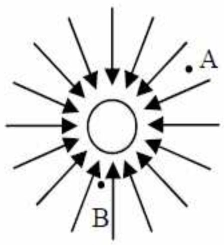
g (gravitational field) is the same near the earth for any mass because g depends on the mass of the earth NOT a mass above the earth.



g is the same (−9.8 m/s²), even if there is no mass.

Likewise, q_1 sets up a field and q_2 feels a force due to q_1. E is about the position, not the charge at that position.





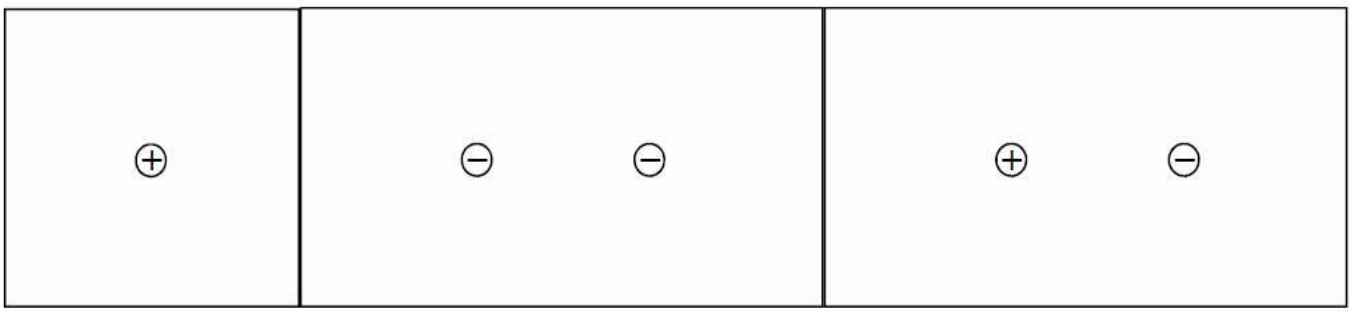
1. A. Is this a + or − charge?
   B. Why?
   C. Is the field stronger at A or B?
   D. Why?

   E. How would the picture change if the charge was decreased?

2. How much force does a 4 C charge feel when it is in a 2.5 N/C electric field?

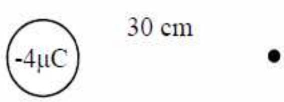
3. A 3 C charge feels 15 N of force. What is the electric field strength at its current position?

4. Draw the electric fields for the following situations.



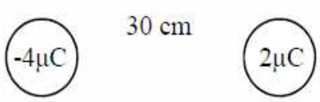
5. Calculate the electric field 5 cm away from a 8 μC charge.

6. Calculate the electric field 4 mm from a 10 μC charge.

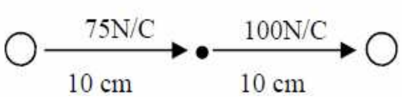


7. A. Calculate the magnitude of the electric field at a point 30 cm away from a –4μC charge.

   B. Draw the direction of the field at the point.
   C. What is the magnitude of the electric field if a 2μC charge is put at that same point?



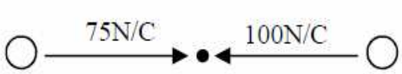
   D. Calculate the force between them.



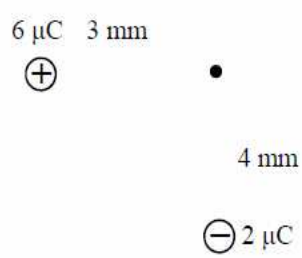
8. Two charges create the electric fields shown above.
   A. What are the signs of the two charges?
   B. If they are equal distance from the point, how can the electric field be greater by one of the charges?

   C. Calculate the net electric field at the point (*magnitude and direction*).

   D. One of the charges is changed. Determine the signs of the charges and the net field at the midpoint.



9. A. Calculate E at the point due to each charge
   B. Then calculate and draw the net electric field.



   C. If an electron was placed at the point, which way would it move?