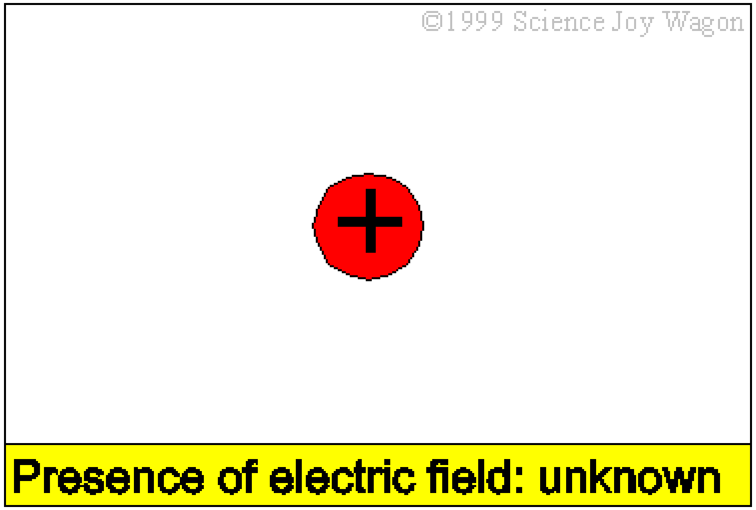
Electric Field Strength

- Electric field strength is the force available to influence a charge.
- The field is created by a single master charge and at a particular point, has an effect on a test charge.



$$\boxed{\vec{\varepsilon} = \frac{\overrightarrow{F_E}}{q_t}}$$

- Where $\vec{\varepsilon}$ is the field strength (in N/C)
  $\overrightarrow{F_E}$ is the electric force (in N) → Coulomb's Law
  q_t is the test charge (in C)

Ex. A pith ball with a charge of 2.3×10^{-6} C feels a force of 3.0 N to the left. What is the electric field strength at this point?

$\varepsilon = ?$

$q = 2.3\times10^{-6}C$

$F_e = 3.0N$ [left]

$\vec{\varepsilon} = \frac{\vec{F_e}}{q}$

$\varepsilon = \frac{3.0N}{2.3\times10^{-6}C}$

$\varepsilon = 1304348\ N/C$

$\varepsilon = 1.3\times10^{6}\ N/C$ [left]

Since the electric field strength is related to Coulomb's Law

$$\varepsilon = \frac{F_e}{q}$$

$$\overrightarrow{F}_{E} = q\,\vec{\varepsilon}$$

$$\frac{k\cancel{q}\,q_m}{r^2} = \cancel{q}\,\vec{\varepsilon}$$

$$\boxed{\vec{\varepsilon} = \frac{kq_m}{r^2}}$$

Ex. What is the electric field strength 30 cm away from a -3.0 x 10^{-6} C charge?

$r = 30\,cm$

$= 0.30\,m$

$q_m = -3.0 \times 10^{-6}\,C$

$k = 9.0 \times 10^{9}\,Nm^2/C^2$

$\mathcal{E} = ?$

$$\mathcal{E} = \frac{k q_m}{r^2}$$

$$\mathcal{E} = \frac{(9.0 \times 10^{9}\,Nm^2/C^2)(3.0 \times 10^{-6}\,C)}{(0.30\,m)^2}$$

$$\mathcal{E} = 3.0 \times 10^{5}\,N/C$$

Electric Field Mapping

- An electric field is said to exist anywhere a force is felt on a test charge

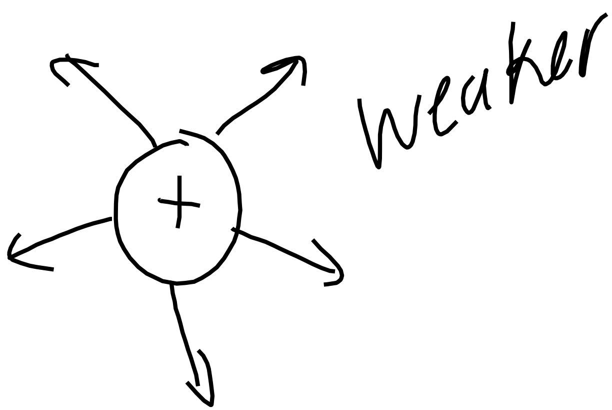
$+ \longrightarrow$

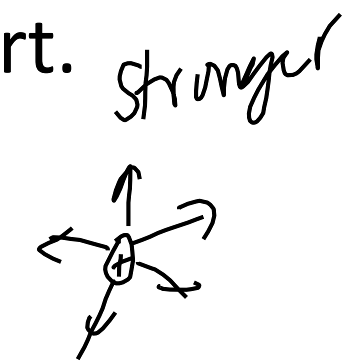
Rule #1 – We use a positive test charge for field mapping; therefore, the electric field lines always start and point away from any positive charge.

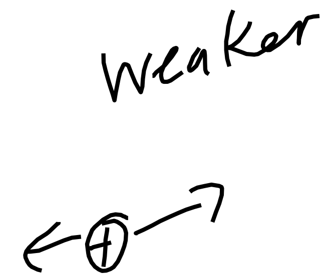
Rule #2 – In theory, we can draw an infinite number of field lines because there are an infinite number of places to put a test charge.

Rule #3 – Even though fields are three-dimensional, they are usually represented by a few lines drawn in a two-dimensional plane

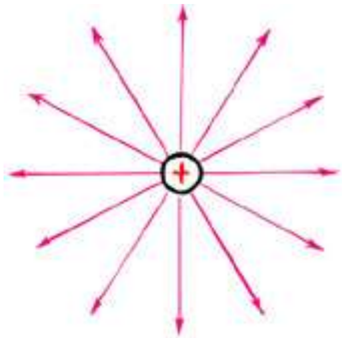
Rule #4 – The number of field lines emanating from a charge is proportional to the magnitude of that charge. From Coulomb's Law, we know that stronger forces occur at closer distances. On a field map, the stronger field is represented by lines that are closer together, while weaker fields are represented by lines that are further apart.



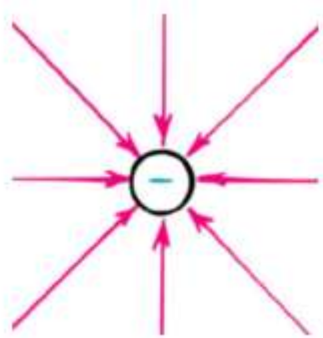




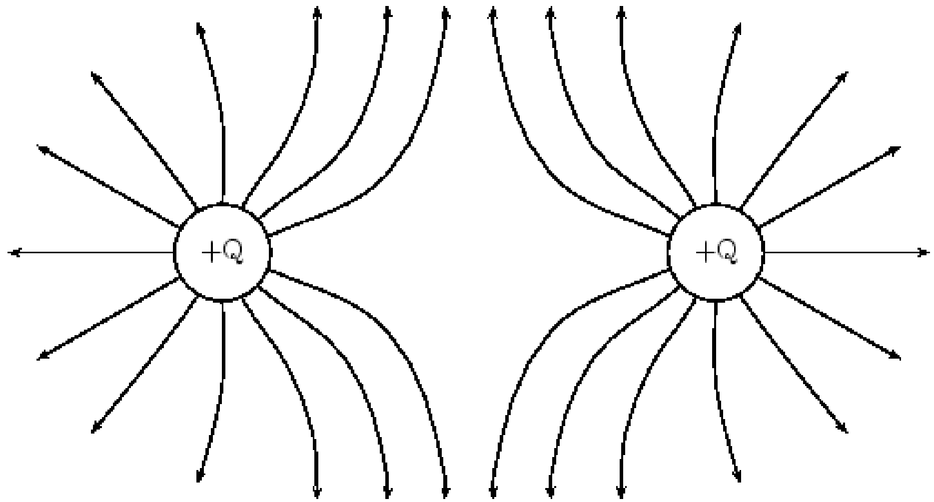
Ex. Field map of a positive charge



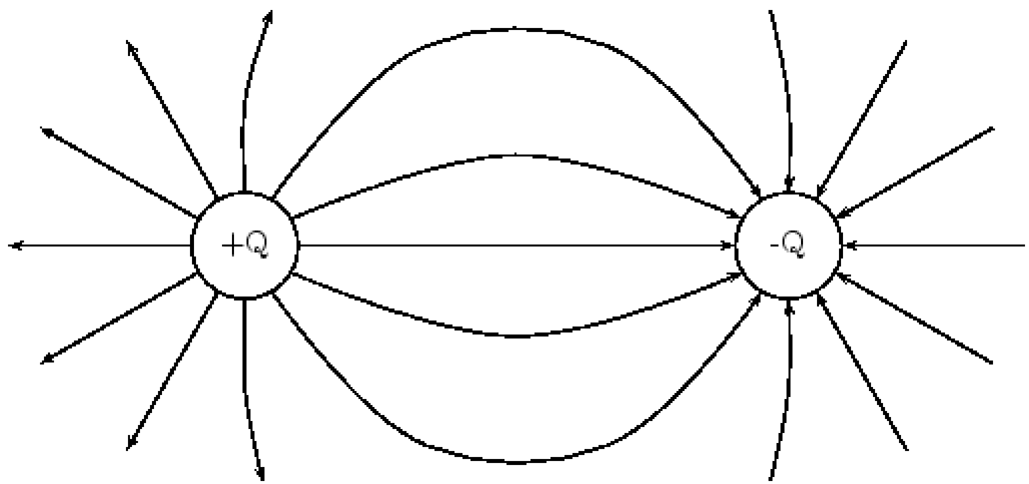
Ex. Field map of a negative charge



Ex. Field map of 2 positive point charges



Ex. Field map of 2 oppositely charged point charges



More Practice!

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