Electric Field Strength

The strength E of at some point is defined by this equation:

$$\vec{E} = \frac{\vec{F}}{q}$$

electric field strength in NC^{-1} (newtons per coulomb) — $\vec{E}$

force in N (newtons) — $\vec{F}$

charge in C (coulombs) — q

Electric field strength has a direction, which will always be the direction of force a positive charge would feel.

The electric field some distance from a point charge can be found according to this equation:

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

electric field strength in NC^{-1} (newtons per coulomb) — E

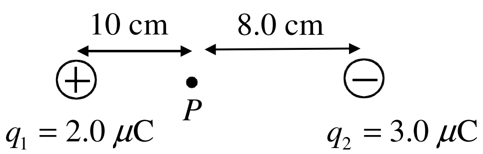
charge in C (coulombs) — q

distance from charge in m (metres) — r

The electric field strength depends only on the charge causing the field, not on other charges that may be in the field experiencing its forces.

If there is more than one charge creating an electric field, their fields overlap and add together. This is called the principle of superposition.

Example: Consider two point charges as shown below. What is the total electric field strength at P?



First calculate the field strength caused by q_1:

$$\begin{aligned} E &= k\frac{q}{r^2} \\ &= 9\times10^9 \times \frac{2.0\times10^{-6}}{(0.10)^2} \\ &= 1.8\times10^6\ \text{NC}^{-1} \text{ to the right (away from } q_1) \end{aligned}$$

Then the field strength caused by q_2:

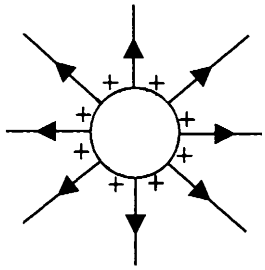
$$\begin{aligned} E &= k\frac{q}{r^2} \\ &= 9\times10^9 \times \frac{3.0\times10^{-6}}{(0.080)^2} \\ &= 4.2\times10^6\ \text{NC}^{-1} \text{ to the right (away from } q_2) \end{aligned}$$

Since both fields are going in the same direction (to the right), they add together. The total field strength is:

$E = 1.8\times10^6 + 4.2\times10^6 = 6.0\times10^6\ NC^{-1}$ to the right

Charges always move to the outside of conductors, because the electric field they create repels them from each other. This also means the electric field inside a conductor, whether it is hollow or solid, will be zero (because it cancels out from every direction.

Example:
Charges and electric field shown around a positively charged conductor.



Charges are most concentrated at the sharpest points on a conductor (they are repelled onto the point by all the other charges). This also means the electric field will be stronger along sharper curves or points on a conductor.

Example:
Charges and electric field shown around an unevenly shaped positively charged conductor.