Electrostatic Force and Field Examples

Example:

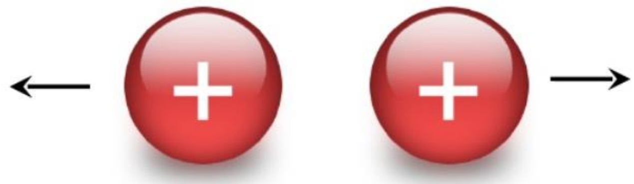
Two point charges of 1.8×10^{-6} C and 2.4×10^{-6} C produce a force of 2.2×10^{-3} N on each other. How far apart are these two charges?

$$F = \frac{Kq_1q_2}{r^2}$$

$$r = \sqrt{\frac{Kq_1q_2}{F_E}}$$

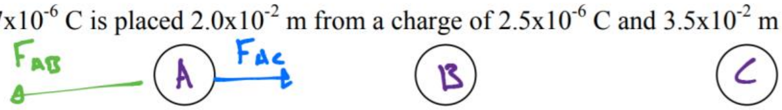
$$r = \sqrt{\frac{(9.0\times10^{9})(1.8\times10^{-6})(2.4\times10^{-6})}{2.2\times10^{-3}}}$$

$$\boxed{r = 4.2\,m}$$



Example:

A charge of 1.7×10^{-6} C is placed 2.0×10^{-2} m from a charge of 2.5×10^{-6} C and 3.5×10^{-2} m from a charge of -2.0×10^{-6} as shown.



1.7×10^{-6} C　　2.5×10^{-6} C　　-2.0×10^{-6} C

What is the net electric force on the 1.7×10^{-6} charge?

$$F_{net} = \text{Winner} - \text{Loser}$$

$$F_{net} = F_{AB} - F_{AC}$$

$$F_{net} = 95.6\,N - 25.0\,N$$

$$\boxed{F_{Net} = 71\,N}$$

$$F_{AB} = \frac{Kq_Aq_B}{r_{AB}^2}$$

$$F_{AB} = \frac{(9.0\times10^{9})(1.7\times10^{-6})(2.5\times10^{-6})}{(2.0\times10^{-2})^2} = 95.6\,N$$

$$F_{AC} = \frac{Kq_Aq_C}{r_{AC}^2}$$

$$F_{AC} = \frac{(9.0\times10^{9})(1.7\times10^{-6})(2.0\times10^{-6})}{(3.5\times10^{-2})^2} = 25.0\,N$$

Direction of net force will be to the left

Fields:

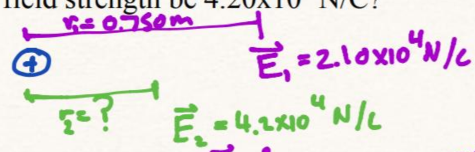
Example:
What is the electric field strength at a point where a -2.00 uC charge experiences an electric force of 5.30×10^{-4} N?

$F = \vec{E} q$

$\vec{E} = \frac{F}{q} = \frac{5.3 \times 10^{-4} N}{2.00 \times 10^{-6} C}$

$= \boxed{265 N/C}$

Example:
At a distance of 7.50×10^{-1} m from a small charged object the electric field strength is 2.10×10^{4} N/C. At what distance from this same object would the electric field strength be 4.20×10^{4} N/C?

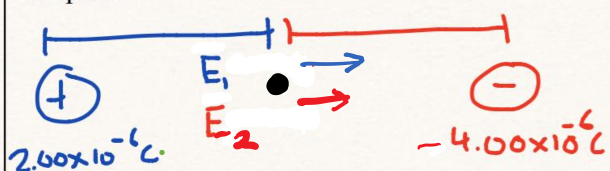


$\vec{E}_1 = \frac{kq}{r_1^2}$ $q = \frac{\vec{E} r_1^2}{k} = 1.3125 \times 10^{-6} C$

$\vec{E}_2 = \frac{kq}{r_2^2}$ ← q is the same! $r_2 = \sqrt{\frac{kq}{E_2}} = \boxed{0.53 m}$

Important Note: the **Direction of an electric field** is the direction that a **positive "test charge" would feel a force.**

Example:
What is the strength of an electric field midway between a 2.00 uC charge and a -4.00 uC that are 0.60 m apart?



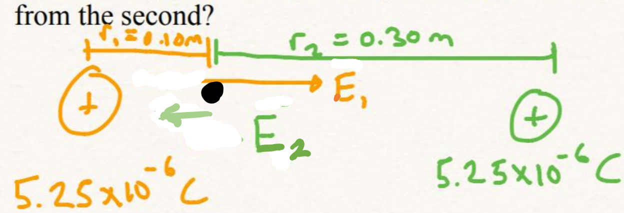
$E_1 = \frac{kq_1}{r_1^2} = 200\,000 N/C$

$E_2 = \frac{kq_2}{r_2^2} = 400\,000 N/C$

Note do not use "-" for sign

$E_T = E_1 + E_2 = 600\,000 N/C$

Example:
Two 5.25 uC charges are 0.40 m apart. What is the strength of the electric field between them at a point 0.10 m away from the first charge and 0.30 m away from the second?



$E_1 = \frac{kq_1}{r_1^2} = 4\,725\,000 N/C$

$E_2 = \frac{kq_2}{r_2^2} = 525\,000 N/C$

$E_T = E_1 - E_2 = 4.20 \times 10^{6} N/C$