Point Charges

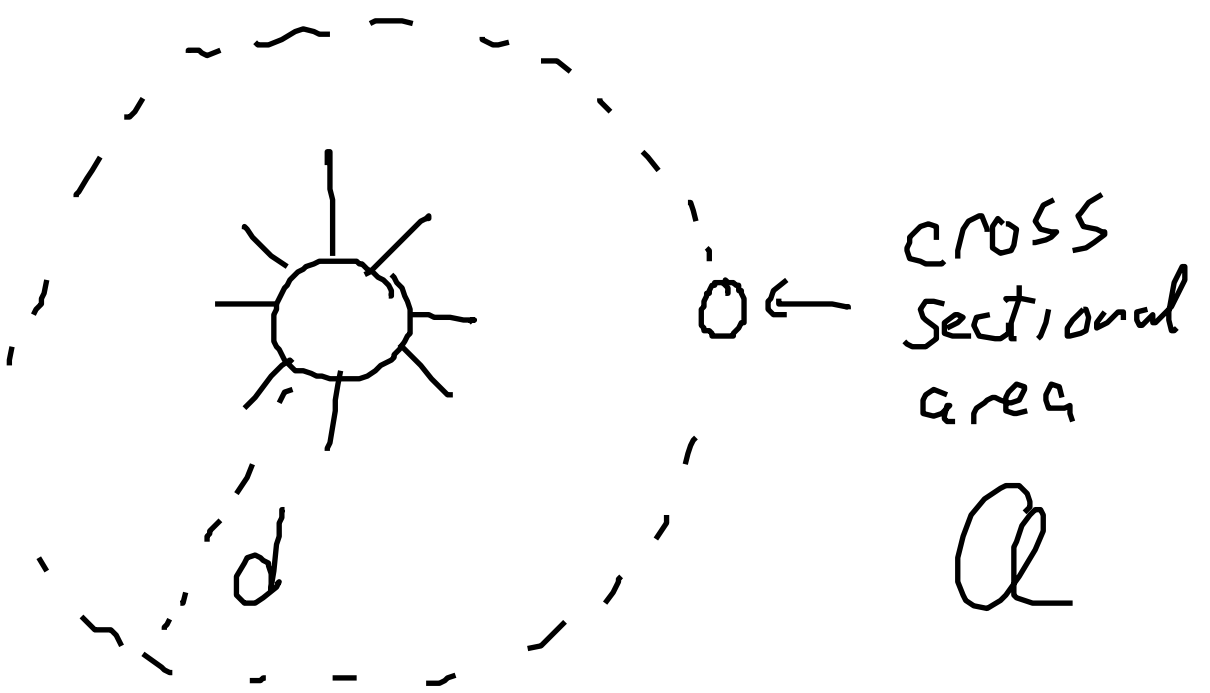
$$|\vec{F}| = F = k\frac{|q_1 q_2|}{d^2}$$

Coulomb's Law

- q_1, q_2 are charges in Coulombs (C)
- d : distance between charges
- $k = 9 \times 10^9 \ \frac{Nm^2}{C^2}$

Coulomb's constant

Optional



Sun puts out power L

All of light passes through sphere

Amount of light seen by detector is $\frac{L}{4\pi d^2}$

Source of inverse-square law

$$F = k\frac{|q_1 q_2|}{d^2} \qquad k = 9\times10^9 \frac{Nm^2}{C^2}$$

$$F = (9\times10^9)\frac{(1)(1)}{(1)^2}$$

$$= 9\times10^9\ N$$

$$= 9 \text{ billion } N$$

$$= 9\ GN$$

Average human weight 1000 N

Coulombs are huge

$1\,mC = 10^{-3}\,C$

milli

$1\,\mu C = 10^{-6}\,C$

micro

$1\,nC = 10^{-9}\,C$

nano

$e = 1.6 \times 10^{-19}\,C$

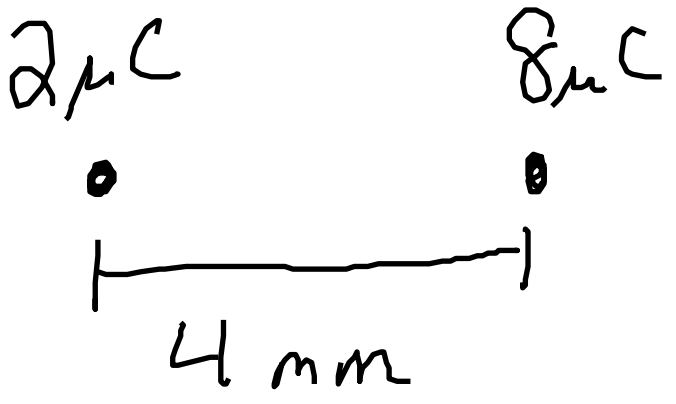
$= 0.160\,aC$

atto

"m" = "$\times 10^{-3}$"

"μ" = "$\times 10^{-6}$"

$5\,\mu C \rightarrow 5 \times 10^{-6}\,C$



Find F on either charge.

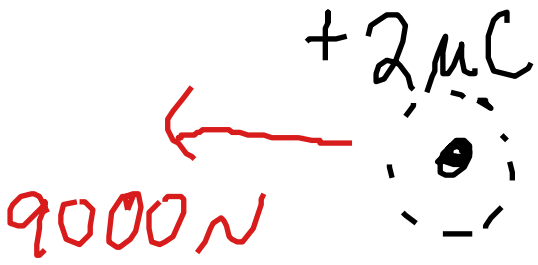
$$F = k \frac{|q_1 q_2|}{d^2}$$

$$= (9 \times 10^9) \frac{(2 \times 10^{-6})(8 \times 10^{-6})}{(4 \times 10^{-3})^2}$$

$$= 9 \times 10^9 \frac{16 \times 10^{-12}}{16 \times 10^{-6}}$$

$$= 9 \times 10^{9-12+6} = 9000\,N$$

$$\sim 10{,}000\,N$$

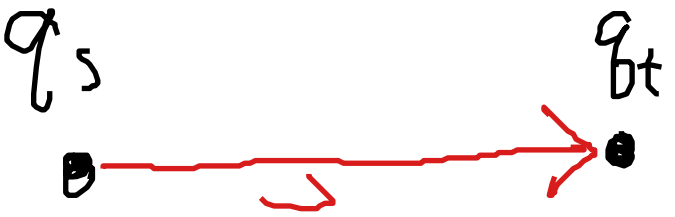


target charge

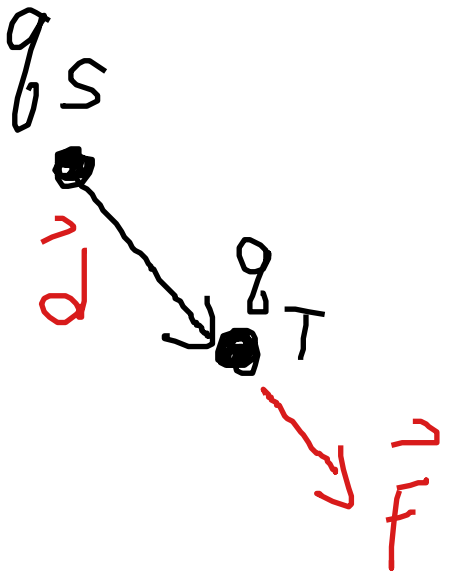
the one we choose to study, that receives forces

source charge

causes force on target



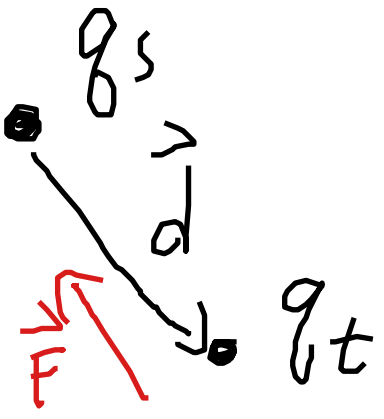
$\vec{d}$: points from source to target always



Both + or −

$q_s q_t > 0$

$\vec{F} \sim \vec{d}$



+ & −

$q_s q_t < 0$

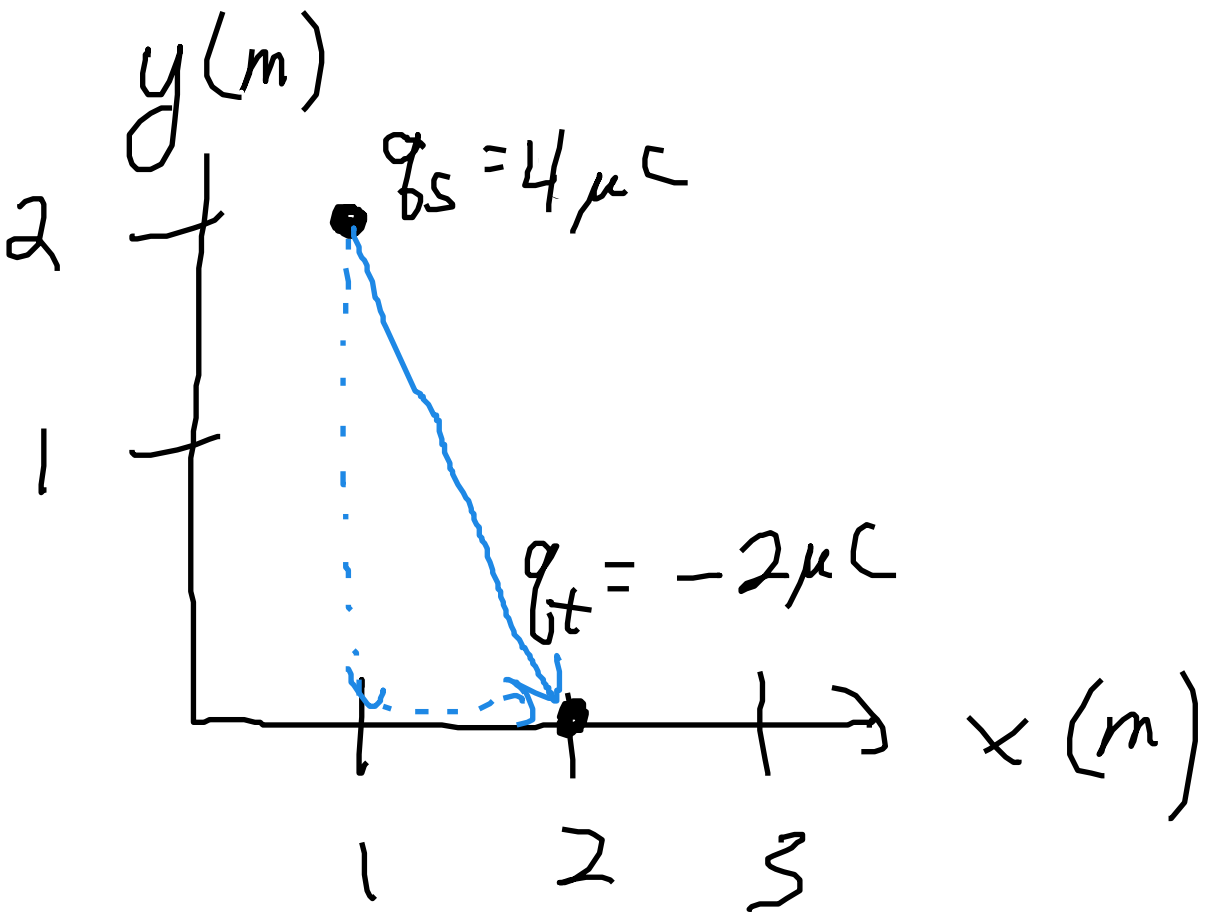
$\vec{F} \sim -\vec{d}$

$$\vec{F} = k \frac{q_s q_t}{d^2} \frac{\vec{d}}{d} \rightarrow \hat{d}$$

Unit vector

$$= k \frac{q_s q_t}{d^3} \vec{d}$$

Vector form of Coulomb's Law



What is $\vec{d}$?

$$1\hat{\imath} - 2\hat{\jmath}$$

$$\langle 1, -2 \rangle$$

$$1\hat{x} - 2\hat{y}$$

$$d = |\vec{d}| = \sqrt{(1)^2 + (2)^2} = \sqrt{5}\ m$$

$$F = (9\times10^{9})\frac{(4\times10^{-6})(-2\times10^{-6})}{(\sqrt{5})^{3}}(\hat{x}-2\hat{y})$$

$$= -0.006\ N\ (\hat{x}-2\hat{y})$$

$$= 0.006\ N\ (-\hat{x}+2\hat{y})$$