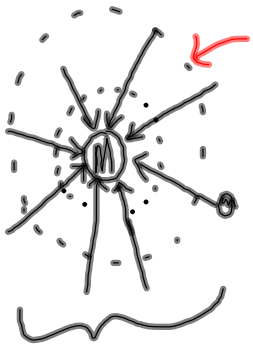
§14.1 Laws of Force

$F_g = \frac{G m_1 m_2}{r^2} \Rightarrow F_g \propto \frac{1}{r^2}$ (inverse square relationship)



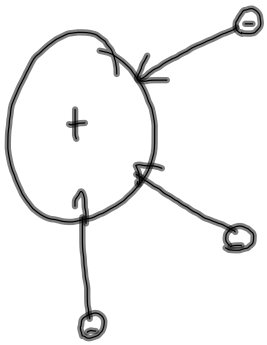
← fewer lines intersecting with surrounding sphere

$SA(\text{sphere}) = 4\pi r^2$

$\frac{\#\text{ of lines}}{SA} \Rightarrow$ related to F_g

The force between electric charges:

⊕ ⊕ ⇒ repulsion
⊖ ⊖ ⇒ repulsion
⊕ ⊖ ⇒ attraction



$F_a \propto q_1$
$F_a \propto q_2$
$F_a \propto \frac{1}{r^2}$

$F_a \propto \frac{q_1 q_2}{r^2}$

$F_a = \frac{k q_1 q_2}{r^2}$

Coulomb's Law

where F_a is the electrostatic force of attraction/repulsion (N) ← sign only

q_1 & q_2 are the magnitudes of the charges (C)

r is the separation (m)

k is $9.0 \times 10^9 \frac{N \cdot m^2}{C^2}$ (Coulomb's Constant)

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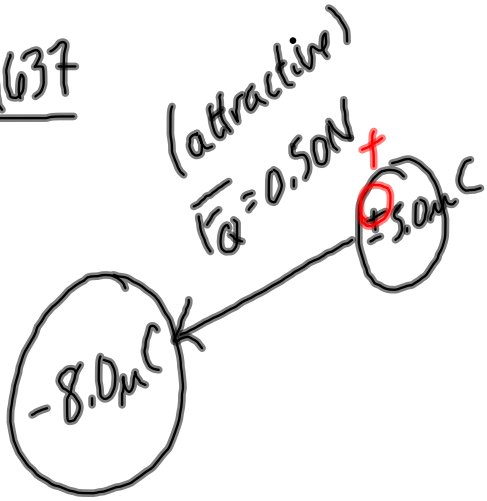


a) The 5.0 μC charge must be + since there is an attractive force

b) r = ?

$$F_Q = \frac{kq_1q_2}{r^2}$$

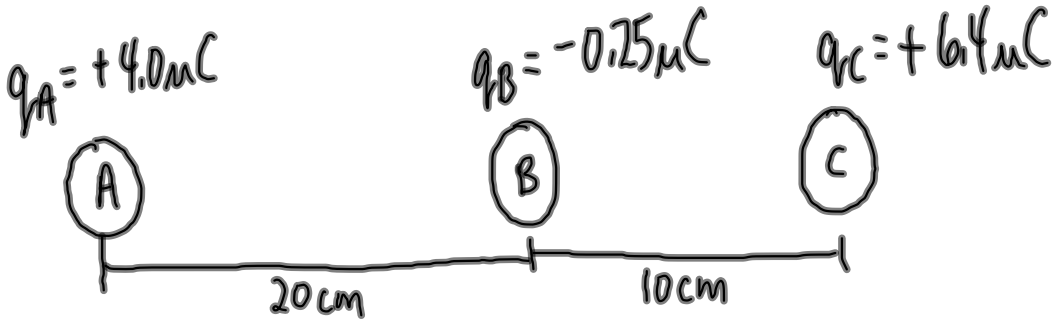
$$r^2 = \frac{kq_1q_2}{F_Q}$$

no signs for charges

$$r^2 = \frac{\left(9.0\times10^9 \frac{N\cdot m^2}{C^2}\right)\left(8.0\times10^{-6}C\right)\left(5.0\times10^{-6}C\right)}{0.50N}$$

$r = 0.85\ m$

Example



$F_{net\ on\ C} = ?$

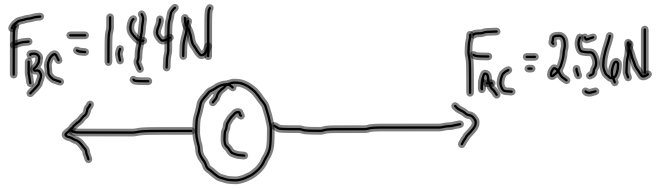
$$F_{AC} = \frac{\left(9.0\times10^{9}\ \frac{N\cdot m^2}{C^2}\right)(4.0\times10^{-6}\ C)(6.4\times10^{-6}\ C)}{(0.30\ m)^2}$$

$\vec{F}_{AC} = 2.56\ N$ [right]

$$F_{BC} = \frac{\left(9.0\times10^{9}\ \frac{N\cdot m^2}{C^2}\right)(0.25\times10^{-6}\ C)(6.4\times10^{-6}\ C)}{(0.10\ m)^2}$$

$\vec{F}_{BC} = 1.44\ N$ [left]

DRAW A FBD



$F_{net\ on\ C} = 2.56N - 1.44N$

$F_{net\ on\ C} = 1.12N$

$\vec{F}_{net\ on\ C} = 1.1\ N$ [right]

MP|639

$q_A = +15.0\,mC$

5.0 cm

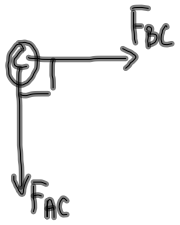
$q_B = -2.0\,mC$

$q_C = +3.0\,mC$

2.0 cm

$\vec{F}_{net\ on\ C} = ?$

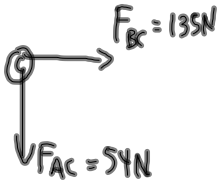
FBD for charge C:



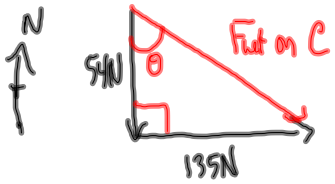
$$F_{AC} = \frac{\left(9.0\times10^{9}\,\frac{N\cdot m^2}{C^2}\right)(5.0\times10^{-6}\,C)(3.0\times10^{-6}\,C)}{(0.050\,m)^2} = 54\,N$$

$$F_{BC} = \frac{\left(9.0\times10^{9}\,\frac{N\cdot m^2}{C^2}\right)(2.0\times10^{-6}\,C)(3.0\times10^{-6}\,C)}{(0.020\,m)^2} = 135\,N$$

FBD:



Vector Addition



$c^2 = a^2 + b^2$

$c^2 = 54^2 + 135^2$

$c = 145\,N$

$\tan\theta = \frac{135N}{54N}$

$\theta = 68^\circ$

$\vec{F}_{net\ on\ C} = 145N\ [S\,68^\circ E]$

TO DO:

① PP|638

② PP|640-641

③ p 684|18-25 (This will be an assignment after XmAS)