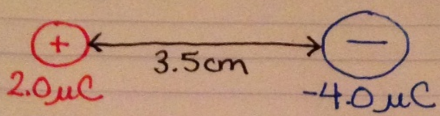
Two masses have a charge of 2.0 μC and -4.0 μC. If the masses are 3.5 cm apart calculate the magnitude of the electric force acting on each mass.



G: $q_1 = 2.0 \times 10^{-6}\,C$

$q_2 = -4.0 \times 10^{-6}\,C$

$r = 3.5\,cm = 0.035\,m$

$K = 8.99 \times 10^{9}\,Nm^2/C^2$

U: $F_E =$ ____ N

E: $F_E = \left| \frac{Kq_1q_2}{r^2} \right|$

S: $F_E = \frac{(8.99 \times 10^{9})(2.0 \times 10^{-6})(4.0 \times 10^{-6})}{(.035)^2}$

S: $F_E = 58.71\,N$

$F_E = 59\,N$

If the 2.0 μC mass from Ex. #1 has a mass of 20 mg, what is its the initial acceleration when released given that electric force is the only relevant force?

$F_E = 59\ N$

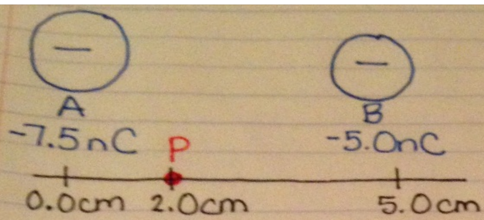
$m = 20\ mg = 2.0 \times 10^{-5}\ Kg$

$$\frac{F_{net}}{m} = \frac{ma}{m}$$

$$\therefore a = \frac{F_{net}}{m} = \frac{F_E}{m} = \frac{(59\ N)}{(2.0 \times 10^{-5}\ Kg)}$$

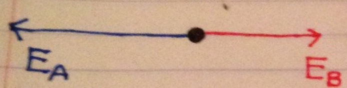
$$a = 2950000\ \frac{m}{s^2}$$

$$\boxed{a = 3.0 \times 10^{6}\ m/s^2}$$



What is the net electric field at Point P? (Magnitude and direction)

FBD:



$$E = \left|\frac{Kq}{r^2}\right|$$

$$E_B = \frac{Kq_B}{r_B^2} = \frac{(8.99\times10^9)(5\times10^{-9})}{(0.03)^2} = 4.994\times10^4\ NC^{-1}$$

$$E_A = \frac{Kq_A}{r_A^2} = \frac{(8.99\times10^9)(7.5\times10^{-9})}{(0.02)^2} = 1.686\times10^5\ NC^{-1}$$

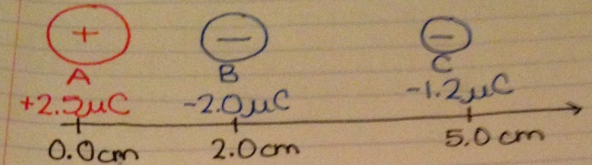
ΣE:

$$\Sigma E_x = E_B - E_A$$

$$= 4.994\times10^4 - 1.686\times10^5$$

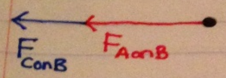
$$E_{net} = -118660\ NC^{-1}$$

$$E_{net} = 1.2\times10^5\ NC^{-1}, \text{ left}$$



What is the net electric force of charge B? (Magnitude & direction)

FBD:



$F_E = \left| \frac{Kq_1 q_2}{r^2} \right|$

$F_{C on B} = \frac{Kq_C q_B}{r_{CB}^2} = \frac{(8.99\times10^9)(1.2\times10^{-6})(2\times10^{-6})}{(0.03)^2}$

$F_{C on B} = \underline{23.97\,N}$

$F_{A on B} = \frac{Kq_A q_B}{r_{AB}^2} = \frac{(8.99\times10^9)(2.5\times10^{-6})(2\times10^{-6})}{(0.02)^2}$

$F_{A on B} = \underline{112.38\,N}$

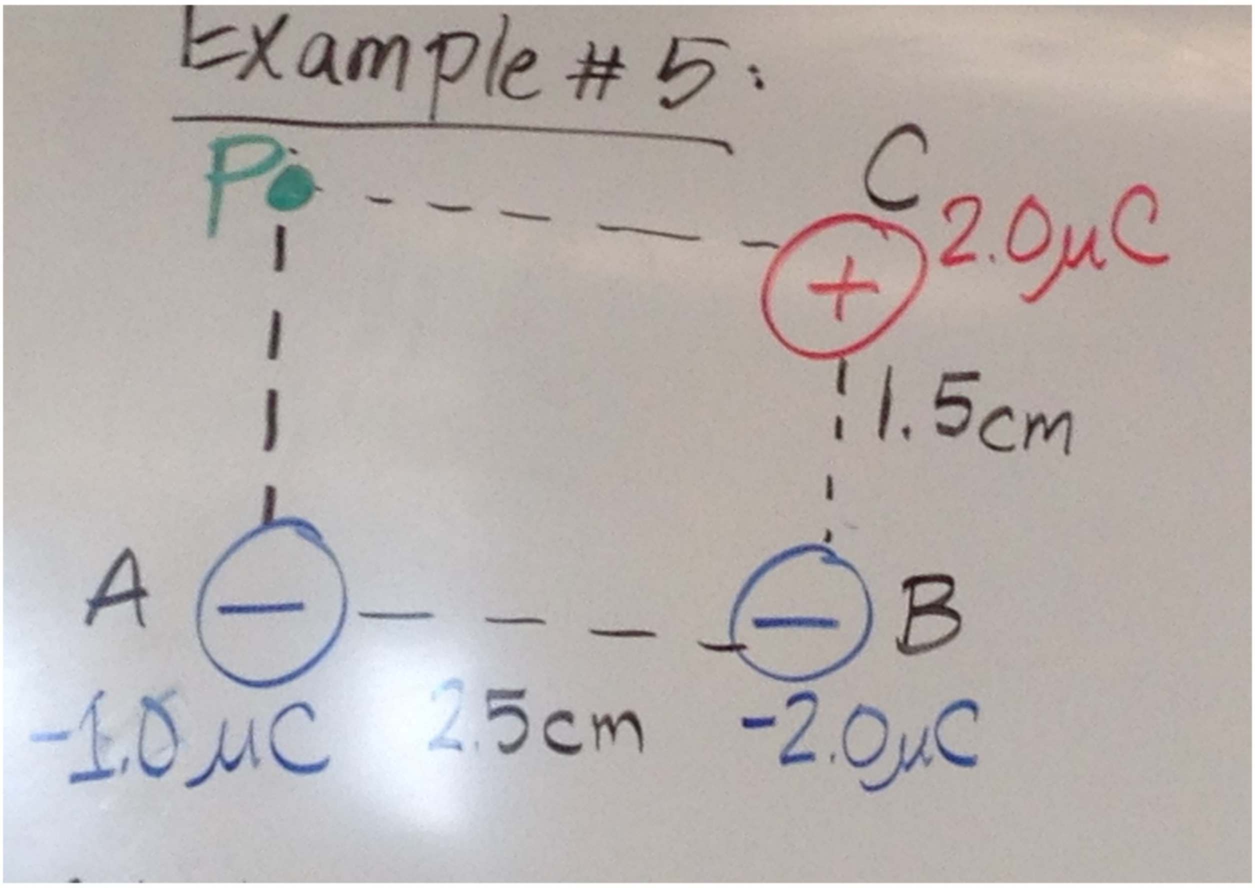
ΣF:

$\Sigma F_x = -F_{C on B} - F_{A on B}$

$= -(23.97) - 112.38$

$F_{net} = \underline{-136.35\,N}$

F_{net} = 140 N, left

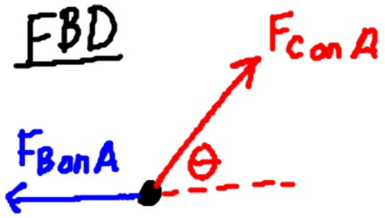

Example # 5:
P
C
+
2.0μC
1.5cm
A
B
-1.0μC
2.5cm
-2.0μC

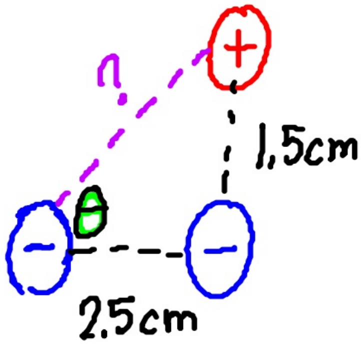
(a) What is the net electric force on charge A? (mag. & dir.)

(b) What is the net electric field at point P? (mag. & dir.)

5(a)

FBD





$$? = \sqrt{(2.5)^2 + (1.5)^2}$$

$$? = 2.915 \text{ cm} \Rightarrow r_{CA} = 0.02915$$

$$\theta = \tan^{-1}\left(\frac{opp}{adj}\right)$$

$$\theta = \tan^{-1}\left(\frac{1.5}{2.5}\right)$$

$$\theta = 30.96^\circ$$

ΣF:

$(21.16 \cos 30.96 - 28.77)$

$$\Sigma F_x = F_{ConA} \cos\theta - F_{BonA}$$

$$\Sigma F_y = F_{ConA} \sin\theta = 21.16 \sin(30.96)$$

$$F_{ConA} = \frac{k q_C q_A}{r_{CA}^2} = \frac{(8.99\times10^9)(2\times10^{-6})(1\times10^{-6})}{(.02915)^2} = 21.16 \text{ N}$$

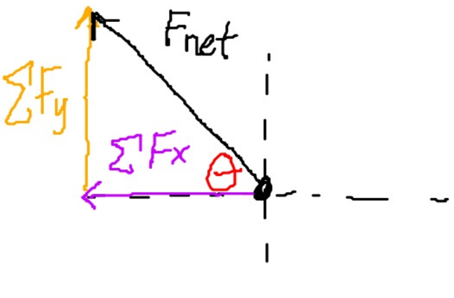
$$F_{BonA} = \frac{k q_B q_A}{r_{BA}^2} = \frac{(8.99\times10^9)(2\times10^{-6})(1\times10^{-6})}{(.025)^2} = 28.77 \text{ N}$$

$$\Sigma F_x = -10.62 \text{ N}$$

$$\Sigma F_y = 10.89 \text{ N}$$

$$F_{net} = \sqrt{(10.62)^2 + (10.89)^2}$$

$$F_{net} = 15.211 \text{ N}$$



$$\theta = \tan^{-1}\left(\frac{|\Sigma F_y|}{|\Sigma F_x|}\right) = \tan^{-1}\left(\frac{10.89}{10.62}\right) = 45.72^\circ$$

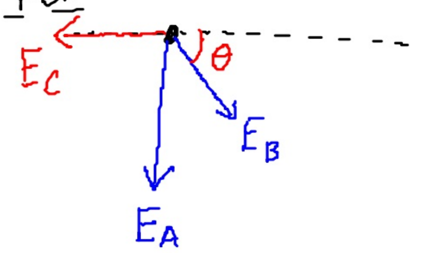
46°

15N, 46° above −x axis

5(b)

$\theta = 30.96^\circ$ (see previous problem)

FBD



$K = 8.99 \times 10^9$

$q_A = 1.0 \times 10^{-6}$

$q_B = 2.0 \times 10^{-6}$

$q_C = 2.0 \times 10^{-6}$

$r_A = 1.5\text{cm} = 0.015\text{m}$

$r_B = 2.915\text{cm} = 0.02915\text{m}$

$r_C = 2.5\text{cm} = 0.025\text{ m}$

$$E_A = \frac{Kq_A}{r_A^2} = 3.996 \times 10^7\ NC^{-1}$$

$$E_B = \frac{Kq_B}{r_B^2} = 2.116 \times 10^7\ NC^{-1}$$

$$E_C = \frac{Kq_C}{r_C^2} = 2.877 \times 10^7\ NC^{-1}$$

$$\sum E_x = E_B \cos\theta - E_C$$

$$\sum E_y = -E_A - E_B \sin\theta$$

$$\sum E_x = -1.063 \times 10^7\ NC^{-1}$$

$$\sum E_y = -5.085 \times 10^7\ NC^{-1}$$

$E_{net} = (\Sigma E_x)^2 + (\Sigma E_y)^2$

$E_{net} = (-1.063 \text{ x } 10^7)^2 + (-5.085 \text{ x } 10^7)^2$

$E_{net} = 5.2 \text{ x } 10^7 \text{ NC}^{-1}$

$\theta = \tan^{-1}(|\Sigma E_y| / |\Sigma E_x|)$

$\theta = \tan^{-1}(|-5.085 \text{ x } 10^7| / |-1.063 \text{ x } 10^7|)$

$\theta = 78°$ below the -x axis