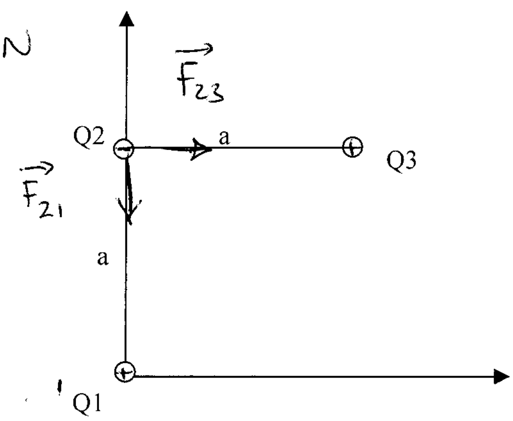
Physics 102.13
Quiz#6-Quiz#7
Chapter 21-22

Instructor: Dr. A. Mekki

Name: Key Id:

1. Consider three charges located at the corner of a triangle as shown in the figure, where q1 = q3 = 5 μC, q2 = -2 μC, and a = 10 cm. Find the resultant force on q2.

$$F_{23} = \frac{k|q_2||q_3|}{r^2} = \frac{9\times10^9 \times 2\times10^{-6} \times 5\times10^{-6}}{(0.1)^2} = 9\text{ N}$$



$$F_{21} = \frac{k|q_2||q_1|}{r^2} = 9\text{ N}$$

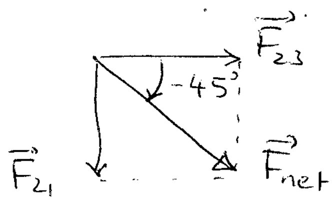
$$F_x = F_{23} = 9\text{ N}$$

$$F_y = -F_{21} = -9\text{ N}$$

$$\vec{F}_{net} = 9\hat{i} - 9\hat{j}\text{ N}$$

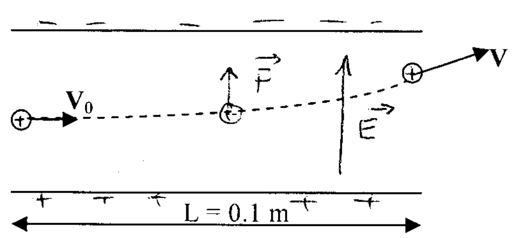
$$|\vec{F}| = 12.7\text{ N}$$

$$\theta = -45°$$



2. A proton enters a region of uniform electric field as in the figure with $v_0 = 3 \times 10^4$ m/s and E = 200 N/C. The width of the plate is L = 0.1 m.

(a) Find the acceleration of the proton while in the electric field



$$F = ma = |q|E$$

$$a = \frac{|q|E}{m} = \frac{1.6\times10^{-19} \times 200}{1.67\times10^{-27}} = 1.9\times10^{10}\text{ m/s}^2$$

(b) Find the vertical deflection y of the proton as it leaves the plates from the other side.

$$y = \frac{1}{2}at^2 + v_{0y}t =$$

$$v_{0x} = \frac{x}{t} \Rightarrow t = \frac{x}{v_{0x}} = \frac{0.1}{3\times10^4} = 3.3\times10^{-6}\text{ s}$$

$$y = \frac{1}{2}(1.9\times10^{10})(3.3\times10^{-6})^2 = 0.105\text{ m}$$

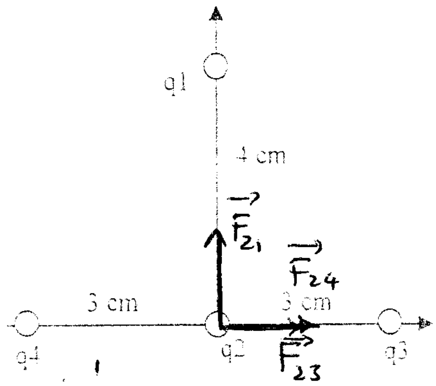
10.5 cm

Physics 102.14
Quiz#6-Quiz#7
Chapter 21-22

Instructor: Dr. A. Mekki

Name: Key Id:

1. Four charges $q_1 = 5e$, $q_2 = -2e$, $q_3 = 5e$, and $q_4 = -5e$ are located on the x-y plane as shown in the figure. Find the electric force on charge q_2 due to charges q_1, q_3 and q_4.



$$F_{21} = \frac{k|q_1||q_2|}{r^2} = 1.44 \times 10^{-24} \text{ N}$$

$$F_{23} = \frac{k|q_2||q_3|}{r^2} = 2.56 \times 10^{-24} \text{ N}$$

$$F_{24} = \frac{k|q_2||q_4|}{r^2} = 2.56 \times 10^{-24} \text{ N}$$

$$F_{net,x} = F_{23} + F_{24} = 5.1 \times 10^{-24} \text{ N}$$

$$F_{net,y} = F_{21} = 1.44 \times 10^{-24} \text{ N}$$

$$\vec{F}_{net} = 5.1 \times 10^{-24} \hat{i} + 1.44 \times 10^{-24} \hat{j} \text{ N}$$

magnitude: $|\vec{F}_{net}| = \sqrt{(5.1)^2 + (1.44)^2} \times 10^{-24} = 5.3 \times 10^{-24}$ N

direction: $\theta = \tan^{-1}\left(\frac{1.44}{5.1}\right) = 15.7^\circ$

2. A proton is moving with a velocity of 2.5×10^6 m/s in a direction opposite to a uniform electric field. The proton stops momentarily after moving a distance of 10 cm.

(a) Find the deceleration of the proton.

$$v^2 = v_0^2 + 2a\Delta x \Rightarrow a = -\frac{v_0^2}{2\Delta x}$$

$$a = -3.1 \times 10^{13} \text{ m/s}^2.$$

(b) Find the magnitude of the electric field.

$$F = qE = ma \Rightarrow E = \frac{ma}{q} = 3.3 \times 10^5 \text{ N/C}.$$

Physics 102.15
Quiz#6-Quiz#7
Chapter 21-22

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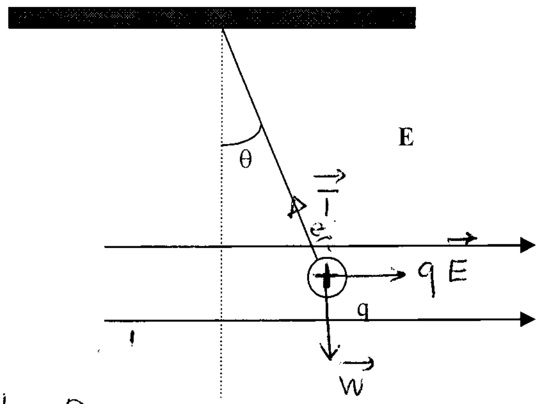
Name: Key Id:

1. A charged plastic ball of mass 1 g is suspended on a light string in the presence of a uniform electric field given by **E** = 3 x 10^5 **i** N/C. The ball is in equilibrium when θ = 40°. Find;
(a) the charge on the ball.
(b) the tension in the string.



a) $\sum F_x = 0 \Rightarrow -T\sin\theta + qE = 0$

$\sum F_y = 0 \Rightarrow T\cos\theta - mg = 0$

$T\sin\theta = qE$

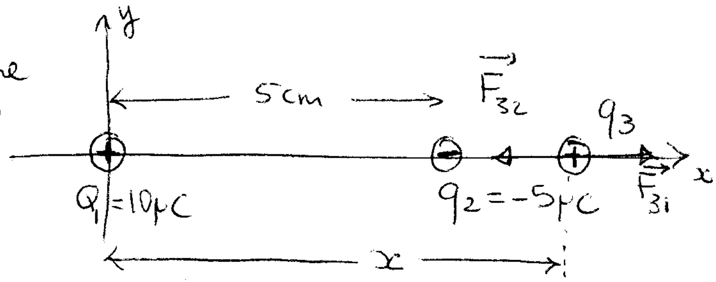
$T\cos\theta = mg$

$\Rightarrow \tan\theta = \frac{qE}{mg} \Rightarrow q = \frac{mg\tan\theta}{E} = \frac{0.001 \times 9.8 \times \tan 40^\circ}{3 \times 10^5}$

$\Rightarrow \boxed{q = 2.7 \times 10^{-8}\,C}$

b) $T = \frac{mg}{\cos\theta} = \boxed{0.01\,N}$

2. A charge Q1 = 10 μC is located at the origin. A charge Q2 = -5 μC is located at x = 5 cm. Where should a charge Q3 be located on the x-axis so that the net electric force on it is zero?



Suppose $Q_3 > 0$ (The result is the same if $Q_3 < 0$)

$F_{31} - F_{32} = 0$

$\Rightarrow F_{31} = F_{32}$

$\frac{k|q_1||q_3|}{x^2} = \frac{k|q_2||q_3|}{(x-5)^2} \Rightarrow \frac{(x-5)^2}{x^2} = \frac{|q_2|}{|q_1|} = \frac{1}{2}$

$\frac{x-5}{x} = \sqrt{\frac{1}{2}} \Rightarrow 1 - \frac{5}{x} = \frac{1}{\sqrt{2}}$

$\frac{5}{x} = 1 - \frac{1}{\sqrt{2}} \Rightarrow x = \frac{5}{1 - \frac{1}{\sqrt{2}}} = \boxed{17\text{ cm}}$