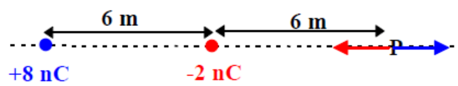
Electric Field

1. What is the magnitude (in milliN) and direction of the electrostatic force on a -2.0 μC charge in a uniform electric field given by $\vec{E} = (100N/C)\hat{x}$?

2. Two point charges, +8 nC and -2 nC lie on the x-axis and are separated by 6 meters as shown in the Figure. What is the magnitude of the electric field (in N/C) at a point P on the x-axis a distance of 6 meters to the right of the negative charge?

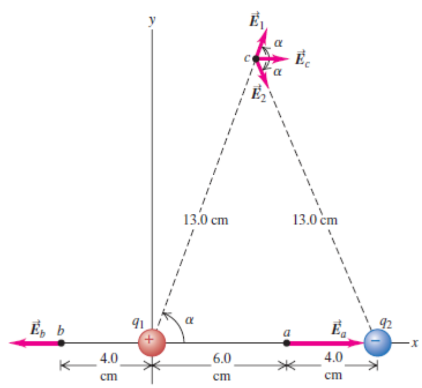


3. A particle with a charge to mass ratio of 0.1 C/kg starts from rest in a uniform electric field with magnitude, E = 10 N/C. How far will the particle move (in m) in 2 seconds?

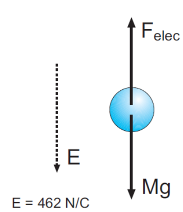
4. At a distance of 1 meter from an isolated point charge the electric field strength is 100 N/C. At what distance (in m) from the charge is the electric field strength equal to 50 N/C?

5. The magnitude of the electric field 300 m from a point charge Q is equal to 1,000 N/C. What is the charge Q (in C)?

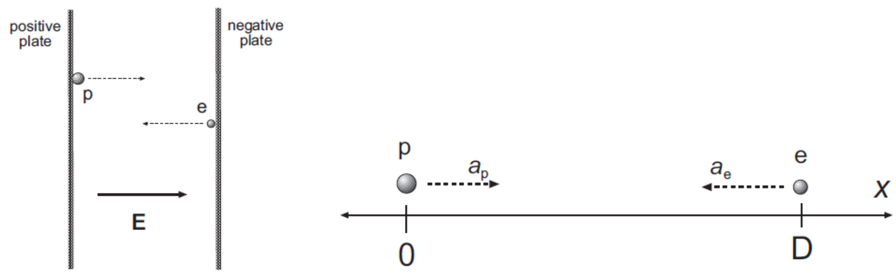
6. Point charges q1 = +12 nC and q2 = -12nC are 0.100 m apart. (Such pairs of point charges with equal magnitude and opposite sign are called *electric dipoles*.) Compute the electric field caused by the field caused by and the total field (a) at point a, (b) at point b and (c) at point c



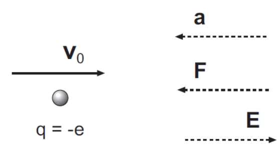
7. A water droplet of mass 3.00×10^{-12} kg is located in the air near the ground during a stormy day. An atmospheric electric field of magnitude 462 N/C points vertically downward in the vicinity of the water droplet. The droplet remains suspended at rest in the air. (a) What is the weight of the drop? (b) What is the electric charge on the droplet? (c) How many electrons does it have?



8. Two large parallel copper plates are 5.0 cm apart and have a uniform electric field between them as depicted in Figure. An electron is released from the negative plate at the same time that a proton is released from the positive plate. Neglect the force of the particles on each other and find their distance from the positive plate when they pass each other.



9. The electrons in a particle beam each have a kinetic energy of 1.60 × 10−17 J. What are the magnitude and direction of the electric field that will stop these electrons in a distance of 10.0 cm?

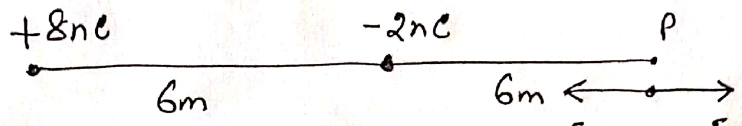


Sample: Electric field: Hints

1. $\vec{F} = q\vec{E}$ $\qquad \vec{E} = 100\ N/C\ \hat{x}$

$\vec{F} = ?$ $\qquad q = -2.0\ \mu C$

2.



$\vec{E}_8 = K \frac{8\times10^{-9}}{(12)^2}\hat{i}$, $\vec{E}_2 = K\frac{-2\times10^{-9}}{(6)^2}\hat{i}$

$\boxed{\vec{E}_8 - \vec{E}_2}$

3. $\frac{q}{m} = 0.1\ \frac{C}{kg}$, $|\vec{E}| = 10\ N/C$, $t = 2$ sec.

$\vec{F}_a = m\vec{a}$ and $\vec{F}_e = q\vec{E}$

$m\vec{a} = q\vec{E}$ $\Rightarrow \frac{q}{m} = \frac{\vec{E}}{\vec{a}}$

Thus, $|\vec{a}| = (10\ N/C)\left(\frac{1}{0.1}\frac{kg}{C}\right)$

Then, $\boxed{x = \frac{1}{2}at^2}$

4. $E_1 = K\frac{q}{r_1^2}$; $E_2 = K\frac{q}{r_2^2}$

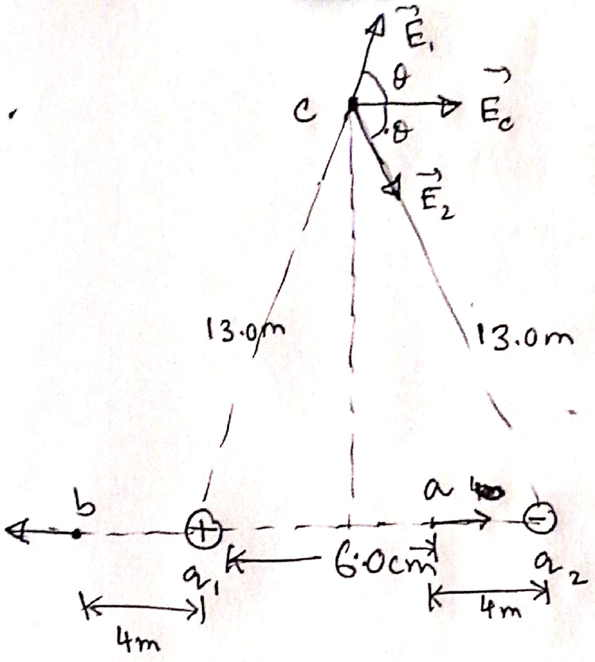
$r_1 = 1m$, $E_1 = 100\ N/C$. $\qquad \frac{E_1}{E_2} = \frac{r_2^2}{r_1^2}$ $\qquad \boxed{r_2 = ?}$

5. $\vec{F} = q\vec{E}$ $\qquad \vec{E} = K\frac{q}{r^2}\hat{r}$

$r = 300m$, $\quad E = 1000\ N/C$

$\boxed{q = ?}$

6.



$\vec{E_a} = E_{1a}\hat{i} + E_{2a}\hat{i}$

$E_{1a} = K\frac{q_1}{r_{1a}^2}$ $\quad r_{1a} = 0.06m$

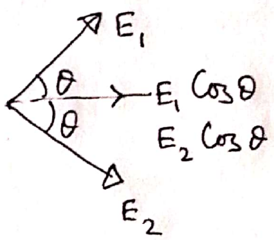
$E_{2a} = K\frac{q_2}{r_{2a}^2}$ $\quad r_{2a} = 0.04m$

$\vec{E_b} = -E_{1b}\hat{i} + E_{2b}\hat{i}$

$E_{1b} = K\frac{q_1}{r_{1b}}$ $\quad r_{1b} = 0.04m$

$E_{2b} = K\frac{q_2}{r_{2b}}$ $\quad r_{2b} = 0.14m$

$\vec{E_c} = \vec{E_{1c}} + \vec{E_{2c}}$



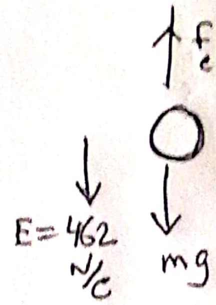
$E_{1c,x} = E_{2c,x} = E_{1c}\cos\theta$

$\cos\theta = \frac{5}{13}$

$E_{1c,y} = -E_{2cy}$ thus no y component.

$E_{1c} = K\frac{q_1}{r_{1c}^2}$ $\quad r_{1c} = 0.13m$; $E_{2c} = K\frac{q_2}{r_{2c}^2}$ $\quad r_{2c} = 0.13m$

7.



(a) $\boxed{\text{weight}, = m g}$

$m = 3 \times 10^{-12}$ kg

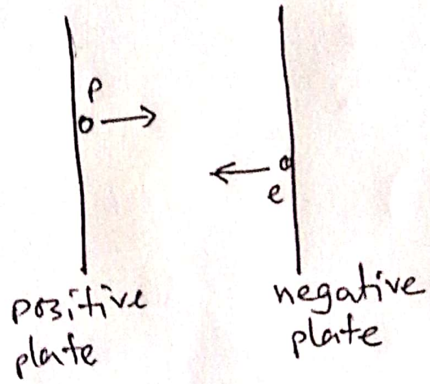
(b) $\vec{F} = q\vec{E}$

$E = 462$ N/C , $F_e = F_g$ = weight

$$\boxed{q = \frac{\text{weight}}{E}}$$

(c) $\boxed{N = \frac{q}{e}}$ $\qquad e = 1.6 \times 10^{-19}$ C .

8.



Proton acceleration,

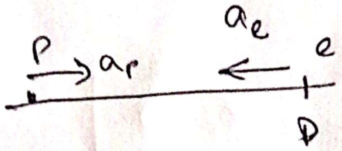
$$a_p = \frac{eE}{m_p}$$

Electron acceleration,

$$a_e = \frac{-eE}{m_e}$$

Position for proton, $x_p = \frac{1}{2} a_p t^2$

" " electron, $x_e = D - \frac{1}{2} a_e t^2$



initial at $x = D$.

same time, $x_p = x_e$ means,

$$\frac{1}{2}\frac{eE}{m_p}t^2 = D - \frac{1}{2}\frac{eE}{m_e}t^2$$

$$\Rightarrow t^2 = \frac{2D}{eE}\left(\frac{1}{m_p} + \frac{1}{m_e}\right)^{-1}$$

At meet point, $x_{meet} = \frac{1}{2}\frac{eE}{m_p} t^2_{meet}$

$$x_{meet} = \frac{1}{2}\frac{eE}{m_p}\frac{2D}{eE}\left(\frac{1}{m_p} + \frac{1}{m_e}\right)^{-1}$$

$$\Rightarrow \boxed{x_{meet} = \frac{D m_e}{m_p + m_e}}$$

$D = 0.05$ m ; $m_e = 9.11 \times 10^{-31}$ kg $\quad m_p = 1.67 \times 10^{-27}$ kg

9.

$W_{net} = \Delta K$ (change in KE)

$\Delta K = K_f - K_i = 0 - (1.67 \times 10^{-17} J)$

$W = -Fd$ $\quad\quad$ $d = \underline{10 \text{ cm}}$

$= -F(0.10 m)$

$$F = \frac{W}{d} = \frac{1.6 \times 10^{-17} J}{0.1 m}$$

$$\boxed{E = \frac{F}{e}}$$