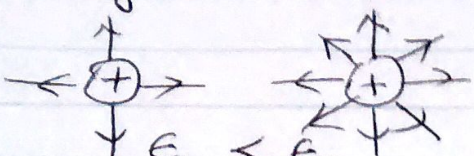
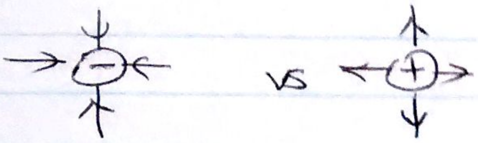
Electricity Review Q's

1. a) # of ε lines ⇒ strength



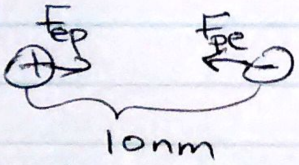
$\varepsilon_1 < \varepsilon_2$

b) direction of ε lines ⇒ charge of master charge (particle generating field)



→ Field line direction is how a ⊕ test charge will flow:
- away from a ⊕ master charge
- towards a ⊖ master charge

#2



Electron experiences force to the left

$q_+ = q_- \equiv q = 1.60 \cdot 10^{-19}\,C$
$r = 10\,nm = 10 \cdot 10^{-9}\,m = 10^{-8}\,m$
$F_{pe} = ?$ force ~~of~~ experienced by e^-

$$\therefore F = \frac{kqq}{r^2}$$

$$F = \frac{(9.00 \cdot 10^{9}\,N\frac{m^2}{C^2})(1.60 \cdot 10^{-19}\,C)(1.60 \cdot 10^{-19}\,C)}{(10^{-8}\,m)^2}$$

$$F = 2.3 \cdot 10^{-12}\,N$$

$$\boxed{\vec{F} = 2.3 \cdot 10^{-12}\,N\,[L]}$$

∴ The force experienced by electron is $2.3 \cdot 10^{-12}\,N\,[L]$.

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3)

By N's 3rd law each electron experiences an equal but opposite force

$q_1 = q_2 \equiv q = 1.60 \cdot 10^{-19}\,C$

$F = \frac{kq_1 q_2}{r^2} = 4.0 \cdot 10^{-11}\,N$

$r = ?$

$$F = \frac{kq_1 q_2}{r^2}$$

$$\therefore r^2 = \frac{kq_1 q_2}{F}$$

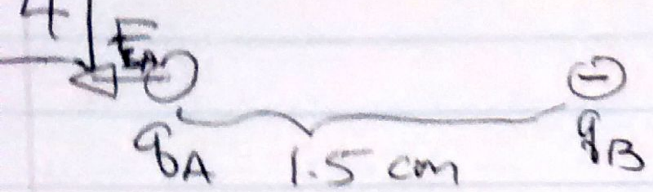
$$r = \sqrt{\frac{kq_1 q_2}{F}}$$

$$= \sqrt{\frac{(9.0 \cdot 10^{9}\,N \frac{m^2}{C^2})(1.60 \cdot 10^{-19}\,C)(1.60 \cdot 10^{-19}\,C)}{4.0 \cdot 10^{-11}\,N}}$$

$$\boxed{r = 2.0 \cdot 10^{-9}\,m}$$

The distance between the electrons is 2.0 nm.

4



$\therefore$ q_A is repulsed, it must also be ⊖

$F_{BA} = 7.00 \cdot 10^{5}\ N$

$q_B = -2.5 \cdot 10^{-7}\ C$

$r = 1.5\ cm = 0.015\ m$

$q_A = ?$

$$F = \frac{k q_A q_B}{r^2}$$

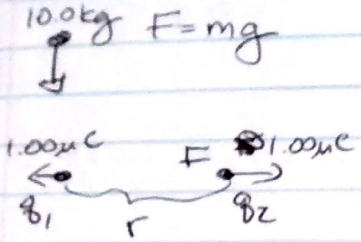
$$q_A = \frac{F \cdot r^2}{k q_B}$$

$$= \frac{(7.00 \cdot 10^{5}\ N)(0.015\ m)^2}{(9.0 \cdot 10^{9}\ N \cdot \frac{m^2}{C^2})(-2.5 \cdot 10^{-7}\ C)}$$

$$\boxed{q_A = 7.0 \cdot 10^{-2}\ C}$$

$\therefore$ The charge on q_A is $7.0 \cdot 10^{-2}\ C$.

5



$F = mg$

$q_1 = q_2 = 1.00\ \mu C = 1.00 \cdot 10^{-6} C$

$m = 10.0 kg$

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

$r = ?$

$$F = mg$$
$$= (10.0 kg)(9.8 \cdot N/kg)$$
$$= 98 N$$

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

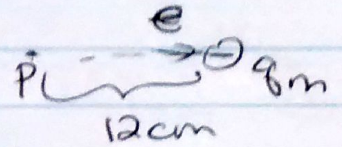
$$\therefore r = \sqrt{\frac{k q_1 q_2}{F}}$$

$$= \sqrt{\frac{(9.0 \cdot 10^9 N \cdot \frac{m^2}{C^2})(1.00 \cdot 10^{-6} C)(1.00 \cdot 10^{-6} C)}{98 N}}$$

$$\boxed{r = 9.6 \cdot 10^{-3} m}$$

$\therefore$ The distance between the two charges is $9.6 \cdot 10^{-3}$ m.

6)



$\vec{E}$ to $\underline{\underline{R}}$ b/c P is left of q_m & $\vec{E}$ pts towards q_m b/c q_m is $\ominus$

$\vec{E} = [R]$

$q_m = 3.5 \cdot 10^{-6}\,C$

$r = 12\,cm = 0.12\,m$

$\vec{E} = ?$

$$E = \frac{kq_m}{r^2}$$

$$E = \frac{(9.0 \cdot 10^{9}\,N \cdot \frac{m^2}{C^2})(3.5 \cdot 10^{-6}\,C)}{(0.12\,m)^2}$$

$$E = 2.2 \cdot 10^{6}\,N/C$$

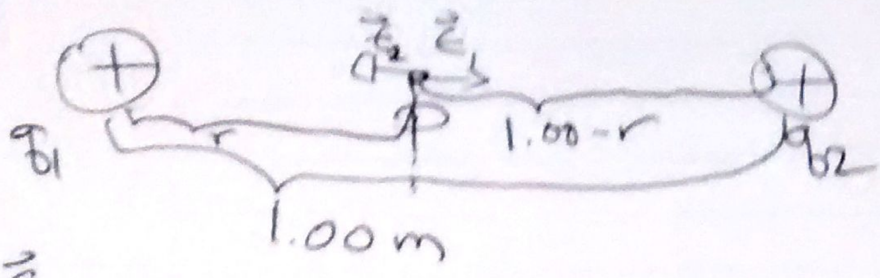
$$\therefore \vec{E} = 2.2 \cdot 10^{6}\,N/C\,[R]$$

The electric field at point P is $2.2 \cdot 10^{6}\,N/C\,[R]$

7

$q_1 = 2.0\cdot10^{-5}\,C$

$q_2 = 1.0\cdot10^{-5}\,C$



$\vec{E}_{net} = 0$

$$E_1 = \frac{kq_1}{r^2} \quad \text{vs} \quad E_2 = \frac{kq_2}{(1-r)^2}$$

$$\therefore E_1 = E_2$$

$$\frac{\cancel{k}q_1}{r^2} = \frac{\cancel{k}q_2}{(1-r)^2}$$

$$q_1(1-r)^2 = q_2 r^2$$

$$q_1(1-2r+r^2) = q_2 r^2$$

$$q_1 - 2q_1 r + q_1 r^2 = q_2 r^2$$

$$(q_1 - q_2)r^2 - 2q_1 r + q_1 = 0$$

$$\therefore (2.0\cdot10^{-5}C - 1.0\cdot10^{-5}C)r^2 - 2(2.0\cdot10^{-5}C)r + (2.0\cdot10$$

$$(1.0\cdot\cancel{10^{-5}C})r^2 - 4.0\cdot\cancel{10^{-5}C}\,r + 2.0\cdot\cancel{10^{-5}}C = 0$$

$$1r^2 - 4r + 2 = 0$$

$$\therefore r = \frac{+4 \pm \sqrt{(4)^2 - 2(1)(2)}}{2(1)}$$

$$= \frac{+4 \pm \sqrt{12}}{2}$$

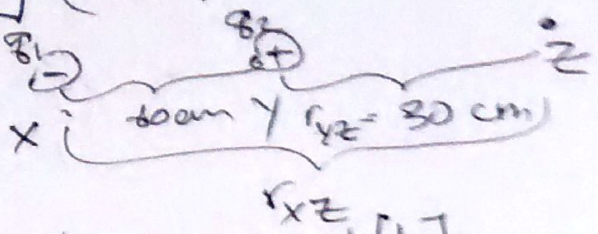
$$\therefore r = \frac{7.5}{2} \text{ or } \frac{0.5}{2}$$

too big

$$\boxed{r = 0.3\,m}$$

$\therefore$ The point where the net electric field is zero is located 30 cm to the right of q_1.

8 | (See picture on sheet)



$q_1 = 2.0 \cdot 10^{-5}\,C$
$q_2 = 8.0 \cdot 10^{-6}\,C$
$r_{xz} = 0.90\,m$
$r_{yz} = 0.30\,m$
$\vec{E} = ?$

$\vec{E}_1$ will be to [L]
$\vec{E}_2$ will be to [R]

$$E_1 = \frac{kq_1}{r_{xz}^2}$$

$$E_1 = \frac{(9.0 \cdot 10^9\,N \cdot \frac{m^2}{C^2})(2.0 \cdot 10^{-5}\,C)}{(0.90\,m)^2}$$

$$\vec{E}_1 = 2.2 \cdot 10^5\,N/C\,[L]$$

$$E_2 = \frac{kq_2}{r_{yz}^2}$$

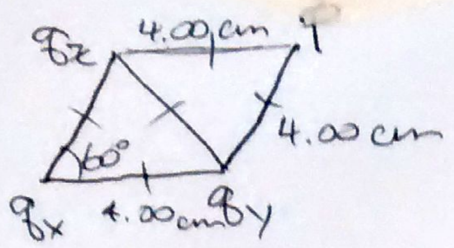
$$= \frac{(9.0 \cdot 10^9\,N \cdot \frac{m^2}{C^2})(8.0 \cdot 10^{-6}\,C)}{(0.30\,m)^2}$$

$$\vec{E}_2 = 8.0 \cdot 10^5\,\frac{N}{C}\,[R]$$

$$E = -E_1 + E_2$$
$$= E_2 - E_1$$
$$= 8.0 \cdot 10^5\,\frac{N}{C} - 2.2 \cdot 10^5\,\frac{N}{C}$$
$$\vec{E} = 5.8 \cdot 10^5\,\frac{N}{C}\,[R]$$

As expected since q_2 is closer and ~~[illegible]~~ ~~[illegible]~~ even though it's charge is smaller.

9]



$q_x = 2.0\cdot10^{-5}C$

$q_y = 2.0\cdot10^{-5}C$

$q_z = 2.0\cdot10^{-5}C$

$r_z = 4.00\,cm = 0.0400\,m$

$r_y = 0.0400\,m$

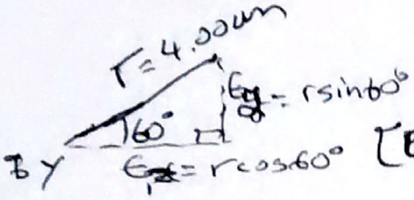
r_x T.B.D.

$\rightarrow \vec{E}_z$ [R] $E_z = \dfrac{kq_z}{r_z^2}$

$$= \frac{(9.0\cdot10^9)(2.0\cdot10^{-5}C)}{(0.04\,m)^2}$$

$$\vec{E}_z = 1.1\cdot10^8\,\frac{N}{C}\ [R]$$

$E_y = E_z$ in magnitude b/c same ~~difference~~ distance, r



$[U]\ E_y = E_z\cdot\sin 60°$

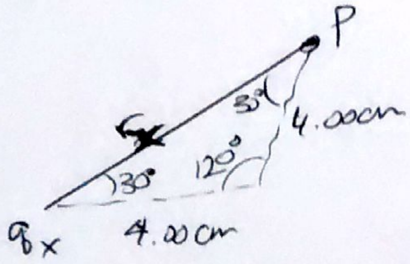
$= (1.1\cdot10^8\,\frac{N}{C})(\sin 60°)$

$= 9.5\cdot10^7\,\frac{N}{C}$ [U]

$[R]\ E_y = E_z\cos 60°$

$= (1.1\cdot10^8\,\frac{N}{C})(\cos 60°)$

$= 5.6\cdot10^7\,\frac{N}{C}$ [R]



$r_x^2 = 4^2 + 4^2 - 2(4)(4)\cos 120°$

$= 48$

$r_x = \sqrt{48}$

$r_x = 6.91\,cm$

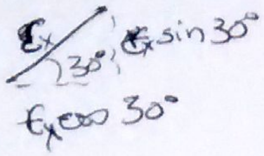
$r_x = 0.0691\,m$

$\therefore\ E_x = \dfrac{kq_x}{r_x^2}$

$$= \frac{(9.0\cdot10^9\,\frac{N}{C})(2.0\cdot10^{-5}C)}{(0.0691\,m)^2}$$

$$E_x = 3.7\cdot10^7\,\frac{N}{C}$$

#9 cont'd



$[R]\ \varepsilon_x \cos 30°$

$= (3.7 \cdot 10^7 \frac{N}{C}) \cos 30°$

$= 3.2 \cdot 10^7 \frac{N}{C}\ [R]$

$[U]\ \varepsilon_x \sin 30°$

$= (3.7 \cdot 10^7 \frac{N}{C}) \sin 30°$

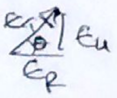
$= 1.9 \cdot 10^7 \frac{N}{C}\ [U]$

	[U]	[R]
ε_x	$1.9 \cdot 10^7 \frac{N}{C}$	$3.2 \cdot 10^7 \frac{N}{C}$
ε_Y	$9.5 \cdot 10^7 \frac{N}{C}$	$5.6 \cdot 10^7 \frac{N}{C}$
ε_Z	—	$1.1 \cdot 10^8 \frac{N}{C}$
ε_T	$1.1 \cdot 10^8 \frac{N}{C}$	$2.0 \cdot 10^8 \frac{N}{C}$

$\varepsilon_T = \sqrt{\varepsilon_U^2 + \varepsilon_R^2}$

$= \sqrt{(1.1 \cdot 10^8 \frac{N}{C})^2 + (2.0 \cdot 10^8 \frac{N}{C})^2}$

$= 2.3 \cdot 10^8 \frac{N}{C}$



$\theta = \tan^{-1}\left(\frac{\varepsilon_U}{\varepsilon_R}\right)$

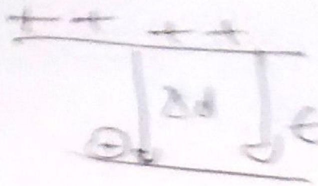
$= \tan^{-1}\left(\frac{1.1 \cdot 10^8 \frac{N}{C}}{2.0 \cdot 10^8 \frac{N}{C}}\right)$

$\doteq 29°$

$\therefore \vec{\varepsilon}_T = 2.3 \cdot 10^8 \frac{N}{C}\ [R29°U]$

The magnitude & direction of the electric field generated by the 3 charges at P is $2.3 \cdot 10^8 \frac{N}{C}$ [R 29° U]

10



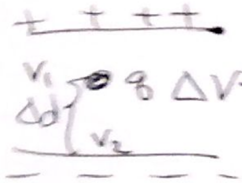
$$\begin{cases} \varepsilon = 100\ \frac{N}{C} \\ q = 1.6\cdot 10^{-19}\ C \\ \Delta d = 3.5\ m \end{cases}$$

$\boxed{\Delta E_e = ?}$

$$\Delta E_e = E_{e_2} - E_{e_1}$$
$$= q\varepsilon d_2 - q\varepsilon d_1$$
$$= q\varepsilon\Delta d$$
$$= (1.6\cdot 10^{-19} C)(100\tfrac{N}{C})(3.5 m)$$
$$\underline{\Delta E_e = 5.6\cdot 10^{-17} J}$$

∴ There has been a gain/loss of electric potential ~~elect~~ energy of $5.6\cdot 10^{-17}$ J.

11



$$\begin{cases} \Delta E_e = 1.6\cdot 10^{-15} J \\ \Delta V = 2500\ V \\ q = ? \end{cases}$$

~~ΔE~~ $E_{e_2} = qV_2 \quad E_{e_1} = qV_1$

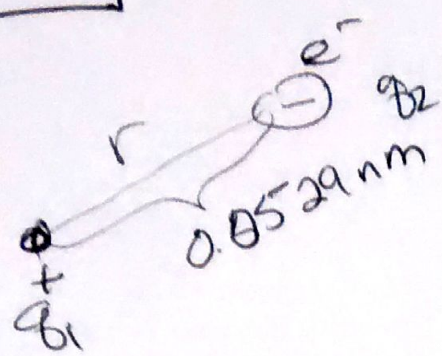
$$\Delta E_e = qV_2 - qV_1$$
$$\Delta E_e = q\Delta V$$
$$q = \frac{\Delta E_e}{\Delta V}$$
$$= \frac{1.6\cdot 10^{-15} J}{2500 V}$$
$$q = 6.4\cdot 10^{-19} C$$

∴ The charge is $6.4\cdot 10^{-19}$ C.

#12

$$\begin{cases} q_1 - q_2 = 1.60\cdot 10^{-19} C \\ r = \ldots \end{cases}$$

12



$q_1 = q_2 = 1.60 \cdot 10$ C

$r = 0.0529$ nm

$= 5.29 \cdot 10^{-11}$ m

$V = ?$

a) $V = \frac{k q_m}{r}$ q_m = proton

$= \frac{(9.0 \cdot 10^{9} \, N \cdot \frac{m^2}{C^2})(1.60 \cdot 10^{-19} \, C)}{(5.29 \cdot 10^{-11} \, m)}$

$V = 27 \, V$

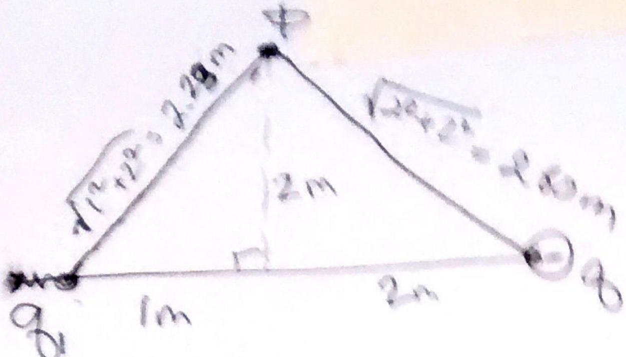
b) $E_e = q_t V$ q_t = electron

$= (1.60 \cdot 10^{-19} \, C)(27 V)$

$= 4.32 \cdot 10^{-18}$ J

$\therefore$ The electric potential due to the proton at 0.0529 nm is 27 V.
The electric potential energy is $4.32 \cdot 10^{-18}$ J.

13



$q_1 = 4.0 \cdot 10^{-5} C$

$q = ?$

$V_p = 5.0 \cdot 10^5 V$

$r_{1p} = 2.23 m$

$r_{qp} = 2.80 m$

$$V_{p1} = \frac{k q_1}{r_{1p}}$$

$$= \frac{(9.0 \cdot 10^9 N \frac{m^2}{C^2})(4.0 \cdot 10^{-5} C)}{(2.23 m)}$$

$$= 1.6 \cdot 10^5 V$$

$$V_p = V_{p1} + V_{pq}$$

$$\therefore V_{pq} = V_p - V_{p1}$$

$$= 5.0 \cdot 10^5 V - 1.6 \cdot 10^5 V$$

$$= 3.4 \cdot 10^5 V$$

$$\therefore V_{pq} = \frac{kq}{r_{qp}}$$

$$q = \frac{V_{pq} \cdot r_{qp}}{k}$$

$$= \frac{(3.4 \cdot 10^5 V)(2.80 m)}{(9.0 \cdot 10^9 N \cdot \frac{m^2}{C^2})}$$

$$\boxed{q = 1.1 \cdot 10^{-4} C}$$

$\therefore$ The charge on q is $1.1 \cdot 10^{-4} C$

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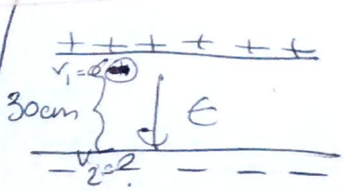
#14

a)


Given:
$q = 1.60\cdot10^{-19}$ C
$E=2.0\cdot10^{6}$ N/C
$v_1=0$
$v_2=?$
$d=0.30$m
$m=9.11\cdot10^{-31}$ kg

$$E_{e_1} + \cancel{E_{k_1}}^{0} = \cancel{E_{e_2}}^{0} + E_{k_2}$$

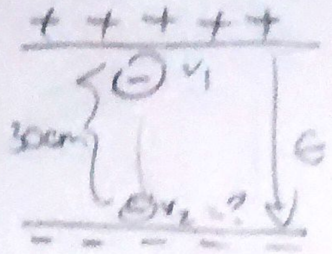
$$E_{e_1} = E_{k_2}$$

$$E_{k_2} = qEd$$
$$= (1.60\cdot10^{-19}\text{ C})(2.0\cdot10^{6}\text{ N/C})(0.30\text{ m})$$
$$E_{k_2} = 9.6\cdot10^{-14}\text{ J}$$

$$\therefore v_2 = \sqrt{\frac{2E_{k_2}}{m}}$$
$$= \sqrt{\frac{2(9.6\cdot10^{-14}\text{ J})}{9.11\cdot10^{-31}\text{ kg}}}$$
$$= \sqrt{2.11\cdot10^{17}\text{ m}^2/\text{s}^2}$$
$$v_2 = 4.6\cdot10^{8}\text{ m/s}$$

$\therefore$ The final speed of the electron is $4.6\cdot10^{8}$ m/s which is impossible. ((B/c the speed of light is $3.00\cdot10^{8}$ m/s

14 b)



Given

$q = 1.60 \cdot 10^{-19} C$

$\epsilon = 2.0 \cdot 10^{6} \frac{N}{C}$

$d = 0.30 m$

$v_1 = 2.0 \cdot 10^{5} \frac{m}{s}$

$m = 9.11 \cdot 10^{-31} kg$

$\boxed{v_2 = ?}$

$$E_{e_1} + E_{k_1} = \underbrace{E_{e_2}}_{0} + E_{k2}$$

$$\therefore E_{k_2} = E_{e_1} + E_{k_1}$$

Find E_{k_1}:

$$E_{k_1} = \frac{1}{2} m v_1^2$$

$$= \frac{(9.11 \cdot 10^{-31} kg)(2.0 \cdot 10^{5} \frac{m}{s})^2}{2}$$

$$E_{k_1} = 1.8 \cdot 10^{-20} J$$

$$E_{e_1} = q \epsilon d$$

$$= (1.60 \cdot 10^{-19} C)(2.0 \cdot 10^{6} \frac{N}{C})(0.30 m)$$

$$= 9.6 \cdot 10^{-14} J$$

$$\therefore E_{k_2} = E_{e_1} + E_{k_1}$$

$$= 9.6 \cdot 10^{-14} J + 1.8 \cdot 10^{-20} J$$

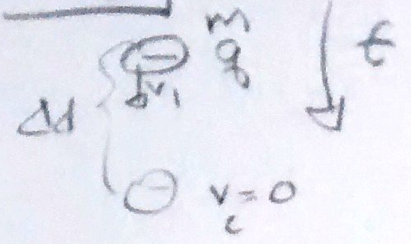
$$E_{k_2} = 9.6 \cdot 10^{-14} J$$

For v: $v_2 = \sqrt{\frac{2 E_{k_2}}{m}}$

$$= \sqrt{\frac{2(9.6 \cdot 10^{-14} J)}{(9.11 \cdot 10^{-31} kg)}}$$

$$= 4.6 \cdot 10^{8} \frac{m}{s}$$

#15



Given:

$q = -3.20 \cdot 10^{-19}\ C$

$m = 6.6 \cdot 10^{-27}\ kg$

$v_1 = 6.0 \cdot 10^{3}\ \frac{m}{s}$

$\varepsilon = 2.0 \cdot 10^{3}\ \frac{N}{C}$

$\Delta d = ?$

$$E_{e_1} + E_{k_1} = E_{e_2} + \underset{0}{\cancel{E_{k_2}}}$$

$$E_{k_1} = E_{e_2} - E_{e_1}$$

$$= q\varepsilon d_2 - q\varepsilon d_1$$

$$E_{k_1} = q\varepsilon \Delta d$$

$$\therefore \Delta d = \frac{E_{k_1}}{q\varepsilon}$$

Find E_{k_1}: $E_{k_1} = \frac{mv^2}{2}$

$$E_{k_1} = \frac{(6.6 \cdot 10^{-27}\ kg)(6.0 \cdot 10^{3}\ \frac{m}{s})^2}{2}$$

$$E_{k_1} = 1.2 \cdot 10^{-19}\ J$$

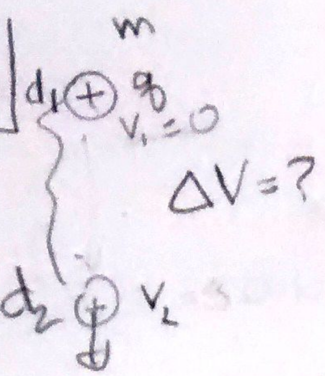
$$\therefore \Delta d = \frac{E_{k_1}}{q\varepsilon}$$

$$\Delta d = \frac{1.2 \cdot 10^{-19}\ \overset{N \cdot m}{\cancel{J}}}{(3.20 \cdot 10^{-19}\ \cancel{C})(2.0 \cdot 10^{3}\ \frac{\cancel{N}}{\cancel{C}})}$$

$$\Delta d = 1.8 \cdot 10^{-4}\ m$$

$\therefore$ The point charge travels $1.8 \cdot 10^{-4}\ m$.

#16



$m = 3.3 \cdot 10^{-27}\,kg$

$q = 1.6 \cdot 10^{-19}\,C$

$v_1 = 0$

$v_2 = 5.0 \times 10^{6}\,\frac{m}{s}$

$\boxed{\Delta V = ?}$

$$E_e = qV$$

$$E_{e_1} + \cancel{E_{k_1}}^{\,0} = E_{e_2} + E_{k_2}$$

$$E_{e_1} = E_{e_2} + E_{k_2}$$

$$qV_1 = qV_2 + \frac{1}{2}mv^2$$

$$qV_1 - qV_2 = \frac{mv^2}{2}$$

$$q\Delta V = \frac{mv^2}{2}$$

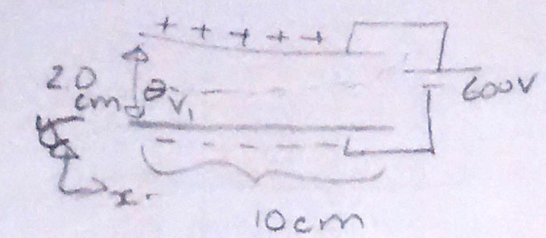
$$\Delta V = \frac{mv^2}{2q}$$

$$= \frac{(3.3 \cdot 10^{-27}\,kg)(5.0 \cdot 10^{6}\,\frac{m}{s})^2}{2(1.6 \cdot 10^{-19}\,C)}$$

$$\Delta V = 2.6 \cdot 10^{5}\,V$$

∴ The electric potential difference required is $2.6 \cdot 10^{5}\,V$.

17.



e^- deflected up

Given
$\Delta V = 600V$
$v_1 = 8.0 \cdot 10^7 \frac{m}{s}$
$m = 9.11 \cdot 10^{-31}$ kg
$q = 1.60 \cdot 10^{-19}$ C
$L = 0.10$ m
$\Delta d = 0.02$ m

$\vec{v}_2 = ?$

Horizontal

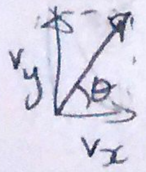
$v_x = v_1 =$ constant
$v_1 = 8.0 \cdot 10^7 \frac{m}{s}$
$a = 0$
$\Delta L = 0.10m$
$\Delta t = \frac{L}{v_1}$
$= \frac{0.10m}{8.0 \cdot 10^7 \frac{m}{s}}$
$= 1.3 \cdot 10^{-9}$ s

Vertical

$v_y = a_y \Delta t$
$a_y = \frac{F_e}{m}$
$= \frac{qV}{md}$
$= \frac{(1.60 \cdot 10^{-19} C)(600V)}{(9.11 \cdot 10^{-31} kg)(0.02 m)}$
$a_y = 5.3 \cdot 10^{15} \frac{m}{s^2}$

$\therefore v_y = a_y \Delta t$
$= (5.3 \cdot 10^{15} \frac{m}{s^2})(1.3 \cdot 10^{-9} s)$
$v_y = 6.8 \cdot 10^6 \frac{m}{s}$

Find $v_2 = \sqrt{v_x^2 + v_y^2}$
$v_2 = \sqrt{(8.0 \cdot 10^7 \frac{m}{s})^2 + (6.8 \cdot 10^6 \frac{m}{s})^2}$
$v_2 = 8.0 \cdot 10^7 \frac{m}{s}$ (as expected since v_y small compared with v_x)



$\theta = \tan^{-1}\left(\frac{v_y}{v_x}\right)$
$\theta = \tan^{-1}\left(\frac{6.8 \cdot 10^6 \frac{m}{s}}{8.0 \cdot 10^7 \frac{m}{s}}\right)$
$\theta = 4.9°$

$\therefore$ The final velocity is $8.0 \cdot 10^7 \frac{m}{s}$ [R4.9°U]

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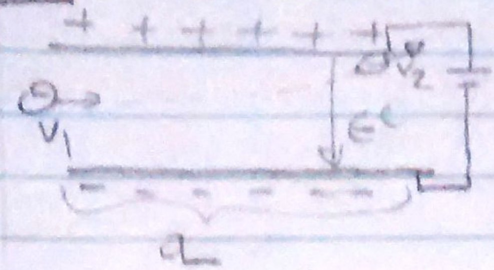

Given:

$\vec{v}_1 = 3.5 \cdot 10^5 \frac{m}{s}$ [R]

$L = 0.200\ m$

$\mathcal{E} = 250 \frac{N}{C}$

$q = 1.60 \cdot 10^{-19}\ C$

$m = 9.11 \cdot 10^{-31}\ kg$

$\boxed{\vec{v}_2 = ?}$

Horizontal

$a_x = 0$

$v_x = v_1 = \text{constant}$

$v_x = 3.5 \cdot 10^5 \frac{m}{s}$

$\Delta t = \frac{L}{v_x}$

$\Delta t = \frac{0.200 m}{3.5 \cdot 10^5 \frac{m}{s}}$

$\Delta t = 6.25 \cdot 10^{-7} s$

Vertical

$\Delta t = 6.25 \cdot 10^{-7} s$

$a_y = \frac{F_y}{m}$

$= \frac{q\mathcal{E}}{m}$

$= \frac{(1.60 \cdot 10^{-19} C)(250 \frac{N}{C})}{(9.11 \cdot 10^{-31} kg)}$

$a_y = 4.4 \cdot 10^{13} \frac{m}{s^2}$

$v_y = a_y \Delta t$

$= (4.4 \cdot 10^{13} \frac{m}{s^2})(6.25 \cdot 10^{-7} s)$

$v_y = 2.7 \cdot 10^7 \frac{m}{s}$

$\therefore v_2 = \sqrt{v_x^2 + v_y^2}$

$= \sqrt{(3.5 \cdot 10^5 \frac{m}{s})^2 + (2.7 \cdot 10^7 \frac{m}{s})^2}$

$v_2 = 2.7 \cdot 10^7 \frac{m}{s}$ As expected since $v_y >> v_x$

$\theta = \tan^{-1}\left(\frac{v_y}{v_x}\right)$

$= \tan^{-1}\left(\frac{2.7 \cdot 10^7 \frac{m}{s}}{3.5 \cdot 10^5 \frac{m}{s}}\right)$

$\theta = 89°$

$\therefore$ The final velocity of the electron is $2.7 \cdot 10^7 \frac{m}{s}$ [R89°U]

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