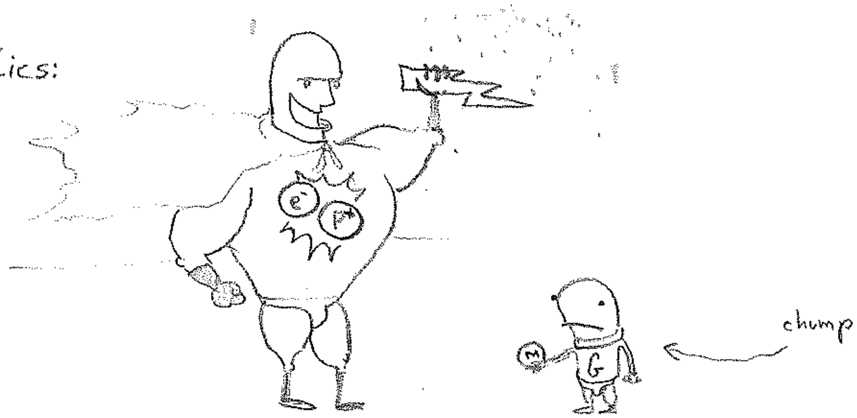
Electrostatics:



① a. $F_e = \frac{kQq}{d^2} = \frac{9\times10^{9}(1.6\times10^{-19})(1.6\times10^{-19})}{(0.10)^2} = 2.30\times10^{-26}\,N$ (repel)

$F_g = \frac{GMm}{d^2} = \frac{6.67\times10^{-11}(9.11\times10^{-31})(9.11\times10^{-31})}{(0.10)^2} = 5.54\times10^{-69}\,N$ (attract)

b. $F_e = \frac{kQq}{d^2} = 2.30\times10^{-26}\,N$ (repel)

$F_g = \frac{GMm}{d^2} = \frac{6.67\times10^{-11}(1.67\times10^{-27})(1.67\times10^{-27})}{(0.10)^2} = 1.86\times10^{-62}\,N$ (attract)

c. $F_e = 2.30\times10^{-26}\,N$ (attract)

$F_g = \frac{GMm}{d^2} = \frac{6.67\times10^{-11}(1.67\times10^{-27})(9.11\times10^{-31})}{(0.10)^2} = 1.01\times10^{-65}\,N$ (attract)

② $E = \frac{kq}{d^2} = \frac{(9.00\times10^{9}\,N\frac{m^2}{C^2})(1.60\times10^{-19}\,C)}{(0.001\,m)^2} = 1.4\times10^{-3}\,N/C$

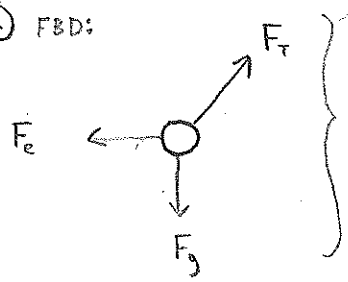
) $F_e = qE$; both have the same $q = 1.6\times10^{-19}\,C$, same $E = 1600\,N/C$, so same F_e

$$F_e = 1.6\times10^{-19}\,C\,(1600\,N/C) = 2.56\times10^{-16}\,N$$

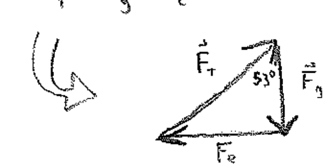
$\vec{a} = \frac{\Sigma\vec{F}}{m}$; electron: $\vec{a} = \frac{2.56\times10^{-16}\,N}{9.11\times10^{-31}\,kg} = 2.8\times10^{14}\,m/s^2$ WEST (by def'n negative charge experiences $\vec{F_e}$ opposite to dir'n of $\vec{E}$)

proton: $\vec{a} = \frac{2.56\times10^{-16}}{1.67\times10^{-27}} = 1.53\times10^{11}\,m/s^2$ EAST (by def'n positive charge experiences $\vec{F_e}$ in the dir'n of $\vec{E}$)

④ FBD:



$\Sigma\vec{F} = 0N = \vec{F_T} + \vec{F_g} + \vec{F_e}$



$\tan 53° = \frac{F_e}{F_g}$

$F_e = F_g \tan 53° = (0.60)(9.8)\tan 53°$

$F_e = 7.803023551\,N = \frac{kQq}{d^2}$

$$Q = \frac{F_e d^2}{kq} = \frac{(7.8\ldots)(0.3)^2}{(9\times10^9)(5\times10^{13}\times1.6\times10^{-19})} = 9.7538\times10^{-6}\,C$$

just $F_e = \frac{kQq}{d^2}$ rearranged!

$Q = +9.75\,\mu C$ (positive as it is attracted toward the negative sphere.)

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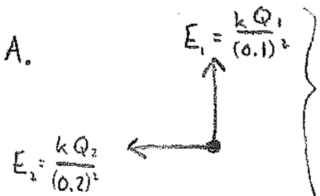
(5) Let $Q_1 = -2.5\,\mu C$

$Q_2 = +4.0\,\mu C$

A.

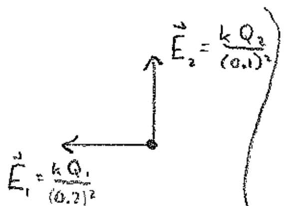


$\vec{E}_1 = 2.25\times10^6\,N/C$ up

$E_2 = 9.00\times10^5\,N/C$ left

$\vec{E}_A = \vec{E}_1 + \vec{E}_2 = 2.4\times10^6\,N/C$ @ 68° above $-x$.

B.



$\vec{E}_1 = 5.625\times10^5\,N/C$ left

$\vec{E}_2 = 3.6\times10^6\,N/C$ up

$\vec{E}_B = \vec{E}_1 + \vec{E}_2 = 3.6\times10^6\,N/C$ @ 81° above $-x$.

(6) $\Sigma\vec{F} = m\vec{a}$

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

$2\times(1.6\times10^{-19}\,C)(1460\,N/C) = (2\times1.67\times10^{-27} + 2\times1.68\times10^{-27})\,a$

$\vec{a} = 6.686567\times10^{10}\,m/s^2$

$\vec{v}_0 = -5.6\times10^5\,m/s$

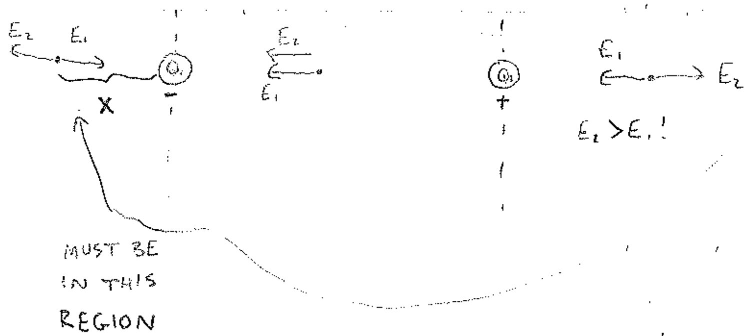
$\vec{v} = 6.0\times10^6\,m/s$

$\vec{a} = 6.686567\times10^{10}\,m/s^2$

$t = ?$

$t = \frac{\Delta\vec{v}}{a} = 9.8\times10^{-5}\,s$

(7)



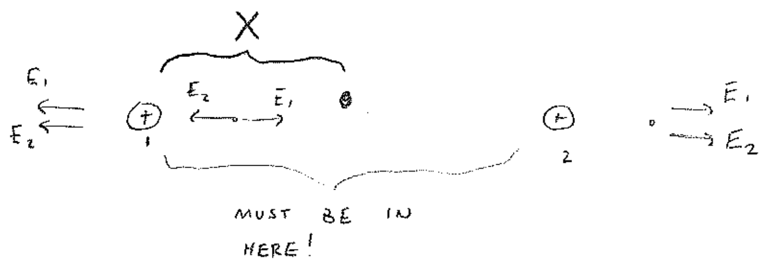
For $\Sigma\vec{E}$ to be zero E_1 and E_2 must be equal strength, opposite direction

$E_1 = \frac{kQ_1}{x^2} = E_2 = \frac{kQ_2}{(0.2+x)^2}$; $\frac{kQ_1}{x^2} = \frac{kQ_2}{(x+0.2)^2}$

$6(x+0.2)^2 = 9x^2$; $6x^2 + 2.4x + 0.24 = 9x^2$

$x = 0.89\,m$ left of Q_1 (QUADRATIC)

(8)

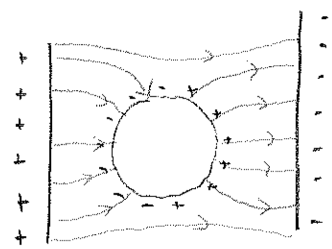


again $E_1 = E_2 \Rightarrow \frac{KQ_1}{x^2} = \frac{K Q_2}{(0.2-x)^2} \Rightarrow 6(0.2-x)^2 = 9x^2$ (I just canceled out k, and the $\times 10^{-6}$ from each charge!)

$0.24 - 2.4x + 6x^2 = 9x^2 \Rightarrow 3x^2 + 2.4x - 0.24 = 0$ (QUADRATIC!)

$x = 0.090\,m$

(9)



(10) A $W_{AB} = \vec{F}_{\parallel}\vec{d} = \underbrace{(-qE)}_{\text{left}}\underbrace{d}_{\text{right}} = -3.5\times10^{-16}\,J$

B. $W_{BC} = \vec{F}_{\parallel}\vec{d} = 0\,J$

C. $W_{CD} = \vec{F}_{\parallel}\vec{d} = \underbrace{(-qE)}_{\text{left}}\underbrace{(-\vec{d})}_{\text{left}} = 3.5\times10^{-16}\,J$

D, $W_{AB} + W_{BC} + W_{CD} = 0\,J$

E. $W = \vec{F}_{\parallel}\vec{d} = 0\,J$

F. $W_{AC} = \vec{F}_{\parallel}\vec{d} = (\underbrace{-qE}_{\text{left}})(d_{\parallel}) = -3.5\times10^{-16}\,J$

G. $W = \vec{F}_{\parallel}\vec{d} = \underbrace{(qE)}_{\text{right}}\underbrace{(d)}_{\text{right}} = 3.5\times10^{-16}\,J$

H. $0\,J$

I. $W = \vec{F}_{\parallel}\vec{d} = \underbrace{(-qE)}_{\text{left}}\underbrace{d}_{\text{right}} = -3.5\times10^{-16}\,J$

(11) $N = \frac{Q}{e} = \frac{12\times10^{-6}\,C}{1.6\times10^{-19}\,C/\text{electron}}$

$N = 7.5\times10^{13}$ electrons

(12) C.

All excess e^- reside on outer surface

$\Rightarrow$ same Q $\Rightarrow$ same # of electrons.