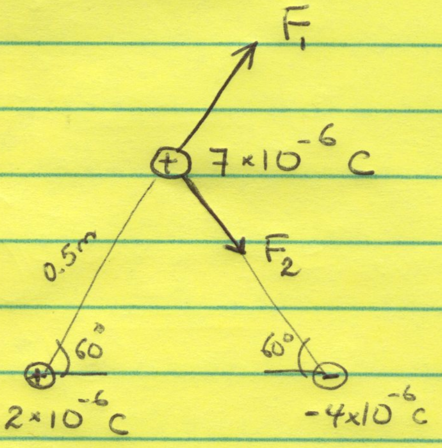
WORKSHOP WEEK 1 PHYSICS

PAGE 636 ELECTRIC FORCES

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

$k = 8.99 \times 10^9 \, N\dfrac{m^2}{C^2}$

(5)



$F_1 = (8.99 \times 10^9)\dfrac{(2 \times 10^{-6})(7 \times 10^{-6})}{(0.5)^2}$

$F_1 = 0.50\,N$

$F_2 = (8.99 \times 10^9)\dfrac{(4 \times 10^{-6})(7 \times 10^{-6})}{(0.5)^2}$

$F_2 = 1.00\,N$

Forces	F_x	F_y
$F_1 = 0.50N$	$+0.50 \cdot \cos 60°$	$+0.50 \cdot \sin 60°$
$F_2 = 1.00N$	$+1.00 \cdot \cos 60$	$-1.00 \sin 60$
$F_{TOTAL} =$	$0.75N\,\hat{i}$	$-\ 0.43N\,\hat{j}$

$F_{TOTAL} = \sqrt{(0.75)^2 + (-0.43)^2}$

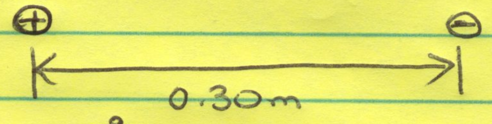
$\boxed{F_{TOTAL} = 0.86N}$

330° from origin

$\theta = \tan\left(\dfrac{-0.43}{0.75}\right)$ $\boxed{\theta = -29.8°}$

$(360° - 30° = 330°)$ 4th quadrant

(7)



a) $+12 \times 10^{-9}\,C$ $-18 \times 10^{-9}\,C$

$F = (8.99 \times 10^9)\dfrac{(12 \times 10^{-9})(18 \times 10^{-9})}{(0.30)^2}$

$\boxed{F = 2.16 \times 10^{-5}\,N \text{ (attraction)}}$

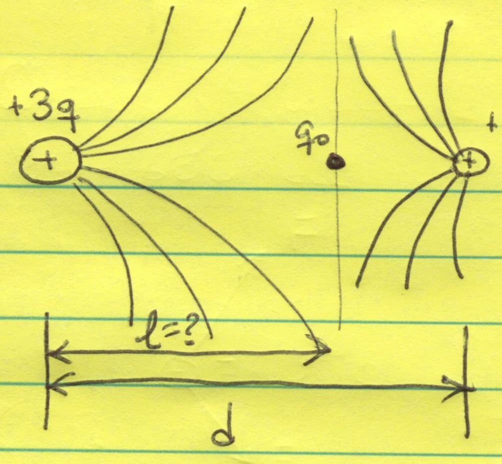
b) after touching → conservation of charge

$q = \dfrac{(12 \times 10^{-9}C) + (-18 \times 10^{-9}C)}{2} = -3 \times 10^{-9}\,C$ each

$F = (8.99 \times 10^9)\dfrac{(3 \times 10^{-9})(3 \times 10^{-9})}{(0.30)^2}$

$\boxed{F = 8.99 \times 10^{-7}\,N \text{ (repulsion)}}$

(8)



equilibrium $F_1 = F_2$

$$\frac{\cancel{k}(3\cancel{q})(\cancel{q_0})}{l^2} = \frac{\cancel{k}(\cancel{q})(\cancel{q_0})}{(d-l)^2}$$

$$3\cancel{q}(d-l)^2 = \cancel{q}l^2$$

$$3(d^2 - 2dl + l^2) = l^2$$

$$3d^2 - 6dl + 3l^2 = l^2$$

$$3d^2 - 6dl + 2l^2 = 0$$

to solve this quadratic equation, let's use $\underline{d}$ equal to 1, 10 or 100 m, and calculate l as a percentage of d.

using $d = 1\,m$

$$3(1)^2 - 6(1)l + 2l^2 = 0$$

$$2l^2 - 6l + 3 = 0$$

$\uparrow$ a $\quad \uparrow$ b $\quad \uparrow$ c

$$l = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$l = \frac{-(-6) \pm \sqrt{(-6)^2 - 4(2)(3)}}{2(2)}$$

$$l = \frac{6 \pm \sqrt{36 - 24}}{4}$$

$$l = \frac{6 \pm \sqrt{12}}{4}$$

$l_1 = 2.37\,m$ ✗

$l_2 = 0.63\,m$ ✓

Because both charges are positive, the point of equilibrium is somewhere in between the charges

l is 63% of d

(9) $F = K\dfrac{q_1 q_2}{r^2}$ $q_e = -1.6\times10^{-19}\,C$ $q_p = +1.6\times10^{-19}\,C$ $Mass_e = 9.11\times10^{-31}\,Kg$ $r = 0.529\times10^{-10}\,m$

a) $$F = \frac{(8.99\times10^{9})(1.6\times10^{-19})(1.6\times10^{-19})}{(0.529\times10^{-10})^2} = \boxed{8.22\times10^{-8}\,N}$$

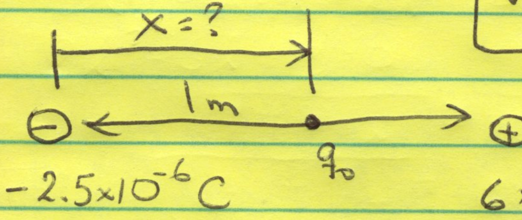
b) $$a = \underbrace{\frac{v^2}{r}}_{\text{rotational motion}} = \underbrace{\frac{F}{m}}_{\text{newton's law}}$$

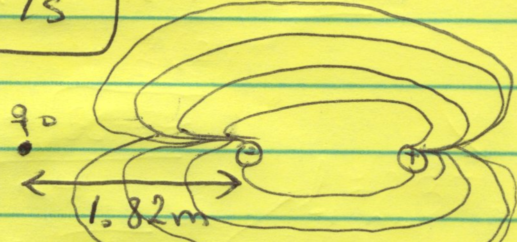
$$v = \sqrt{\frac{Fr}{m}} = \sqrt{\frac{(8.22\times10^{-8})(0.529\times10^{-10})}{9.11\times10^{-31}}}$$

$v = 2{,}184{,}764\ m/s$

$$\boxed{v = 2.18\times10^{6}\ m/s}$$

(11)





$$\frac{F_1}{q_o} = \frac{F_2}{q_o} \qquad E_1 = E_2 \qquad \frac{\cancel{K}q_1}{x^2} = \frac{\cancel{K}q_2}{(1-x)^2}$$

$$\frac{2.5\times\cancel{10^{-6}}}{x^2} = \frac{6\times\cancel{10^{-6}}}{(1-x)^2}$$

$2.5(1-x)^2 = 6(x^2)$

$2.5(1-2x+x^2) = 6x^2$

$2.5 - 5x + 2.5x^2 = 6x^2$

$0 = \underset{a}{3.5}x^2 + \underset{b}{5}x \underset{c}{-2.5}$

quadratic → find x

$$x = \frac{-(5) \pm \sqrt{5^2 - 4(3.5)(-2.5)}}{2(3.5)}$$

$$x = \frac{-5 \pm \sqrt{60}}{7}$$

$x_1 = 0.39m$ ✗

$x_2 = -1.82m$ ✓

because this is a dipole, the point of electric field equal zero is 1.82 m to the left of the small charge