PHY 212 HOMEWORK 1 SOLUTIONS

1. 21.09 $F_{gravity} = F_{electric}$

$$mg = \frac{1}{4\pi\epsilon_0}\frac{q^2}{r^2} \Rightarrow r^2 = \frac{1}{4\pi\epsilon_0}\frac{(1.6\times10^{-19}\,C)^2}{(9.11\times10^{-31}\,kg)(9.8\,m/s)}$$

$$= 25.8\,m^2 \Rightarrow r = 5.08\,m$$

2. 21.11. $\vec{F}_2$ is in the $+x$-direction, so $\vec{F}_1$ must be in the $-x$-direction and q_1

$$|F_1| = |F_2| \qquad \frac{k q_1 q_3}{r_{13}^2} = k\frac{|q_2| q_3}{r_{23}^2}$$

$$\therefore q_1 = (0.0200/0.0400)^2\,|q_2| = 0.75\,nC$$

3. 21.20 $\vec{F} = \vec{F}_1 + \vec{F}_2$ and $F = F_1 - F_2$ since they are acting in opposite directions at $x = 0$.

$$F = \frac{1}{4\pi\epsilon_0}\,6\times10^{-9}\,C\left(\frac{4\times10^{-9}\,C}{(0.2\,m)^2} - \frac{5\times10^{-9}\,C}{(0.3\,m)^2}\right) = 2.4\times10^{-6}\,N \text{ to the right.}$$

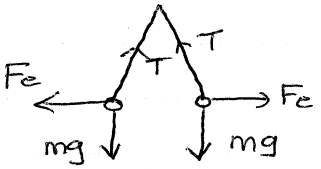
4. 21.37 a) $\tan^{-1}\left(\frac{-1.35}{0}\right) = -\frac{\pi}{2}$, $\hat{r} = -\hat{\jmath}$

b) $\tan^{-1}\left(\frac{12}{0.2}\right) = \frac{\pi}{4}$, $\hat{r} = \frac{\sqrt{2}}{2}\hat{\imath} + \frac{\sqrt{2}}{2}\hat{\jmath}$

c) $\tan^{-1}\left(\frac{2.6}{1.10}\right) = 1.97$ radians $= 112.9°$, $\hat{r} = -0.39\hat{\imath} + 0.92\hat{\jmath}$

5. 21.70 $\sum F_x = T\sin\theta - F_e = 0$

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

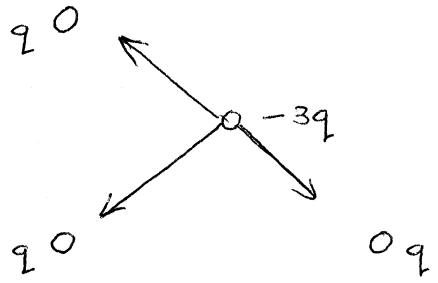


So, $\frac{mg\sin\theta}{\cos\theta} = F_e = \frac{kq^2}{d^2}$. But $\tan\theta \approx \frac{d}{2L} \Rightarrow d^3 = \frac{2kq^2L}{mg}$

$$\Rightarrow d = \left(\frac{q^2L}{2\pi\epsilon_0 mg}\right)^{1/3}$$

6. 21.75 a) $F = \frac{1}{4\pi\epsilon_0}\frac{q(3q)}{(L/\sqrt{2})^2} = \frac{1}{4\pi\epsilon_0}\frac{6q^2}{L^2}$ N, toward the lower left edge.

The other two forces are equal and opposite.



b) $F = \frac{1}{4\pi\epsilon_0}\left(\frac{q(3q)\sqrt{2}}{L^2} + \frac{q(3q)}{(\sqrt{2}L)^2}\right) = \frac{q^2}{4\pi\epsilon_0 L^2}\left(3\sqrt{2} + \frac{3}{2}\right)$ N