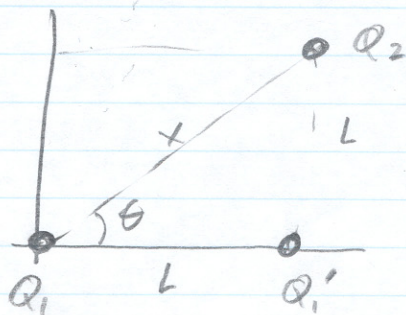


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$$L = 20 \text{ cm}$$

$$\theta = \tan^{-1} L/L = 45^\circ$$

$$\therefore \cos \theta = 1/\sqrt{2} = 0.71$$

$$\sin \theta = 1/\sqrt{2} = 0.71$$

$$Q_1 = Q_1' = +1.0 \times 10^{-3} \text{ C}$$

$$Q_2 = -1.0 \times 10^{-6} \text{ C}$$

$$\vec{F}_{21} = k_e \frac{Q_1 Q_2}{x^2} [\cos \theta \hat{x} + \sin \theta \hat{y}]$$

$$= k_e \frac{Q_1 Q_2}{(\sqrt{2}L)^2} \left[ \frac{1}{\sqrt{2}} \hat{x} + \frac{1}{\sqrt{2}} \hat{y} \right] \quad x = \sqrt{2} L$$

$$= k_e \frac{Q_1 Q_2}{L^2} \left[ \frac{1}{2\sqrt{2}} \hat{x} + \frac{1}{2\sqrt{2}} \hat{y} \right]$$

$$\vec{F}_{21'} = k_e \frac{Q_1' Q_2}{L^2} [\hat{y}]$$

$$\therefore \vec{F}_{\text{Total}} = \frac{k_e Q_1 Q_2}{L^2} \left[ \frac{1}{2\sqrt{2}} \hat{x} + \left(1 + \frac{1}{2\sqrt{2}}\right) \hat{y} \right]$$

$$= \frac{9.0 \times 10^9 \text{ Nm}^2/\text{C}^2 \times (1.0 \times 10^{-3} \text{ C})(-1.0 \times 10^{-6} \text{ C})}{(0.2 \text{ m})^2}$$

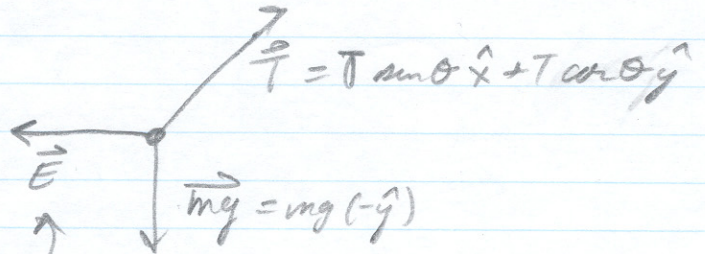
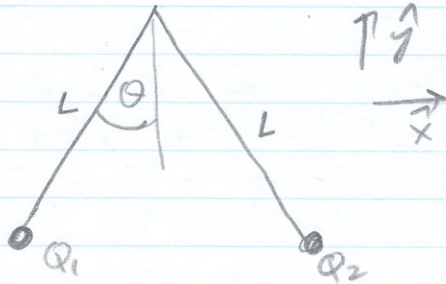
$$\left[ 0.35 \hat{x} + 1.35 \hat{y} \right]$$

$$= -2.25 \times 10^2 \left[ 0.35 \hat{x} + 1.35 \hat{y} \right]$$

$$= -7.9 \times 10^1 \hat{x} - 3.0 \times 10^2 \hat{y}$$

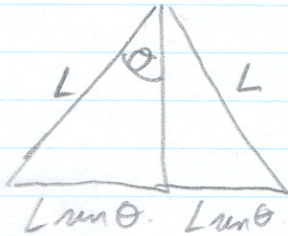


(3)



$$\vec{T} = T \sin \theta \hat{x} + T \cos \theta \hat{y}$$

$$\vec{E} = k_e \frac{Q_1 Q_2}{(2L \sin \theta)^2} (-\hat{x})$$



$$\sum F_x = 0 \Rightarrow 0 = -\frac{k_e Q_1 Q_2}{4L^2 \sin^2 \theta} + T \sin \theta$$

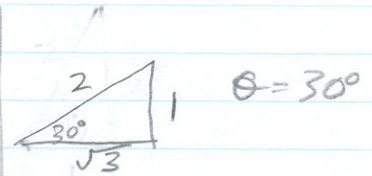
$$\sum F_y = 0 \Rightarrow 0 = -mg + T \cos \theta$$

$$i. \frac{-k_e Q_1 Q_2}{4L^2 \sin^2 \theta} + mg \tan \theta$$

$$ii. M = \frac{-k_e Q_1 Q_2}{4L^2 g \sin^2 \theta \tan \theta}$$

$$= \frac{-(9.0 \times 10^9 \text{ Nm}^2/\text{C}^2) (1 \times 10^{-6}) (3 \times 10^{-6}) \text{ C}^2}{4 (0.2 \text{ m})^2 \cdot 9.8 \text{ m/s}^2 \cdot 1/4 \cdot 1/\sqrt{3}}$$

$$= 1.19 \times 10^{-1} \text{ kg} \quad (0.12 \text{ kg})$$



$$\sin 30^\circ = 1/2$$

$$\tan 30^\circ = 1/\sqrt{3}$$



$$\textcircled{4} \quad \vec{F} = 0 \text{ by symmetry.}$$

$$\textcircled{5} \quad \sum F_y = 0 \Rightarrow EQ = Mg$$

$$Q = \frac{Mg}{E} = \frac{1 \times 10^{-15} \text{ kg} \times 9.8 \text{ m/s}^2}{1 \times 10^7 \text{ N/C}}$$

$$= 9.8 \times 10^{-22} \text{ C}$$