11-24.

Given: M = mass of stick

r = length of stick

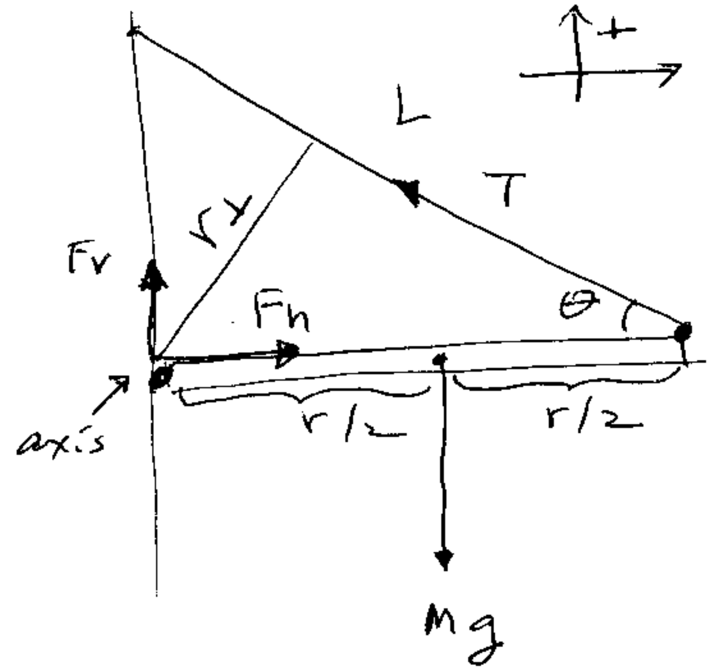
L = length of string

~~Define~~

Define θ as shown in diagram.

Goal: Tension in string

Force exerted at hinge



net force

$$\cancel{F_{net,x}}^{0} = F_h - T\cos\theta$$

$$\cancel{F_{net,y}}^{0} = F_v + T\sin\theta - Mg$$

$$\therefore \quad \left.\begin{array}{l} F_h = T\cos\theta \\ F_v = Mg - T\sin\theta \end{array}\right\} \text{ need to find } T$$

net torque

$$\tau_{net} = T r_\perp - Mg\frac{r}{2}$$

$$0 = T\cancel{r}\sin\theta - Mg\frac{\cancel{r}}{2}$$

$$\therefore T = \frac{Mg}{2\sin\theta}$$

combine with net force results

$$F_h = T\cos\theta = \frac{Mg}{2\tan\theta}$$

$$F_v = Mg - T\sin\theta = Mg - \frac{Mg}{2} = \frac{Mg}{2}$$

Checks

F_v is independent of θ and always equal to half the weight. Note that the vertical component of T is always $\frac{Mg}{2}$ as well. This makes sense to maintain the meter stick horizontal.

Checks, con't.

For $\theta = 0$, $T \to \infty$. The string can't hold the stick horizontal w/o a vertical component of force.

For $\theta = 90°$, $T = \frac{Mg}{2}$. This makes sense based on a previous check.