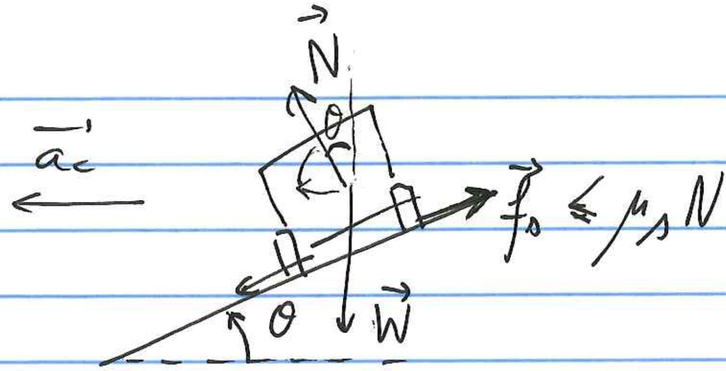
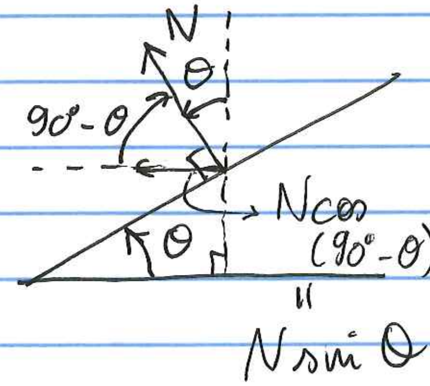


$$\vec{W} + \vec{N} + \vec{f_s} = \vec{F}_{net} = m\vec{a}_c \qquad \left(v \to a_c = \frac{v^2}{r}\right)$$

what is the perfect banking angle θ ?
$\hookrightarrow$ at which $f_s = 0$

$$\vec{W} + \vec{N} = \vec{F}_{net} = m\vec{a}_c$$



horizontal components:

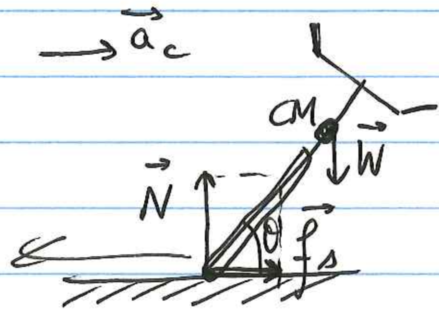
$$-N\sin\theta = -ma_c = -m\frac{v^2}{r}$$

vertical components:

$$N\cos\theta = N\sin(90°-\theta) = mg = W$$

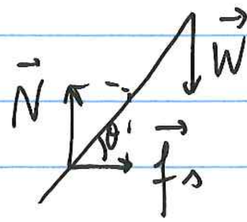
$$\begin{cases} N\sin\theta = m\dfrac{v^2}{r} \\ N\cos\theta = mg \end{cases} \longrightarrow \frac{N\sin\theta}{N\cos\theta} = \frac{m\frac{v^2}{r}}{mg}$$

$$\tan\theta = \frac{v^2}{gr}$$



$$\vec{N} + \vec{f_s} = \vec{F}$$

$$\tan\theta = \frac{N}{f_s} \rightarrow \begin{aligned} N &= F\sin\theta \\ f_s &= \underline{F\cos\theta} \end{aligned}$$



$$\begin{cases} \text{horizontal: } m a_c = f_s \\ \text{vertical: } 0 = N - W = N - mg \end{cases}$$

$$\begin{cases} m\dfrac{v^2}{r} = F\cos\theta \\ 0 = F\sin\theta - mg \rightarrow F\sin\theta = mg \end{cases}$$

$$\frac{F\sin\theta}{F\cos\theta} = \frac{mg}{m\frac{v^2}{r}} \Rightarrow \tan\theta = \frac{gr}{v^2}$$

$$\theta = \tan^{-1}\left(\frac{gr}{v^2}\right)$$

$$\frac{(10\,\tfrac{m}{s^2})(30\,m)}{v^2} \Rightarrow 1$$

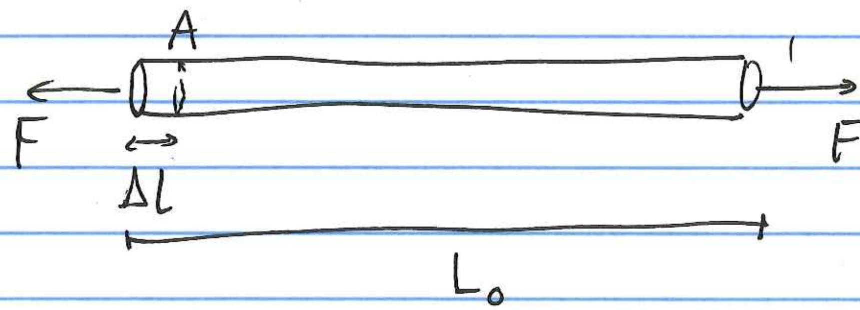
$$\mu_s N = \underline{f_{s,max}} \qquad f_s = F\cos\theta$$

$$f_s = \frac{N}{\tan\theta} = \frac{mg}{\tan\theta}$$

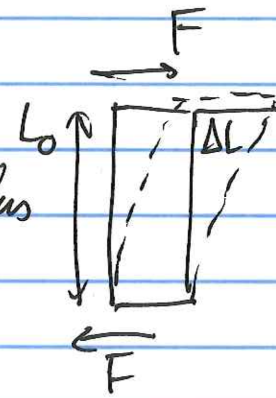
$$f_s = f_{s,max} = \mu_s mg = \frac{mg}{\tan\theta}$$

$$\hookrightarrow \mu_{s,min} = \frac{1}{\tan\theta} = \frac{v^2}{gr}$$

stress, strain

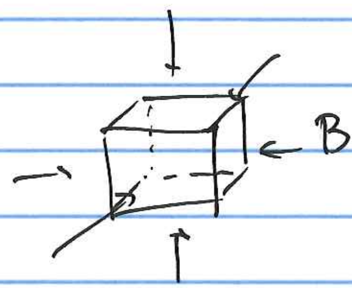


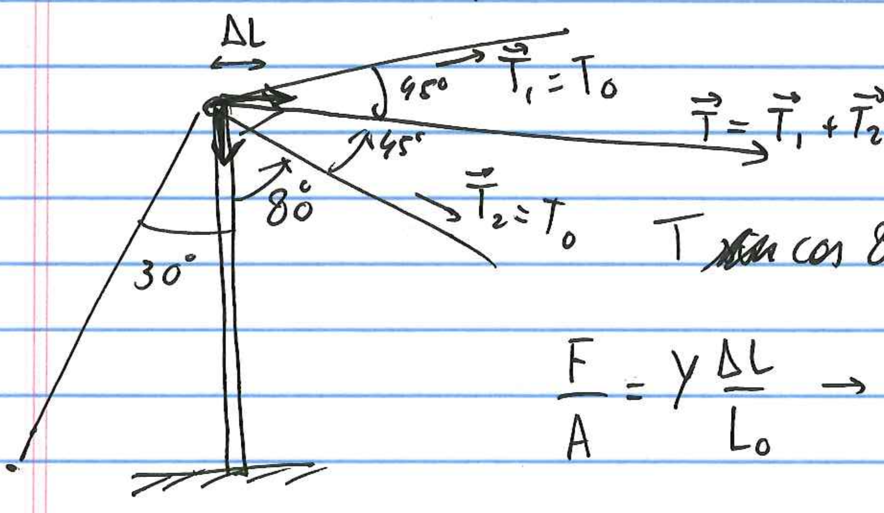
$$\frac{F}{A} = Y \frac{\Delta L}{L_0} \rightarrow \text{shear modulus}$$



elastic modulus

$$\frac{F}{A} = S \frac{\Delta L}{L_0}$$





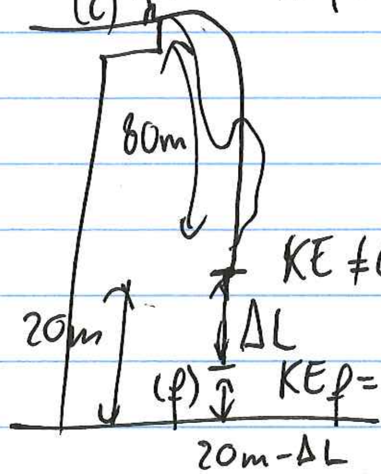
$$T \cos 80° = \sqrt{2}\, T_0 \cos 80°$$

$$\frac{F}{A} = Y \frac{\Delta L}{L_0} \rightarrow \Delta L = \frac{F}{A} \frac{L_0}{Y}$$

$$= \frac{\sqrt{2}\, T \cos 80°}{A} \frac{L_0}{Y}$$

$$\frac{F}{A} = S \frac{\Delta L}{L_0} \longrightarrow \Delta L = \frac{F}{A} \cdot \frac{L_0}{S}$$

(i) → $KE_i = 0$, $PE_i = mg(100m)$ → $KE_i + PE_i$



$\frac{1}{2}kx^2$, $x = \Delta L$

(f) $KE_f = 0$, $PE_f = mg(20m - \Delta L) + \underbrace{\frac{1}{2}k(\Delta L)^2}_{PE_k}$

$KE_f + PE_f$

$$mg(100m) = mg(20m - \Delta L) + \frac{1}{2}k(\Delta L)^2$$

$$mg(100m - 20m + \Delta L) = \frac{1}{2}k(\Delta L)^2$$

$$mg(80m + \Delta L) = \frac{1}{2}k(\Delta L)^2$$

$$KE = \frac{1}{2}mv^2$$

$$\left.\begin{aligned} PE_g &= mgh \\ PE_k &= \frac{1}{2}k(\Delta L)^2 \end{aligned}\right\}$$ conservative forces: work only depends on the starting and ending point

~~#~~ momentum conservation

$x: \; m_{He} v_{He,i} = m_{He} v_{He,f} \cos 120° + m_{Au} v_{Au,f} \cos\varphi$

$y: \; 0 = -m_{He} v_{He,f} \sin 120° + m_{Au} v_{Au,f} \sin\varphi$

kinetic energy conservation

$$\frac{1}{2} m_{He} v_{He,i}^2 = KE_i = KE_f = \frac{1}{2} m_{He} v_{He,f}^2 + \frac{1}{2} m_{Au} v_{Au,f}^2$$