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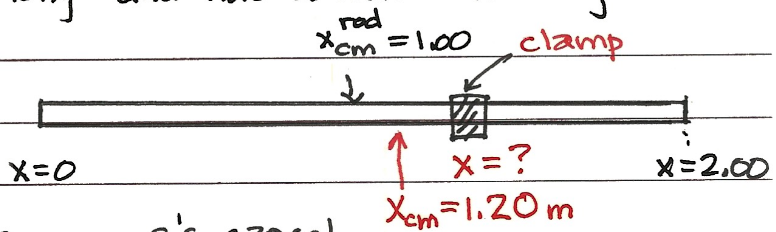
TOPIC 1

Chapter 11 In-Class Solutions

Ex. 3

A uniform rod is 2.00 m long and has a mass 1.80 kg.

$X_{cm}^{Total} = 1.20\ m$



$$X_{cg} = \frac{m_1 g x_1 + m_2 g x_2}{(m_1+m_2)g}$$

g's cancel

$X_{cg} \rightarrow X_{cm}$

$$X_{cm} = \frac{m_1 X_1 + m_2 X_2}{m_1+m_2}$$

let $m_1 = 1.80\ kg$ $\quad X_1 = 1.00\ m$

$m_2 = 2.40\ kg$ $\quad X_2 = ?$

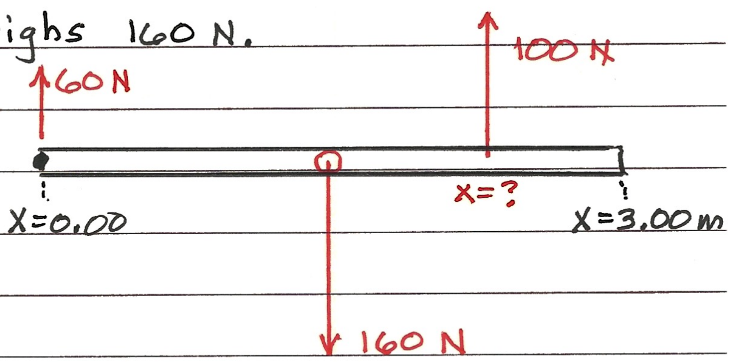
$$m_2 X_2 = (m_1+m_2)X_{cm} - m_1 X_1$$

$$X_2 = \frac{(m_1+m_2)X_{cm} - m_1 X_1}{m_2} = \frac{(4.20\ kg)(1.20m) - (1.80\ kg)(1.00m)}{2.40\ kg}$$

$$\boxed{X_2 = 1.35\ m}$$

Ex. 8

Two people are carrying a uniform wooden board that is 3.00 m long, and weighs 160 N.



1.) $\Sigma F_y = 0$

Other force = 100 N.

However, where should this force be applied?

2.) $\Sigma \tau = 0$ Calculate the torques with respect to $x=0.0\ m$

$$\Sigma \tau = (60\ N)(0) - 160\ N(1.50\ m) + 100\ N(x) = 0$$

$$X = \frac{160\ N\,(1.50\ m)}{100\ N} = \boxed{2.40\ m}$$

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Ex. 12 A uniform ladder 5.00 m long rests against a frictionless, vertical wall, ...

ladder $Mg = 160\ \text{N}$

man $mg = 740\ \text{N}$

a.) $f_s^{max} = ?$

$$f_s^{max} = \mu_s N$$

$$\sum F_y = 0$$

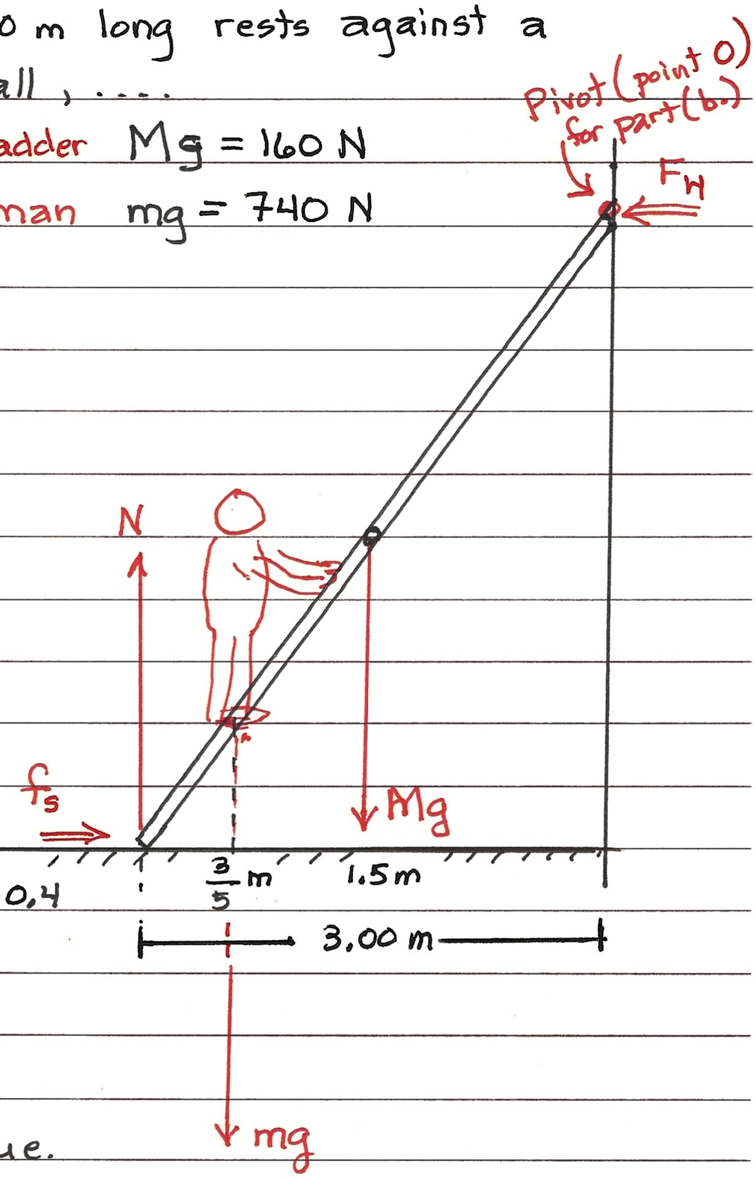
$$\sum F_y = N - mg - Mg = 0$$

$$N = mg + Mg$$

$$f_s^{max} = \mu_s (mg + Mg)$$

$$= 0.4\,(740 + 160)\ \text{N}$$

$$\boxed{f_s^{max} = 360\ \text{N}}$$



b.) $f_s = ?$ when the man is $\frac{1}{5}$th the way up the ladder?

$\sum \tau = 0$ Pivot at the top of the ladder so f_s is an external torque.

$$\sum \tau = Mg\,(1.5\text{m}) + mg\left(\tfrac{4}{5}(3.00\text{m})\right) - N\,(3.00\text{m}) + f_s\,(4.00\text{m}) = 0$$

$$f_s = \frac{\overset{900\ \text{N}}{N}\,(3.00\,\text{m}) - \overset{740\ \text{N}}{mg}\left(\tfrac{12}{5}\,\text{m}\right) - \overset{160\ \text{N}}{Mg}\,(1.5\,\text{m})}{4.00\ \text{m}} \qquad \boxed{f_s = 171\ \text{N}}$$

c.) How far up the ladder can the man go?

$$\sum \tau = Mg\,(1.5) + mg\left(3 - \tfrac{3}{5}\underline{\underline{s}}\right) - N\,(3.00\text{m}) + \overset{360\ \text{N}}{f_s^{max}}\,(4.00\text{m}) = 0$$

Solve for s. $\boxed{s = 2.70\ \text{m}}$

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Ex. 27

A circular steel wire 2.00 m long must stretch no more ...

$L_o = 2.00\,m$

$\Delta L = 0.25\,cm$

$F = 700\,N$

$$Y = \frac{\text{stress}}{\text{strain}} = \frac{F/A}{\Delta L/L_o} = \frac{F L_o}{(A)\Delta L} = \frac{F L_o}{\frac{\pi D^2}{4}\Delta L}$$

$$D^2 = \frac{4FL_o}{\pi \Delta L\, Y} = \frac{4(700\,N)(2.00\,m)}{\pi(0.25\times10^{-2}\,m)(2.0\times10^{11}\,N/m^2)} = 3.565\times10^{-6}\,m^2$$

$D = 1.89\times10^{-3}\,m$ $\boxed{D = 1.89\,mm}$

Ex. 36

In the Challenger Deep of the Marianas Trench, the depth ...

depth = 10.9 km

$p = 1.16\times10^{8}\,Pa \cong \Delta p$

$K_{water} = 45.8\times10^{-11}\,Pa^{-1}$

$\rho = 1.03\times10^{3}\,kg/m^3$

$$B = -\frac{\Delta p}{\Delta V/V_o} \qquad \Delta V = -\frac{\Delta p\, V_o}{B}$$

$$\Delta V = -K\,\Delta p\, V_o$$

$$\Delta V = -45.8\times10^{-11}\,Pa^{-1}(1.16\times10^{8}\,Pa)(1\,m^3) = \boxed{-5.31\times10^{-2}\,m^3}$$

or -53.1 liters

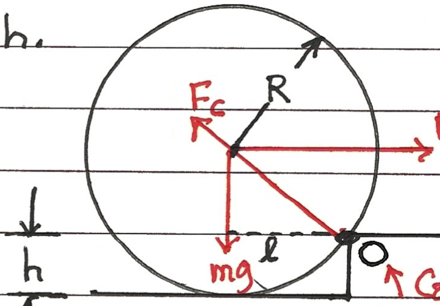
b.) bottom of the trench

$$\rho = \frac{\text{mass}}{\text{volume}} = \frac{1.03\times10^{3}\,kg}{1\,m^3 - 5.31\times10^{-2}\,m^3}$$

$$\boxed{\rho = 1.09\times10^{3}\,\frac{kg}{m^3}}$$

Prob. 74

You are trying to raise a bicycle tire of mass m and radius R up over a curb of height h.



Calculate torques about the point O

$$\Sigma\vec{\tau} = \vec{0} \qquad \Sigma\tau = -F(R-h) + mg\ell = 0$$

$$\ell^2 = R^2 - (R-h)^2 = R^2 - R^2 - h^2 + 2Rh$$

$$\ell = \sqrt{2Rh - h^2}$$

center of the wheel

$$\boxed{F = \frac{mg\sqrt{2Rh-h^2}}{R-h}}$$

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TOPIC 4

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Prob. 74 Cont'd.

b.) When the force is applied at the top of the wheel.

$$\Sigma \tau = 0 \qquad \Sigma \tau = -F(2R-h) + mg\ell = 0$$

Top of the wheel

$$\boxed{F = \frac{mg\sqrt{2Rh-h^2}}{2R-h}}$$

c.) There is less force required when the force is applied at the top of the wheel.