NAME: Key

Angled Equilibrium Problems

Assignment

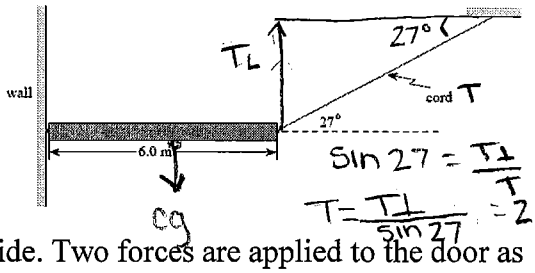
1. A uniform 25 kg bar, 6.0 m long, is suspended by a cord as shown. What is the tension in the cord?

$\Sigma\tau = 0$ CWτ = CCWτ

$Cg(3m) = T_\perp(6m)$

$245N(3m) = T_\perp(6m)$

$T_\perp = 122.5N$



$\sin 27 = \frac{T_\perp}{T}$

$T = \frac{T_\perp}{\sin 27} = 270N$

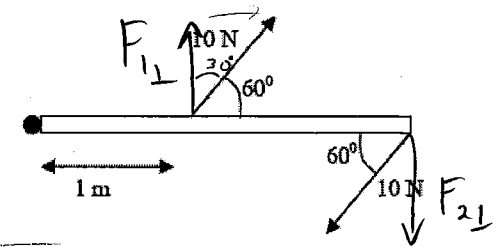
2. The diagram below shows the top view of a door that is 2 m wide. Two forces are applied to the door as indicated in the diagram. What is the net torque on the door with respect to the hinge?

$\cos 30° = \frac{F_{1\perp}}{10}$, $F_{1\perp} = 8.66N$, $F_{2\perp} = 8.66N$

$CW\tau = F_{2\perp}(2m)$ $CCW\tau = F_{1\perp}(1m)$

$= 8.66(2)$ $= 8.66N.m$

$= 17.3\ N.m$ Net $\tau = 8.66\ N.m$ CW



3. A beam of negligible mass is attached to a wall by means of a hinge. Attached to the center of the beam is a 400 N weight. A rope also helps to support this beam as shown in the diagram.

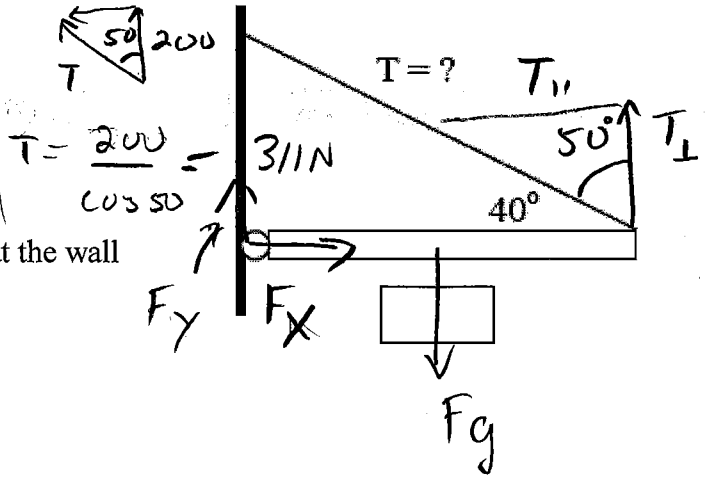
a) What is the tension in the rope?

$\Sigma\tau = 0$ CWτ = CCWτ

$F_g(\frac{1}{2}x) = T_\perp(x)$

$400(\frac{1}{2}x) = T_\perp(x)$

$T_\perp = 200N$



$T = \frac{200}{\cos 50} = 311N$

b) What are the vertical and horizontal forces that the wall exerts on the beam?

$\Sigma F_X = 0$ $\Sigma F_Y = 0$

$F_L = F_R$ $F_{up} = F_{down}$

$T_{||} = F_X$ $F_Y + T_\perp = F_g$

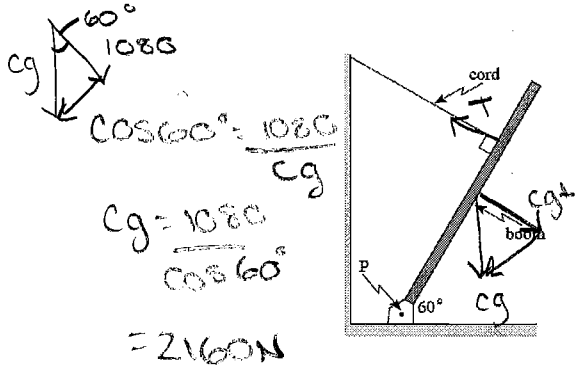
4. A boom hinged at P is held stationary, as shown in the diagram below. If the tension in the supporting cord, attached three-quarters of the way along the boom from P, is 720 N, what is the weight of the boom?

$\Sigma\tau = 0$, CWτ = CCWτ

$Cg_\perp(\frac{1}{2}x) = T(\frac{3}{4}x)$

$Cg_\perp(\frac{1}{2}x) = 720(\frac{3}{4}x)$

$Cg_\perp = 1080N$



$\cos 60° = \frac{1080}{Cg}$

$Cg = \frac{1080}{\cos 60°}$

$= 2160N$

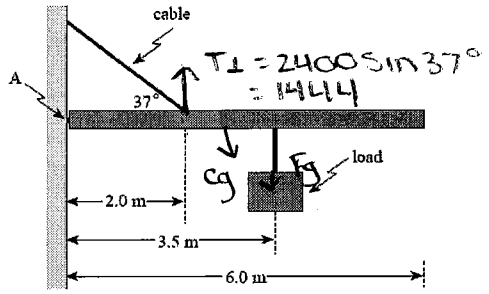
5. A uniform beam 6.0 m long, and with a mass of 75 kg, is hinged at A. The supporting cable keeps the beam horizontal. If the maximum tension the cable can withstand is 2.4×10^3 N, what is the maximum mass of the load?

$\Sigma\tau = 0$ CWτ = CCWτ

$Cg(3m) + Fg(3.5m) = T_\perp(2m)$

$(735N)(3m) + F(3.5) = 1444(2m)$

$F = 195N$, $m = 19.9kg$



6. A uniform 350 kg beam of length 4.2 m is held stationary by a horizontal cable. The cable is attached to a point on the beam 3.0 m from the hinge. If the maximum tension the cable can withstand is 1.3×10^4N, what maximum mass, ***m***, can be suspended from the end of the beam?

$Cg_\perp = Cg\cos 50°$

$= 2205N$

$T_\perp = T\cos 40$

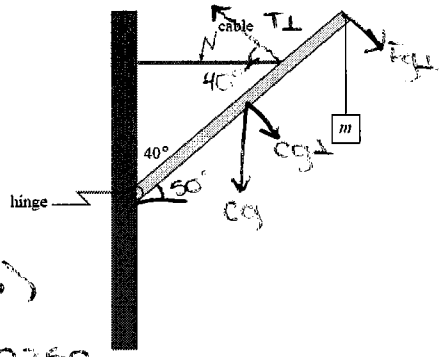
$= 9960N$

$\Sigma\tau = 0$, CWτ = CCWτ

$Cg_\perp(2.1) + Fg_\perp(4.2) = T_\perp(3m)$

$(2205)(2.1) + Fg_\perp(4.2) = (9960)(3)$

$Fg_\perp = 6012N$, $Fg = \frac{Fg_\perp}{\cos 50} = 9350N$



7. A uniform 4.8 m long ladder of mass 16 kg leans against a **frictionless** vertical wall as shown in the diagram below. What minimum force of friction is needed at the base of the ladder to keep it from sliding?

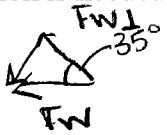
$\Sigma F_x = 0$, $F_W = F_f$

$\Sigma\tau = 0$, CWτ = CCWτ

$Cg_\perp(2.4) = F_{W\perp}(4.8)$

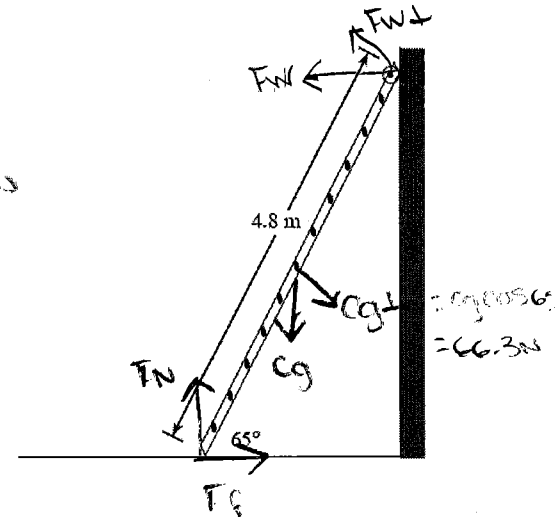
$66.3(2.4) = F_{W\perp}(4.8)$

$F_{W\perp} = 33.1N$



$F_W = \frac{F_{W\perp}}{\cos 25} = 36.5N$

$F_f = F_W = 37N$



Enrichment

8. The diagram shows a horizontal beam of negligible mass. The wall exerts a 42.0 N horizontal force on the lever. Find the weight of the load.

$\Sigma\tau = 0$, CWτ = CCWτ

$F_g(1.8) = T_1(1.3m)$

$= (22.3N)(1.3m)$

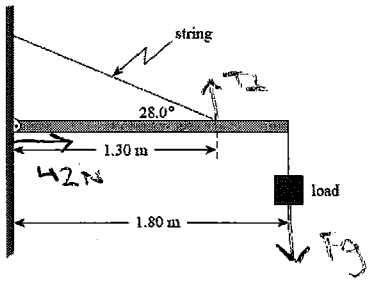
$F_g = 16.1N$

$\Sigma F_x = 0$, $F_W = T_x$

$42N = T_x$

$\tan 28° = \frac{T_1}{T_x}$

$T_1 = 22.3N$

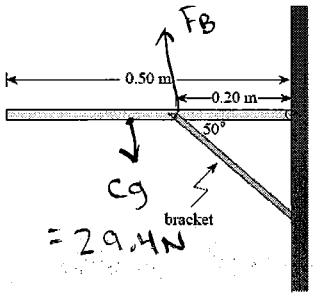


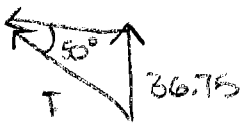
9. A uniform 3.0 kg shelf of width 0.50 m is supported by a bracket, as shown in the diagram below. What force does the bracket exert on the shelf?

$\Sigma\tau = 0$, CWτ = CCWτ

$F_B(.2) = (29.4)(.25)$

$F_B = 36.75N$





$F = \frac{36.75N}{\sin 50}$

$= 48N$

Answers: 1) 270 N, 2) 8.66 Nm clockwise 3a) 311 N b) V: 200 N, H: 238 N 4) 2160 N, 5) 20 kg, 6) 950 kg, 7) 37 N, 8) 16.1 N, 9) 48 N