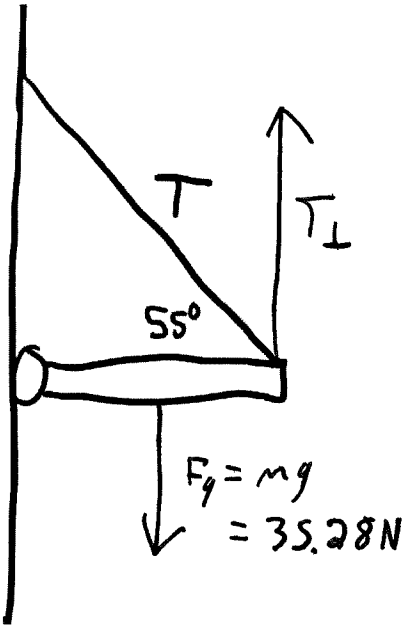
Torque not at 90° Practice Name:_____

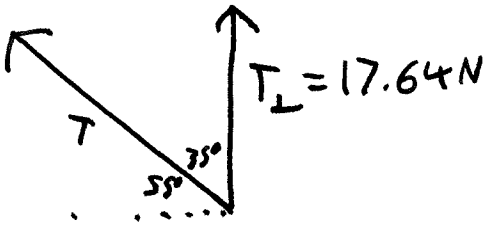
1. A 3.6 kg board of length 0.80 m is attached to a wall with a hinge and supported by a rope which makes a 55° angle with the board. What is the tension in the rope?



$\tau_c = \tau_{cc}$

$35.28N \times 0.40m = T_\perp \times 0.80m$

$17.64N = T_\perp$



$\cos 35° = \frac{17.64N}{T}$

$T = \frac{17.64N}{\cos 35°}$

$= 21.53N$

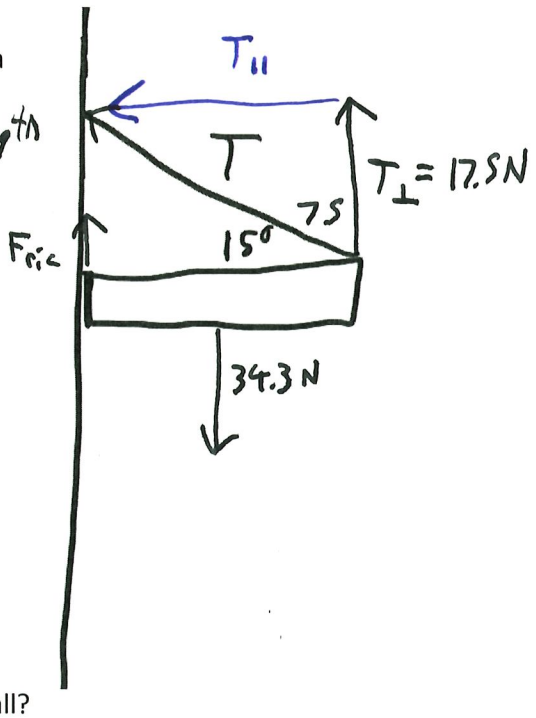
$\simeq \boxed{22N}$

Torque not at 90° Practice Name:_____

2. A 3.5 kg board is held against a wall by the force of friction and a rope which makes a 15° angle with the board.

   a. What is the tension in the rope?

Let ℓ be length of board



$T_c = T_{cc}$

$0.5 \times \ell \times 34.3N = T_\perp \times \ell$

$17.15\ N = T_\perp$

$T = \frac{17.15N}{\cos 75} = \cancel{67.61N}$

66.26N

   b. What is the normal force between the board and the wall?

Left forces = right forces

$F_N = T_{||} = \sqrt{\cancel{67.61^2} - 17.15^2} = \cancel{65.31N}$

66.28^2

64N

   c. What is the upwards support force provided by the friction?

Up forces = down forces

$F_{fric} + 17.15N = 34.3\ N$

$F_{fric} = \cancel{16.8N}\ 17.15\ N$

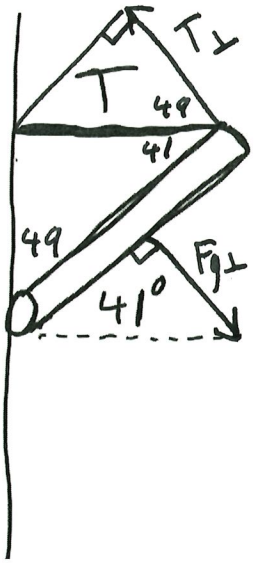
   d. What is the minimum value of μ between the wall and the board?

$\mu = \frac{F_{fric}}{F_N} = \frac{\cancel{16.8N}}{\cancel{65.31N}} = 0.26$

$\frac{17.15}{64} = 0.27$

Torque not at 90° Practice Name:_____

3. A board of mass 22 kg is attached to a wall via a hinge, and held at an angle of 41° above the horizontal by a rope as shown.
   a. What is the tension in the rope?



$F_{g\perp} = \cos 41 \times 22kg \times 9.8 m/s^2$

$= 162.72 N$

$T_c = T_{cc}$

$162.72 \times 0.5 \cancel{\times \ell} = T_\perp \times \cancel{\ell}$

$81.36 = T_\perp$

$\cos 49 = \frac{T_\perp}{T} \rightarrow T = \frac{T_\perp}{\cos 49} = \frac{81.36}{\cos 49} = 124 N$

   b. What upwards support is the hinge providing?

Hinge is only force opposing gravity

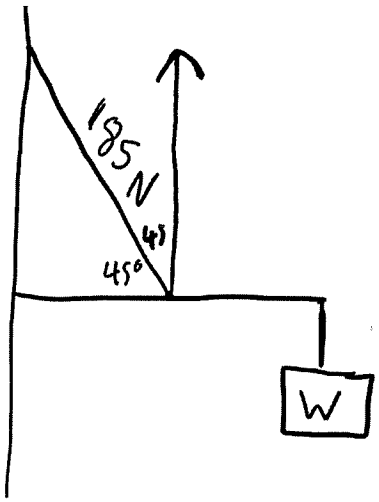
So $F_{up} = F_{down}$

$Hinge = F_g = mg = 215.6 N$

$\simeq 220 N$

Torque not at 90° Practice Name:_____

4. A board of negligible mass has an object hanging from its end. In the middle of the board a rope is attached at a 45° angle. The tension in the rope is 185 N. Determine the weight of the object hanging from the board.



$T_{\perp} = \sin 45^{\circ} \times 185N$

$= 130.81N$

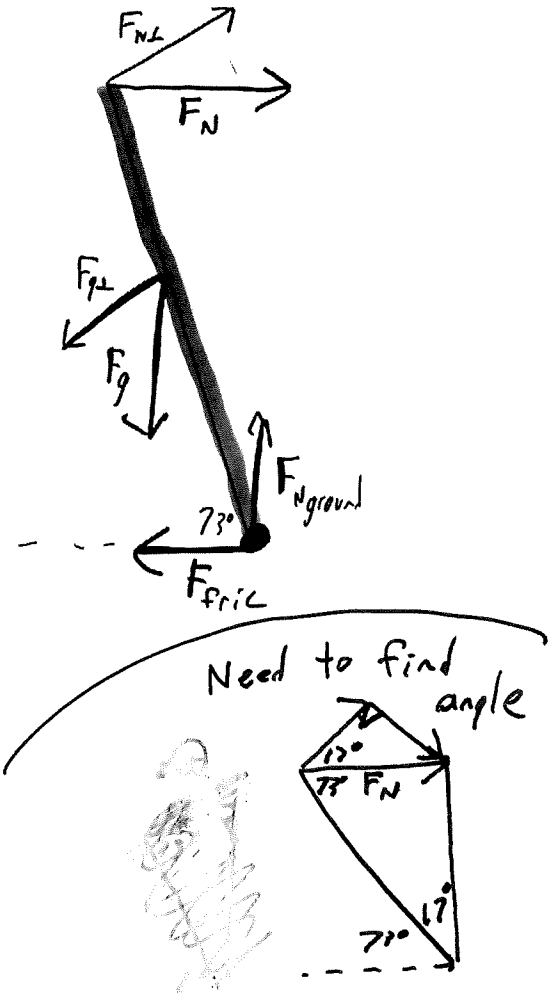
$T_c = T_{cc}$

$w \times 2 = 130.81N \times 2 \times 0.5$

$w = 65.41N$

Torque not at 90° Practice Name:_____

5. A 3.0 m long ladder of mass 15.0 kg leans against a building, making an angle of 73° with the ground, a friction force acts on the base of the ladder to keep it from sliding.



a. Determine the $F_{g\perp}$ for the ladder.

$\cos 73 \times 15 \times 9.8$

$= 42.98\ N$

b. Determine the perpendicular component of the normal force provided by the wall.

$\tau_c = \tau_{cc}$

$F_{N\perp} \times 3 = 42.98 \times 1.5$

$F_{N\perp} = 21.49N$

c. Determine the normal force provided by wall.

$\cos 17° = \frac{F_{N\perp}}{F_N} \rightarrow F_N = \frac{21.49N}{\cos 17}$

$= 22.47N$

d. Determine the friction force acting on the base of the ladder.

Only left/right forces are F_N and f_{fric}

so $F_{fric} = F_N = 22.47N$

e. Determine the minimum coefficient of friction between the base of the ladder and the ground.

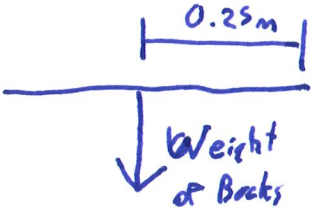
Only up/down forces are $F_{N\,ground}$ and F_g

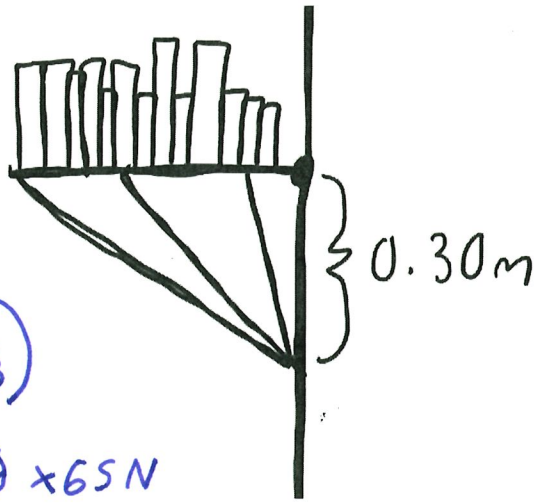
$F_{N\,ground} = 15 \times 9.8 = 147N$

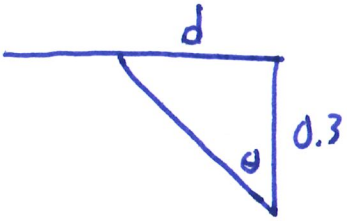
$\mu = \frac{22.47N}{147N} = 0.15$

Torque not at 90° Practice Name:_____

6. A 0.50 m long bookshelf is connected to the wall with a hinge, and supported by a single piece of wood between the wall and the bookshelf with the wall end 0.30 m below the bookshelf. The support can withstand 65 N before breaking. Where along the bookshelf should the other end of the support be placed to maximize the weight of books that can be placed on the shelf, and how much weight can be supported?







$\theta = \tan^{-1}\left(\frac{d}{0.3}\right)$

$F_\perp = \cos\theta \times 65N$

$T_c = T_{cc}$

$d \times F_\perp = W \times 0.25 \rightarrow$ Max Weight of Books $= \frac{d \times \cos\left(\tan^{-1}\left(\frac{d}{0.3}\right)\right) \times 65N}{0.25m}$

IF $d = 0.1 \rightarrow$ Max weight $= 24.7N$

$d = 0.2 \rightarrow$ Max weight $= 43.27N$

$d = 0.25 \rightarrow$ Max weight $= 49.93N$

$d = 0.3 \rightarrow$ Max weight $= 55.15N$

$d = 0.4 \rightarrow$ Max weight $= 62.4N$

$d = 0.5 \rightarrow$ Max weight $= 66.88N$

Max is when support is at far end, at that position 67N of books can be supported.