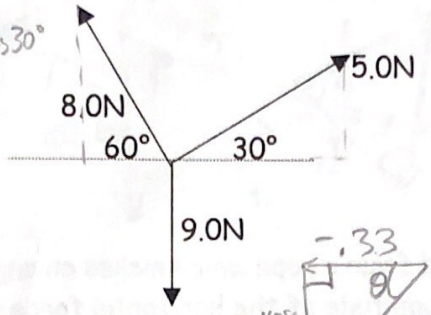
Equilibrium Worksheet#1

key
(name)

1. What is the magnitude and direction of the force necessary to produce equilibrium in the following?

$\sum F_x = 8N\cos 60° + 5\cos 30°$

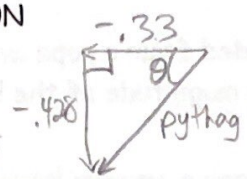
$\sum F_y = -9N + 8\sin 60 + 5\sin 30$



need opp of θ

$F_x = 0.330$

$F_y = 0.428$



$\tan\theta = \frac{.428}{.33}$

F = 0.54N [52° S of W]

2. What is the magnitude and direction of the force needed to produce equilibrium with F_1 and F_2 ?

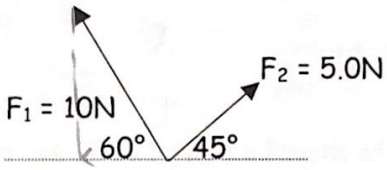
opposite of net F_x and net F_y

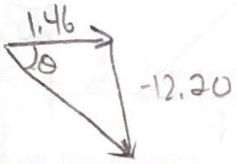
$\sum F_x = -10\cos 60° + 5\cos 45°$

$= -1.46$

$\sum F_y = 10\sin 60° + 5\sin 45°$

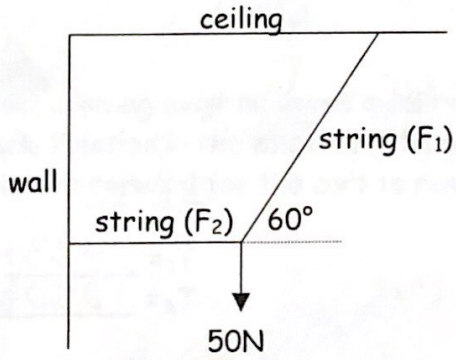
$= 12.20$





F = 12N [83° S of E]

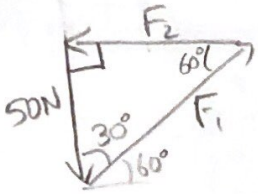
3. An object on which the force of gravity is 50 N is supported by two strings as shown below. Calculate the magnitude of the force of tension exerted by each string.



$\tan 30° = \frac{F_2}{50N}$ $F_2 =$

$\cos 30° = \frac{50}{F_1}$ $F_1 =$

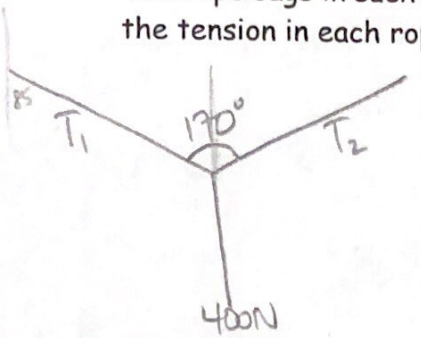
equilibrium △:

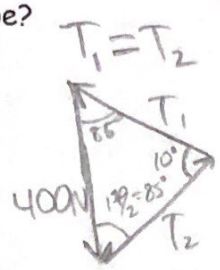


F_1 = 58N

F_2 = 29N

4. A boy weighing 400 N hangs on the middle of a rope stretched between two trees. The rope sags in such a way that it makes an angle of 170° at the boy's hands. What is the tension in each rope?





$T_1 = T_2$

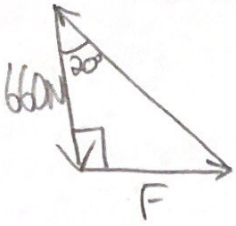
$\frac{T_1}{\sin 85°} = \frac{400}{\sin 10°}$

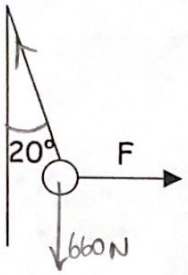
$T_1 = T_2 = 2294.7\,N$

T = 2.3×10^3 N. ✓

5. A 660 N object is suspended from a rope which makes an angle of 20° with the wall as shown below. What is the magnitude of the horizontal force necessary to produce equilibrium?

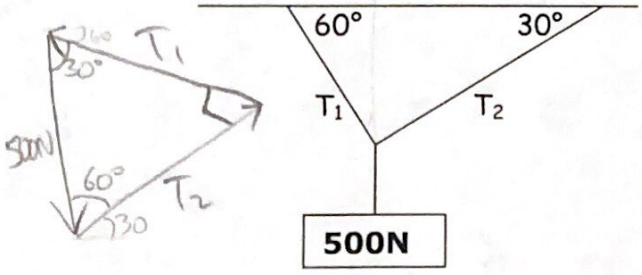
$\tan 20° = \frac{F}{660N}$





F = 240 N ✓

6. A 500 N crate is suspended from a cable in such a manner that the cable makes an angle of 30° with the ceiling at one end and an angle of 60° with the ceiling at the other end. Calculate the tension force exerted by each cable on the crate.



$\sin 60° = \frac{T_1}{500N}$

$\cos 60° = \frac{T_2}{500N}$

T_1 = 433 N. ✓

T_2 = 250 N. ✓

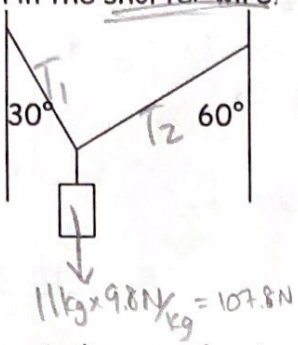
Answers: 1. 0.54N, 53° S of W 2. 12.3N, 83° S of E 3. 29N, 58°N ✓

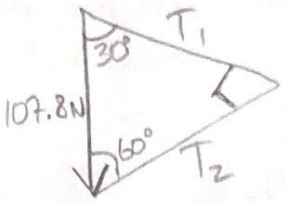
4. $2.29 * 10^3$N 5. 240N 6. T_1 = 433N, T_2 = 250N

Equilibrium Worksheet#2

key
(name)

1. A lamp is supported between two vertical poles with two wires attached to the poles as shown. The lamp hangs from a short chain. If the lamp has a mass of 11 kg, what is the tension in the shorter wire?



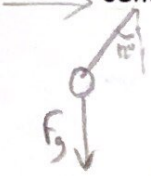


$\sin 60 = \frac{T_1}{107.8N}$ $T_1 = 93N$

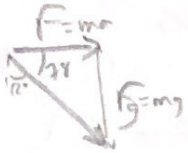
$11kg \times 9.8N/kg = 107.8N$

$T_1 =$ 93N.

2. As an airplane accelerates along a horizontal runway, a pendulum hanging from its ceiling is displaced 12° from the vertical. Calculate the acceleration of the plane.



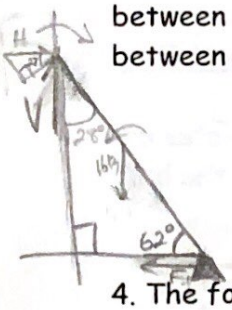
$\tan 78° = \frac{mg}{ma}$



$a = \frac{g}{\tan 78°}$

$a =$ 2.1 m/s² ✓

3. A uniform ladder has a mass of 16 kg and a length of 8.5 m. It stands on the ground and leans against a vertical wall, making an angle of 62° with the ground. The friction between the ladder and the wall is not significant. What is the smallest force of friction between the ladder and the ground which will just prevent the ladder from slipping?



$F_f = H$

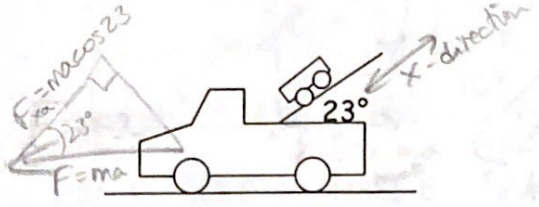
$\tau_{cw} = \tau_{ccw}$

$H \cos 28° \times 8.5m = 16 \times 9.8 \times 4.25 \times \cos 62°$

$H = 41.7N$

Ff = 42 N. ✓

4. The following diagram shows a cart on a ramp which is fixed to the floor in the back of a truck. Friction in the wheels of the cart is negligible. At what rate must the truck accelerate forward for the cart to remain stationary with respect to the ramp?

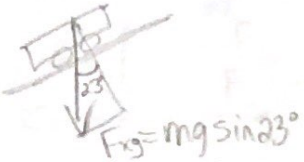


$F_{xa} = F_{xg}$

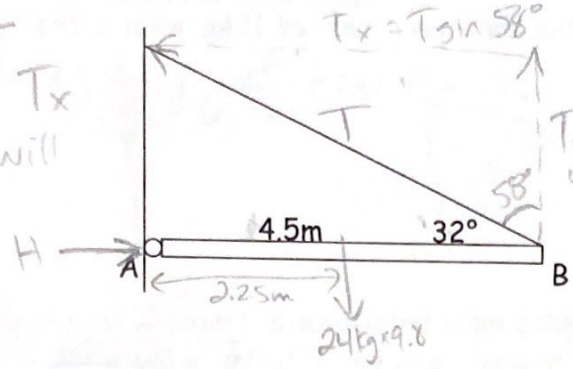
$ma\cos 23 = mg \sin 23°$

$a = 4.16 m/s$

$a =$ 4.2 m/s² ✓



5. The following diagram shows a uniform 24 kg beam hinged to the wall at A and supported by a cable from B. What is the magnitude of the horizontal force exerted by the wall on the beam?



need T to get T_x which will = H

$T_x = T\sin 58°$

$T_y = T\cos 58°$

$\tau_{cw} = \tau_{ccw}$

$24 \times 9.8 \times 2.25 = T\cos 58° \times 4.5m$

$T = 221.92\,N$

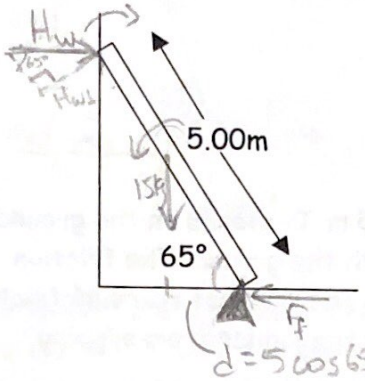
$T_x = T\sin 58 = 188\,N = H$

since $\Sigma F_x = 0 = T_x - H$

$F_x =$ 190 N ✓

6. A uniform ladder with a mass of 15 kg rests against a wall as shown. If the friction from the wall is not significant, what is the minimum coefficient of friction between the ladder and the floor that will keep the ladder from slipping?

$f_f = H_w$



$\tau_{cw} = \tau_{ccw}$

$H_w \sin 65° \times 5m = 15 \times 9.8N \times 2.5\cos 65°$

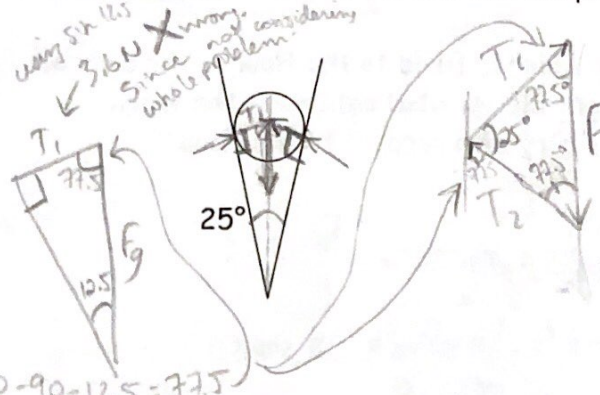
$H_w = 34.27 = F_f$ since $\Sigma F_x = 0$

$\mu = \frac{F_f}{F_N} = \frac{34.27}{15 \times 9.8}$

$\mu T =$ 0.23 ✓

7. A steel ball of mass 1.7 kg rests in the V-shaped wedge formed by two steel plates as shown in the diagram. Find the magnitude of the force exerted on each plate by the ball if the friction between the ball and the plates is not significant.

using $\sin 12.5 \times 3.6N$ ✗ wrong. Since not considering whole problem



$180 - 90 - 12.5 = 77.5$

$F_g = 1.7 \times 9.8N$

$T_1 = T_2$

$\frac{T_1}{\sin 77.5°} = \frac{F_g}{\sin 25°}$

$T_1 = 38$

$F =$ 38N ✓

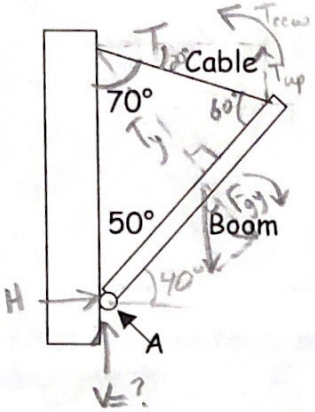
Answers: 1. 93N 2. 2.1m/s² 3. ~~41.7~~ 42N 4. ~~4.16~~ 4.2m/s² 5. ~~188~~ 190N 6. 0.23~~8~~ 7. 38N

Equilibrium Worksheet#3

Key

_____ (name)

1. The following diagram shows a uniform boom of length 2.6 m and mass 53 kg. The boom is hinged to the wall at point A and supported by a cable as shown. What is the vertical component of the force acting at point A?



180-70-50

$T_y = T\sin 60°$ $\quad F_{gy} = F_g \cos 40° \left(= F_g \sin 50°\right)$

$\Sigma \tau_{cw} = \Sigma \tau_{ccw}$

$T\sin 60° \times \not{x} = mg\cos 40° \times \not{x}/2$

$T = 229.7$

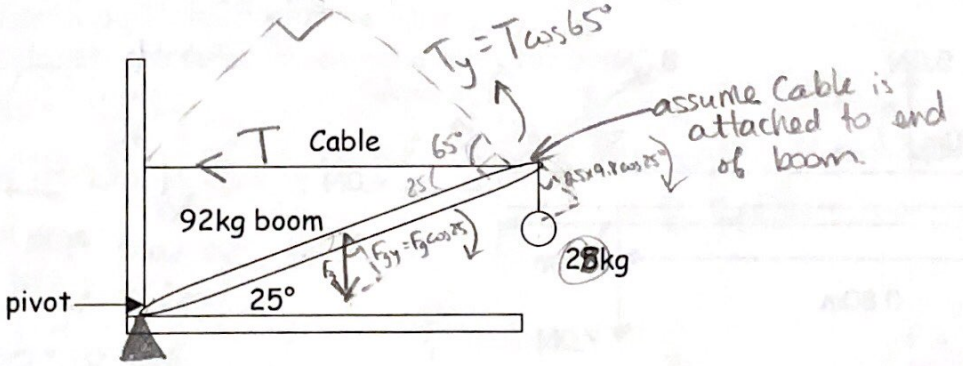
$T_{up} = T\sin 20°$

$\Sigma F_{\substack{up \\ +down}} = 0 = V - F_g + T_{up}$

$V = mg - T\sin 20°$

$= 53\times 9.8 - 229.7\times\sin 20$ $\quad F_V = \underline{4.4\times 10^2 N}$ ✓

2. A uniform boom of length 3.6 m and mass 92 kg supports a load of 28 kg as shown. What is the tension in the horizontal cable supporting the boom'?



$T_y = T\cos 65°$

$\Sigma \tau_{cw} = \Sigma \tau_{ccw}$

1470.8 $\quad$ 895.29

$F_g \cos 25\times 1.8m + 28\times 9.8\cos 25\times 3.6m = T\cos 65°\times 3.6m$

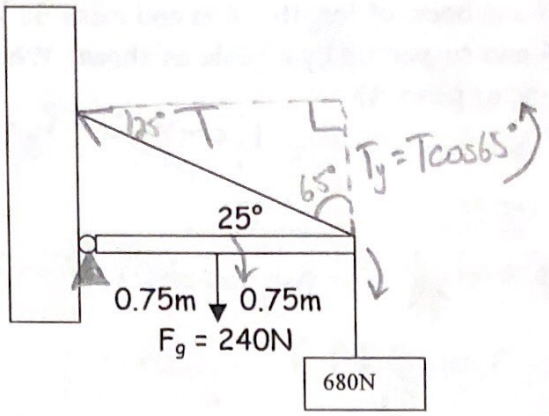
$T = 1555\ N$

mg 92×9.8

$F = \underline{1.6\times 10^3 N}$.

Equ

3. What is the tension in the cable shown in the following diagram?



$T_y = T\cos 65°$

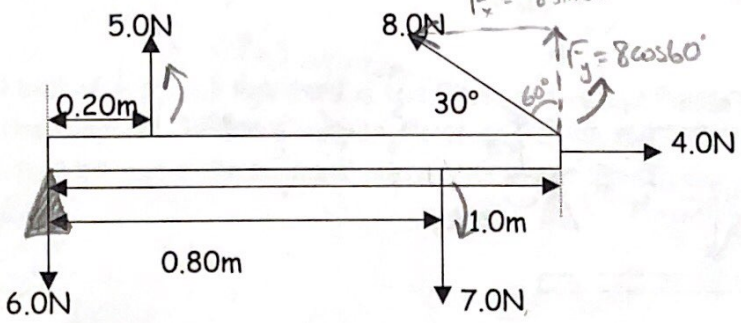
$\Sigma \tau_{ccw} = \Sigma \tau_{cw}$

$T\cos 65 \times 1.5m = 240 \times .75 + 680 \times 1.5$

$T = 1893\ N$

F = 1.9×10^3 N ✓

4. A bar 1.0 m long has five forces acting on it as shown in the following diagram. What are the magnitude, direction, and location of the single force required to produce static equilibrium 'um? The weight and thickness of the bar are not significant.



sum forces to get net force needed. (1)

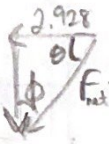
$\Sigma F_x = -8\sin 60 + 4N = -2.928N$

$\Sigma F_y = -6N + 5N - 7N + 8\cos 60$

$= -4$

$F_x = -8\sin 60°$

$F_y = 8\cos 60°$



$F_{net} = 4.96\ N$

So need opposite of this

$\tan \theta = \frac{2.928}{4}$

$\theta = 36°$ E of N

use Στ's to get distance (2)

$\Sigma \tau_{cw} = \Sigma \tau_{ccw}$

$7N \times 0.8m = 5N \times 0.2m + 8\cos 60° \times 1m + F_{net} \times d$

$d = 0.15\ m$

F = 5.0N [36° E of N]

0.15m from left end ✓

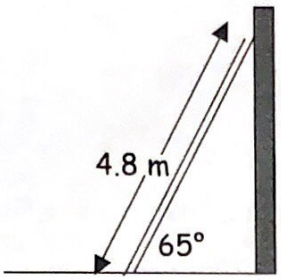
Answers: 1. 440N 2. ~~2.5*10³N~~ 1.6×10^3N 3. 1.9*10³N

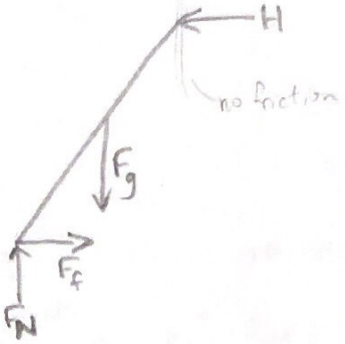
4. 4.96N, 54° N of E, 0.15m from left end

Equilibrium Worksheet#4

Key
(name)

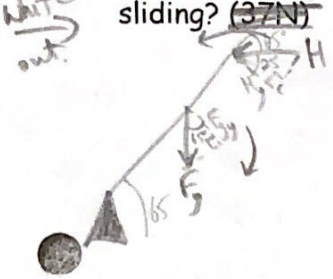
1. A uniform 4.8 m long ladder of mass 16 kg leans against a frictionless vertical wall as shown in the diagram below. a) Draw and label a free body diagram showing the forces acting on the ladder.





b) What minimum force of friction is needed at the base of the ladder to keep it from sliding? ~~(37N)~~

write out



$F_f = H$

$H_y = H\cos 65°$

$F_{gy} = F_g \cos 65°$

$\Sigma \tau_{cw} = \Sigma \tau_{ccw}$

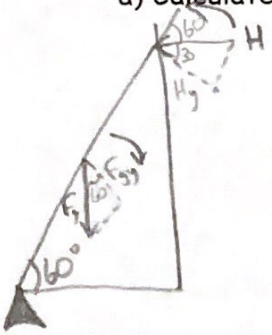
$16 \times 9.8N \cos 65 \times 2.4m = H \cos 25 \cdot 4.8m$

$H = 36.6$

F = 37 N ✓

2. A uniform 5.0 m ladder of mass 25 kg leans against a frictionless wall. The ladder makes an angle of 60° with the floor.

a) Calculate the force of contact against the wall



$H_y = H\cos 30°$

$F_{gy} = F_g \cos 60°$

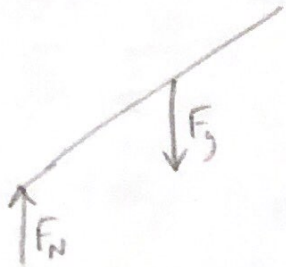
$\Sigma \tau_{cw} = \Sigma \tau_{ccw}$

$25 \times 25 \times 9.8 \times \cos 60 = H \cos 30 \times 5$

$H = 70.7$

F = 71 N ✓

b) Calculate the force normal that the floor exerts on the ladder.



$F_N = F_g = 25kg \times 9.81 N/kg = 245N$

F = 250 N ✓

c) Calculate the friction force exerted by the floor.

$F_f = H$

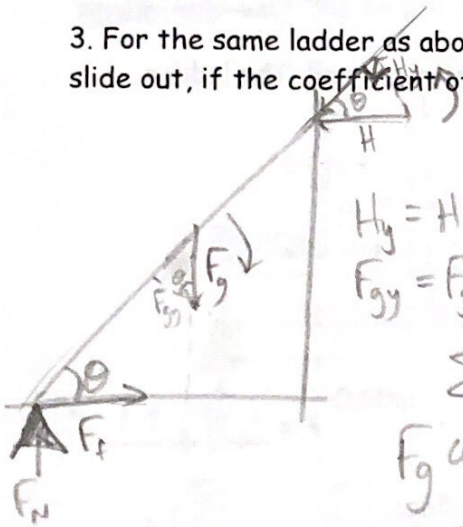
F = 71N ✓

d) Calculate the minimum coefficient of friction needed for the ladder not to slide.

$\mu = \frac{F_f}{F_N} = \frac{71N}{245N} =$

μ = 0.29 ✓

3. For the same ladder as above, what is the minimum angle at which the ladder will not slide out, if the coefficient of friction is 0.40?



$F_f = F_N \mu = F_g \mu = 245 \times 0.4$
$= 98N = H$

$H_y = H \sin\theta$

$F_{gy} = F_g \cos\theta$

$\Sigma \tau_{cw} = \Sigma \tau_{ccw}$

$F_g \cos\theta \times \frac{\ell}{2} = H \sin\theta \times \ell$ (98N)

θ = 51° ✓

$\frac{25 \times 9.8}{2 \times 98} = \frac{\sin\theta}{\cos\theta} = \tan\theta$ $\quad \frac{\frac{o}{h}}{\frac{a}{h}} = \frac{o}{a}$

$\theta = 51°$

Answers:

1. (b) 37N 2. (a) 71N (b) ~~245~~ 250N (c) 71N (d) 0.29 3. 51°