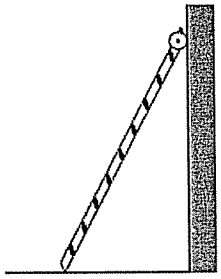
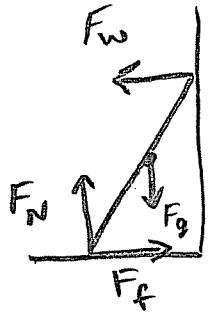
PHYSICS 12

NAME: _____

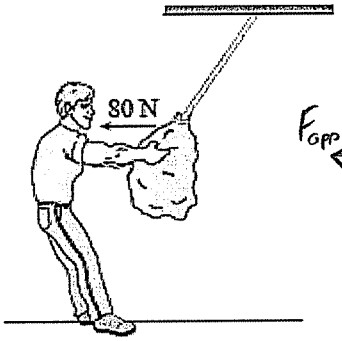
Torque and Equilibrium Review

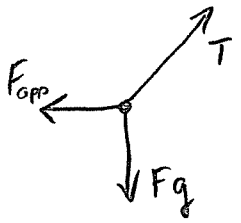
1. A uniform ladder leans against a frictionless wall as shown. Draw a free body diagram for it.

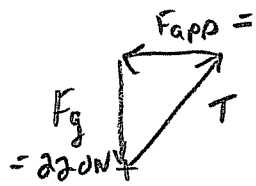




2. A 220 N bag of potatoes is suspended from a rope as shown in the diagram. A person pulls horizontally on the bag with a force of 80 N. What is the tension in the rope?







$T^2 = 80^2 + 220^2$

$T = 234\ N$

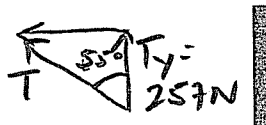
3. A uniform 15 kg beam of length 4.0 m is supported against a wall as shown in the diagram. A 25 kg object is suspended 3.0 m from the hinge P.

a) What is the tension in the support cable?

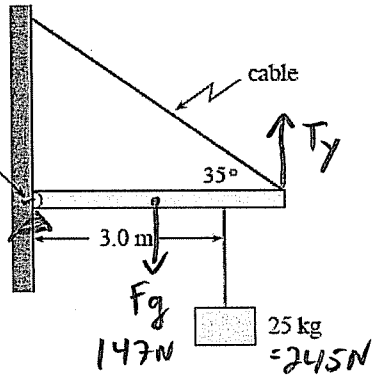
$\Sigma \tau = 0 \quad CWT = CCWT$

$(147N)(2m) + 245N(3.0m) = T_y(4.0m)$

$T_y = 257.25$



$T = \frac{T_y}{\cos 55^\circ} = 450\ N$



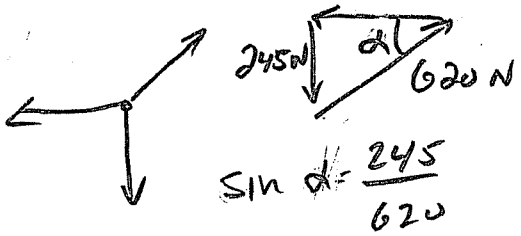
b) What is the magnitude of the horizontal component of the reaction force of the wall on the beam at the hinge P?

$\Sigma F_x = 0 \quad F_w = T_x \quad T_x = T \sin 55^\circ$

$= 450 \sin 55^\circ = 370\ N$

$F_w = 370\ N$

4. A 25 kg block is pulled by a horizontal force. The supporting rope can withstand a maximum tension force of 620 N. To what maximum angle, θ, can the block be pulled without the rope breaking?



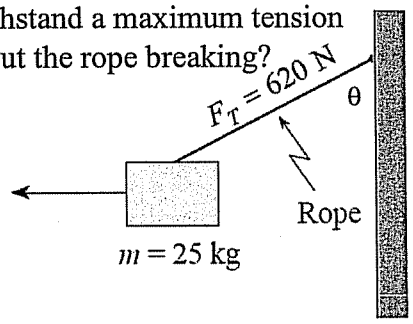
$\sin \alpha = \frac{245}{620}$

$\alpha = 23^\circ$

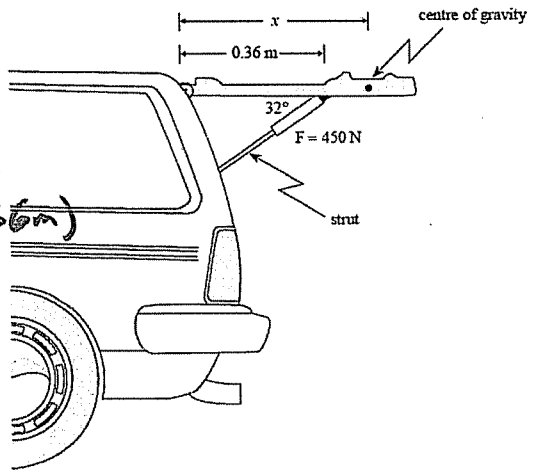
$\theta = 90 - \alpha$

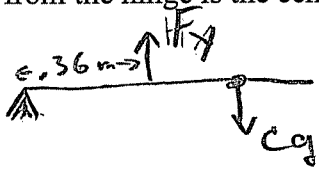
$= 90 - 23$

$\theta = 67^\circ$



5. The diagram shows the rear door of a station wagon supported horizontally by a strut. The mass of the door is 18 kg and the compression force in the strut is 450 N. At what distance, x, from the hinge is the centre of gravity of the door located?





$\Sigma\tau = 0$ CWτ = CCWτ

$(176.4\,N)(x) = (238.5)(.36m)$

$x = .487\,cm$

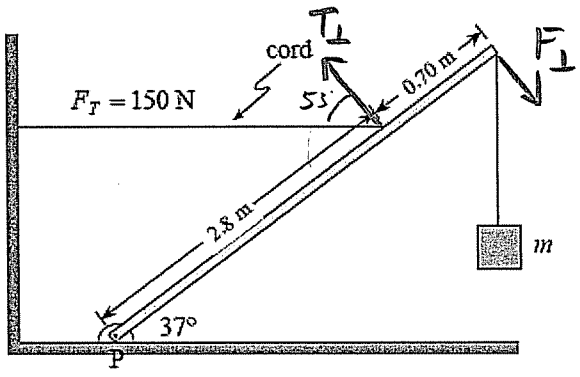
$\hat{x} = .49\,cm$

$F_y = 450\sin 32°$

$= 238.5$

$F_g = (18)(9.8) = 176.4$

6. A uniform 3.5 m beam of negligible mass, hinged at P, supports a hanging block as shown. If the tension F_T in the horizontal cord is 150 N, what is the mass of the hanging block?



no F_g

$T_1 = 150N\cos 53°$

$= 90.3\,N$

$\Sigma\tau = 0$ CWτ = CCWτ

$F_1(3.5m) = (90.3N)(2.8)$

$F_1 = 72.24$

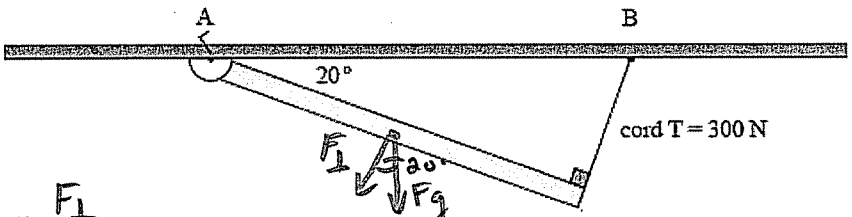
$F = \frac{F_1}{\cos 37°}$

$F = 90.4$

$m = \frac{F_g}{9.8} = \frac{90.4}{9.8}$

$m = 9.2\,kg$

7. A 3.8 m uniform beam is attached to the ceiling with a hinge at A and a cord with a tension of 300 N at B. Determine the mass of the beam.



$\Sigma\tau = 0$ CWτ = CCWτ

$F_1(1.9m) = (300N)(3.8)$

$F_1 = 600\,N$

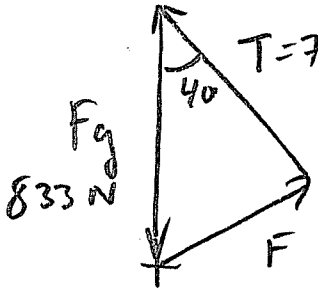
$F_g = \frac{F_1}{\cos 20°}$

$= 638.5\,N$

$m = \frac{638.5}{9.8}$

$m = 65.2\,kg$

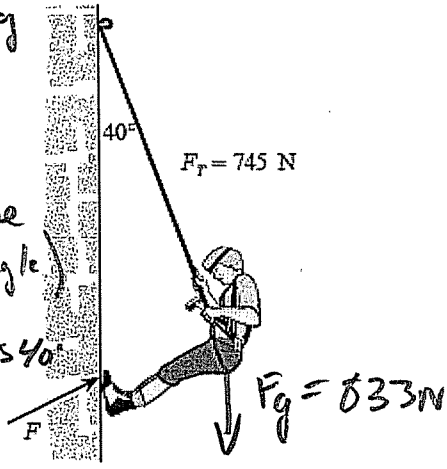
8. An 85.0 kg mountaineer remains in equilibrium while climbing a vertical cliff. The tension force in the supporting rope is 745 N. Find the magnitude of the reaction force, F, which the cliff exerts on the mountaineer's feet.



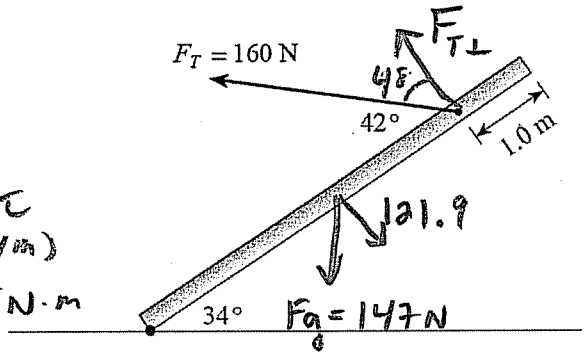
use cos law (may not be right triangle)

$F^2 = (745)^2 + 833^2 - 2(\ )(\ )\cos 40°$

$F = 546\,N$



9. A uniform 15 kg pipe of length 5.0 m has a 160 N force applied 4.0 m from its lower end as shown. Using the point where the pipe touches the ground as a pivot, calculate the sum of the torques acting on the pipe.



$F_{g\perp} = 147\cos 34°$
$= 121.9$ N

$F_{T\perp} = 160\text{N}\cos 48°$
$= 107$ N

CWT: $(122)(2.5\text{m})$ 305 N·m

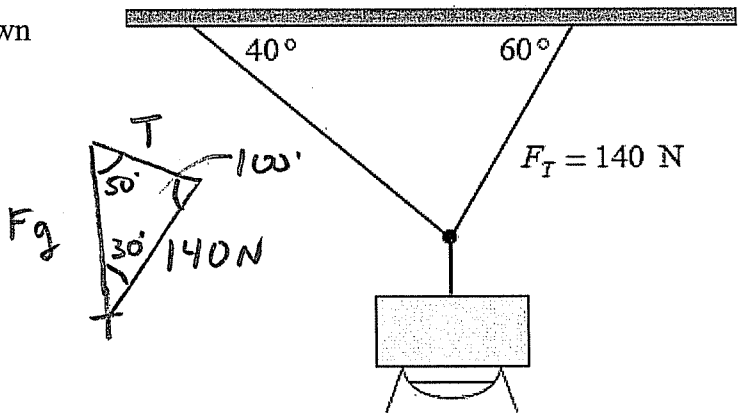
CCWT: $107(4\text{m})$ 428 N·m

$428 - 305$

123 N·m CCW

10. A floodlight is suspended from two cables as shown below. The tension in the right cable 140 N.

a) What is the tension in the left cable?



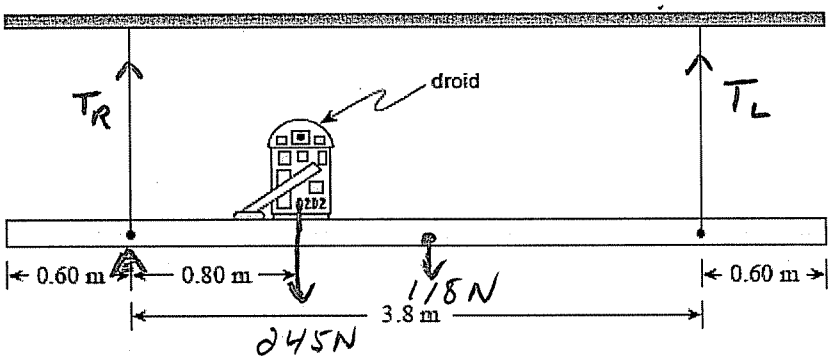
$\frac{T}{\sin 30°} = \frac{140\text{N}}{\sin 50°}$, $T = 91.4$ N

b) What is the mass of the floodlight?

$\frac{F_g}{\sin 100°} = \frac{140}{\sin 50°}$, $F_g = 180$ N

$m = 18.4$ kg

11. A 25 kg droid rests on a 5.0 m long shelf supported by two cables as shown. The mass of the shelf is 12 kg. Find the tension in **each** cable.



$\Sigma\tau = 0$ CWT = CCWT

$(245\text{N})(.8\text{m}) + 118(1.9\text{m}) = T_L(3.8\text{m})$

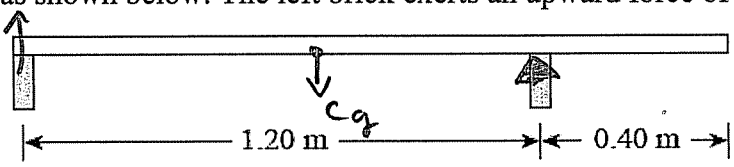
$T_L = 110$ N

$\Sigma F_y = 0$ $F_{up} = F_{down}$

$T_R + 110\text{N} = 245\text{N} + 118\text{N}$

$T_R = 253$ N

12. A uniform 1.60 m board rests on two bricks as shown below. The left brick exerts an upward force of 12 N on the board. What upward force does the right brick exert?



$\Sigma\tau = 0$ CWT = CCWT

$(12\text{N})(1.2\text{m}) = C_g(.4\text{m})$

$C_g = 36$ N

$\Sigma F_y = 0$ $F_{up} = F_{down}$

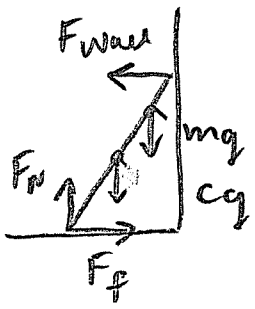
$F_L + F_R = C_g$

$12 + F_R = 36$ N

$F_R = 24$ N

ladder Problem

a)



$C_{g\perp} = (42)(9.8)\cos 68°$

$= 154.2\ N$

$Mg_\perp = (52)(9.8)\cos 68°$

$= 190.9\ N$

$\Sigma \tau = 0 \quad CWT = CCWT$

$(154.2)(1.9) + (190.9)(3) = F_{W\perp}(3.8)$

$F_{W\perp} = 227.8\ N$

$F_W = \frac{227.8\ N}{\cos 22°} = 246\ N$

$\Sigma F_x = 0 \quad F_{wall} = F_f$

$F_f = 246\ N$

$\Sigma F_y = 0 \quad F_{up} = F_{down}$

$F_N = Cg + Mg$

$= 921\ N$

$F_f = \mu F_N, \quad \mu = \frac{F_f}{F_N} = \frac{246}{921} = .27$

Answers:1. ↙ , **2.** 2.3 ×10² N, **3a.** 450 N, **3b.** 370 N, **4.** 67°, **5.** 0.49 m, **6.** 9.2 kg, **7.** 65 kg, **8.** 546 N, **9.** 120 N·m in a counter-clockwise direction. **10a.** 91.4 n, **10b.** 18.4 kg, **11.** 253 N, 110 N, **12.** 24 N