NAME: _____

Rotational Equilibrium

1. A uniform beam of mass 25 kg rests on supports P and Q, as shown in the diagram below. What force is exerted by support P & support Q on the beam?

Pivot at P

$\Sigma \tau = 0$, CWτ = CCWτ

F_Q ↑ ; C_g ↓

$C_g(d_1) = F_Q(d_2)$

$(25)(9.8)(4\text{m}) = F_Q(6\text{m})$

$F_Q = 163\text{ N}$

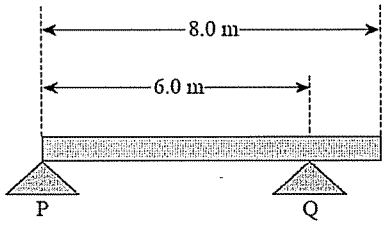
$\Sigma F_y = 0$

$F_{up} = F_{down}$

$F_p + F_Q = C_g$

$F_p + 163 = 245\text{N}$

$F_p = 82\text{ N}$



2. A 3.0 m uniform beam of mass 15 kg is pivoted 1.0 m from the end as shown below. A 35 kg child sits 0.60 m from the pivot. How far, ***d***, from the pivot, must a 20 kg child sit in order for the beam to be in equilibrium? What force does the pivot exert on the beam?

$\Sigma \tau = 0$, CWτ = CCWτ

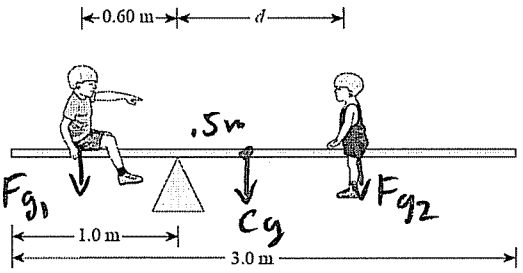
$C_g(d_1) + F_{g_2}(d_2) = F_{g_1}(d_3)$

$15(9.8)(.5\text{m}) + 20(9.8)d = 35(9.8)(.6\text{m})$

$73.5 + 196d = 205.8$

$196d = 132.3$

$d = \frac{132.3}{196.} = 0.675\text{m}$



3. A platform for window-cleaning is supported as shown. If a man of mass 75 kg stands at point X, what is the tension in support A & B (if you assume that the mass of the platform is negligible in comparison to the mass of the man)?

Pivot at T_1 $\Sigma \tau = 0$, CWτ = CCWτ

$C_g(d_1) = T_2(d_2)$

$75(9.8)(.85) = T_2(2.1\text{m})$

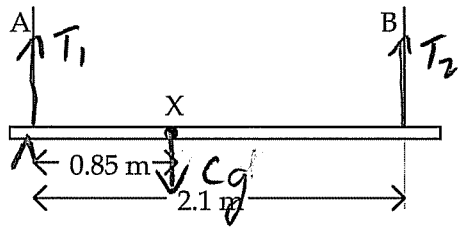
$T_2 = 298\text{N}$

$F_{up} = F_{down}$

$T_1 + T_2 = C_g$

$T_1 + 298 = 735$

$T_1 = 437\text{N}$



4. A uniform 18 kg beam hinged at **P** is held horizontal by a vertical string that can withstand a maximum tension of 350 N. A 5.0 kg mass is suspended from the end of the beam as shown. At what minimum distance, ***x***, can the string be attached without breaking?

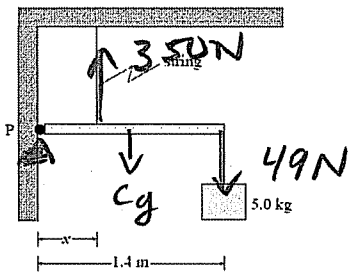
Pivot at P. $\Sigma \tau = 0$, CWτ = CCWτ

$C_g d_1 + F_g d_2 = T d_3$

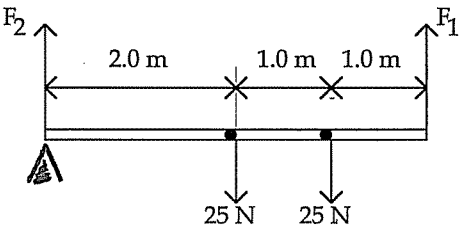
$18(9.8)(0.7\text{m}) + 5(9.8)(1.4) = 350\text{N}(x)$

$123.5 + 68.6 = 350x$

$x = .55\text{m}$



5. Forces are exerted on a bar as shown. What is the magnitude of F_1 & F_2?



Pivot at F_2 $\Sigma\tau = 0$ CWτ = CCWτ

$(25N)(2m) + (25N)(3m) = F_1(4m)$

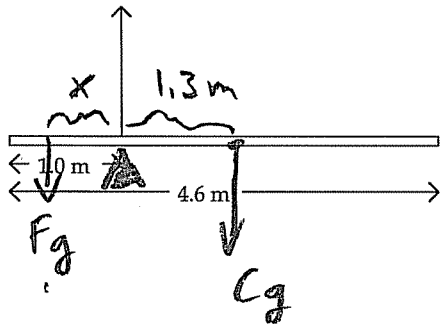
$F_1 = 31.25N$

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

$F_1 + F_2 = 25N + 25N$

$F_2 = 18.75N$

6. A uniform beam of mass 160 kg is being lifted as shown. How far from the left end should a weight of mass 500 kg be hung to keep the beam level?



$\Sigma\tau = 0$ CWτ = CCWτ

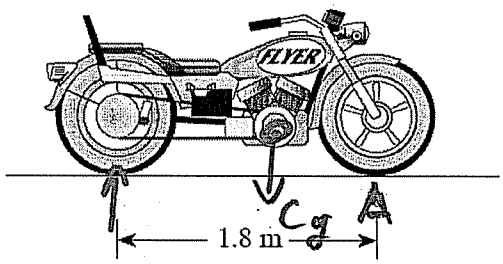
$C_g(d_1) = F_g(d_2)$

$(160)(9.8)(1.3) = 500(9.8)(x)$

$x = .42m$

which is 0.58m left end

7. The motorcycle shown has a mass of 200 kg and a wheel base of 1.8 m. If the rear wheel exerts a 1 200 N force on the ground, find how far the motorcycle's centre of gravity is located from the front wheel.



Pivot at front tire, C_g not in middle

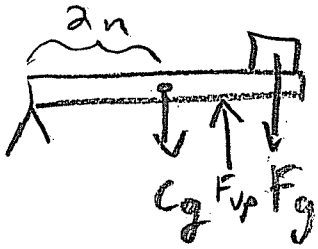
$\Sigma\tau = 0$ CWτ = CCWτ

$F(d_1) = C_g(d_2)$

$(1200N)(1.8m) = (200kg)(9.8)(x)$

$x = 1.1m$

8. A load of mass 12 kg is hung from the end of a horizontal bar whose mass is 8.0 kg and whose length is 4.0 m. At what distance from the load should a single upward force of 196 N be exerted to keep the bar in equilibrium?



$\Sigma\tau = 0$, CWτ = CCWτ

$C_g d_1 + F_g d_2 = F_{up} d_3$

$8(9.8)(2m) + (12kg)(9.8)(4) = 196N(x)$

$627 = 196x$

$x = 3.2m$ which is 0.8m from load.