Rotational Equilibrium Practice Name:_____

1. A bolt needs to be tightened with a torque of 23 Nm. If the wrench is 0.42 m long, what force must be applied?

$$\tau = Fd$$

$$\frac{\tau}{d} = F \rightarrow \frac{23\,Nm}{0.42m} = 55\,N$$

2. A 0.45 m long wrench has 63 N of force applied to the end. What torque is the wrench applying?

$$\tau = Fd$$
$$= 63\,N \times 0.45m$$
$$= 28.35\,Nm$$
$$\approx 28\,Nm$$

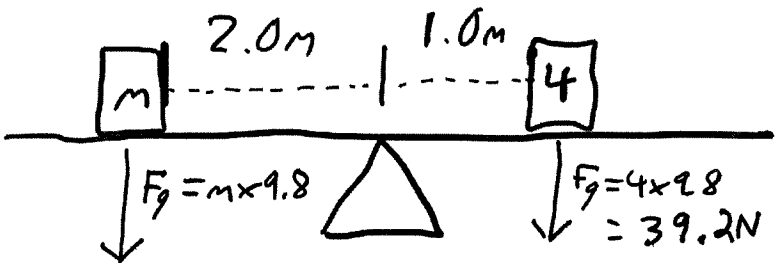
3. A motor can generate 5.3 Nm of torque, an 0.23 m fan blade is connected to the motor, what force can the end of the fan blade apply?

$$\tau = Fd \rightarrow \frac{\tau}{d} = F$$

$$\frac{5.3\,Nm}{0.23} = 23N$$

Rotational Equilibrium Practice Name:_____

4. A see-saw is balanced with a 4.0 kg mass 1.0m from the pivot and another object 2.0 m from the pivot on the other side. What is the mass of the second object?



$\tau_c = 39.2N \times 1.0m = 39.2Nm$

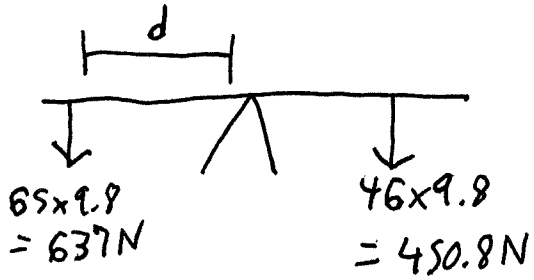
$\tau_{cc} = m \times 9.8 \frac{N}{kg} \times 2.0m = m \times 19.6 \frac{Nm}{kg}$

$39.2Nm = m \times 19.6 \frac{Nm}{kg}$

$\div 19.6 \qquad \div 19.6$

$m = 2.0kg$

5. A see-saw has a 46 kg mass located 63 cm from the pivot, how far from the pivot should a 65 kg mass be placed so that the see-saw balances.



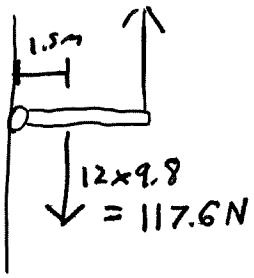
$\tau_{CW_c} = 450.8N \times 0.63m = 284Nm$

$\tau_{cc} = 637N \times d$

$\frac{284Nm}{637N} = 0.45m$

Rotational Equilibrium Practice Name:_____

6. A 3.0 m long beam has mass of 12 kg and is supported by a hinge connected to a wall and a string hanging from the ceiling.
   a. What is the tension in the string?



T_C T_{CC}

$117.6N \times 1.5m$ $T \times 3.0m$

$= 176.4Nm$

$176.4Nm = T \times 3.0m$

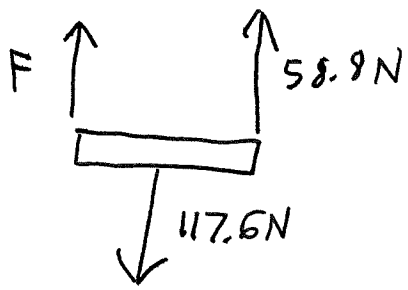
$\div 3.0m \quad \div 3.0m$

$58.8N = T$

$T \simeq 59N$

   b. What support force is provided by the hinge?

Up and down Forces must balance



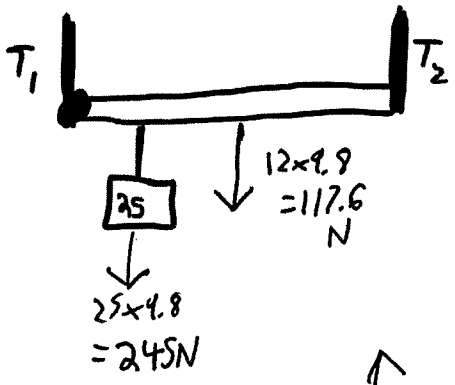
$F = 117.6N - 58.8N$

$= 58.8N$

$\simeq 59N$

Rotational Equilibrium Practice Name:_____

7. A 2.0 m long beam of mass 12 kg has a 25.0 kg mass suspended from it 0.3 m from the left side. What is the tension in each of the support ropes?



Set pivot on left rope

$T_c = T_{cc}$

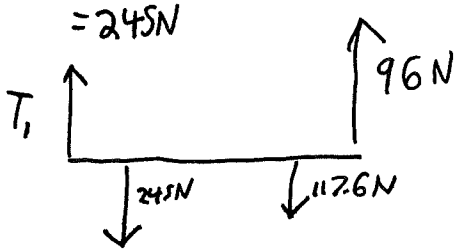
$245N \times 0.3m + 117.6N \times 1.0m = T_2 \times 2.0m$

$191.1Nm = T_2 \times 2.0m$

$\div 2.0m \quad \div 2.0m$

$95.55N = T_2$

$96N = T_2$

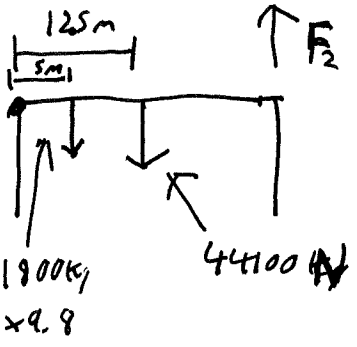


$245 + 117.6 = 96 + T_1$

$266.67 = T_1$

$270N = T_1$

8. A 25 m long bridge deck weighs 4500 kg, and has supports at either end. An 1800 kg elephant is standing 5.0 m from one side. What supporting force is provided by each support?



$T_c = T_{cc}$

$17640N \times 5.0m + 44100N \times 12.5m = F_2 \times 25m$

$639450Nm = F_2 \times 25m$

$\div 25 \quad \div 25$

$25578N = F_2$

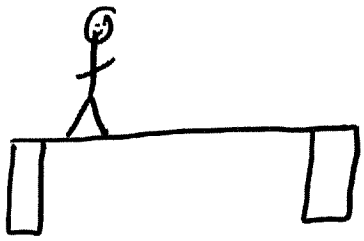
Up forces = Down forces

$F_1 + 25578N = 17640N + 44100N$

$F_1 = 36162N$

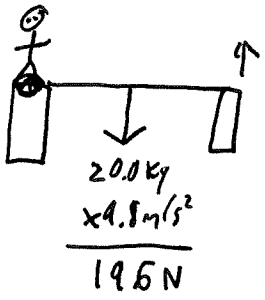
Rotational Equilibrium Practice Name:_____

9. A 5.0-meter-long plank of wood weighing 20.0 kg is being used as a bridge, there is a support on either side. A 65 kg woman walks across the bridge. What is the greatest force the supports must provide during her walk across the bridge?



It will either be when she is on the support or when she is in the midde

(1) She is on a support



$T_c = T_{cc}$

$196 \times 2.5 = F_2 \times 5$

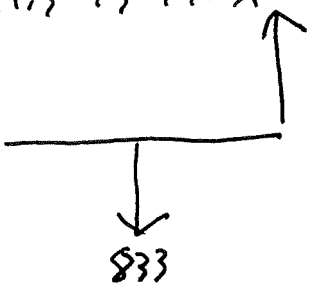
$98N = F_2$

U_p = Down

$F_1 + 98N = 65 \times 9.8 + 196N$

$F_1 = 735N$ ← This is max

(2) She is in middle



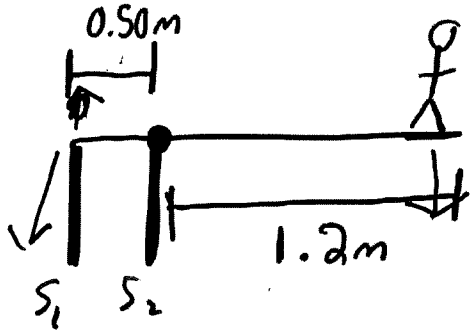
$T_c = T_{cc}$

$833 \times 2.5 = F \times 5$

$F = 416.5N$

Rotational Equilibrium Practice Name:_____

10. A diving board ~~which has mass of 7.5 kg is~~ of neg mass supported by two supports as shown. A 56 kg diver stands on the end. ~~What is the force acting ON each support?~~ What is the force each support is applying to the board and in what direction does it act?



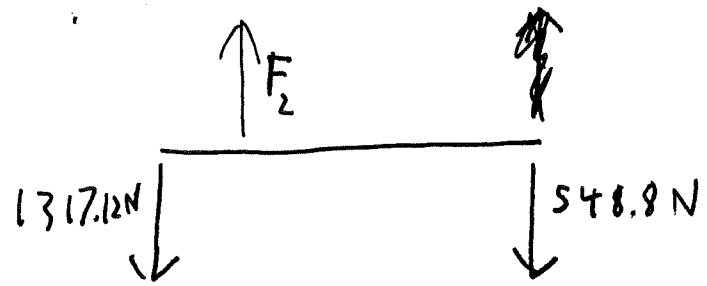
$T_c = T_{cc}$

$56 \times 1.8 \times 1.2 = F_1 \times 0.5$

$1317.12\ N = F_1$

Down

$\simeq 1300\ N$



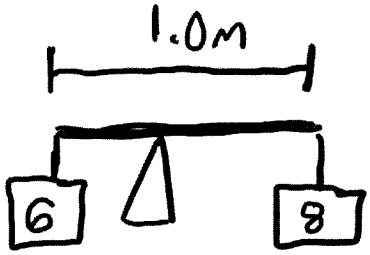
$F_2 = 1317.12\ N + 548.8N$

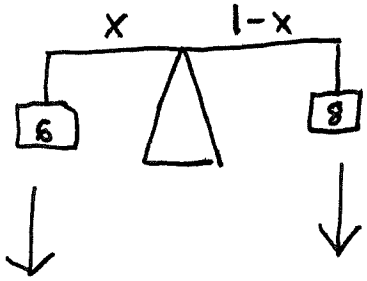
$= 1865.92N$

$\simeq 1900N$ up

Rotational Equilibrium Practice Name:_____

11. A 1.0 metre long board of negligible mass has a 6.0 kg mass at one end and an 8.0 kg mass at the other. Where should the pivot be placed so the board balances?





Let x be the distance from the pivot to the 6 kg mass. The distance to the 8 kg block is the remainder of 1m, 1−x.

$$\tau_{cc} = \tau_{c}$$

$$6.0\,kg(x) = 8.0\,kg(1-x)$$

$$6x = 8 - 8x$$

$$+8x \qquad +8x$$

$$14x = 8$$

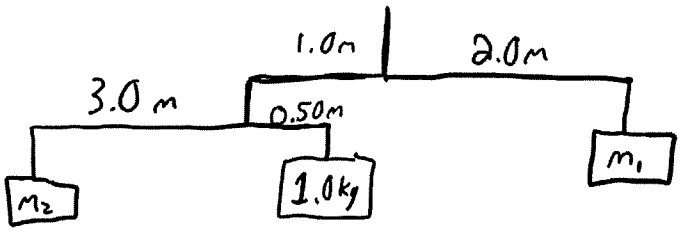
$$\div 14 \quad \div 14$$

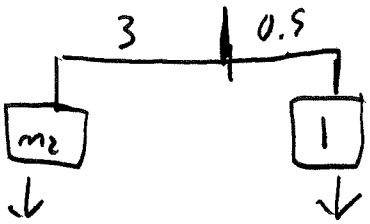
$$x = 0.57$$

Pivot should be placed 0.57m from the 6 kg mass.

Rotational Equilibrium Practice Name:_____

12. A mobile is hung as shown, the rods connecting the masses have negligible mass. If it is in equilibrium what at the values of m_1 and m_2?





$T_{cc} = T_c$

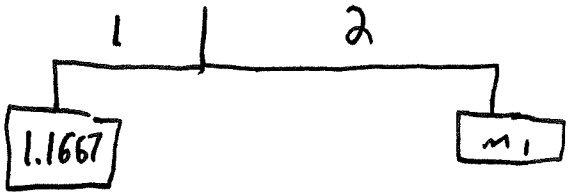
$m_2 \times 3m = 0.5 \times 1$

$= 0.5$

$m_2 = \frac{0.5}{3}$

$m_2 = 0.1667\ kg$

$\approx 0.17\ kg$



$T_{cc} = T_c$

$1.1667 \times 1 = m_1 \times 2$

$\div 2 \qquad \div 2$

$0.58 = m_1$