## EQUILIBRIUM

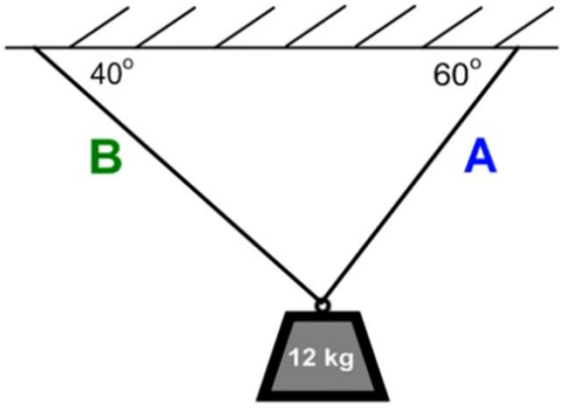
we defined equilibrium as the condition in which the resultant of all forces and moments acting on a body is zero.

$$\Sigma F_x = 0 \qquad \Sigma F_y = 0 \qquad \Sigma M_O = 0$$

## Strategy

1. Identify all forces with locations
2. Don’t forget pivot point forces
3. Construct force equation
4. Construct moment equation
5. Algebra
6. Math
7. Check your answer

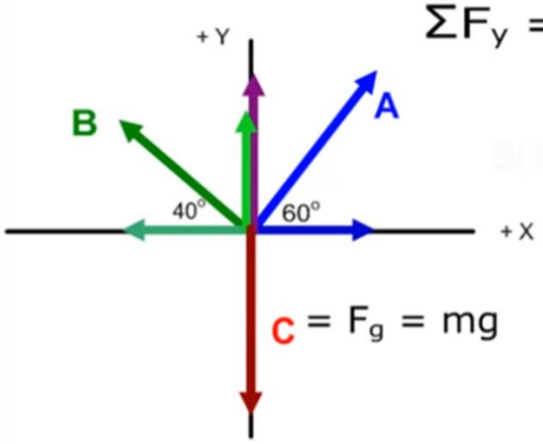
**Problem 1 /A 12 Kg mass is hung from two cables as shown . What are the tensions in cables A and B ?**




Write out $\Sigma F_x=0$ and $\Sigma F_y=0$ 'statements'.

$$\Sigma F_x = A\cos 60 - B\cos 40 + 0 = 0$$

$$\Sigma F_y = A\sin 60 + B\sin 40 - mg = 0$$



Write out $\Sigma F_x=0$ and $\Sigma F_y=0$ 'statements'.

$$\Sigma F_x = A\cos60 - B\cos40 + 0 = 0$$

$$A\cos60 = B\cos40 \qquad A = B\frac{\cos40}{\cos60}$$

$$A=1.532B$$

$$\Sigma F_y = A\sin60 + B\sin40 - mg = 0$$

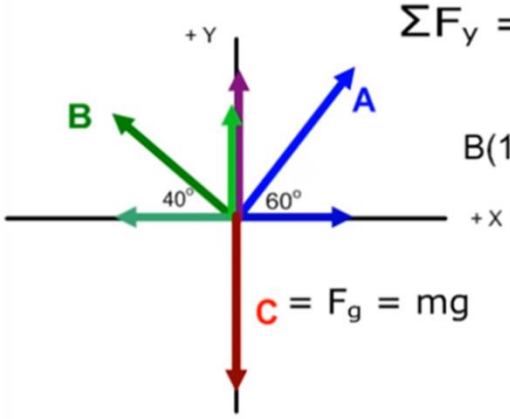
$$1.532B\sin60 + B\sin40 = mg$$

$$B(1.532\sin60 + \sin40) = (12kg)(9.8\ m/s^2)$$

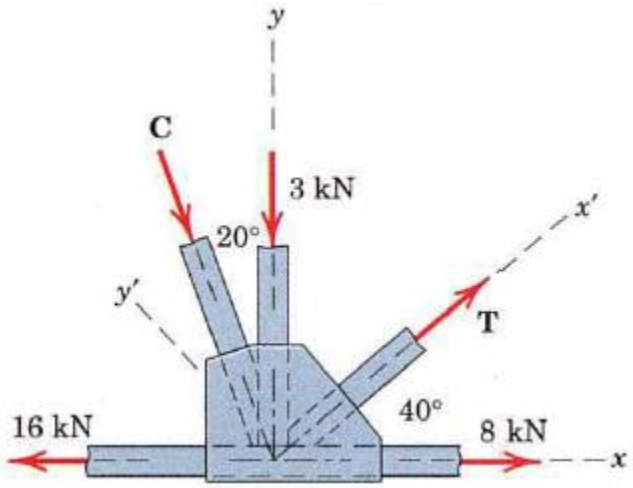
$$1.97B = 117.6N$$

$$B=59.7N$$

$$A=91.5N$$



**Problem 2/ Determine the magnitudes of the forces C and T, which, along with the other three forces shown, act on the bridge truss joint.**




Solution

$[\Sigma F_x = 0]$ $8 + T\cos 40 + C\sin 20 - 16 = 0$

$0.766T + 0.342C = 8$ ----------(1)

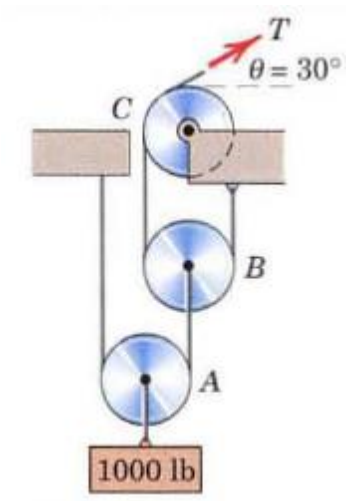
$[\Sigma F_y = 0]$ $T\sin 40 - C\cos 20 - 3 = 0$

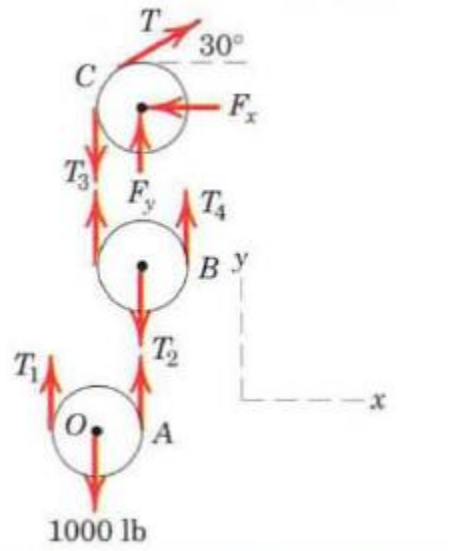
$0.643T - 0.940C = 3$ ---------- (2)

Simultaneous solution of Equations (1) and (2) produces

$T = 9.09$ kN $C = 3.03$ kN

**Problem 3/ Calculate the tension *T* in the cable which supports the 1000 lb load with the pulley arrangement shown. Each pulley is free to rotate about its bearing, and the weights of all parts are small compared with the load.**




Solution

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**Subject: Mechanical Engineering**
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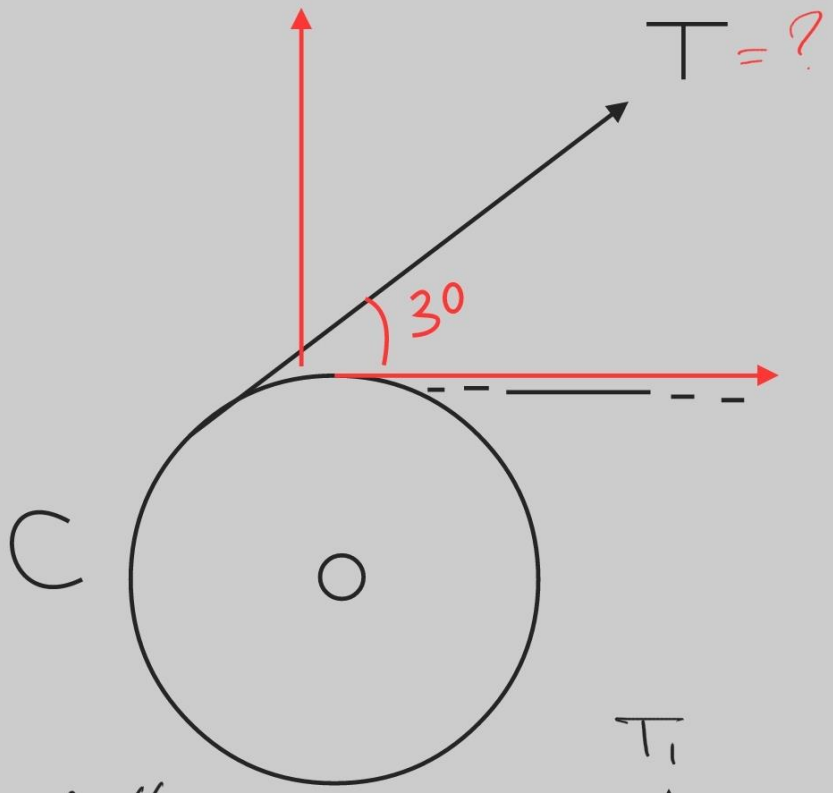
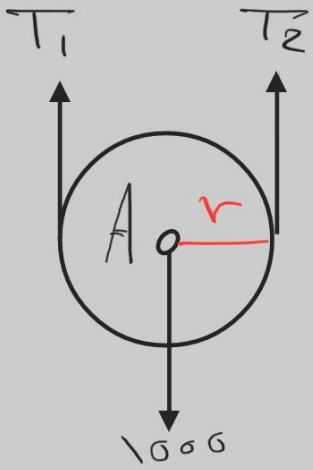



At Point A //

$\Sigma F_y = 0$

$T_1 + T_2 - 1000 = 0$

$$T_1 + T_2 = 1000 \quad \text{---} (1)$$

$\Sigma M = 0$ (at point A)

$T_1 r - T_2 r = 0 \Rightarrow T_1 r = T_2 r$

$$\therefore T_1 = T_2 \quad \text{---} (2)$$

Sub. (2) in 1

$2T_1 = 1000$

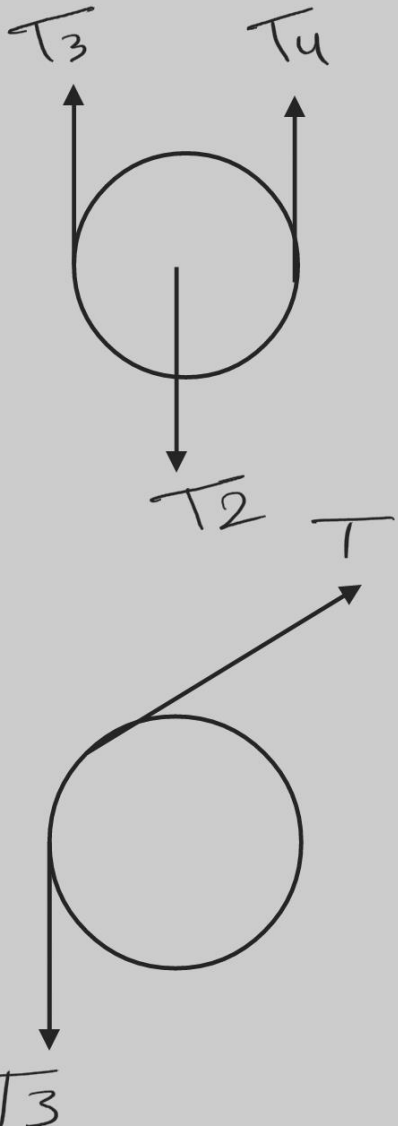
$\therefore T_1 = T_2 = 500$ lb

At point B//

$T_3 = T_4 = \frac{1}{2} T_2$

$= \frac{1}{2} \times 500$

$T_3 = T_4 = 250\ lb$

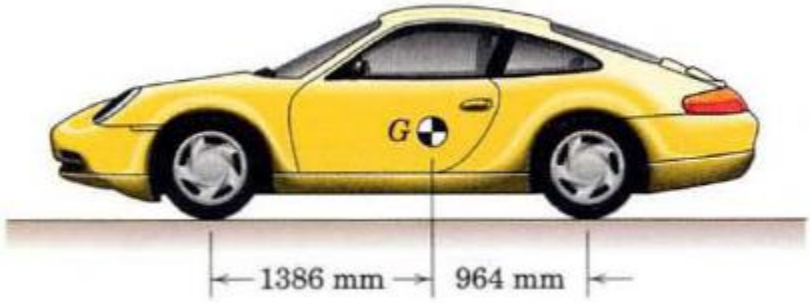



At point C//

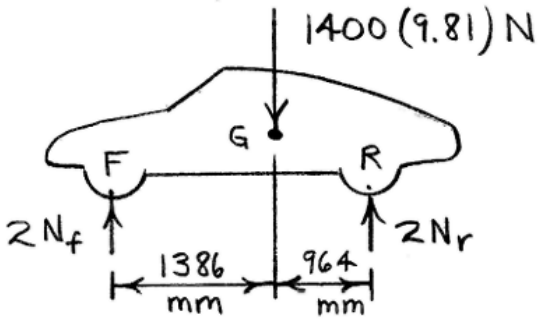
$T_3 = T = 250\ lb$

**Problem 5**

The mass center G of the 1400-kg rear-engine car is located as shown in the figure. Determine the normal force under each tire when the car is in equilibrium. State any assumptions.




Solution




$$+\uparrow \Sigma F = 0 : \quad 2N_f + 2N_r - 1400(9.81) = 0$$

$$\circlearrowleft \Sigma M_F = 0 : \quad -1400(9.81)(1386) + 2N_r(1386 + 964) = 0$$

$$\text{Solution} : \begin{cases} N_f = 2820 \text{ N} \\ N_r = 4050 \text{ N} \end{cases}$$