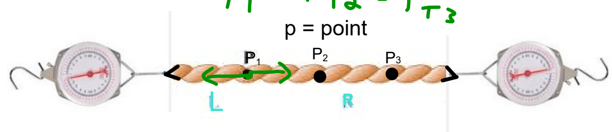
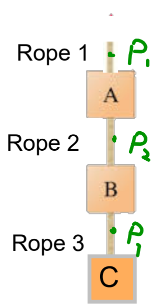
Tension

Tension is the force exerted through a rope, cable, or string. $F_T = |\vec{F}_T|$

Assumption #1: The force being transmitted through the rope/string is same at all points in the rope/string (no stretching). (acts in all/both direction)

$F_{T1} = F_{T2} = F_{T3}$



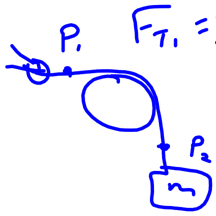


$F_{T1} > F_{T2} > F_{T3}$

a change in Tension at P_3 instant change at P_1 & P_2

Assumption #2 : The rope/string has such a small mass compared to the load that it can be considered negligible. Pulley changes direction of tension

$F_{T1} = F_{T2}$

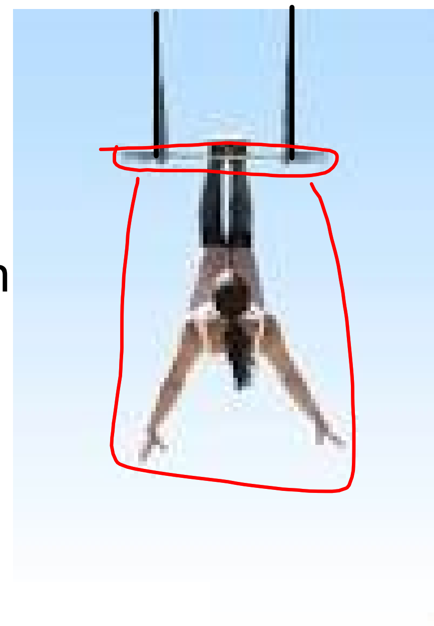


Assumption #3: a) A pulley experiences no friction with the axle as it turns. b) The mass of the pulley is not needed. Rotational inertia of the pulley is neglible. So, we will assume the pulley to be **massless**.

ex. None of the force exerted at the start of motion contributes to making the pulley turn - all contributes to supporting and moving the load.

At end of motion, it doesn't require more force (or effort) to stop the motion because the pulley won't want to keep rotating.

Tension Examples



Ex 1: Trapeze artist has a mass of 48.6 kg. The bar has a mass of 1.5 kg. What is the tension in each of the ropes supporting her bar?

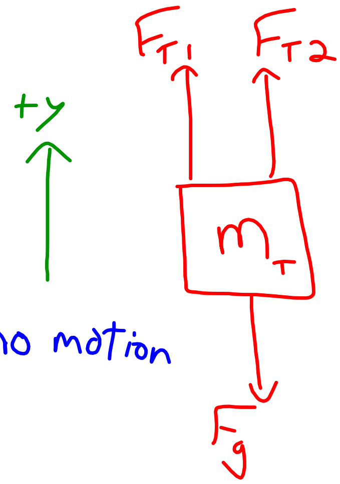
Ex 2: Mike tries walking a right rope. He has a mass of 74.8 kg. He balanced on his right foot such that he at static equilibrium and the rope is making angles of 5.0 ° with the horizontal.

a) What is the magnitude of tension transmitted in the rope?

b) What is the tension in the rope to the east of Mike and the tension in the rope west of Mike?

Do Practice Problems 14, 16, 17 on Page 478

Ex 1



no motion

$m_A = 48.6\ kg$

$m_B = 1.5\ kg$

$m_T = m_A + m_B = 50.1\ kg$

$\vec{a}_y = 0\ m/s^2$

$\vec{g} = 9.81\ m/s^2$ (down)

$F_{T1} = ?$ $\quad F_{T2} = ?$

Assume $F_{T1} = F_{T2}$ b/c symmetry

$$F_{Net,y} = F_{T1} + F_{T2} - F_g = ma_y = 0\ N$$

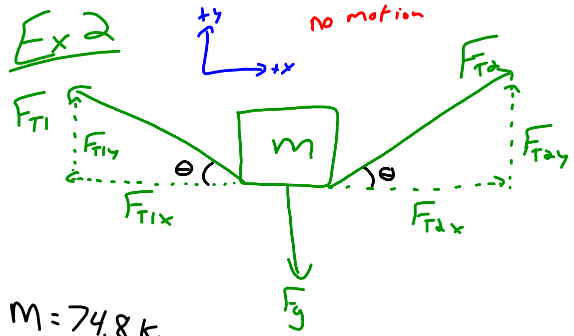
$$F_{T1} + \overset{F_{T1}}{F_{T2}} = F_g$$

$$2F_{T1} = mg$$

$$F_{T1} = \frac{mg}{2} = \frac{(50.1\ kg)(9.81\ m/s^2)}{2}$$

$$= \boxed{246\ N}$$ in each

Ex 2



$m = 74.8\ kg$ $\quad \theta = 50°$

$\vec{a}_x = 0\ m/s^2$ $\quad \vec{g} = 9.81\ m/s^2$ (down)

$\vec{a}_y = 0\ m/s^2$

$$F_{Net,x} = F_{T2x} - F_{T1x} = ma_x = 0\ N$$

$$F_{T2x} = F_{T1x}$$

$$F_{T2}\cancel{\cos(\theta)} = F_{T1}\cancel{\cos(\theta)}$$

$$F_{T2} = F_{T1}$$

$$F_{Net,y} = F_{T1y} + F_{T2y} - F_g = ma_y = 0\ N$$

$$F_{T1y} + F_{T2y} = F_g$$

$$F_{T1}\sin(\theta) + F_{T2}\sin(\theta) = F_g$$

$$2F_{T1}\sin(\theta) = mg$$

$$F_{T1} = \frac{mg}{2\sin(\theta)}$$

$$F_{T1} = \frac{(74.8\ kg)(9.81\ m/s^2)}{2\sin(50°)} = \boxed{4210\ N}$$

b) $\vec{F}_{T1} = 4210\,N$ [W 50° up]

$\vec{F}_{T2} = 4210\,N$ [E 50° up]