Phy 4A 10/19

Tuesday, October 18, 2016 8:18 PM

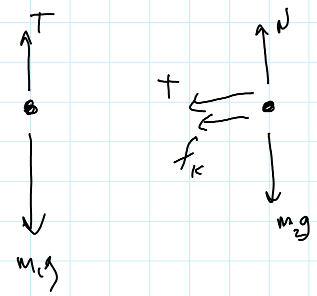
Goals for the Lecture:

1) Get ready for exam #2

Worksheet p. 126

Top $|\vec{F}_{Rope \to box}| = |\vec{F}_{Box \to Rope}|$

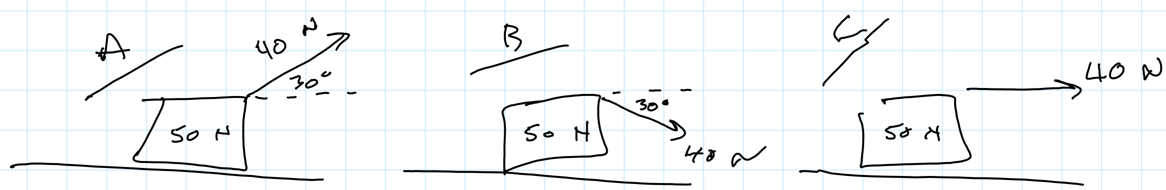
Bottom



p. 135

Top $f_s = 35$ N

bottom



if $\mu_s = 0.5$

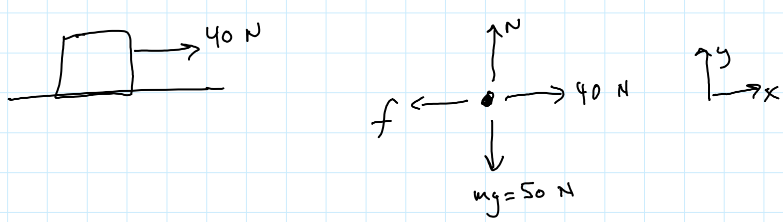
$\mu_K = 0.2$

i) Does the block begin moving (if it starts at rest)?

ii) Find the friction force on the blocks (after 1 sec.)

iii) Find the acceleration of the blocks

C)



$\Sigma F_y = 0$

$N - 50 = 0$

$N = 50$ N

$(f_s)_{max} = \mu_s N$

$= (0.5)\ 50$

$= 25$ N

$(f_s)_{max} <$ Pulling force

$25 < 40$

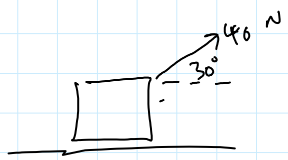
so, it <u>moves</u> to the right

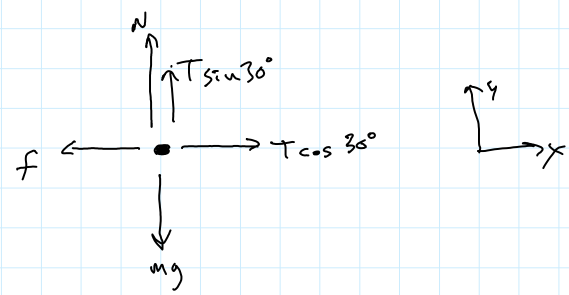
so, kinetic friction

$$f_k = \mu_k N$$
$$= (0.2)(50)$$
$$= 10\ N$$

$$\Sigma F_x = ma \quad \rightarrow +$$
$$40 - 10 = \left(\frac{50}{9.8}\right) a$$
$$a \simeq 6\ \frac{m}{s^2}$$

A)





$$\Sigma F_y = 0 \quad \uparrow +$$
$$N + T\sin 30 - mg = 0$$
$$N = mg - T\sin 30$$
$$= 50 - 20$$
$$= 30\ N$$

$(f_s)_{max}$? $T\cos 30°$

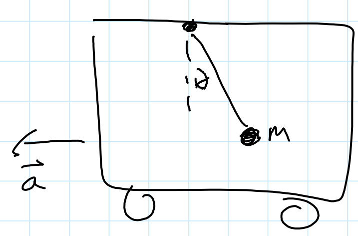
$15 < 34.6$

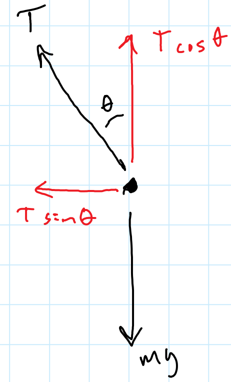
it moves!

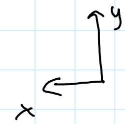
$$f_k = \mu_k N = (0.2)(30) = 6\ N$$

a: $\Sigma F_x = ma \quad \rightarrow +$

$$T\cos 30 - f_k = ma$$
$$34.6 - 6 = 5a$$
$$a = 5.7\ \frac{m}{s^2}$$







$\Sigma F_x = ma$ (← +)

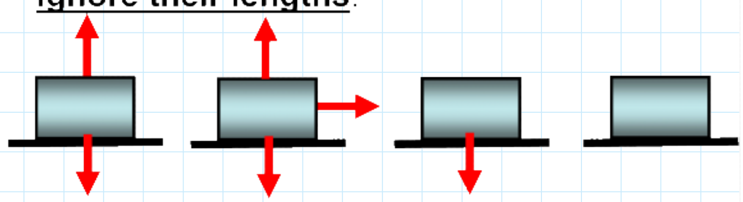
$\Sigma F_y = 0$ (↑ +)

$T \sin\theta = ma$

$T \cos\theta = mg$

$\tan\theta = \dfrac{a}{g}$

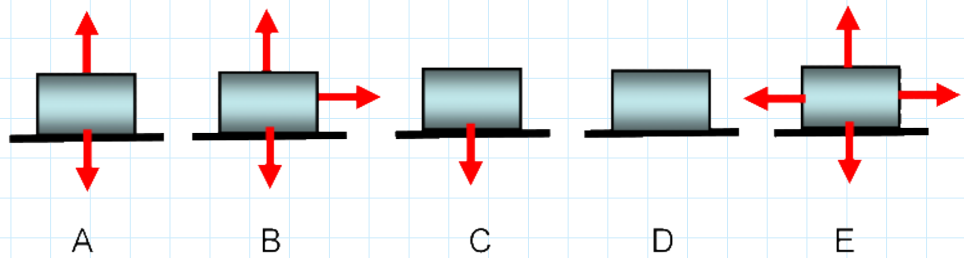
A block sits ***at rest*** on a frictionless surface. Which of the following sketches most closely resembles the correct freebody diagram for all forces acting on the block? Each red arrow represents a force. Observe their number and direction, but **ignore their lengths**.



A B C D

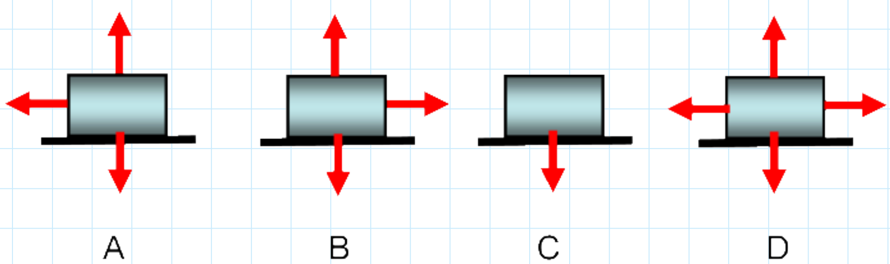
1. A
2. B
3. C
4. D

Now, the same block moves with a **constant velocity *to the right on the frictionless surface***. Which of the following most closely resembles the correct freebody diagram for all forces acting on the block?



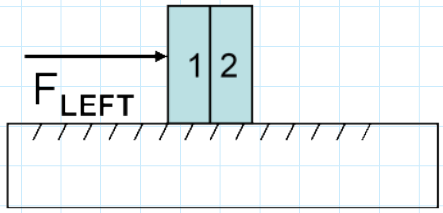
1. A
2. B
3. C
4. D

Now, the block moves with a **constant** velocity ***to the right*** on a surface ***that has friction***. Which of the following most closely resembles the correct freebody diagram for all forces acting on the block?



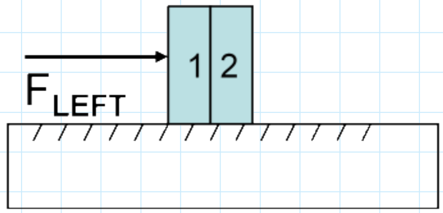
1. A
2. B
3. C
4. D
5. None of the above

Tom pushes two identical blocks on a horizontal frictionless table ***from the left***. The force that block 1 exerts on block 2 is F_{12}. The force that block 2 exerts on block 1 is F_{21}. Compare ***the magnitude*** of F_{12} and F_{21}.



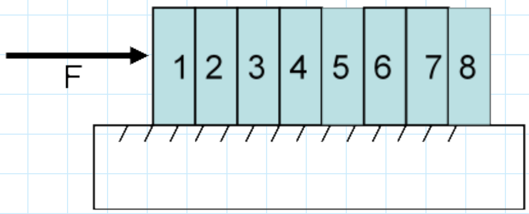
1. $F_{12} < F_{21}$
2. $F_{12} = F_{21}$
3. $F_{12} > F_{21}$
4. Cannot be determined

Tom pushes two identical blocks on a horizontal frictionless table ***from the left***. The force that block 1 exerts on block 2 is F_{12}. The force that block 2 exerts on block 1 is F_{21}. Compare ***the magnitude*** of F_{12} and F_{LEFT}.



1. $F_{12} < F_{LEFT}$
2. $F_{12} = F_{LEFT}$
3. $F_{12} > F_{LEFT}$
4. Cannot be determined

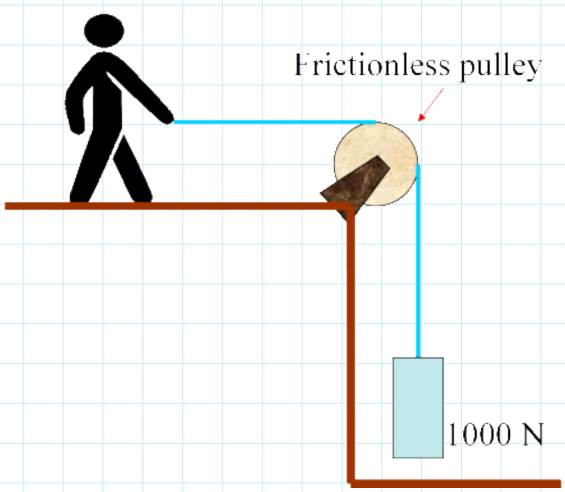
Tom now pushes eight identical blocks on the horizontal and frictionless table (he's compulsive). The force that block 1 exerts on block 2 is F_{12}; the force that block 7 exerts on block 8 is F_{78}. What is the ratio F_{12}/ F_{78}?

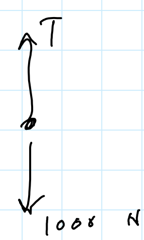


1. 8
2. 1/8
3. 1
4. 7
5. 1/7

Robert lifts the blue box, which weighs 1000 N, just a little way off the ground and holds it for 2 minutes, as shown. With what force does he have to pull on the rope to hold the box off the ground?

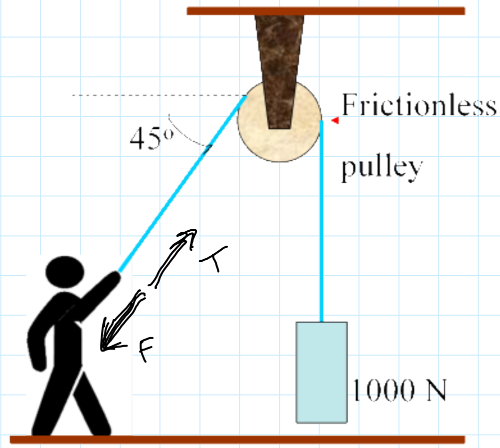
1. 0 N
2. 500 N
3. 1000 N
4. 2000 N
5. None of the Above





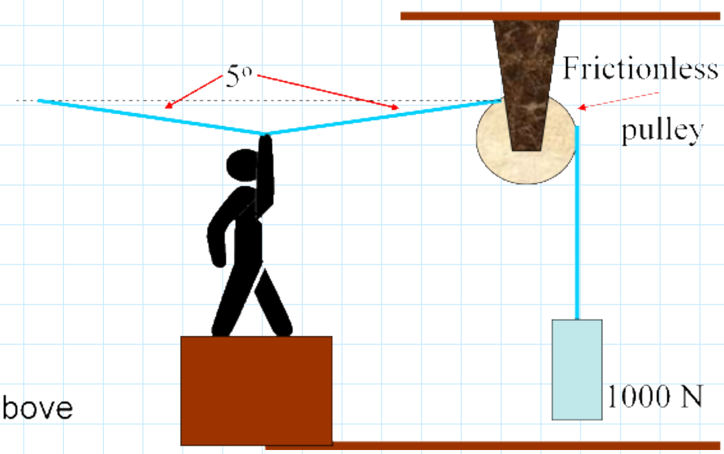
Now, Robert pulls on the rope at an angle. With what force does he have to pull on the rope to hold the box off the ground?

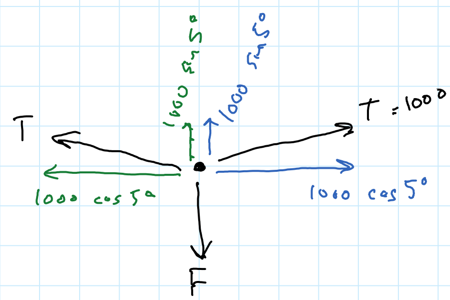
1. 0 N
2. 50 N
3. 500 N
4. 700 N
5. 1000 N
6. 1400 N
7. 2000 N
8. None of the Above



Robert again lifts the 1,000 N weight just a little off the ground using a new technique as shown below. With what force does he have to pull on the rope to hold the box off the ground?

1. 0 N
2. 87.15 N
3. 174.3 N
4. 996.2 N
5. 1000 N
6. 1992 N
7. 2000 N
8. None of the Above

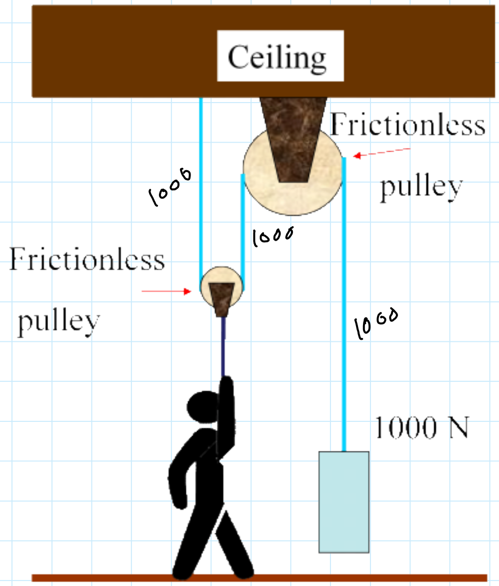




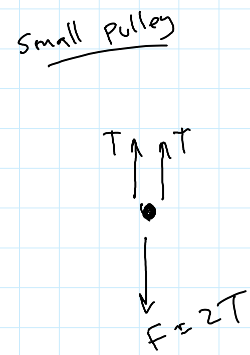
$F = 2(1000 \sin 5°)$

$= 174$

Robert now uses two pulleys to lift the 1000 N weight just a little off the ground as shown. With what force does he have to pull down on the rope attached to the smaller pulley to hold the box off the ground?



1. 0 N
2. 250 N
3. 500 N
4. 1000 N
5. 1500 N
6. 2000 N
7. None of the Above

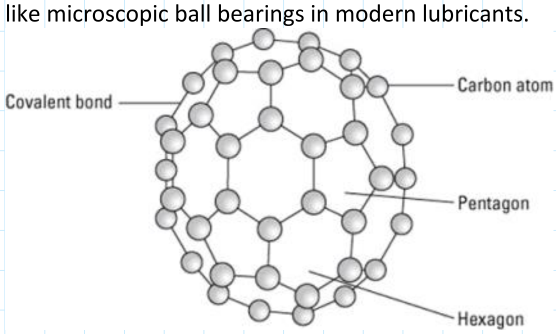


Application of the day - Friction

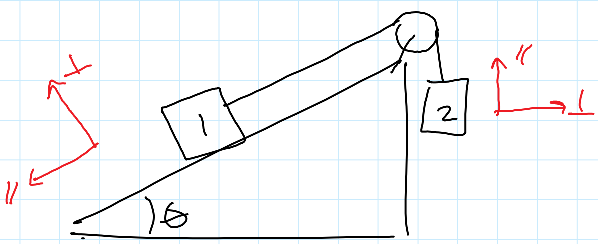
Sometimes we want to maximize friction – Running (speed up, slow down, make turns) so, running shoes have soles that maximize friction (as do race car tires). Racing tires have coefficients of friction >3 (most object have between 0 and 1)

Sometimes we want to minimize friction – use lubricants, as in engines to reduce wear (friction causes small particles to break off the surfaces that rub together)

Buckyballs – molecules consisting of 60 carbon atoms arranged in the shape of a soccer ball. They act like microscopic ball bearings in modern lubricants.



Sports – trying to go fast in a turn and maintain static friction, not going to kinetic friction



given: $m_1, m_2, \theta, \mu_k, \mu_s$

Find: Does it start moving from rest?

if so, find T and a

Let:

$\theta = 30°$

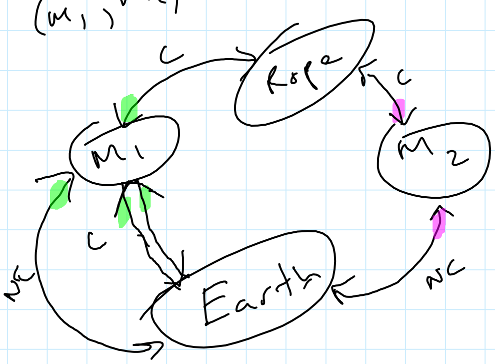
$m_1 = 20$ kg

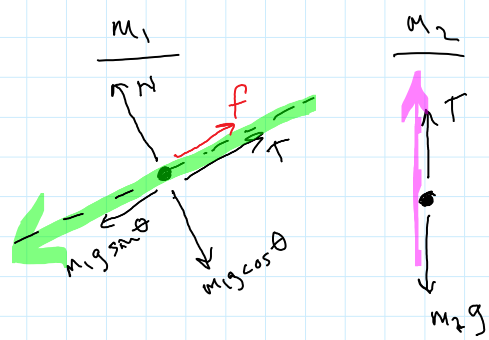
$m_2 = 2$ kg

$\mu_s = 0.4$

$\mu_k = 0.2$

Draw a system schema: (m_1, m_2, earth, rope)





Which way is friction?

$$T_{initial} = m_2 g = 2(10) = 20 \text{ N}$$

$$m_1 g \sin\theta = 20(10)\left(\tfrac{1}{2}\right) = 100 \text{ N}$$

m_1 wants to slide down incline

So, friction is up

Does it slide?

$$(f_s)_{max} = \mu_s N$$

Find N: $\Sigma F_\perp = 0$

$$N = m_1 g \cos\theta$$
$$= 20(10)\cos 30$$
$$= 173 \text{ N}$$

$$(f_s)_{max} = 0.4(173) = 69 \text{ N}$$

Forces down incline	?	Forces up incline
$m_1 g \sin\theta$	?	$(f_s)_{max} + T_{initial}$
100	?	69 + 20
100	>	89

So, it slides down!

So, kinetic friction

Find a and T:

m_1

$$\Sigma \vec{F} = m\vec{a}$$

$\Sigma F_{\parallel} = m_1 a_{\parallel}$ (+) $\Sigma F_\perp = 0$

$N = 173$ N

$$m_1 g \sin\theta - f_k - T = m_1 a$$

$$m_1 g \sin\theta - \mu_k N - T = m_1 a$$

m_2

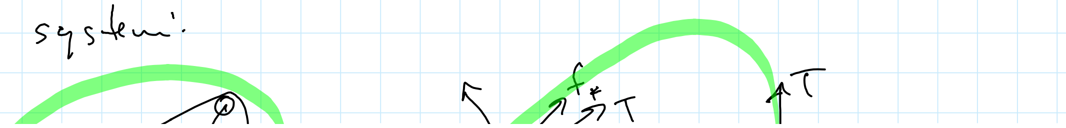
$$\Sigma \vec{F} = m\vec{a} \quad \uparrow +$$

$$T - m_2 g = m_2 a$$

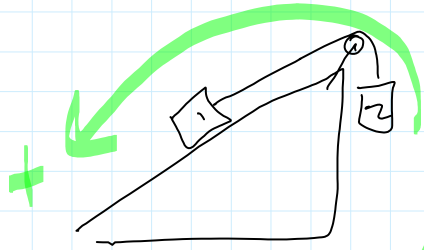
Solve for T and acceleration

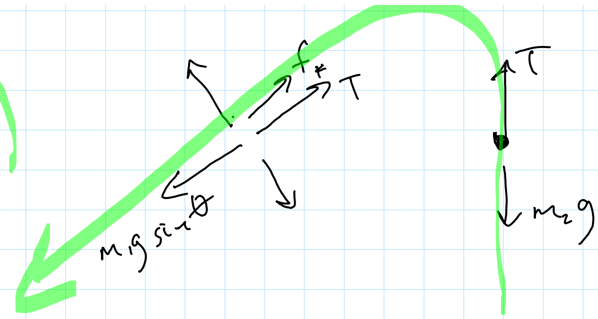
Note: $T \neq m_2 g$ anymore because $a \neq 0$; must solve for T

View it as one system:



View it as one system.



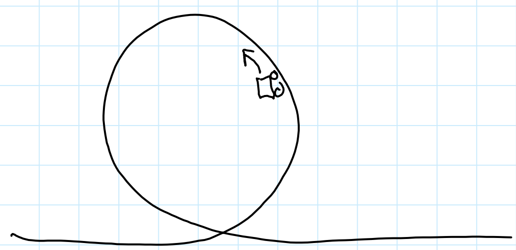


$$\sum F_{system} = M_{system}\, a \quad \curvearrowleft +$$

$$m_1 g \sin\theta - f_k - \cancel{T} + \cancel{T} - m_2 g = (m_1 + m_2)\, a$$

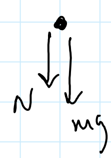
solve for a

Loop-the-loop



Find V_{min} at top of loop to make it around

at top



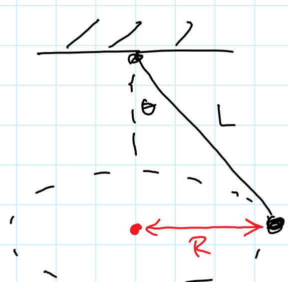
$$\sum F_{radial} = M a_c \quad \downarrow +$$

$$N + mg = m\frac{v^2}{R}$$

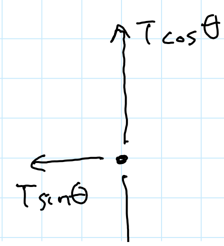
$N \to 0$ at V_{min}

$$\cancel{m} g = \frac{\cancel{m} V_{min}^2}{R}$$

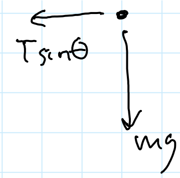
$$\sqrt{gR} = V_{min}$$



moving in a horizontal circle



$R = L \sin\theta$



given: L, θ

find: v

$\sum F_{radial} = m a_c \quad \leftarrow +$

$T \sin\theta = \frac{m v^2}{R}$

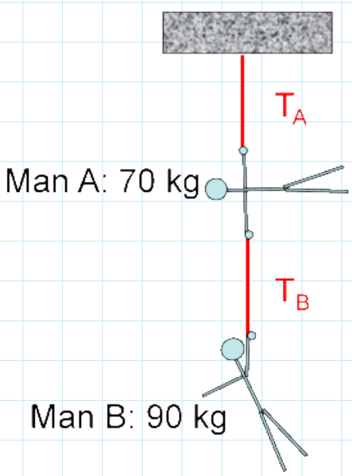
$\sum F_y = 0$

$T \cos\theta = mg$

$\tan\theta = \frac{v^2}{gR}$

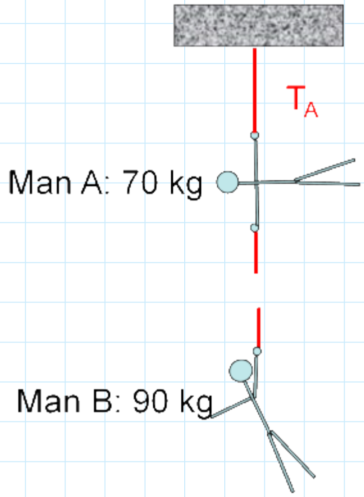
$\tan\theta = \frac{v^2}{g L \sin\theta}$

Man A (70kg) and Man B (90kg) are hanging motionless from a roof. What is the tension, T_A, in the top rope? (Assume the ropes are massless and use $g = 10\ m/s^2$.)



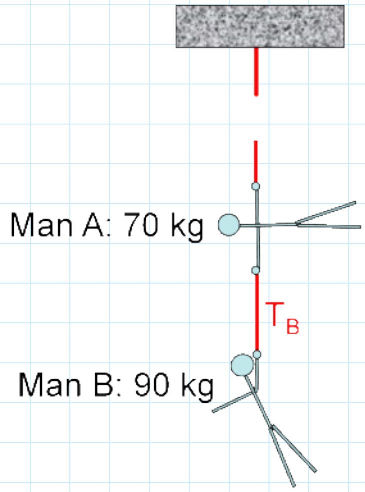
1. 0 N
2. 200 N
3. 700 N
4. 900 N
5. 1600 N
6. None of the Above

If you cut the rope between Man A and Man B so that Man A stays motionless, what is the tension, T_A, in the top rope? (Assume the ropes are massless and use $g = 10\ m/s^2$. Ignore any oscillations resulting from cutting the rope.)



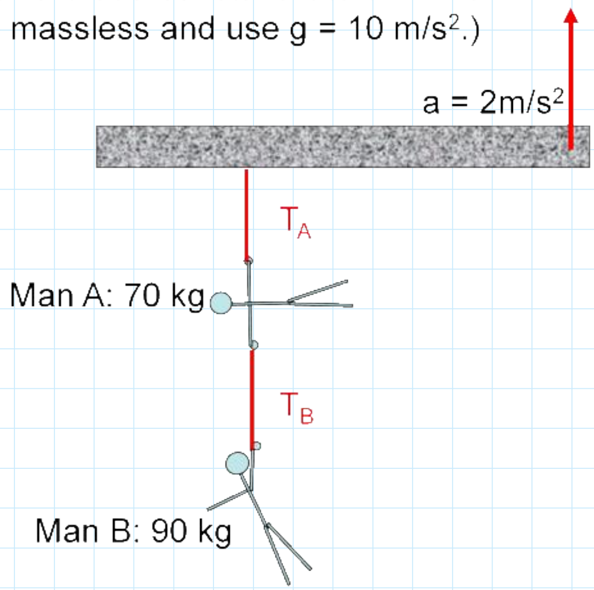
1. 0 N
2. 200 N
3. 700 N
4. 900 N
5. 1600 N
6. None of the Above

If you cut the rope between Man A and the roof, what is the tension, T_B, in the *bottom* rope? (Assume the ropes are massless and use $g = 10\ m/s^2$. Ignore any oscillations resulting from cutting the rope)



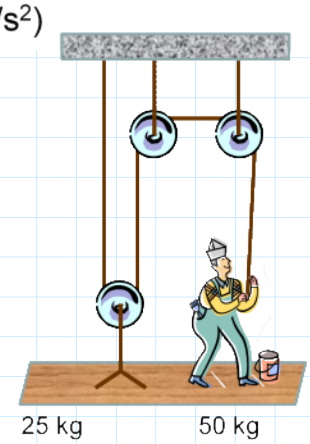
1. 0 N
2. 200 N
3. 700 N
4. 900 N
5. 1600 N
6. None of the Above

Man A (70kg) and Man B (90kg) are hanging motionless from a platform at rest. What is the tension, T_A, in the top rope if the platform accelerates upward at a constant rate of 2 m/s^2? (Assume the ropes are massless and use g = 10 m/s^2.)



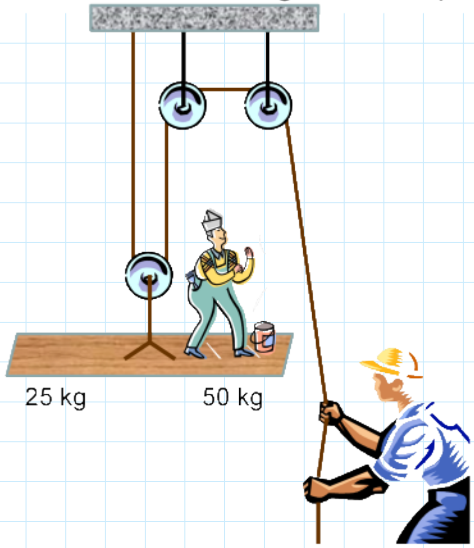
1. 0 N
2. 200 N
3. 700 N
4. 840 N
5. 900 N
6. 1600 N
7. 1740 N
8. 1920 N
9. None of the Above

A 50 kg person stands on a 25 kg platform. He pulls on the rope that is attached to the platform via the frictionless pulley system shown below. With what force does he have to pull on the rope to move the platform up at a steady rate? (Ignore friction and assume g = 10m/s^2)



1. 750 N
2. 625 N
3. 500 N
4. 250 N
5. 75 N
6. 50 N
7. 25 N
8. Impossible to determine

A 50 kg person stands on a 25 kg platform. Another man on the ground pulls on the rope that is attached to the platform via the frictionless pulley system shown below. With what force does he have to pull on the rope to move the platform up at a steady rate? (Ignore friction and assume $g = 10 m/s^2$)



1. 750 N
2. 625 N
3. 500 N
4. 375 N
5. 250 N
6. 75 N
7. 50 N
8. 25 N