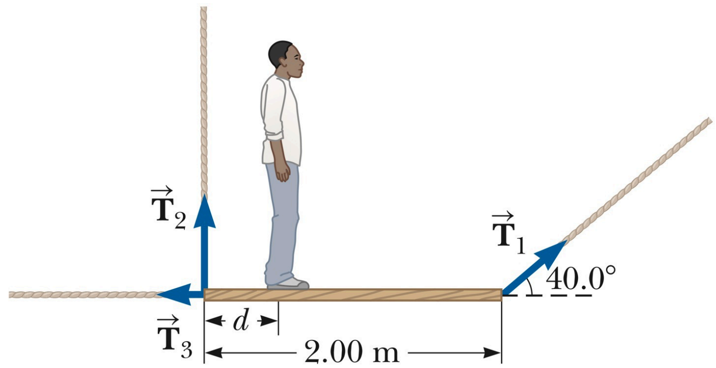
PHY 110 Spring 2018 Quiz 11 Solution



The uniform plank weighs 200 N and is supported by three ropes as shown. A person weighing 750 N stands a distance $d = 0.3$ m from the left end of the plank.

1. What is the value of tension T_1?

a) 331 N b) 426 N c) 507 N d) 665 N

As with any 2-d problem with three unknown forces, look first (if possible) at sum of torques where two of the unknown forces cross, which in this case is the left end of the board.

$$+CCW \sum \tau_{left\,end} = \left(T_1 \sin 40\right)2 - 200\left(1\right) - 750\left(0.3\right) = 0$$

$$T_1 = \frac{425}{2\sin 40} = 330.59\,N$$

2. What is the value of tension T_2?

a) 641 N **b) 738 N** c) 822 N d) 975 N

$$+\uparrow \sum F_y = 330.59\sin 40 + T_2 - 200 - 750 = 0$$

$$T_2 = 950 - 330.59\sin 40 = 737.5\,N$$

3. What is the value of tension T_3?

a) 94 N b) 127 N **c) 253 N** d) 319 N

$$+\rightarrow \sum F_x = 330.59\cos 40 - T_3 = 0 \qquad T_3 = 330.59\cos 40 = 253.2\,N$$

4. Suppose the man moved slightly to the right on the plank and the ropes maintained the angles shown in the diagram after he stopped moving. How would the tensions change?

a) All three tensions would increase.
b) T_1 and T_2 would increase, but T_3 would decrease.
c) T_1 and T_3 would increase, but T_2 would decrease.
d) T_1 would increase, but T_2 and T_3 would decrease.

If the man moves to the right, he creates more CW (-) torque about the left end, requiring T_1 to increase in order to keep the sum of torques zero. If T_1 increases but the weights remain the same, T_2 must decrease to keep the sum of y-forces zero. If T_1 increases, T_3 must increase to keep the sum of x-forces zero.

5. An object in static equilibrium is acted on by only two constant external forces. $\vec{F}_A$ acts at point A on the object and $\vec{F}_B$ acts at point B on the object. What must be true about those two forces?

a) $\vec{F}_A \bullet \vec{F}_B = 0$
b) $\vec{F}_A = \vec{F}_B$
c) The two forces cannot be parallel or antiparallel.
d) The two forces must act along the same line.

The object described is what we called a "two-force member" in class. The two forces must be equal and opposite in direction (the two forces in answer b are in the same direction), and they must act along the same line, otherwise they create an unbalanced torque. Thus they must be parallel or antiparallel (so answer c is out). Answer a describes two vectors that are perpendicular.

$\vec{\tau} = \vec{r} \times \vec{F} \quad \tau = rF\sin\theta = rF_\perp = r_\perp F$

For static equilibrium, $\sum \vec{F} = 0$ *and* $\sum \vec{\tau} = 0$ *about any axis or location.*