PHY 131 Fall 2018

Exam #8: *Statics*

Name________________________________

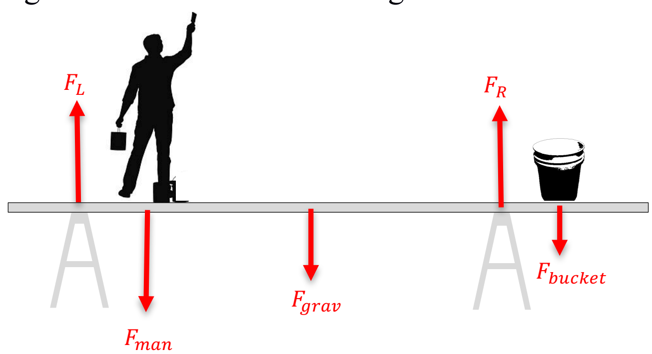
$\tau = F \times r \sin\theta \qquad \sum F = ma \qquad F_{fr,k} = \mu_k F_N \qquad F_{fr,s} \le \mu_s F_N$

*Use g = 10 m/s² = 32 ft/s².*

SHOW YOUR WORK and PUT YOUR ANSWER IN THE BOX!

1. (35 points) A 12-foot long 12" by 2" plank rests on two saw-horses as shown in the figure. The plank has a mass of 12.0 kg. The centers of sawhorses are a horizontal distance of 8 feet apart. Three feet of the plank is over the right sawhorse, and one foot is over the left sawhorse. A painter has a total mass of 70 kg and is a horizontal distance of one foot to the right of the sawhorse on the left. He sets a 5-gallon bucket of paint that has a mass of 18 kg one foot to the right of the sawhorse on the right.

a) What is the contact force between the left sawhorse and the plank?
b) What is the contact force between the right sawhorse and the plank?
c) As measured from the left end of the board, where must the painter be so that the forces exerted by the two sawhorses are equal?




a) The sawhorses are holding up 100 kg, which exerts a force of 1000 Newtons. To get the force the left sawhorse exerts on the plank, the most straightforward method is to take torques about the sawhorse on the right.

$$\tau_{cw} = (180\text{ N})(1\text{ ft}) + F_L(8\text{ ft}) = 180\text{ N ft} + F_L(8\text{ ft})$$

$$\tau_{cw} = (700\text{ N})(7\text{ ft}) + (120\text{ N})(3\text{ ft}) = 4900\text{ N ft} + 360\text{ N ft} = 5260\text{ N ft}$$

Setting these equal and solving for $F_L$ gives:

$$F_L = \frac{5260\text{ N ft} - 180\text{ N ft}}{8\text{ ft}} = \mathbf{635\ N}$$

b) The sawhorses are exerting a total upward force of 1000 Newtons, so $F_R$ must be **365 N**

c) The sawhorses are exerting a total upward force of 1000 Newtons, so $F_L$ must be 500 N if $F_L = F_R$. Taking torques about the sawhorse on the right (although any point will do) we have

$$\tau_{cw} = (180\text{ N})(1\text{ ft}) + (500\text{ N})(8\text{ ft}) = 4180\text{ N}$$

$$\tau_{cw} = (700\text{ N})(x) + (120\text{ N})(3\text{ ft}) = (700\text{ N})(x) + 360\text{ N ft}$$

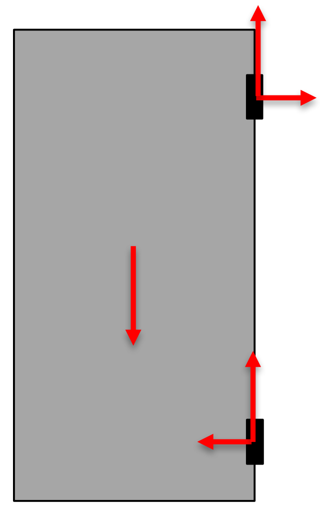
Setting these equal and solving for $x$ we get

$$x = \frac{4180\text{ N ft} - 360\text{ N ft}}{700\text{ N}} = 5.46\text{ ft}$$

Which means that $x = 9\text{ ft} - 5.46\text{ ft} = \mathbf{3.54\ ft}$

2. (35 points) A door has dimensions of 7.0 feet by 3.0 feet. There are two hinges, one 8.0 inches from the top and the other 8.0 inches from the bottom. The uniform door weighs 45 pounds.

a) What is the horizontal force supplied by the top hinge? Give direction and magnitude.
b) What is the horizontal force supplied by the bottom hinge? Give direction and magnitude.
c) What is sum of the vertical forces supplied by the two hinges?



a) To get the horizontal force exerted by the top hinge, take torques about the bottom hinge.

$$\tau_{cw} = \left(F_{T,H}\right)(5.667 \text{ ft})$$

$$\tau_{ccw} = (45 \text{ lbs})(1.5 \text{ ft}) = 67.5 \text{ ft lbs}$$

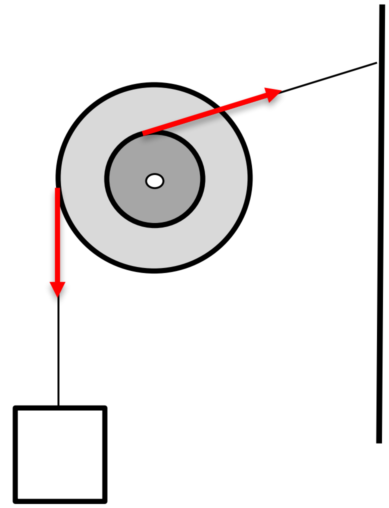
Setting these equal and solving for $F_{T,H}$

$$F_{T,H} = \frac{67.5 \text{ ft lbs}}{(5.667 \text{ ft})} = \mathbf{11.9 \text{ lbs to the right}}$$

b) To balance the forces in the horizontal direction, $F_{B,H}$ must be **11.9 lbs to the left**.

c) To balance the forces in the vertical direction, $F_{B,V} + F_{T,V}$ must be **45 lbs upward**.

3. (30 points) A light pulley has two wheels of different diameters. One is 1 inch and the other is 2 inches. They are affixed and the pulley is free to turn on its axle. A 4-kg mass is suspended from a light cord attached to the outer wheel; the 4-kg mass is held suspended in this way because there is a light cord wound around the inner wheel that is attached to the wall as shown. The cord makes an angle of 30 degrees with the horizontal. What is the tension in this cord that is wound around to the inner wheel?



Taking torques about the axle of the pulley we have

$$\tau_{cw} = \text{T (0.5 inches)}$$

$$\tau_{ccw} = (40\text{ N})(1\text{ inch}) = 40\text{ N in}$$

Setting these equal gives T = **80 N**