Name Answers
Physics 200

Essex High School
November 7, 2016

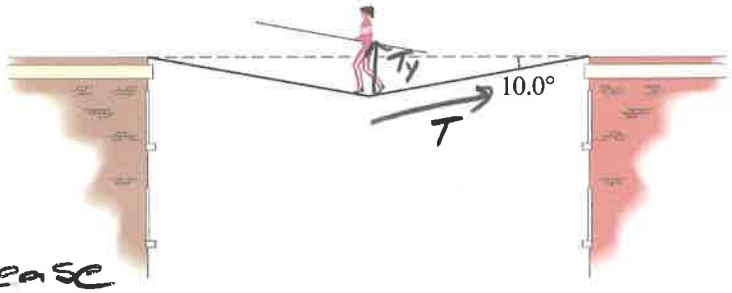
Statics

Conceptual Questions (4 pts each)

1. What is equilibrium? Can a moving object be in equilibrium? Explain.

Equilibrium is a state in which net force equals zero. Equilibrium may be static (motionless) or dynamic (constant velocity).

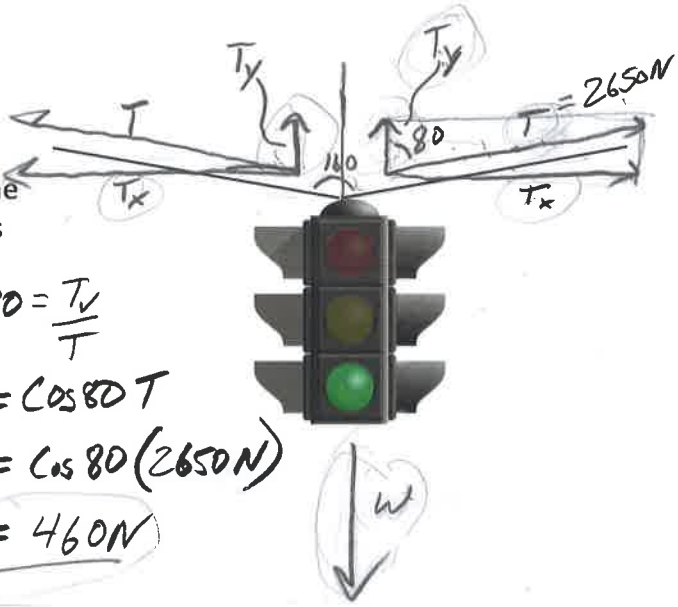
2. If the tightrope walker shown below wants to decrease the 10° angle, does the tension in the rope need to be increased or decreased? Why?



she is being supported by $T_y = \sin\theta T$. As θ decreases, T will need to increase to keep $\sin\theta T$ constant.

Problems (6 pts each)

1. Two cables suspend a traffic light. The angle between the cables is 160°. If the tension in the cables is 2650 N, what is the **mass** of the traffic light?



$\cos 80 = \frac{T_y}{T}$

$T_y = \cos 80\, T$

$T_y = \cos 80\,(2650N)$

$T_y = 460N$

$\Sigma F = T_y + T_y - w = 0$

$\Sigma F = 460N + 460N - w = 0$

$920N = w$

$w = mg$

$920N = m(9.8\ m/s^2)$

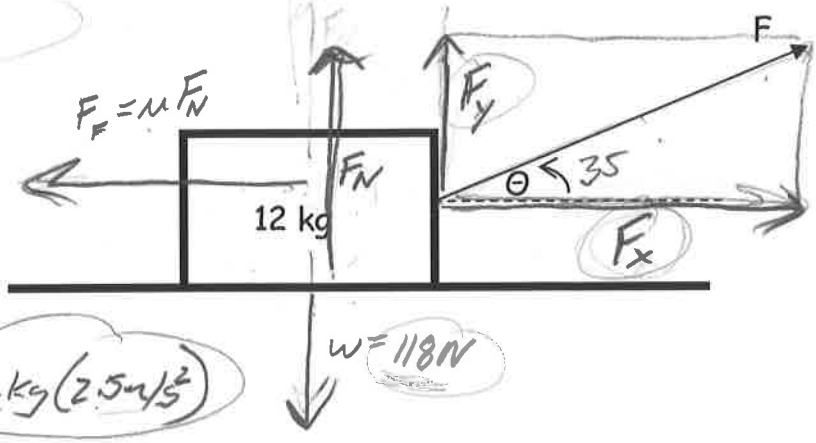
$m = 93.9\ kg$

4. Given an angle of 35° and $\mu_k = 0.25$, find the force that would accelerate the block at a rate of 2.5 m/s^2. (5 pts)

$\Sigma F_y = 0 = F_N + F_y - w = 0$

$F_N = w - F_y$

$F_N = 118N - \sin 35° F$



$\Sigma F_x = F_x - F_F = ma = 12kg(2.5m/s^2)$

$30N = \cos 35° F - \mu(118N - \sin 35° F)$

$30N = 0.819F - 29.5N + 0.143F$

$59.5N = 0.962F$

$F = 61.9N$

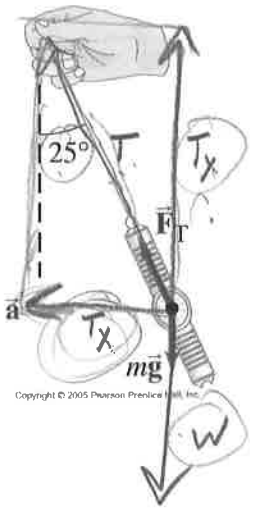
$\Sigma F = ma = (12kg)(2.5m/s^2)$

$\Sigma = 30N$

5. Francesca, who likes physics experiments, dangles her watch from a thin piece of string while the jetliner she is in takes off from JFK Airport (Fig. 4–58). She notices that the string makes an angle of 25º with respect to the vertical as the aircraft accelerates for takeoff, which takes about 18 s. Estimate the takeoff speed of the aircraft.

No vertical motion, so $\Sigma F_y = 0 = T_y - w$

$T_y = w = mg$



$T = \frac{T_y}{\cos 25°} = \frac{mg}{\cos 25°}$

$T_x = T \sin 25° = \left(\frac{mg}{\cos 25°}\right) \sin 25° = 0.466mg$

$\Sigma F_x = ma = T_x$

$ma = 0.466mg$

$a = 0.466g$

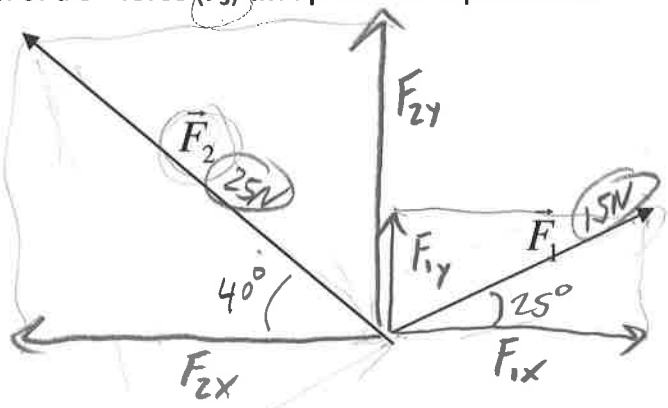
Takeoff speed

$V_x = V_{ox} + at$

$V_x = 18s(0.466g)\left(\frac{9.8m/s^2}{g}\right)$

$V_x = 82 m/s$

2. A force (F_1) of 15 N at 25° and a force (F_2) of 25 N at 140° act on a point. What is the magnitude and direction of a 3rd force (F_3) that produces equilibrium?

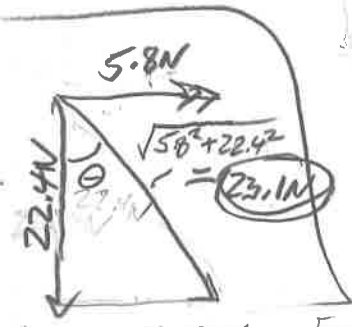


$F_{1x} = \cos 25°(15N) = 13.4N$

$F_{1y} = \sin 25°(15N) = 6.34N$

$F_{2x} = -\cos 40°(25N) = -19.2N$

$F_{2y} = \sin 40°(25N) = 16.1N$



$\sum F_{1+2} = F_{1x} + F_{2x} + F_{1y} + F_{2y}$

$\sum F = 13.4N\,right + 19.2N\,left + 6.34N\,up + 16.1N\,up$

$\sum F = 5.8N\,left + 22.4N\,up$

$\theta = \tan^{-1}\frac{5.8N}{22.4N}$

$\theta = 14°$ East of South

To produce equilibrium, F_3 needs to be opposite $\sum F_{1+2}$ in direction and magnitude

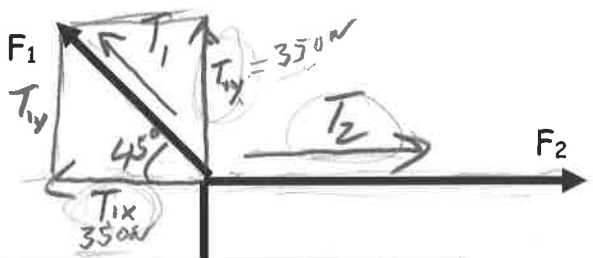
$F_3 = F_{3x} + F_{3y} = 5.8N\,right + 22.4N\,down$

3. A 350 N sign is suspended by ropes as shown. Find the tension in each. Rope A makes an angle of 45° with the vertical (5 pts) No motion, so...

Vertical forces cancel $\Rightarrow T_{1y} + W = 0$ $\quad T_{1y} = -W = 350N\,up$

$\frac{T_{1y}}{T_1} = \sin 45° \Rightarrow T_1 = \frac{T_{1y}}{\sin 45°} = \frac{350N}{\sin 45°}$

$T_1 = 495N$



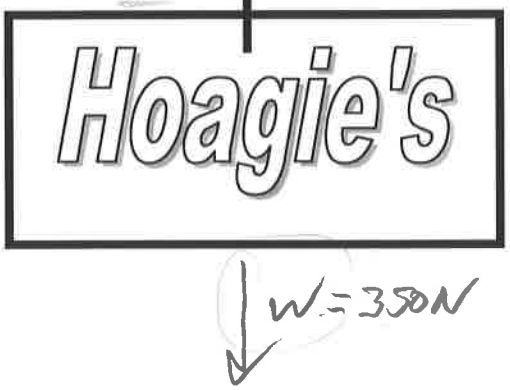
Horizontal forces also cancel (because there's no horizontal acceleration), so...

$\sum F_x = T_{1x} + T_2 = 0$

$|T_{1x}| = |T_{1y}|$, because triangle is isosceles

$T_2 = -T_{1x} = 350N$

$T_2 = 350N$ right



$W = 350N$