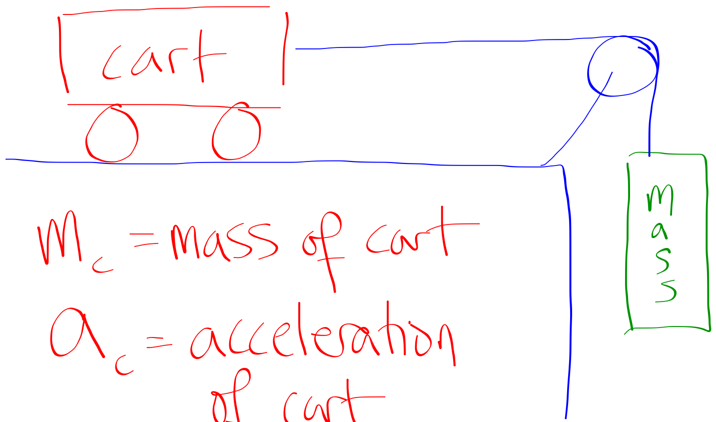
Test: Friday not Wednesday

Lab: Turn in what you have now (if not already done)



m_c = mass of cart

a_c = acceleration of cart

m_h = mass of hanging mass

a_h = acceleration of hanging mass

1. Draw FBD for cart & mass
2. Use Newton's 2nd to solve for T for both cart & mass

g = acceleration due to gravity

F_{Fr} = force of friction on cart

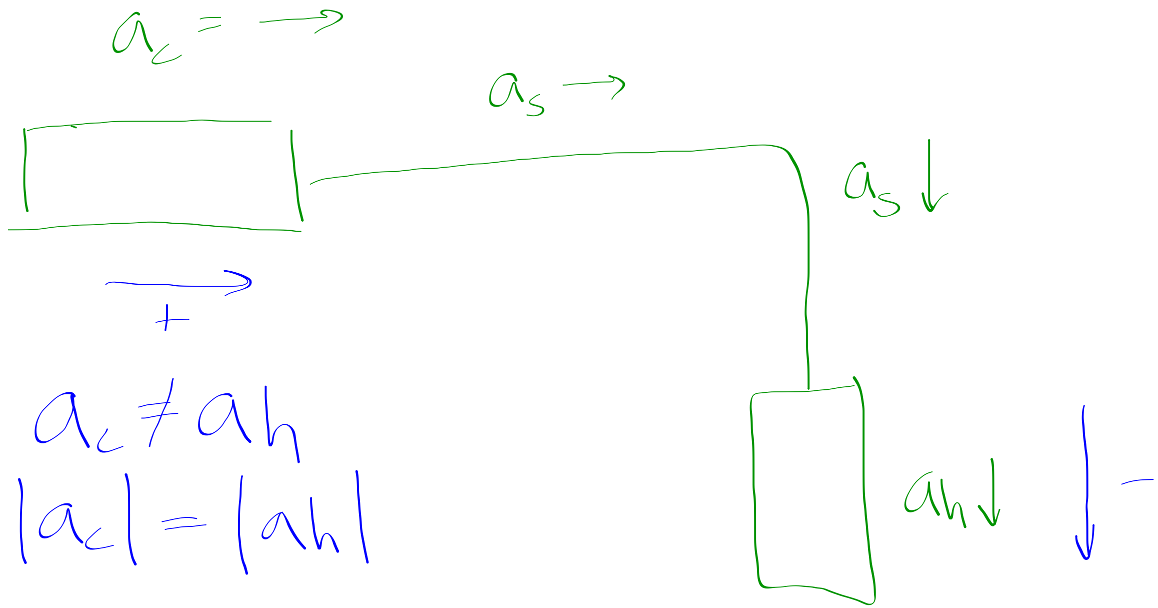
T = tension in the string

3. Mathematical relationship between a_c and a_h

$T = \cancel{0.51\ N}$

$a = \cancel{\uparrow}$

$mg = 0.49\ N$



$$a_c \neq a_h$$

$$|a_c| = |a_h|$$

$$a_c = -a_h \; ; \; a_h = -a_c$$

$$\Sigma F_c = m_c a_c$$

$$-F_{Fr} + T = m_c a_c$$

$$T = m_c a_c + F_{Fr}$$

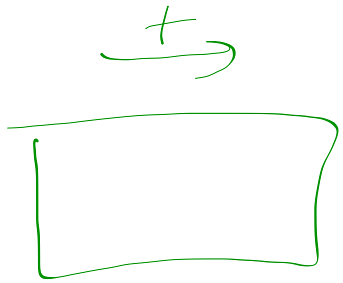
$$\Sigma F_h = m_h a_h$$

$$T - m_h g = m_h a_h$$

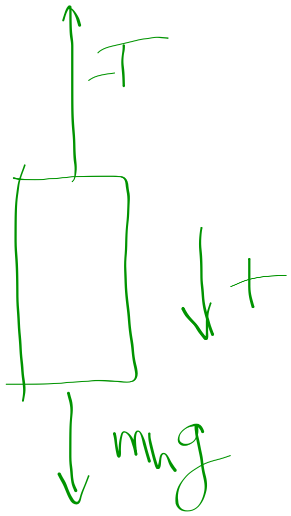
$$T = m_h a_h + m_h g$$

$$T = m_h(-a_c) + m_h g$$

$$T = m_h g - m_h a_c$$



$$a_c = a_h = a$$

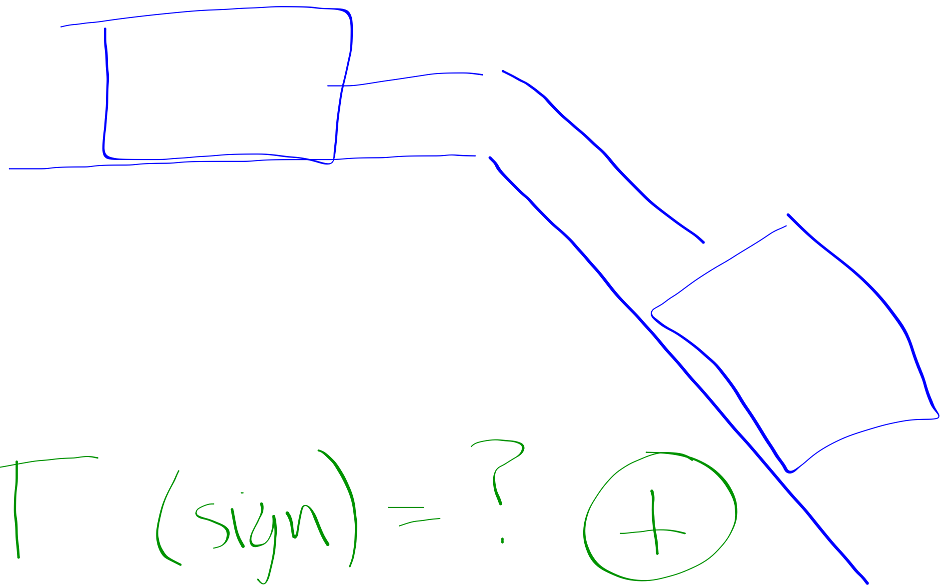


$$-F_{Fr} + T = m_c a$$

$$T = m_c a + F_{Fr}$$

$$-T + m_h g = m_h a$$

$$T = m_h g - m_h a$$



T (sign) = ? $+$

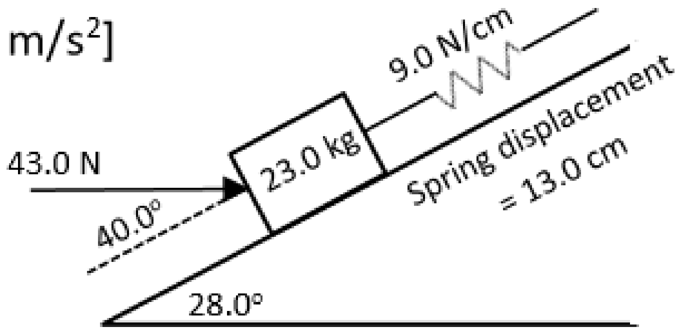
F_{Fr} (sign) = ? $+$

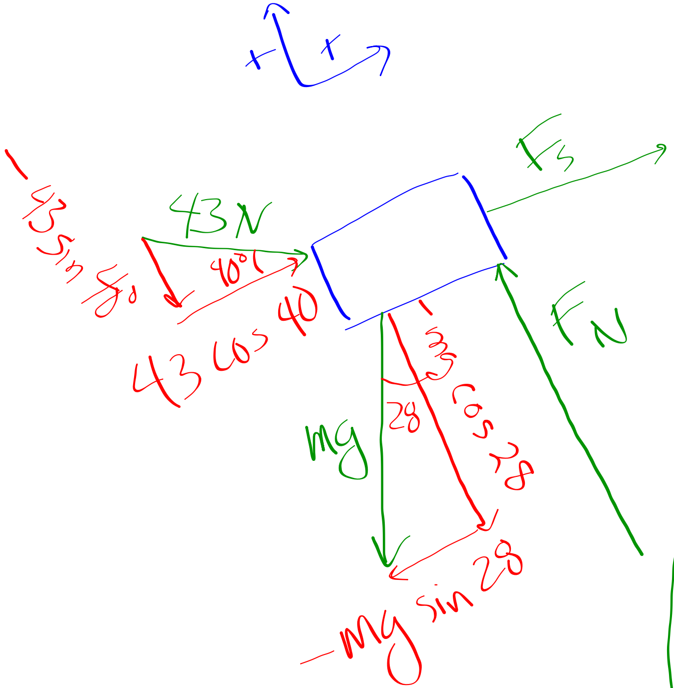
$\cancel{T = -5N}$

$\cancel{F_{Fr} = -2.6N}$

$-F_{Fr} = -2.6N$

13. Find the acceleration of the mass. [a = 1.92 m/s²]





$$\Sigma F_x = ma_x$$

$$43\cos 40 - mg\sin 28 + F_s = ma_x$$

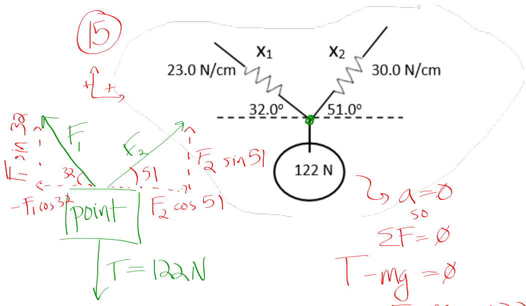
$$\frac{43\cos 40 - (23)(9.8)\sin 28 + F_s}{23} = a_x$$

$$a_x = 1.92\ \text{m/s}^2$$

$$F_s = kx$$

$$= (9)(13) = 117$$

15



$\rightarrow a = 0$

so

$\Sigma F = 0$

$T - mg = 0$

$T = mg = 122N$

$\Sigma F_x = ma_x = 0$

$-F_1 \cos 32 + F_2 \cos 51 = 0$

$\Sigma F_y = ma_y = 0$

$F_1 \sin 32 + F_2 \sin 51 - 122 = 0$

$F_1 = \dfrac{F_2 \cos 51}{\cos 32}$

$F_1 = \dfrac{122 - F_2 \sin 51}{\sin 32}$

$$\frac{F_2 \cos 51}{\cos 32} = \frac{122 - F_2 \sin 51}{\sin 32}$$

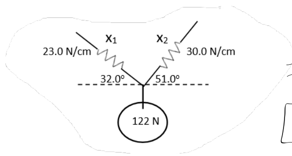
$$F_2(\cos 51)(\sin 32) = 122(\cos 32) - F_2(\sin 51)(\cos 32)$$

$$F_2[(\cos 51)(\sin 32) + (\sin 51)(\cos 32)] = 122(\cos 32)$$

$$F_2 = \frac{122 \cos 32}{[(\cos 51)(\sin 32) + (\sin 51)(\cos 32)]}$$

$$F_2 = \frac{103.46}{0.333 + 0.659} = 104.3N$$

$$F_1 = \frac{F_2 \cos 51}{\cos 32} = \frac{(104.3)(\cos 51)}{\cos 32} = 77.4N$$



$F_1 = k_1 x_1$

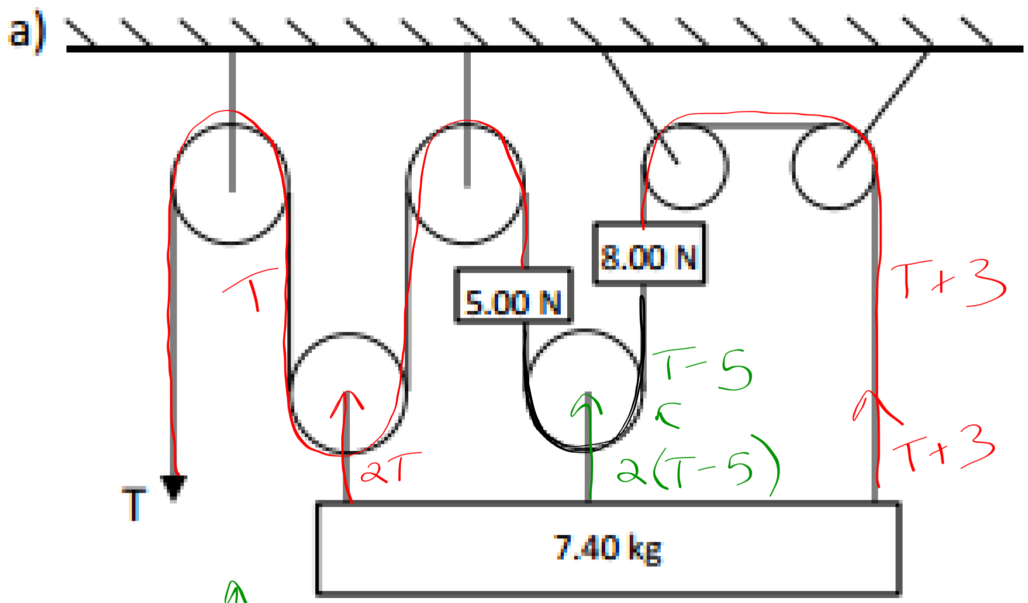
$77.4 = 23 \text{ N/cm}(x_1)$

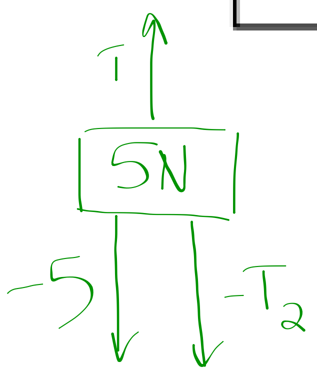
$\boxed{x_1 = 3.37 \text{ cm}}$

$F_2 = k_2 x_2$

$104.3 = 30 \text{ N/cm}\ x_2$

$\boxed{x_2 = 3.48 \text{ cm}}$

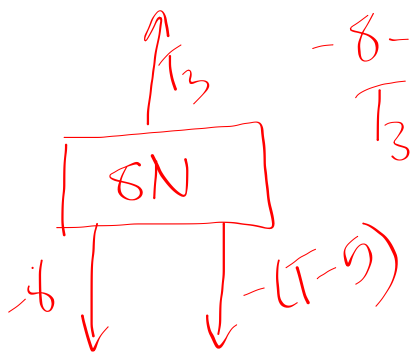




$\Sigma F = 0$

$T - 5 - T_2 = 0$

$T_2 = T - 5$

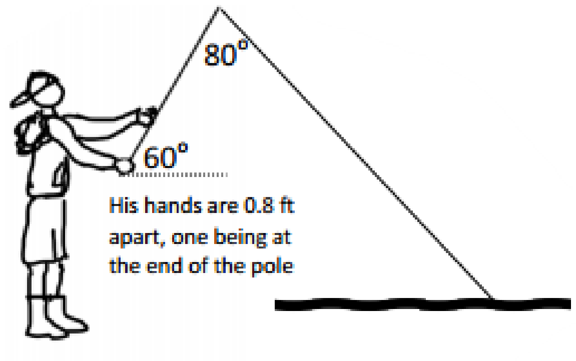


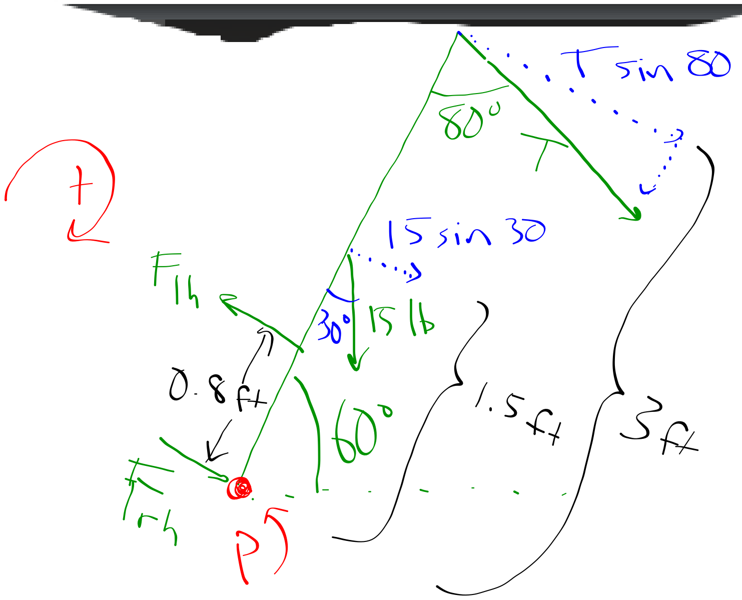
$\Sigma F = 0$

$-8 - (T-5) + T_3 = 0$

$T_3 = T + 3$

11. Cole LaDrinque snags a big one, which exerts a 30.0 pound tension in his line. What force must he apply (perpendicular to the pole) with the upper hand to support his 15.0-lb, 3.00-ft long pole as well as the fish? (Cole holds the pole at 60.0 degrees to the horizontal). [F = 125 lb]



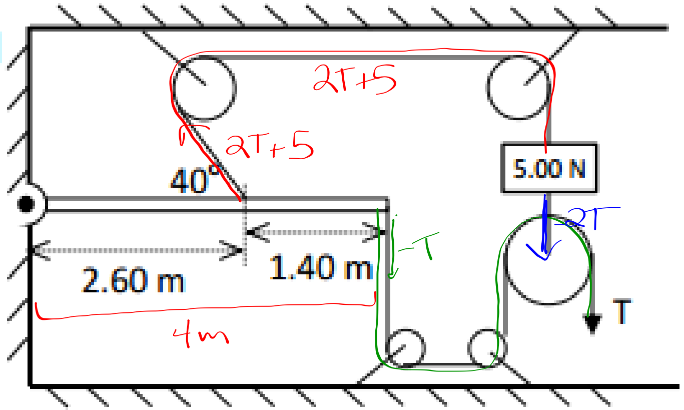


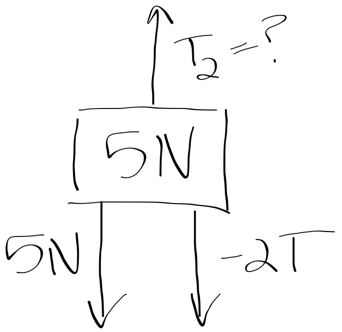
$$\Sigma \tau = 0$$

$$(F_{rh})(0) - (F_{lh})(0.8) + (15 \sin 30)(1.5) + (T \sin 80)(3) = 0$$

8. Find the tension in the string. [0.588 N]

Uniform bar with ~~mass~~ of 2.00 N

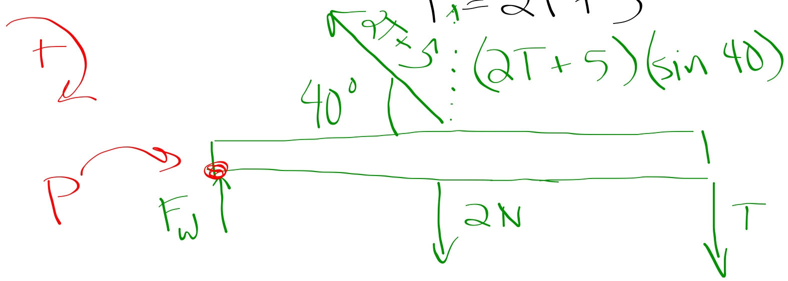




$$\Sigma F = 0$$

$$-5N + {}^{-}2T + T_2 = 0$$

$$T_1 = 2T + 5$$

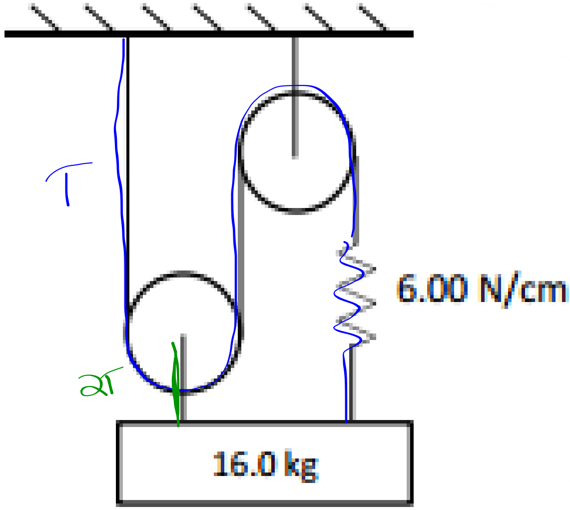


$$\Sigma \tau = 0$$

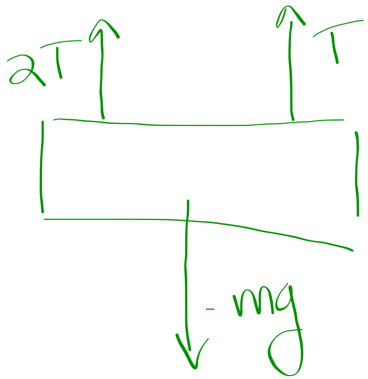
$$(F_w)(0) + {}^{-}(2T+5)(\sin 40)(2.6) + (2)(2) + T(4) = 0$$

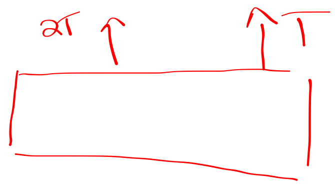
$$-2T(\sin 40)(2.6) - 5(\sin 40)(2.6) + 4 + 4T = 0$$

12. Find the stretch in each spring: a)



[Answers: a) x = 8.71 cm; b) x = 3.33 cm]





$\Sigma F = 0$

$2T + T - mg = 0$

$3T = (16)(9.8)$

$T = 52.27\ N$

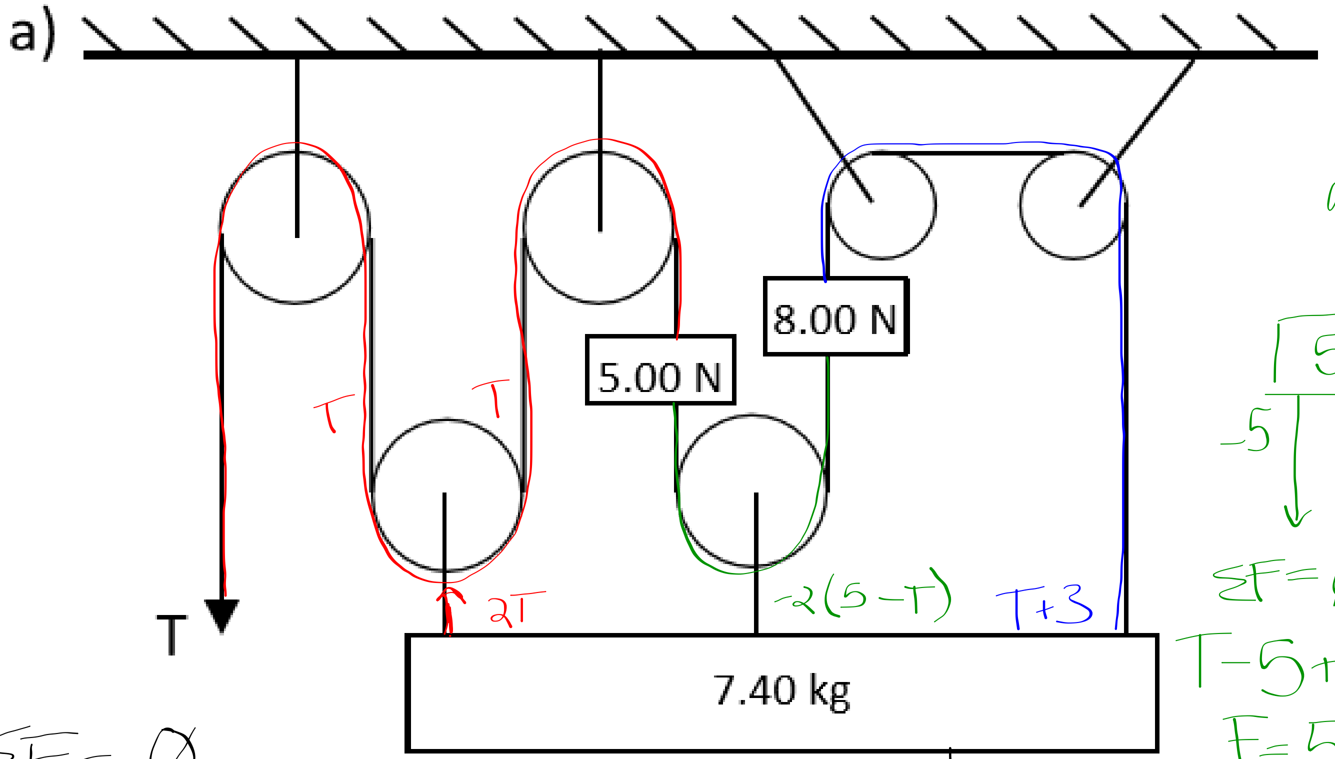
$T = F_s$

$F_s = kx$

$52.27 = (6\ N/cm)\, x$

$\boxed{x = 8.71\ cm}$

a)



T

$5N$

-5 $\quad F = 5 - T$

$\Sigma F = 0$

$T - 5 + F = 0$

$F = 5 - T$

$\Sigma F = 0$

$2T + -2(5-T) + (T+3) - mg = 0$

$5T = 10 - 3 + (7.4)(9.8)$

$T = 15.9\ N$

$F = T + 3$

$8N$

$-8 \quad 5 - T$

$\Sigma F = 0$

$F - 8 + 5 - T = 0$

$F = T + 3$

$$\frac{\frac{o}{h}}{\frac{a}{h}} = \frac{o}{a}$$

$$-42.84 + \frac{12.35\cos\theta}{\sin\theta} = 0$$

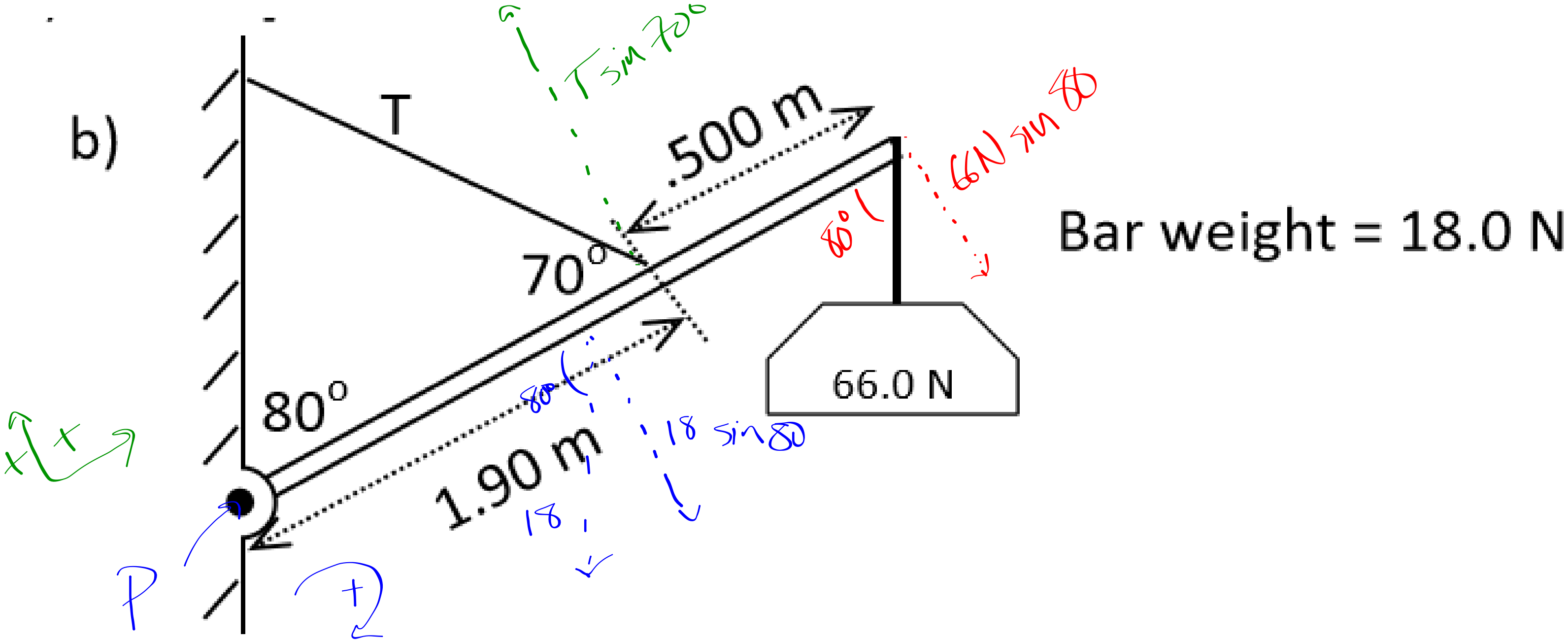
$$\frac{\sin\theta}{\cos\theta} = \tan\theta$$

$$\frac{12.35\cos\theta}{\sin\theta} = 42.84$$

$$\frac{\cos\theta}{\sin\theta} = 3.5$$

$$\frac{\sin\theta}{\cos\theta} = \frac{1}{3.5} = 0.286 = \tan\theta$$

$$\theta = \tan^{-1} 0.286 = \boxed{15.9^\circ}$$



$$\Sigma \tau = \emptyset$$

$$(18\sin 80)\left(\frac{1.9+.5}{2}\right) - T\sin 70(1.9) + (66\sin 80)(2.4) = \emptyset$$

① Draw a FBD (clear, labeled drawings)

Show frame of reference

Break forces into components

② Apply Newton's 2^{nd} Law

$\Sigma F_x = ma_x$

$\Sigma F_y = ma_y$

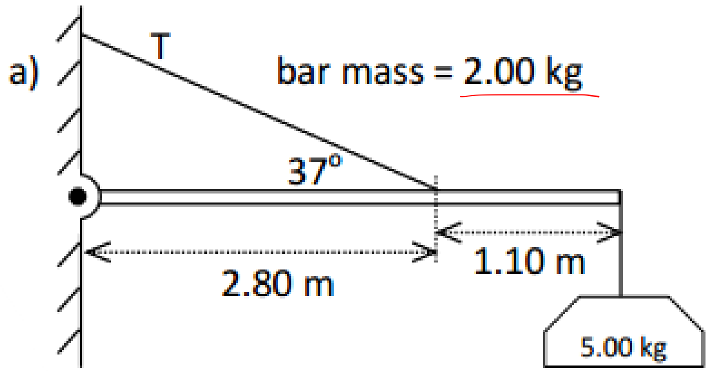
$\Sigma \tau = \emptyset$

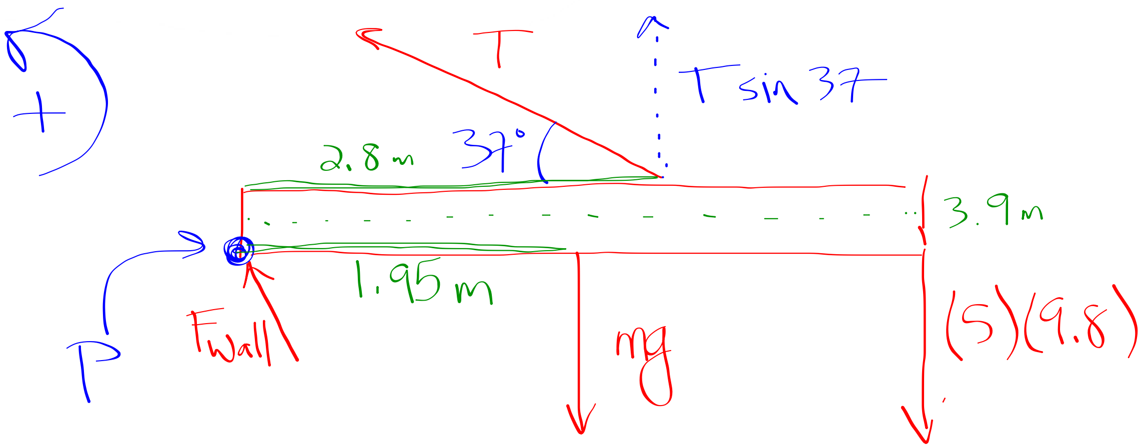
Show me formulas!

Show me initial substitutions!

. . . Use additional equations as needed

7. Find the tensions T in each case. [a) 136 N; b) 99.3 N]



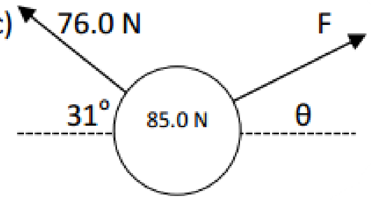


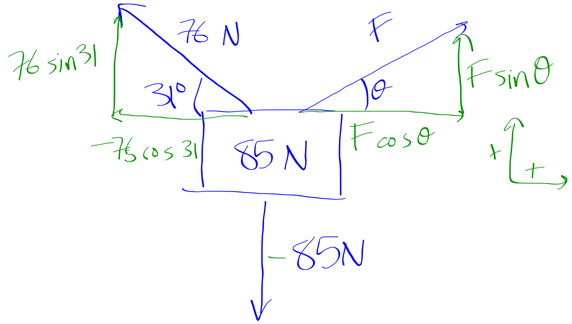
$$\Sigma \tau = 0$$

$$F_{wall}(0) + -(mg)(1.95) + T(\sin 37)(2.8) + -(5)(9.8)(3.9) = 0$$

$$T = \frac{(2)(9.8)(1.95) + (5)(9.8)(3.9)}{(\sin 37)(2.8)} = 136\,N$$

c)





$$\Sigma F_x = \cancel{ma_x} = 0$$

$$-76\cos 31 + F\cos\theta = 0 \rightarrow F = \frac{76\cos 31}{\cos\theta}$$

$$\Sigma F_y = \cancel{ma_y} = 0$$

$$76\sin 31 + F\sin\theta - 85\,N = 0 \rightarrow F = \frac{85 - 76\sin 31}{\sin\theta}$$

$$\frac{76\cos 31}{\cos\theta} = \frac{85 - 76\sin 31}{\sin\theta}$$

$$\frac{\sin\theta}{\cos\theta} = \tan\theta$$

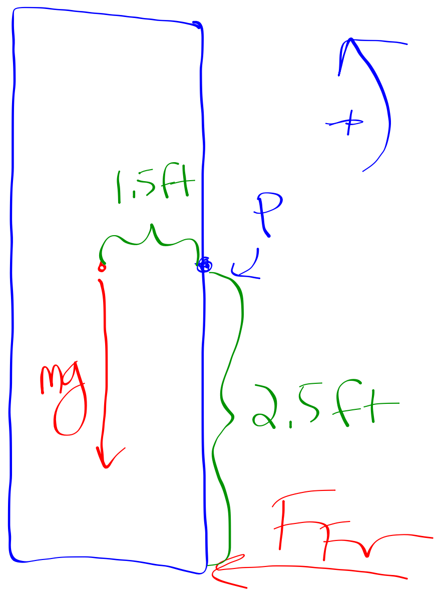
$$\frac{\sin\theta}{\cos\theta} = \frac{85 - 76\sin 31}{76\cos 31} = \frac{45.86}{65.14}$$

$$\tan\theta = 0.704$$

$$\theta = \tan^{-1} 0.704 = \boxed{35.1^\circ}$$

$$F = \frac{76\cos 31}{\cos\theta} = \frac{65.14}{\cos 35.1} = \boxed{79.62\,N}$$

24. A 94 lb crate, 3.0-feet wide and 5.0 feet high, ~~cruises serenely across a frictionless icy surface~~. When it strikes a ~~frictional region, it tips over~~. What is the minimum μ that will tip it? (Think rotation). [.60]

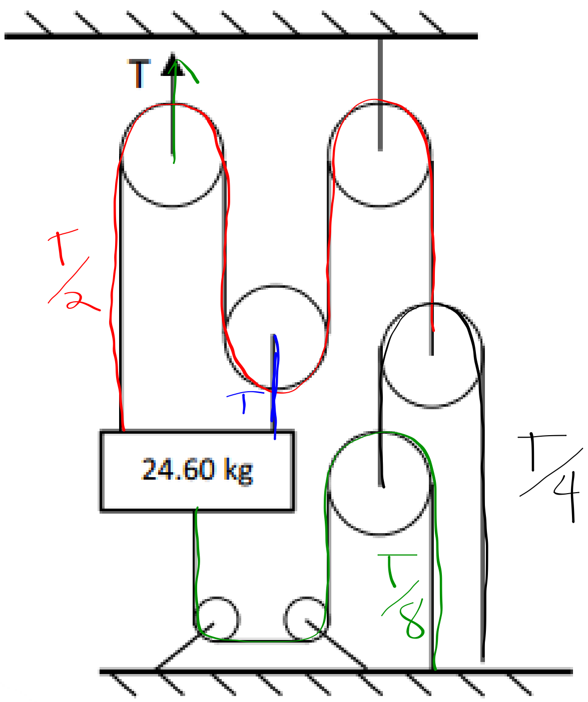


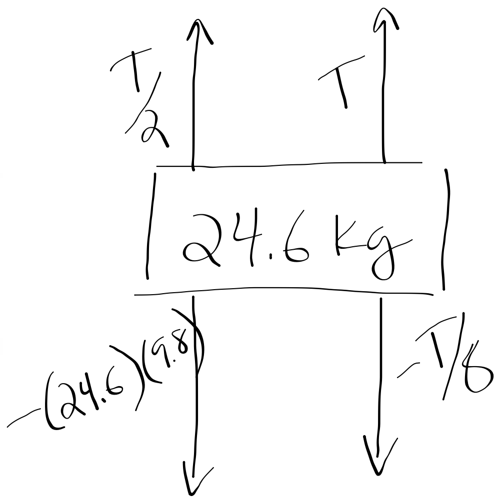
$$\Sigma\tau = \emptyset$$

$$(mg)1.5 - (F_{Fr})2.5 = \emptyset$$

$$F_{Fr} = \mu F_N$$

b)





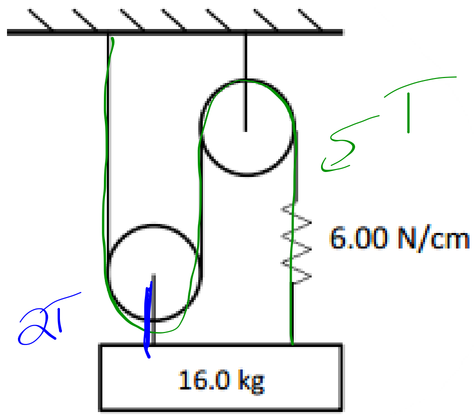
$$\Sigma F = 0$$

$$\frac{T}{2} + T - \frac{T}{8} - (24.6)(9.8) = 0$$

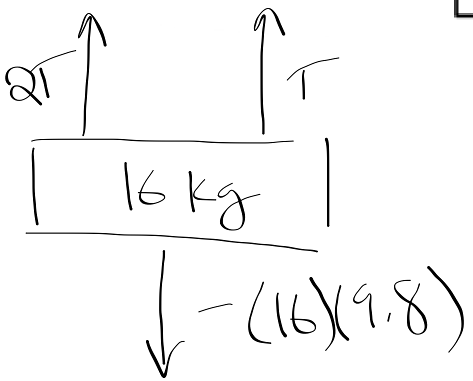
$$\frac{11}{8} T = (24.6)(9.8)$$

$$\boxed{T = 175.3\,N}$$

12. Find the stretch in each spring: a)



[Answers: a) x = 8.71 cm; b) x = 3.33 cm]



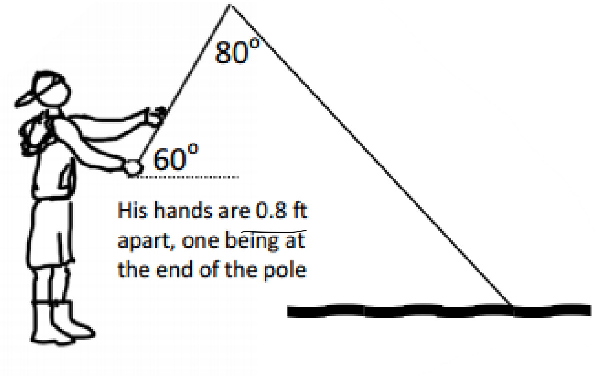
$\Sigma F = 0$

$T = \frac{(16.0)(9.8)}{3} = \boxed{52.27\ N}$

$F_s = kx$

$52.27 = 6\ N/cm \cdot x$

$x = 8.71\ cm$



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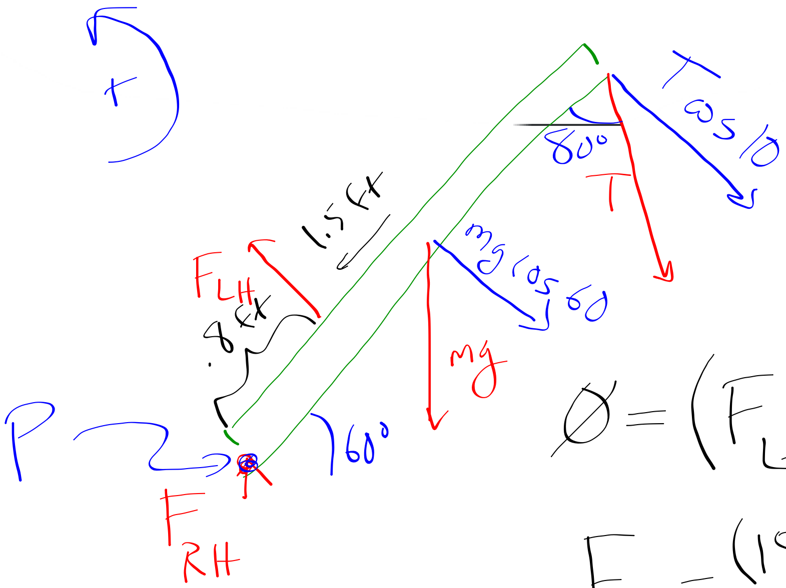


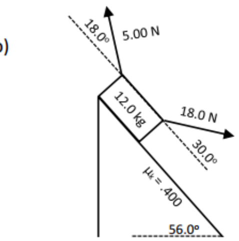
$$\Sigma\tau = 0$$

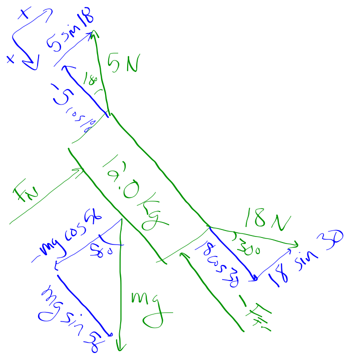
$$0 = (F_{LH})(0.8) - mg(\cos 60)(1.5) - T(\cos 10)(3)$$

$$F_{LH} = \frac{(15)(\cos 60)(1.5) + (30)(\cos 10)(3)}{0.8}$$

$$\boxed{= 124.9 \text{ lb}}$$

b)





$$\Sigma F_x = ma_x$$

$$-5\cos 18 - F_{Fr} + mg\sin 56 + 18\cos 30 = ma_x$$

$$\Sigma F_y = \cancel{ma_y} = 0$$

$$5\sin 18 + 18\sin 30 + F_N - mg\cos 56 = 0$$

$$F_N = 55.22\ N$$

$$F_{Fr} = \mu F_N = (0.4)(55.22)$$

$$= 22.1\ N$$

$$\frac{-4.76 - 22.1 + 97.5 + 15.59}{12} = a_x$$

$$\boxed{a = 7.19\ m/s^2}$$

$x_0 = 0$

$x = 48$

$v_0 = 0$

$v = 26.27\ m/s$

$a = 7.19$

$t = 3.65s$

$$v^2 = \cancel{v_0^2} + 2a(\Delta x)$$

$$v = \sqrt{2(7.19)(48)} = \boxed{26.27\ m/s}$$

$$v = \cancel{v_0} + at$$

$$26.27 = (7.19)t$$

$$\boxed{t = 3.65s}$$