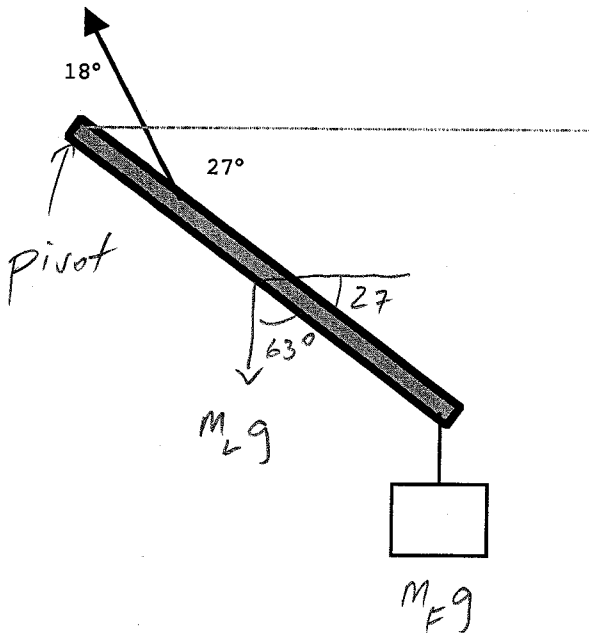
Quiz #8B

Clearly indicate (with a box) your answers to the following questions. SHOW ALL WORK.

1. The tibia is a bone in the lower leg. It can be approximated by a long, thin uniform rod of mass 5.0-kg and length 28 cm, tilted at an angle of 27° below the horizontal as shown below. The foot can be approximated as a 2.0-kg mass hanging from the end of the rod. What must be the tension in the tendon to hold the leg steady in this position.

The tendon makes an angle of 18° with respect to the leg as shown and attaches to the leg 5.0 cm from the knee joint at the top end.



$$\Sigma\tau = \tau_T + \tau_{leg} + \tau_{Foot} = 0$$

$$\tau_T = +(.05)F_T \sin 162^\circ$$
$$= .01545F_T$$

$$\tau_{leg} = -(.14)(5)(9.8)\sin 63^\circ$$
$$= -6.112$$

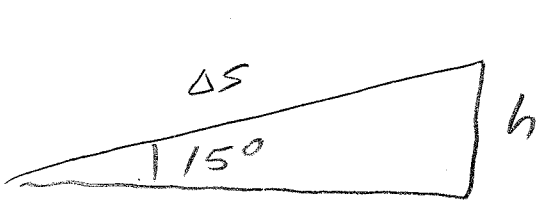
$$\tau_{Foot} = -(.28)(2)(9.8)\sin 63^\circ$$
$$= -4.890$$

$$.01545F_T - 6.112 - 4.890 = 0$$

$$.01545F_T = 11$$

$$\boxed{F_T = 710\ N}$$

2. A 1.2-kg cue ball (in the shape of a solid sphere) is rolled up a long ramp inclined 15° above the horizontal with an initial speed of 7.5 m/sec. How far up the ramp does the ball roll before coming to a stop?



$v = 7.5\ m/s$

$$\Sigma W_F = -mgh = 0 - \frac{1}{2}mv^2 - \frac{1}{2}\left(\frac{2}{5}MR^2\right)\left(\frac{v^2}{R^2}\right)$$

$$+mgh = +\frac{7}{10}mv^2$$

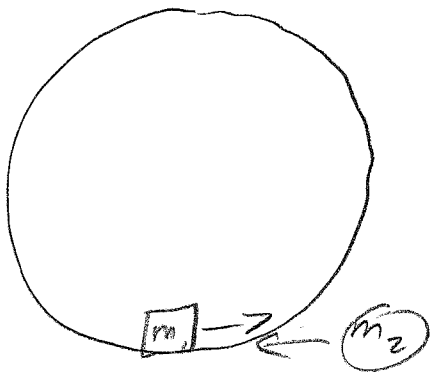
$$h = \frac{7v^2}{10g} = 4.02\ m$$

$$\Delta s = \frac{h}{\sin 15^\circ} = \boxed{16\ m}$$

3. A 25.0 kg child is standing on the rim of a 75.0-kg merry-go-round with a radius of 1.00 meters (and the shape of a solid cylinder). The merry-go-round is rotating at a rate of 11.2 rev/min.

A heavy 5.0-kg ball is thrown to the boy with a speed of 7.5 m/s in a direction exactly opposite to the boy's linear velocity at that point (tangent to the edge of the merry-go-round). The boy catches it. What is the new rotation speed (in rad/sec) of the merry-go-round?

Top view



$I_{mgr} = \frac{1}{2} M_{mgr} R^2$

$= 37.5 \text{ kg} \cdot \text{m}^2$

$I_{child} = M_c R^2$

$= 25 \text{ kg} \cdot \text{m}^2$

$I_{ball} = M_b R^2$

$= 5.0 \text{ kg} \cdot \text{m}^2$

$\omega_{mgr,i} = 11.2 \frac{\text{rev}}{\text{min}} = 1.17 \text{ rad/s}$

$\omega_{child,i} = 1.17 \text{ rad/s}$

$\omega_{ball,i} = \frac{7.5 \text{ m/s}}{1 \text{ m}} = -7.5 \text{ rad/s}$

$I_{mgr}\omega_{mgr,i} + I_{ch}\omega_{ch,i} + I_{ball}\omega_{ball,i} = (I_{mgr} + I_{ch} + I_{ball})\omega_f$

$(37.5)(1.17) + 25(1.17) + (5)(-7.5) = (37.5 + 25 + 5)\omega_f$

$35.625 = 67.5\,\omega_f$

$\omega_f = 0.53 \text{ rad/s}$