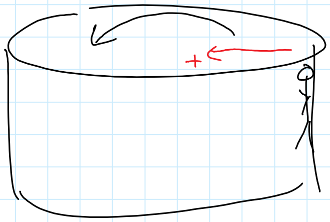
Phy 2A 5/8

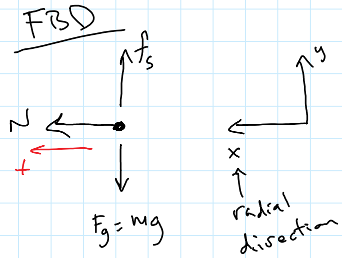
Thursday, May 4, 2017 3:06 PM

Review for exam

From the homework:

3) A certain amusement park ride consists of a large rotating cylinder of radius R = 2.85 m. As the cylinder spins, riders inside feel themselves pressed against the wall. If the cylinder rotates fast enough, the frictional force between the riders and the wall can be great enough to hold the riders in place as the floor drops out from under them. If the cylinder makes 0.570 rotations per second, what is the magnitude of the normal force FN between a rider and the wall, expressed in terms of the rider\'s weight W?





$$\Sigma F_{radial} = m a_{cp} \quad (\leftarrow +)$$

$$N = m \frac{v^2}{R} = \frac{mg}{g}\frac{v^2}{R} = W \frac{v^2}{gR}$$

$$\Sigma F_y = 0$$ Not moving in the y-direction

$$f_s - mg = 0$$

$$f_s = mg$$

$$v = 0.57 \frac{rev}{second} \cdot \frac{2\pi R\ m}{rev} = 2\pi R (0.57)\ \frac{m}{s} = 10.2\ \frac{m}{s}$$

a) $$N = \frac{v^2}{gR} W = \frac{(10.2)^2}{(9.8)(2.85)} W = 3.73\ W$$

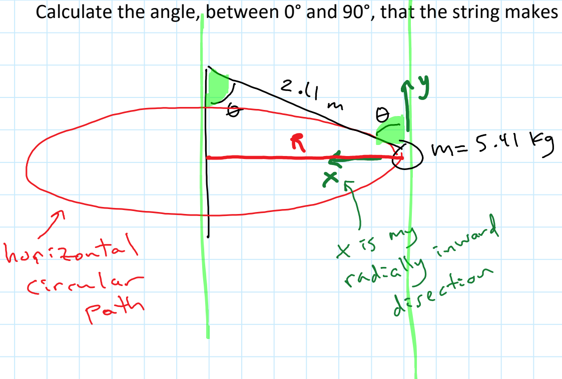
b) $$f_s = mg$$

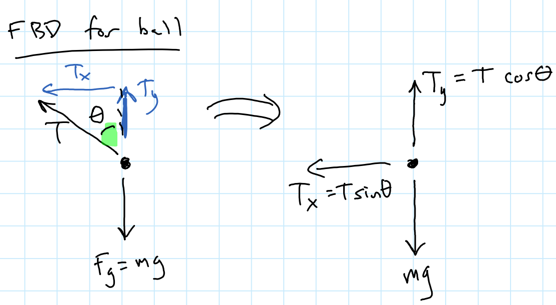
$$\mu_s N = mg$$

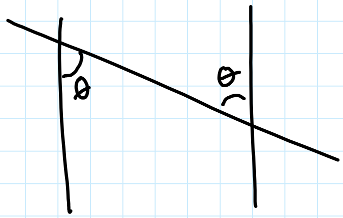
(μ_s ↑ minimum needed)

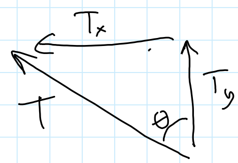
$$(\mu_s)_{min} = \frac{mg}{N} = \frac{mg}{3.73(mg)} = \frac{1}{3.73} = 0.268$$

4) A 5.41-kg ball hangs from the top of a vertical pole by a 2.11-m-long string. The ball is struck, causing it to revolve around the pole at a speed of 4.29 m/s in a horizontal circle with the string remaining taut. Calculate the angle, between 0° and 90°, that the string makes with the pole. Take g = 9.81 m/s2.









$\cos\theta = \frac{adj}{hyp} = \frac{T_y}{T}$

$T\cos\theta = T_y$

$\sum \vec{F} = m\vec{a}$

$\sum F_{radial} = m a_{cp}$ ← +

$T\sin\theta = m\frac{v^2}{R}$

$\sum F_y = 0$

$T\cos\theta - mg = 0$

$T\cos\theta = mg$

$T = \frac{mg}{\cos\theta}$

what is R?

$R = 2.11\sin\theta$

$T\sin\theta = \frac{mv^2}{2.11\sin\theta}$

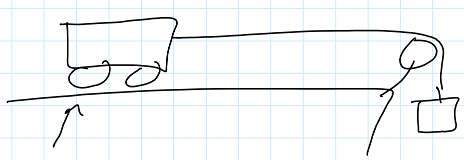
lots of algebra to solve

Muddiest Points:

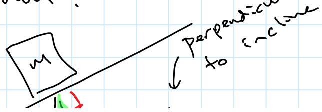
1) Friction:
   a) Static vs kinetic friction
   b) How to solve for mu
   c) Using friction and static friction
2) Incline problems:
   a) Sin vs cos
   b) When does Fnet = 0
   c) How to use Fx = ma and Fy = ma
3) Circular motion
   a) Acp = v^2/R what are v and R
   b) FBD for circular motion

1)

Friction



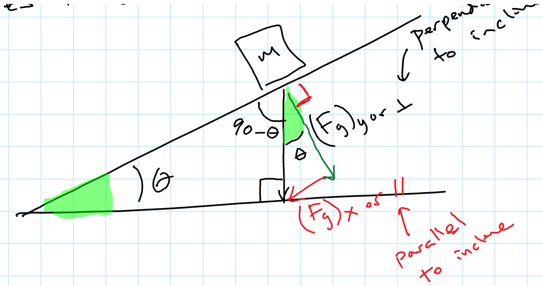
Let go of block at rest,
Does it slide down?



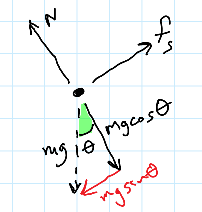
FBD

N

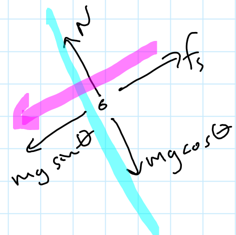
f



FBD



$\Downarrow$



$$\sum \vec{F} = m\vec{a}$$

$$\sum F_{\parallel} = m a_{\parallel} \qquad \text{To find N:} \quad \sum F_{\perp} = 0$$

$$mg\sin\theta - f_s = 0 \qquad N - mg\cos\theta = 0$$

$$f_s = mg\sin\theta \qquad N = mg\cos\theta$$

if $(f_s)_{max} \geq mg\sin\theta$ Does Not slide

$$\mu_s N \;?\; mg\sin\theta$$

$$\mu_s mg\cos\theta \;?\; mg\sin\theta$$

if $m = 10$ kg
$g = 9.8\ \frac{m}{s^2}$
$\theta = 20°$
$\mu_s = 0.3$
$\mu_k = 0.15$

$$(0.3)(10)(9.8)\cos 20° \;?\; (10)(9.8)\sin 20°$$

$$27.6\ \text{N} < 33.5\ \text{N}$$

it Slides!

find the friction force acting on the block:

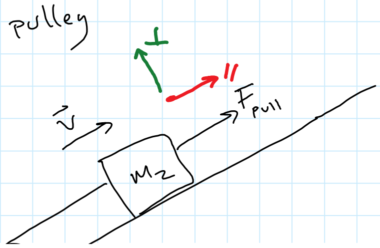
It is sliding: so, Kinetic friction

$$f_k = \mu_k N = (0.15)\, mg\cos\theta$$

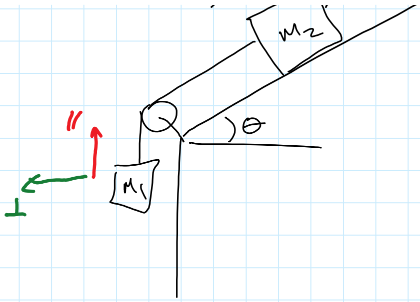
$$= (0.15)(10)(9.8)\cos 20°$$

$$= 13.8\ \text{N}$$

Incline and pulley



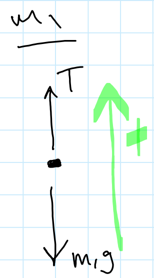
given: $m_1 = 10$ kg
$m_2 = 20$ kg
rope is massless
pulley is massless
V_i is up incline

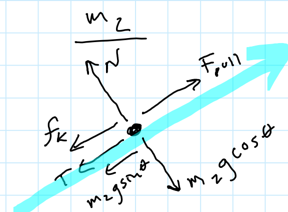


rope is massless
pulley is massless
V_i is up incline
$F_{pull} = 30\ N$
$\theta = 40^\circ$
$g = 9.8\ \frac{m}{s^2}$
$\mu_k = 0.2$

Find: a of blocks
and
T in Rope

Draw Free body diagrams for each mass in the system:





m1:

$$\Sigma\vec{F} = m_1\vec{a}$$

$\Sigma F_{\parallel} = m_1 a$ ↑+

$$T - m_1 g = m_1 a$$

$$T = m_1 a + m_1 g$$

~~$\Sigma F_{\perp} = 0$~~ No forces in this direction

m2:

$$\Sigma\vec{F} = m_2\vec{a}$$

$\Sigma F_{\parallel} = ma$ ↗+

$$F_{pull} - f_k - T - m_2 g\sin\theta = m_2 a$$

to find N

$\Sigma F_{\perp} = 0$ ↖+

$$N - m_2 g\cos\theta = 0$$

$$N = m_2 g\cos\theta$$

$$F_{pull} - \mu_k N - T - m_2 g\sin\theta = m_2 a$$

$$F_{pull} - \mu_k(m_2 g\cos\theta) - T - m_2 g\sin\theta = m_2 a$$

$$F_{pull} - \mu_k m_2 g\cos\theta - (m_1 a + m_1 g) - m_2 g\sin\theta = m_2 a$$

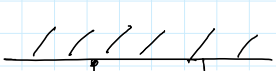
$$30 - (0.2)(20)(9.8)\cos 40^\circ - 10a - (10)(9.8) - (20)(9.8)\sin 40^\circ = 20a$$

$$-224 = 30a$$

$$a = -7.47\ \frac{m}{s^2}$$

blocks are slowing down

Pulleys and ropes

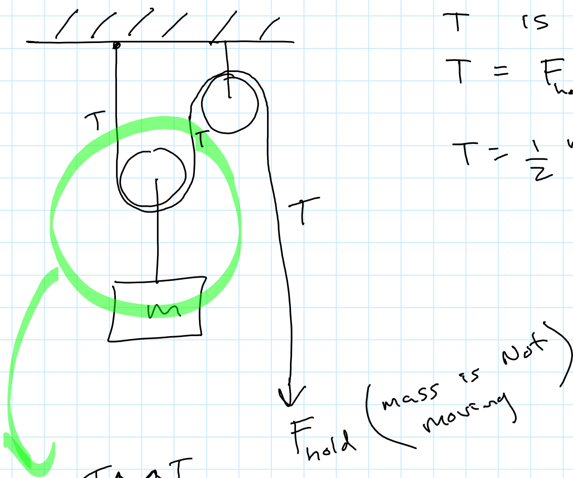


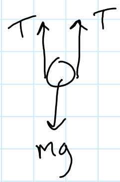
T is same everywhere in the rope

T is same everywhere in the rope

$T = F_{hold}$

$T = \frac{1}{2} mg$





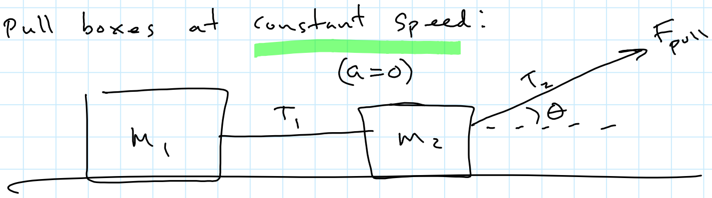
$\Sigma F = 0$ Not moving

$T + T - mg = 0$

$T = \frac{1}{2} mg$

Pull boxes at constant speed:

$(a = 0)$



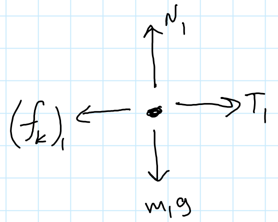
given: $m_1 = 10$ kg

$m_2 = 20$ kg

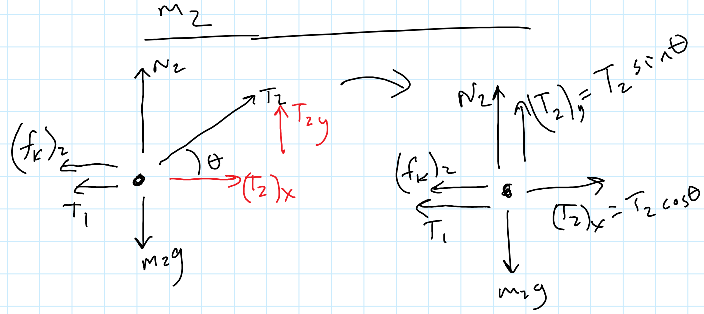
$\mu_k = 0.2$

$\theta = 30°$

m_1



m_2



$\Sigma \vec{F} = m_1 \vec{a}$

to find N

$\Sigma F_x = m a_x$ $\quad \Sigma F_y = m a_y \nearrow 0$

$\Sigma \vec{F} = m_2 \vec{a}$

$\Sigma F_x = m a_x$ $\quad \Sigma F_y = 0$

$\sum F_{\parallel} = m a_{\parallel}$ (+ →)

$T_1 - (f_k)_1 = m_1 a_{\parallel} \nearrow 0$ since speed is constant

$T_1 = (f_k)_1$

$= \mu_k N_1$

$= \mu_k m_1 g$

$= (0.2)(10)(9.8)$

$= 19.6\ N$

to find N

$\sum F_\perp = m a_\perp \nearrow 0$

$N_1 - m_1 g = 0$

$N_1 = m_1 g$

$\sum F_{\parallel} = m_2 a_{\parallel}$

$T_2 \cos\theta - (f_k)_2 - T_1 = 0$

$T_2 \cos\theta - \mu_k (m_2 g - T_2 \sin\theta) - T_1 = 0$

$T_2 \cos\theta - \mu_k (m_2 g - T_2 \sin\theta) - 19.6 = 0$

$T_2 \cos 30^\circ - (0.2)[(20)(9.8) - T_2 \sin 30^\circ] - 19.6 = 0$

$T_2 [\cos 30^\circ + (0.2) \sin 30^\circ] - (0.2)(20)(9.8) - 19.6 = 0$

$T_2 [0.966] = 58.8$

$T_2 = 60.9\ N$

$\sum F_\perp = 0$

$N_2 + T_2 \sin\theta - m_2 g = 0$

$N_2 = m_2 g - T_2 \sin\theta$