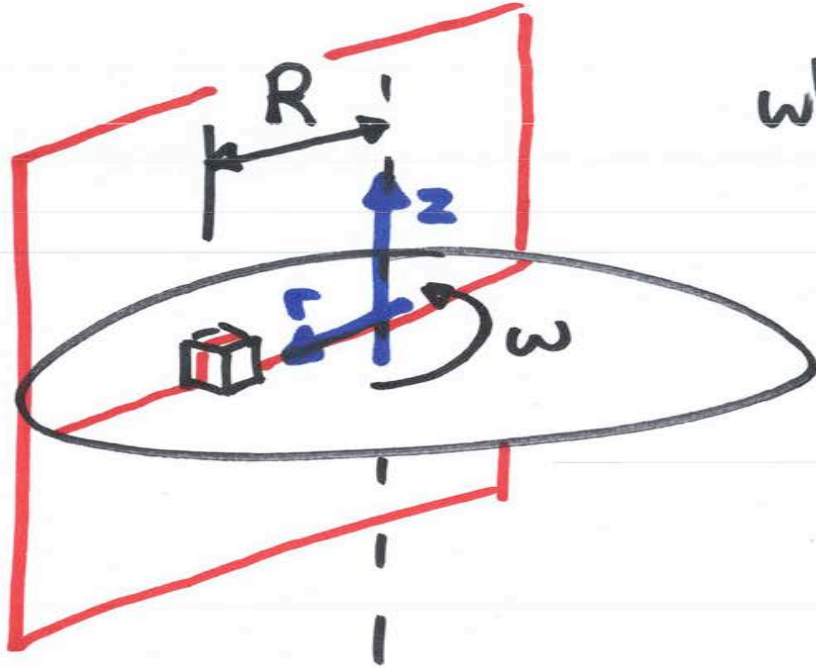




what is the maximum rot. speed (ω) before the block slips?

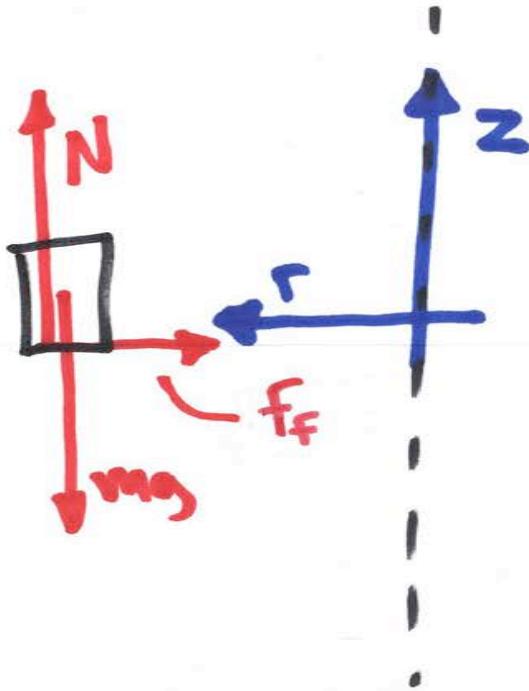
$$R = 0.1 \text{ m}$$

$$m = 1 \text{ kg}$$

$$\mu_s = 0.3$$

$$\mu_k = 0.2$$

FBD:



Newton's 2nd Law:

$$\sum F_r = m a_r = -f_f \quad (1)$$

$$\sum F_z = m \cancel{a_z} = N - mg \quad (2)$$

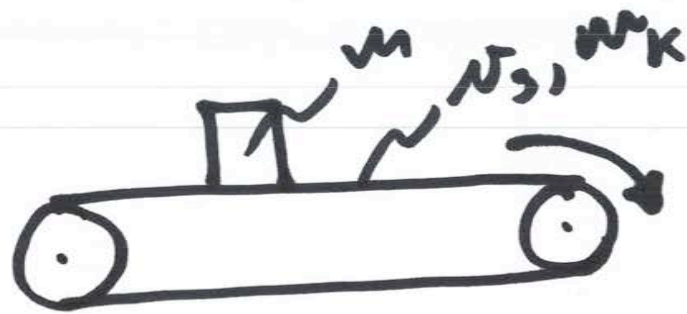
$$a_r = -\omega^2 r = a_{\text{centripetal}} \quad (3)$$

sub (2), (3) and $f_f = \mu N$ into (1)

$$m(-\omega^2 r) = -\mu [mg]$$

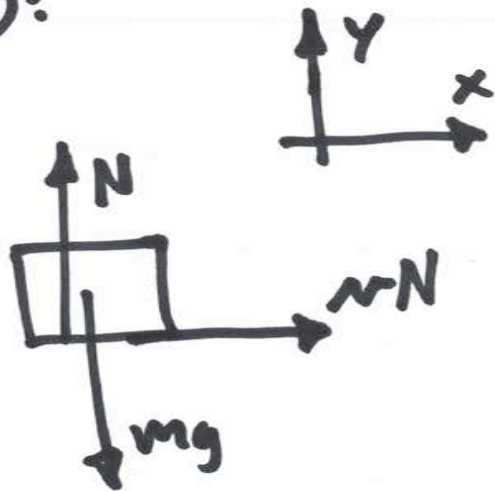
$$\omega = \sqrt{\frac{\mu g}{r}} = \sqrt{\frac{(0.3)(9.81)}{0.1}} = 5.4 \frac{\text{rads}}{\text{sec}}$$

$$\omega = 5.4 \frac{\cancel{\text{rads}}}{\cancel{\text{s}}} \left(\frac{1 \text{ cycle}}{2\pi \cancel{\text{rads}}} \right) \left(\frac{60 \cancel{\text{s}}}{1 \text{ min}} \right) = 51 \text{ rpm}$$



how fast do i need
to accelerate the coverer
belt to slide the block.

FBD:



Newton's 2nd Law:

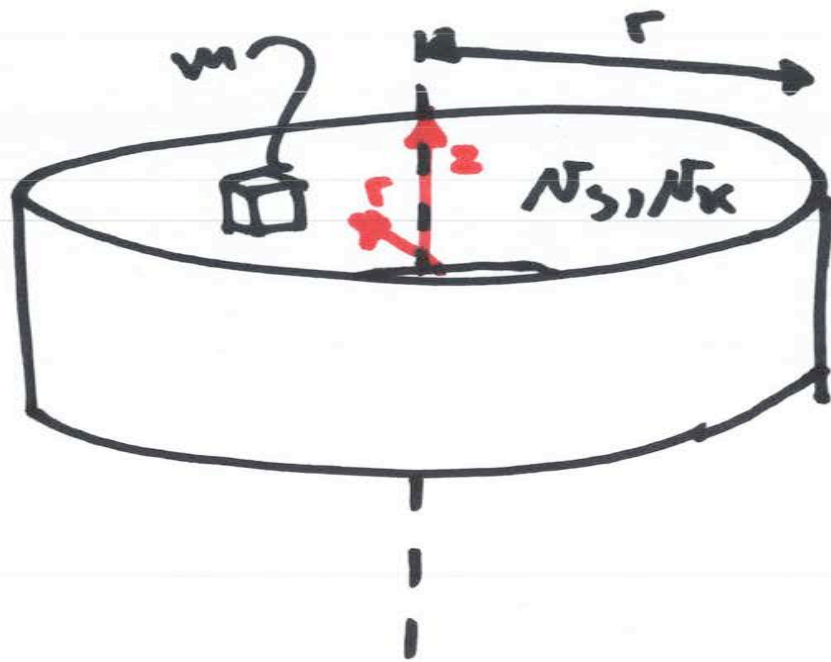
$$\sum F_x = ma_x = \mu N \quad (1)$$

$$\sum F_y = \cancel{m} \cancel{a}_y = N - mg \quad (2)$$

sub (2) into (1)

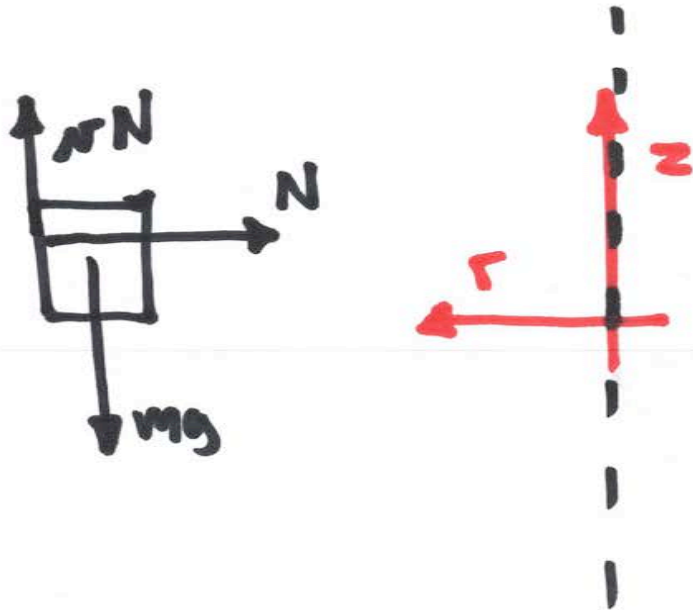
$$ma_x = \mu [mg]$$

$$\boxed{a_x = \mu g}$$



Determine minimum velocity so block doesn't drop.

FBD:



Newton's 2nd Law:

$$\sum F_r = m a_r = -N$$

(1)

$$a_r = \omega^2 r = \frac{v^2}{r}$$

$$\sum F_z = m a_z^0 = N - mg$$

(2)

sub (2) into (1)

$$m \left(-\frac{v^2}{r} \right) = - \left[\frac{mg}{N} \right]$$

$$v = \sqrt{\frac{r g}{N}}$$

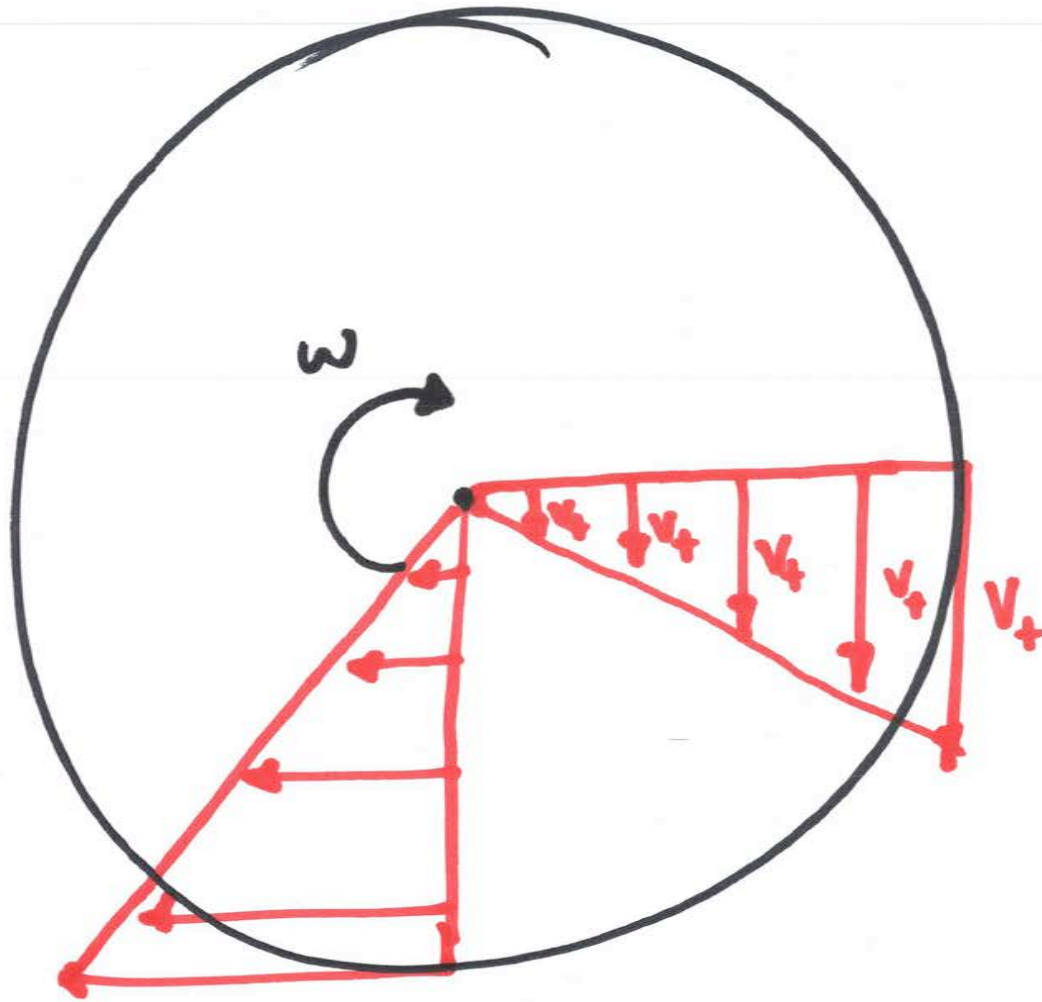
$$r = 3 \text{ m}$$

$$N_s = 0.3$$

$$v = \sqrt{\frac{(3)(9.81)}{0.3}} = 9.9 \text{ m/s}$$

$$\omega = \frac{v}{r} = \frac{9.9}{3} = 3.3 \text{ rads/s}$$

ω vs. v



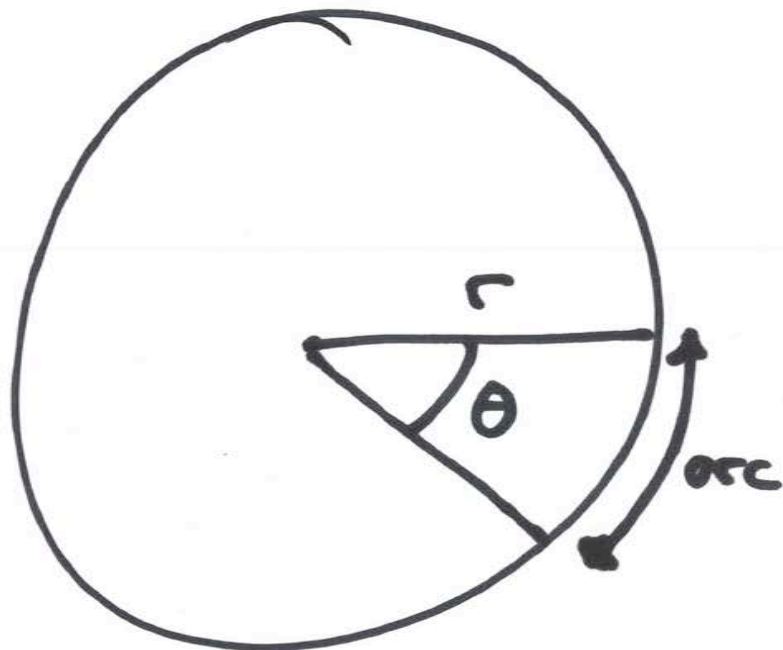
$$\omega = 2 \frac{\text{cycle}}{\text{sec}}$$

$$\omega = \left(2 \frac{\text{cycles}}{\text{sec}} \right) \left(\frac{2\pi \text{ rad}}{1 \text{ cycle}} \right)$$

$$= 12.6 \frac{\text{rads}}{\text{sec.}}$$

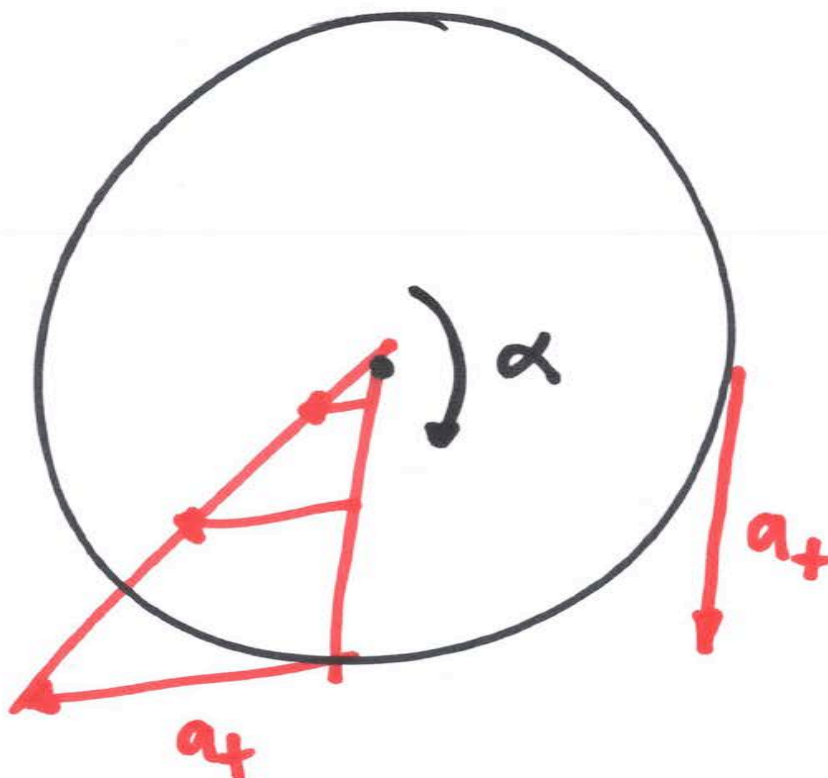
$$v = \omega r \left[\frac{\text{rad}}{\text{sec}} \right] [m]$$

θ vs. x

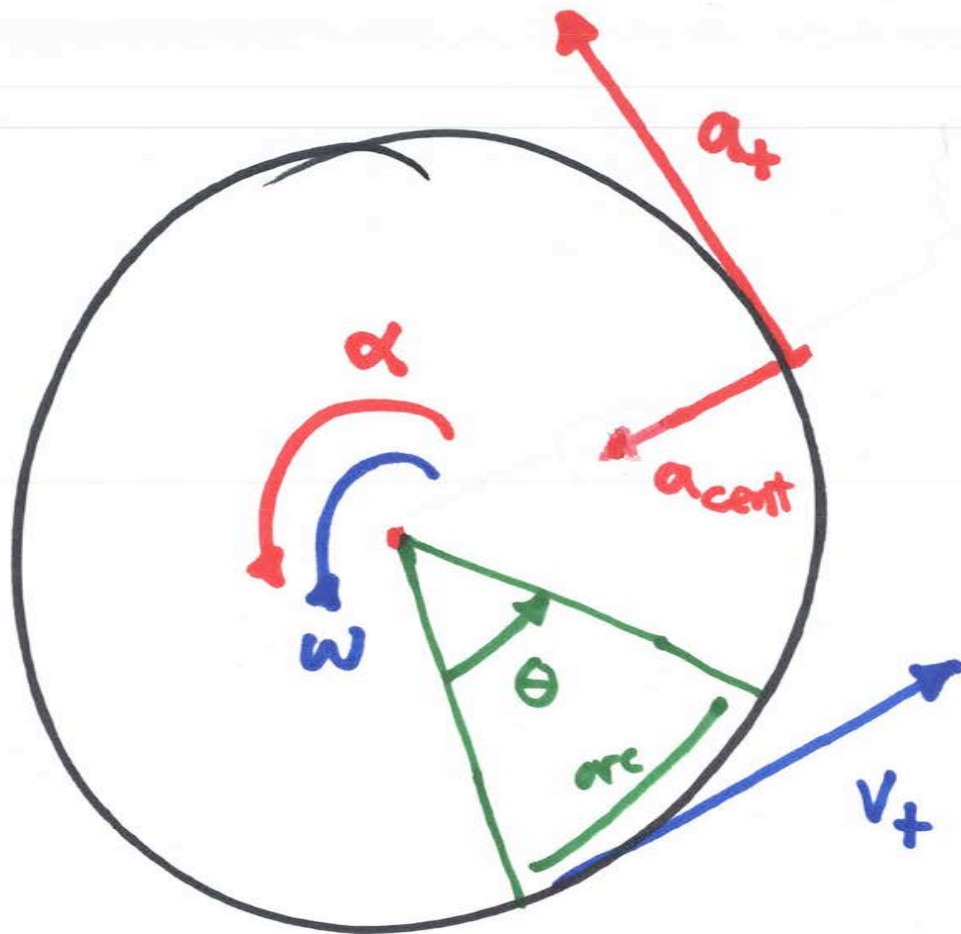


$$arc = r \theta$$

α vs. a



$$a_t = \alpha r$$



$$a_c = \text{centripetal}$$

$$= \omega^2 r$$

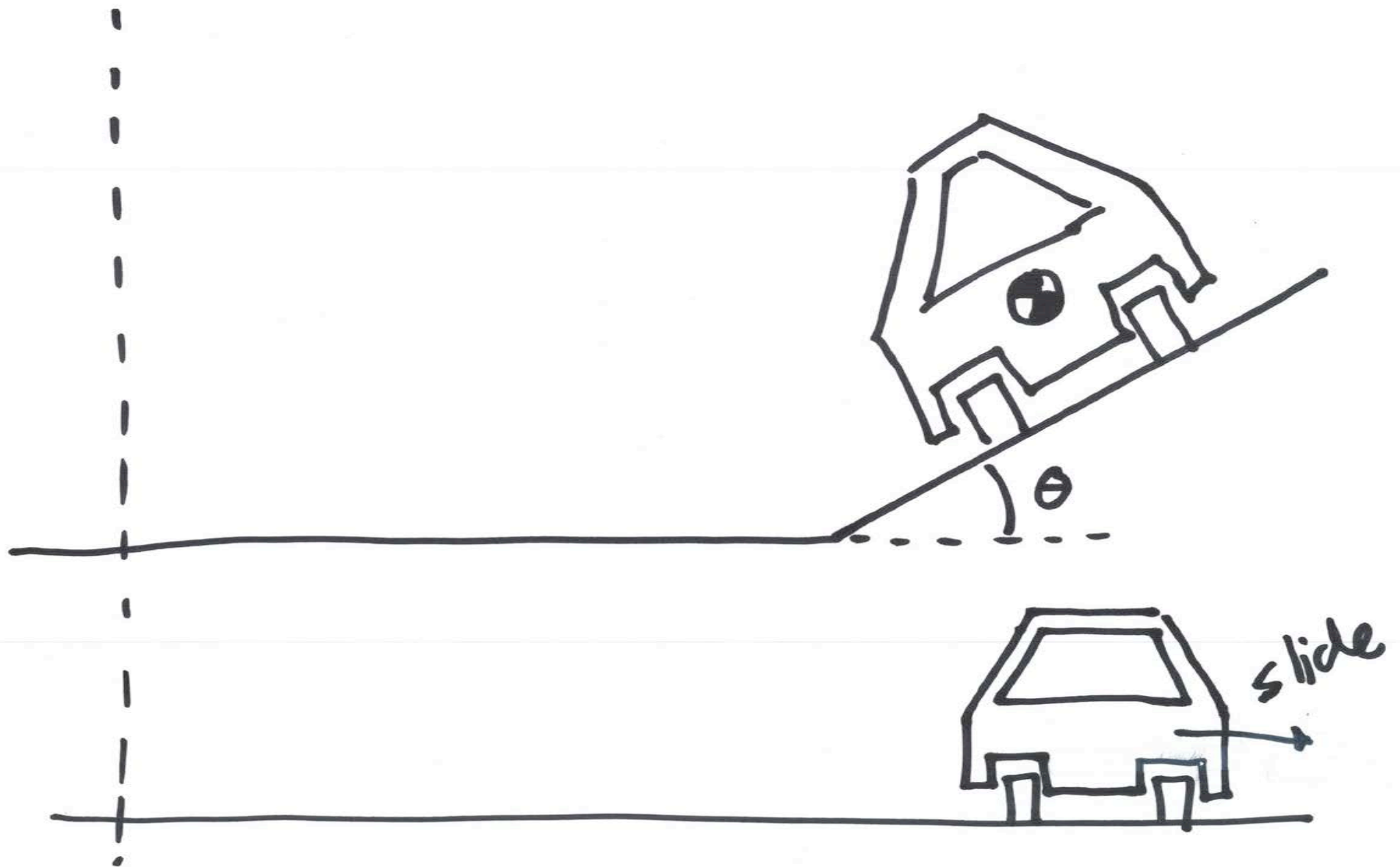
$$= \frac{v^2}{r}$$

$$a_t = \alpha r$$

$$v_t = \omega r$$

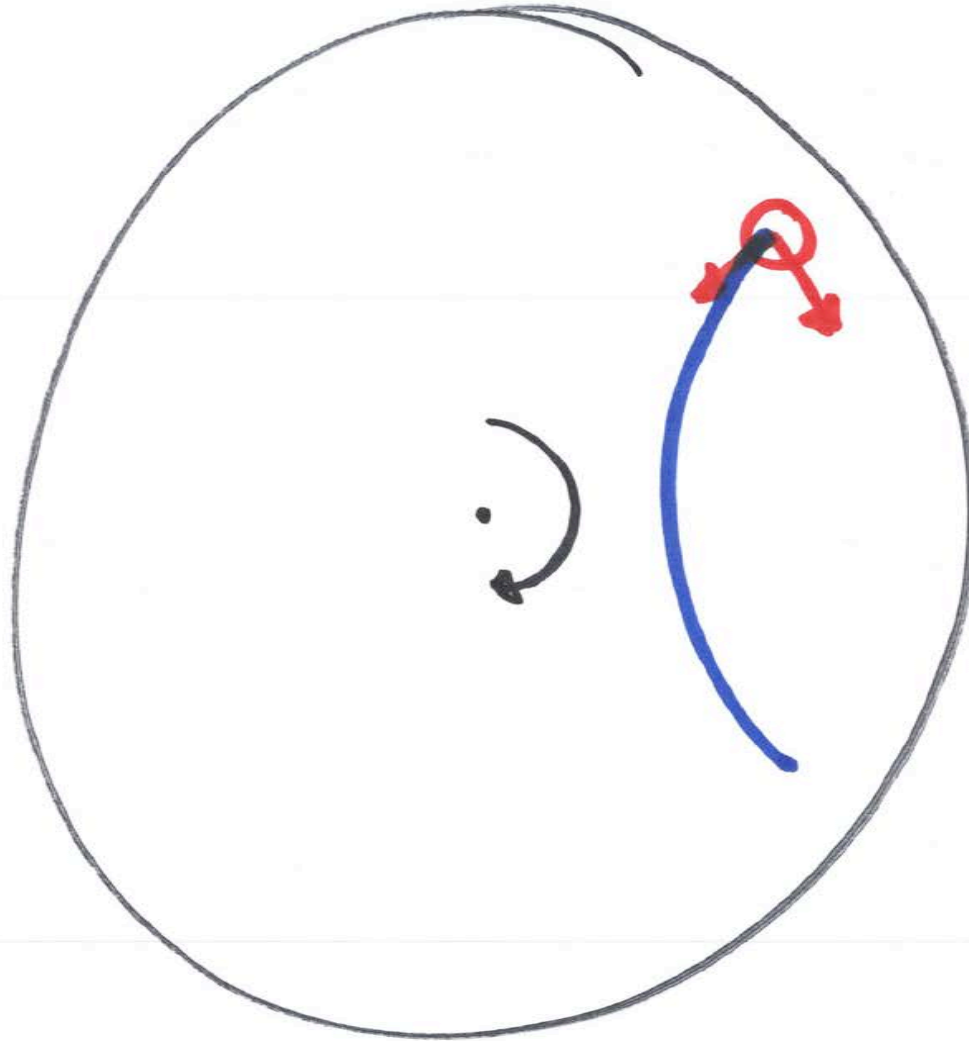
$$\text{arc} = \theta r$$

Banked turn.

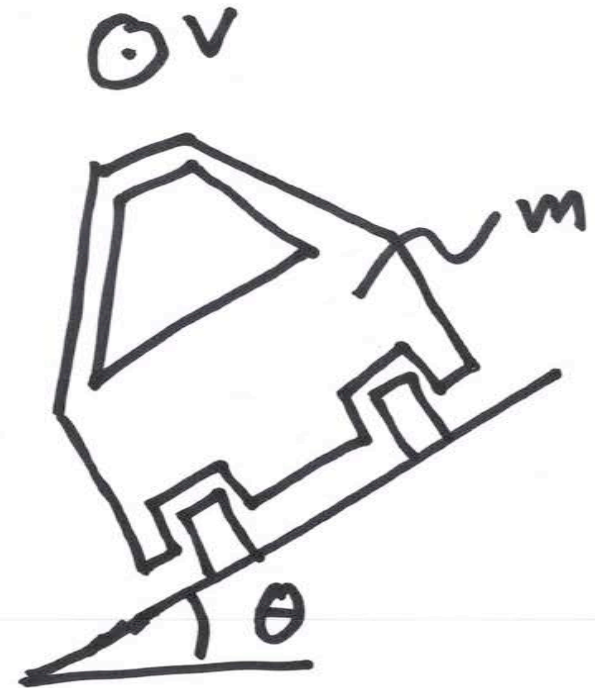
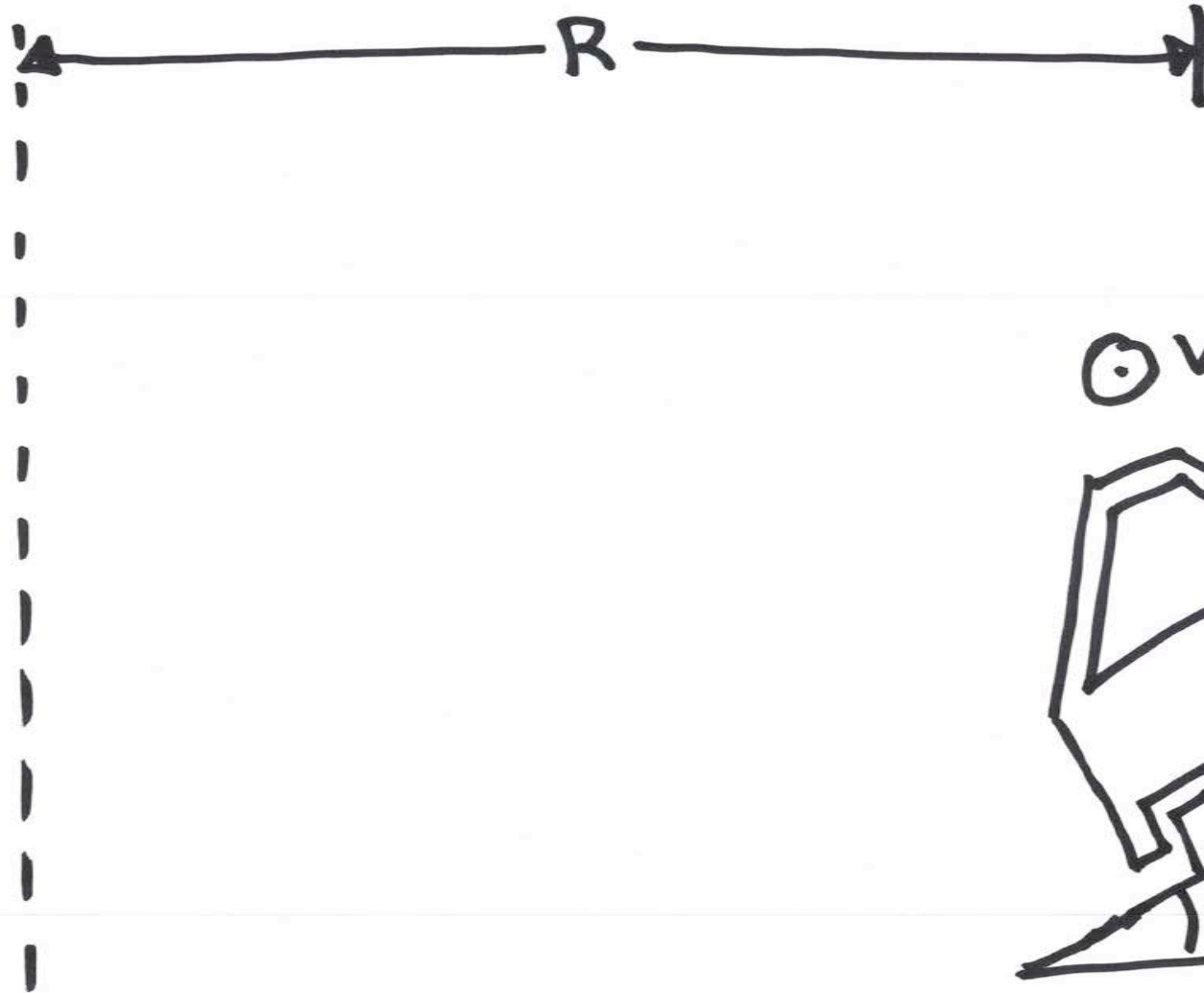


Coriolis effect merry go round

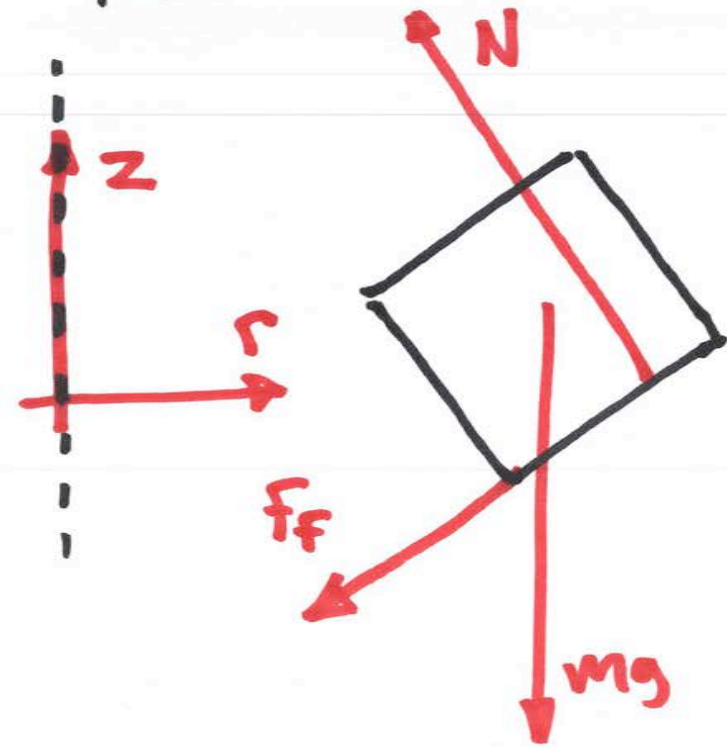
google



Banked turn:



FBD:

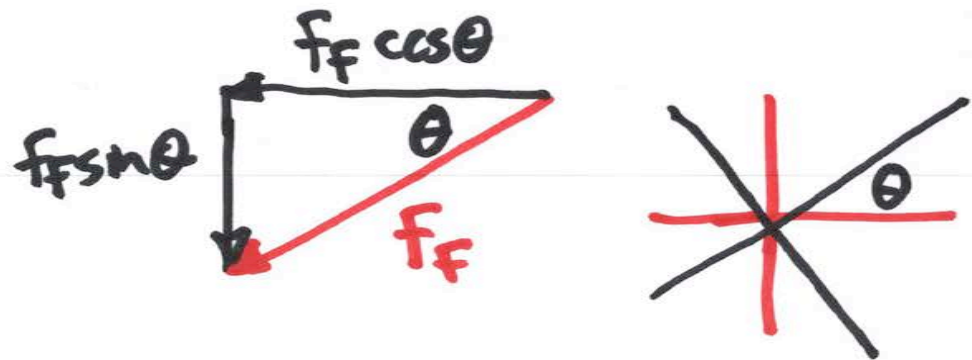
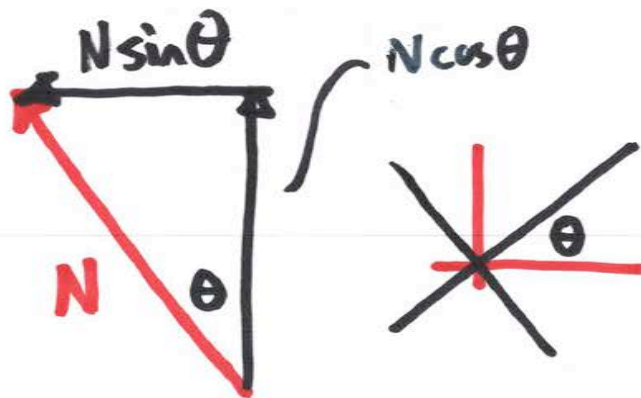


Newton's 2nd Law:

$$\sum F_z = m a_z = N \cos \theta - mg - f_f \sin \theta$$

$$\sum F_r = m a_r = -N \sin \theta - f_f \cos \theta$$

$$a_r = -\frac{v^2}{r} = a_{\text{centripetal}} = -\omega^2 r =$$



solve for N in (1)

$$N = \frac{1}{\cos\theta} (mg + f_f \sin\theta) \quad (1a)$$

sub (1a) into (2)

$$m \left(-\frac{v^2}{r} \right) = - \left[\frac{1}{\cos\theta} (mg + f_f \sin\theta) \right] \sin\theta - f_f \cos\theta$$

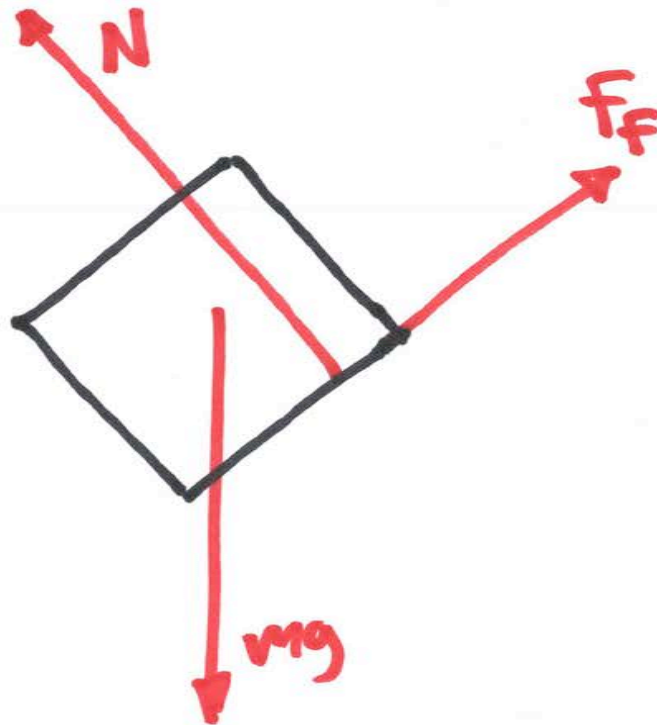
$$\boxed{-mv^2 = -r \tan\theta mg - r \tan\theta f_f \sin\theta - f_f r \cos\theta}$$

zero friction: $f_f = 0 \Rightarrow \boxed{v^2 = rg \tan\theta}$

maximum/min velocity: $F_f = \mu_s N$

Minimum velocity :

FBD



Banked turn

Constants

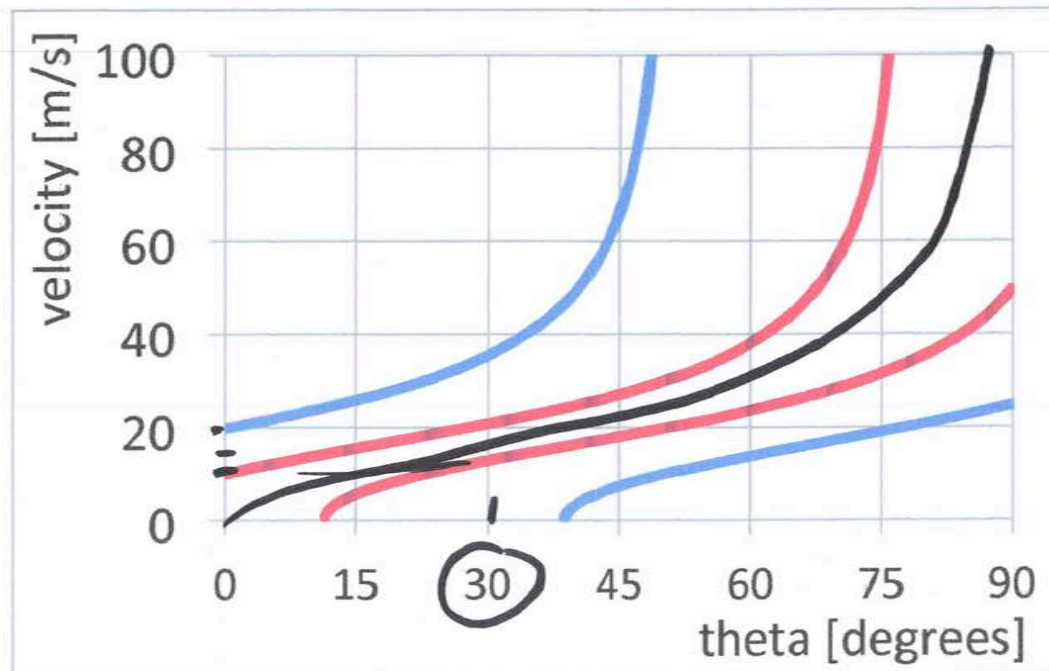
g 9.81

Parameters

R 50 m
 theta_o 0 degrees
 theta_f 90 degrees
 dtheta 0.1 degrees
 n_theta = 900

Extra point on graph for 2nd axis

theta 91 degrees
 velocity 1 m/s
 velocity = 3.6 km/h



Table

u_s input:	u_s	0.2	u_s	0.8
start_v =	114	0	387	0
number_v =	787	787	514	514
theta	v_min	v_max	v_min	v_max
[degrees]	[m/s]	[m/s]	[m/s]	[m/s]
0		10		20
0.1		10		20
0.2		10		20
0.3		10		20
0.4		10		20
0.5		10		20
0.6		10		20

zero friction case

$$v^2 = r g \tan \theta$$

$$v = \omega r$$

$$\omega^2 r^2 = r g \tan \theta$$

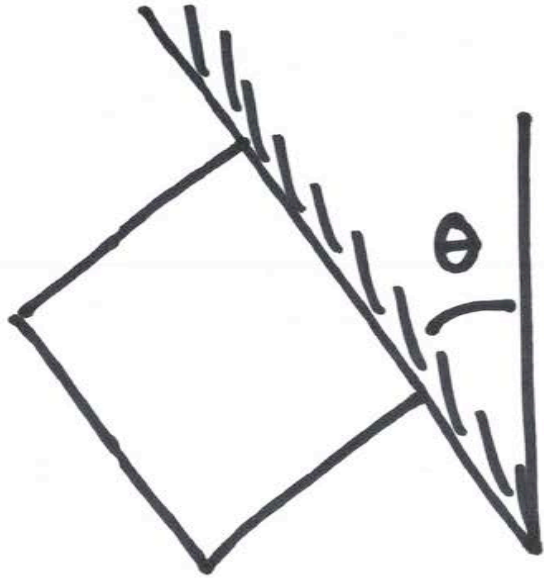
$$\boxed{\omega^2 = \frac{g \tan \theta}{r}}$$

$$\theta = 30^\circ$$

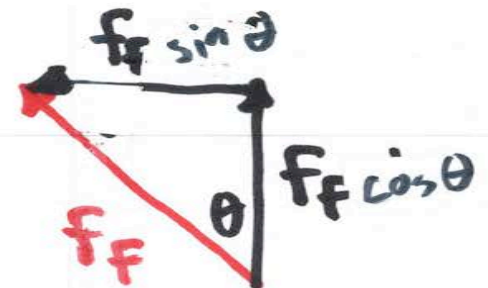
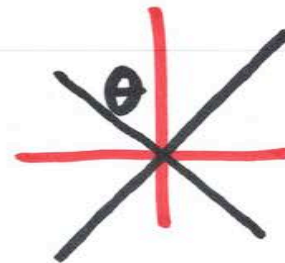
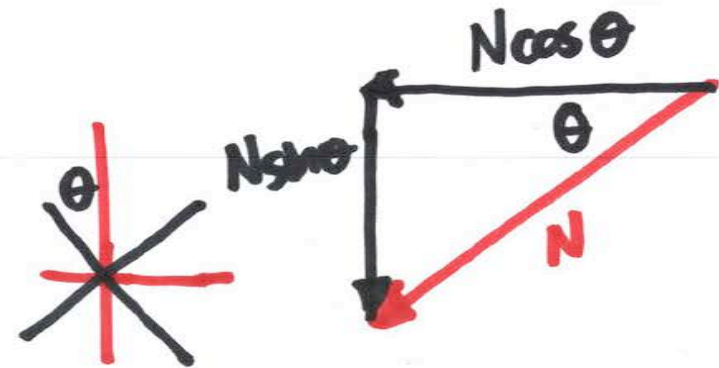
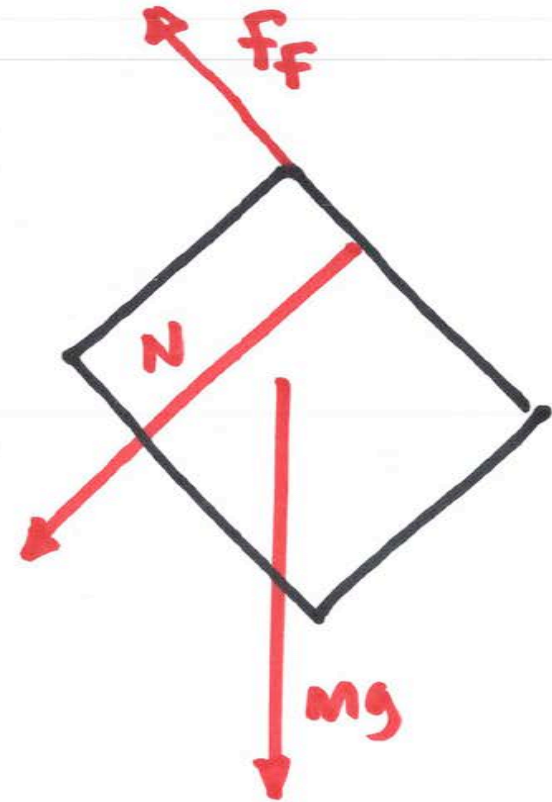
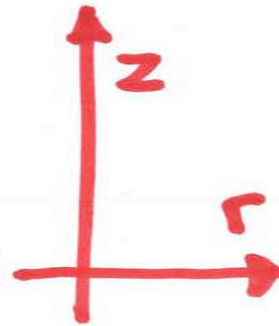
$$R = 50 \text{ m}$$

$$v = \sqrt{(50)(9.81) \tan(30)} = 16.8 \text{ m/s}$$

Banked Roof



FBD:



Newton's 2nd Law:

$$\sum F_z = m \cancel{a_z} = F_f \cos \theta - N \sin \theta - mg \quad (1)$$

$$\sum F_r = m a_r = -F_f \sin \theta - N \cos \theta \quad (2)$$

$$a_r = -v^2/r = a_{\text{cent.}} \quad (3)$$

solve for max. velocity, so $F_f = \mu_s N$. (4)

sub (4) into (1) and solve for N:

$$0 = \mu_s N \cos \theta - N \sin \theta - mg$$

$$N = \frac{mg}{\mu_s \cos \theta - \sin \theta}$$

(la)

sub (1a) & (3) into (2)

$$N \left(-\frac{v^2}{r} \right) = -N_s \left[\frac{v \cancel{r} g}{N_s \cos \theta - \cancel{r} \sin \theta} \right] \sin \theta - \left[\frac{\cancel{r} g}{N_s \cos \theta - \cancel{r} \sin \theta} \right] \cos \theta$$

$$-\frac{v^2}{r} = \frac{g}{N_s \cos \theta - \sin \theta} \left[-N_s \sin \theta - \cos \theta \right]$$

$$v_{\max} = \sqrt{gr \frac{N_s \sin \theta + \cos \theta}{N_s \cos \theta - \sin \theta}}$$

$V_{\min}$:

use (2) :

$$m \left(-\frac{v^2}{r} \right) = -\mu_s N \sin \theta - N \cos \theta$$

minimum velocity when $N = 0$

$$V_{\min} = 0$$

