Lecture Notes

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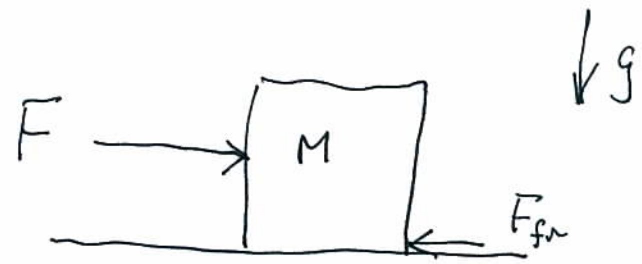
Physic 317 K

Feb. 6 - 10

Frictional Force

$F_s < \mu_s N$

$F_k = \mu_k N$

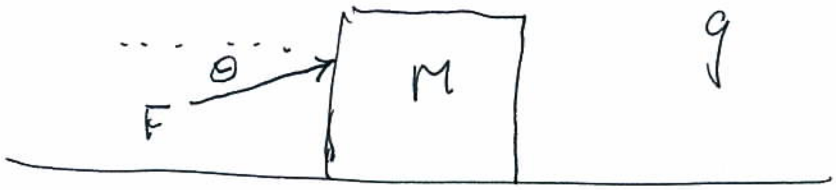


Given μ_s, What minimum Force F does it take to move object?

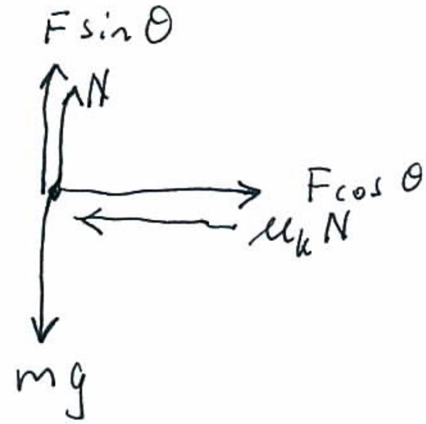
(a) $\mu_k mg$

(b) $\mu_k mg$

(c) $> \mu_k mg$



Minimum Force to move object



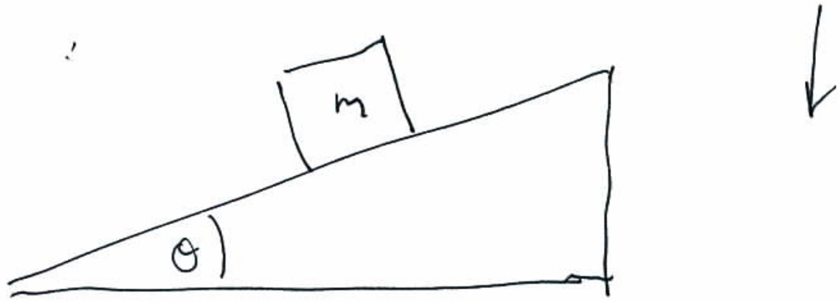
$$mg = F\sin\theta + N$$

$$\mu_k N = F\cos\theta$$

$$\mu_k (mg - F\sin\theta) = F\cos\theta$$

$$\mu_k mg = F(\cos\theta + \mu_k \sin\theta)$$

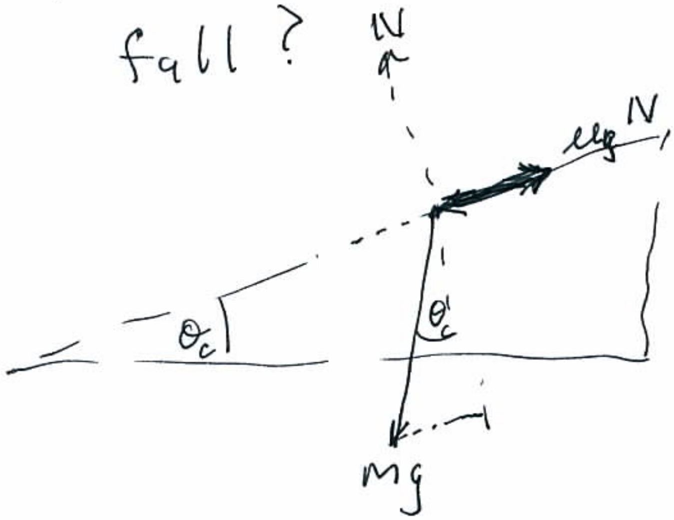
$$\boxed{F = \frac{\mu_k mg}{\cos\theta + \mu_k \sin\theta}}$$



Friction Force on incline

μ_s given:

At what angle will block m fall?

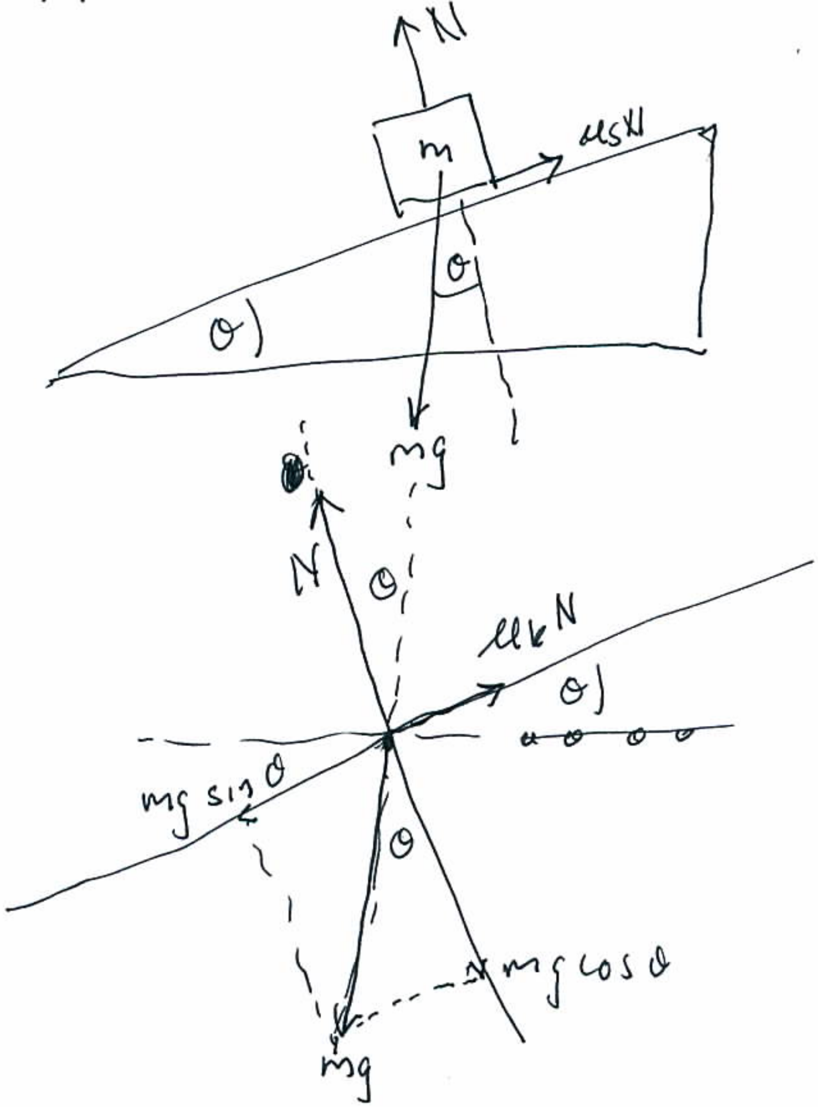


$$N = mg\cos\theta$$

$$mg\sin\theta_c = \mu_k N = \mu_s mg\cos\theta_c$$

$$\boxed{\tan\theta_c = \mu_s}$$

Acceleration down plane



$$N = mg\cos\theta$$

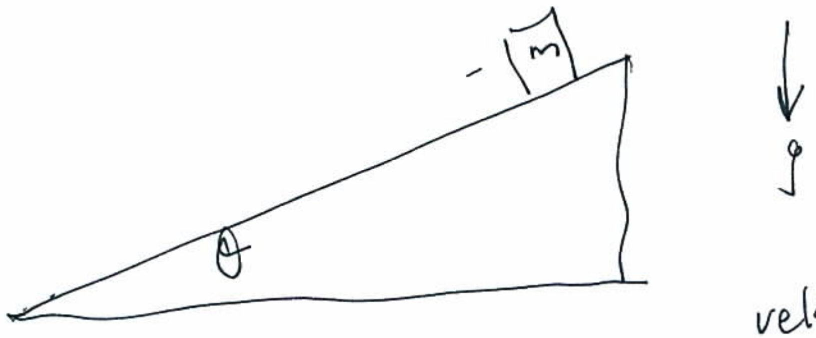
$$ma = mg\sin\theta - \mu_k N$$

$$= mg(\sin\theta - \mu_k\cos\theta)$$

$$\boxed{a = g(\sin\theta - \mu_k\cos\theta)}$$

If $\mu_k\cos\theta > \sin\theta$, kinetic friction decelerates block

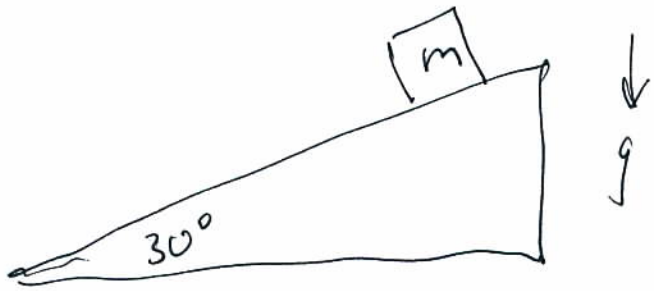
(4)



Block has an initial velocity value $\vec{v}_0 = 10\,m/s$ along incline. T or F

It will always reach the bottom of the incline. ($\mu_k = .75$, $\theta = 30^\circ$)

(a)	(b)	(c)
T	F	not enough info given

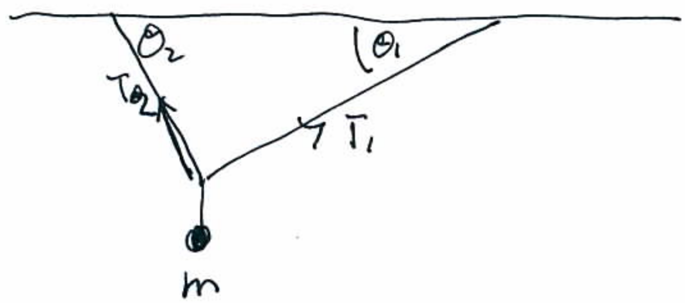


what information has to be given?

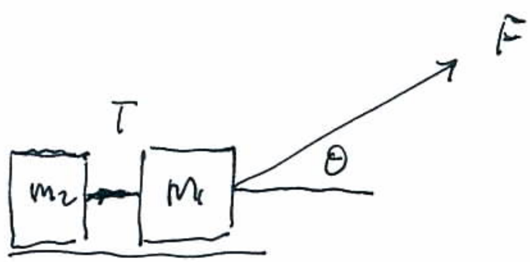
How far down incline does block go, if $F_k > mg\sin\theta$

$$2a(s_f - s_i) = V_f^2 - V_i^2$$

$$s_f - s_i = \frac{V_f^2}{2a} = \frac{V_s^2}{2g(\mu_k\cos\theta - \sin\theta)}$$



What is tension in supporting cables (of negligible mass)

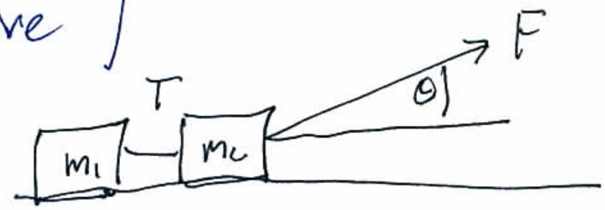


μ_k

what force to apply to go at const. velocity

Find Tension:

(somewhat repetitive)

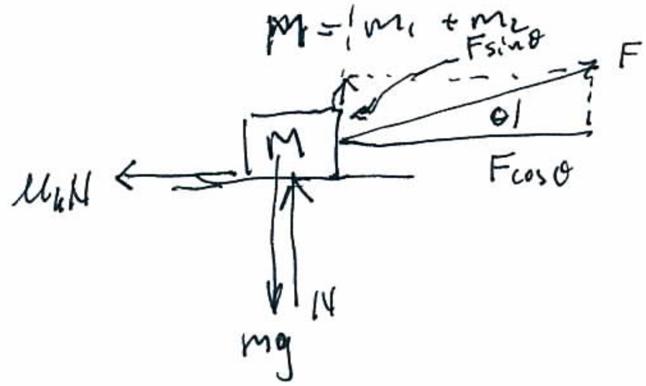


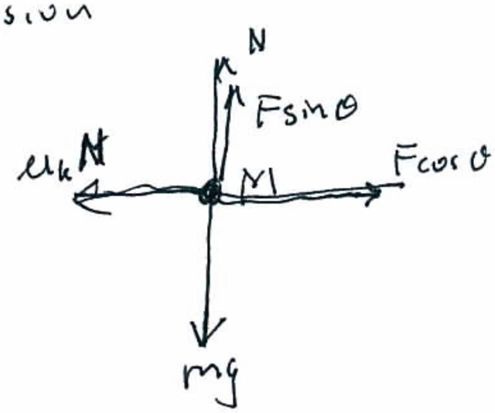
μ_k given

What is acceleration

What is tension

$M = (m_1 + m_2)$





Vertical Force

$N + F\sin\theta - Mg = 0$; $N = Mg - F\sin\theta$

$Ma = F\cos\theta - \mu_k N$

$Ma = F\cos\theta + \mu_k F\sin\theta - \mu_k Mg$

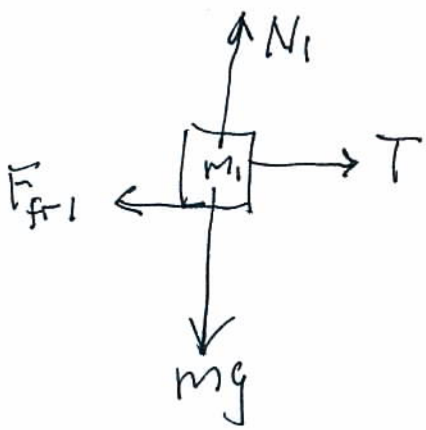
$Ma = F(\cos\theta + \mu_k \sin\theta) - \mu_k Mg$

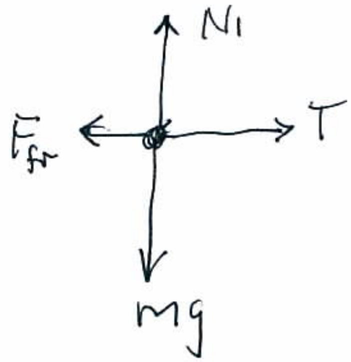
$$a = \frac{F}{M}(\cos\theta + \mu_k \sin\theta) - \mu_k g$$

(correct answer if positive)

Now, to solve for Tension:

$$\boxed{a = \frac{F}{m_1+m_2}(\cos\theta + \mu_k \sin\theta) - \mu_k g}$$





Vertica Component $N_1 - m_1 g = 0$, $N_1 = m_1 g$

$$F_{fr1} = \mu_k N = \mu_k m_1 g$$

$$F_x = T - F_{fr1} = T - \mu_k m_1 g = m_1 a$$

$\cancel{= m_1}$

$$= \frac{m_1 F}{m_1+m_2}(\cos\theta + \mu_k \sin\theta) - \mu_k m_1 g$$

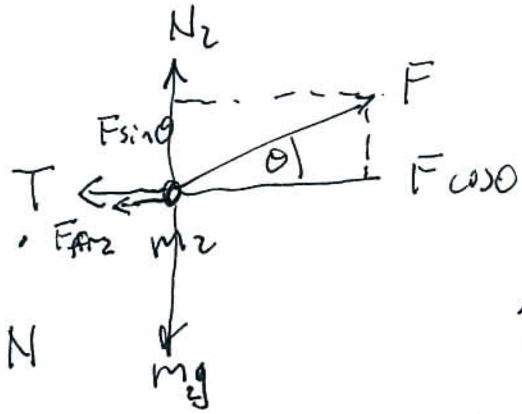
$$\boxed{\cancel{a = \frac{F}{m_1+m_2}(\cos\theta + \mu_k \sin\theta) - \mu_k g}}$$

solve for tension

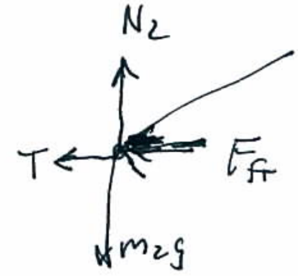
$$T = \frac{m_1}{m_1+m_2} F(\cos\theta - \mu_k \sin\theta)$$

Not in Lecture

Analyze Force diagram on m_2 alone



$F_{fr} = \mu_k N$



$$\sum_i \vec{F}_i = m a$$

Check: everything know

Upon substitution, we should obtain a identity

$$N_2 + F\sin\theta = mg$$

$$F\cos\theta - T - \mu_k N = m a$$

substitute all quanties we calculated. What will be result?

(a) We get new value

(b) We find an identity

(c) Not enough info

Car going around bend

Typically, on a rainy day, μ_s & μ_k are:

(a) less than on a dry day

(b) more than on a dry day

(c) ~~not enough info given~~

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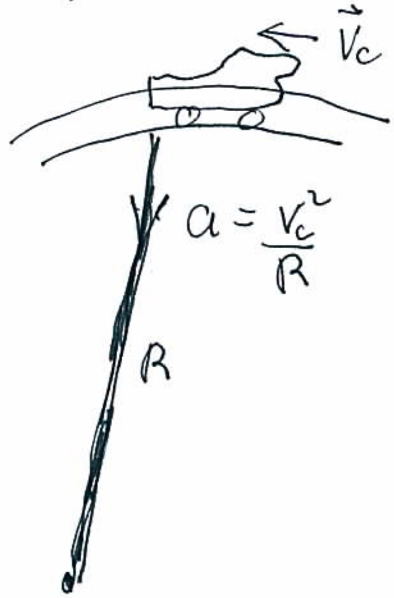
skidding - result of ignoring ~~in acces~~ weather conditions

Fastest velocity around a bend



Need normal force. Supplied by friction

$mg = N$

$F < \mu_s N$

$ma = \frac{mv^2}{R}$

$ma = \frac{mv^2}{R} = F < \mu_s N$

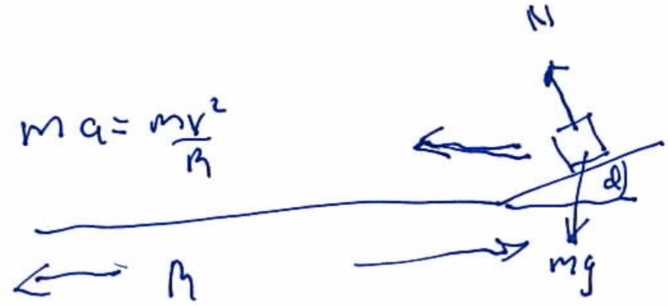
$\frac{mv^2}{R} < \mu_s mg$

$v < \left(\frac{\mu_s g}{R}\right)^{1/2} \longleftrightarrow v^2 < \frac{\mu_s g}{R}$

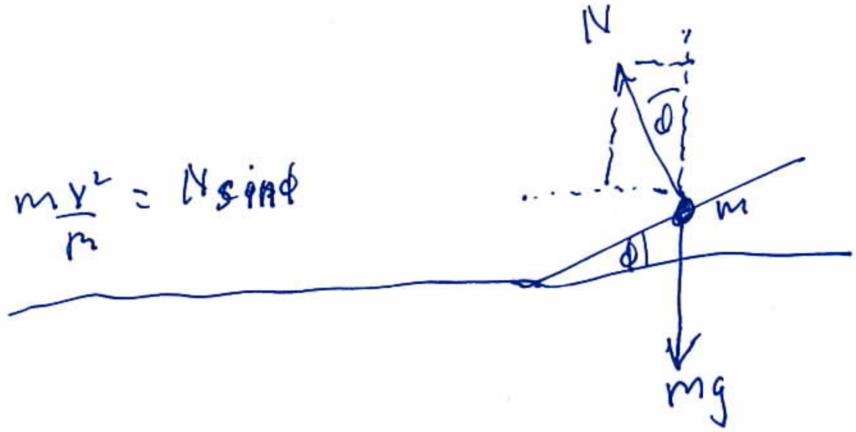
(10)

Banked Car (no need for friction to supply acceleration)

$ma = \frac{mv^2}{R}$



$\frac{mv^2}{R} = N\sin\phi$



$N\cos\phi = mg$

$N = \frac{mg}{\cos\phi}$

$\frac{mv^2}{R} = \frac{mg}{\cos\phi} \sin\phi = mg\tan\phi$

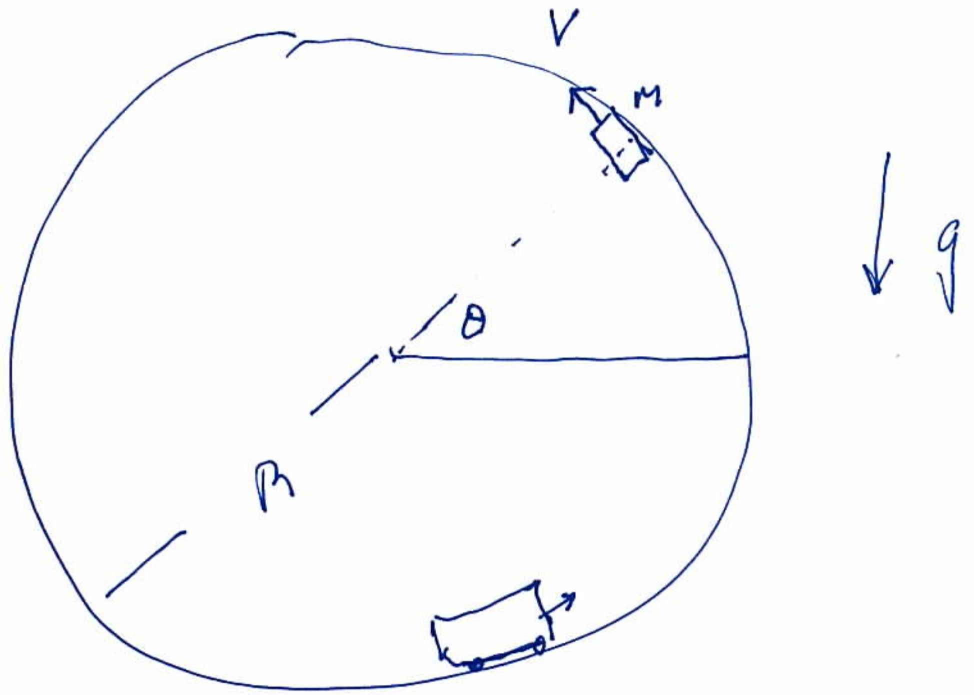
Bank angle

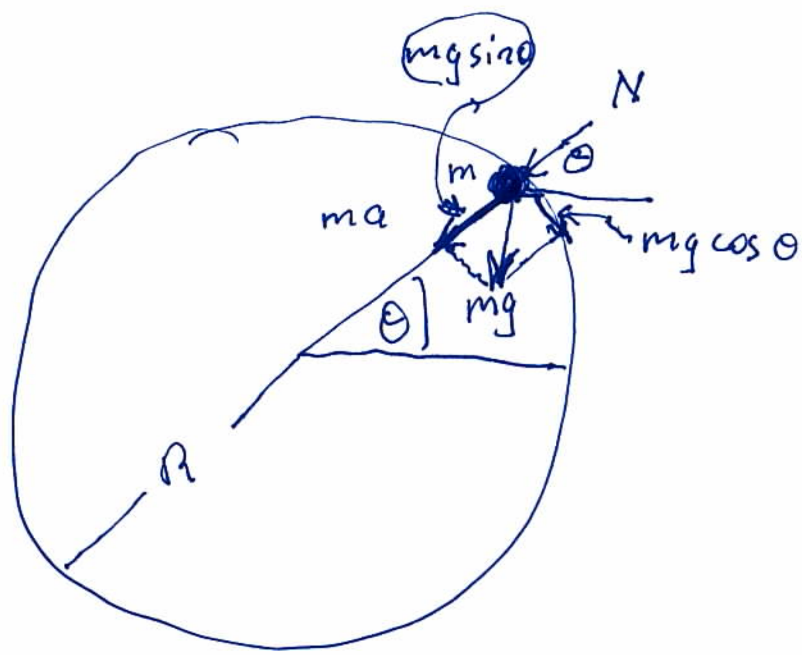
$$\boxed{\tan\phi = \frac{v^2}{gR}}$$

Given radius of turn and speed limit (suggested speed) angle of embankment

$$\phi = \tan^{-1}\left(\frac{v^2}{gR}\right)$$

At what speed will cart fall off track?





$ma = m\frac{v^2}{R} = mg\sin\theta + N$ (as long as $N > 0$, needed force can be applied)

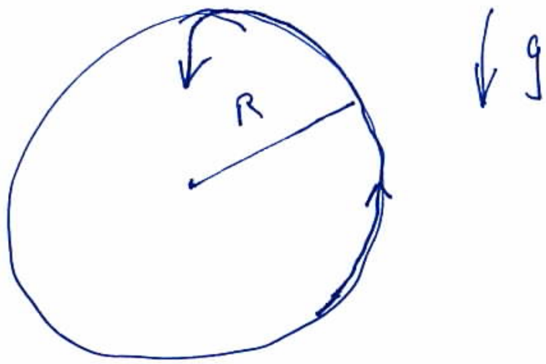
If N negative, normal force doesn't work

$N = 0$, when transition from circular motion arise

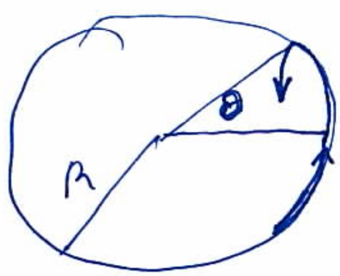
$\therefore\ v^2 = gR\sin\theta$; Falls of track at speed: $v = \sqrt{gR\sin\theta}$

What happens if $V < (gR)^{1/2}$

(1) Reaches maximum point of contact then plops down

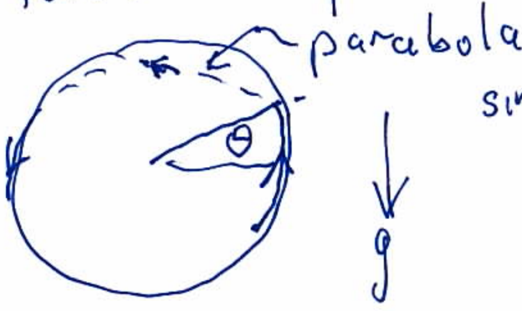


(2) Reaches maximum angle of contact, where $\sin\theta = \frac{V^2}{gR}$, and then falls vertically downward



$$\sin\theta = \frac{v^2}{gR}$$

(3) At maximum angle of contact cart takes off from trajectory and form a parabolic trajectory



$$\sin\theta = \frac{V^2}{gR}$$

On a drizzily windless day the rain drops fall (recall your personal observations)

(a) at constant acceleration g

(b) at constant acceleration $a < g$

(c) at constant velocity

Why?

air resistance $\vec{F}_{AR} = -\eta' \vec{v}$,

larger surface, large η'

~~Termi~~ Force on object falling in air

$\downarrow y$

$$\vec{F}_{tot} = m\vec{g} - \eta' \vec{v}$$

~~At~~ if v initially zero, objects accelerates, gains speed, force decreases, less acceleration. Eventually no acceleration

& ~~velo~~ velocity constant

$$\vec{F}_{tot} = m\vec{g} - \eta \vec{v} = 0$$

$$\vec{v} = m\vec{g}/\eta \equiv \text{terminal velocity}$$

Why is terminal velocity of a jet pilot ejected out off crashing plane, larger without a parachute than with a parachute?

(15)

~~14~~