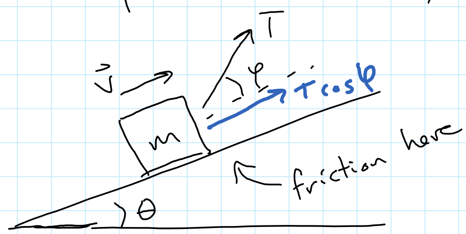
Phy 4A 10/17

Monday, October 17, 2016 9:55 AM

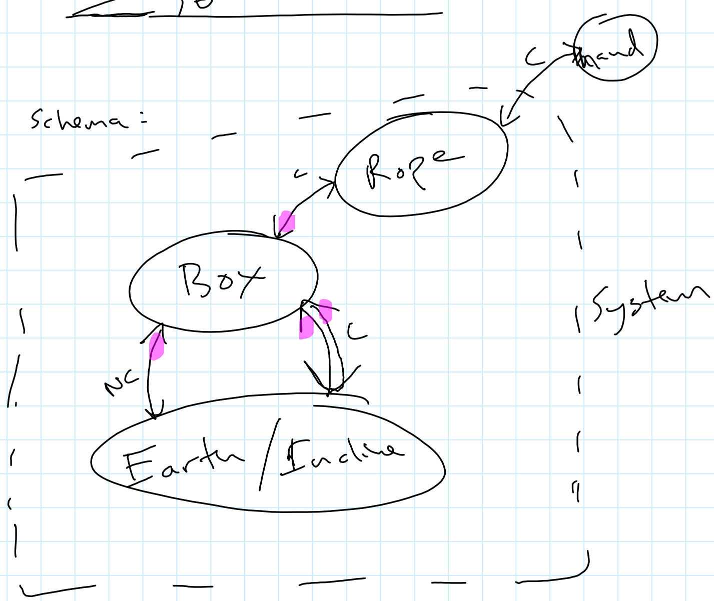
Goals for the Lecture:

1) Use Newton's Second Law to solve circular motion problems

Pulling a box up an incline w/ a rope

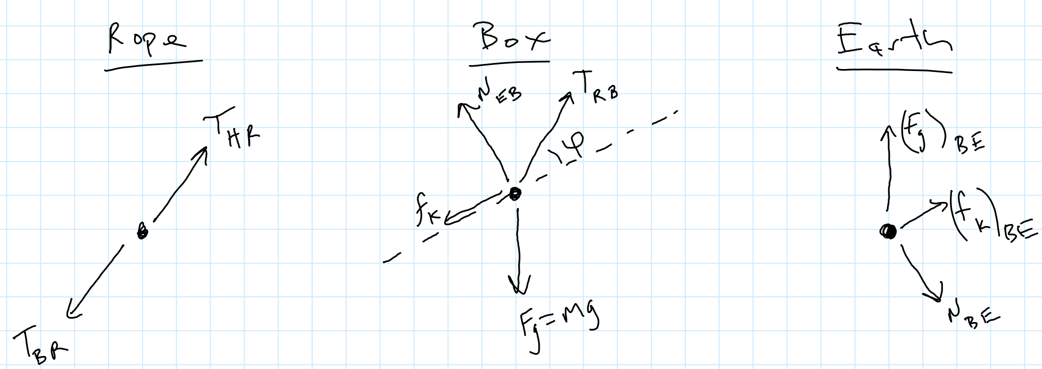


system schema:



Assume: massless Rope

FBD

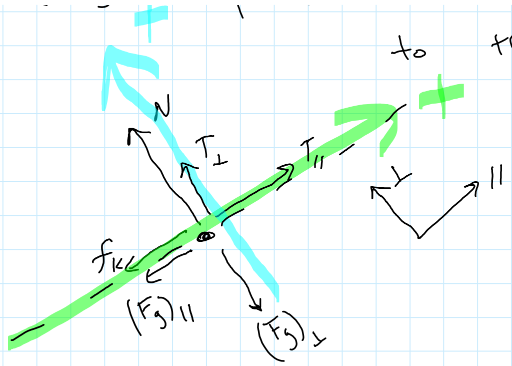


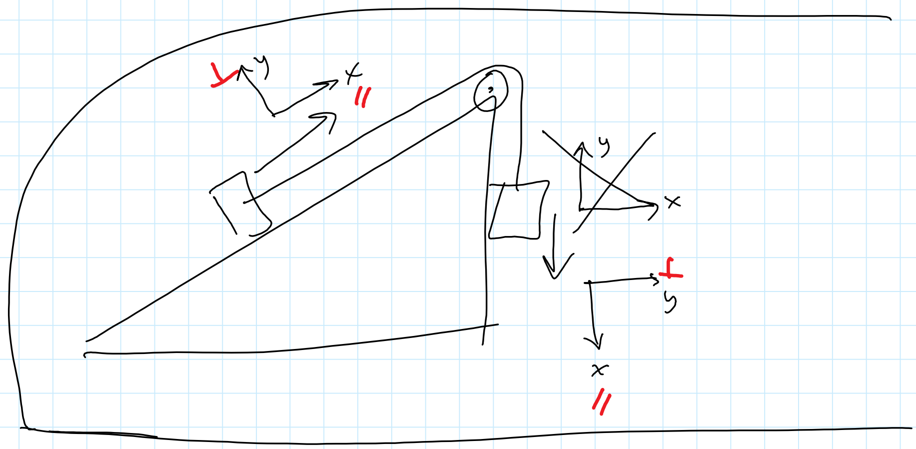
given: μ_k, m, θ, φ, T

find: a

use components: parallell and perpendicular to the incline:

to the incline :





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

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

+ up incline

$$\sum F_{\perp} = m a_{\perp}$$

+

$$T_{\parallel} - f_k - (F_g)_{\parallel} = ma$$

$$N + T_{\perp} - (F_g)_{\perp} = m \cancel{a_{\perp}}^{0}$$

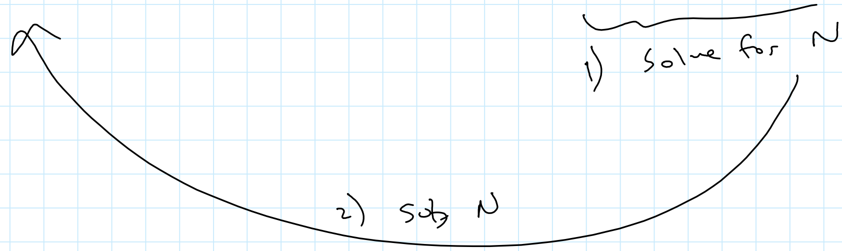
$$N + T_{\perp} - (F_g)_{\perp} = 0$$

$$\boxed{\begin{aligned} F_g &= mg \\ (F_g)_\perp &= mg\cos\theta \\ (F_g)_\parallel &= mg\sin\theta \\ T_\parallel &= T\cos\varphi \\ T_\perp &= T\sin\varphi \end{aligned}}$$

$$T\cos\varphi - \mu_k N - mg\sin\theta = ma$$

$$\underbrace{N + T\sin\varphi - mg\cos\theta = 0}$$

1) Solve for N



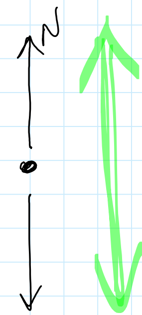
3) Solve for a

Apparent Weight:

mass : how much stuff something is made of
always the same

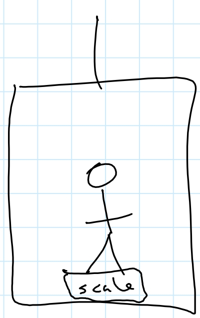
weight : gravitational force between object and planet/moon

FBD



Person's mass = 50 kg   use $g = 10 \frac{m}{s^2}$ $(F_g) = mg$

Elevator



a) Not moving:

$\Sigma F = 0 \quad \uparrow +$

$N = mg = 500\ N$

b) starts going down w/ $a = 2 \frac{m}{s^2} \downarrow$

$\Sigma F = ma \quad \uparrow +$

$N - mg = m(-2)$

$N = mg - 2m$

$= 400\ N$

c) V = constant in $\downarrow$ direction
$(a = 0)$

$N = mg = 500\ N$

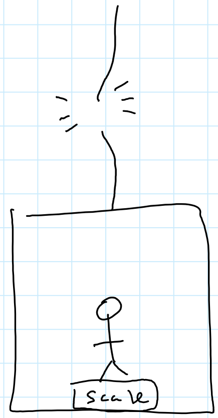
d) slows down $\quad a = 2 \frac{m}{s^2} \uparrow$

$\Sigma F = ma$

$N - mg = m(+2)$

$N = mg + 2m$

$= 600\ N$



e) Rope breaks → freefall

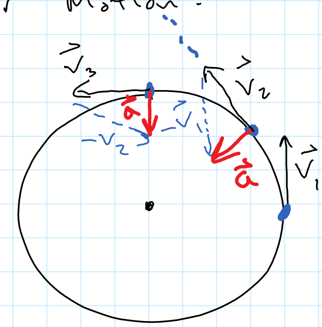
$\Sigma F = ma$ ↑+

$N - mg = m(-g)$

$N = 0$

"weightlessness"

Uniform Circular Motion: constant speed



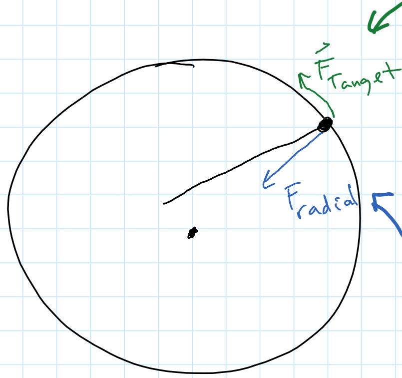
$|\vec{v}_1| = |\vec{v}_2| = |\vec{v}_3|$

Find $\vec{a}$: $a_{ave} = \frac{\Delta \vec{v}}{t} = \frac{\vec{v}_f - \vec{v}_i}{t}$

For circular motion

$a_{radial} = \frac{v^2}{R} = a_c$ centripetal acceleration

causes Tanget acceleration (changes objects speed only)



causes radial acceleration (changes objects direction only)

Centripetal Force

$F = ma$ $F = m a$

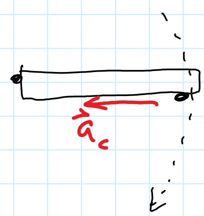
Centripetal Force

$F = ma$

$F_c = m a_c$

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

Top view of door



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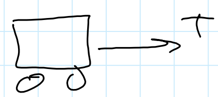
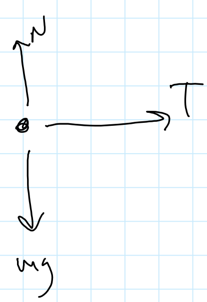
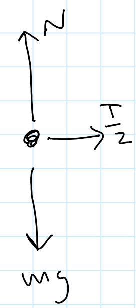
worksheet II-20



still speeds up, but at a lower rate





II-21

$\Sigma F = ma$ $\downarrow +$

$mg - T = ma$

$T = mg - ma$

$T < mg$

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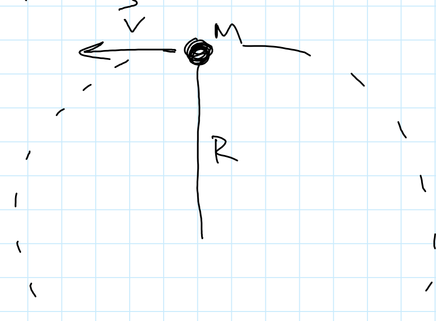
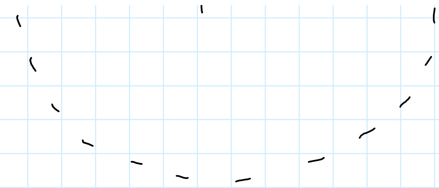
vertical circle: mass on a string

uniform circular motion: speed is constant $= v$





given: m, R, v

Find T in string at Top and bottom of Path

bottom

$$\Sigma F = ma \quad \uparrow + \text{ (radially inward)}$$

$$T - mg = m\left(\frac{v^2}{R}\right)$$

$$T = mg + \frac{mv^2}{R}$$

Top

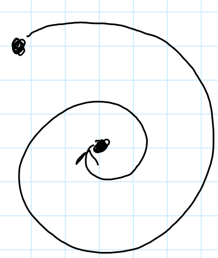
$$\Sigma F = ma$$

$$\Sigma F_{radial} = m a_c \quad \downarrow + \text{ (radially inward)}$$

$$T + mg = \frac{mv^2}{R}$$

$$T = \frac{mv^2}{R} - mg$$

ΣF_{radial}

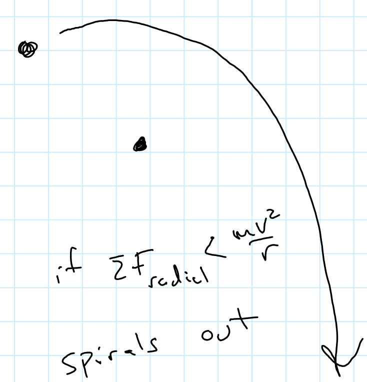


if $\Sigma F_{radial} > \frac{mv^2}{R}$

spirals in

if $\Sigma F_{radial} = \frac{mv^2}{R}$

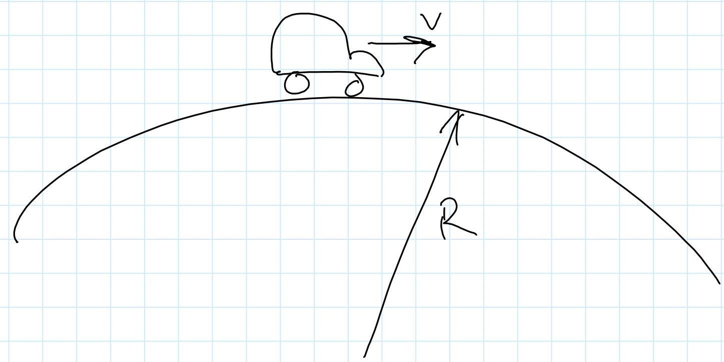
circular motion



if $\Sigma F_{radial} < \frac{mv^2}{r}$

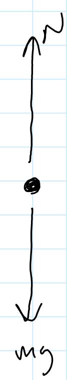
spirals out

Drive over a speed bump:



given : m, R

find : V_{max} such that car is just in contact with ground



$$\Sigma F_{radial} = m a_c \quad \downarrow +$$

$$mg - N = m \frac{v^2}{R}$$

at V_{max}, $N \to 0$

$$mg = \frac{m V_{max}^2}{R}$$

$$V_{max} = \sqrt{R g}$$