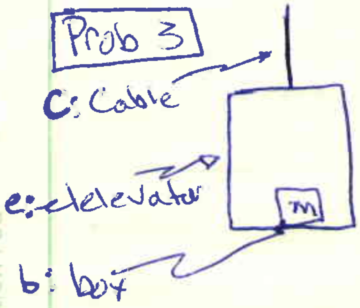
Pset #1

Prob 3



System: Elevator / box / Earth

Interactions

contact: e ⟷ b Normal force

contact: e ⟷ c tension

GRAV: e ⟷ E

$g = 10\,m/s^2$

$m = 50\,kg$: mass box

$M = 1000\,kg$: mass Elevator

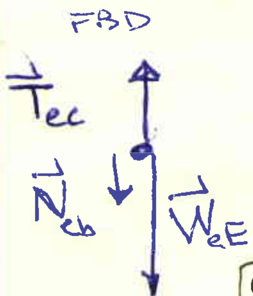
$a = 1\,m/s^2$

Motion.

$a = 1\,m/s^2$ could be ⇑ up or down ⇓

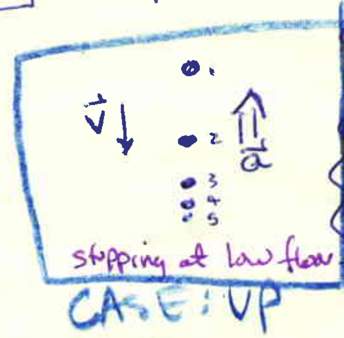
Find expressions for all Forces on elevator, Then evaluate..

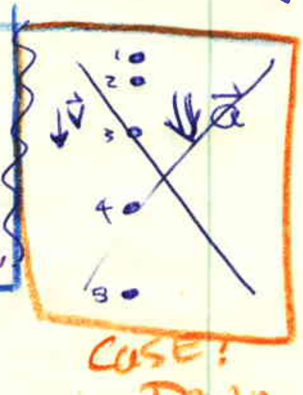
object: ELEVATOR



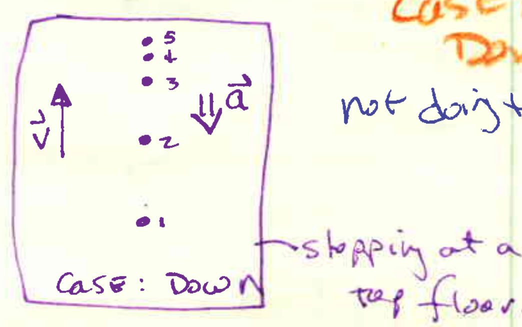
obj: box

$\boxed{\vec{a}_e = \vec{a}_b = \vec{a}}$ Motion





not doing this.



$\boxed{\text{case UP}}$ first... Moving down to stop at Lower floor.

means a ⇑.

ELEVATOR

NII: $\Sigma \vec{F}_e = m_e \vec{a} = M\vec{a}$

only 1-D $\{ F_{net\,e} = Ma = T_{ec} - W_{eE} - N_{eb}$

know $\boxed{W_{eE} = Mg}$ (local gravity)

so $T_{ec} = Ma + Mg + N_{eb}$.

so $T_{ec} = Ma + Mg + ma + mg$

or $\boxed{T_{ec} = (M+m)(a+g)}$

Need to find N_{eb} (on elevator by ~~Box~~) .. oh, Go look at ~~Box's~~ Box's Forces. One F on box is by elevator

b/c NIII : $\vec{N}_{eb} = -\vec{N}_{be}$.

FBD box: apply NII $\Sigma \vec{F}_{box} = m\vec{a}$ with $\vec{a}$ ⇑

1-D : $F_{net\,box} = ma = N_{be} - W_{bE} = N_{be} - mg$. since $W_{be} = mg$.

solve $\boxed{N_{be} = ma + mg}$. so means $\boxed{N_{eb} = ma + mg}$

Pset # 1

Prob 3 continued discussion in case: Up, $\vec{a}$ is upward

summary 3 eqn on Elevator

$W_{EE} = Mg \quad = (1000\,kg)(10\,m/s^2) = 10{,}000N = 10^4 N$

$\vec{a}\Uparrow \quad N_{eb} = m(a+g) = m(g+a) = (50\,kg)(10+1)\,m/s^2 = 550N$

$T_{ec} = (M+m)(a+g) = (M+m)(g+a) = (1050\,kg)(11\,m/s^2) = 11{,}550N$

$= 12{,}000N$

Case Down if $\vec{a}\Downarrow$. Replace each "a" in all of the preceding Application of NII + NIII With $(-a)$.

$\vec{a}\Downarrow$ then

$W_{EE} = Mg \quad = 10{,}000N$

$N_{eb} = -ma + mg = m(g-a) = (50)(10-1) = 450N$

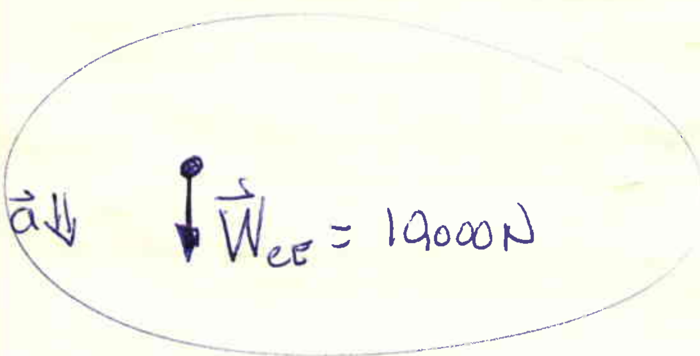
$T_{ec} = (M+m)(g-a) = (1050)(9) = 9450N.$

(b) elevator is on last floor ...

Assume not touching ground or walls ...

Cable Breaks — DRAW FBD of Elevator

$\vec{g} = \vec{a}\Downarrow$



in free fall $\Rightarrow$

No Normal force.

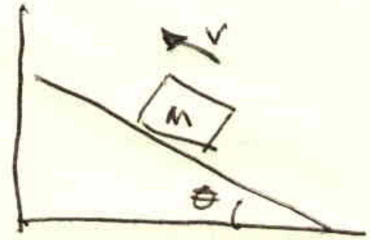
b/c box is in free fall too $\Rightarrow$

accel @ $\vec{g}$.

So this is equivalent to NO contact

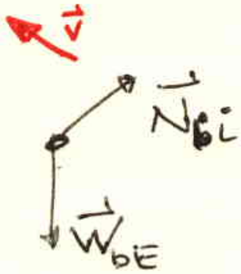
Pset #1 PROB 4 | p.1

PROB #4 Box Moving up incline angle $\alpha = \Theta$ in Drawing. stops + slides back down.

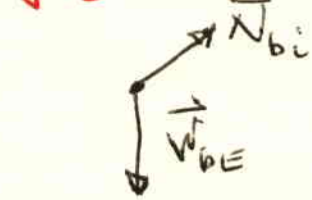


FBD UP

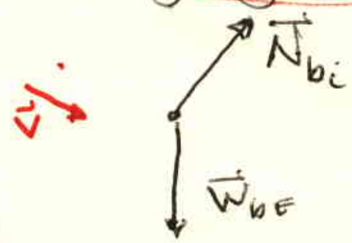
a)



FBD Stopped

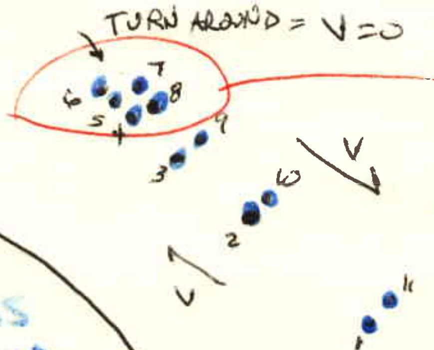


FBD going down



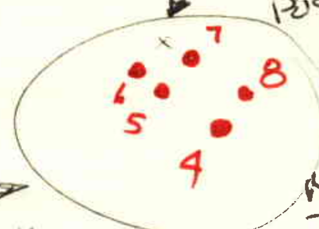
b = box
i = incline
E = Earth

b) MOTION DIAGRAM: going up : stopped : going down



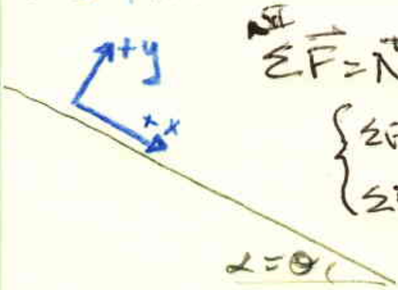
BLOW UP / ZOOM in

dot Not in Same position at 2 time Moment



if dot at Some position for 2 "snap shots" then it WOULD have Stopped and "rested" for one Δt interval ... No!

c) convenient coord. system: ONE that aligns one Axis with $\vec{a}$.



$$\Sigma\vec{F} = \vec{N}_{bi} + \vec{W}_{bE} = m\vec{a}$$

$$\begin{cases} \Sigma F_x = ma \\ \Sigma F_y = 0 \end{cases}$$

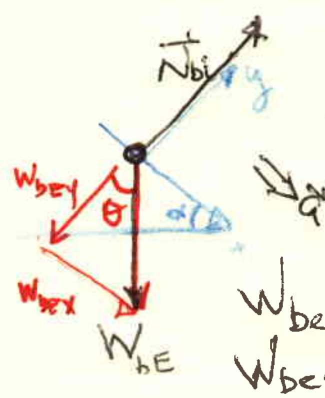
convenient!

So...

$$\Sigma F_x = ma = N_{bix} + W_{bEx}$$

$$ma = 0 + W_{bE}\sin\Theta$$

$$\boxed{F_{net} = ma = mg\sin\Theta}$$



$W_{bEx} = W_{bE}\sin\Theta$
$W_{bEy} = W_{bE}\cos\Theta$

by the way:
$$\Sigma F_y = \emptyset = N_{biy} - W_{bEy}$$
$$N_{bi} = mg\cos\Theta$$

Pset # 1

PROB #4

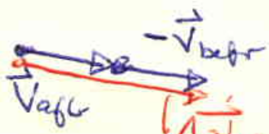
{a Really long but pretty thorough complete sentence response to part "d"}

d) Yes. F_{net} is <u>down</u> the incline, along or parallel to the incline surface that the block is constrained (by the N_{bi}) to move along. Since $\vec{F}_{net}$ is down the incline, then when the motion is up the incline, DOTS on the MD are more closely spaced as ~~as~~ the box progresses because it is slowing down. At the top, when the box momentarily stops it actually stops going up and starts going down. A tiny moment before it stop + after it stops would have velocity vectors in opposite direction

since $\vec{a} = \frac{\Delta\vec{V}}{\Delta t} = \frac{\vec{V}_{aftr} - \vec{V}_{befor}}{\Delta t}$,

$\Delta\vec{V} = \vec{V}_{aftr} - \vec{V}_{befor}$ the $\Delta\vec{V}$ vector is pointed

$= \vec{V}_{aftr} + (-\vec{V}_{before})$ down the hill so $\vec{a}$ is down hill, so F_{net} is down hill, consistent with MD.



On the ~~up~~ downhill path, accel is down hill (in Direction of $F_{net} = mg\sin\theta$) indicated in the MD by increasing spacing as time ticks on from → .

Pset # 1

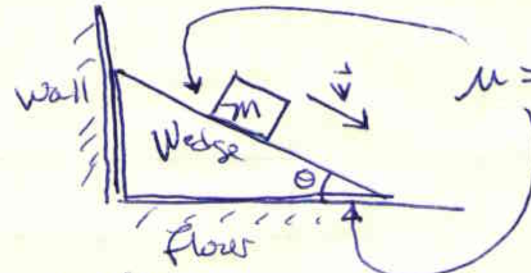
PROB 4 P3

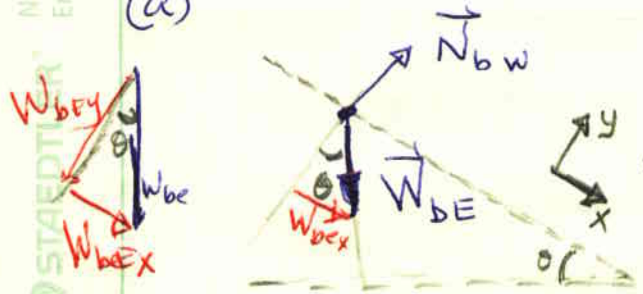
PROB 4 e) a similar Motion Diagram {in spacing, vector direction}

- a ball thrown straight up, stops, comes back down
- it will be interesting to see yours!

PROB 5

(a) Block FBD.





$\Rightarrow \vec{a}$ down ~~track~~ wedge constrained by N_{bw}

w = wedge f = floor

b : block

E : Earth.

WL = wall

in that coord system NII: $\Sigma \vec{F} = m\vec{a}$

$$\Sigma F_x = ma = W_{bE} \sin\theta = \boxed{F_{net} = mg \sin\theta}$$

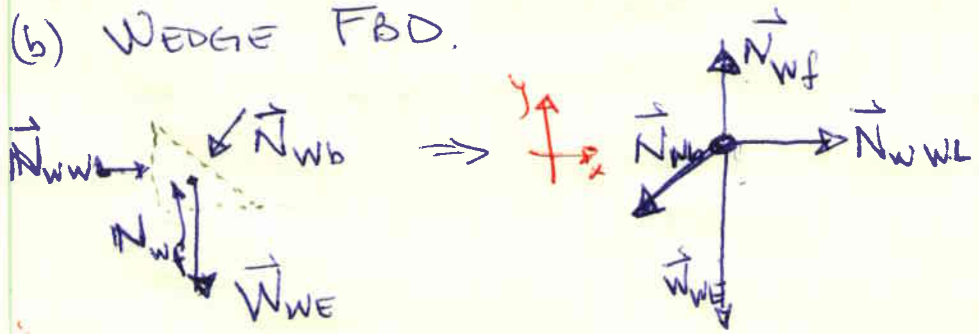
$\Sigma F_y = 0 =$

component of W_{bE} in x-direction

$\Sigma F_y = 0 = N_{bw} - W_{bEy}$

$N_{bw} = W_{bey} = W_{bE} \cos\theta = mg\cos\theta$

(b) WEDGE FBD.



Find

Force By WL on W

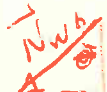
$|\vec{N}_{WWL}| = N_{WWL}$

$\vec{F}_{net\,w}$ appears somewhat back, but $\vec{a}_{wedge} = 0$ b/c Wall is in the way [constrained by N_{WWL}!]

So $\Sigma \vec{F} = M_w \vec{a} = 0 \left\{ \Sigma F_x = N_{WWL} - N_{Wbx} = 0 \right.$

$N_{WWL} = N_{Wbx} = N_{Wb} \sin\theta$.

TRIG
$\sin(\theta + \phi) = \sin\theta \sin\phi + \cos\theta \cos\phi$



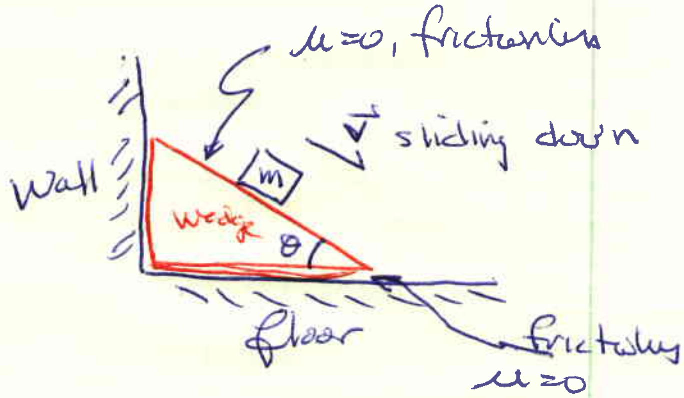
$N_{Wbx} = N_{Wb} \sin\theta$

But NIII says $N_{Wb} = N_{bW} = mg \cos\theta \sin\theta = \frac{1}{2} mg \sin 2\theta$

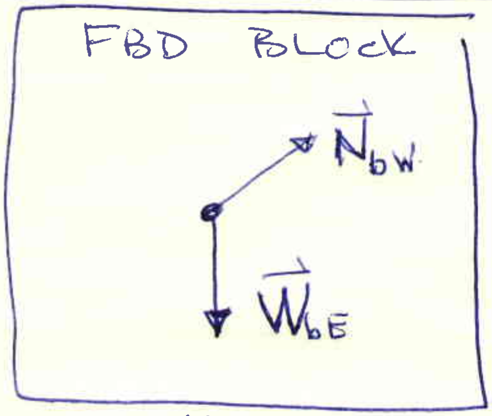
$\| N_{WWL} = \frac{1}{2} \sin 2\theta \|$

Prob #5

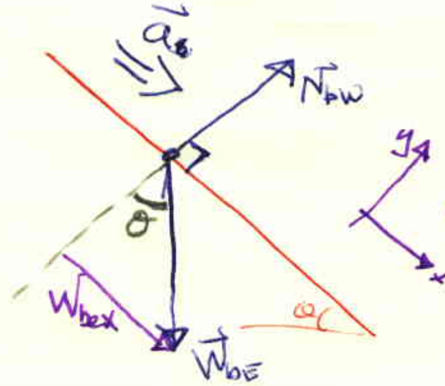
(a) System: block
wedge
floor
(Earth)



find F_{net} on BLOCK



no other interactions with Block.



convenient coord system: 2 vectors aligned with coord-axis.

Apply NII to block: $\sum \vec{F}_b = m_b \vec{a}_b$

$$\begin{cases} \sum F_x = m_b a_{bx} = m_b a = W_{bex} = F_{net} \\ \sum F_y = 0 = N_{bW} - W_{bEy} \end{cases}$$

NOTE: convenient coord system choice when all $\vec{accel}$ is in on coord. axis dir Then one (or 2) component of $F_{net} = 0$

so $F_{net\ block} = W_{bEx}$

so $\boxed{F_{net\ block} = mg \sin\theta}$ ##

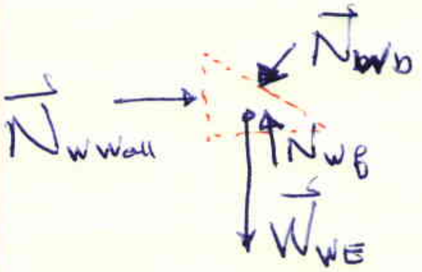
$$\sin\theta = \frac{W_{bex}}{W_{bE}}$$

$$W_{bex} = W_{bE} \sin\theta = mg \sin\theta$$

Pset #1

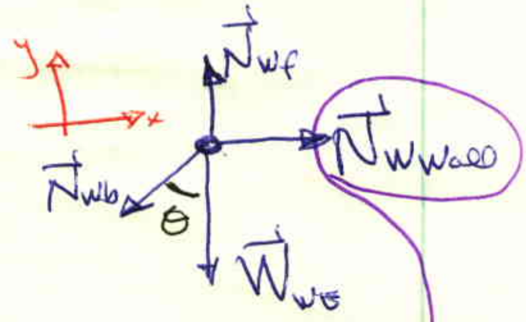
$\boxed{\text{PROB \#5}}$ (b) find Force by wall on wedge.

in this system I Need all Forces on WEDGE.



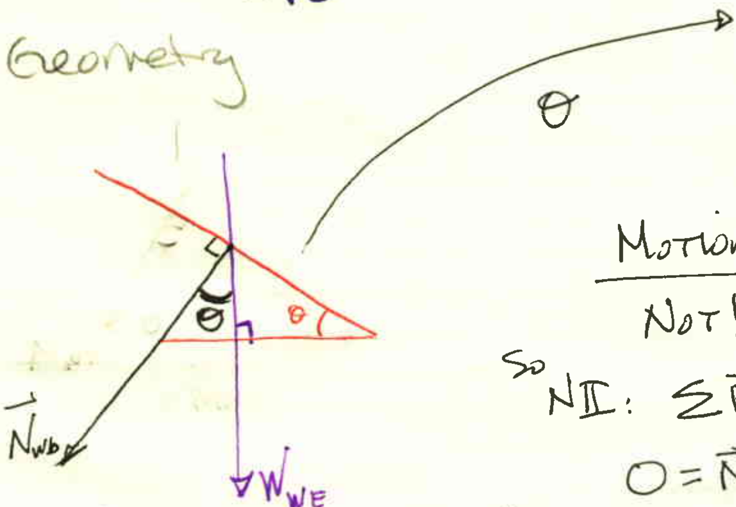
w: wedge
b: box
f: floor
E: Earth
wall = wall

FBD wedge



find this!

Geometry



Motion of WEDGE

Not! $\vec{v}=0$ + $\vec{a}=0$

So NII: $\Sigma \vec{F}_w = M_w \vec{a} = 0$

$0 = \vec{N}_{wf} + \vec{N}_{wb} + \vec{W}_{wE} + \vec{N}_{wwall}$

y x

$\Sigma F_x = N_{wwall} - N_{wbx} = 0$

$N_{wwall} = N_{wbx} = N_{wb} \sin\theta$

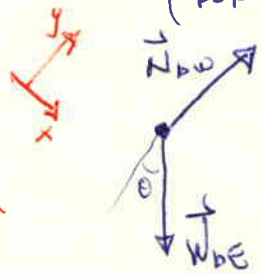
$N_{wbx} = N_{wb}\sin\theta$

if I can solve for N_{wb}! I've got it.

This is Force Interaction between WEDGE + Box.

NIII: $\vec{N}_{wb} = -\vec{N}_{bw}$ (box on wedge) ⇒ look @ FBD of Box

(wedge on box)



$\Sigma F_y = 0 = N_{bw} - W_{bEy}$

$N_{bw} = W_{bEy}$

$N_{bw} = m_b g \cos\theta$

(look at Drawing on p.1)

in coordinate system

$a_y = 0$ so

$\Sigma F_y = 0$ NII. So

So $\boxed{N_{wwall} = N_{bwx} = m_b g \cos\theta \sin\theta = \frac{1}{2} mg \sin 2\theta}$

FORCE BY WALL ON WEDGE