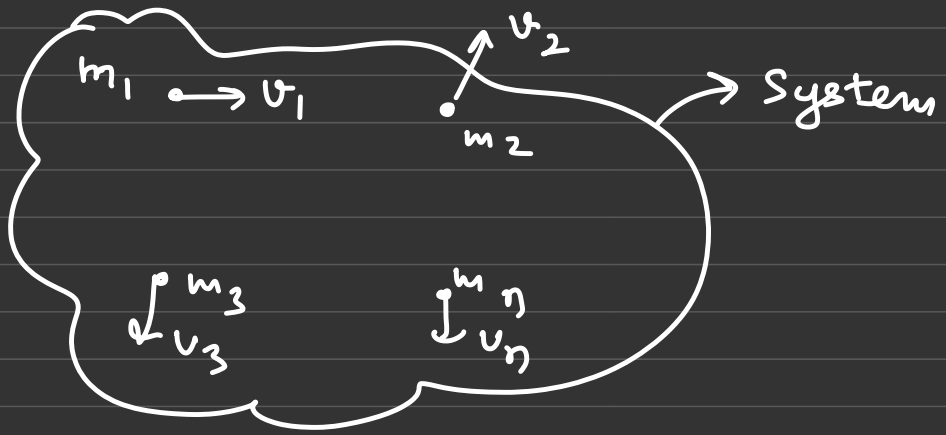
E&M4


VMC
Vidyamandir
Classes
SINCE 1986
IIT JEE | MEDICAL | FOUNDATION

Law of Conservation of momentum:

System:



$$\vec{p}_{system} = m_1 \vec{v}_1 + m_2 \vec{v}_2 + m_3 \vec{v}_3 + \dots + m_n \vec{v}_n$$

$$\frac{d}{dt}(\vec{p}_{system}) = m_1 \frac{d\vec{v}_1}{dt} + m_2 \frac{d\vec{v}_2}{dt} + \dots + m_n \frac{d\vec{v}_n}{dt}$$

$$\frac{d}{dt}(\vec{p}_{system}) = m_1 \vec{a}_1 + m_2 \vec{a}_2 + \dots + m_n \vec{a}_n$$

$$\frac{d}{dt}(\vec{P}_{system}) = (\vec{F}_{net})_1 + (\vec{F}_{net})_2 + \cdots (\vec{F}_n)_{net}$$

$(\vec{F}_1)_{ext}$ $(\vec{F}_1)_{int}$ $(\vec{F}_2)_{ext}$ $(\vec{F}_2)_{in}$ $(\vec{F}_n)_{ext}$ $(\vec{F}_n)_{in}$

$$\frac{d}{dt}(\vec{P}_{system}) = \sum \vec{F}_{ext} + \sum \vec{F}_{int}$$

$\sum \vec{F}_{int} = 0$

$$\sum \vec{F}_{ext} = \frac{d}{dt}(\vec{P}_{system})$$

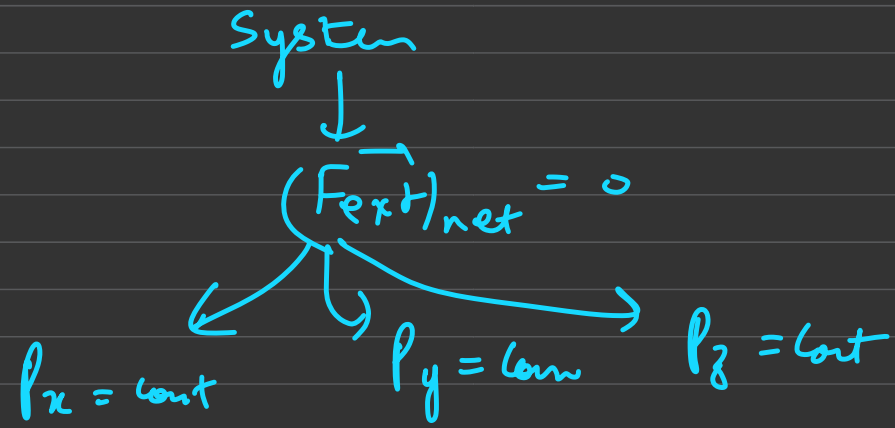
if $\vec{F}_{ext} = 0$ then $P_{system} = cst$

if on any System $ext = 0$ then

$P_{system} = Const$

" Law of Conservation of linear momentum "

#



on any System

$(F_{ext})_x = 0$ $(F_{ext})_y \neq 0$

$(F_{ext})_z \neq 0$

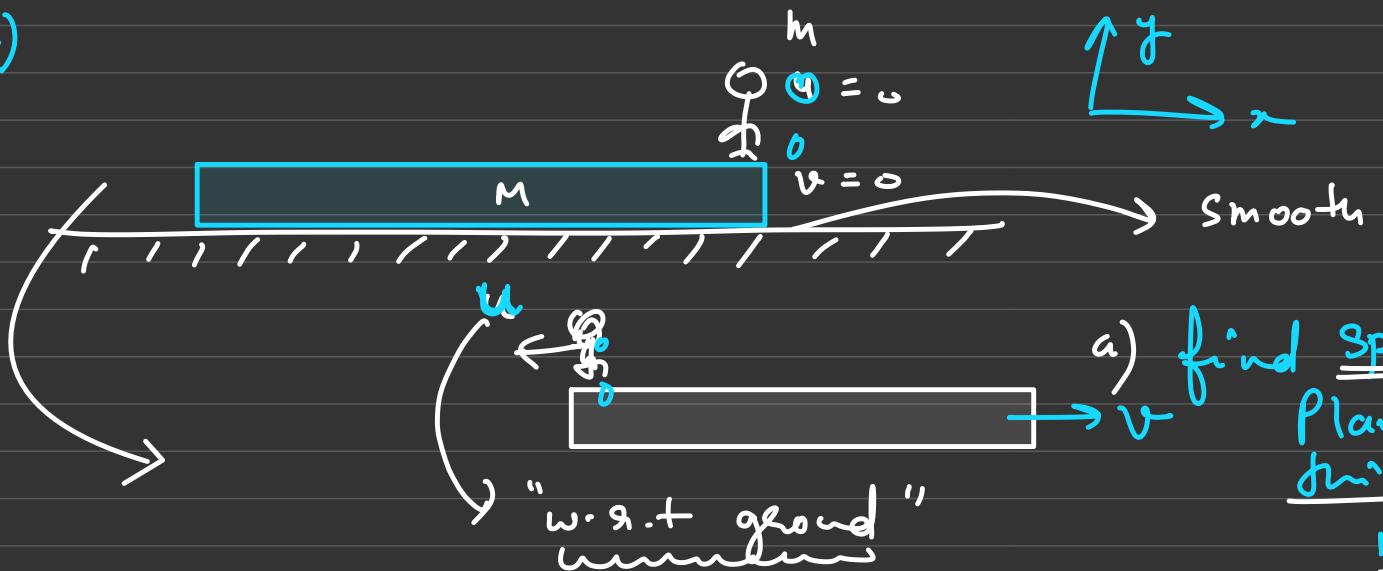
$p_x = \text{const}$ but $p_y \neq \text{const}$

$p_z \neq \text{const}$

as

$t = 0$

Q)



a) find <u>speed of plank at this instant</u>?

as (F_{ext}) along x-axis $= 0$ hence

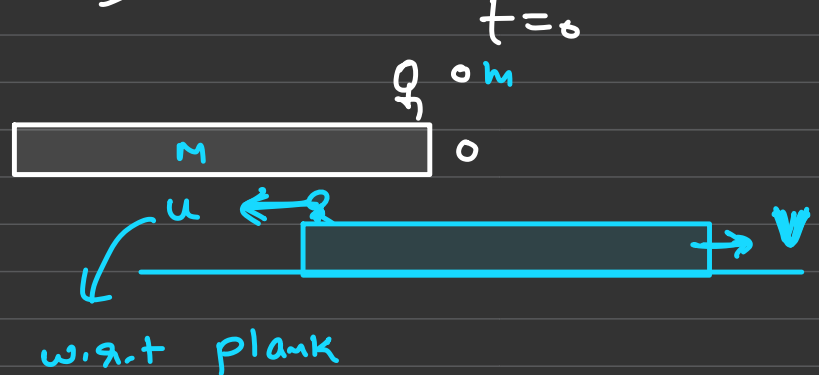
momentum must be conserved

$t = 0$ ——— after time t

$0 + 0 = -mu + M(+V)$

$$V = \left(\frac{mu}{M}\right)\hat{i}$$

(b)

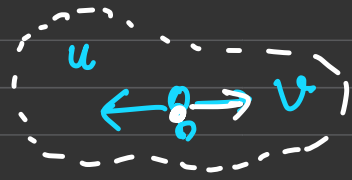


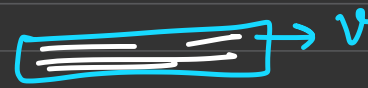
find speed of plank at this instant?

"whenever we apply L. of. C. of L.M then

that must be w.r.t ground "

$t = 0$ after 't'



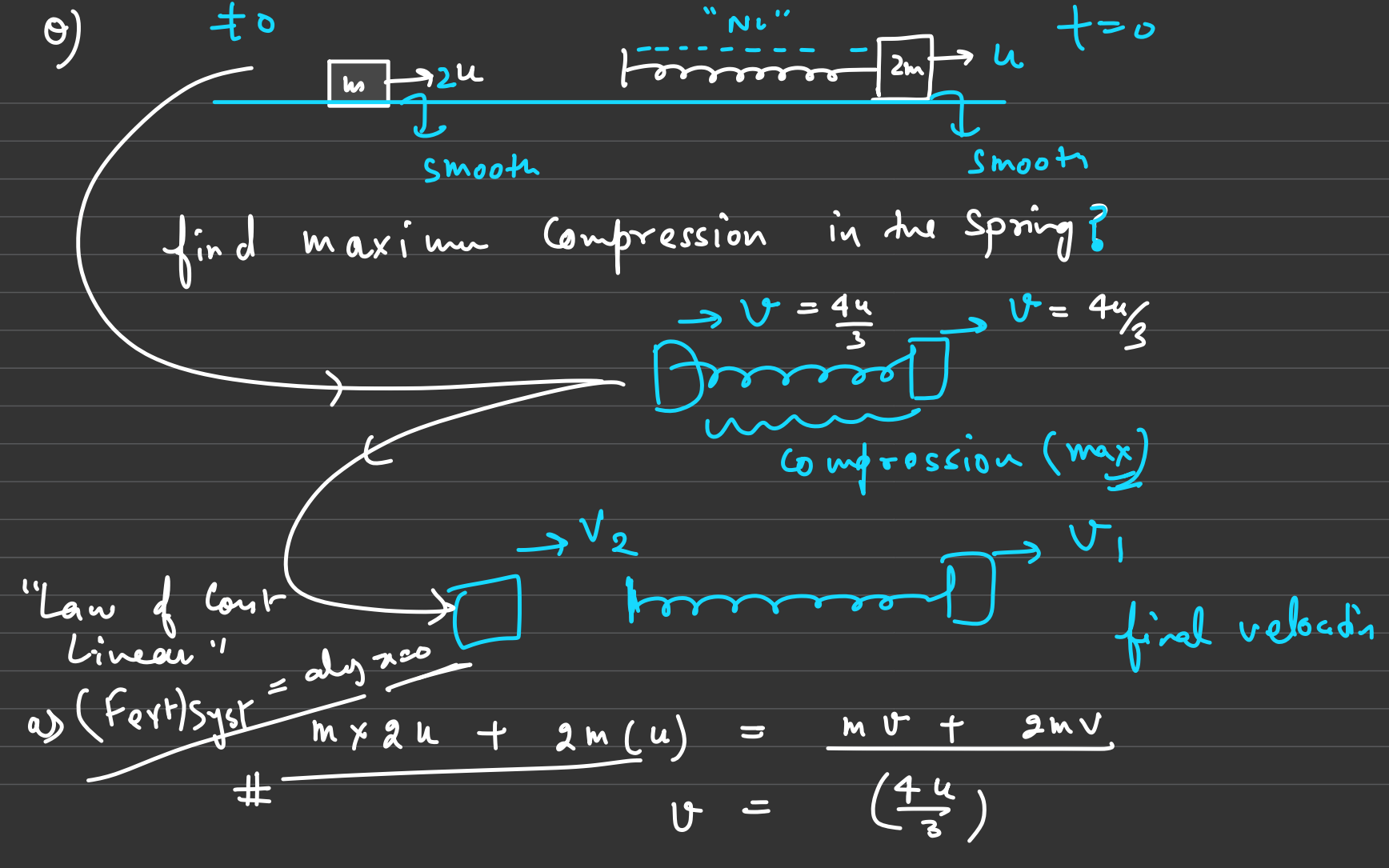


$$0 + 0 = +m(v - u) + M(v)$$

$$0 + 0 = mv - mu + Mv$$

$$v = \frac{mu}{m+M}$$

" w.r.t ground"


θ)
t≠0
"Nil"
t=0
m
2u
2m
u
smooth
smooth
find maximum Compression in the Spring?
v = 4u/3
v = 4u/3
Compression (max)
V2
V1
"Law of Conservation of Linear"
final velocity
a) (Ferl)Syst = 0 ⇒ a = 0
m × 2u + 2m(u) = mv + 2mv
#
v = (4u/3)

Law of conservation of energy:

loss in Kinetic energy of m = gain KE of $2m$ + gain spring P.E

$$\frac{1}{2}m(2u)^2 - \frac{1}{2}m(v)^2 = \frac{1}{2}2m(v)^2 - \frac{1}{2}2m(u)^2 + \frac{1}{2}k x_m^2$$

$v = \left(\frac{+1}{3}\right)$

{ x_m = ? Solve it }

(iii) find final velocities?

"On System of m, $2m$, Spring, we can simply apply Law of Conservation" $(F_{ext})_x = 0$

$m(2u) + 2m(u) = m(v_1) + 2m(v_2)$

$$4u = v_1 + 2v_2 \quad \text{—(1)}$$

Law of Conservation of energy :

$$\frac{1}{2}m(2u)^2 - \frac{1}{2}m(v_1^2) = \frac{1}{2}2m(v_2)^2 - \frac{1}{2}2m(u)^2$$

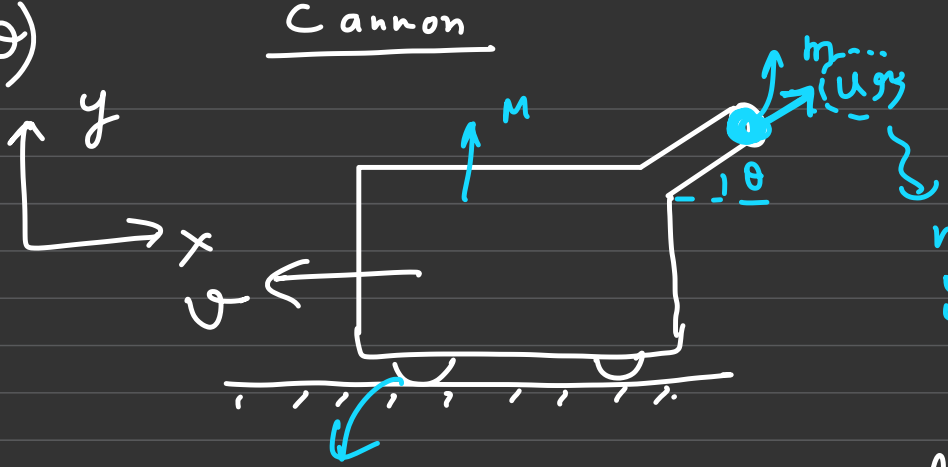
—(11)

$v_1 = \{ x_1 \; y_1 \}$ → we have to velocity in which bodies are set?

$v_2 = \{ x_2 \; y_2 \}$

Q)

Cannon



Just before firing whole system is at rest

nozzle velocity

"Speed of bomb w.r.t cannon"

find speed (recoil speed) of cannon. ?

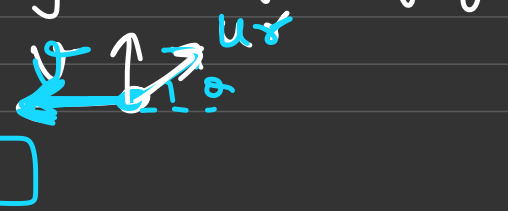
$(F_{ext})_x = 0$ $\quad P_x = \text{const}$

Just before firing

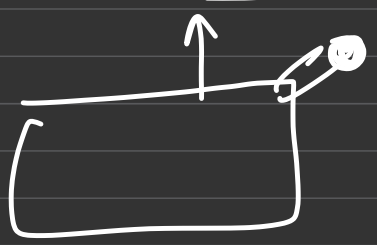
$0 + 0$

$=$

Just After firing



find $(mu_r \sin\theta)$

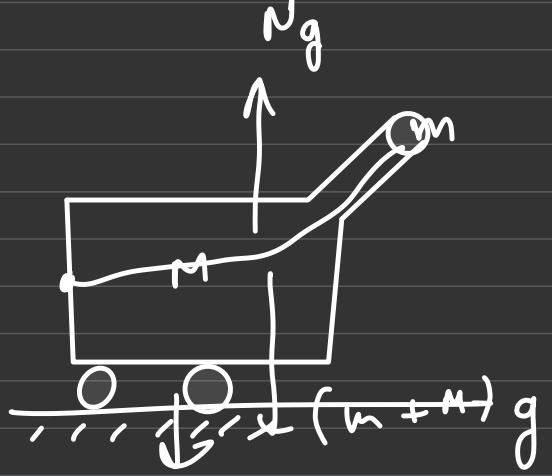


impulse $\Rightarrow$

$$0 = -MV + m(u_r \cos\theta - V)$$

$$MV = mu_r\cos\theta - mV$$

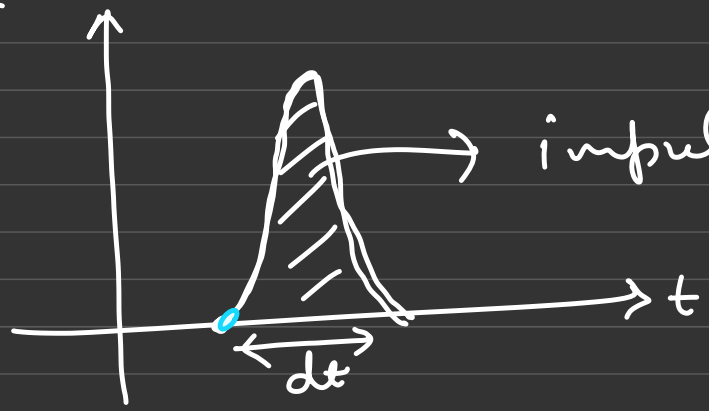
$$V = \frac{mu_r\cos\theta}{m+M}$$ Ans



$N_g >>> (m+M)g$

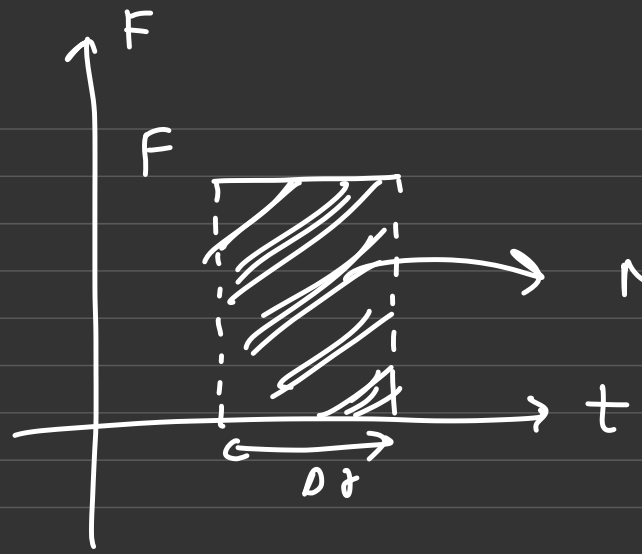
Impulse: if a force is changing finite momentum of body in very small time (dt) then impulse due to that force must be $I = \int F\,dt$

(i)



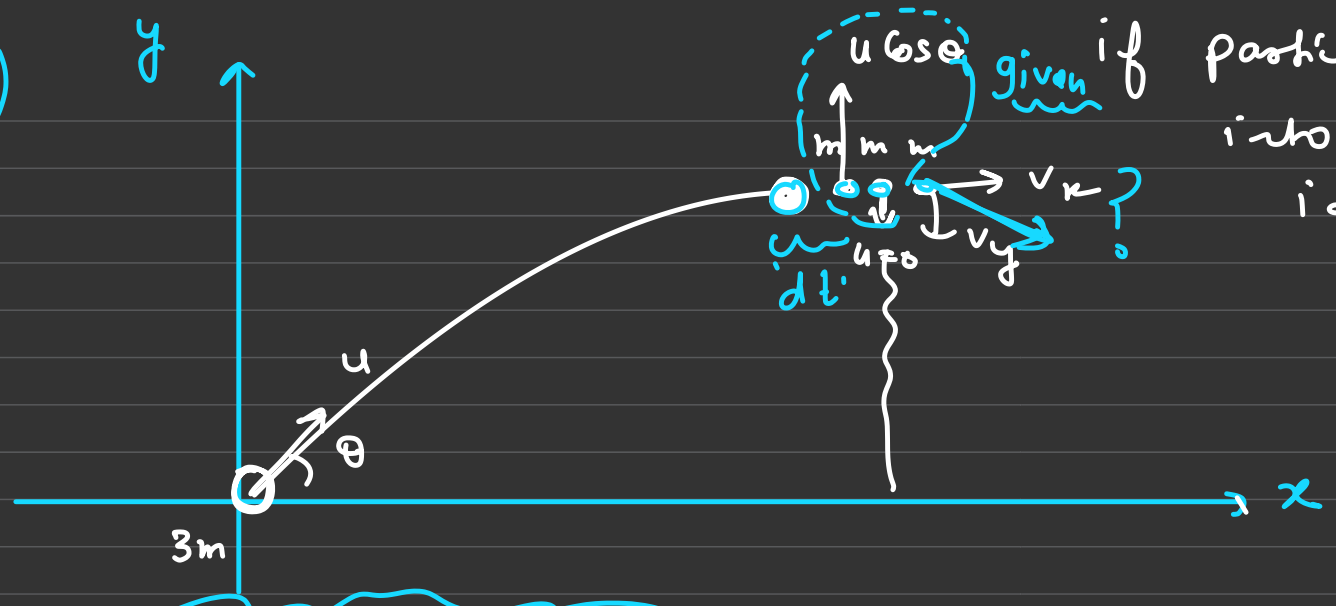
$$I = \int F\,dt = \int \frac{dp}{dt}\cdot dt = \int dp = \Delta p$$

(ii)



$I = F \Delta t$

Non-impulsive



given if particle breaks into three identical Particle at topmost point then find speed of third Particle

$I = \int F\,dt = \Delta p$

if F = finite $I = 0 = \Delta p = p_i = p_f$

if F = large (impulsive) $I \neq 0$ $\Delta p \neq 0$ $p_i \neq p_f$

Law of Conservation of momentum along x-axis is valid as $(F_{ext})_x = 0$

just before	just after
$3mv\cos\alpha = +mv_n$	

$$v_n = 3v\cos\alpha \;\rightarrow$$

as $(3mg)\downarrow$ is not impulsive hence impulse along y-axis $= 0$

$$p_i = p_f$$

$$0 = m u\cos\theta + 0 - m v_y$$

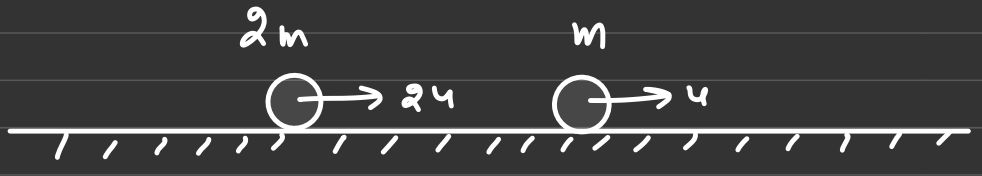
$$v_y = u\cos\theta$$

$$v = \sqrt{(3u\cos\theta)^2 + (u\cos\theta)^2}$$

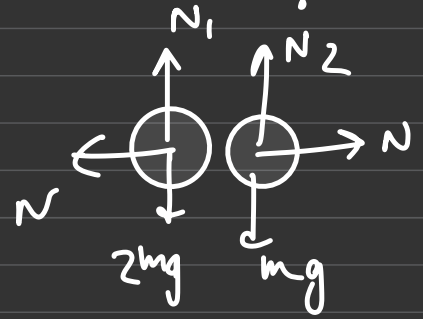
$$v = u\cos\theta\sqrt{10}$$

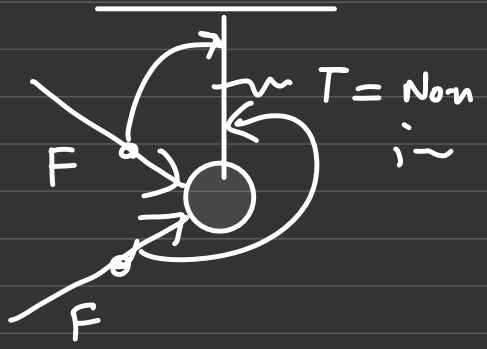
8)

Given: moving in straight line



find velocities after collision "if there is no loss in KE"





INEB

II) DTS #3 → Level 1 / Level 2