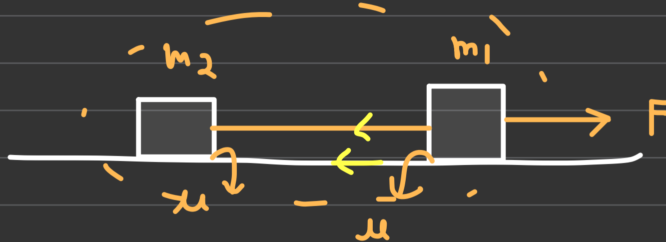
Dynamics 6

θ)



$$F - \mu m_1 g - \mu m_2 g = (m_1 + m_2) a$$

$$a = \frac{F - \mu m_1 g - \mu m_2 g}{m_1 + m_2}$$

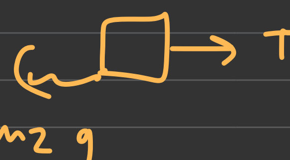
$$F = T + \mu m_1 g$$

$$T = F - \mu m_1 g$$

$$y = x - c$$

$$\Rightarrow a$$

$$T - \mu m_2 g = m_2 a$$



$$T = \mu m_2 g + m_2\left[\frac{F - \mu m_1 g - \mu m_2 g}{m_1 + m_2}\right]$$

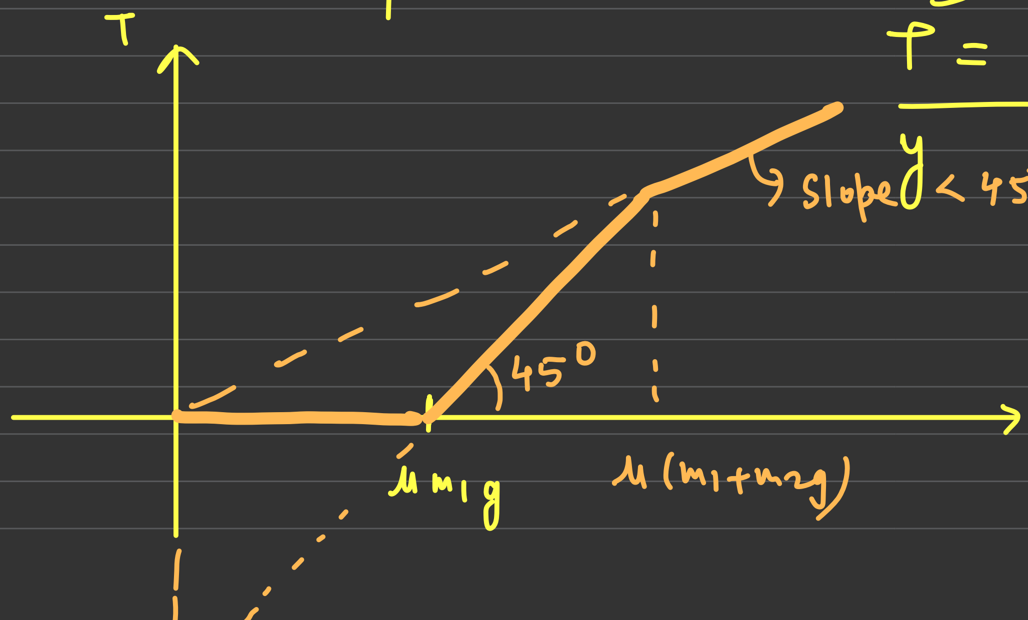
$$T = \mu m_2 g + \frac{m_2 F - \mu m_1 m_2 g - \mu m_2^2 g}{m_1 + m_2}$$

$$T = \frac{\mu m_1 \cancel{m_2} g + \mu \cancel{m_2}^2 g + m_2 F - \mu \cancel{m_1} m_2 g - \mu \cancel{m_2}^2 g}{m_1 + m_2}$$

$$T \nearrow = \frac{m_2 F \nearrow}{m_1 + m_2}$$

$$y = m x$$

$$T(F) = \begin{cases} 0 & F \le \mu m_1 g \\ F - \mu m_1 g & \mu m_1 g < F \le \mu(m_1+m_2) g \\ \dfrac{m_2 F}{m_1+m_2} & F > \mu(m_1+m_2) g \end{cases}$$



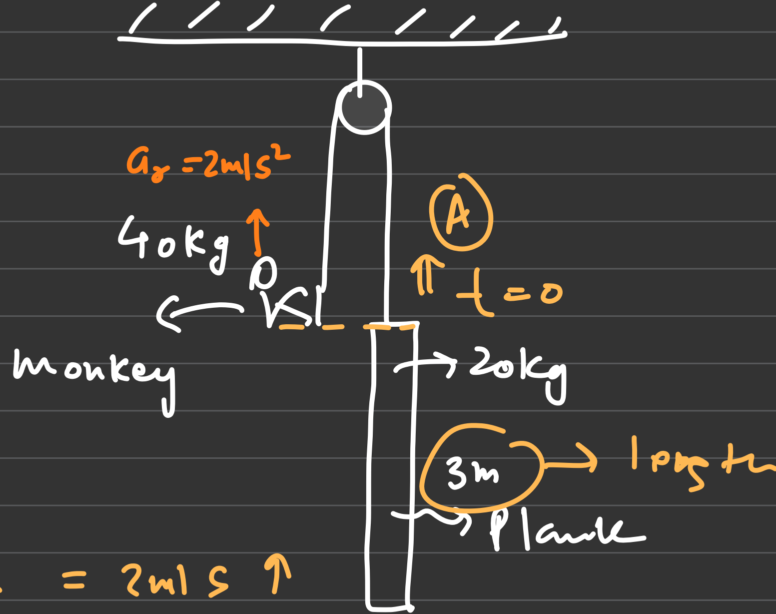
$T = \mu m_1 g - F$ ↑

y c x

Slope < 45°

$T = F - \mu m_1 g$

(2)



$\vec{a}_{m,r} = 2 m/s$ ↑

given

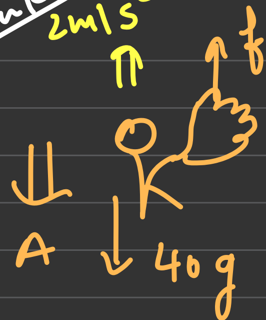
a_r = relative acceleration of monkey w.r.t rope is $2 m/s^2$ ↑

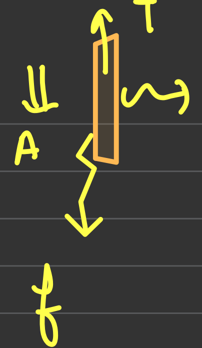
then find

(i) acceleration of monkey and plank w.r.t ground

(ii) find time after which monkey reaches bottom of plank?

FBD of monkey

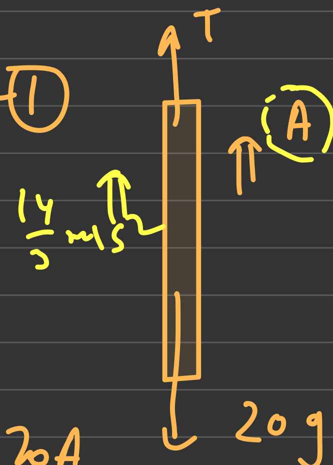




$f - T = 0 \times A$

$T = f$

$40g - \cancel{f} = 40(A-2)$ — (1)



$\cancel{f} - 20g = 20A$ — (2)

$20g = 40A - 80 + 20A$

$60A = 200 + 80$

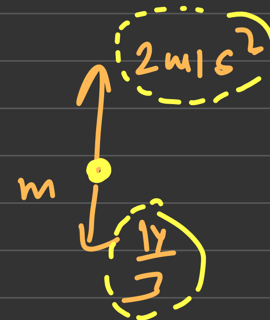
$60A = 280$

$$A = \frac{28\cancel{0}}{6\cancel{0}} = \frac{14}{3}\,m/s^2$$

check Calculation

Acceleration of Plank w.r.t ground

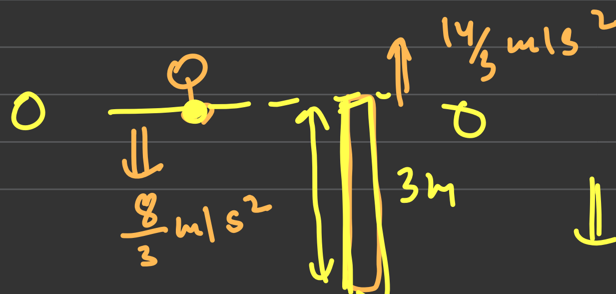
#



$$\frac{14}{3} - 2 = \frac{8}{3}\,m/s^2 \downarrow$$

"Acc. of monkey w.r.t ground"

Part # 2



$\Uparrow$ +ve

$\Downarrow$ −ve

$\# \quad u_{rel} = 0$

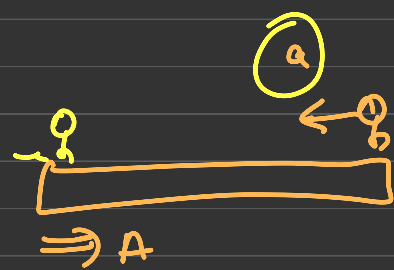
$a_{rel} = \frac{8}{3} + \frac{14}{3} = -\left(\frac{22}{3}\right) m/s^2$

$\# \quad S_{rel} = -3m$

$S_{rel} = \frac{1}{2} a_{rel} t^2$

$-3 = \frac{1}{2}\left(-\frac{22}{3}\right) t^2$

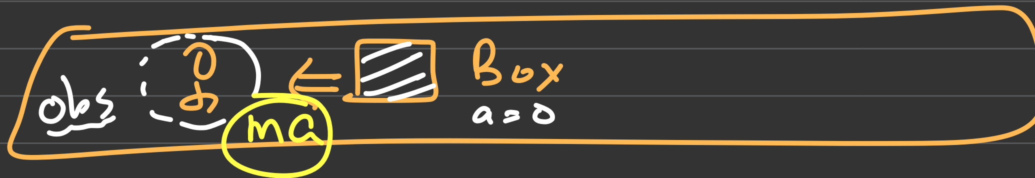
$\sqrt{\frac{9}{11}} = t$

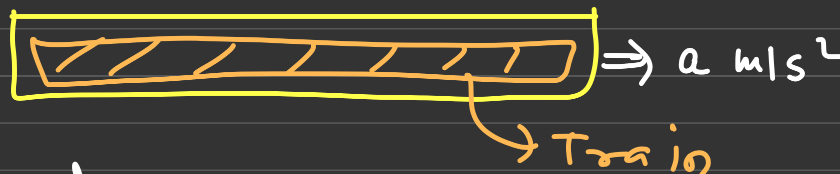


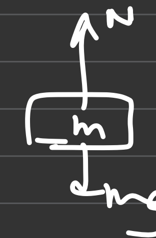
$u_{rel} = 0$

$a_{rel} =$

Pseudo force Concept:







$N = mg$

obs at ground will find box at rest

if obs. is inside train then, he can see, box is accelerating opposite direction of train

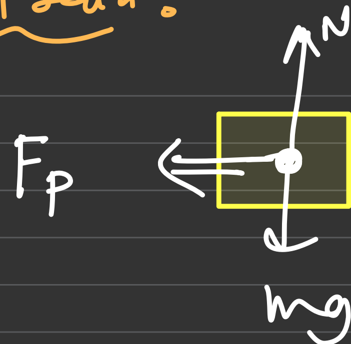
To correct Newton's second law, if we want to calculate acceleration w.r.t Non-inertial frame (Acc. frame) then we have show a pseudo force ($m \times a$) in opposite direction of N.I.f.

Acc of

mass of object

Acc. of non-inertial frame

FBD w.r.t train:



$F_p = ma$

$F_p = m \times a_r$

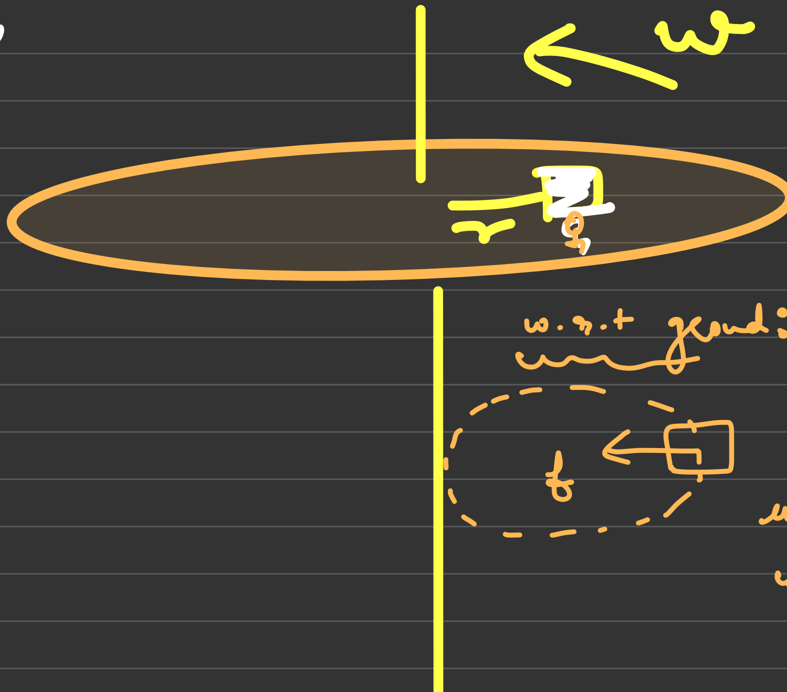
$ma = m \times a_r$

$a_r = a$

"Acceleration of box w.r.t train"

Q)

find ω_{max} for which block is not slipping w.r.t disc?



FBD

w.r.t ground:

$f = m a_c$

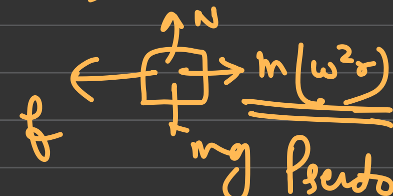
$f = m\omega^2 r$

$\mu mg = m\omega^2 r$

$\omega = \sqrt{\frac{g\mu}{r}}$

FBD w.r.t disc!

we find block is at rest



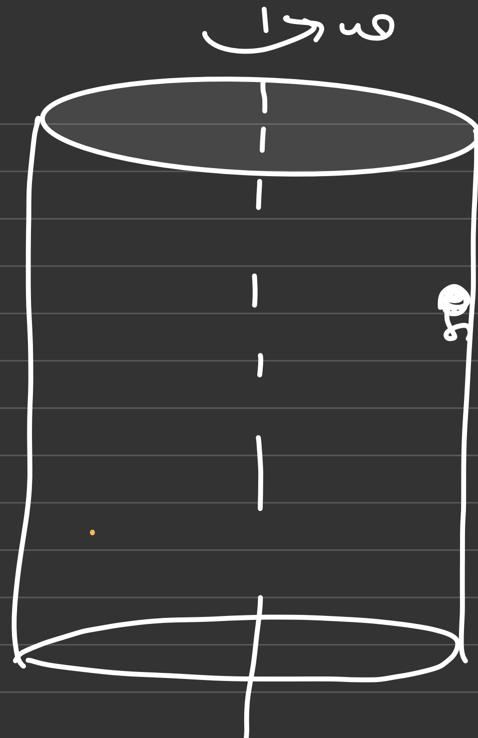
Pseudo

"Centrifugal force"

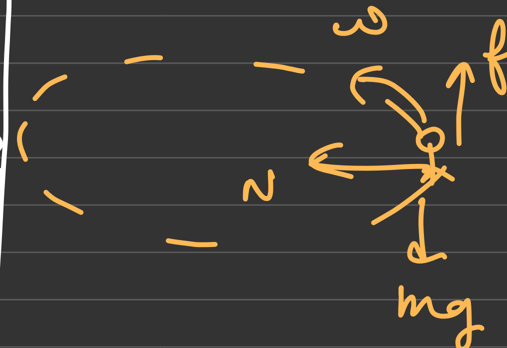
$f = m\omega^2 r$

$f = \mu mg = m\omega^2 r$

Q:



ω.r.t ground



$N = mr\omega^2$ —— (1)

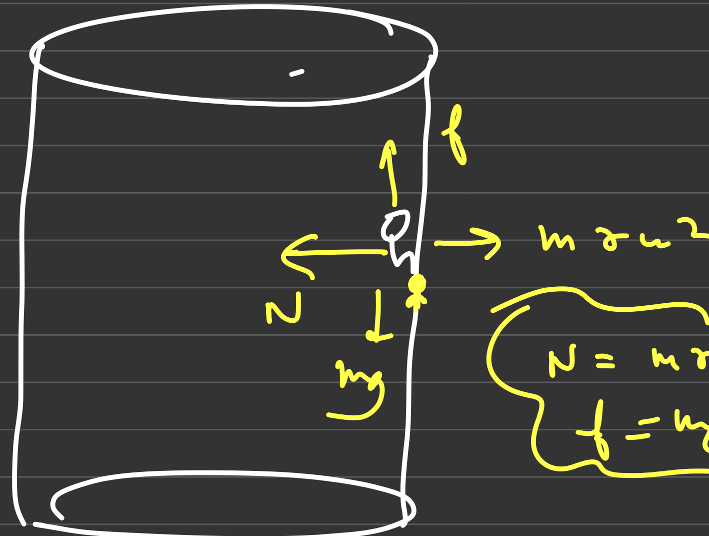
$f = mg$

$\mu N = mg$

$\mu(mr\omega^2) = mg$

$\omega = \sqrt{\frac{g}{\mu r}}$

w.r.t disc:



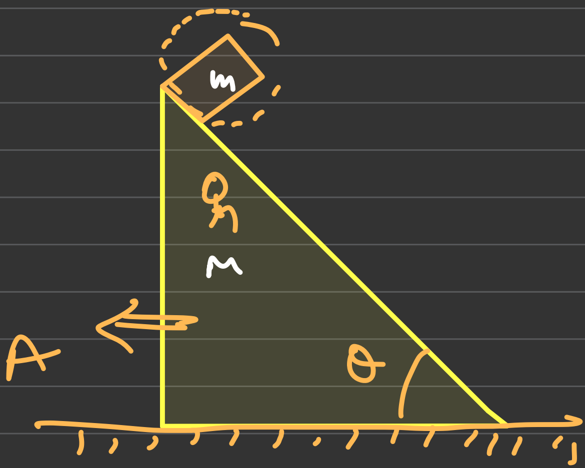
$N = mr\omega^2$

$f = mg$

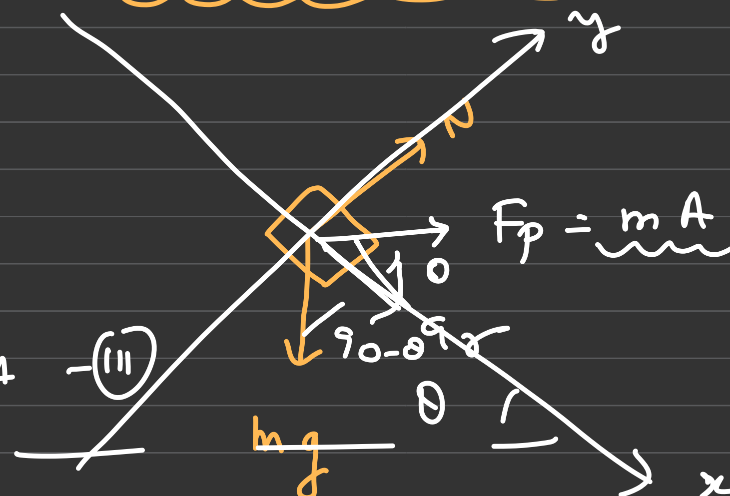
Q)

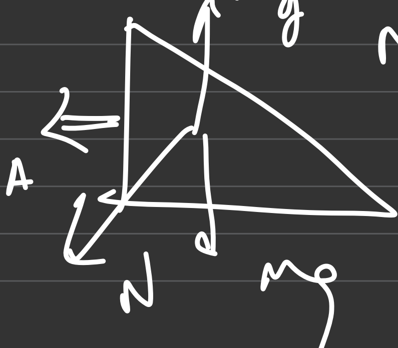
No-friction

find acceleration of both blocks



w.r.t wedge

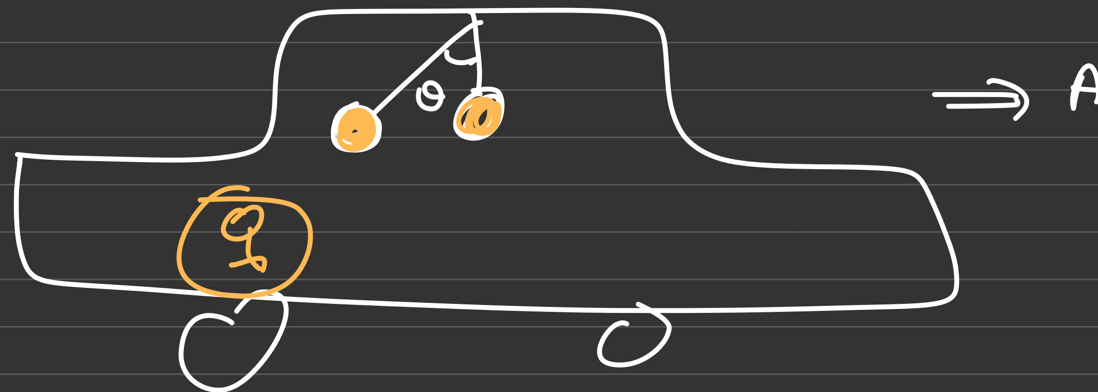


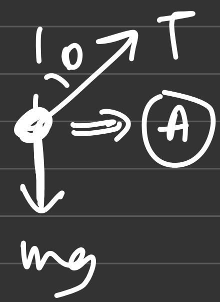


$N\sin\theta = MA$ — (III)

$mg\sin\theta + mA\cos\theta = m a_r$ — (I)

$N + mA\sin\theta = mg\cos\theta$ — (II) e)

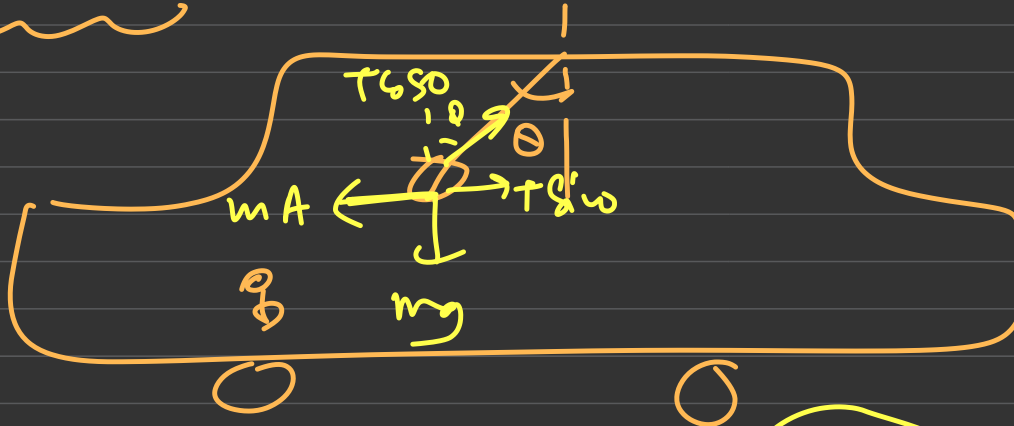




$$\begin{cases} T\cos\theta = mg & \text{— (I)} \\ T\sin\theta = mA & \text{— (II)} \end{cases}$$

$$\tan\theta = \frac{A}{g}$$

w.r.t Car :

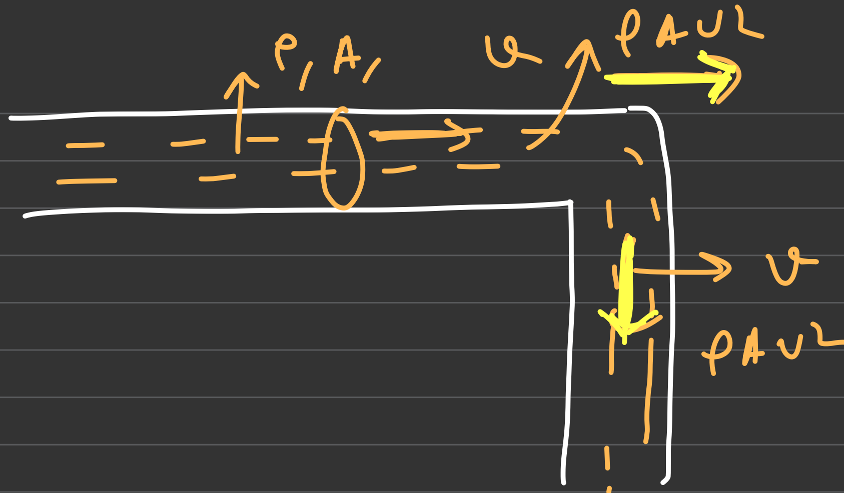


$$T\sin\theta = mA$$

$$T\cos\theta = mg$$

$$\tan\theta = \frac{A}{g}$$

Q



find force exerted by water on pipe?

$$(\text{change in})\{\text{momentum per sec}\} = \left(\frac{P}{t}\right)_f - \left(\frac{P}{t}\right)_i$$

$$(\text{change momentum})\ \text{per sec} = \left(\frac{\Delta \vec{P}}{\Delta t}\right)$$

Volume flowing per sec $= (Av)$

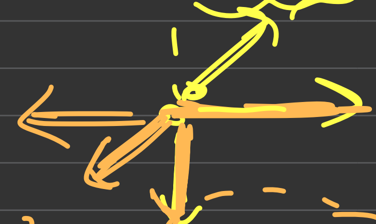
mass flowing per sec $= (Av)\rho$

momentum per sec $= (Av)\rho v = \rho A v^2$

$\sqrt{2}\rho A v^2$ → force exp by pipe

$-(P/t)_i$

$-\rho A v^2$



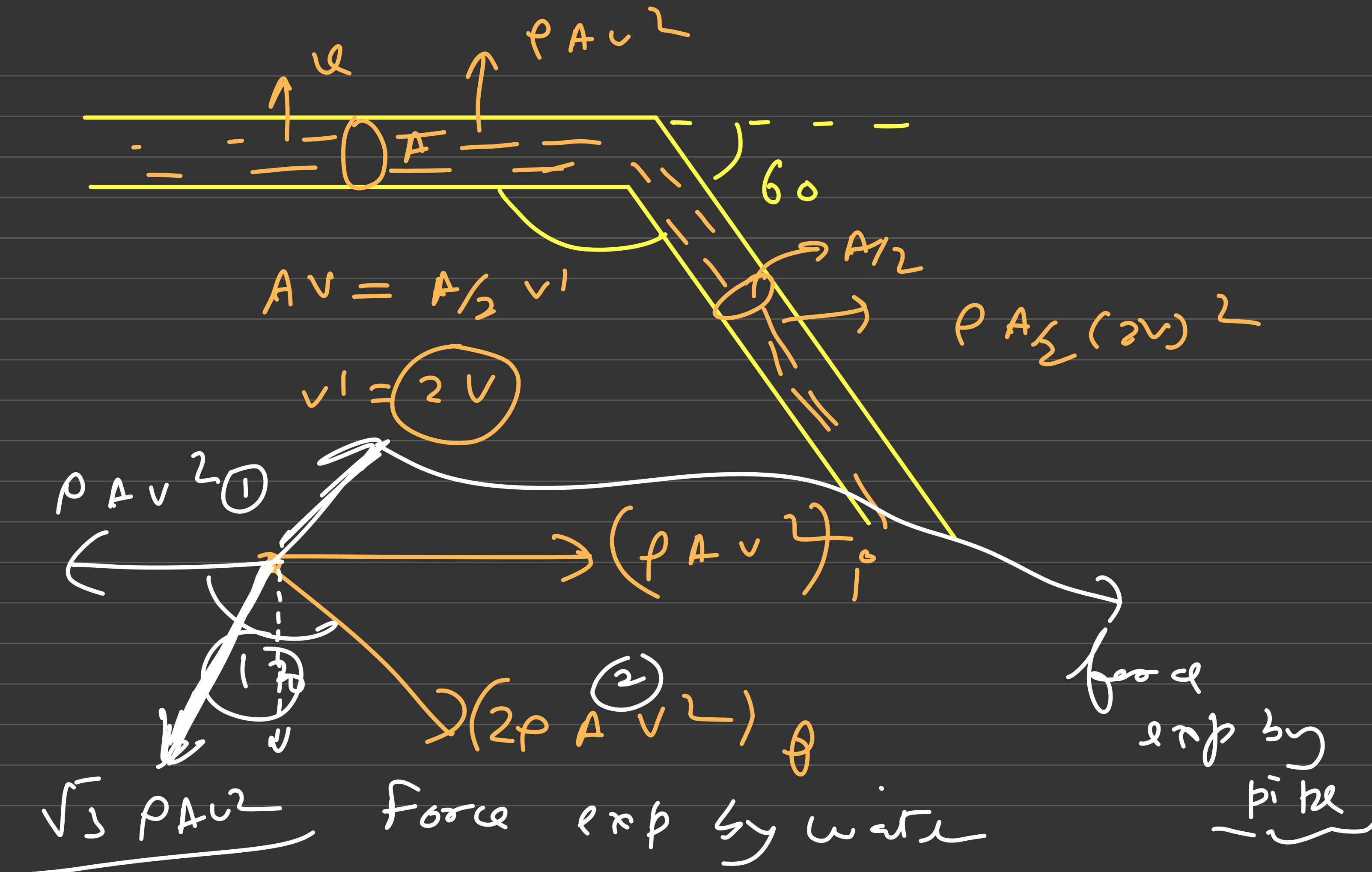
$\rho A v^2$

$\rho A v^2 = (P/t)_f$

force exp by water ← $\sqrt{2}\rho A v^2$

$\Rightarrow$ change in (momentum per sec)

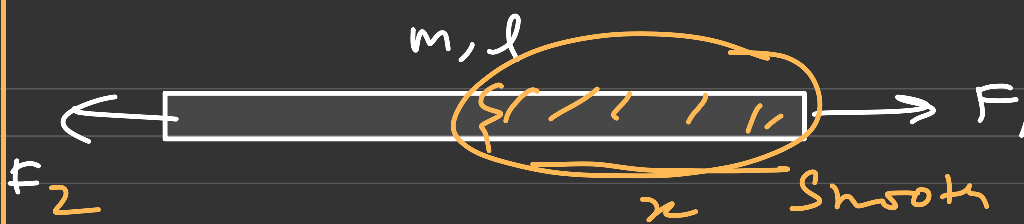
$\Rightarrow$ $\underbrace{(P/t)_f - (P/t)_i}$ $=$



u
$\rho A u^2$
A
60
$A/2$
$\rho \frac{A}{2} (2v)^2$
$AV = \frac{A}{2} v'$
$v' = 2V$
$\rho A v^2$ ①
$(\rho A v^2)\hat{i}$
$(2\rho A v^2)$ ② θ
120
v
$\sqrt{3}\rho A u^2$
Force exp by water
force exp by pipe

ills #7

$\underbrace{F_1 > F_2}$ $\underbrace{\text{given}}$



$F_1 - F_2 = ma$

$a = \frac{F_1 - F_2}{m}$

$l \rightarrow m$

$1 \rightarrow \frac{m}{l}$

$x \rightarrow \frac{m}{l}x$

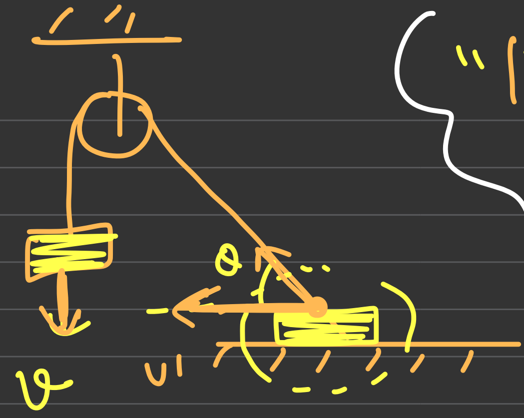
$F_1 - T = m' \times a$

$$T = F_1 - m'\left[\frac{F_1 - F_2}{m}\right]$$

$$T = F_1 - \cancel{\frac{m}{l}}(x)\left[\frac{F_1 - F_2}{\cancel{m}}\right]$$

$$T = F_1 - \frac{x(F_1 - F_2)}{l}$$

θ)



"|Velocity| along String must NOT change"

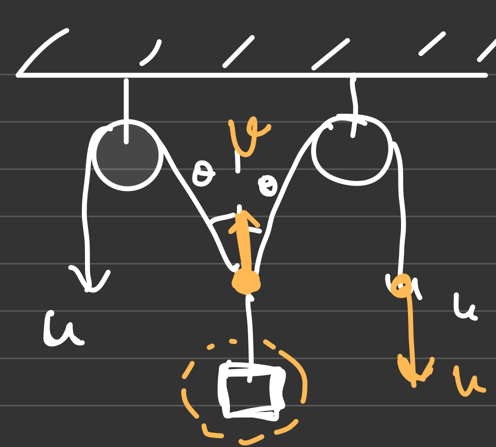
$$v'\cos\theta = v$$

$$v' = \frac{v}{\cos\theta}$$

Ans

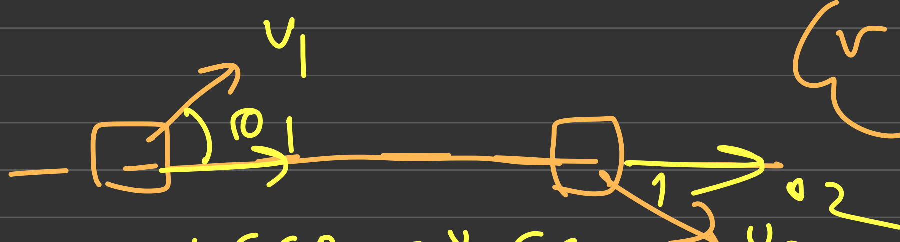
Q)

find velocity of block?



$v\cos\theta = u$

$$\boxed{v = \frac{u}{\cos\theta}}$$



$$v_1\cos\theta_1 = v_2\cos\theta_2$$

Homework: # → "Complete module and work book of Dynamics"

Energy # (I) work
(II) power
(III) Energy