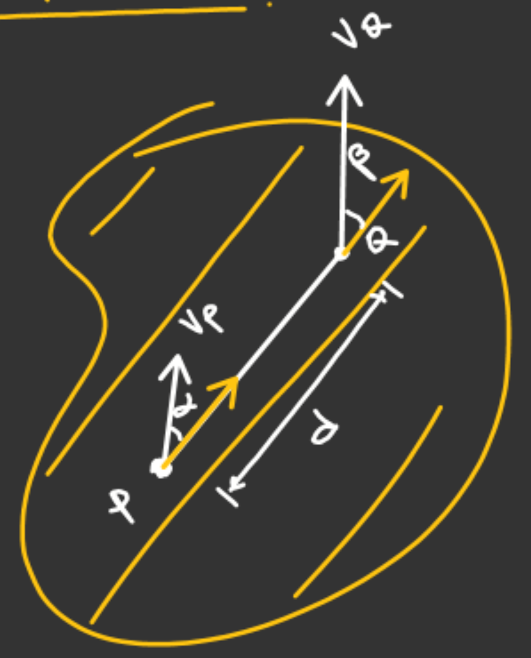
Nishant Jindal

Rigid body Constrain :→

1st Constrain :-



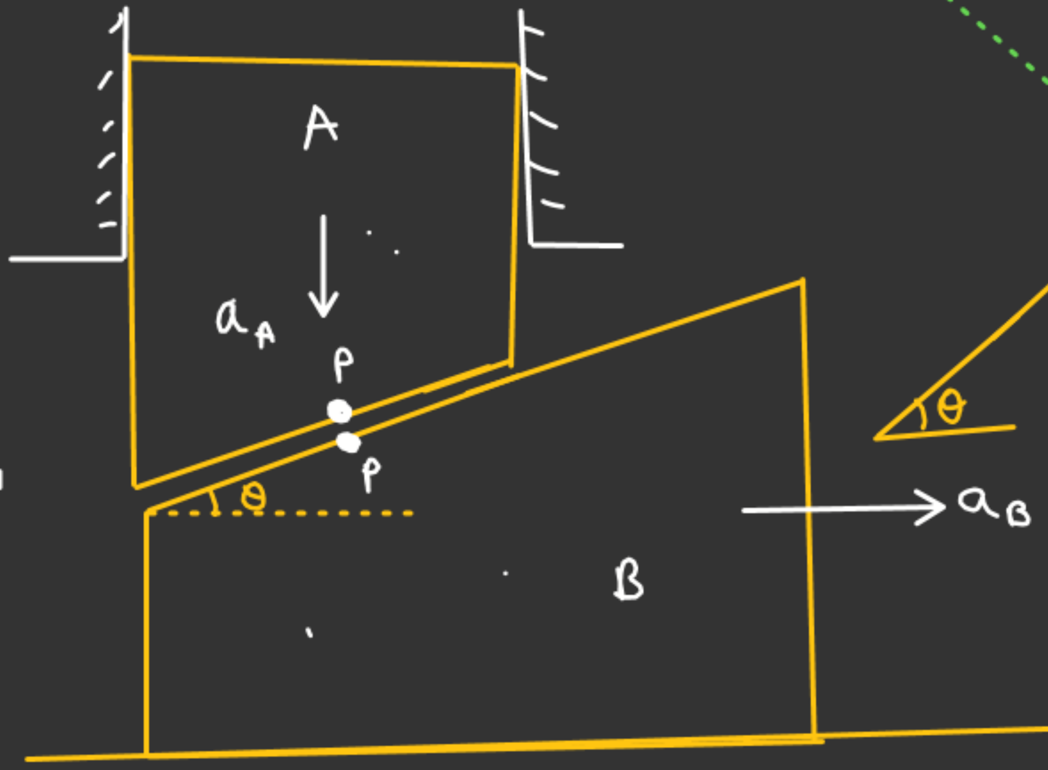
Along the line joining velocites of two points must be same

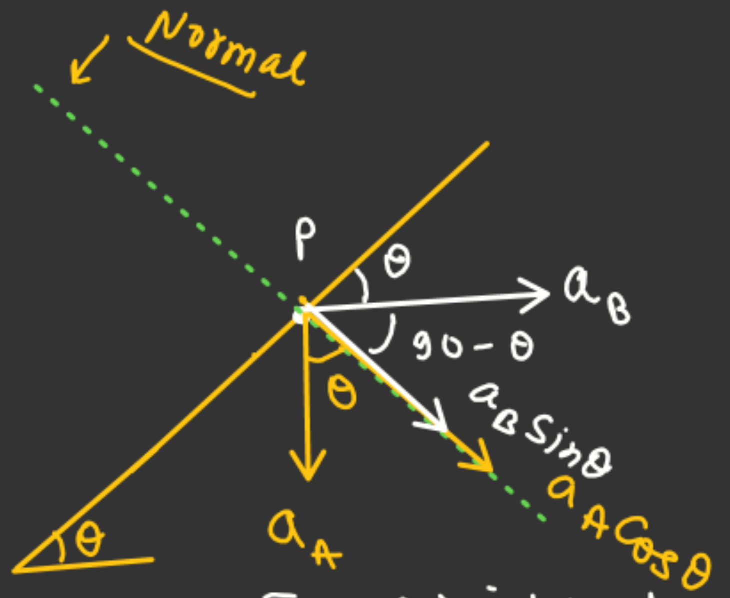
$$\left(v_P \cos\alpha = v_Q \cos\beta\right)$$

2nd Constrain

↳ For two rigid bodies in contact

Velocites or accleration of two rigid bodies in contact must be same along normal to contact surface.





For rigid body

$$a_B \sin\theta = a_A \cos\theta.$$

$$\boxed{a_A = a_B \tan\theta}$$

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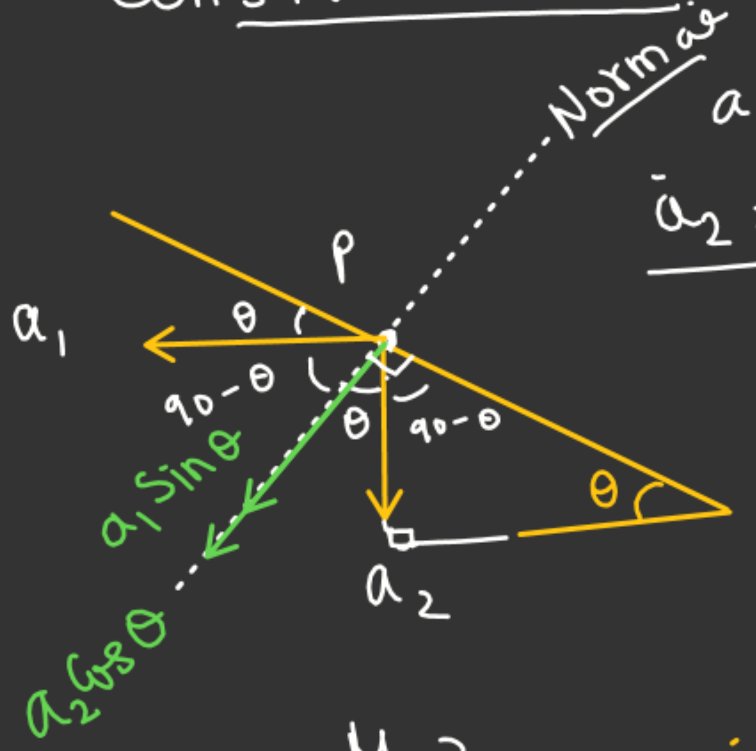
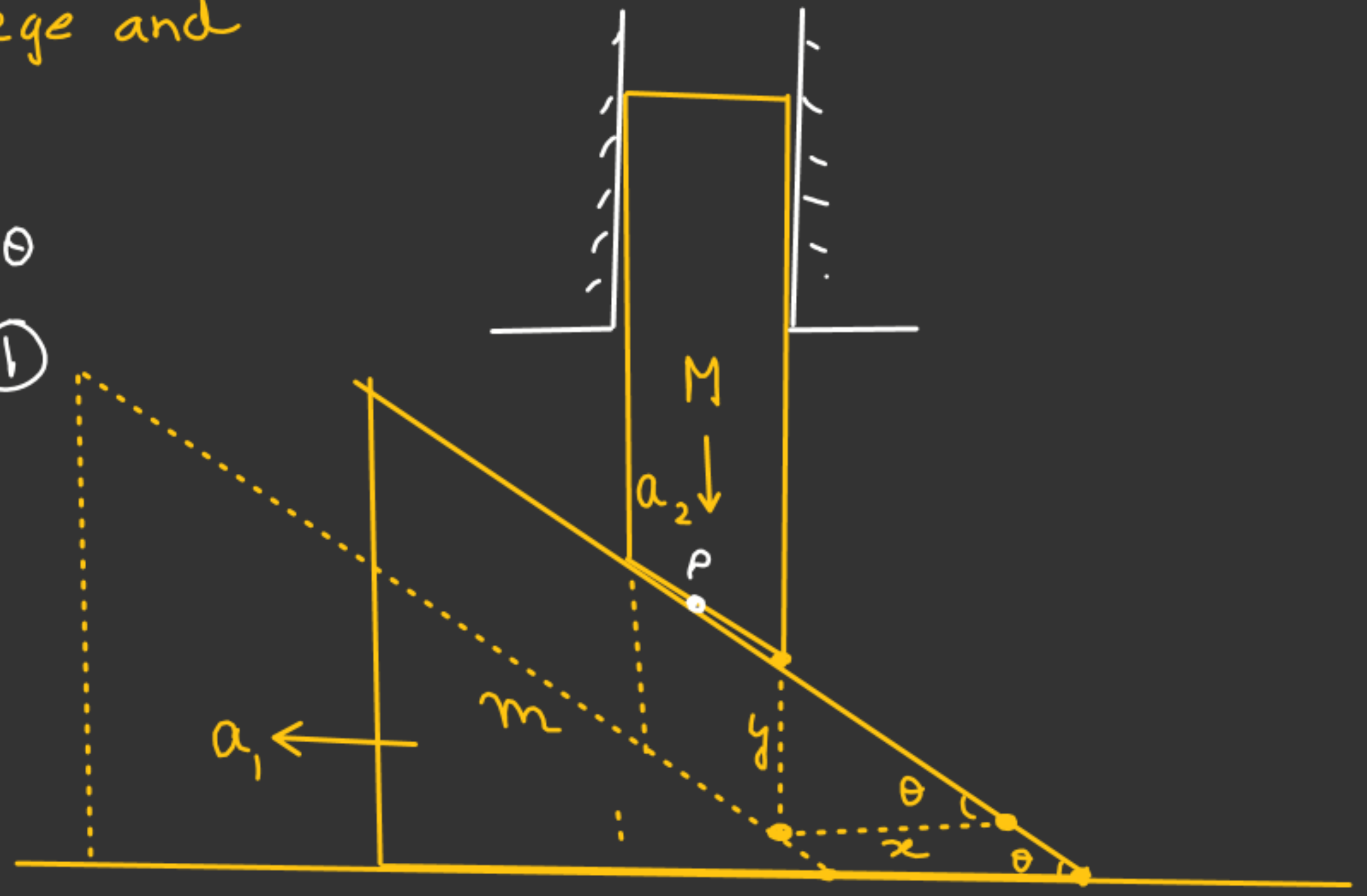
Rod is released, all the contact surfaces are smooth. Find accleration of Wege and rod

Sol^n Constrain relation



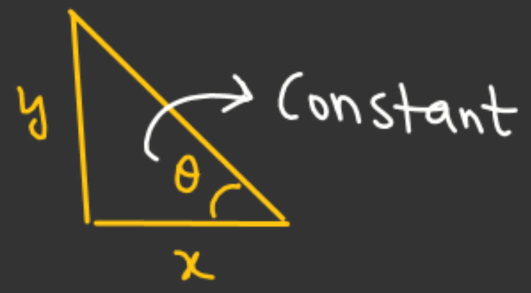
$a_1 \sin\theta = a_2 \cos\theta$

$a_2 = a_1 \tan\theta$ — (1)



M-2

$\tan\theta = \frac{y}{x}$



$y = x \tan\theta$

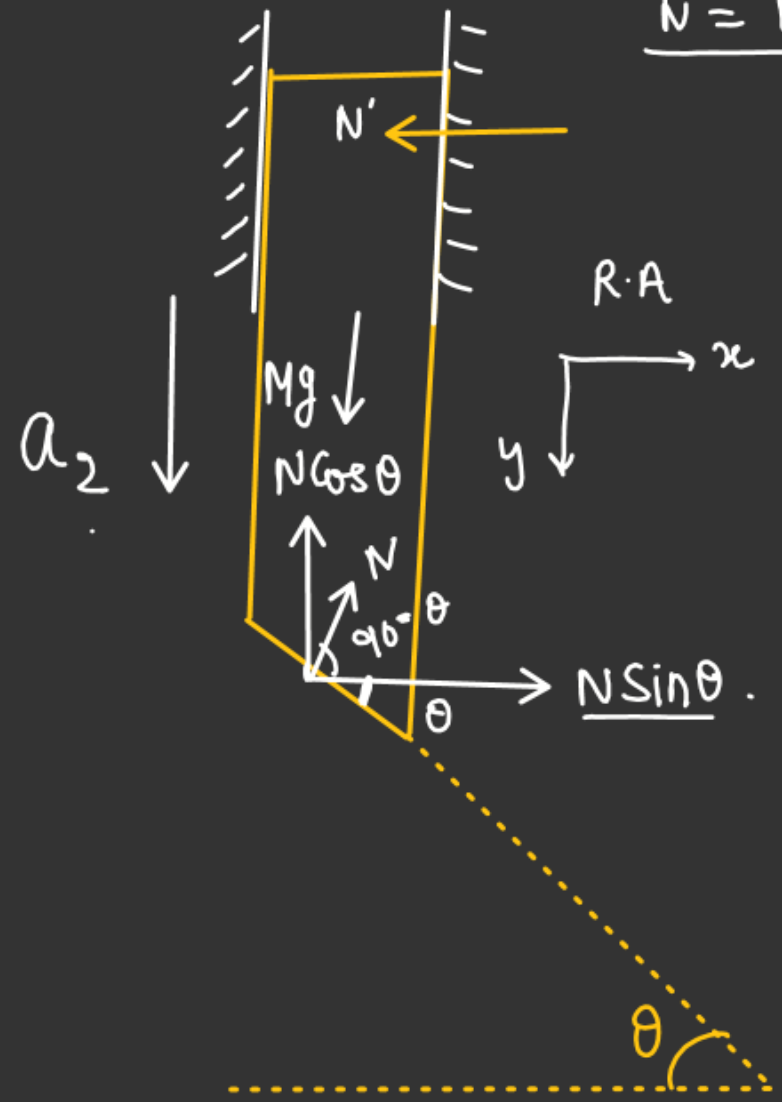
$\frac{dy}{dt} = \frac{dx}{dt}(\tan\theta)$

$V_2 = v_1 \tan\theta$

$\frac{dv_2}{dt} = \frac{dv_1}{dt} \tan\theta \Rightarrow a_2 = a_1 \tan\theta$

F.B.D of Rod w.r.t earth

$$a_2 = a_1 \tan\theta \quad \text{— (1)}$$



$N' = N\sin\theta$

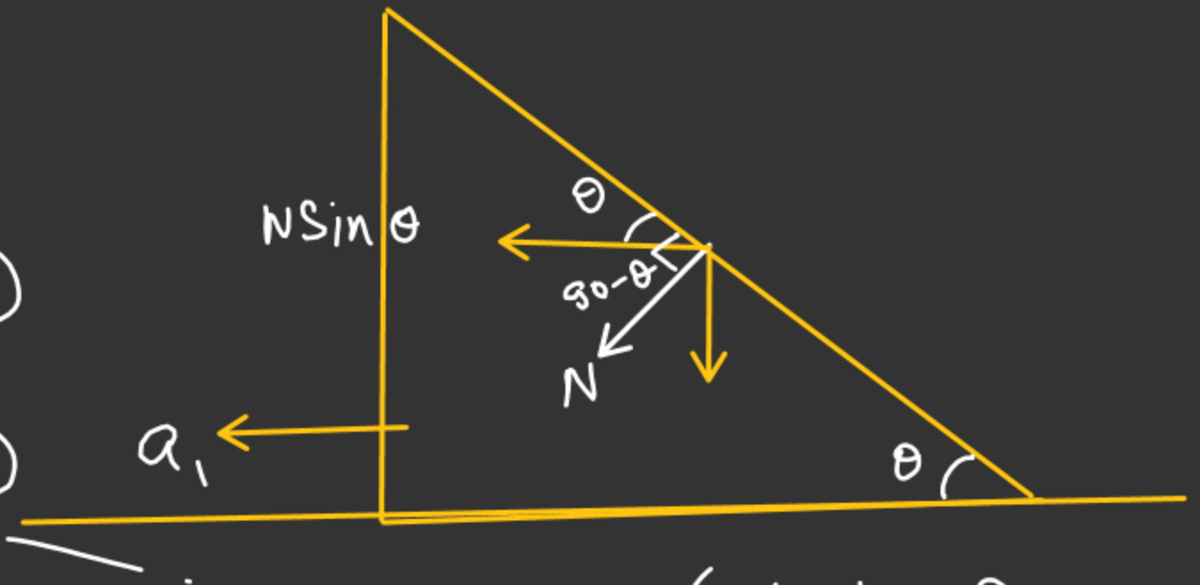
In y-direction

2nd Law

$$Mg - N\cos\theta = Ma_2 \quad \text{— (2)}$$

$$N\sin\theta = m a_1 \quad \text{— (3)}$$

$$\hookrightarrow N = \left(\frac{m a_1}{\sin\theta}\right) \quad \text{Put in (2)}$$



$$Mg - m a_1 \cot\theta = M a_2$$

$$Mg = M a_1 \tan\theta + m a_1 \cot\theta$$

$$Mg = a_1\left(M\tan\theta + \frac{m}{\tan\theta}\right)$$

$$a_1 = \left(\frac{Mg\tan\theta}{m + M\tan^2\theta}\right)$$

$$a_2 = \left(\frac{Mg\tan^2\theta}{m + M\tan^2\theta}\right)$$

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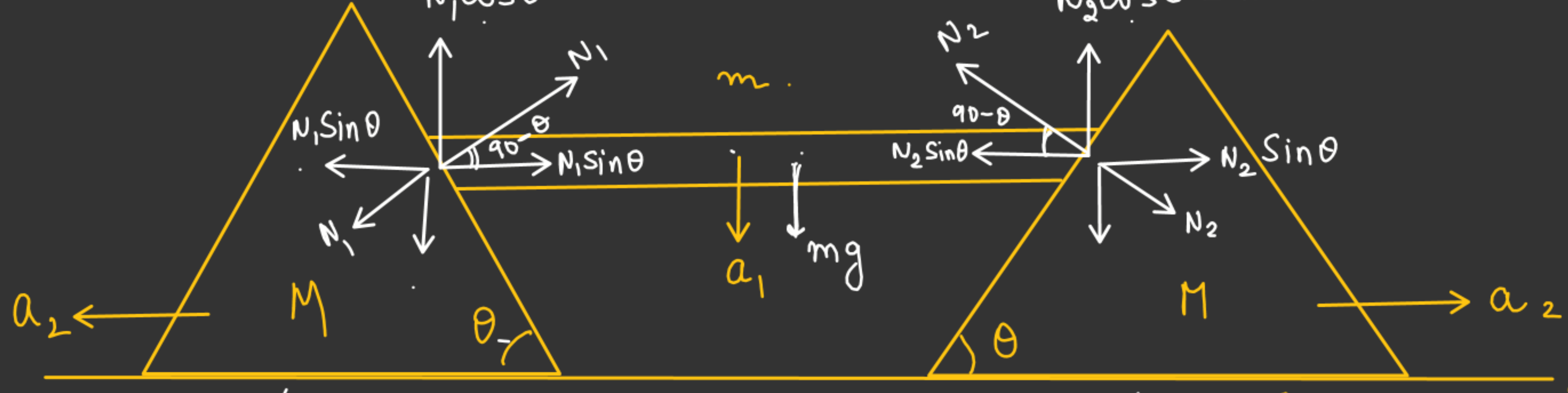
Q: Case-1. (All Contact Surfaces are Smooth)

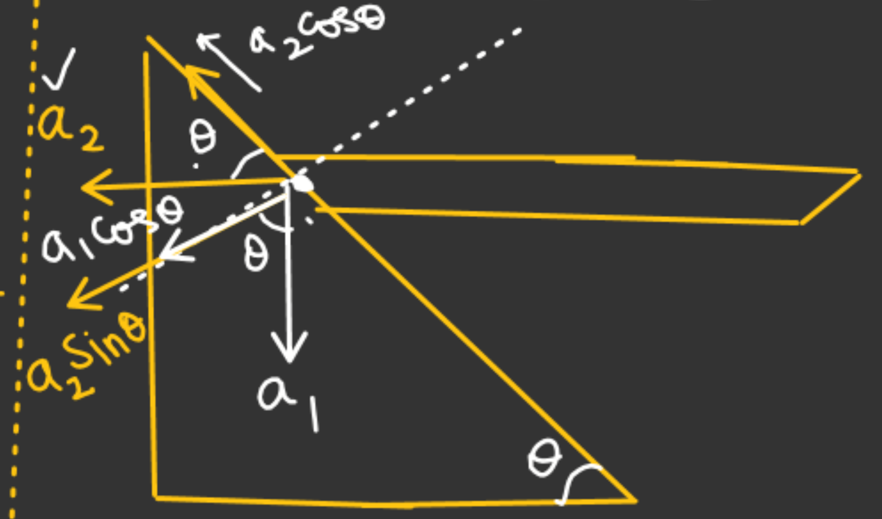
$N_1\cos\theta = N\cos\theta$ $\qquad$ $N_2\cos\theta = N\cos\theta$.



Constrain Relation

$a_1\cos\theta = a_2\sin\theta$.

$\underline{a_1 = a_2\tan\theta}$ — (1)



For wedge ↙ $\qquad$ Smooth

$N_1\sin\theta = Ma_2$. $\qquad$ $N_1\sin\theta = N_2\sin\theta$ $\qquad$ $N_2\sin\theta = Ma_2$

$\underline{N_1 = N_2 = N}$

$\Downarrow$

$(N_1 = N_2)$

F.B.D of wedge.

$N\sin\theta = Ma_2$ — (2)

For Rod

$mg - 2N\cos\theta = ma_1$ — (3)

$\left[\begin{array}{l} a_1 = ? \\ a_2 = ? \\ N = ? \end{array}\right]$

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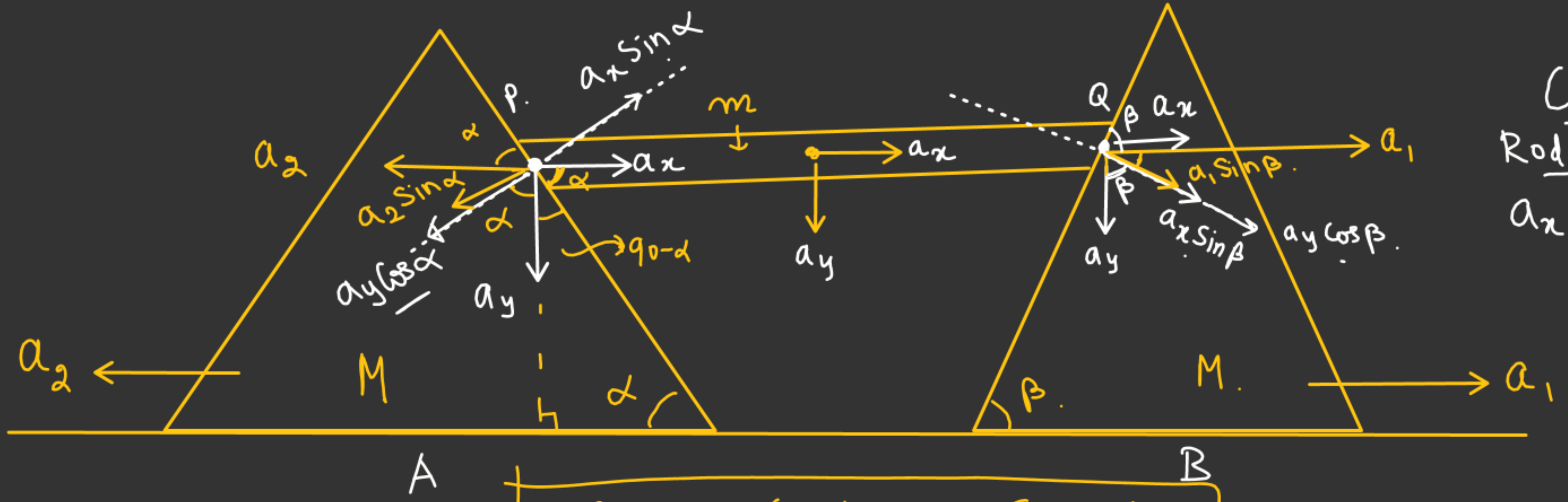
$a_1 > a_2$



Constrain relation

Rod & wedge B.

$a_x \sin\beta + a_y \cos\beta = a_1 \sin\beta$ → (2)

Correct

$\boxed{a_2 \sin\alpha + a_y \cos\alpha = a_x \sin\alpha}$ ✗

⇓ Wrong

$a_2 \sin\alpha = a_y \cos\alpha - a_x \sin\alpha$ — (1) ✓

⇓ Constrain relation for Wedge A & Rod