Nishant Jindal

Topic (Test → 18th june. Mains)

- → 1-D Motion
  (Non-uniform & uniform motion)
- → Motion under gravity.
- → Graph.
- → Projectile Motion

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Safety parabola

$$\sec^2\theta - \tan^2\theta = 1$$

$$\sec^2\theta = (1+\tan^2\theta)$$

For No hitting

$$D < 0$$

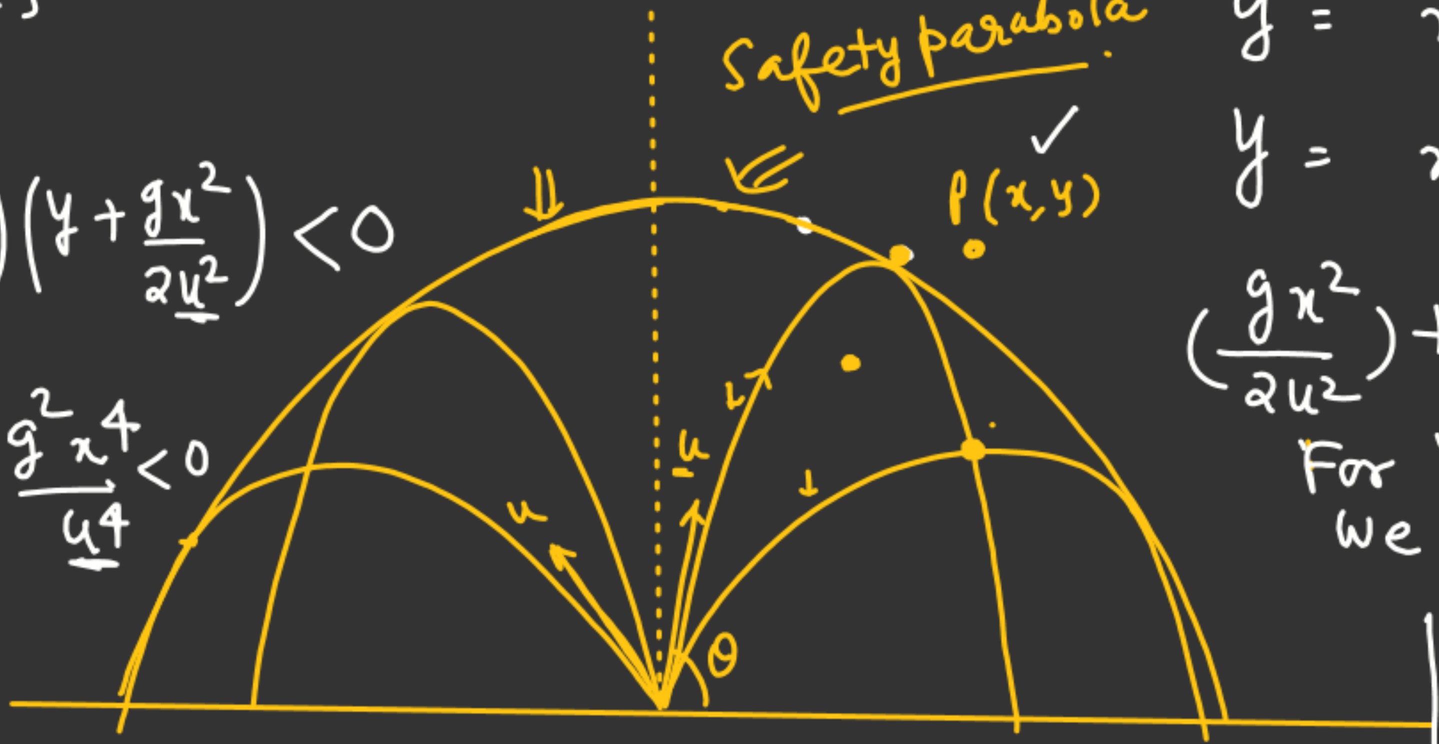
$$x^2 - 4\left(\frac{gx^2}{2u^2}\right)\left(y+\frac{gx^2}{2u^2}\right) < 0$$

$$\Downarrow$$

$$x^2 - \frac{2gx^2}{u^2}y - \frac{g^2x^4}{u^4} < 0$$

$$x^2 - \frac{g^2x^4}{u^4} < \frac{2gx^2}{u^2}y \Rightarrow y > \left(\frac{\cancel{x^2}u^2}{2g\cancel{x^2}} - \frac{gx^2}{2u^2}\right)$$

$$\boxed{y > \left(\frac{u^2}{2g} - \frac{g}{2u^2}x^2\right)}$$



Equation of trajectory

$$y = x\tan\theta - \frac{g}{2u^2\cos^2\theta}x^2$$

$$y = x\tan\theta - \frac{g}{2u^2}\sec^2\theta\, x^2$$

$$y = x\tan\theta - \frac{g}{2u^2}(1+\tan^2\theta)x^2$$

$$y = x\tan\theta - \frac{gx^2}{2u^2} - \frac{gx^2}{2u^2}\tan^2\theta$$

$$\left(\frac{gx^2}{2u^2}\right)\tan^2\theta - x\tan\theta + \left(y+\frac{gx^2}{2u^2}\right) = 0$$

For 'θ' to be real i.e we have 'θ' so that projectile hit the co-ordinate P(x,y)

i.e i) $D > 0$.

ii) $D = 0 \Rightarrow$ only one 'θ' for which projectile hit the point P.

iii) $D < 0 \Rightarrow$ No value of 'θ' so that projectile hit the point P.

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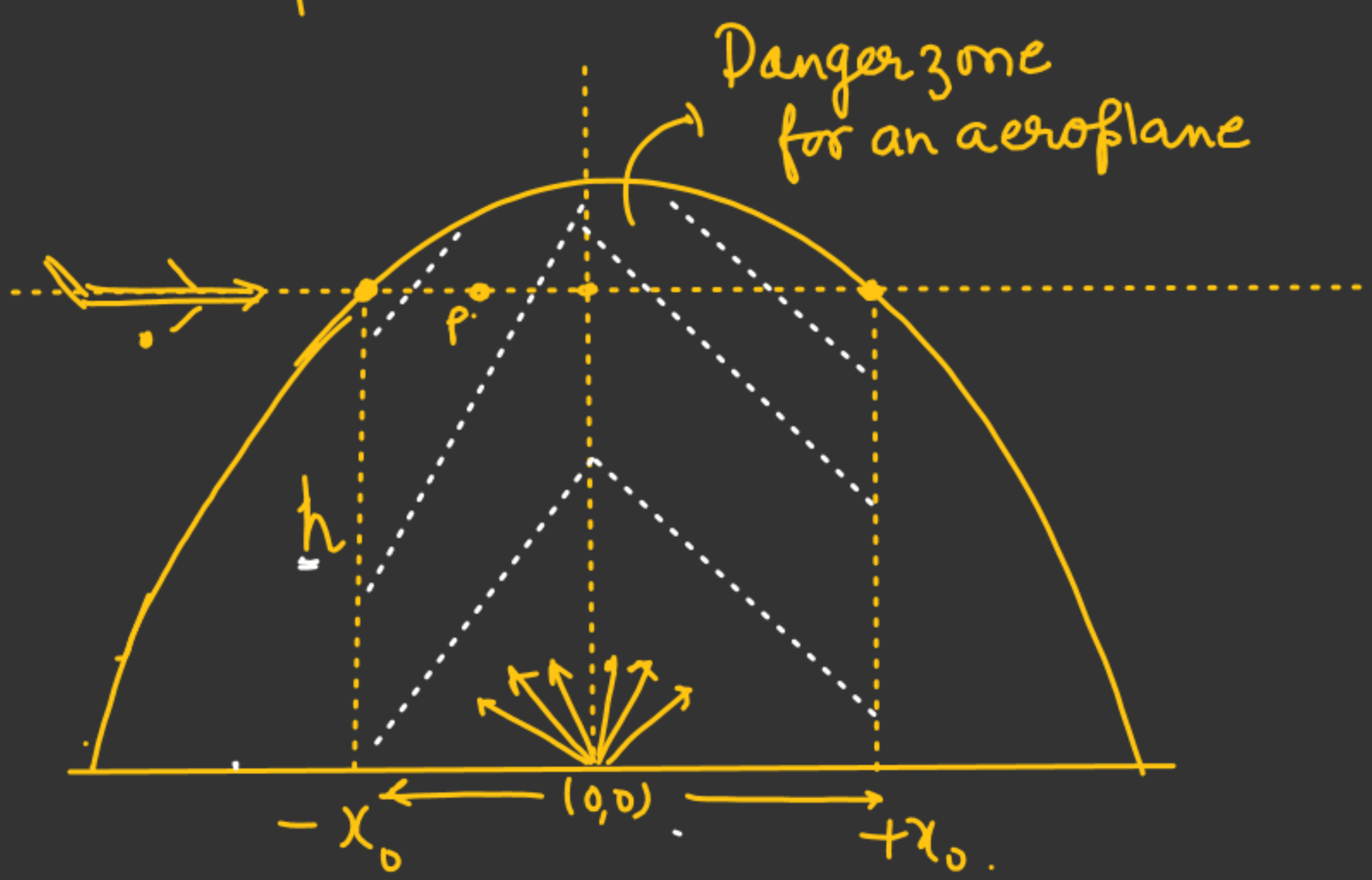

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Relative Velocity

Frame of refrance :→

↳ [From where we Can observe the State of a particle]

Two type of frame of refrance :–

① Inertial frame :- [Stationary frame or frame moving with Constant Velocity]

[(*) In general Earth is treated as to be inertial frame.

(*) With inertial frame we Can observe the actual status of a body.]

② Non - Inertial frame

↳ [All acclerated frames are non- inertial frame]

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$\vec{r}_{P/O'}$ = Position of particle 'P' w.r.t moving frame

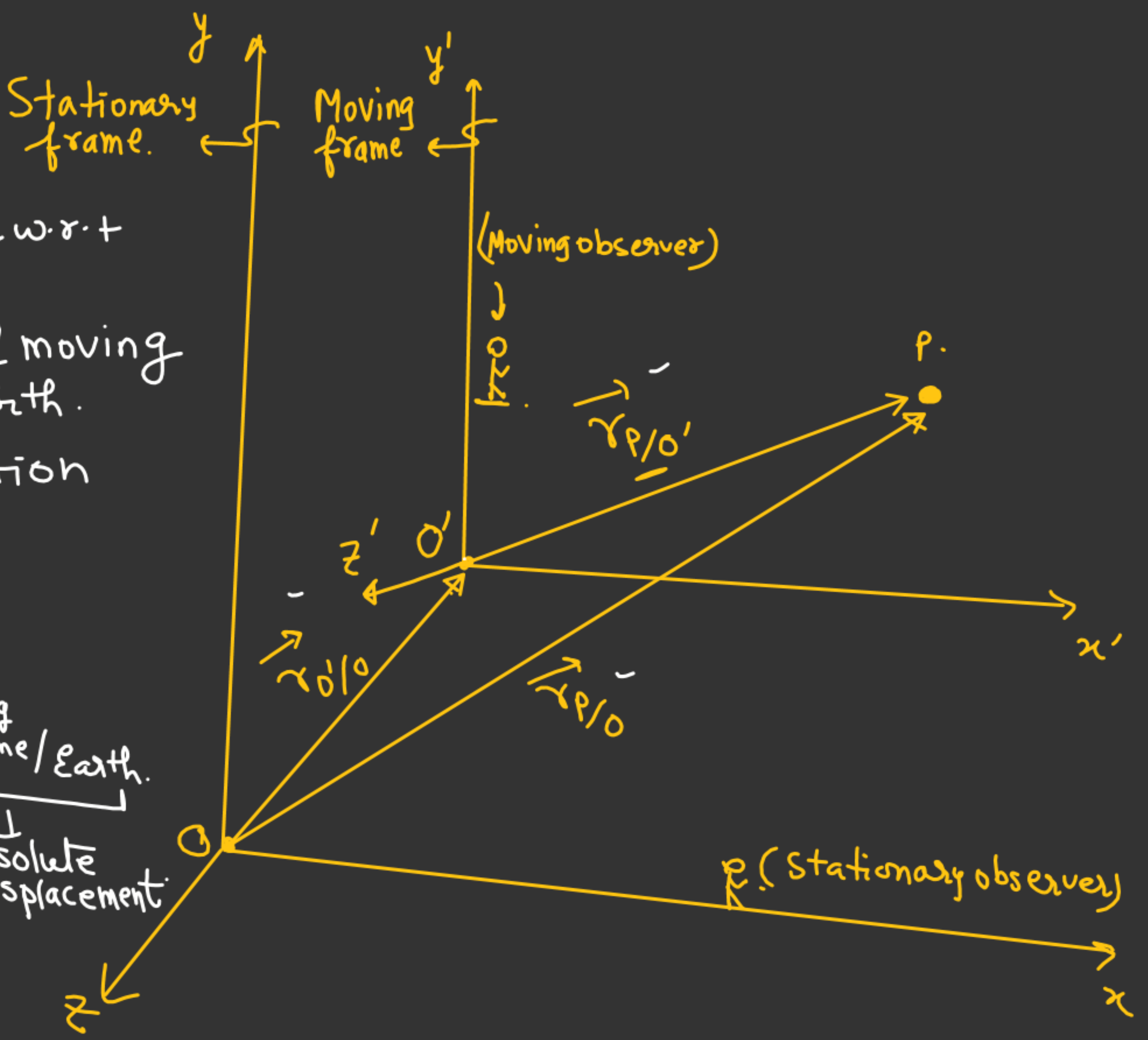
$\vec{r}_{P/O}$ = Position of particle w.r.t earth.

$\vec{r}_{O'/O}$ = Position vector of moving frame w.r.t earth.

By Δ-Law of vector addition

$$\vec{r}_{P/O} = \vec{r}_{P/O'} + \vec{r}_{O'/O}$$

$$\underbrace{\vec{r}_{P/E}}_{\text{(Absolute displacement)}} = \underbrace{\left(\vec{r}_{P/\text{moving frame}}\right)}_{\text{(Relative displacement)}} + \underbrace{\vec{r}_{\text{moving frame}/\text{Earth}}}_{\text{Absolute displacement}}$$



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$$\vec{r}_{P/E} = \vec{r}_{P/\text{moving frame}} + \vec{r}_{\text{moving frame}/E}.$$

$$\underline{\vec{r}_{P/\text{moving frame}}} = \vec{r}_{P/E} - \vec{r}_{\text{moving frame}/E}.$$

Differentiating w.r.t time both the equation:-

$$\frac{d}{dr}\left(\vec{r}_{P/E}\right) = \frac{d}{dt}\left(\vec{r}_{P/\text{moving frame}}\right) + \frac{d}{dt}\left(\vec{r}_{\text{moving frame}/E}\right)$$

$\Downarrow$

$$\underline{\vec{v}_{P/E}} = \vec{v}_{P/\text{moving frame}} + \underline{\vec{v}_{\text{moving frame}/E}}.$$

$$\underline{\vec{v}_{P/\text{moving frame}}} = \vec{v}_{P/E} - \vec{v}_{\text{moving frame}/E}.$$

$\Downarrow$

Relative velocity.

Differentiating w.r.t time.

$$\frac{d}{dt}\left(\vec{v}_{P/E}\right) = \frac{d}{dt}\left(\vec{v}_{P/\text{moving frame}}\right) + \frac{d}{dt}\left(\vec{v}_{\text{moving frame}/E}\right)$$

$\Downarrow$

$$\vec{a}_{P/E} = \underline{\vec{a}_{P/\text{moving frame}}} + \vec{a}_{\text{moving frame}/E}.$$

$$\vec{a}_{P/\text{moving frame}} = \underline{\vec{a}_{P/E}} - \vec{a}_{\text{moving frame}/E}.$$

$\Downarrow$

(Relative acleration)

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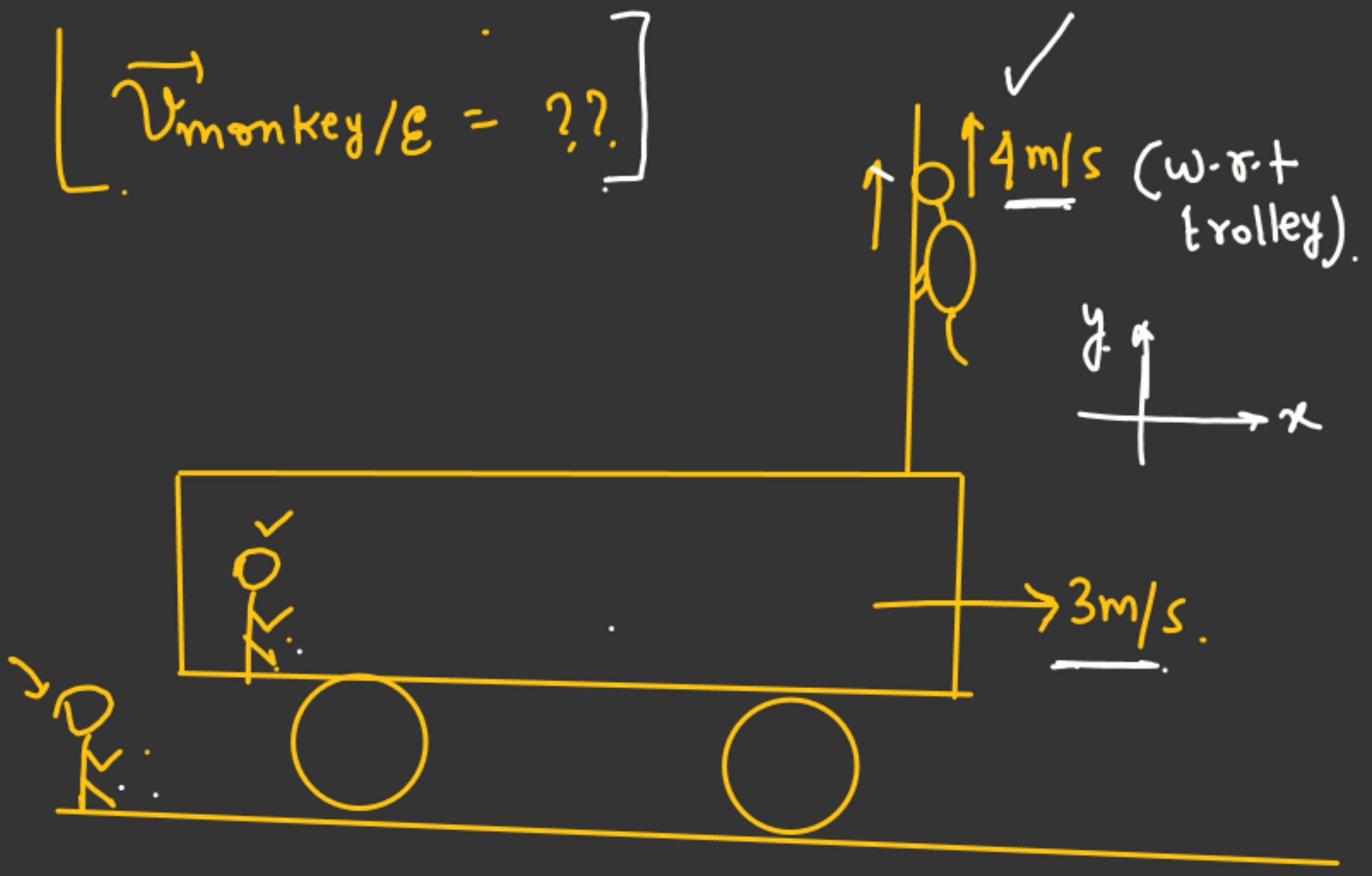
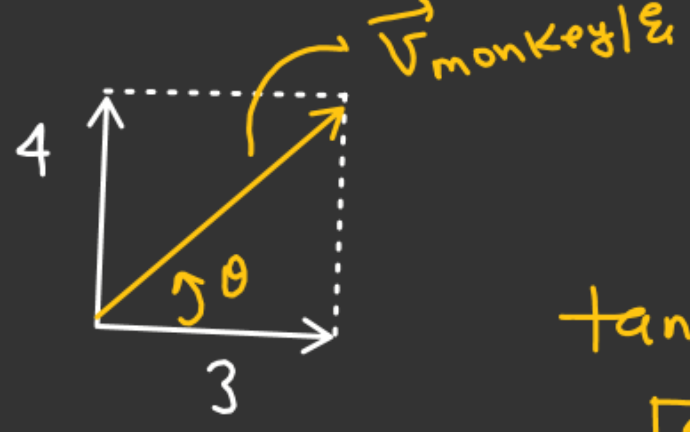
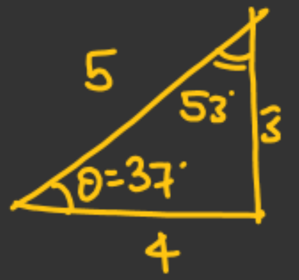
$$\left[\vec{v}_{monkey/E} = ??\right]$$



$$\vec{v}_{monkey/E} = \vec{v}_{monkey/trolley} + \vec{v}_{trolley/E}$$

$$\boxed{\vec{v}_{monkey/E} = 4\hat{j} + 3\hat{i}}$$



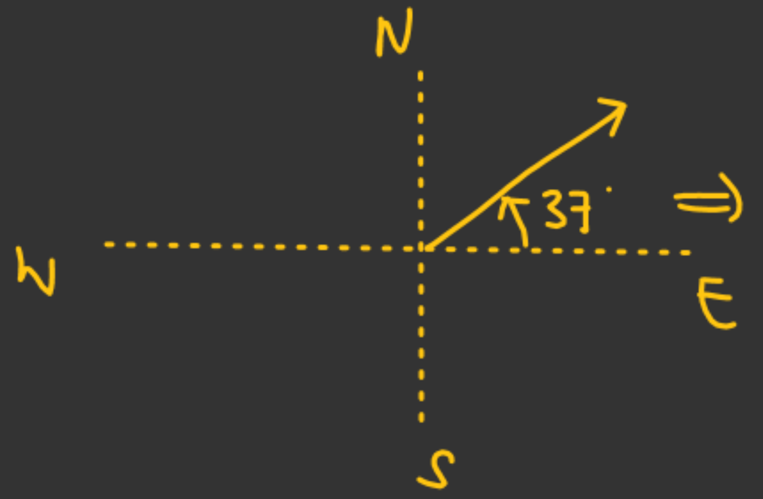


$$\tan\theta = \frac{4}{3}$$

$$\boxed{\theta = 53^\circ}$$

$$|\vec{v}_{monkey/E}| = \sqrt{(3)^2 + (4)^2}$$

$$= 5\,m/s$$



$\Rightarrow$ 37° North of east w.r.t ground