PRAYAS

JEE 2026

Physics

COM and System of particles

Lecture - 08 | **Manish Singh Tak (Masti Sir)**

Physics Wallah

Part-02

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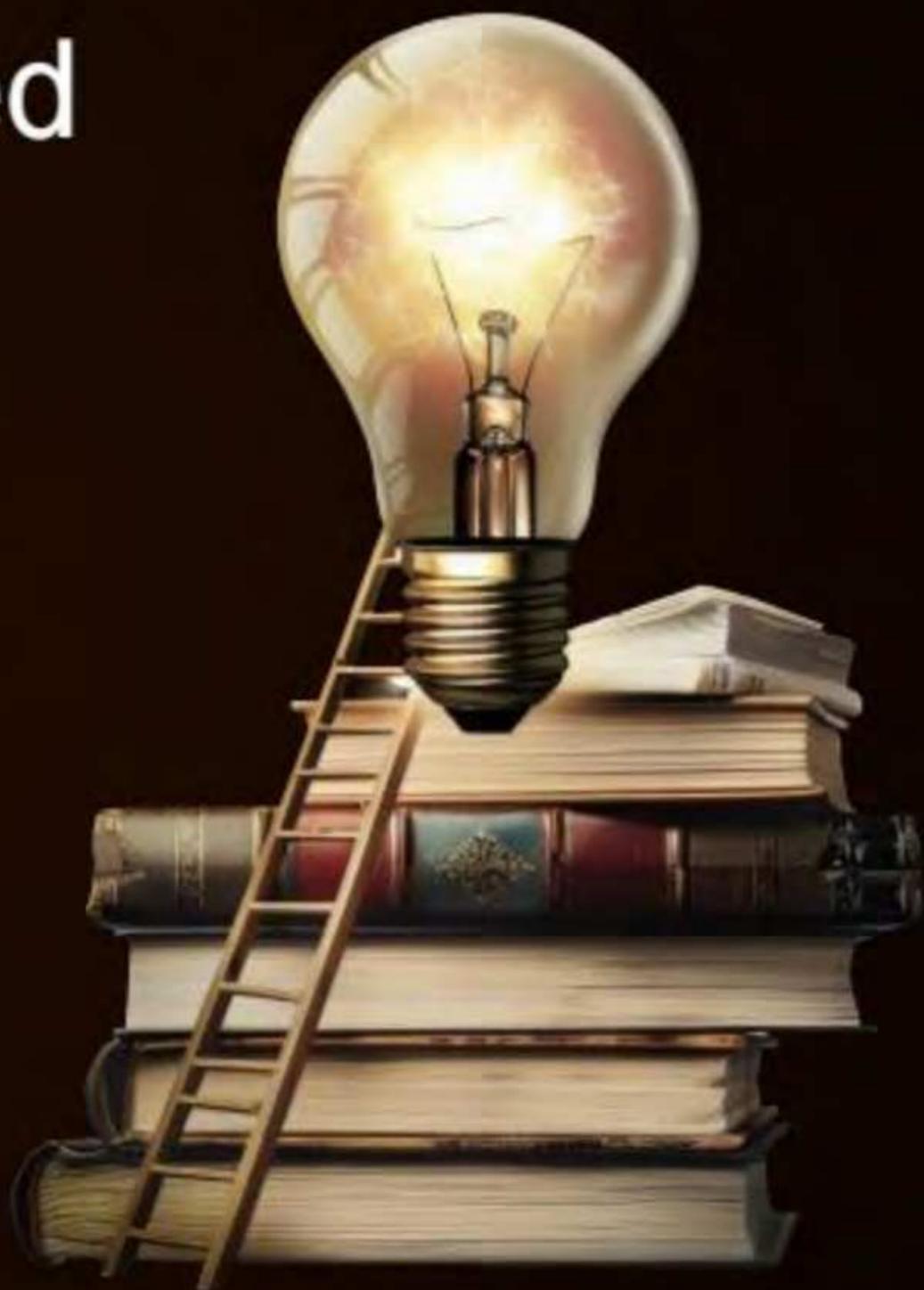
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JM - Jan $\longrightarrow$ 98 percen

$\downarrow$

JA

Class notes + dpp.

$\downarrow$

JM 99% + JA

Selection

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Question

A tank a total mass of 500kg horizontal fire shell of mass 25kg with muzzle velocity 100m/s. Tank is initially at rest and is on smooth horizontal surface. Find speed of shell and tank after firing

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$$\underline{muzzle\ velocity} :\to velocity\ of\ bullet\ w.r.t\ Gun$$

$$\vec{V}_{bullet/Gun} = \vec{V}_b - \vec{V}_G = \vec{V}_m$$

$$\boxed{\vec{V}_b = \vec{V}_m + \vec{V}_G}$$

$$2\sigma + (-v)$$

$$2\sigma + V$$

w.r.t Ground

$$if\ \vec{F}_{ext.} = 0\ then\ \vec{P}_i = \vec{P}_f$$

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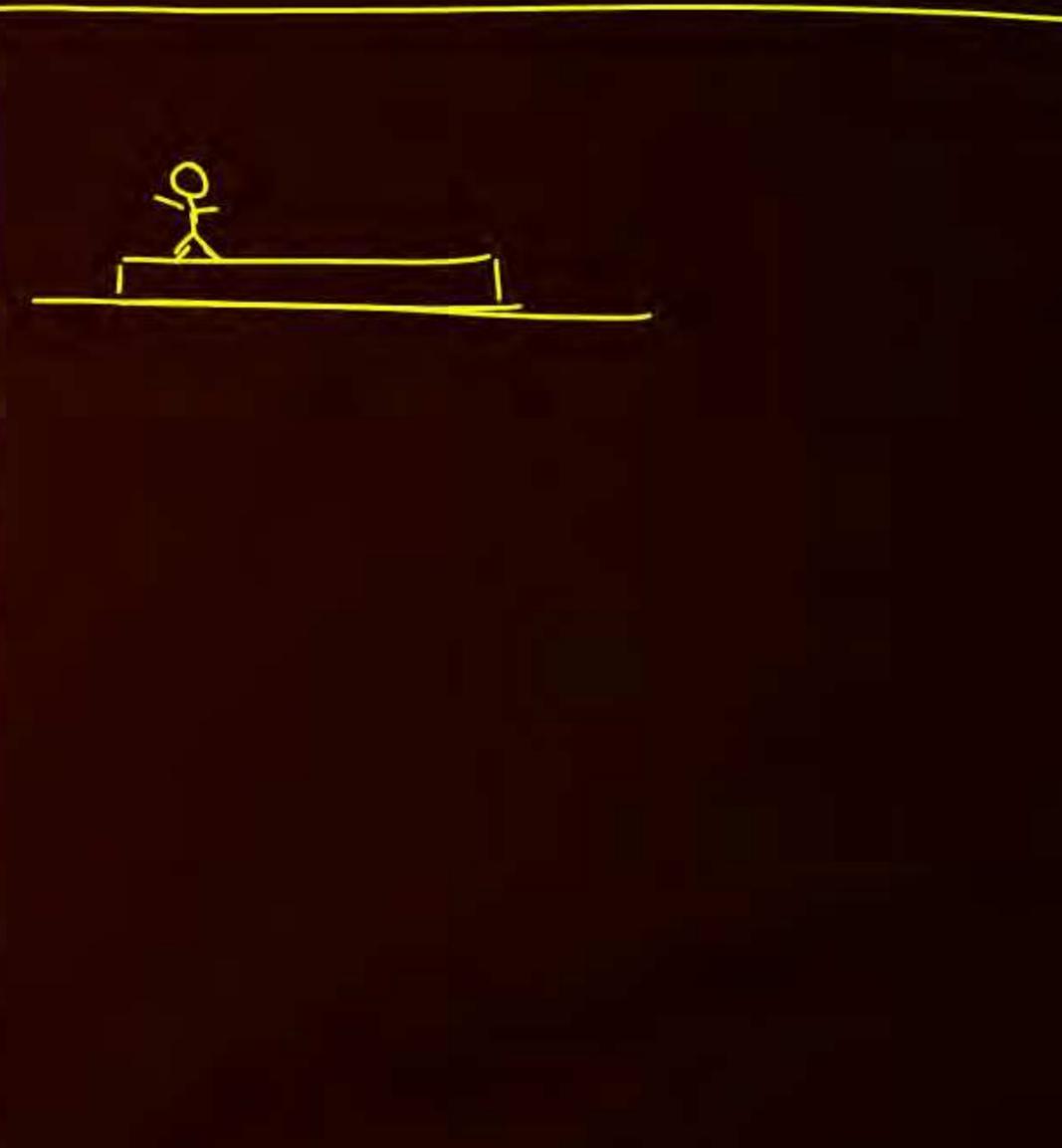
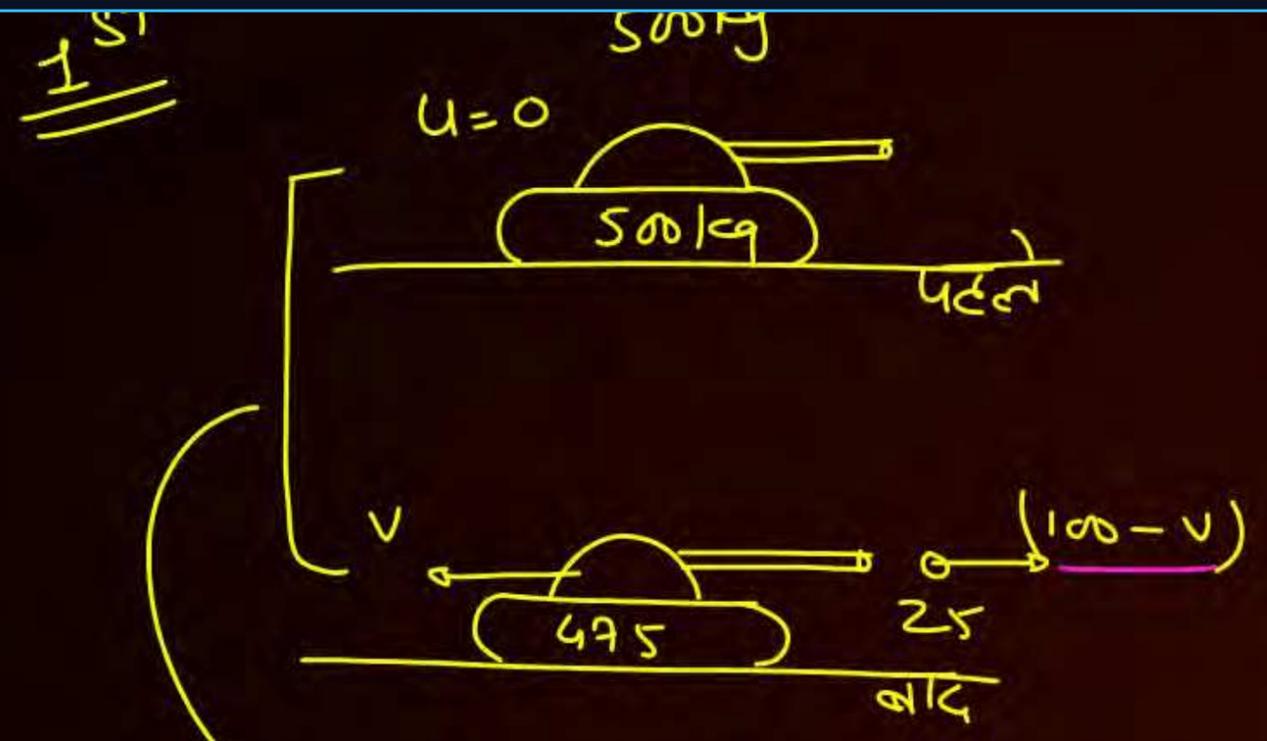## Question 46

A tank a total mass of 500kg horizontal fire 2 shells of each of mass 25kg with muzzle velocity 100m/s. Tank is initially at rest and is on smooth horizontal surface. Find speed of tank after firing both shells
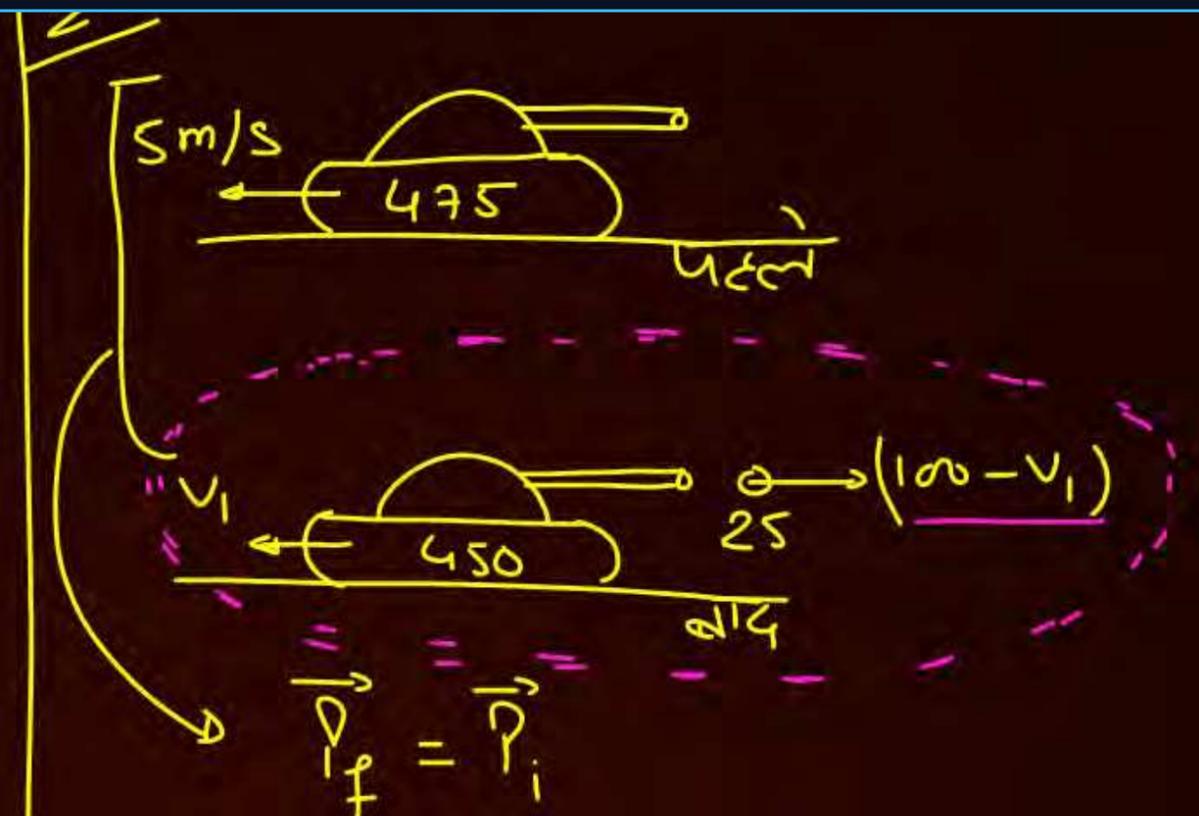
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1st

$u = 0$

500 kg

500 kg

पहले

V

475   25 $(100 - V)$

बाद

$$P_f = P_i$$

$$25(100 - V) - 475V = 0$$

$$V = \frac{2500}{500} = 5 \, m/s$$

$$V_{shell-1} = 100 - 5 = 95 \, m/s$$

2nd

5 m/s

475

पहले

V_1 450   25 $(100 - V_1)$

बाद

$$\vec{P_f} = \vec{P_i}$$

$$25(100 - V_1) - 450V_1 = -475(5)$$

$$2500 - 475V_1 = -2375$$

$$V_1 = \frac{2500 + 2375}{475} = \frac{4875}{475} \approx 10.26$$

$$V_{shell-2} = 100 - 10.26$$

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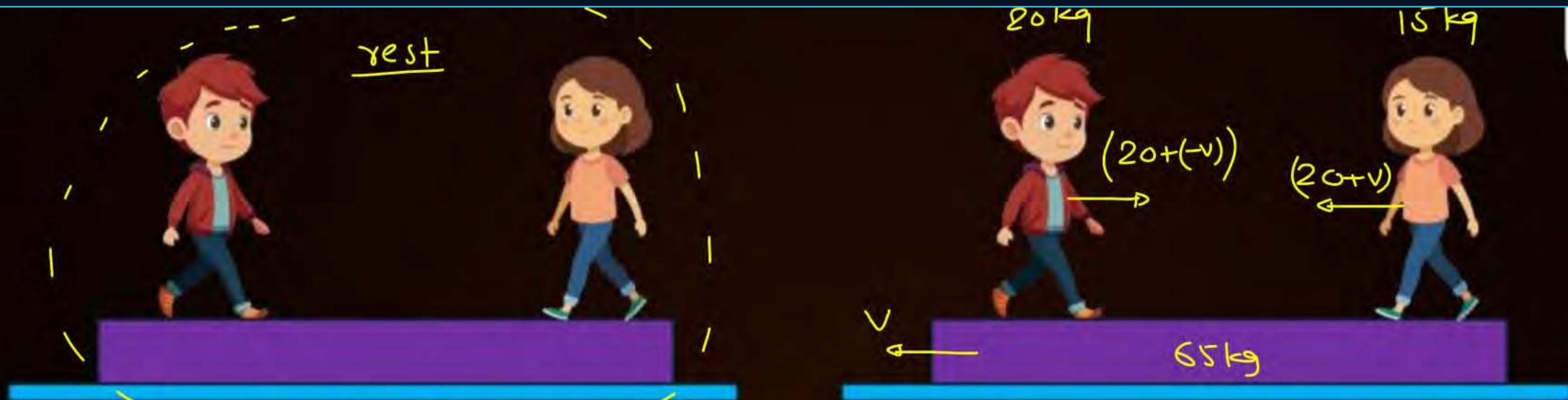https://ATDB.uno | Unauthorised redistribution is strictly prohibited
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Question

A Boy of mass 20kg and a Girl of mass 15kg are standing on a plank of mass 65kg. initially system was at rest. now both start moving toward each other with Speed 20m/s w.r.t plank. find speed of boy, girl and plank

20kg

15kg

Smooth

65kg

rest

20 kg

15 kg

$(20+(-v))$

$(20+v)$

V

65 kg

$$f_{ext.}\Big)_x = 0 \implies P_i = P_f \implies 0 = 20(20-v) - 15(20+v) - 65v = 0$$

$$V = 1 \, m/s$$

$$V_{boy} = 20 + (-1) = 19 \, m/s$$

$$V_{girl} = 20 + 1 = 21 \, m/s$$

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Question

A boy of mass 20 kg is standing on a plank of mass 80kg. Plank is kept on a smooth horizontal surface. Initially system was moving with speed 3m/s in +ive x-direction. Now boy start moving on plank with speed 10m/s in +ive x-direction w.r.t. plank. Find speed of plank
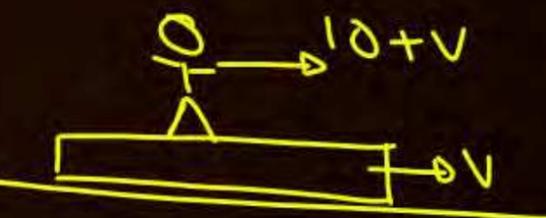
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$20\,kg$

$\longrightarrow 3\,m/s$

$\longrightarrow 10-v$

$3\,m/s$

v

$80\,kg$

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$P_i = P_f$

$20 \times 3 + 80 \times 3 = 20(10-v) - 80v = 0$

$v = -1\,m/s$

$\longrightarrow 10+v$

$\longrightarrow v$

$20 \times 3 + 80 \times 3 = 20(10+v) + 80v$

$v = 1\,m/s$

$$\underline{2^{nd} \; Profile}$$

$$if \quad f_{ext.} = 0 \quad \Rightarrow \quad \vec{P_i} = \vec{P_f}$$

$$\underline{also \quad U_{cm} = 0} \quad \Rightarrow \quad CoM \; will \; not \; move \quad \left(a_{cm} = 0 \; , \; U_{cm} = 0 \right)$$

$$\Rightarrow \quad \vec{S}_{cm} = 0 \qquad (displacement)$$

$$\Rightarrow \quad \boxed{m_1 \vec{S_1} + m_2 \vec{S_2} + \dots = 0} \qquad \left(\vec{S}_{cm} = \frac{m_1 \vec{S_1} + m_2 \vec{S_2} + \dots}{M} \right)$$

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Question

A boy of mass 20 kg is standing on a plank of mass 80kg. Plank is kept on a smooth horizontal surface. Initially system was at rest. Now boy move from point A to B. find displacement of boy and plank in this motion

Smooth

A ← 10m → B

rest

20

$(10+(-x))$

smooth

A   10m   B

$X \leftarrow$ A   B
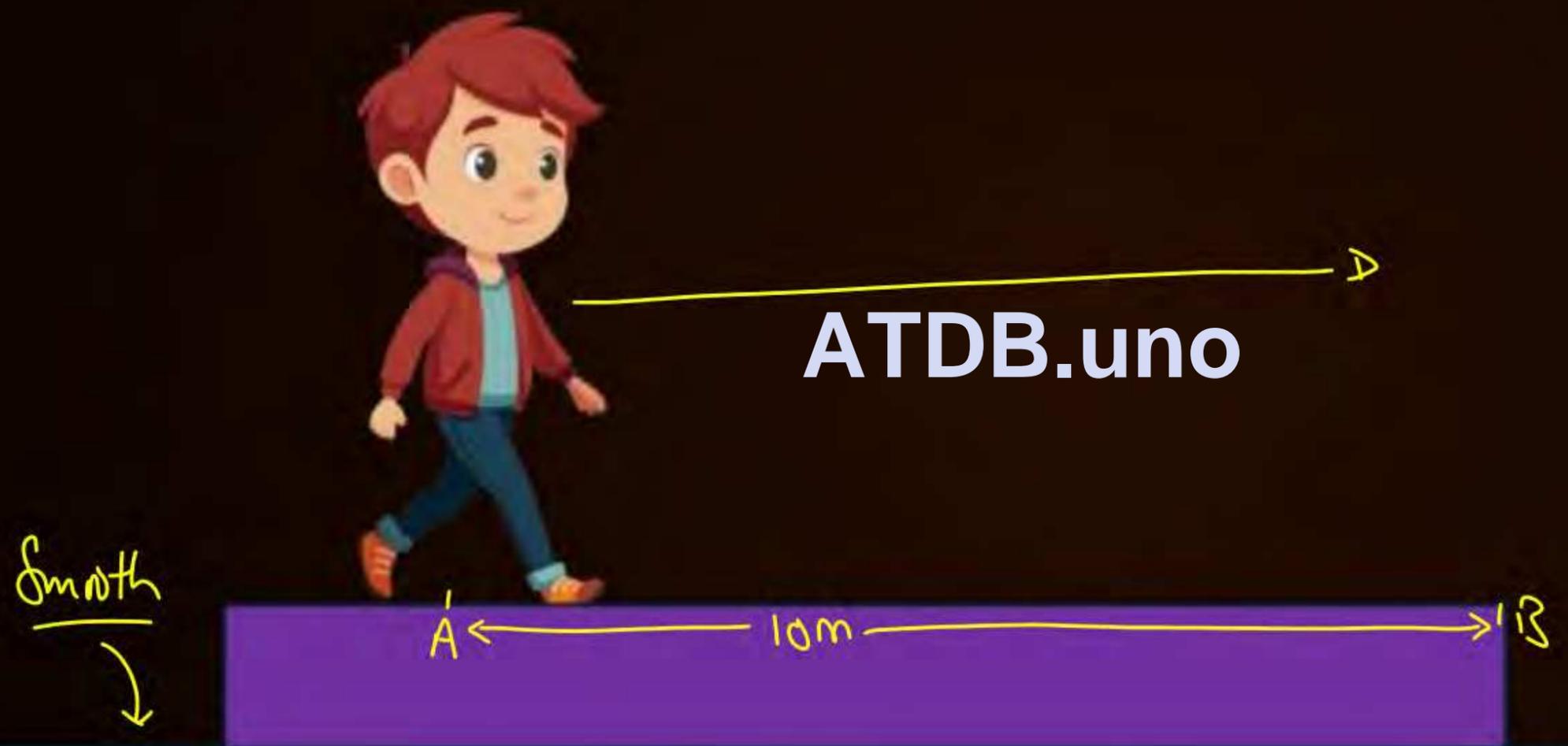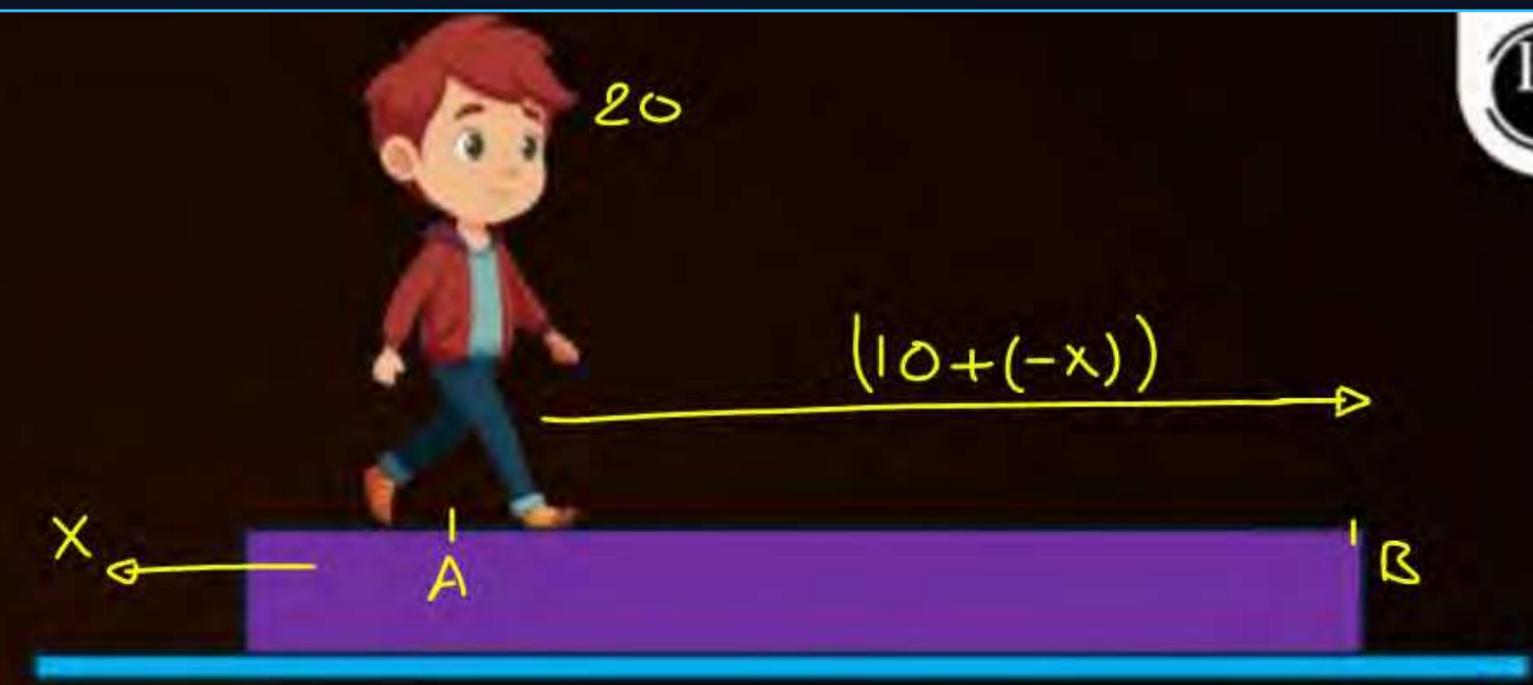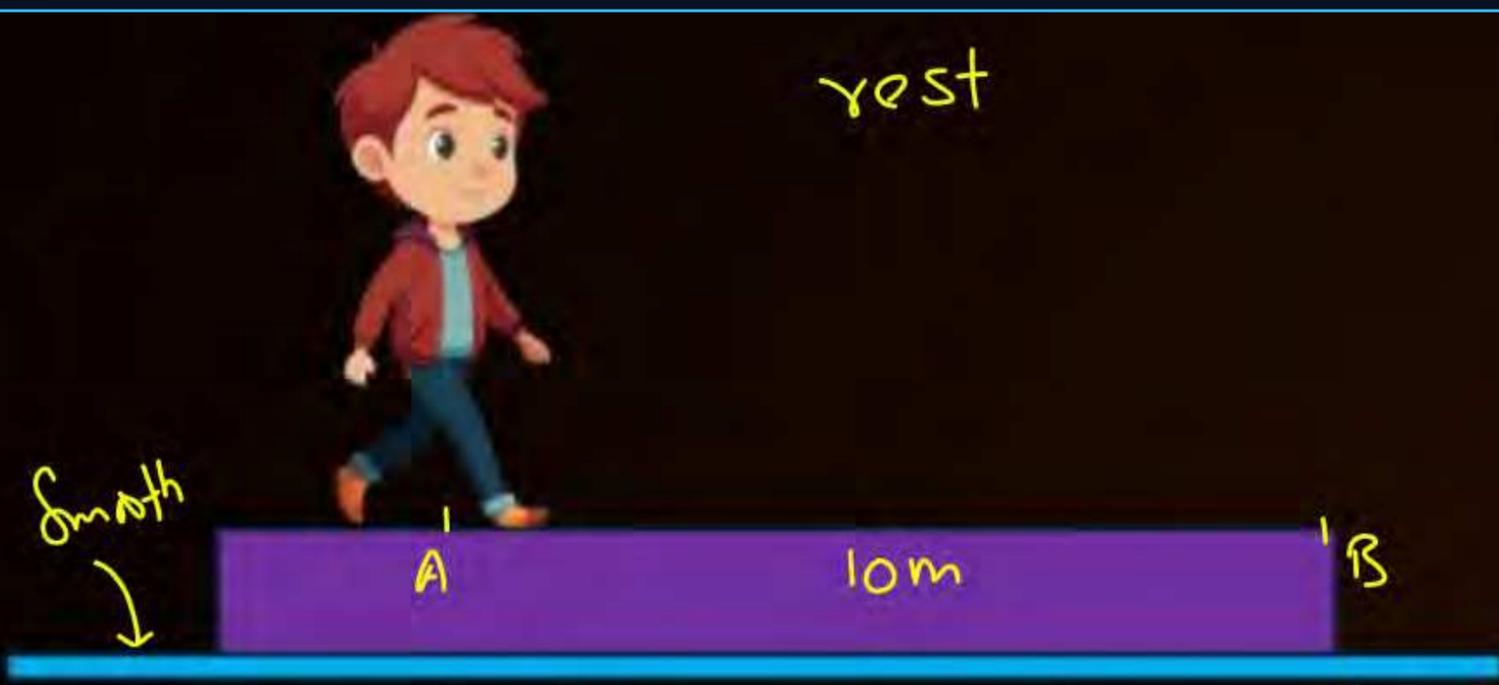
$$\left. f_{ext.}\right)_x = 0 \quad \text{and} \quad U_{cm} = 0$$

$$\Rightarrow \quad m_1 \vec{s_1} + m_2 \vec{s_2} + \cdots = 0$$

$$20(10-x) - 80x = 0$$

$$x = 2m$$

$$S_{boy} = (10-2)\hat{i} = 8\hat{i}$$

$$S_{plank} = -2\hat{i}$$

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Question

A boy of mass 40kg and a girl of mass 30kg are standing on a plank of mass 50kg. initially System was at rest. find displacement of plank if boy move to the position of girl
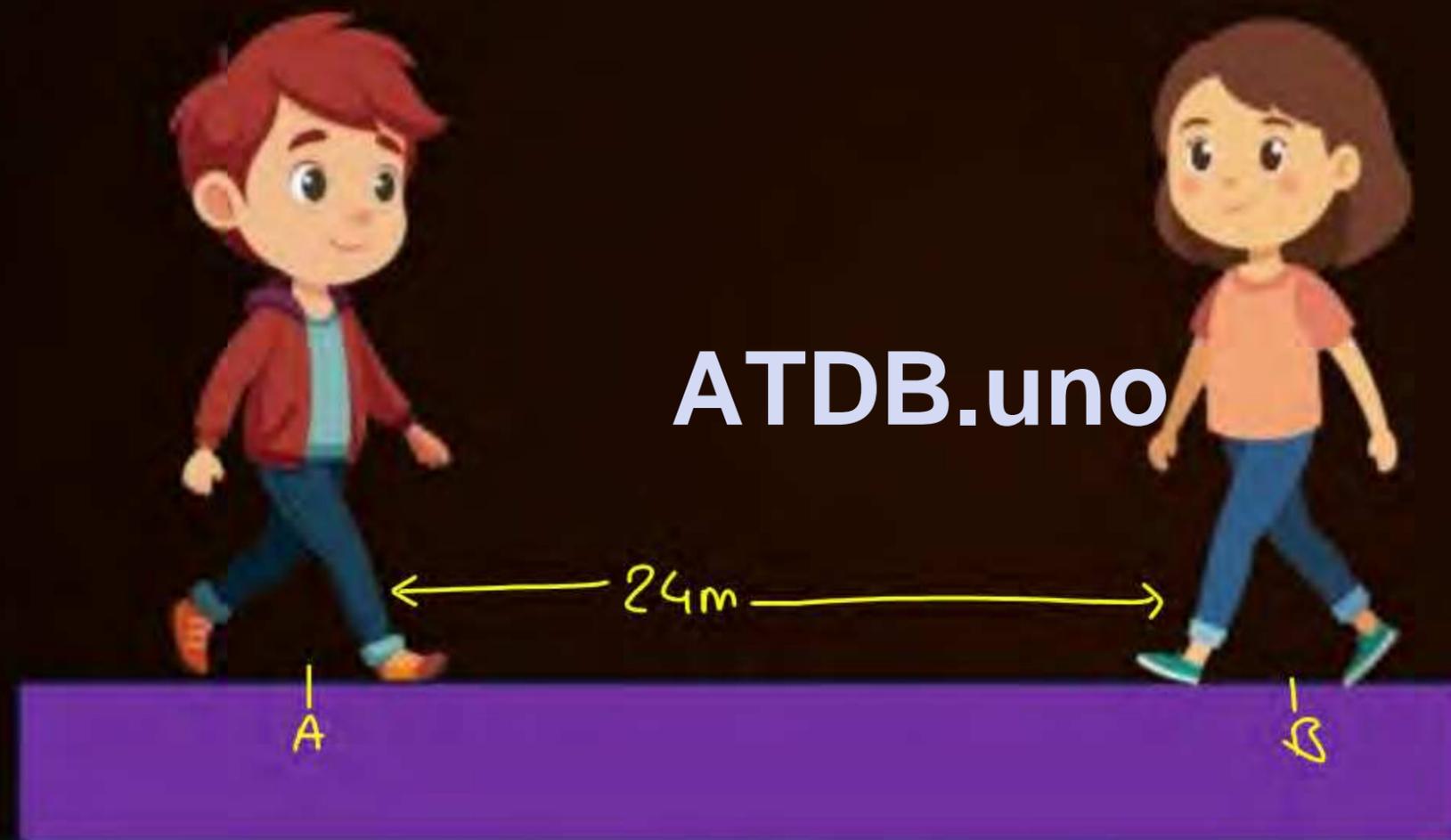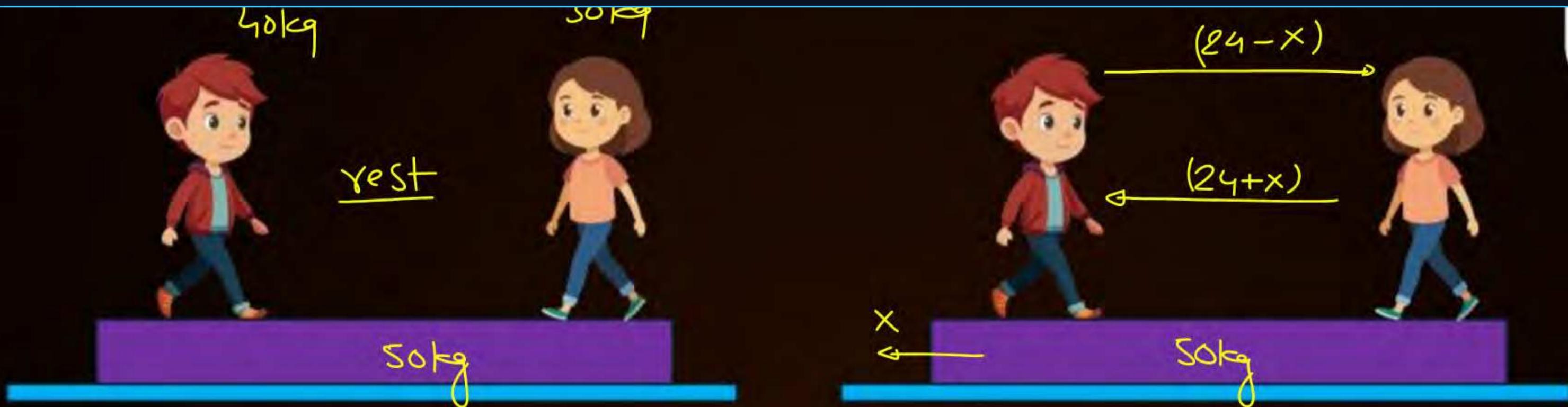

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$\longleftarrow$ 24m $\longrightarrow$

A   B

40kg   50kg

rest

(24-x)

x

50kg

x
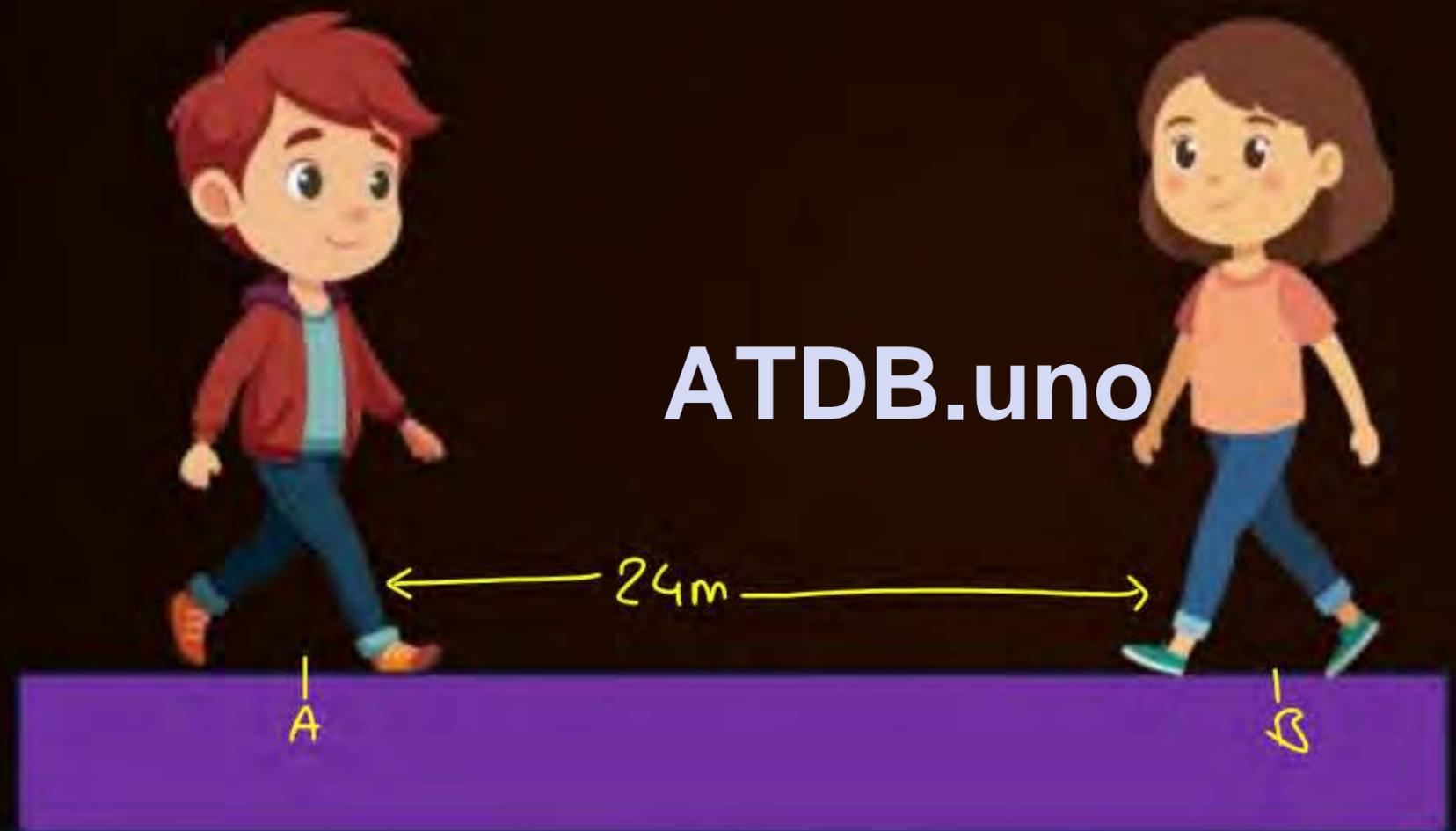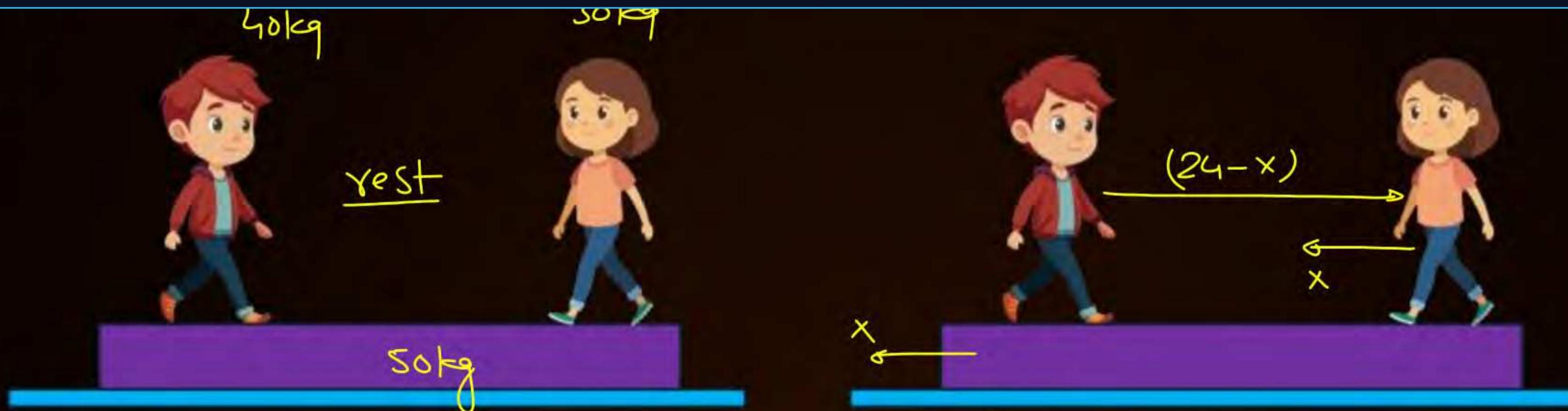
$$m_1\vec{s_1} + m_2\vec{s_2} + \ldots \quad 40(24-x) - 30x - 50x = 0$$

$$\Rightarrow \frac{40 \times 24}{120} = x \Rightarrow x = 8$$

Question

A boy of mass 40kg and a girl of mass 30kg are standing on a plank of mass 50kg. initially System was at rest. find displacement of plank if boy and girl Switch their positions

40kg

50kg

rest

$(24-x)$

$(24+x)$

x

50kg

50kg

$m_1\vec{S_1} + m_2\vec{S_2} + \cdots = 0$

$40(24-x) - 30(24+x) - 50x = 0$

$40 \times 24 - 30 \times 24 = 120x$
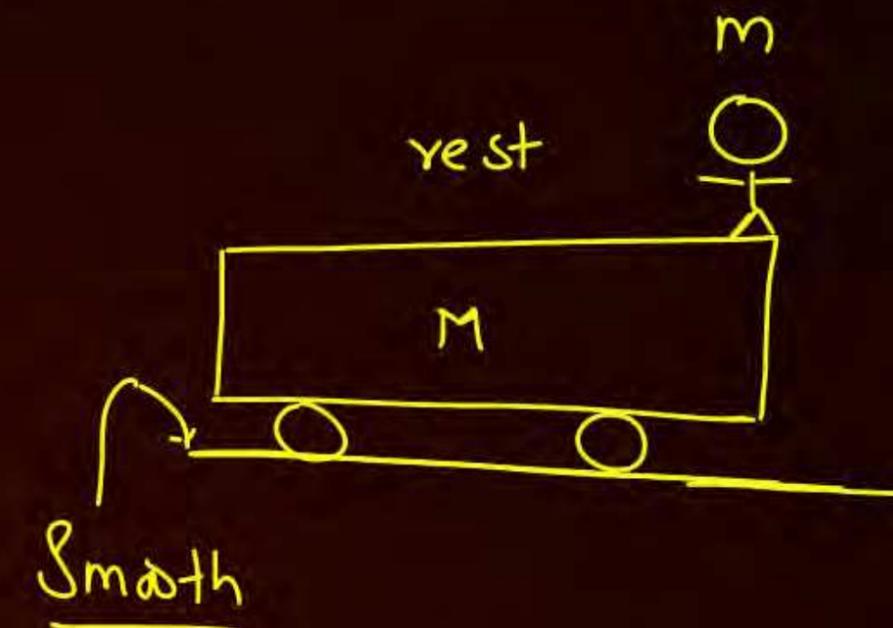
$\underline{x = 2}$

Q. man horizontally jump from the

find (i) velocity of cart after jump.

(ii) klook done by internal forces

of man

Sol^n

$\xrightarrow{} V - V_1$
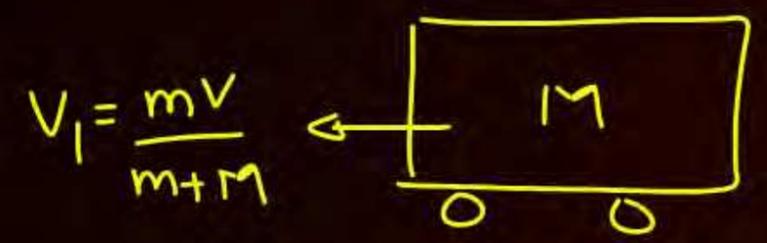
$V_1 \xleftarrow{} \boxed{M}$

rest

m

$\boxed{M}$

Smooth

$$\vec{P_i} = \vec{P_f} \implies 0 = m(V - V_1) - MV_1$$

$$V_1 = \frac{mV}{m+M}$$

$$\xrightarrow{} \quad V - V_1 = \frac{MV}{m+M}$$

$$\left(V - \frac{mV}{m+M} = \frac{MV}{m+M} \right)$$

$$V_1 = \frac{mV}{m+M} \longleftarrow \boxed{M}$$

(b) $\quad |W|_{internal} + |W|_{friction} = \Delta k.\mathcal{E}. = \frac{1}{2} m \left(\frac{MV}{m+M} \right)^2 + \frac{1}{2} M \left(\frac{mV}{m+M} \right)^2$

forces of
man

$\quad$ Static

$|W|_{fr}$ on boy $= -\frac{1}{2} M \left(\frac{mV}{m+M} \right)^2$

(c) find work done by Static friction
on Cart

Sol^n $\quad |W|_{fr}$ or Cart $\neq 0$

$\left(|W|_{fr} \text{ on Cart} + \text{boy} = 0 \right)$

$|W|_{fr}$ on Cart $= \frac{1}{2} M \left(\frac{mV}{m+M} \right)^2$

$\left(\begin{array}{l} \text{net work done by internal tension,} \\ \text{internal normal and internal Static friction} \\ \text{is always zero} \end{array} \right)$

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