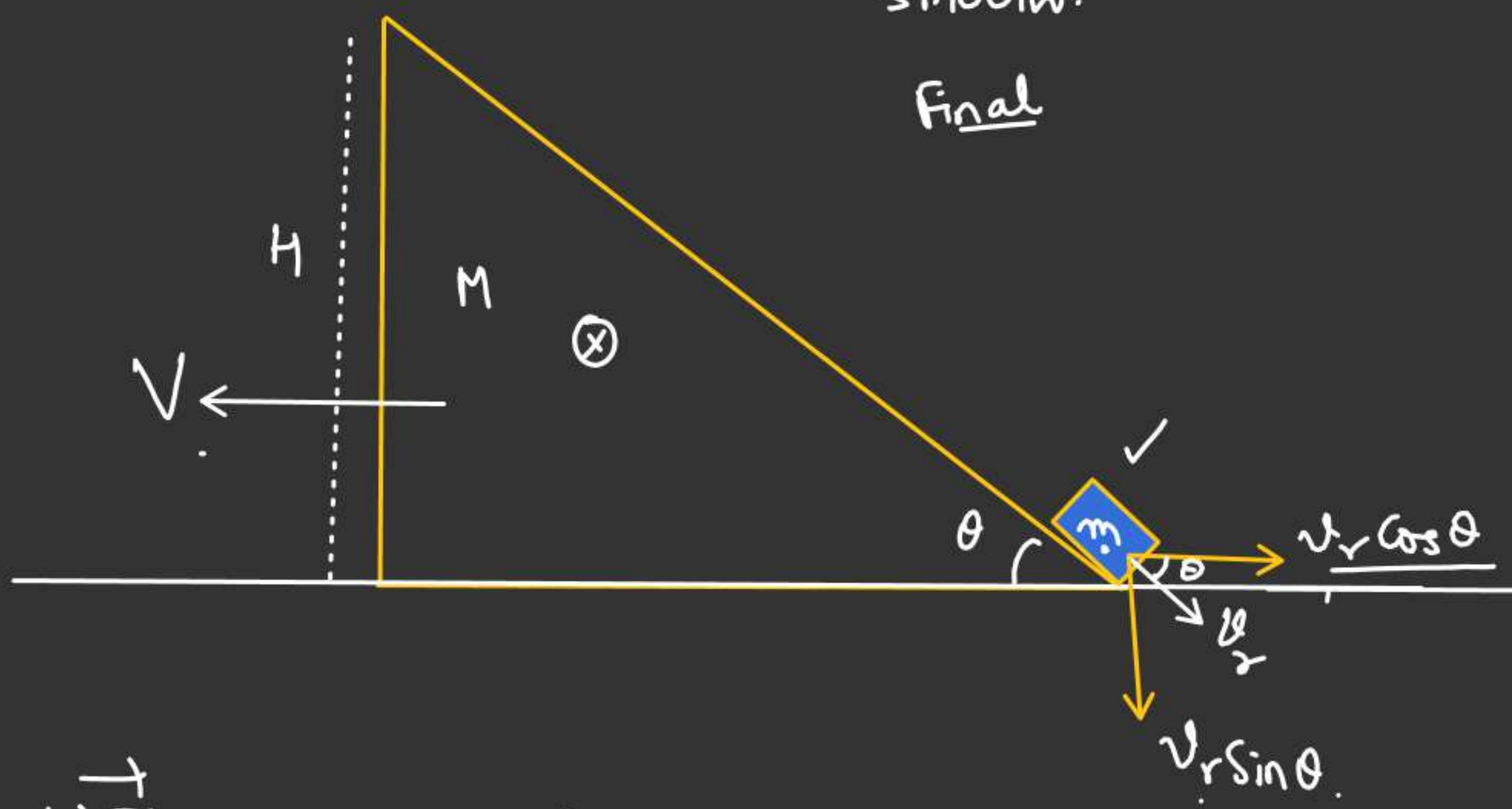
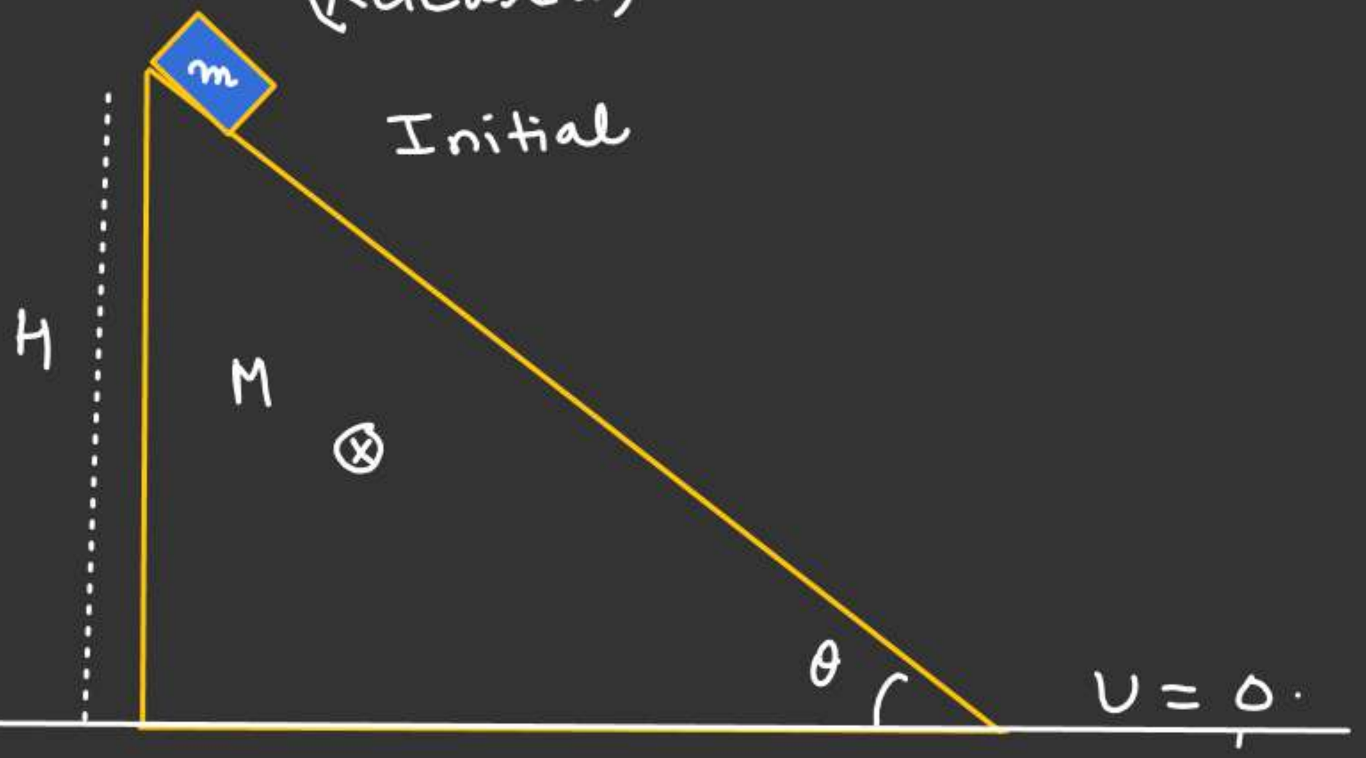
All Contanct surfaces are smooth.





$$(\vec{v}_{block/E})_x = (\vec{V}_{block/wedge})_x + (\vec{V}_{wedge/E})_x$$

$$= v_r\cos\theta\,\hat{i} - V\hat{i}$$

$$= (v_r\cos\theta - V)\,\hat{i}.$$

L.M.C in x-direction

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

$$(M+m)V = m v_r\cos\theta$$

$$V = \left(\frac{m V_r\cos\theta}{M+m}\right) \quad (1)$$

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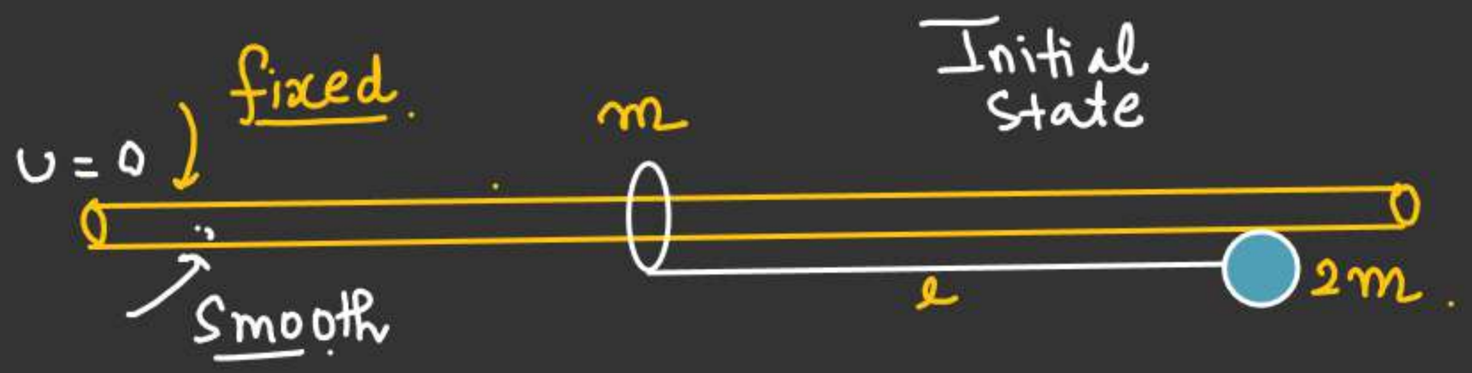
Energy Conservation

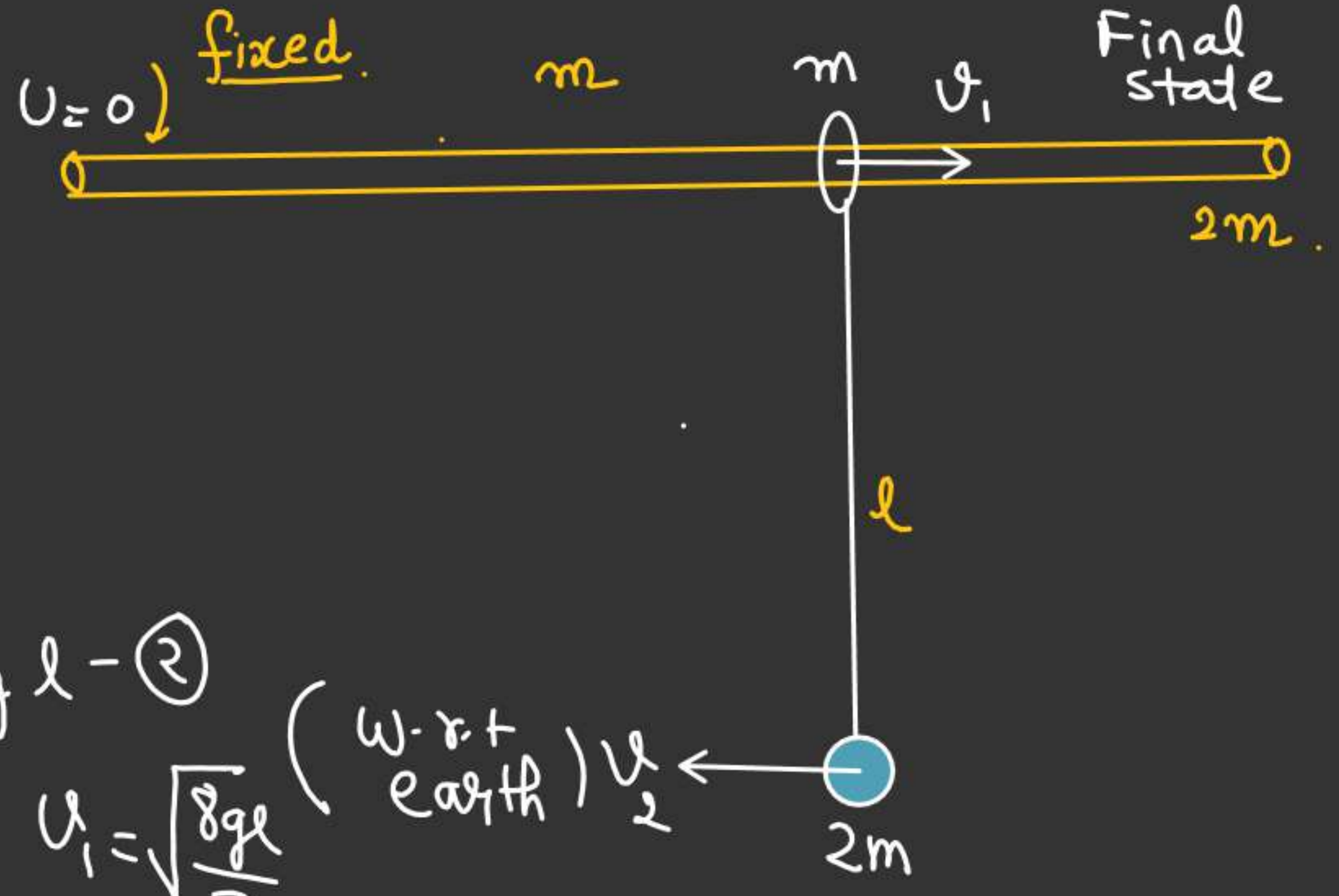
$$mgH = \frac{1}{2}MV^2 + \frac{1}{2}m\left[(V_r\cos\theta - V)^2 + (V_r\sin\theta)^2\right] \quad - (2)$$

$$\vec{v}_{block/E} = \left[(v_r\cos\theta - V)\hat{i} - V_r\sin\theta\,\hat{j}\right]$$

$$|\vec{v}_{block/E}| = \sqrt{(V_r\cos\theta - V)^2 + (V_r\sin\theta)^2}$$

Q. Ball is released from the position shown in the fig. Find velocity of ring and ball when string become vertical.
Also find Tension in the string when string become vertical.





In x-direction

L.M.C

$$0 = mv_1 - 2mv_2$$

$$v_1 = 2v_2 \quad \text{--- (1)}$$

Energy conservation.

$$0 = \frac{1}{2}mv_1^2 + \frac{1}{2}(2m)v_2^2 - 2mgl \quad \text{- (2)}$$

$$2mgl = 2mv_2^2 + mv_2^2 \Rightarrow v_2 = \sqrt{\frac{2}{3}gl}, \quad v_1 = \sqrt{\frac{8gl}{3}}$$

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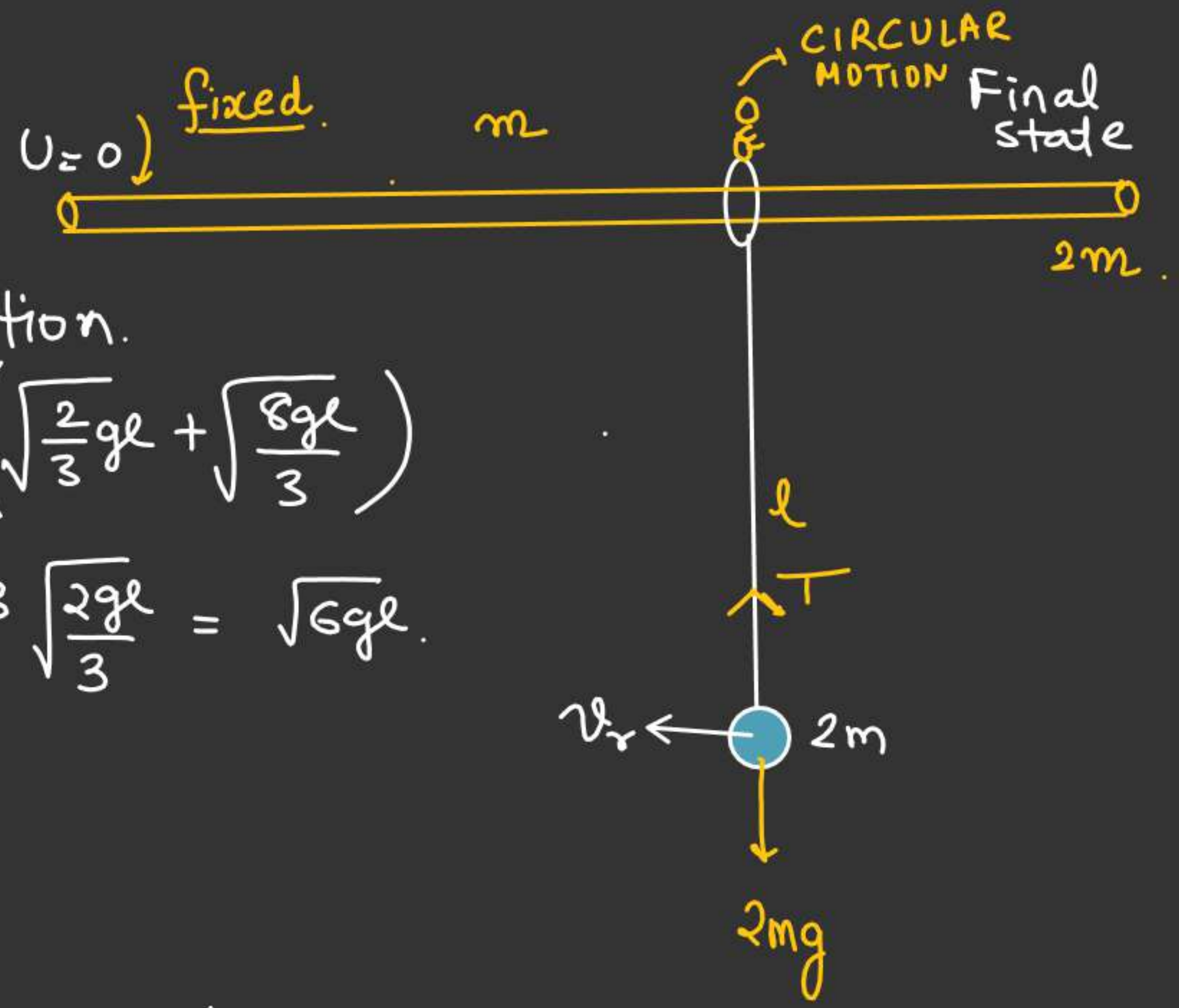
$v_2 = \sqrt{\frac{2}{3}g\ell}$, $v_1 = \sqrt{\frac{8g\ell}{3}}$



w.r.t ring frame

ball perform circular Motion.

So, $v_r = (v_1 + v_2) = \left(\sqrt{\frac{2}{3}g\ell} + \sqrt{\frac{8g\ell}{3}}\right)$

$= 3\sqrt{\frac{2g\ell}{3}} = \sqrt{6g\ell}$.

$T - 2mg = \frac{2m v_r^2}{\ell}$.

$T = 2mg + \frac{2m}{\ell} \times 6g\ell$

$\underline{T = 14mg}$ ✓

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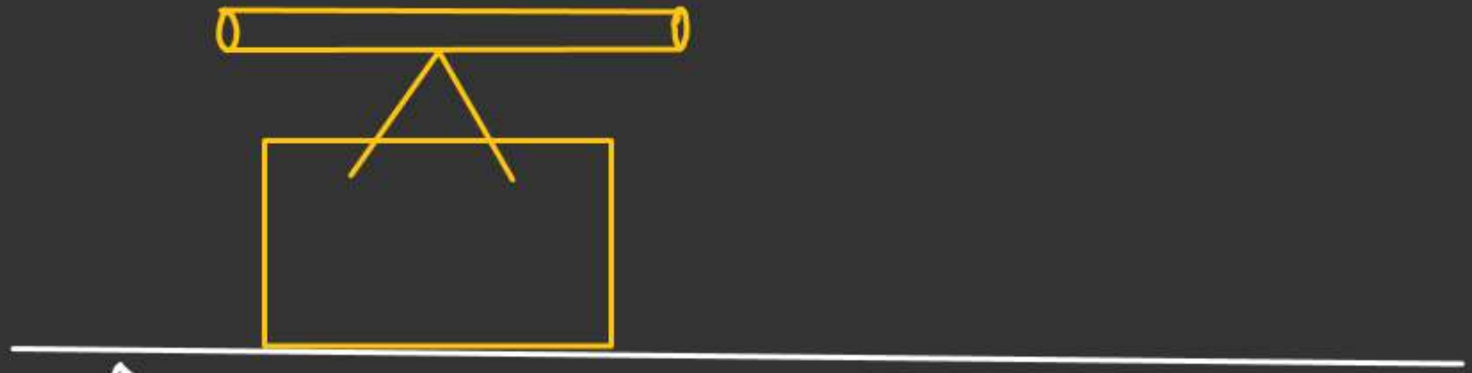
Case of firing of bullets.

$M = $ (Mass of block + gun + n bullet)

$m = $ mass of bullet.

$n = $ No of bullets.



Just after 1st firing

(Muzzle velocity)

$\left(J = \int_0^{\Delta t} F \cdot dt \right)$ → Impulse.

[Muzzle velocity → velocity of bullet w.r.t gun.

$$\int_0^{\Delta t} F\,dt = \int_{p_i}^{p_f} dp$$

$$\Downarrow$$

$$0 = \Delta p.$$

$$\vec{v}_{bullet/E} = \vec{v}_{bullet/gun} + \vec{v}_{gun/E}$$

$$= (v_0 \hat{i} - V_1 \hat{i})$$

$$= (v_0 - V_1)\hat{i}$$

$$\Downarrow$$

$$v_2$$

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v_0 = muzzle velocity.

After 1^{st} firing.

$$v_2 = (v_0 - v_1)$$

$$v_1 + v_2 = v_0 \quad — ①$$

L.M.C

$$(p_i) = (p_f)$$

Just before 1^{st} firing — Just after 1^{st} firing

$$0 = m\underline{\underline{v_2}} - (M-m)v_1 \quad — ②$$

Put $v_2 = v_0 - v_1$ in ②

$$m(v_0 - v_1) - (M-m)v_1 = 0$$

$$mv_0 - \cancel{mv_1} - Mv_1 + \cancel{mv_1} = 0$$

$$v_1 = \left(\frac{mv_0}{M}\right)$$

Recoiling belocity after 1^{st} firing.

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Case of 2nd firing.

Just before 2nd firing

$v_1 \leftarrow$ (M − m) Initial. State.

$\longrightarrow$ +ve.

−ve $\longleftarrow$

Just after 2nd firing Final State

$v_3 \leftarrow$ (M − 2m) $\quad \xrightarrow{m} v_4$ (w.r.t earth)

v_3 ⇓ [Recoiling velocity after 2nd firing]

$$v_4 + v_3 = v_0 \quad \text{—} \ (1)$$

L.M.C.

$$-(M-m)v_1 = mv_4 - (M-2m)v_3$$

$$-(M-m)v_1 = m(v_0 - v_3) - (M-2m)v_3$$

$$-(M-m)v_1 = mv_0 - mv_3 - (M-2m)v_3$$

$$(m + M - 2m)v_3 = mv_0 + (M-m)v_1$$

$$(M-m)v_3 = mv_0 + (M-m)v_1$$

$$v_3 = \left(\frac{mv_0}{M-m}\right) + v_1$$

$v_n = ??$ H.W

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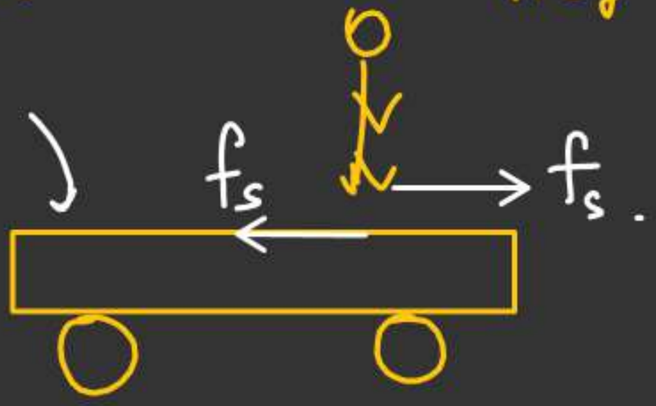
Case of jumping: [Series jumping].

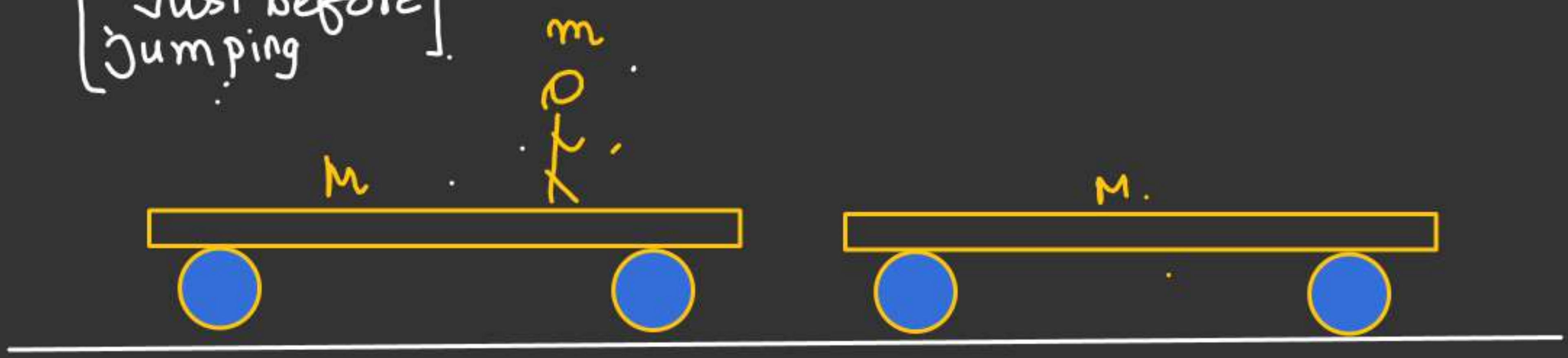
After jumping velocity of both the trolley.

During Jumping

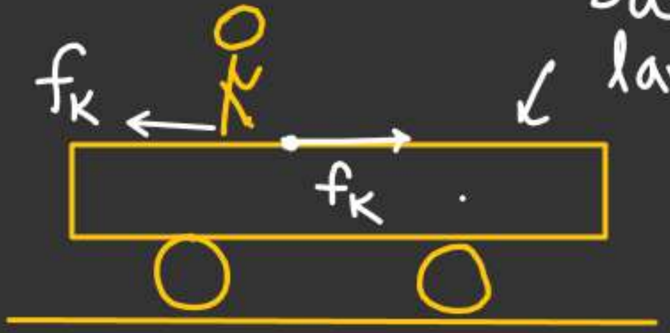


$f_s = \frac{dp}{dt}$

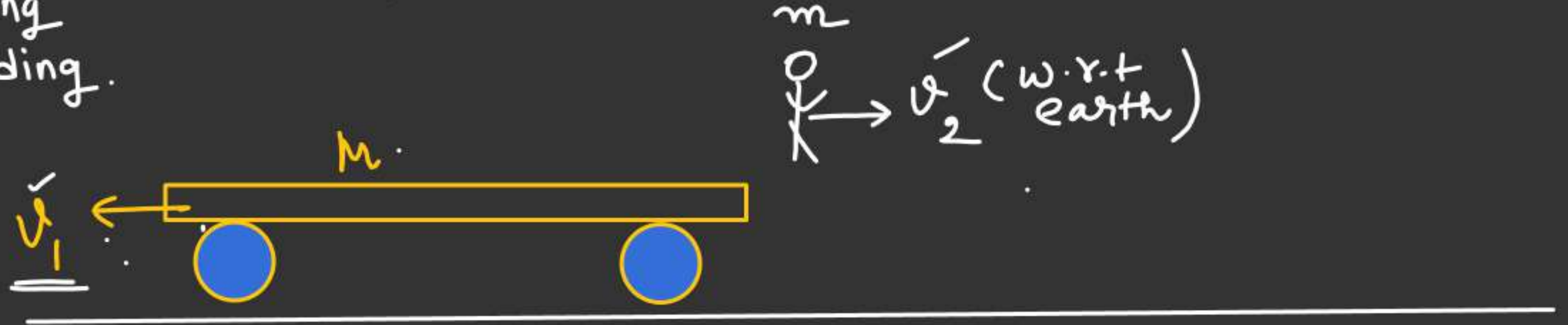
[Just before Jumping]



During landing.



Just after jumping



$0 = mv_2 - Mv_1$ —(1)

v_r be the relative velocity of Man w.r.t trolley.

$v_1 + v_2 = v_r$ —(2)
(given)

Put $v_2 = (v_r - v_1)$ in (1)

$0 = mv_r - mv_1 - Mv_1$

$v_1 = \left(\frac{mv_r}{M+m}\right)$

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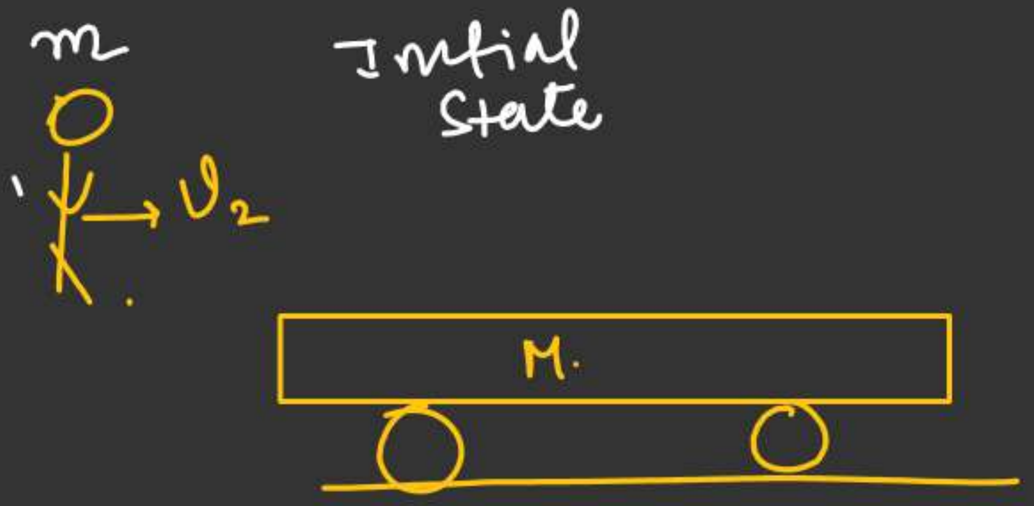
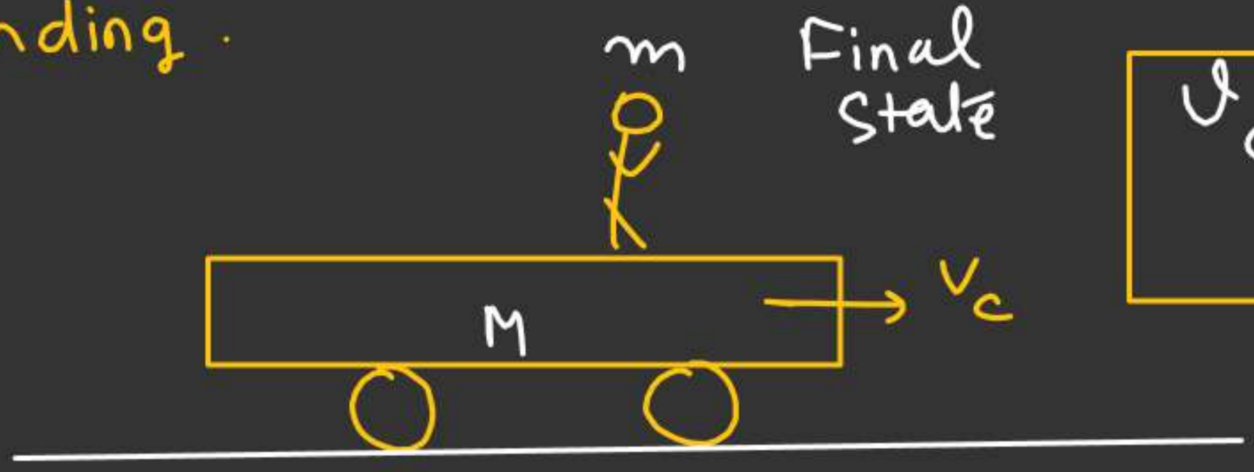
Just before landing ✓



Just after landing.



From – 2

$$v_2 = v_r - v_1$$

$$v_2 = \left(v_r - \frac{m v_r}{M+m}\right)$$

$$v_2 = \left(\frac{M v_r}{M+m}\right)$$

$$m v_2 = (M+m) v_c$$

$$v_c = \left(\frac{m v_2}{M+m}\right)$$

$$v_c = \frac{m}{M+m} \times \left(\frac{M v_r}{M+m}\right)$$

$$\boxed{v_c = \frac{Mm \cdot v_r}{(M+m)^2}}$$