

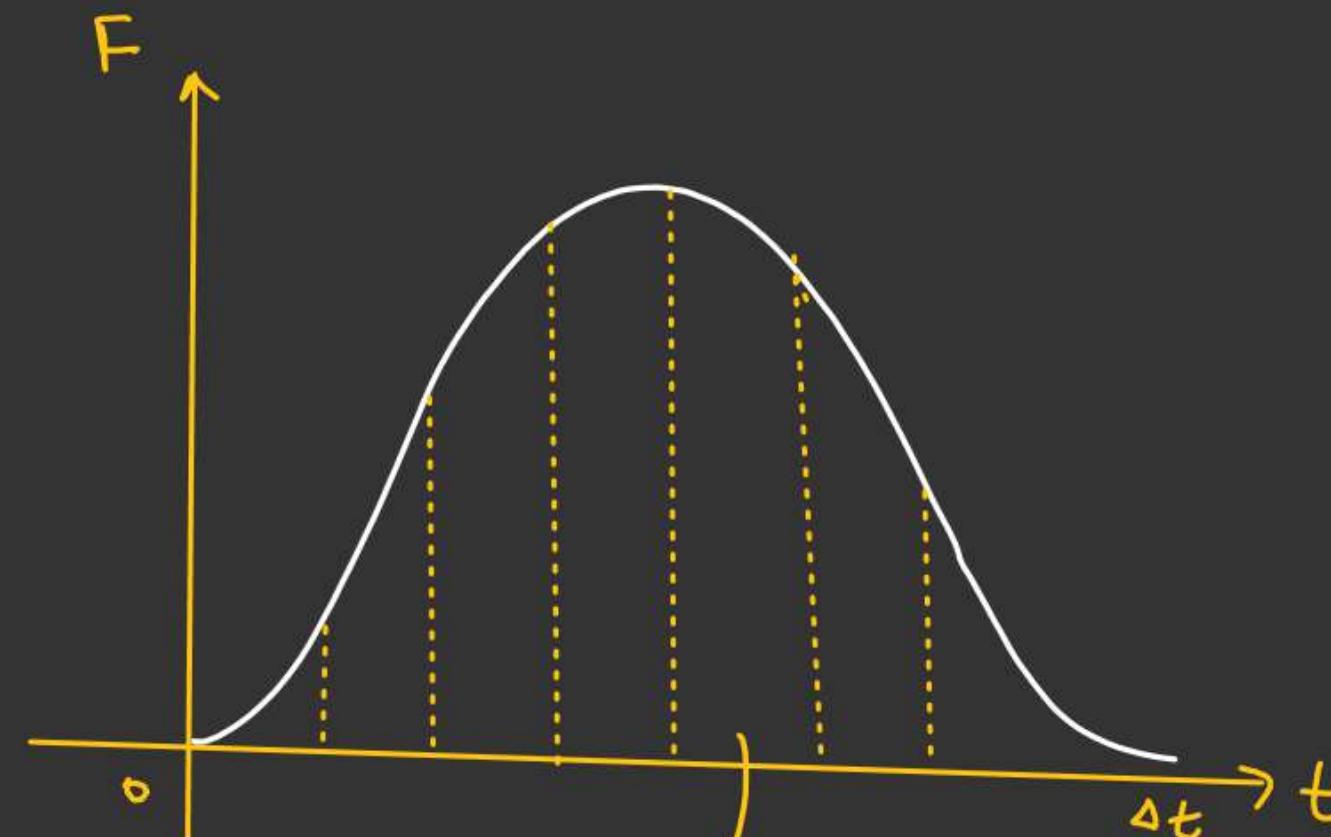
## IMPULSE

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

$$\underline{\Delta p} = \boxed{\int_0^{\Delta t} F \cdot dt}$$

If  $F$  is constant in  $\Delta t$  time

$$J = F \int_0^{\Delta t} dt = (\underline{F \Delta t})$$



Area Under  
 $F$  Vs  $t$  Curve  
is Equal to -  
Change in linear  
moment

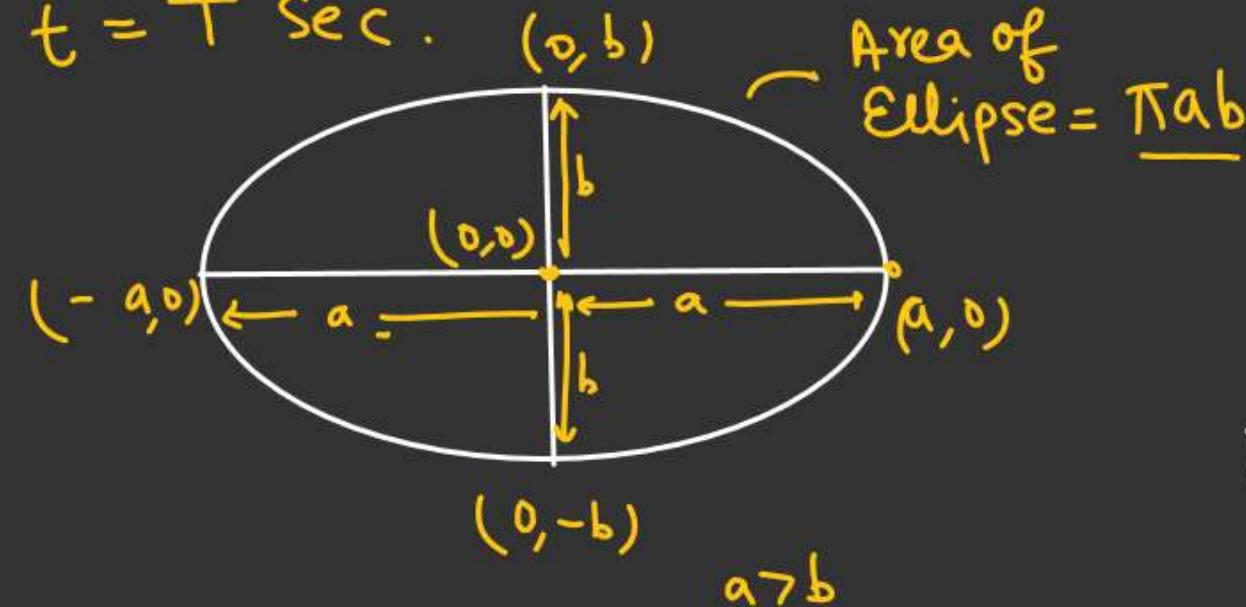
$J \rightarrow$  Unit  $\rightarrow$

$(\text{Kg m/s})$

# A Force which vary with time  $t$  as shown in the graph acts on a particle of mass  $m$ .

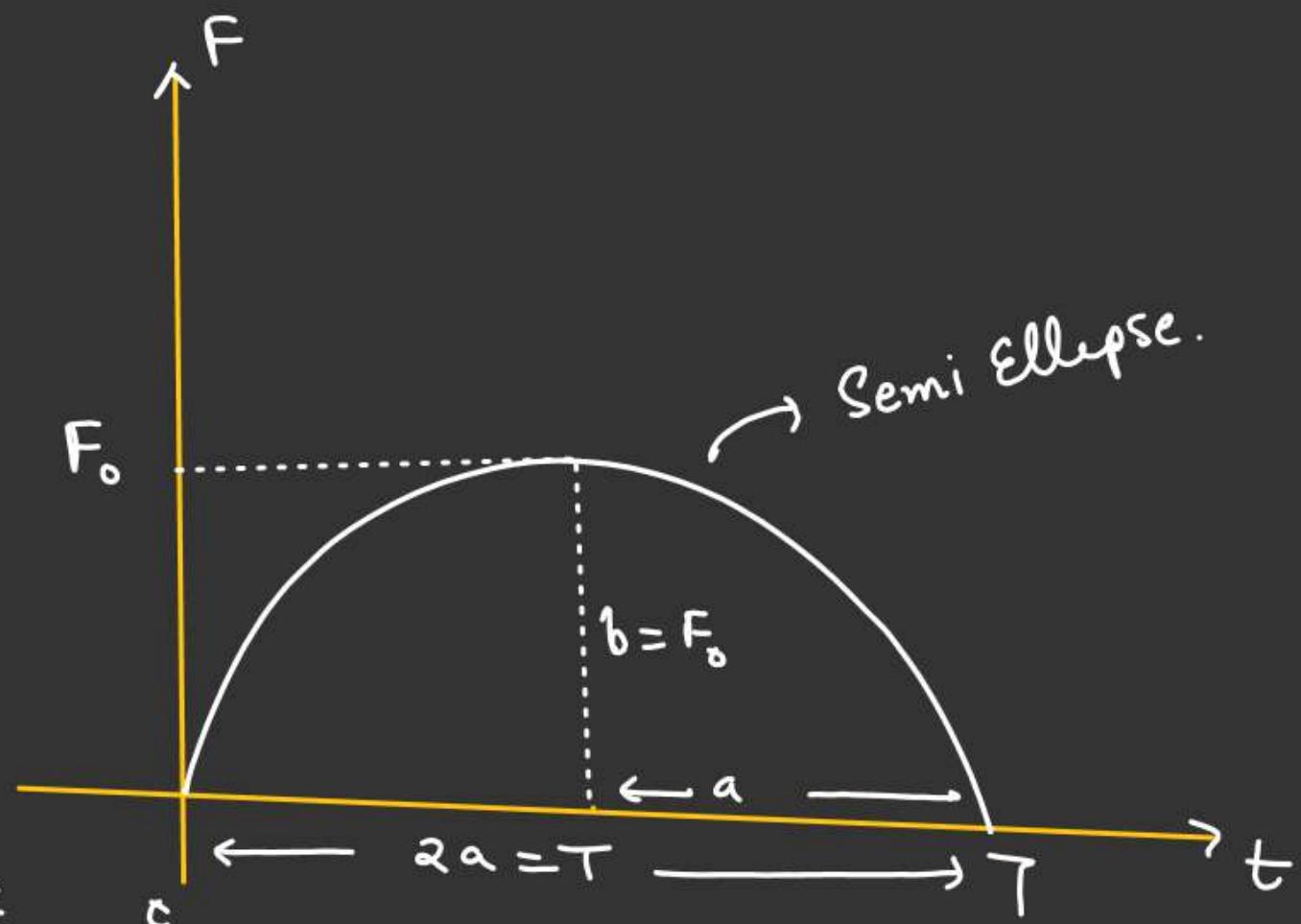
Initially particle at rest.  $\Rightarrow p_i = 0$

Find linear momentum of particle at  $t = T$  Sec.



$a$  = Semi Major axis

$b$  = Semi Minor axis



$\Delta p$  = Area of  $F$  vs  $T$  graph.

$$p_f - p_i = \pi \left(\frac{1}{2}\right) F_0 \times \frac{1}{2} = \left(\frac{\pi F_0 T}{4}\right) \checkmark$$

$$\left[ p_f = \frac{\pi F_0 T}{4} \right]$$



## Important points for Impulse

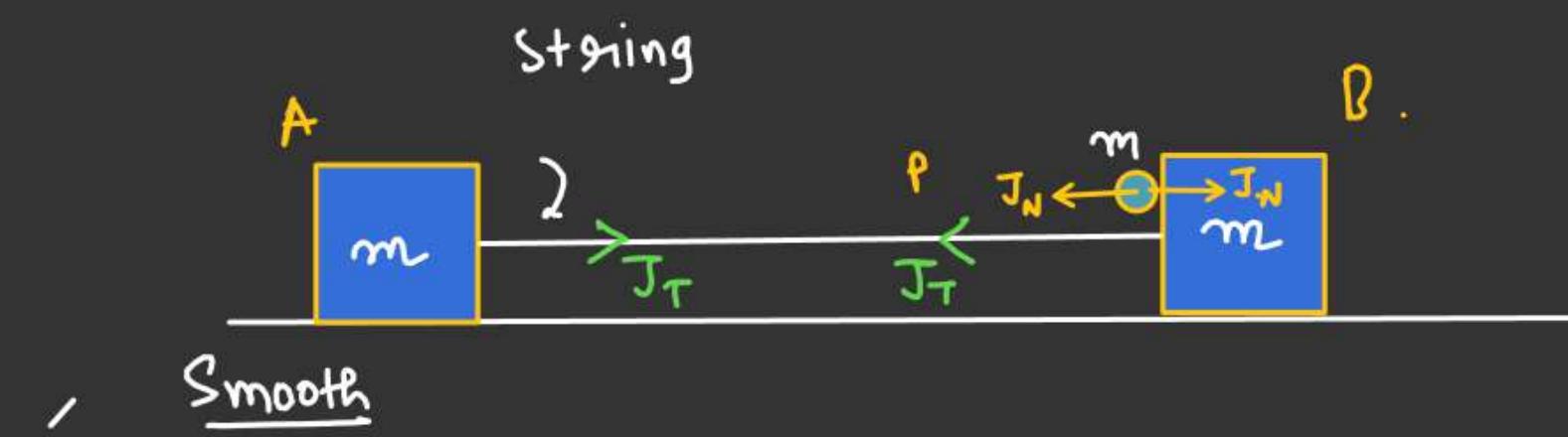
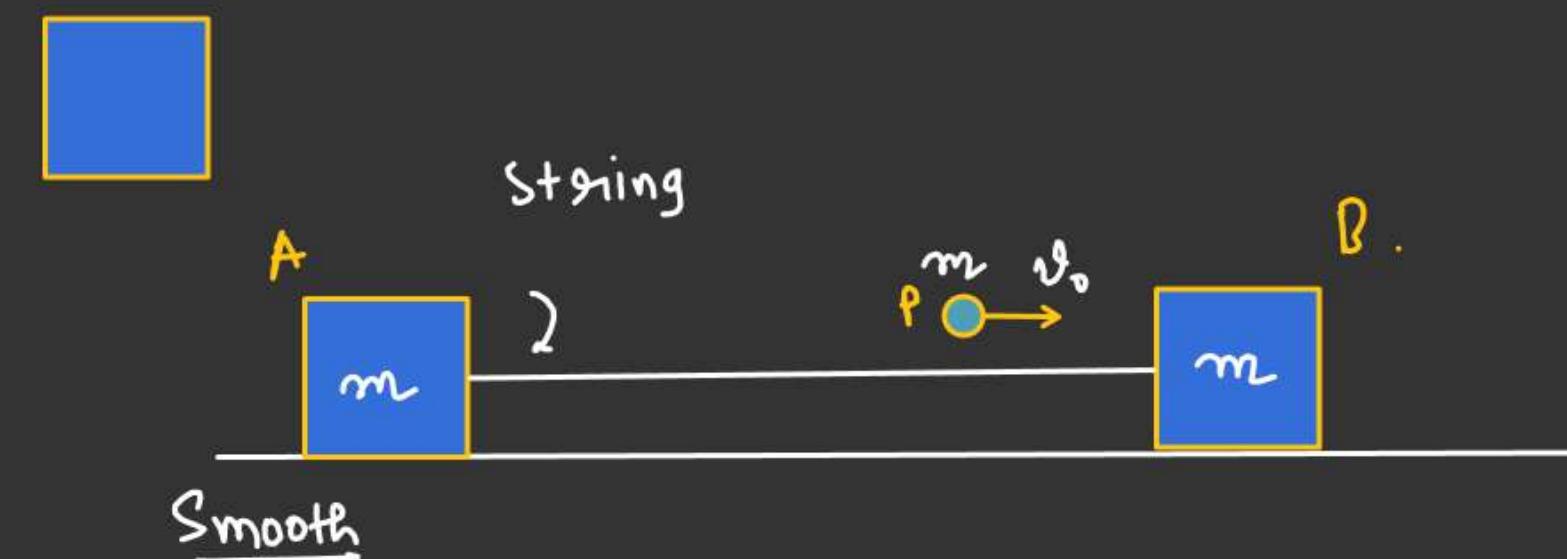
- Gravitational force & Spring force never be impulsive
- If string suddenly taut then tension in the string impulsive in nature . and always acts along the string
- In Case of impulse we only see the change in linear momentum of the body just before impulse applied to just after impulse applied

Ques: Two block system attached with string

- A mud-particle moving with velocity  $v_0$  stick to block B.

a) Find velocity of each block just after particle sticks to B.

b) Also find impulse due to tension



$J_N = \underline{N \Delta t} = \text{Impulse due to Normal reaction}$

$J_T = T \Delta t = \text{Impulse due to tension}$

M-1

For whole System

$$\vec{J}_{\text{net}} = 0$$

$$(\Delta \vec{p})_{\text{system}} = 0$$

$$(\vec{p}_i)_{\text{system}} = (\vec{p}_f)_{\text{system}}$$

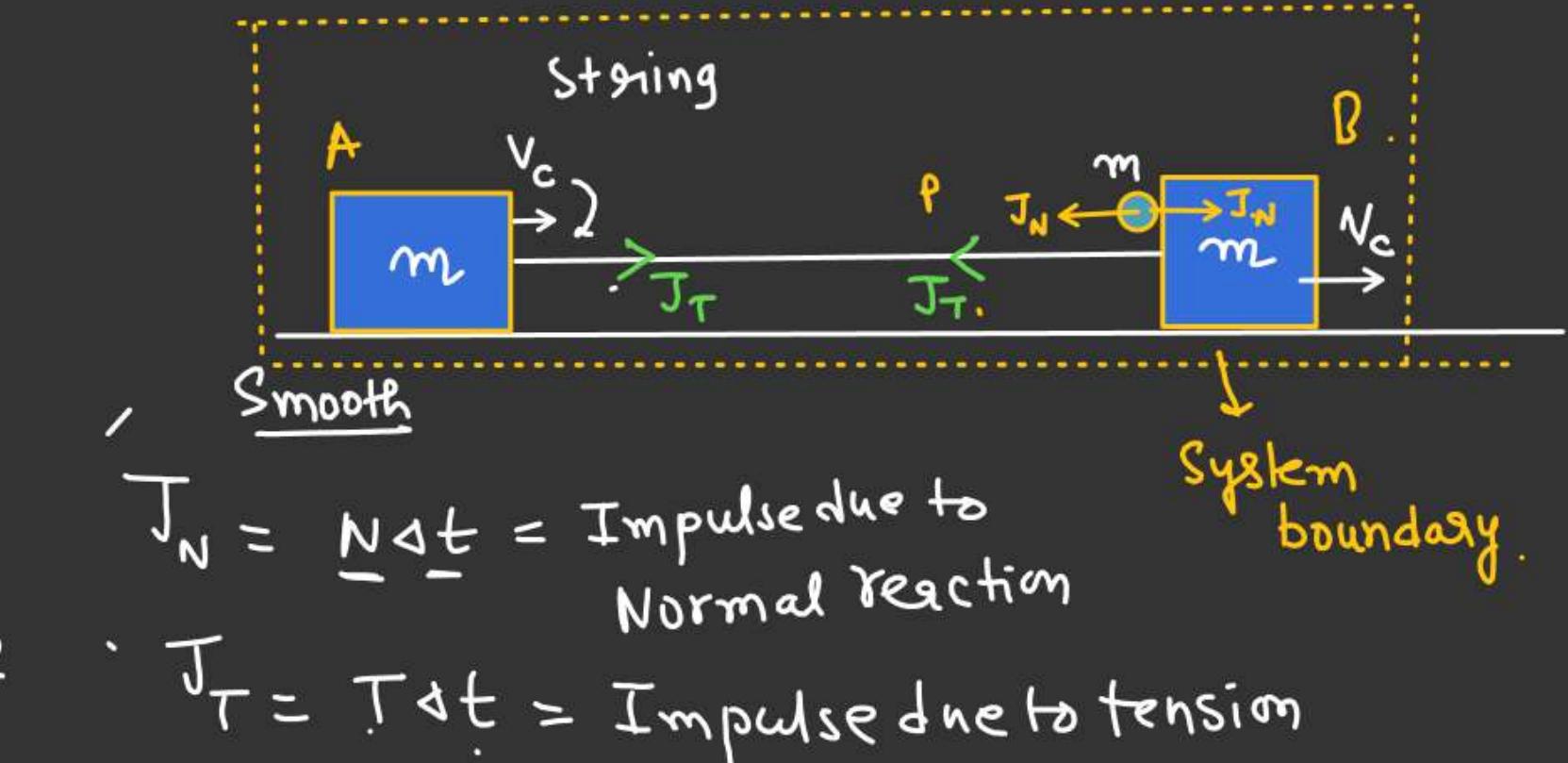
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Just before collision  
of mud-particle

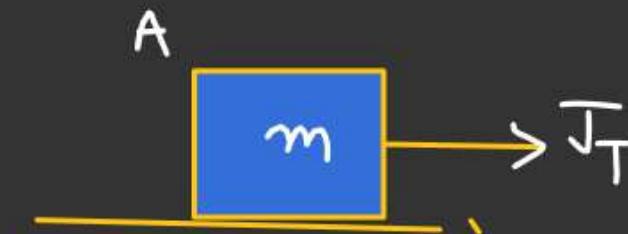
Just after  
collision of  
Mud-particle

$$m v_0 = 3m v_c$$

$$v_c = \frac{v_0}{3} \checkmark$$



$$\underline{\underline{J_T = ??}}$$



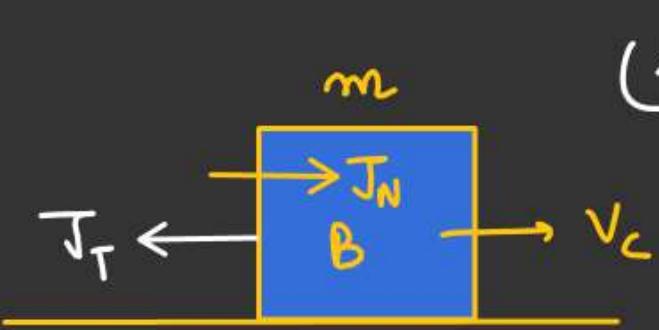
$$\underline{\underline{J_T = \left( \frac{m v_0}{3} \right) \text{ kg m/s}}}$$

$$\vec{J}_T = (\Delta \vec{p})_A$$

$$\vec{J}_T = (\vec{p}_f)_A - (\vec{p}_i)_A$$

$$\vec{J}_T = (m v_c) \hat{i} - 0$$

## Impulse due to Normal reaction



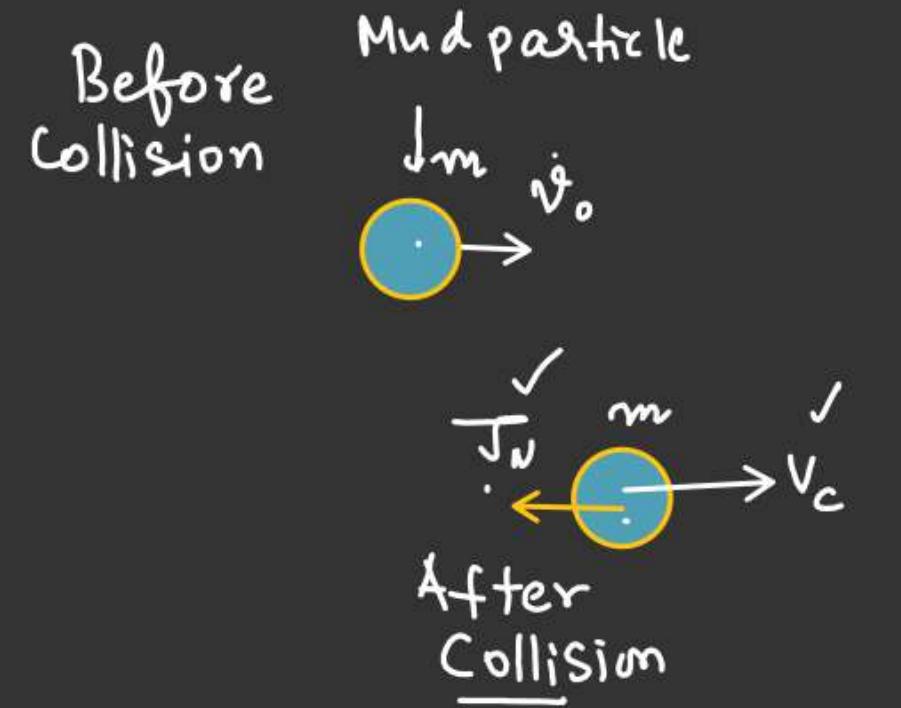
$$(\vec{\Delta p})_{\text{block } B} = (m v_c - 0) \hat{i} = \left( \frac{m v_0}{3} \right) \hat{i}$$

$$\bar{J}_N \hat{i} - J_T \hat{i} = (\vec{\Delta p})_{\text{block } B}$$

$$\bar{J}_N \hat{i} = J_T \hat{i} + (\vec{\Delta p})_{\text{block } B}$$

$$\bar{J}_N \hat{i} = \frac{m v_0}{3} \hat{i} + \frac{m v_0}{3} \hat{i}$$

$$\bar{J}_N = \left( \frac{2 m v_0}{3} \right) \checkmark$$



$$-\bar{J}_N \hat{i} = (\vec{\Delta p})_{\text{mud particle}}$$

$$-\bar{J}_N \hat{i} = m v_c \hat{i} - m v_0 \hat{i}$$

$$-\bar{J}_N = (m v_c - m v_0)$$

$$\bar{J}_N = m v_0 - m v_c$$

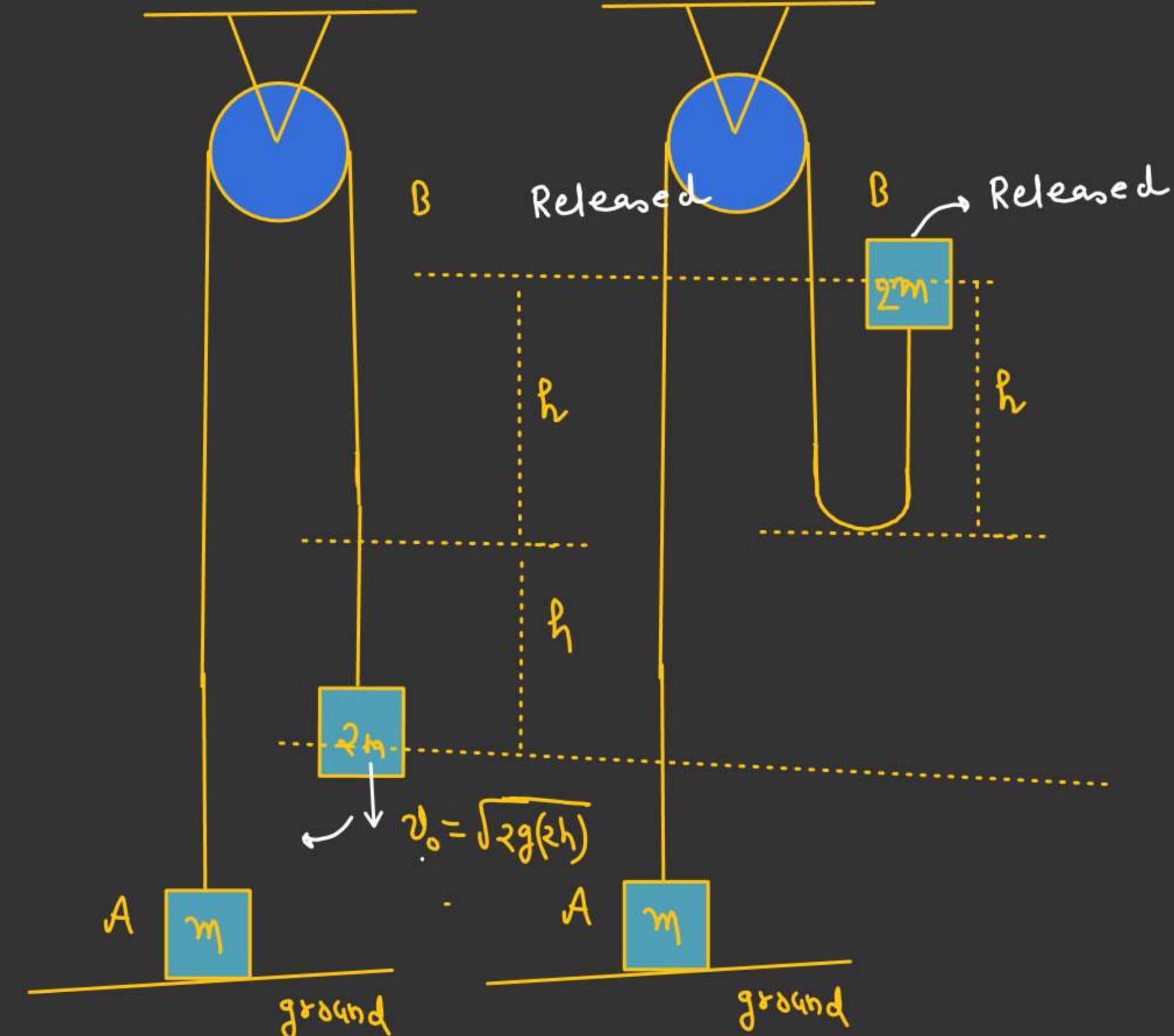
$$= \left( m v_0 - m \frac{v_0}{3} \right)$$

$$= \left( \frac{2 m v_0}{3} \right) \checkmark$$

Block B is released from the position shown in the fig.

- Find velocity of both the blocks just after string is taut.
- Also find impulse due to tension

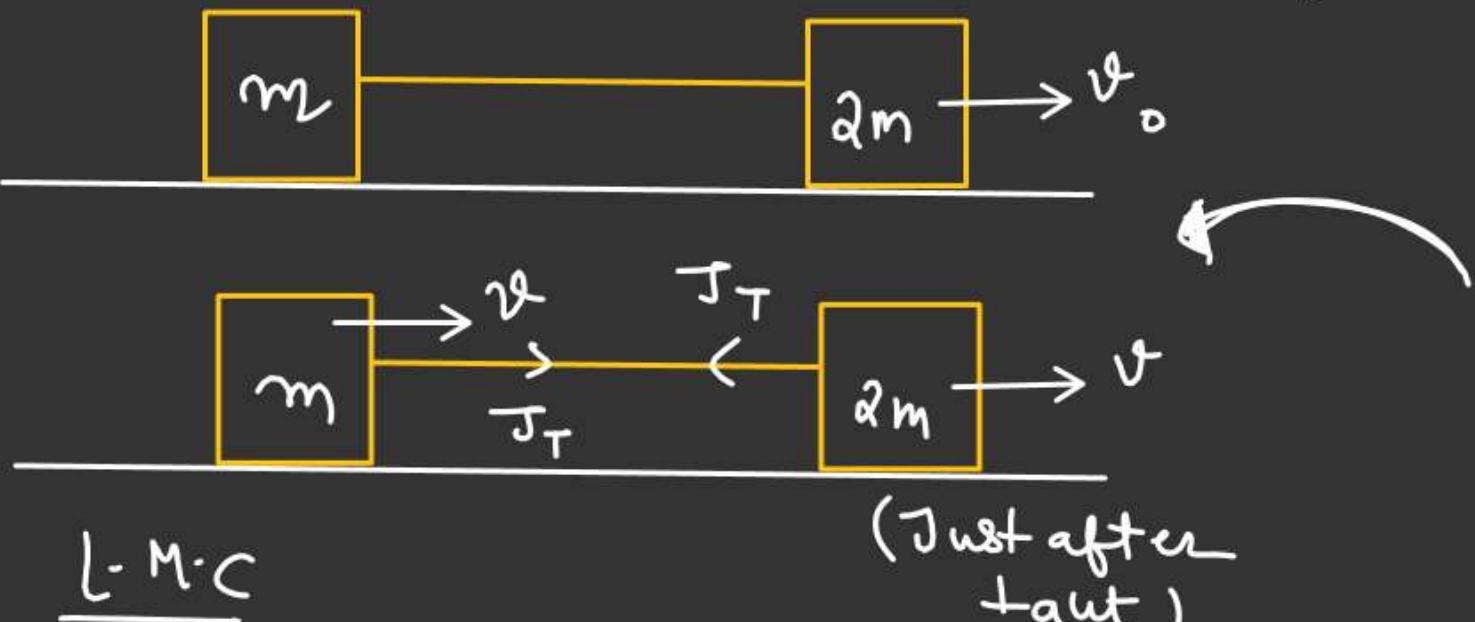
$$v_0 = \sqrt{2gh}$$



Note

No Role of gravity in changing the linear momentum of block from just before taut to just after taut.

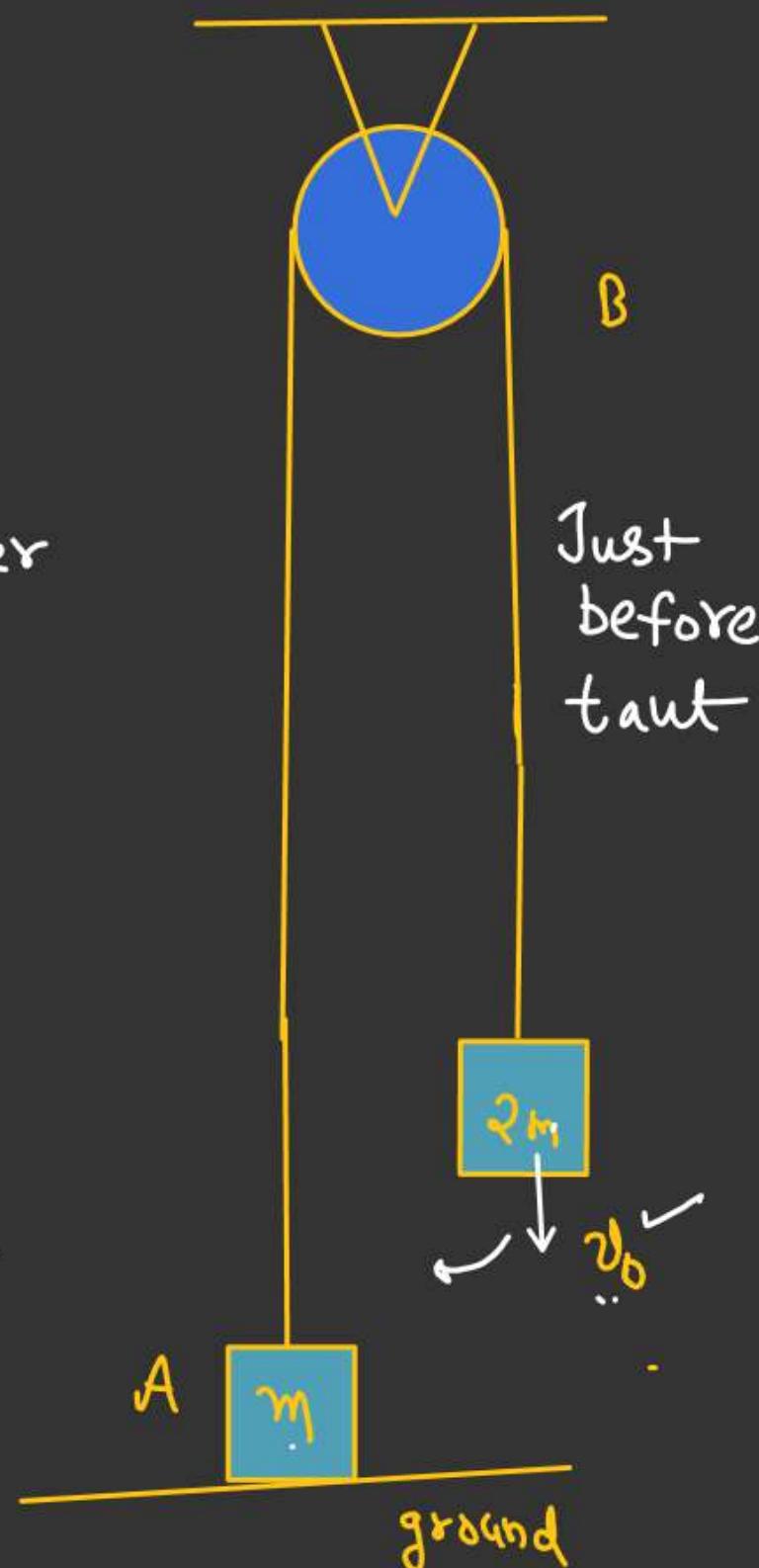
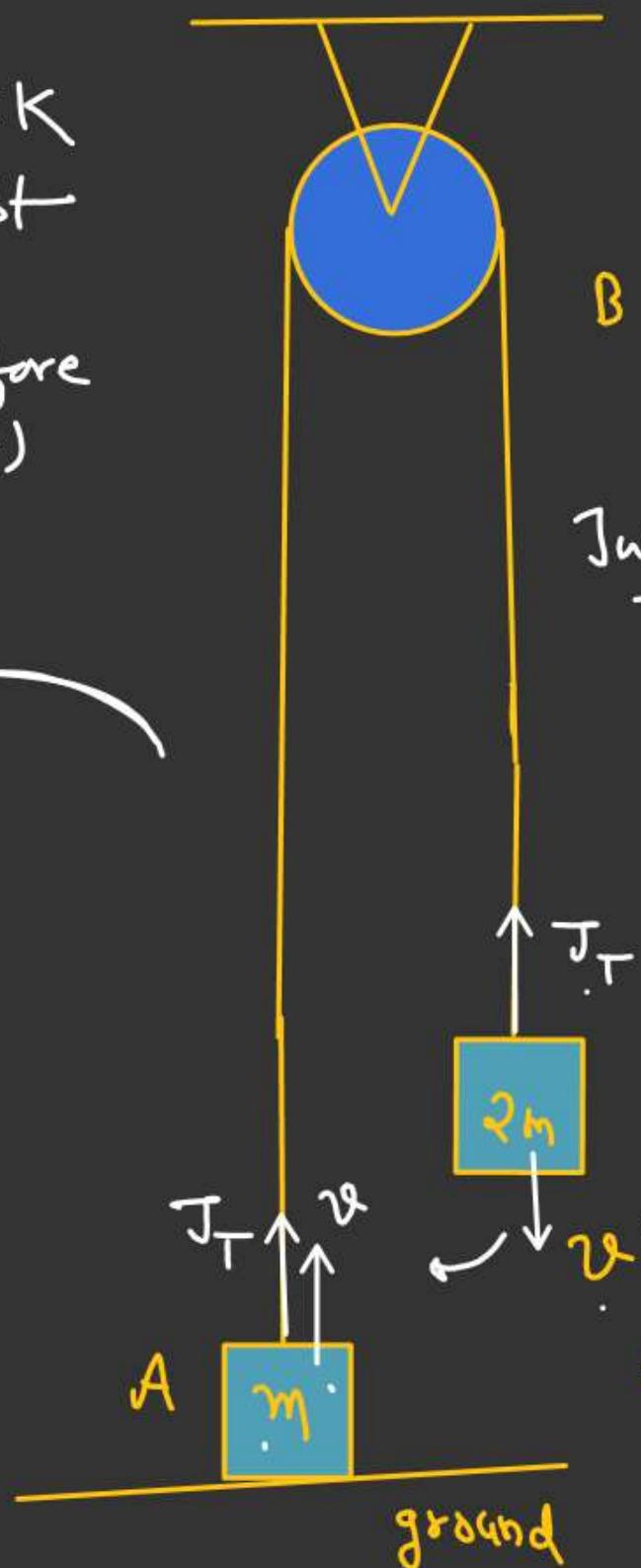
Initial state (Just before taut)



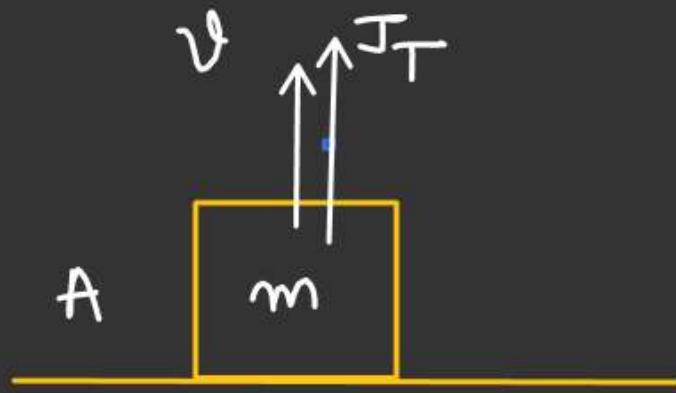
$$2m v_0 = 3m v$$

$$v = \left(\frac{2v_0}{3}\right) = \frac{2}{3} \times 2\sqrt{gh}$$

$$v = \left(\frac{4}{3}\sqrt{gh}\right) \checkmark$$



$$\underline{J_T = ??}$$



$$\vec{J}_T = (\vec{\Delta p})_A$$

$$\vec{J}_T \hat{j} = (\vec{p}_f)_A - (\vec{p}_i)_A$$

||

$$J_T = mv \quad \text{O}$$

$$J_T = \frac{m^2 v_0}{3} = \frac{2m}{3} \cdot (2\sqrt{gh}) = \left(\frac{4m}{3}\sqrt{gh}\right) \checkmark$$

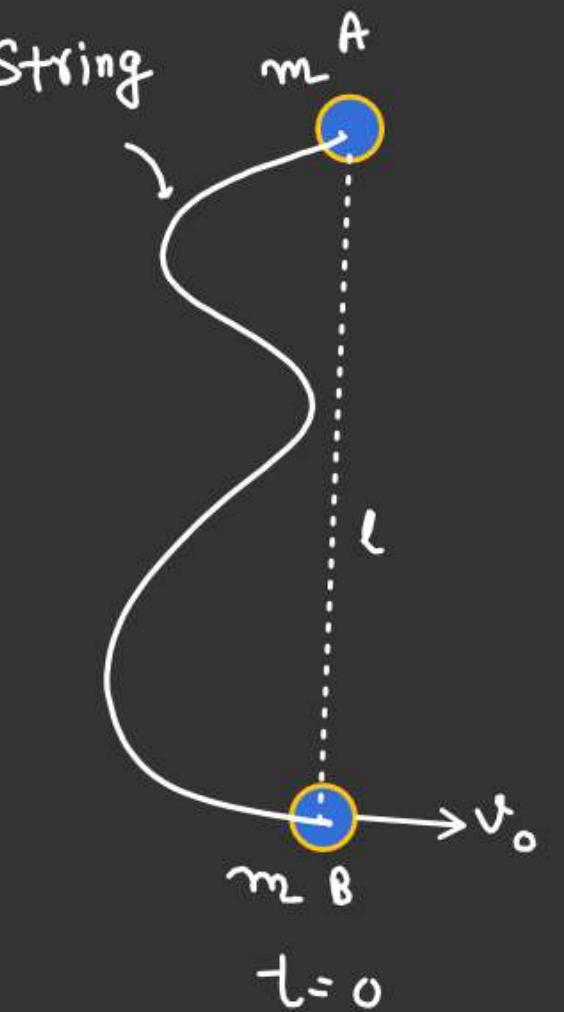
length of string is  $2l$ .

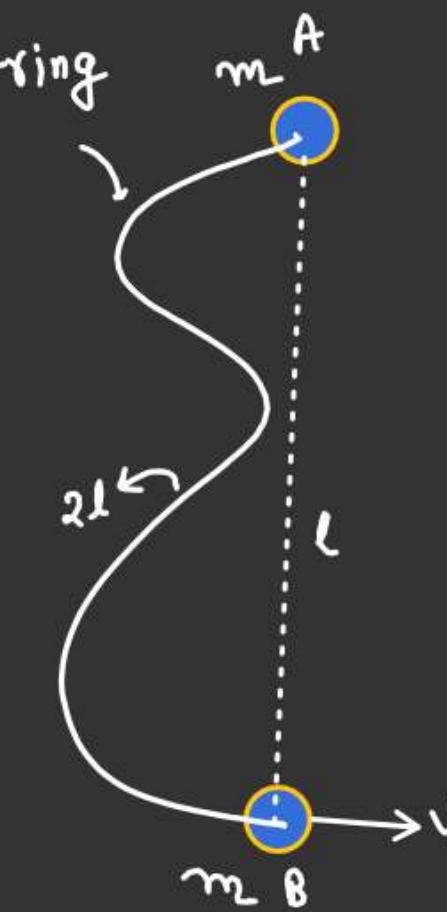
Whole system is on a smooth horizontal plane.

Ball B projected horizontally with velocity  $v_0$ .

Find :- 1) Speed of ball B & A just after string is taut.

2) Impulse due to tension.





$$\cos \theta = \frac{\sqrt{3}l}{2l} = \frac{\sqrt{3}}{2}$$

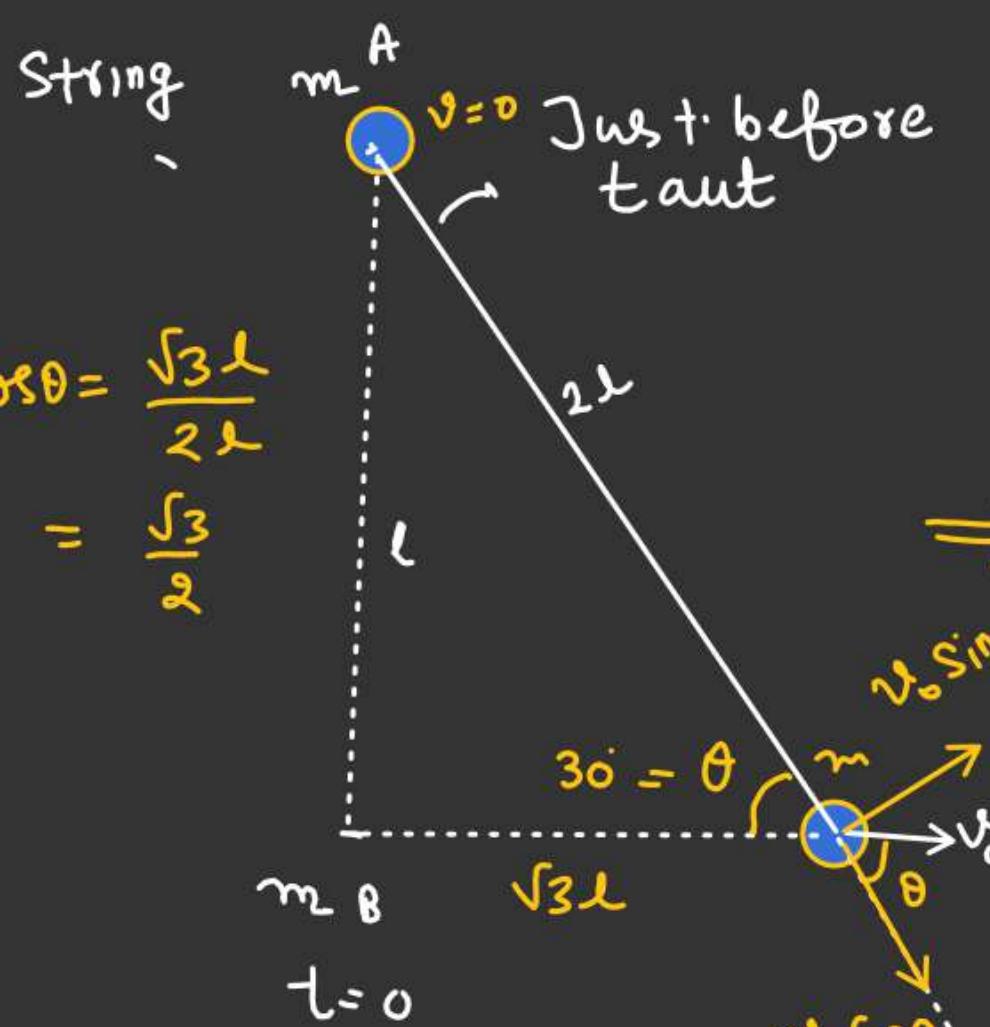
## Along the String

$$(\mathcal{J}_T)_{\text{net}} = 0$$

$$(\Delta p)_{\text{system along the string}} = 0.$$

$$m_{U_0 Cu_3 O} = 2m_O$$

$$U = \frac{U_0 \cos \theta}{2} = \frac{\sqrt{3} U_0}{4}$$



$$\sin 30^\circ = \frac{1}{2}$$

$$\left[ \begin{array}{l} J_T = (\kappa p)_{\text{ball A}} \\ J_T = m u_A \\ \quad = (m \sqrt{3} u_b) \end{array} \right]$$

$$\text{Speed of B} = \sqrt{\left(\frac{\sqrt{3}v_0}{2}\right)^2 + \left(\frac{v_0}{2}\right)^2}$$

$$\left(\frac{v_0}{t}\right) \text{kgm/s} = \sqrt{\frac{3v_0^2}{16} + \frac{v_0^2}{4}} = \sqrt{\frac{7v_0^2}{16}} = \sqrt{7} \frac{v_0}{4}$$