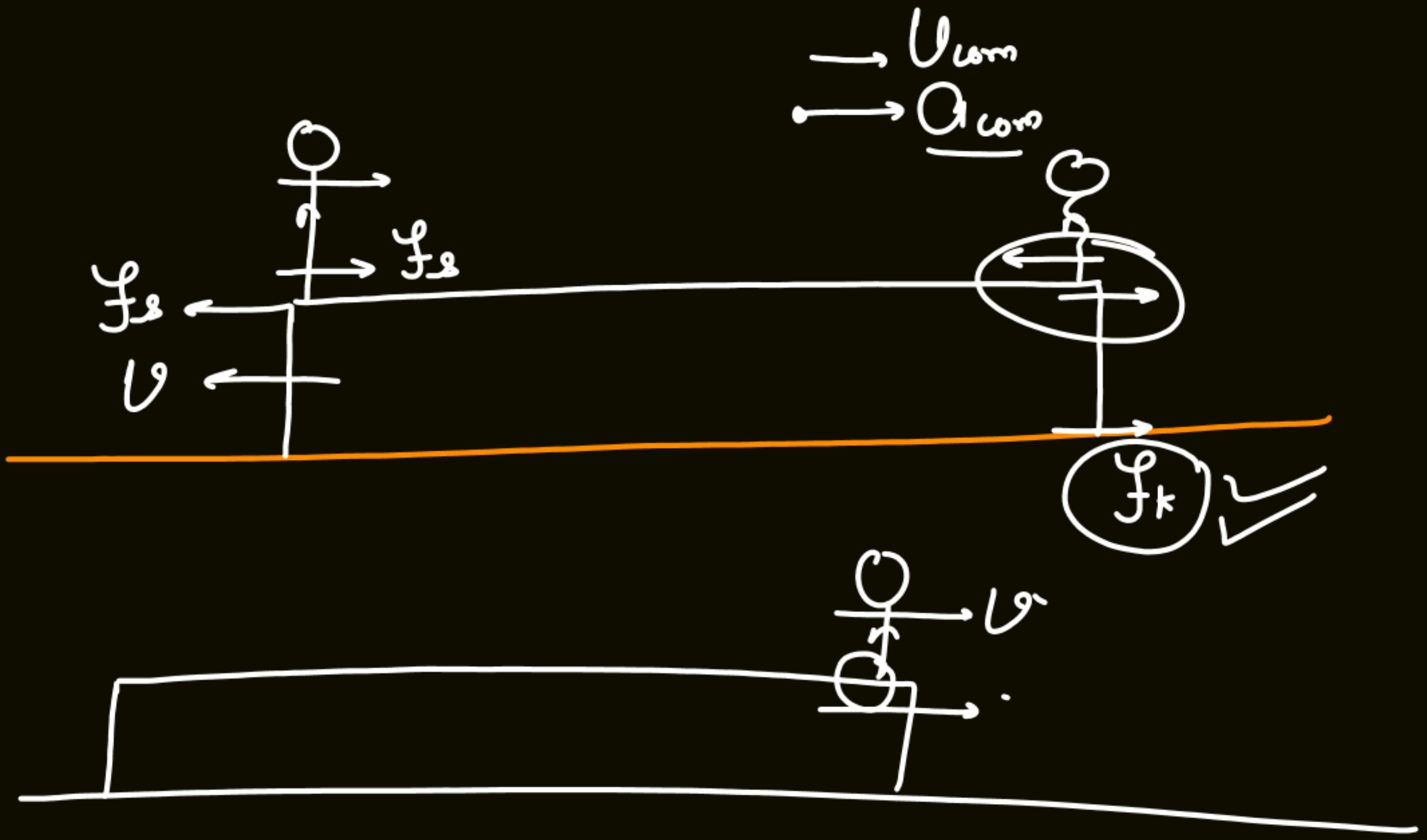
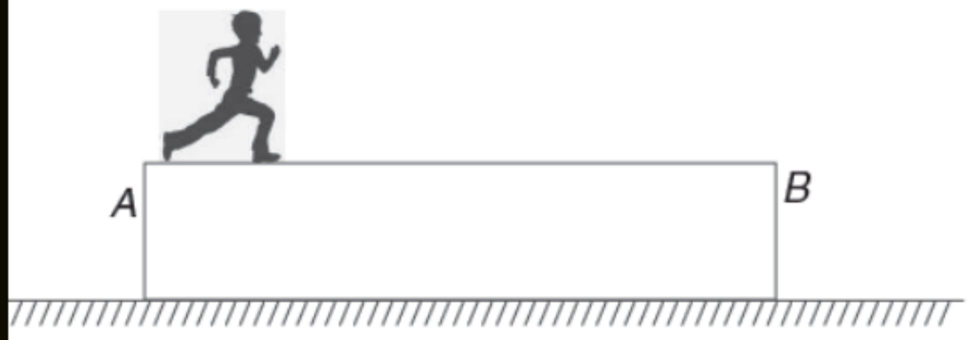


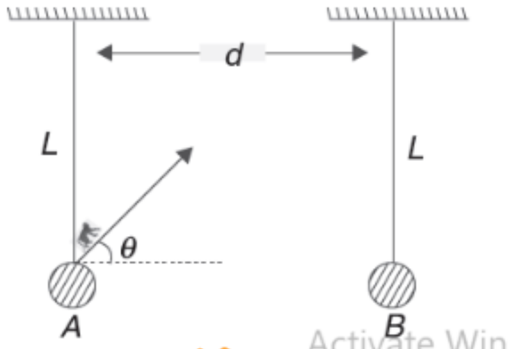
A platform is kept on a rough horizontal surface. At one end A of the platform there is a man standing on it. The man runs towards the end B and the platform is found to be moving. In which direction will the platform be moving after the man abruptly comes to rest on the platform at B?

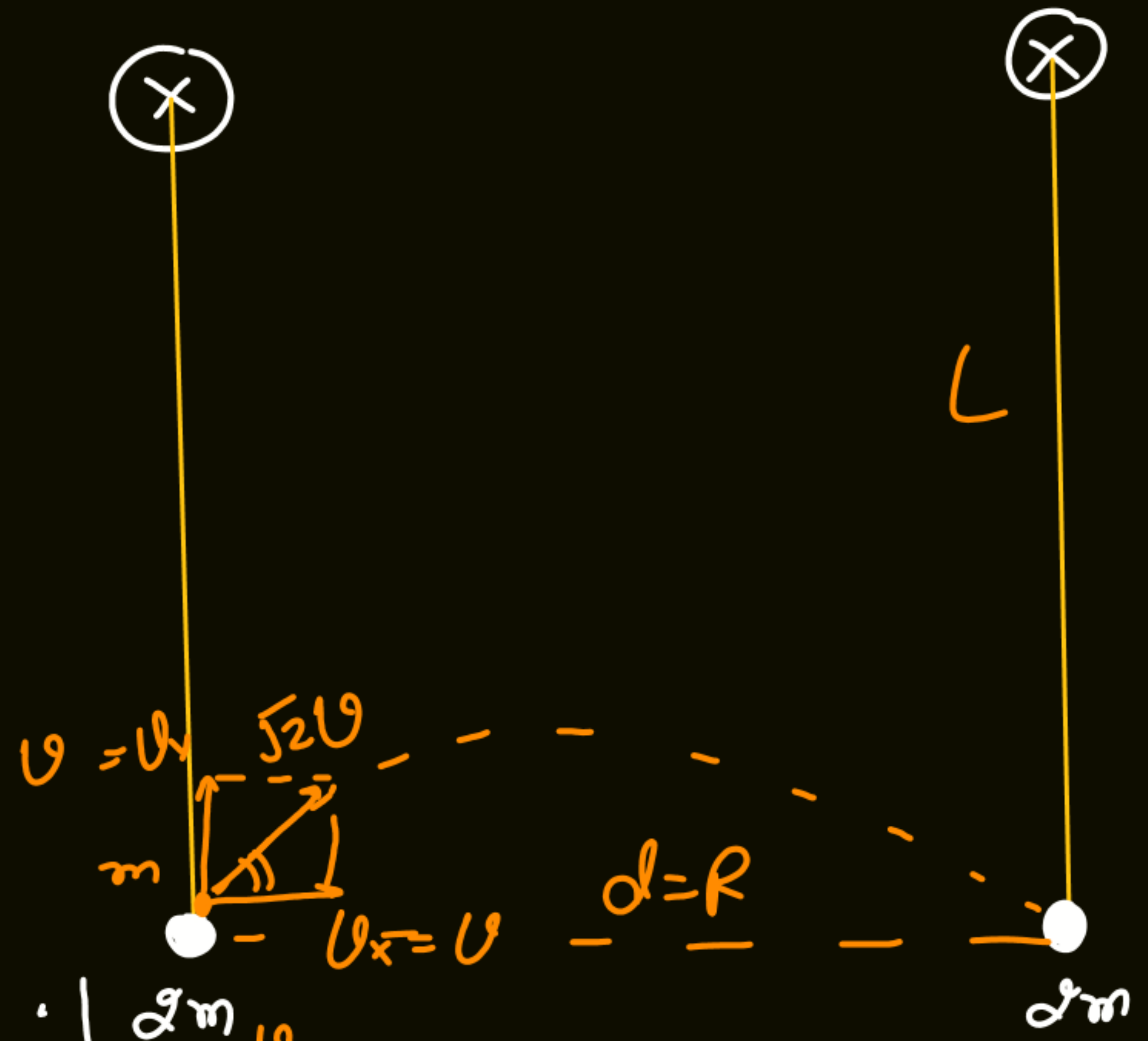


Vertical strings of same length L support two balls A and B of mass $2m$ each. There is a small monkey of mass m sitting on ball A. Suddenly, the monkey jumps off the ball A at an angle $\theta = 45°$ to the horizontal and lands exactly on the ball B. Thereafter, the monkey and the ball B just manage to complete the vertical circle.

(a) Find distance d between the two string and the speed with which the monkey jumped of the ball A.

(b) Find the impulse of the string tension on ball A during the small period when the monkey interacted with the ball to jump off it.





$v_{monkey} = \sqrt{2}v$
$= \sqrt{90gL}$

$R = d = \dfrac{2v_x v_y}{g}$
$= \dfrac{2v^2}{g}$
$= \dfrac{2}{g} \times 45gL$
$= \underline{\underline{90L}}$

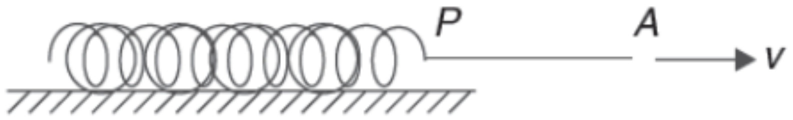
$mv + 0$
$= 3m\sqrt{5gL}$
$v = \sqrt{45gL}$

$\sqrt{5gL}$

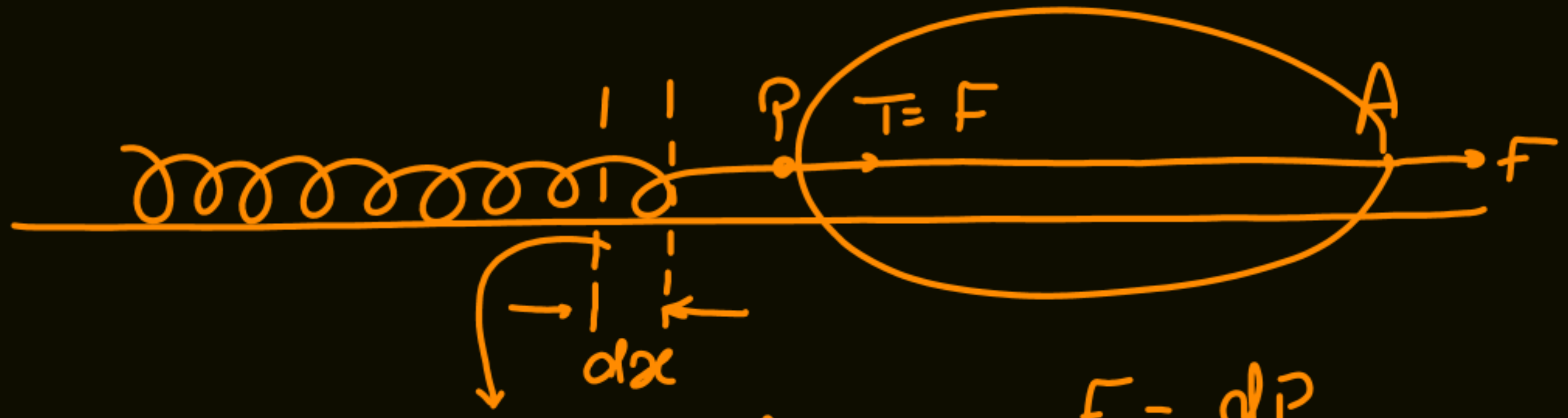
$J_2 = mv$
$J_1 = mv$

$J = J_2 = mv = m\sqrt{45gL}$

A heap of rope is lying on a horizontal surface. One free end A of the rope is pulled horizontally with a constant velocity v. Assume that the heap does not move and the moving part of the rope remains straight and horizontal (i.e. there is no sag). Mass per unit length of the rope is λ. Find the tension at point P where the straightened part of the rope meets the heap. How much force the external agent must apply at end A?



Sol:



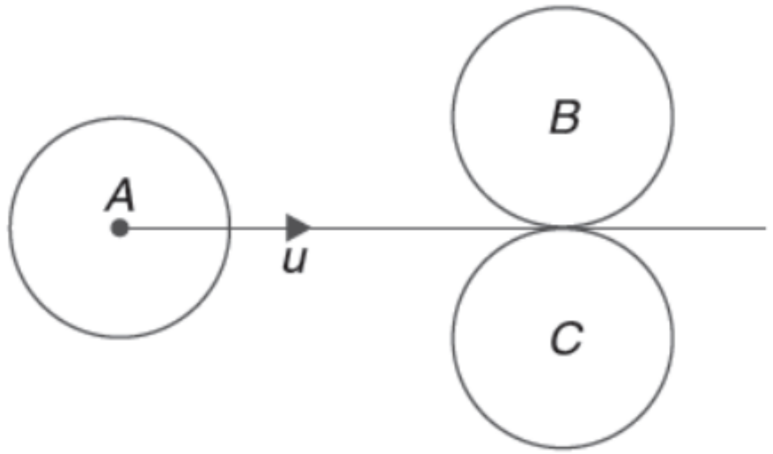
$dm = \lambda dx$

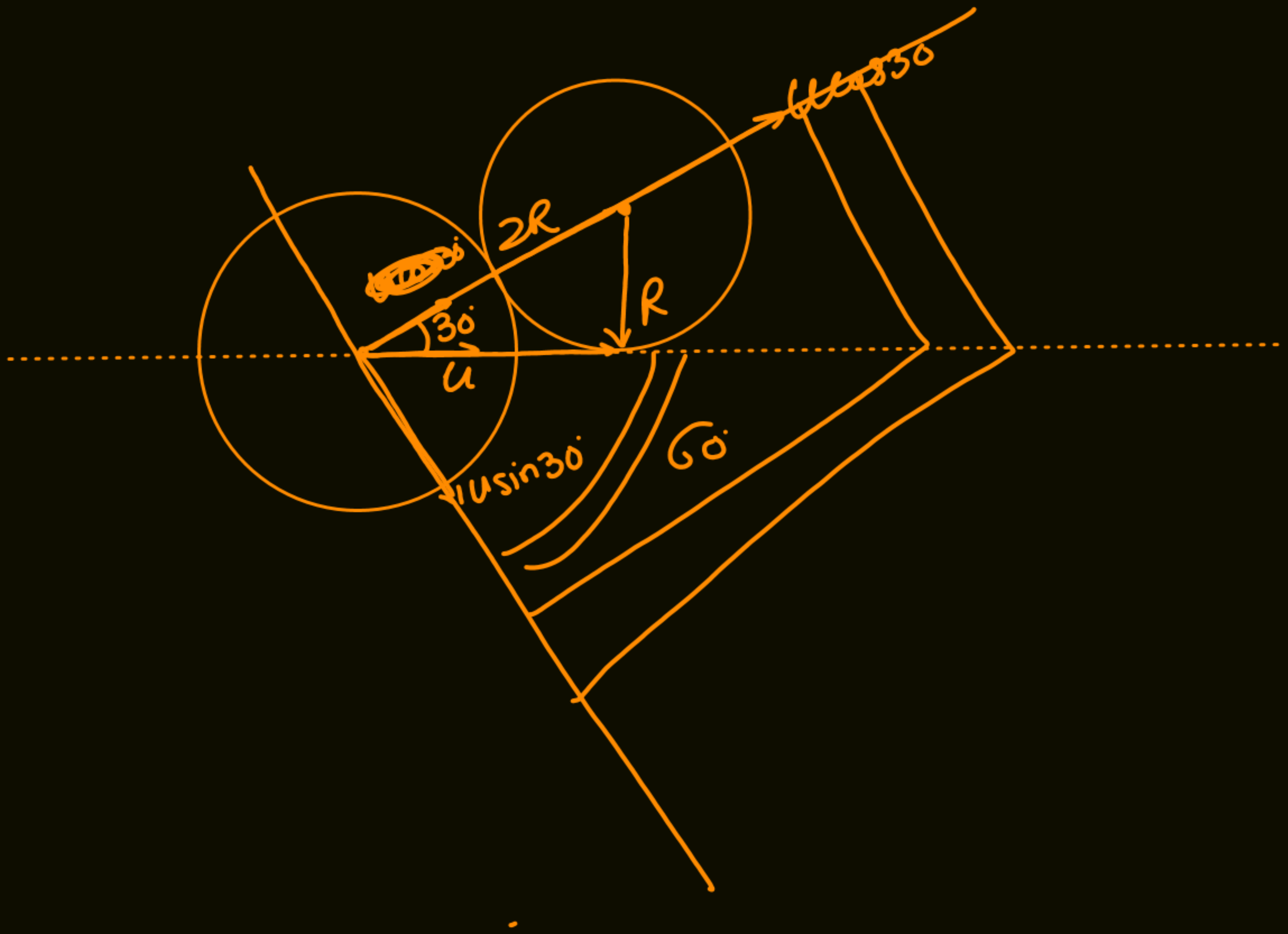
$P_i = 0$

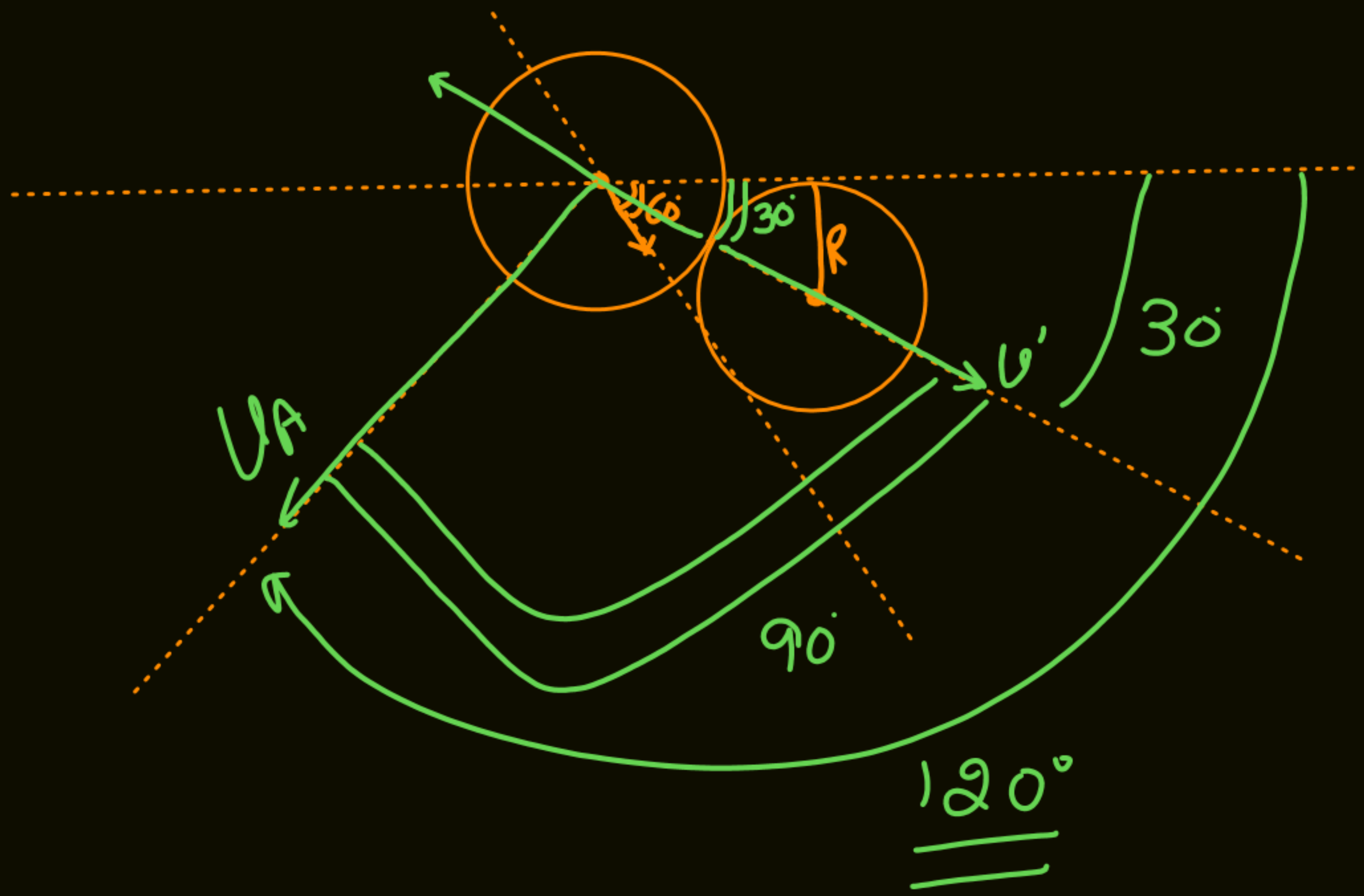
$P_f = (\lambda dx)v$

$$F = \frac{dP}{dt} = \frac{(\lambda dx)v}{dt} = \lambda v\left(\frac{dx}{dt}\right) = \underline{\lambda v^2} = T_P = F$$

On a billiard table two balls B and C are at rest touching each other. A third ball A, travelling with speed u, strikes the two balls elastically (see fig.). Somehow, A hits B first and within a fraction of a second hits ball C. You may assume that B and C are placed symmetrically with respect to the line of motion of A and that all the balls are identical. What angle does the final velocity of A make with its original direction of motion.

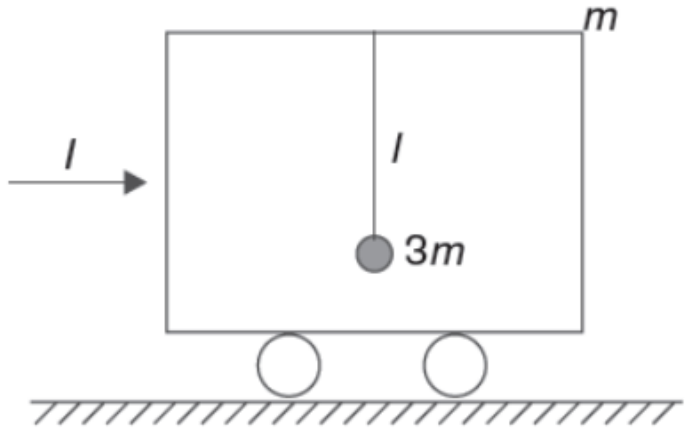






60
30°
R
v'
v_A
30°
90°
120°

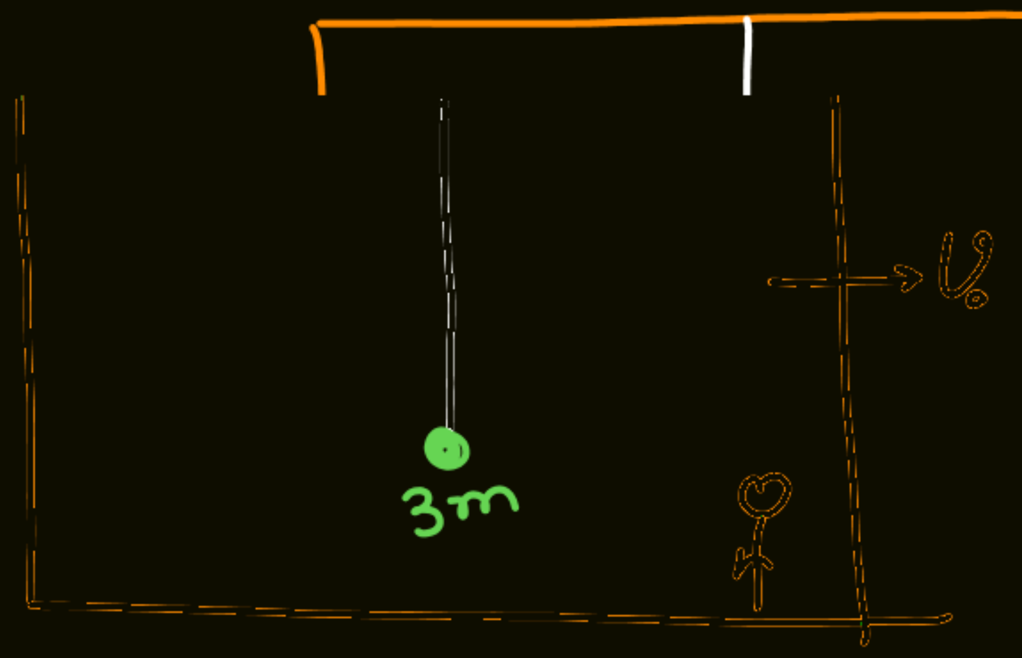
A toy car of mass m is placed on a smooth horizontal surface. A particle of mass $3m$ is suspended inside the car with the help of a string of length l. Initially everything is at rest. A sudden horizontal impulse $I = 2m\sqrt{gl}$ is applied on the car and it starts moving.



(a) Find the maximum angle θ_0 that the string will make with the vertical subsequently.

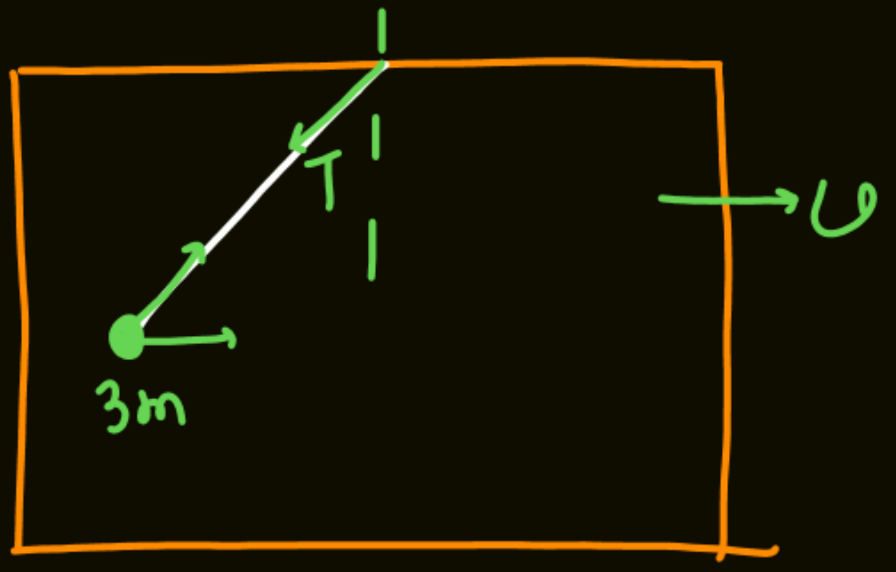
(b) Find tension in the string when it makes angle θ_0 with the vertical.

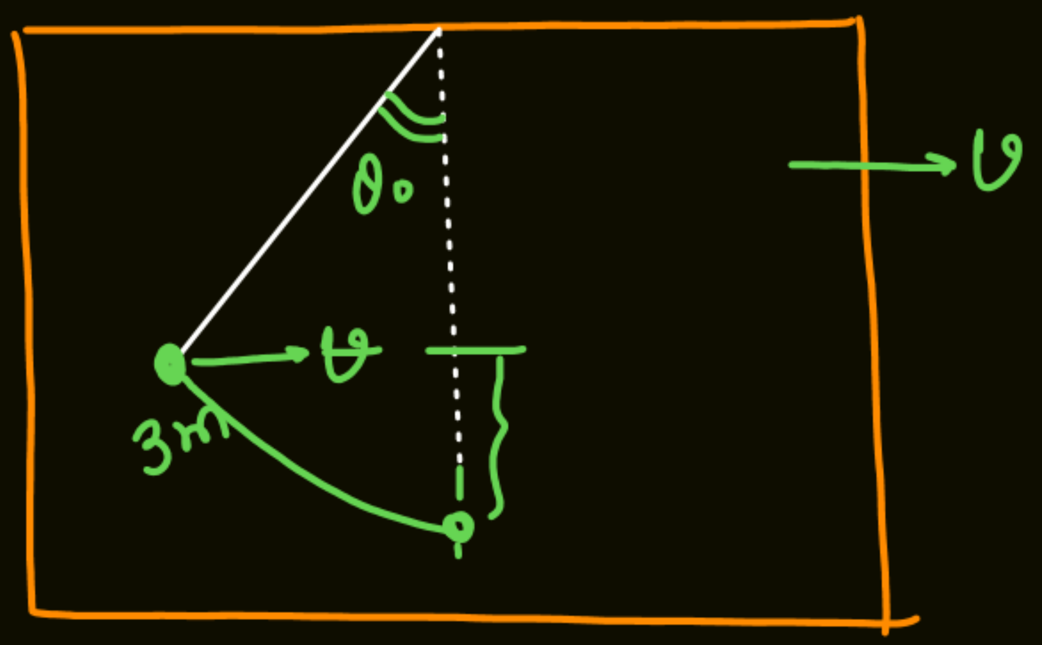
Sol:-



IMT : $2\cancel{m}\sqrt{gl} = \cancel{m}v_0 - 0$

$v_0 = (\sqrt{gl})2$





MIC $\Rightarrow m\,2\sqrt{gl} + 3m\times 0$
$= 4mV$

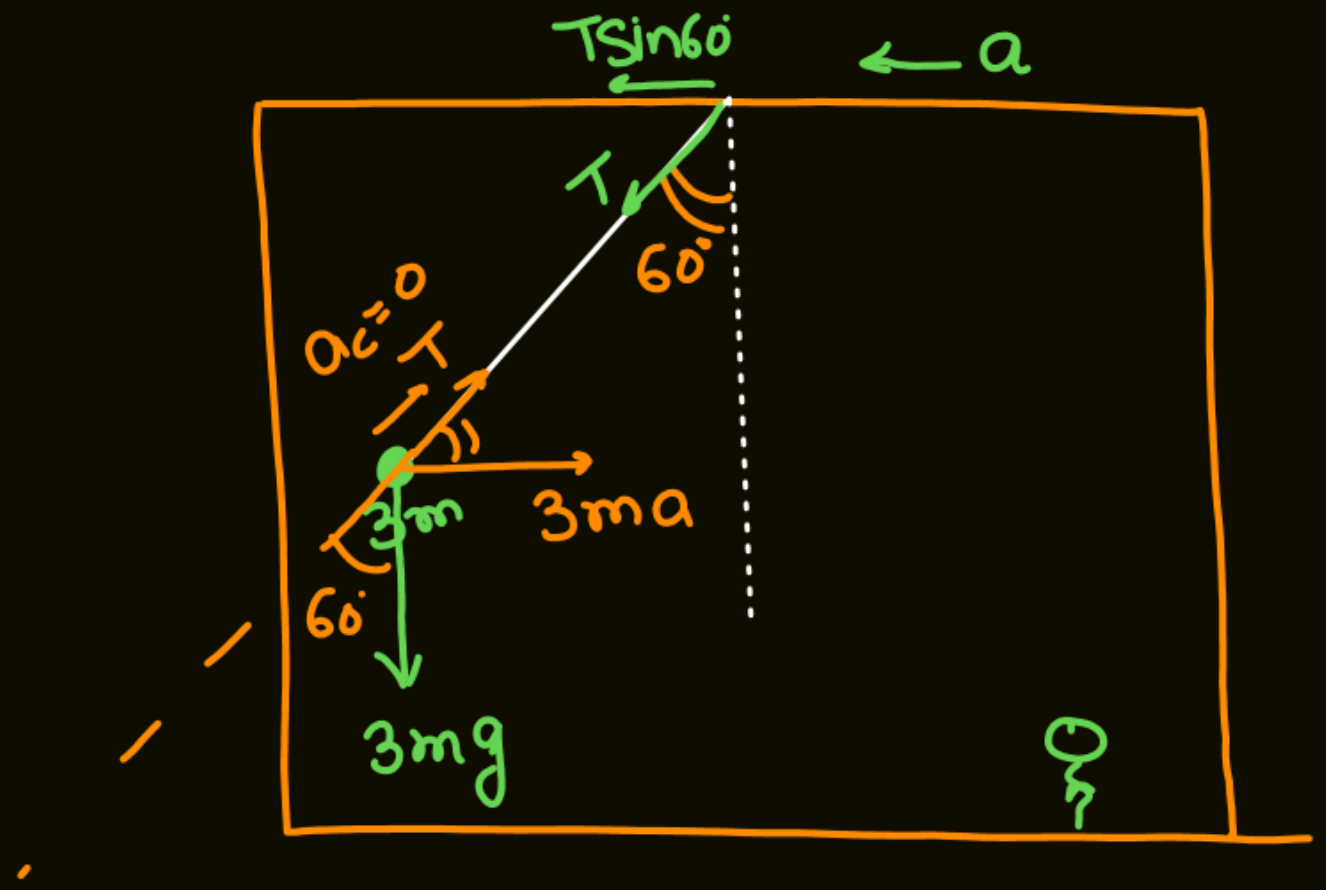
$$\boxed{V = \frac{\sqrt{gl}}{2}}$$

TMEC

$$\frac{1}{\cancel{2}}m\,\overset{2}{\cancel{4}}gl + 0 + 0 = \frac{1}{2}\times\cancel{4}m\frac{gl}{\cancel{4}} + 3mgl\{1-\cos\theta_0\}$$

$$\frac{\cancel{3}}{2}\cancel{m}gl = \cancel{3}\cancel{m}gl\{1-\cos\theta_0\}$$

$$1-\cos\theta_0 = \frac{1}{2} \qquad \cos\theta_0 = \frac{1}{2} \qquad \boxed{\theta_0 = 60^\circ}$$



$$\frac{T\sqrt{3}}{2} = ma$$

$$T = \frac{3}{2}mg - \frac{9}{4}T$$

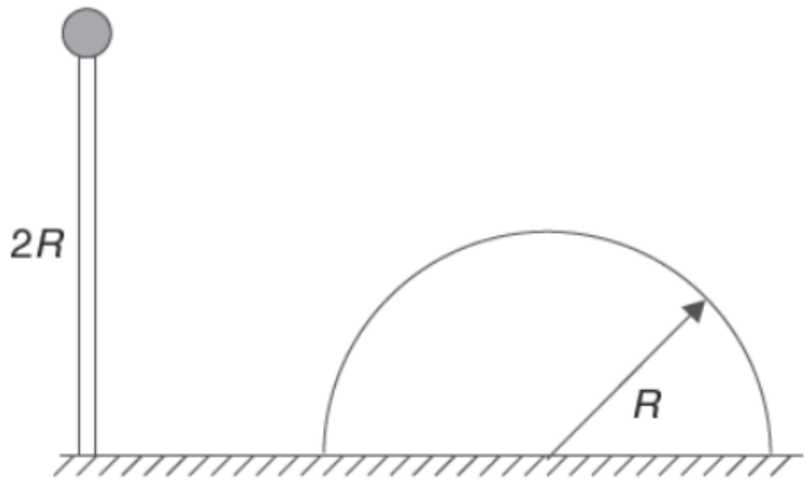
$$\frac{13}{4}T = \frac{3}{2}mg$$

$$\boxed{T = \frac{6mg}{13}}$$

$$T + 3ma\cos 30^\circ = 3mg\cos 60^\circ$$

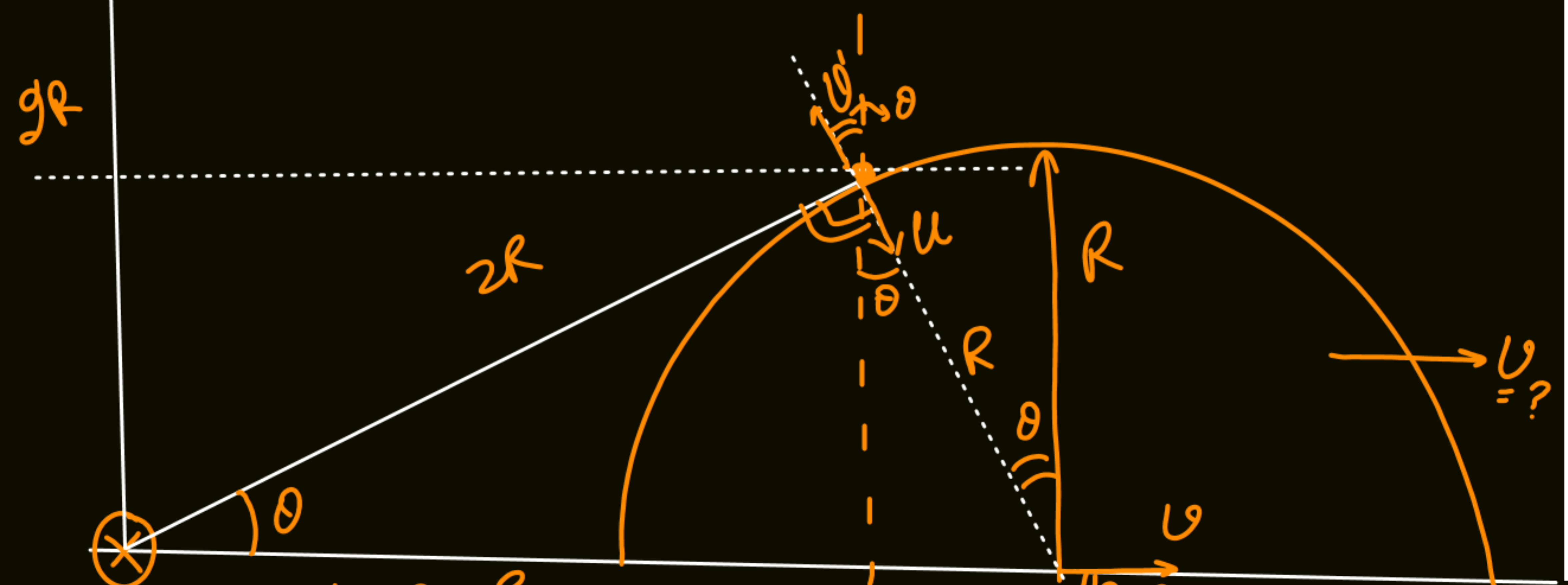
$T = 3mg$

A light rigid rod has a small ball of mass m attached to its one end. The other end is hinged on a table and the rod can rotate freely in vertical plane. The rod is released from vertical position and while falling the ball at its end strikes a hemisphere of mass m lying freely on the table. The collision between the ball and the hemisphere is elastic. The radius of hemisphere and length of the rod are R and $2R$ respectively. Find the velocity of the hemisphere after collision.

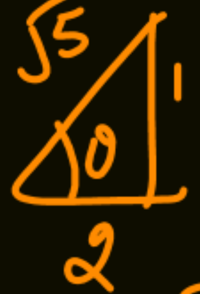


$e = 1 = \frac{u\sin\theta + v'}{u}$

$\boxed{v' = u - v\sin\theta}$



$\tan\theta = \frac{R}{2R} = \frac{1}{2}$



$\sin\theta = \frac{1}{\sqrt{5}}$

$mg2R(1-\sin\theta) = \frac{1}{2}mu^2 - 0$

$\boxed{u = \sqrt{4gR(1-\sin\theta)}}$

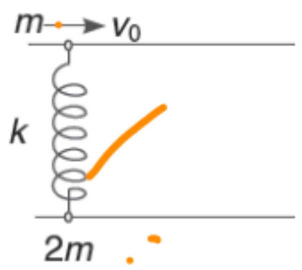
M/C Hor^n: $0 + mu\sin\theta = mv + (-mv'\sin\theta)$

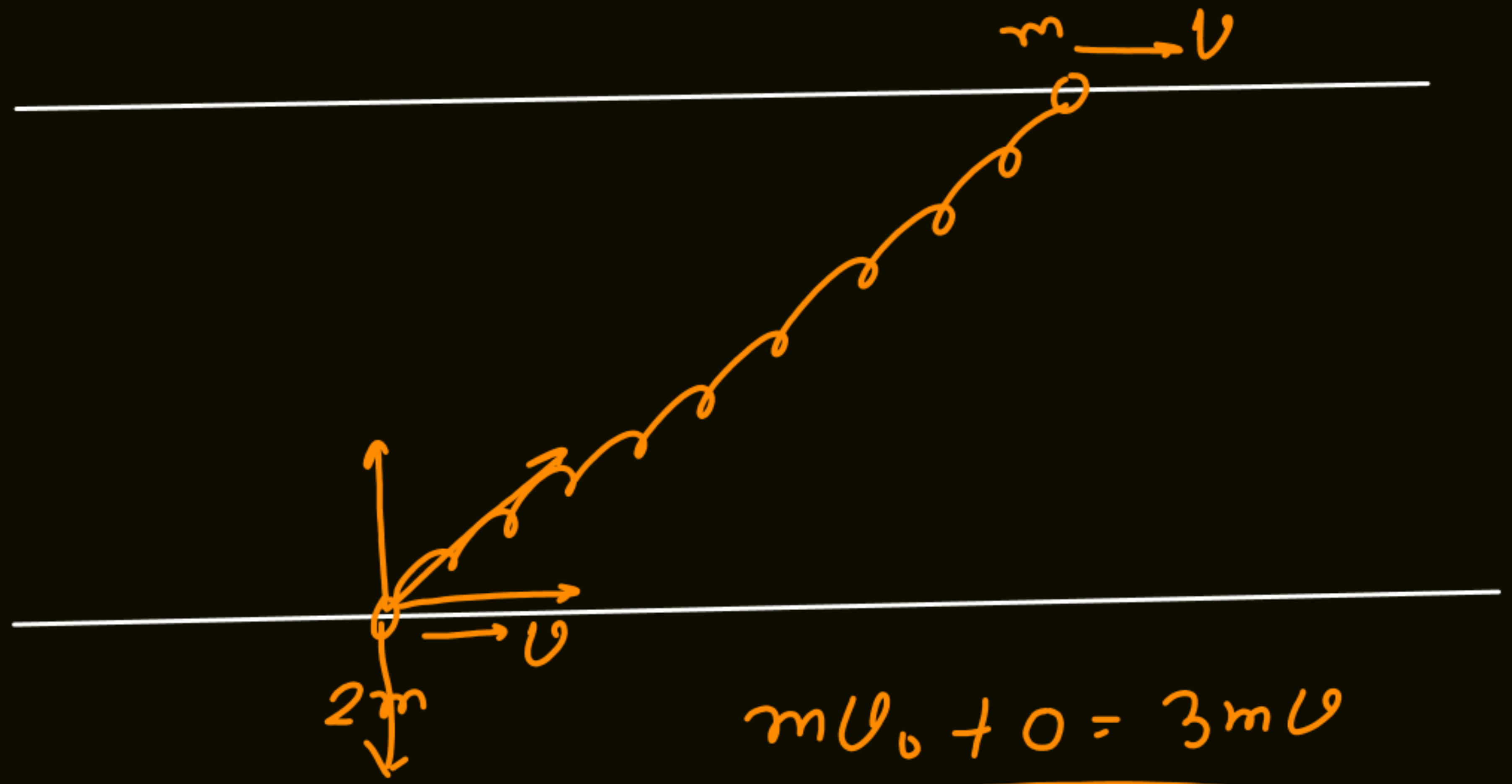
$u\sin\theta + v'\sin\theta = v$ — (1)

$u\sin\theta + u\sin\theta - v\sin^2\theta = v$

$v = \frac{2u\sin\theta}{(1+\sin^2\theta)}$

Two ring of mass m and $2m$ are connected with a light spring and can slide over two frictionless parallel horizontal rails as shown in figure. Ring of mass m is given velocity 'v_0' in horizontal direction as shown. Calculate the maximum stretch in spring during subsequent motion.





$$mv_0 + 0 = 3mv$$

$$\boxed{v = v_0/3}$$

TMEC

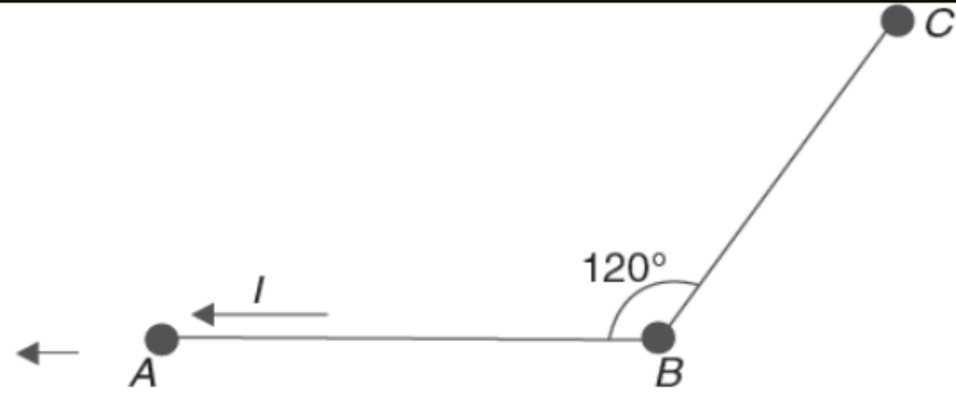
$$\cancel{\tfrac{1}{2}}mv_0^2 + 0 + 0 = \cancel{\tfrac{1}{2}} \times 3m\frac{v_0^2}{9} + \cancel{\tfrac{1}{2}}kx_0^2$$

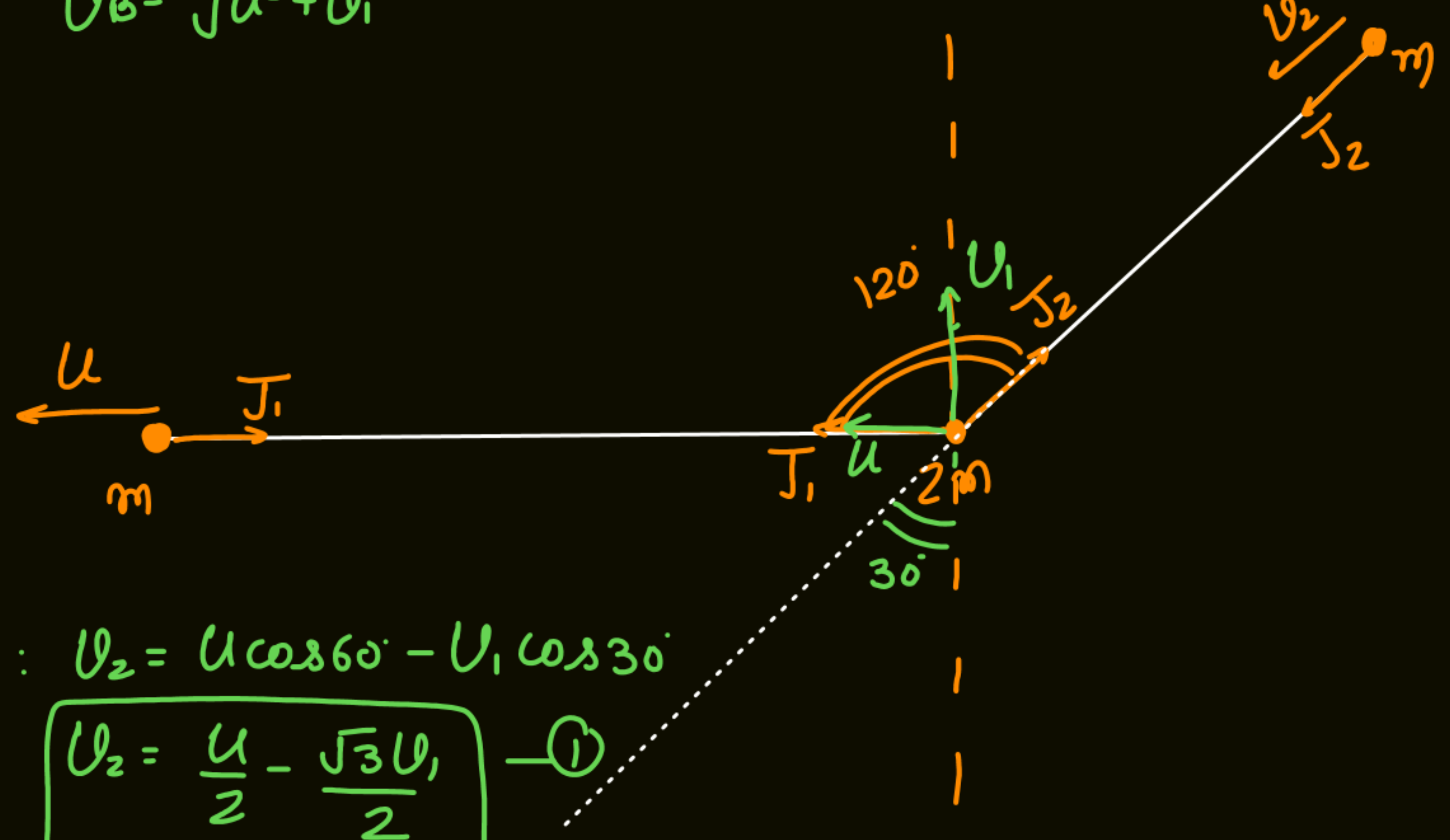
$$\frac{2mv_0^2}{3} = kx_0^2$$

$$\boxed{x_0 = \sqrt{\frac{2m}{3k}}\, v_0}$$

$v_B = \sqrt{u^2+v_1^2}$

There particles A, B and C have masses m, $2m$ and m respectively. They lie on a smooth horizontal table connected by light inextensible strings AB and BC. The string are taut and $\angle ABC = 120°$. An impulse is applied to particle A along BA so that it acquires a velocity u. Find the initial speeds of B and C.





S|C : $v_2 = u\cos60° - v_1\cos30°$

$$\boxed{v_2 = \frac{u}{2} - \frac{\sqrt{3}v_1}{2}} \quad -(1)$$

IMT

$$J_2 = m v_2 \quad -(2)$$

$$J_1 - J_2\sin30° = 2mu$$

$$\boxed{J_1 - \frac{J_2}{2} = 2mu} \quad -(3)$$

$$J_2\cos30° = 2m v_1$$

$$J_2\frac{\sqrt{3}}{2} = 2m v_1 \quad -(4)$$

find v_1 and v_2