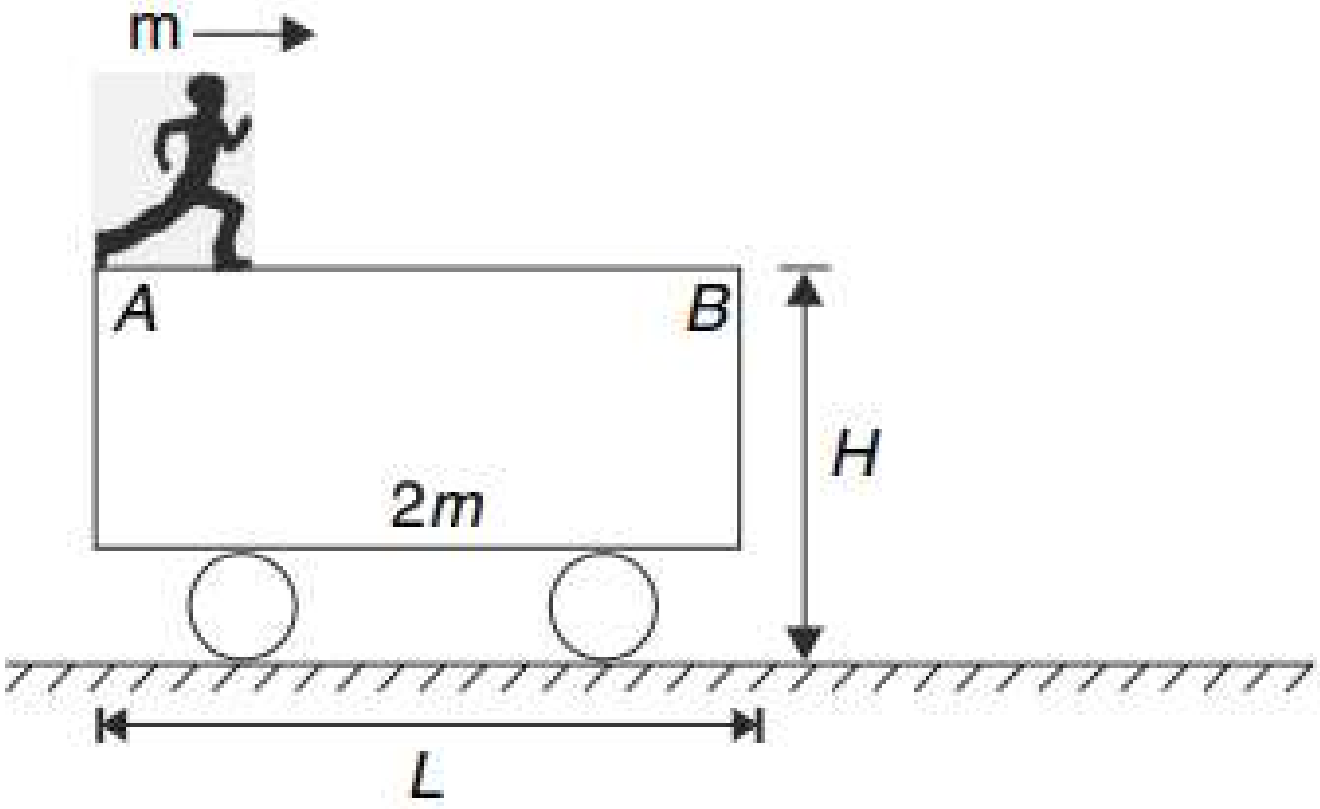
A man of mass m is standing on the flat top of a cart of mass $2m$. The length and height of the cart is L and H respectively and it is at rest on a smooth horizontal ground. The man starts running from end A, speeds up and jumps out of the cart at point B with a velocity u relative to the cart in horizontal direction. Calculate the total horizontal distance covered by the man by the time he lands on the ground.

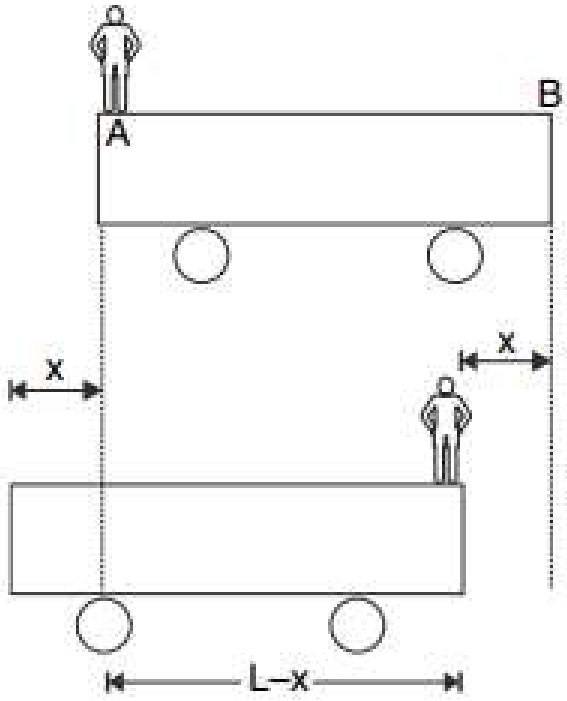


Let displacement of the cart be x ($\leftarrow$) by the time man reaches the edge B.

Since centre of mass of the system (Man + Cart) will remain at rest hence,

$$m(L-x) = 2x$$

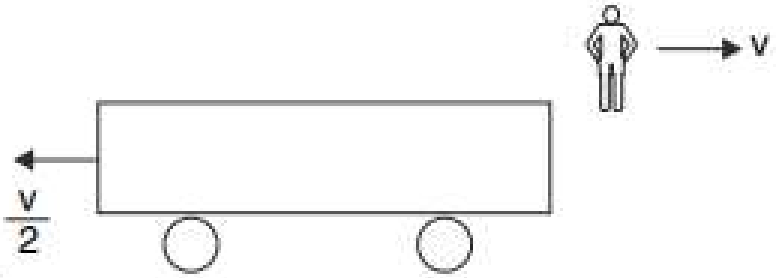
$$\Rightarrow x = \frac{L}{3}$$



$\therefore$ Horizontal displacement of man $= L - \frac{L}{3} = \frac{2L}{3}$

Let the man jump out with absolute velocity v ($\rightarrow$)

For momentum to remain conserved the velocity of cart must be $\frac{v}{2}(\leftarrow)$



A per question $u(\rightarrow) = v(\rightarrow) - \frac{v}{2}(\leftarrow)$

$$u = \frac{3v}{2} \therefore v = \frac{2u}{3}$$

Time of flight for the man from B to ground is $t = \sqrt{\frac{2H}{g}}$.

Horizontal distance covered $= vt = \frac{2u}{3}\sqrt{\frac{2H}{g}}$

$\therefore$ Total horizontal distance travelled from the start $= \frac{2L}{3} + \frac{2u}{3}\sqrt{\frac{2H}{g}}$