PRAYAS

JEE 2026

Physics

COM and System of particles

Lecture – 10

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Topics to be covered

A Momentum and energy Conservation

B

C

D

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Question

A block of mass m is release from rest on a stationary smooth wedge of mass 3m and height h. wedge is free to move on smooth horizontal surface. When block just land on horizontal surface. find

1. Displacement of wedge
2. Speed of block and wedge

$\rightarrow (F_{ext})_x = 0 \quad (\vec{P}_i)_x = (\vec{P}_f)_x$

$\rightarrow W_{NC} = 0 \quad (W_{N_1} = 0$ on System$)$

$W_{N_1} \neq 0$ block

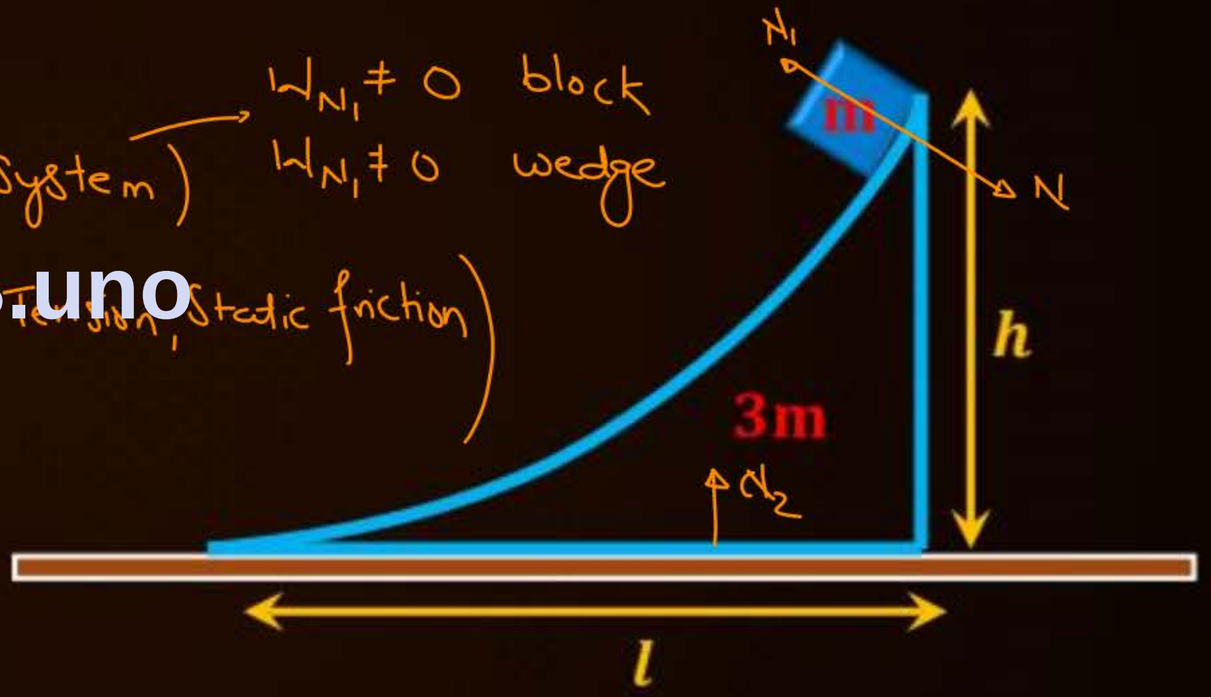
$W_{N_1} \neq 0$ wedge

(internal Normal, Tension, Static friction $W = 0$)

$K_1 + U_1 = K_2 + U_2$

$\rightarrow (F_{ext})_x = 0 \quad (v_{cm})_x = 0$

$m_1\vec{v}_1 + m_2\vec{v}_2 + \dots = 0$



Question — 56

A block of mass m is moving on smooth horizontal surface with speed V_0. Block encounter a smooth wedge as shown. Find maximum height attend by the block if

(1) ~~Wedge is fixed~~

(2) Wedge (mass = 2m) is free to move on horizontal surface

$\longrightarrow F_{ext.})_x = 0 \qquad \vec{P}_i)_x = \vec{P}_f)_x$ (External

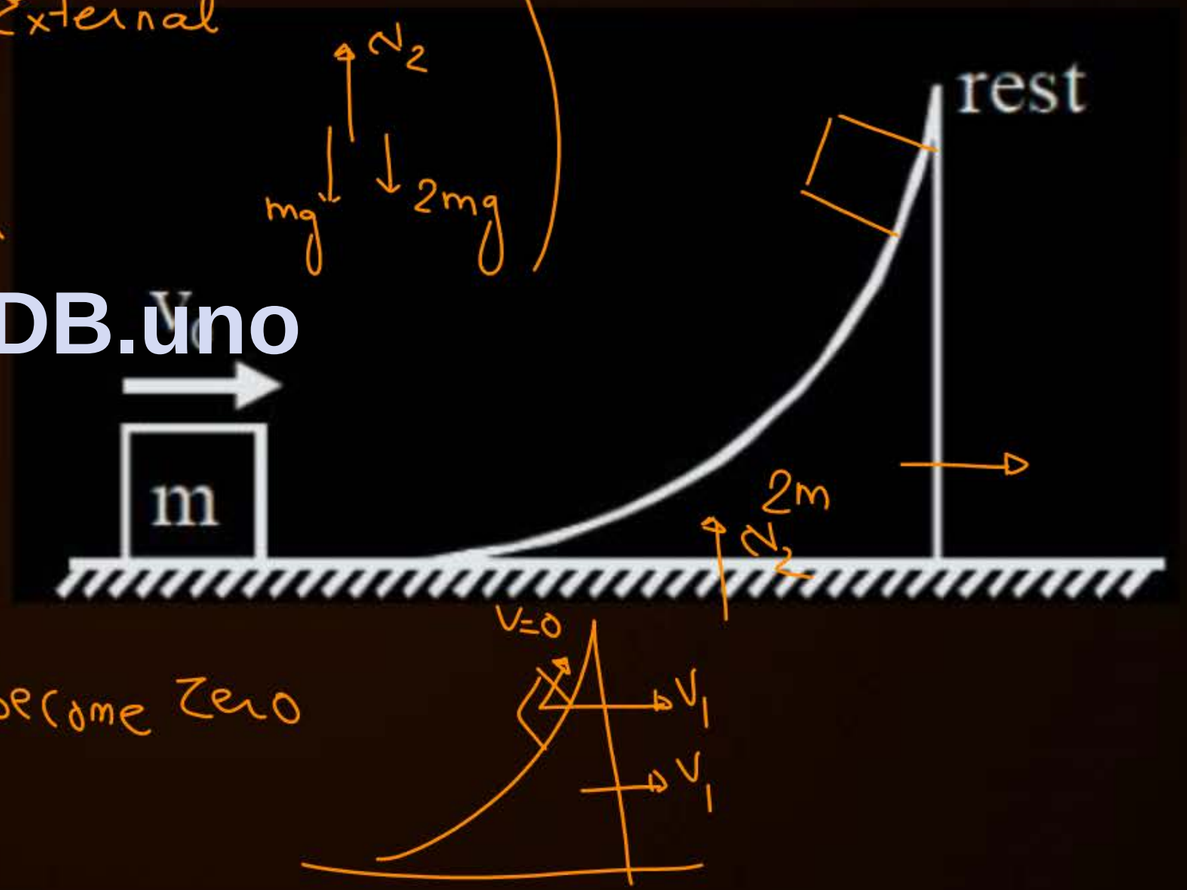
System → (block + wedge)

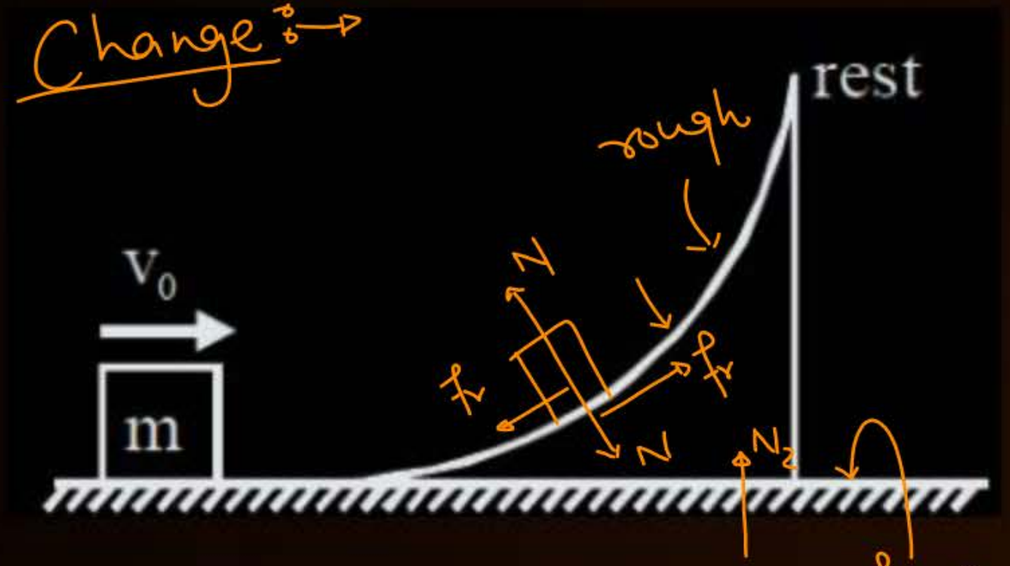
$\longrightarrow W_{NC} = 0 \qquad K_1 + U_1 = K_2 + U$

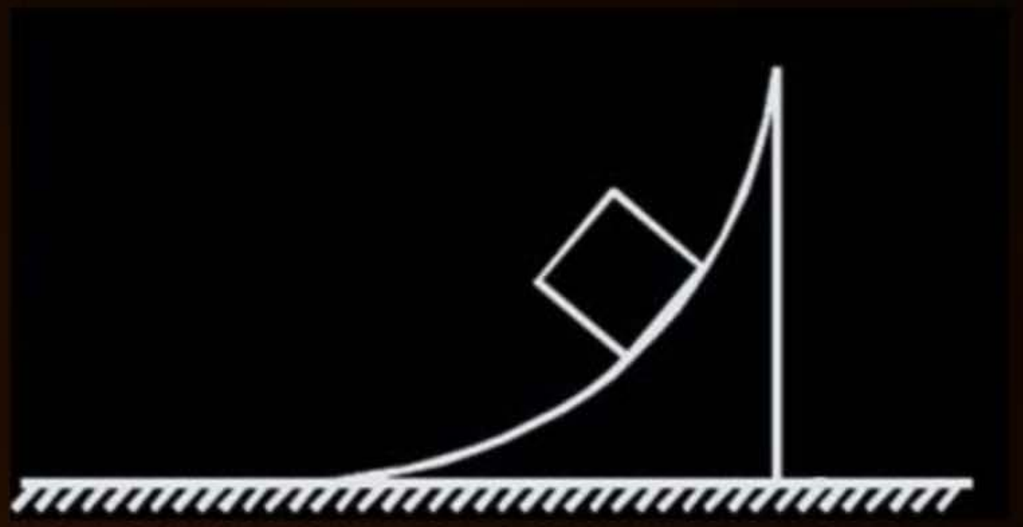
$\longrightarrow m_1 s_1 + m_2 s_2 = 0$ ✗

because $U_{cm} \neq 0$

→ at highest point $V_{block/wedge}$ become zero







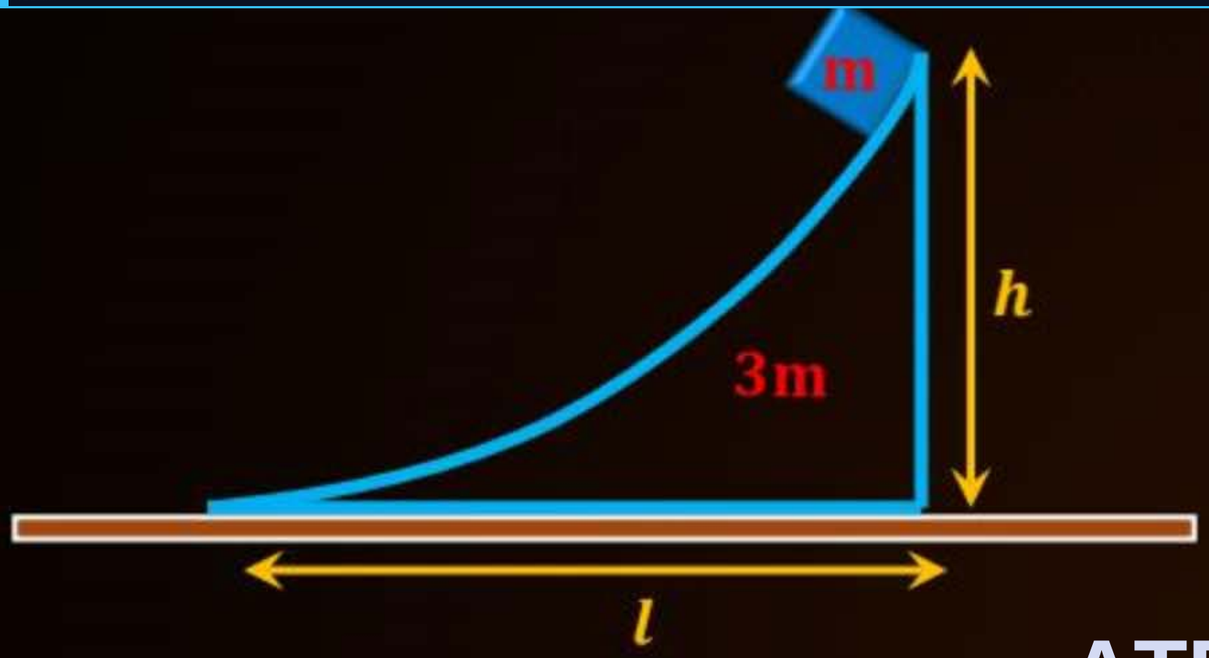
System → block + wedge

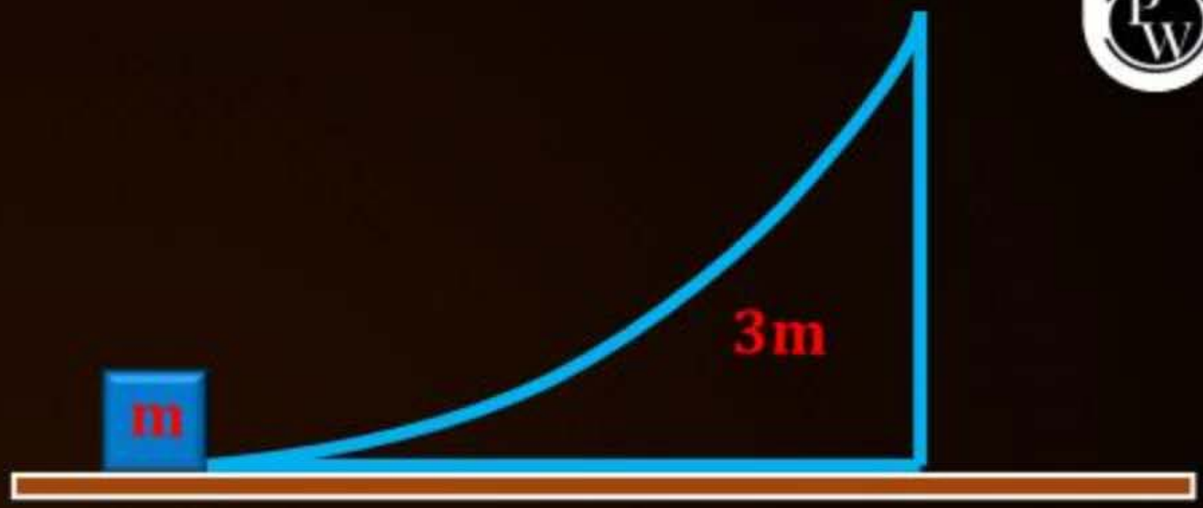
$\vec{P}_i)_x = \vec{P}_f)_x \rightarrow F_{ext})_x = 0$

$K_1 + U_1 = K_2 + U_2 \rightarrow X \quad W_{NC} \neq 0$

Total $W_N = 0$

Total $W_{f_r} \neq 0$ (kinetic)





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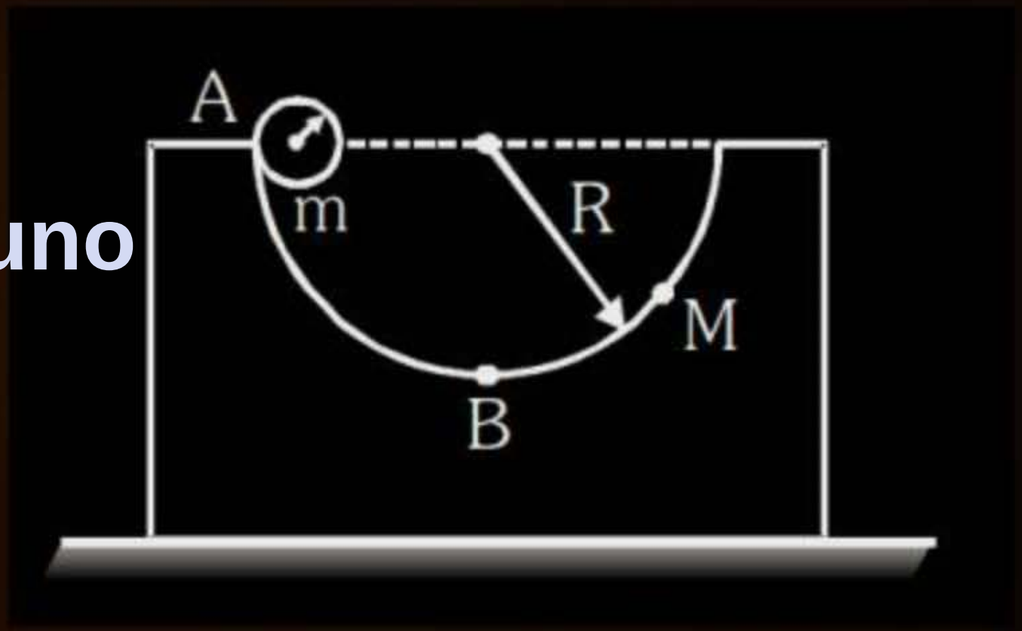
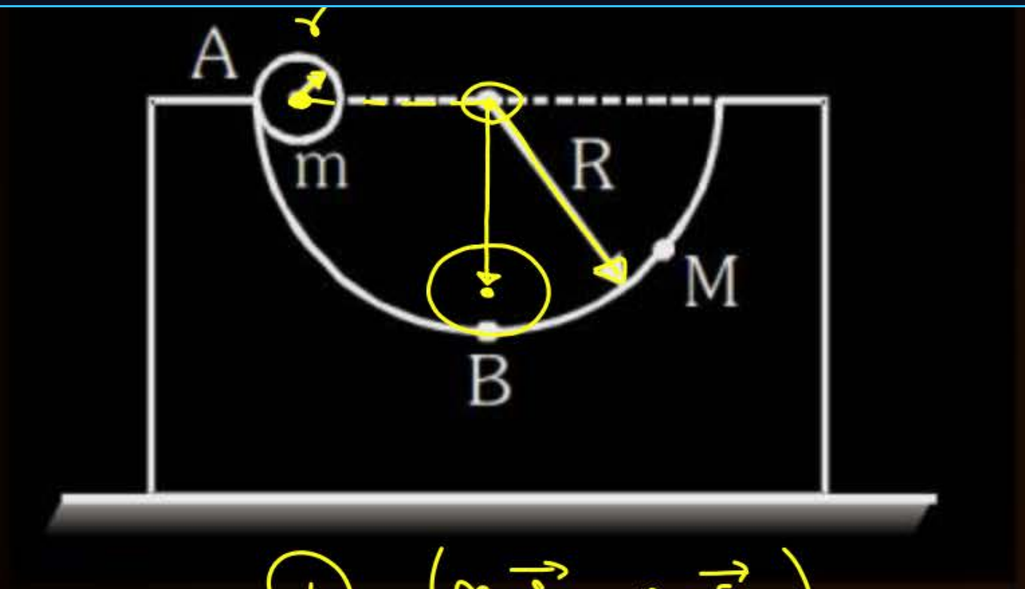
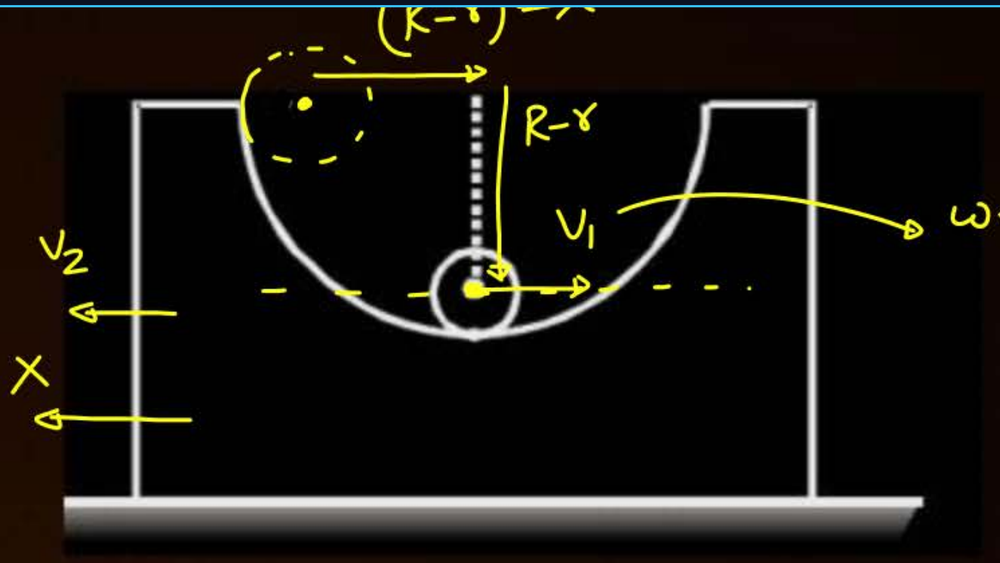
A block of mass M with a semicircular track of radius R, rests on a horizontal frictionless surface. A uniform cylinder of radius r and mass m is released from rest at the top point A (see Fig). The cylinder slips on the semicircular frictionless track. How far has the block moved when the cylinder reaches the bottom (point B) of the track ? How fast is the block moving when the cylinder reaches the bottom of the track?







(1) $(m_1\vec{v}_1 + m_2\vec{v}_2)_x = 0 \Rightarrow m(R-r-x) - Mx = 0 \Rightarrow x = \frac{m(R-r)}{m+M}$

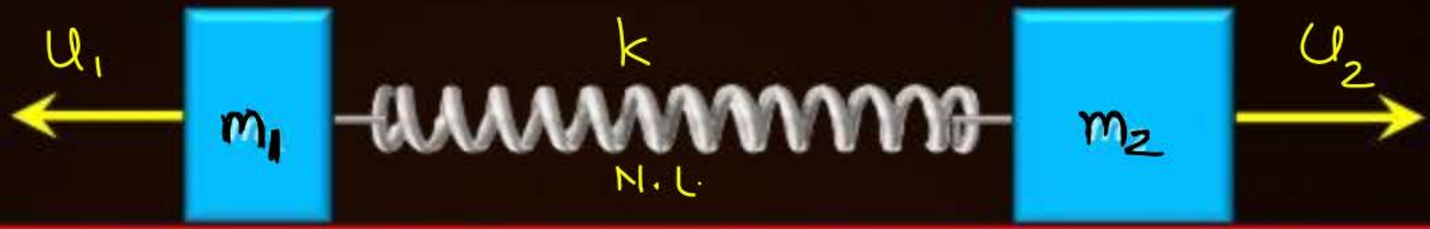
(2) $\vec{r}_i)_x = \vec{r}_f)_x \Rightarrow 0 = mv_1 - Mv_2 \Rightarrow v_2 = \frac{mv_1}{M}$

$K_1 + U_1 = K_2 + U_2 \Rightarrow 0 + mg(R-r) = \frac{1}{2}mv_1^2 + \frac{1}{2}Mv_2^2 + 0$

Two blocks Spring Mass System

→ 2 blocks Connected by an ideal Spring

→ System is kept on Smooth horizontal Surface



Smooth

→ $f_{ext})_x = 0$ (System 2 blocks + Spring)

$\vec{P}_f)_x = \vec{P}_i)_x$

→ $W_{NC} = 0$ ($W_N = 0$)

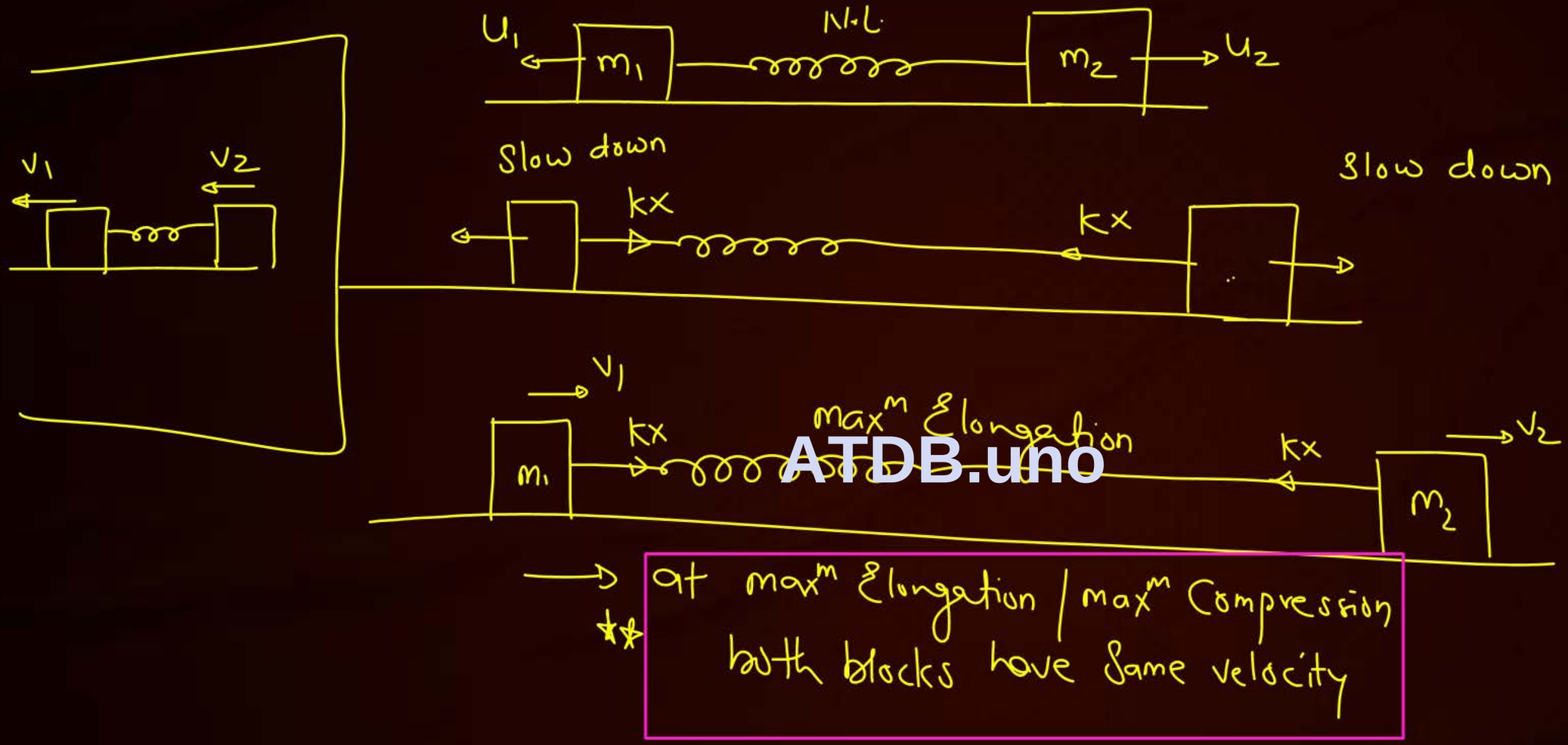
$K_1 + U_1 = K_2 + U_2$

→ is u_{cm} Zero $\vec{u}_{cm} = \left(\frac{m_2 u_2 - m_1 u_1}{m_1 + m_2}\right)\hat{i}$

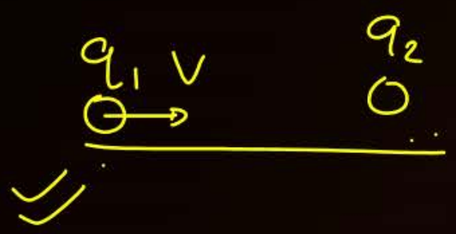
May or may not zero

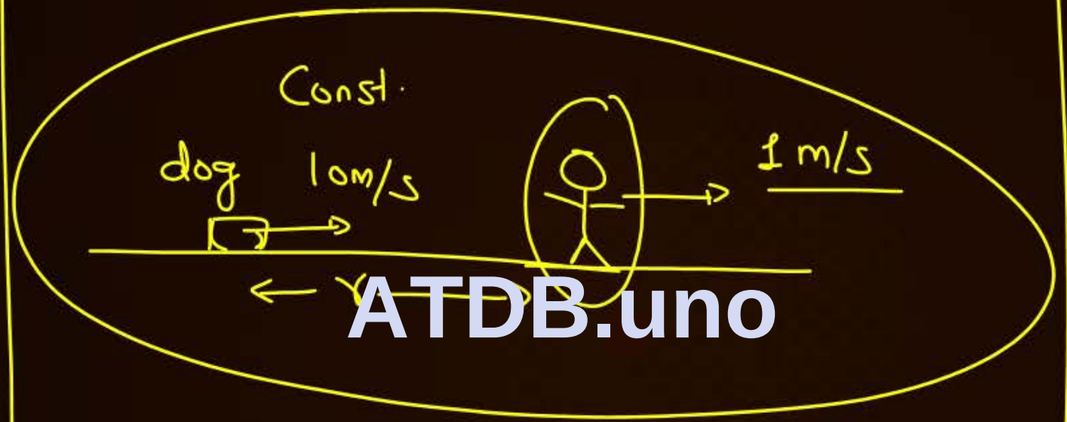
→ at max^m elongation / max^m Compression both blocks have same velocity

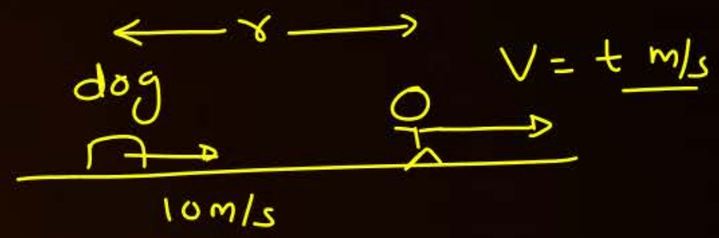
$\vec{v}_1 = \vec{v}_2 = \vec{v}_{cm}$ $\left(\vec{v}_{cm} = \frac{m_1\vec{v}_1 + m_2\vec{v}_2}{m_1 + m_2}\right)$



→ ** at max^m Elongation / max^m Compression both blocks have same velocity

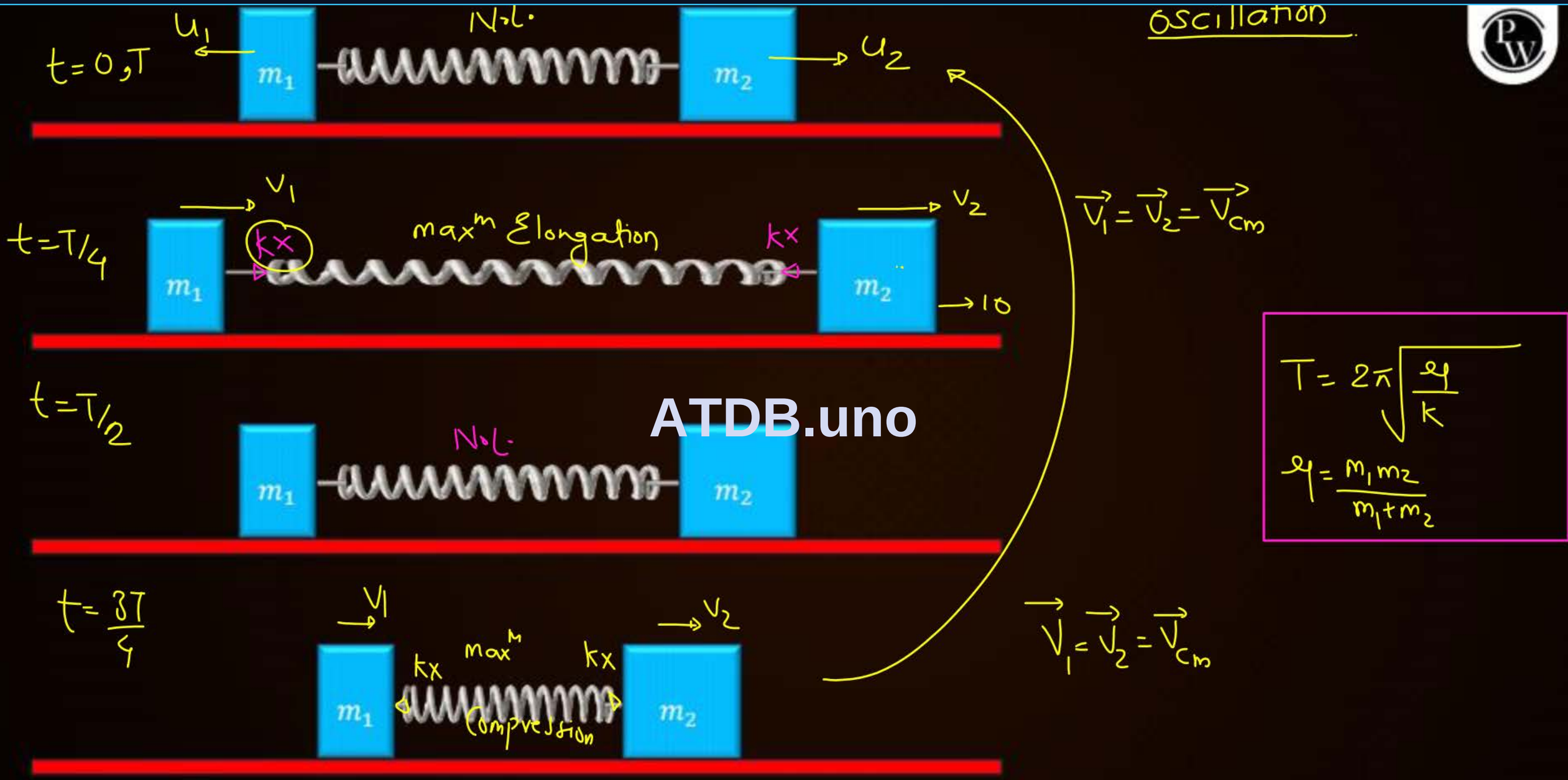






$t = 10$ Y is minimum

Oscillation



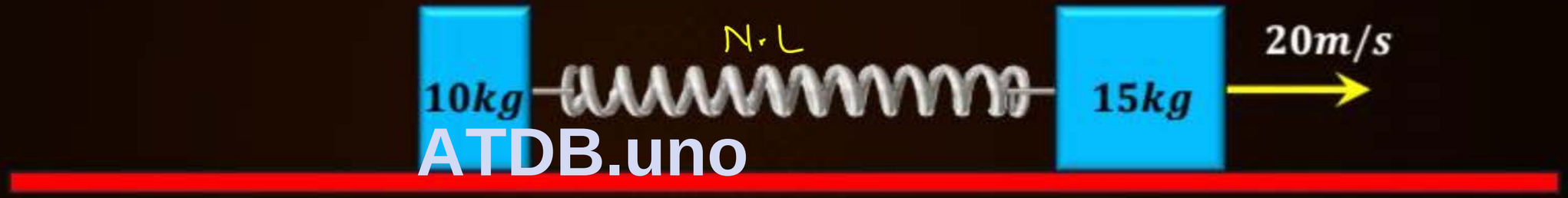
$$T = 2\pi\sqrt{\frac{\mu}{k}}$$

$$\mu = \frac{m_1 m_2}{m_1 + m_2}$$

Question → 58

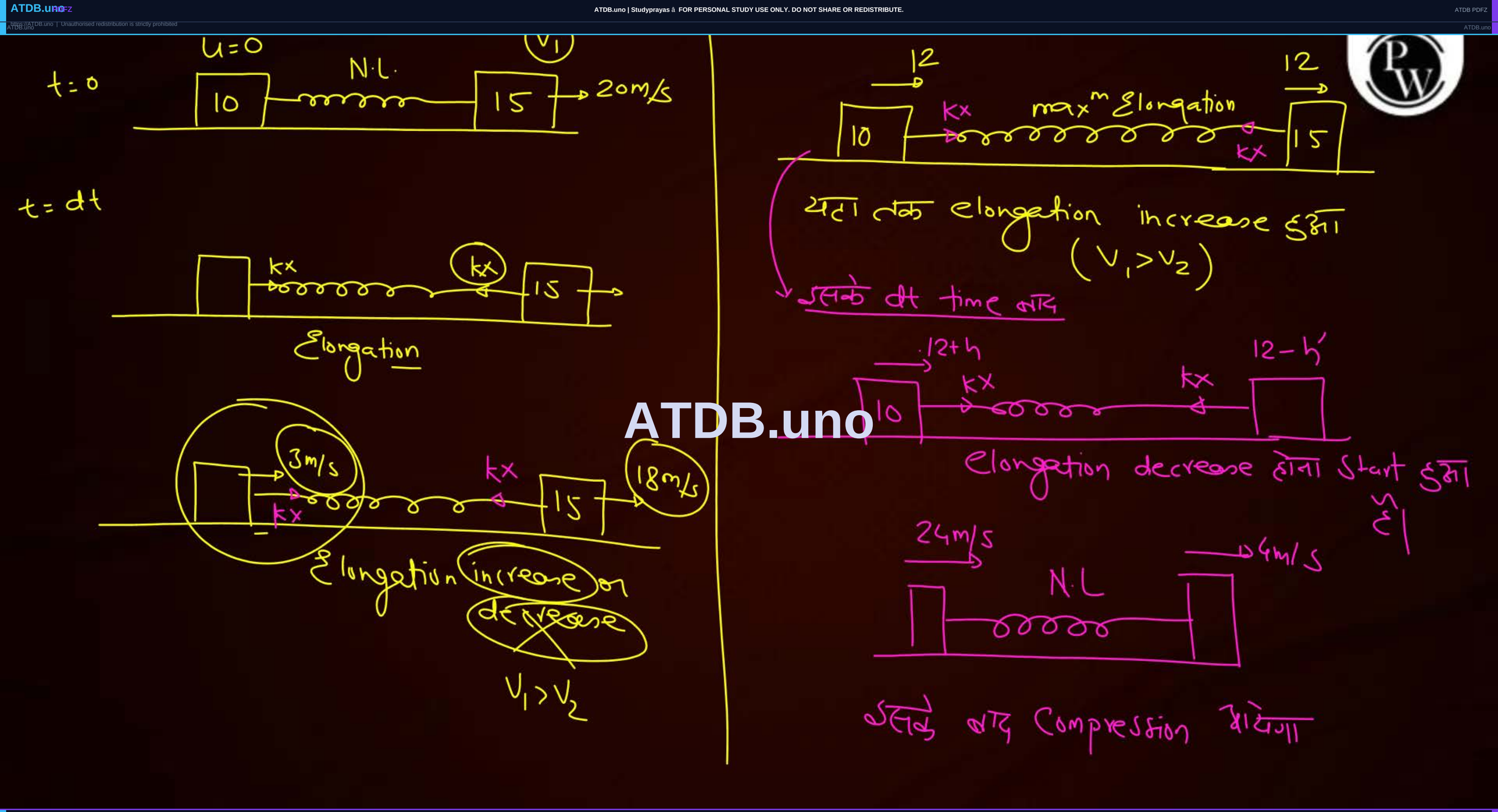
Two block are connected by a spring (k = 600 N/m). When spring is at natural length a sharp impulse imparted 20m/s velocity to 15 kg block. Find

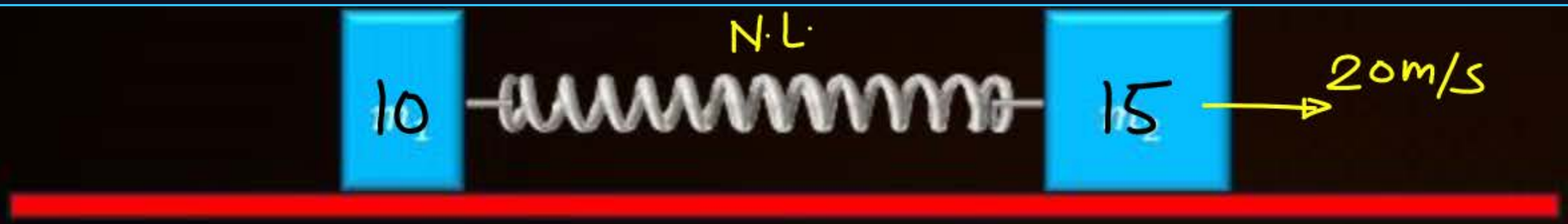
1. Velocity of COM
2. Maximum Compression and maximum elongation
3. Maximum and minimum speed of each block

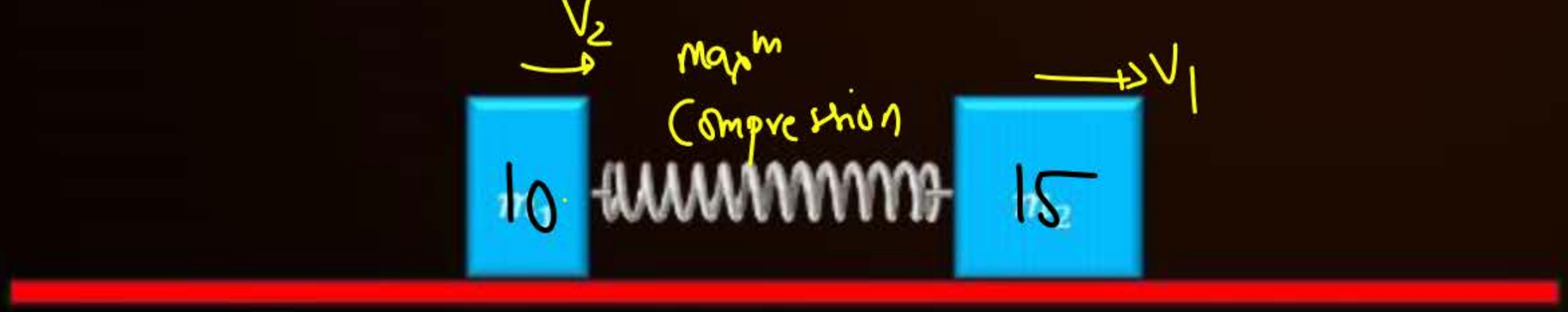


$$\vec{V}_{cm} = \vec{v}_{cm} = \frac{m_1\vec{u}_1 + m_2\vec{u}_2}{m_1 + m_2} = \frac{15(20) + 10(0)}{25} = 12\,m/s$$

$(f_{ext.} = 0)$







$$\left(V_{cm} = \text{Constant} \quad f_{ext} = 0 \Rightarrow \vec{P}_i = \vec{P}_f = M\vec{V}_{cm}\right)$$

$$\vec{V}_1 = \vec{V}_2 = V_{cm} = \frac{15(20)+10(0)}{25}$$

$$V_1 = V_2 = 12\ m/s$$

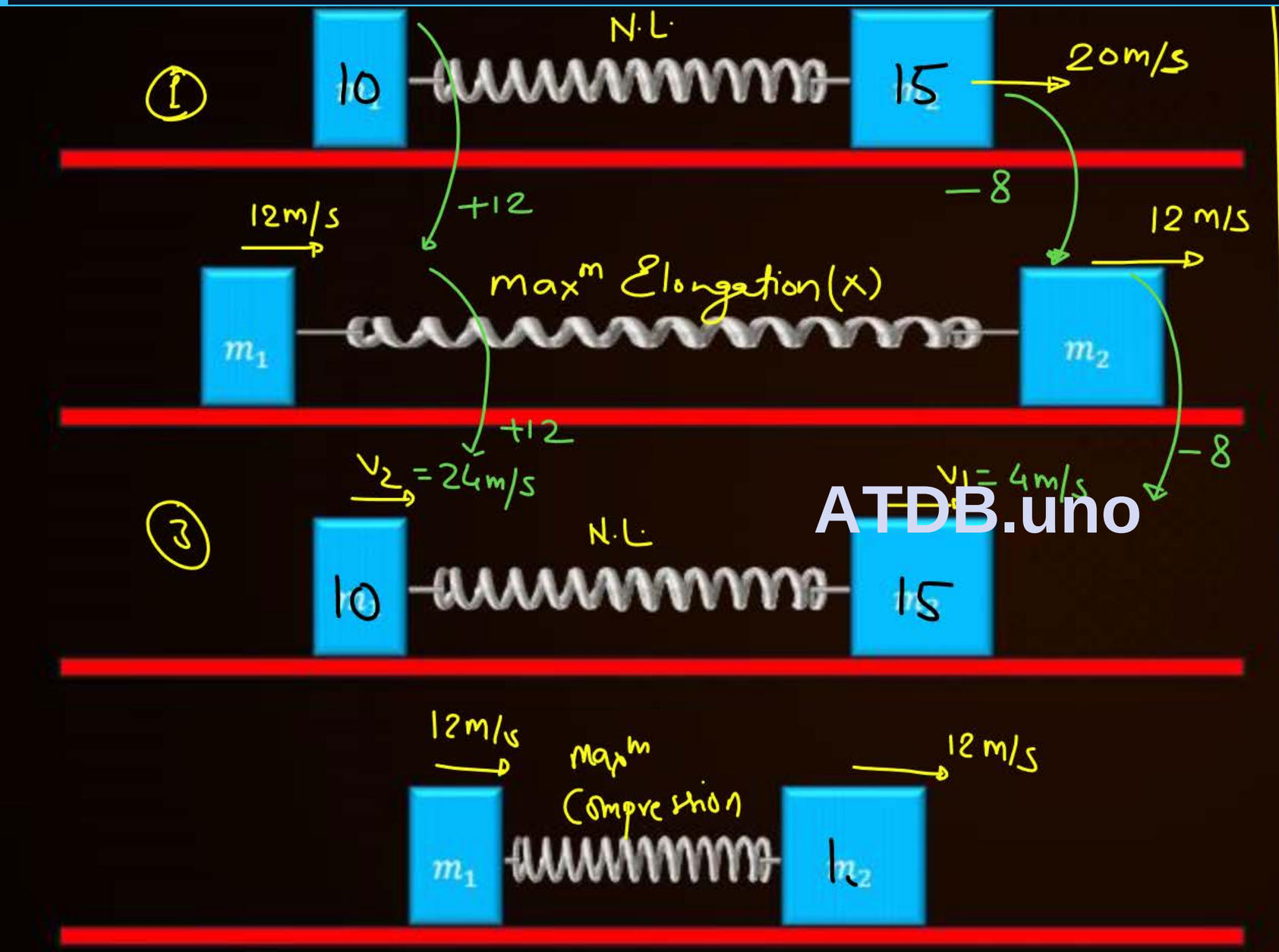
$$K_1 + U_1 = K_2 + U_2$$

$$\frac{1}{2}15(20)^2 + 0 = \frac{1}{2}10(12)^2 + \frac{1}{2}15(12)^2 + \frac{1}{2}kx^2$$

$$\Rightarrow 3000 - (720+1080) = \frac{1}{2}\times 600\, x^2$$

$$x = \sqrt{\frac{1200}{300}} = \underline{2m}$$

max^m elongation / max^m Compression



basic ✓

$$\vec{P}_f = \vec{P}_i$$

$$\Rightarrow 15(20) + 10(0) = 15V_1 + 10V_2$$

$$\Rightarrow 2V_2 + 3V_1 = 60 \quad \text{— (ii)}$$

$$K_1 + U_1 = K_2 + U_2$$

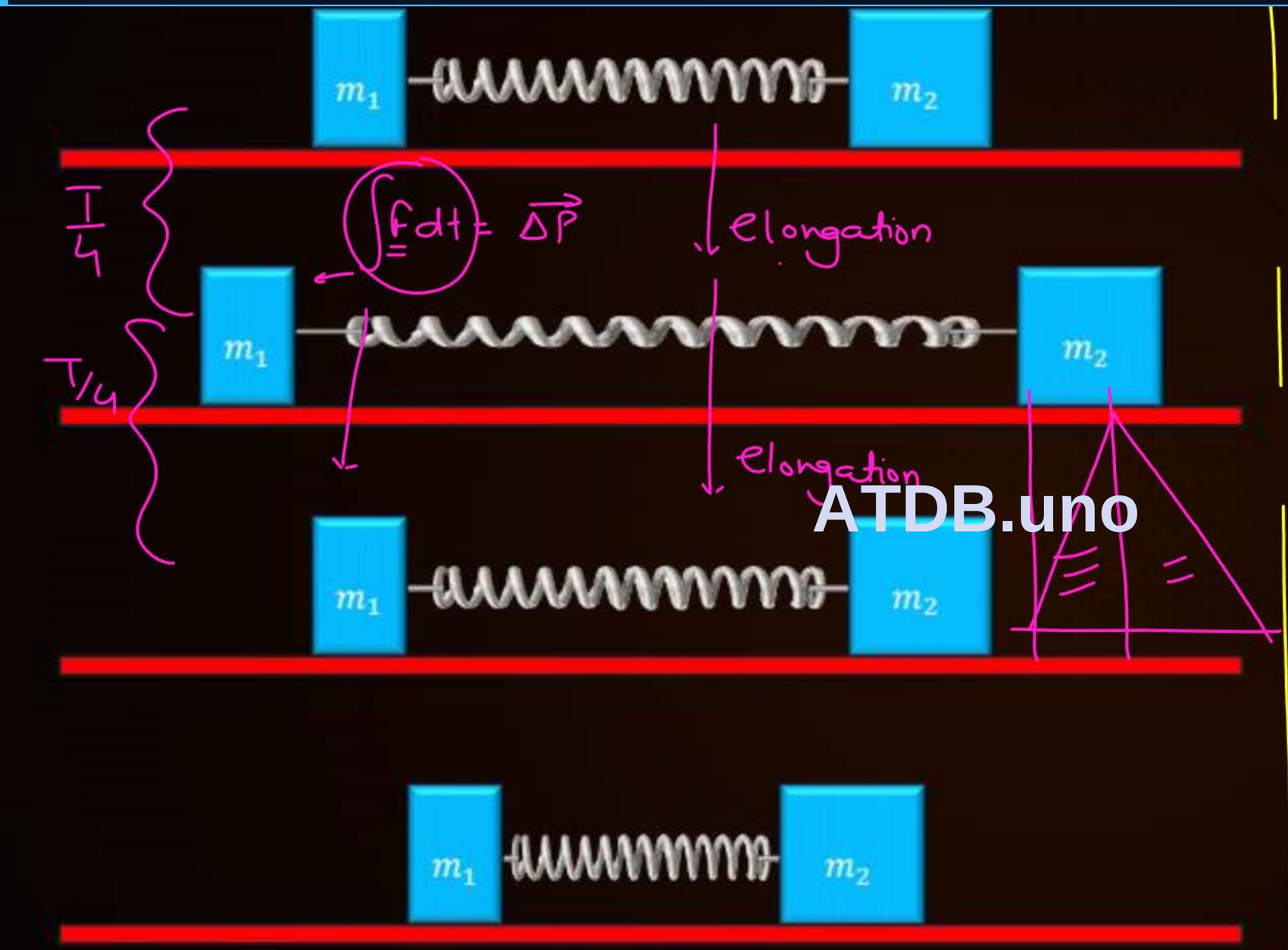
$$\frac{1}{2}15(20)^2 + 0 + 0 = \frac{1}{2}15V_1^2 + \frac{1}{2}10V_2^2$$

$$\Rightarrow 2V_2^2 + 3V_1^2 = 1200 \quad \text{— (iii)}$$

Jagaad

15 kg — max^m → 20 m/s — min. → 4 m/s

10 kg — max^m → 24 m/s — min. → 0



basic से.

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$\Rightarrow 2v_2 + 3v_1 = 60$ — (ii)

$K_1 + U_1 = K_2 + U_2$

$\frac{1}{2}15(20)^2 + 0 + 0 = \frac{1}{2}15v_1^2 + \frac{1}{2}10v_2^2$

$\Rightarrow 2v_2^2 + 3v_1^2 = 1200$ — (iii)

Jagaad

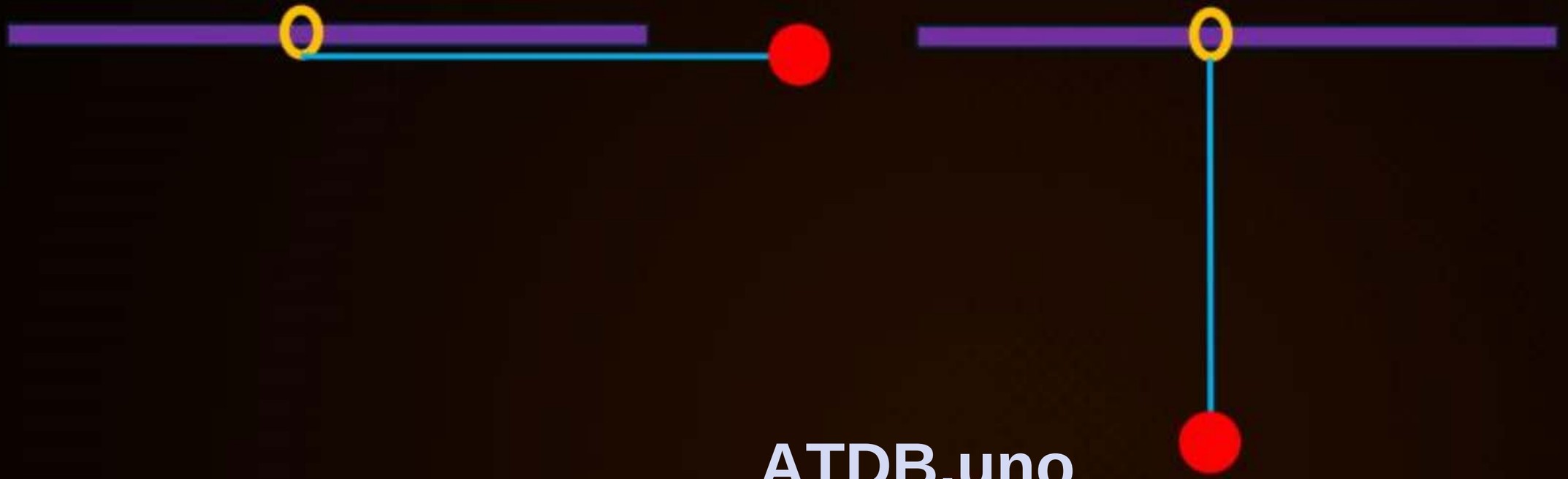
15 kg max^m → 20 m/s min. → 4 m/s

10 kg max^m → 24 m/s min. → 0

Question 33

A ring of mass m and a ball of mass 2m are connected with an ideal string as shown. Ring is free to move in smooth, fixed horizont5al rod. System is release from rest as shown. When string become horizontal Find

1. Displacement of ring
2. Speed of ring
3. Tension in string



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