# PRAYAS

## JEE 2026



**Physics**

## COM and System of particles

**Lecture - 12**

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# Topics to be covered

A Collision

B

C

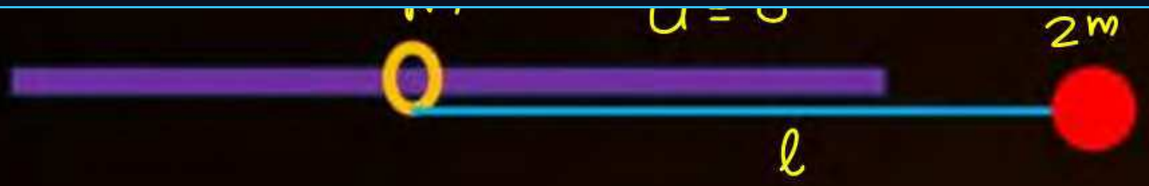
D

ATDB.uno

## Question

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 horizontal rod. System is release from rest as shown. When string become vertical Find

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

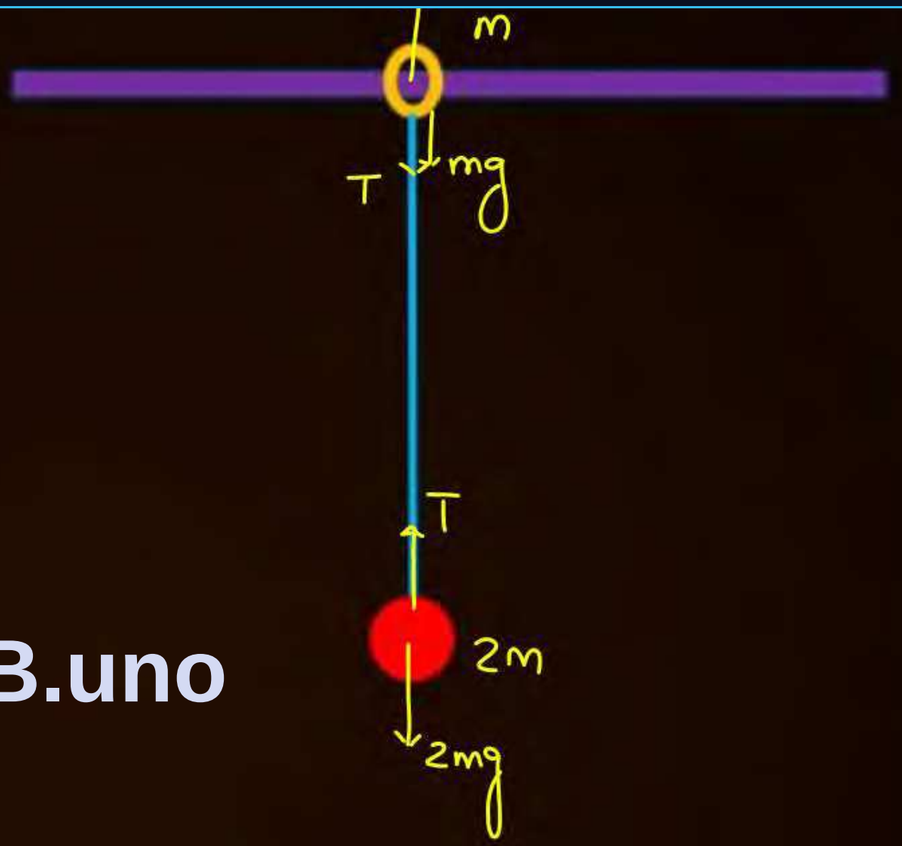


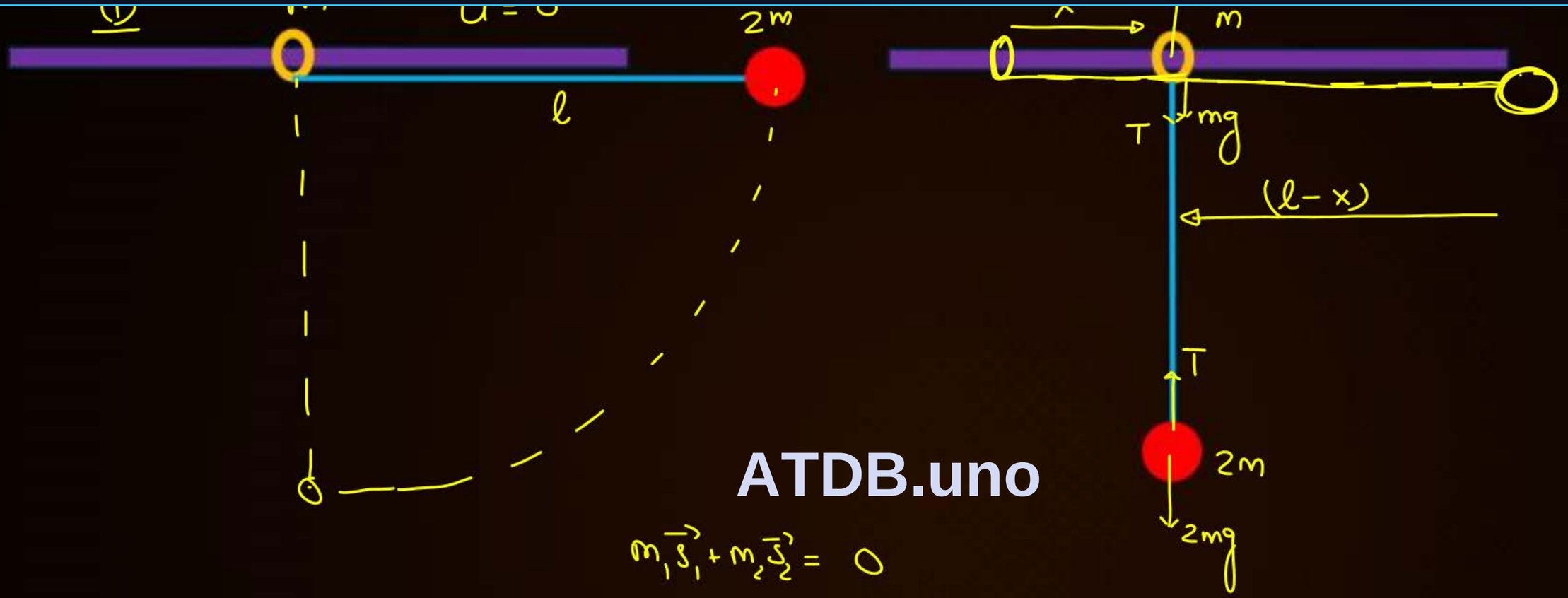

$$f_{ext.})_x = 0 \quad (\text{Ring} + \text{ball})$$

$$U_{cm})_x = 0$$

$$W_{NC} = 0$$

(ii)



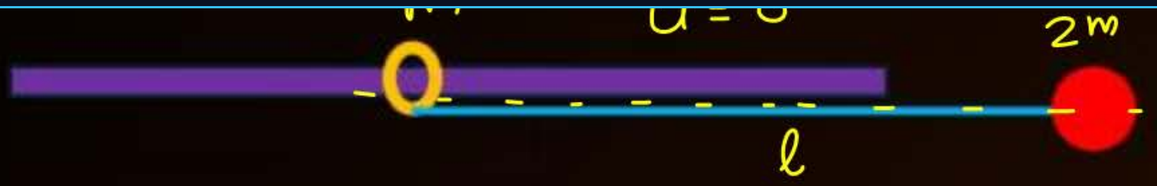


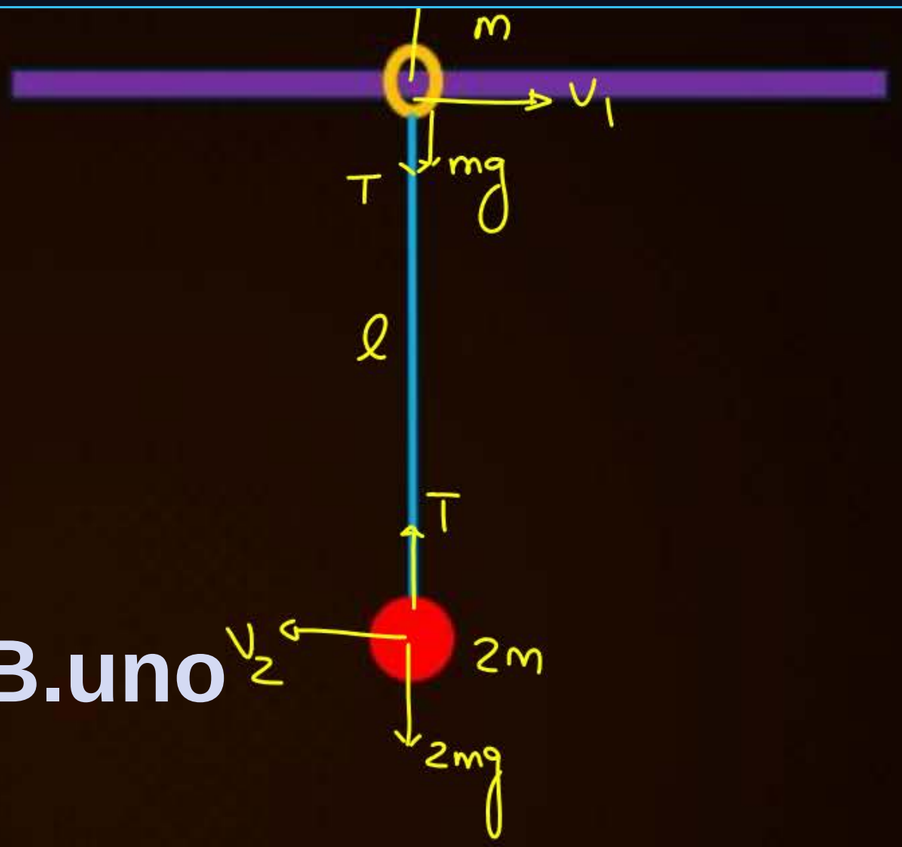



$$m_1\vec{s}_1 + m_2\vec{s}_2 = 0$$

$$mx - 2m(\ell - x) = 0$$

$$\Rightarrow x = \frac{2\ell}{3} \Rightarrow \vec{s}_{Ring} = \frac{2\ell}{3}\hat{i} \qquad \vec{s}_{ball} = \frac{\ell}{3}(-\hat{i})$$




(2) $\vec{P}_f = \vec{P}_i$

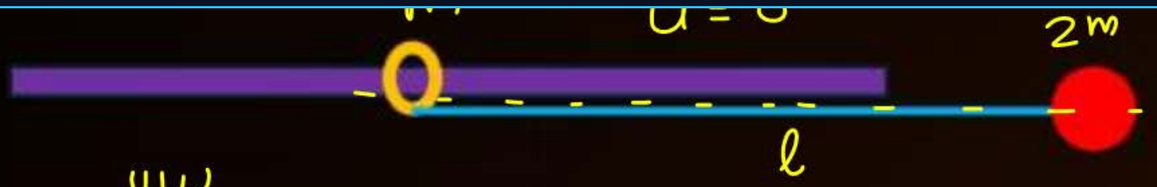
$$mv_1 - 2mv_2 = 0 \Rightarrow v_1 = 2v_2$$

$$K_1 + U_1 = K_2 + U_2$$

$$0 + 0 = \frac{1}{2}mv_1^2 + \frac{1}{2}2mv_2^2 + (-2mg\ell)$$

$$(2v_2)^2 + 2v_2^2 = 4g\ell \Rightarrow v_2 = \sqrt{\frac{2g\ell}{3}}$$

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



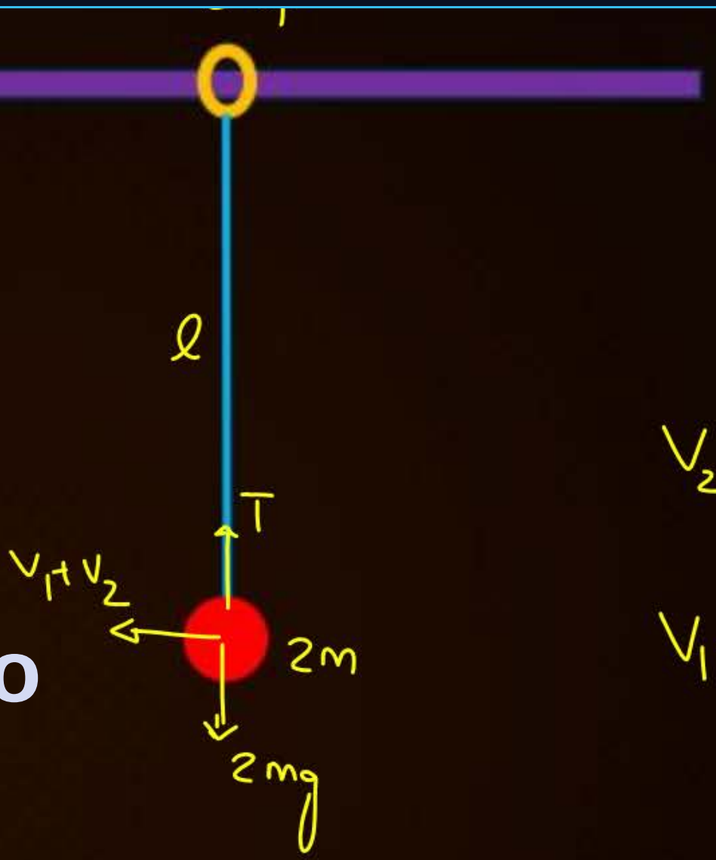

(iii)

is motion of ball Circular

→ no (w.r.t Ground)

→ yes (w.r.t Ring)

⟹ w.r.t Ring → motion Circular




$$V_2 = \sqrt{\frac{2g\ell}{3}}$$

$$V_1 = 2\sqrt{\frac{2g\ell}{3}}$$



Centripetal force $T - 2mg = \frac{2m(V_1+V_2)^2}{\ell}$

$$T = 2mg + \frac{2m}{\ell}\left(3\sqrt{\frac{2g\ell}{3}}\right)^2 = 2mg + 2mg(6)$$

$$= 14mg$$

→ Collision is short time event

→ Impulsive force → Short time

↳ N, T, $f_r$

Non-Impulsive → mg, Spring

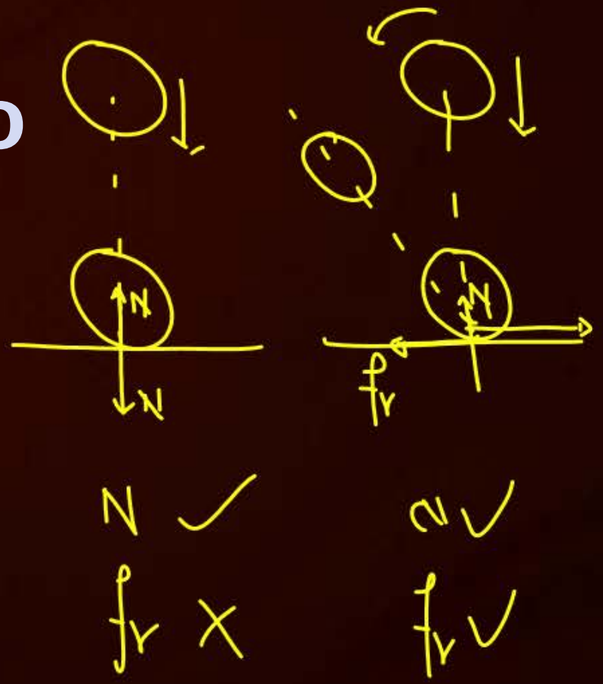
→ LOI → Common Normal

Significent change in momentum

$f_r$ → ∝ Impulsive

↳ relative motion along Surface





# Coefficient of restitution (e)

$$e = \frac{V_{sep.} \text{ of Collision points along LOI}}{V_{app.} \text{ of Collision points along LOI}}$$

$$e = \frac{V_{sep.}}{V_{app.}}$$

## Type of Collision

(1) elastic Collision $e = 1$

(2) inelastic Collision $0 < e < 1$

(3) perfact inelastic Collision $e = 0$

e may be greater than 1 and may be -ive

In general $0 \leq e \leq 1$

→ elastic Collision ⟶ $e = 1$

no loss in k.E. $\quad K.E_{initial} = K.E_{final}$

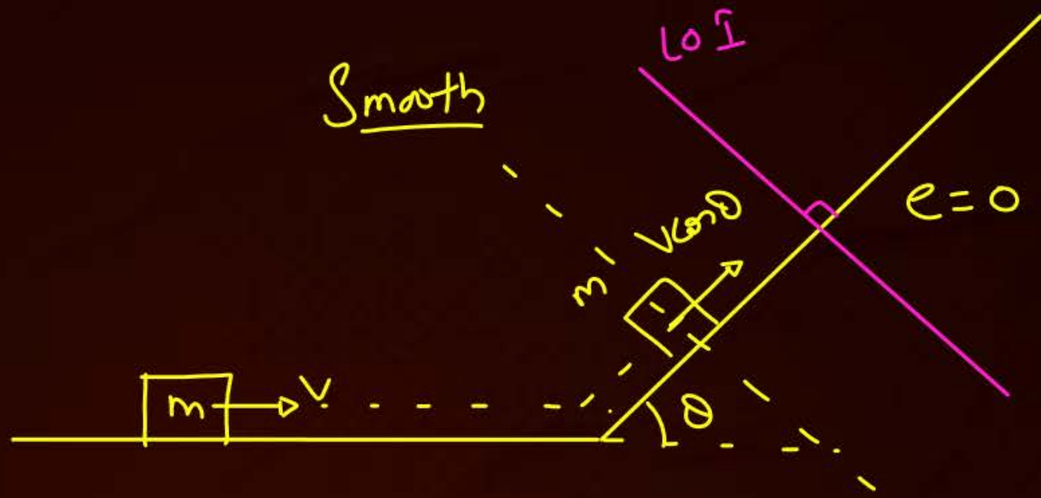
# Perfact inelastic Collision (e=0)

→ e = 0 ⇒ objects always Stick with each other after Collision ⟶ False

→ objects Stick with each other after Collision ⇒ e = 0 ⟶ True

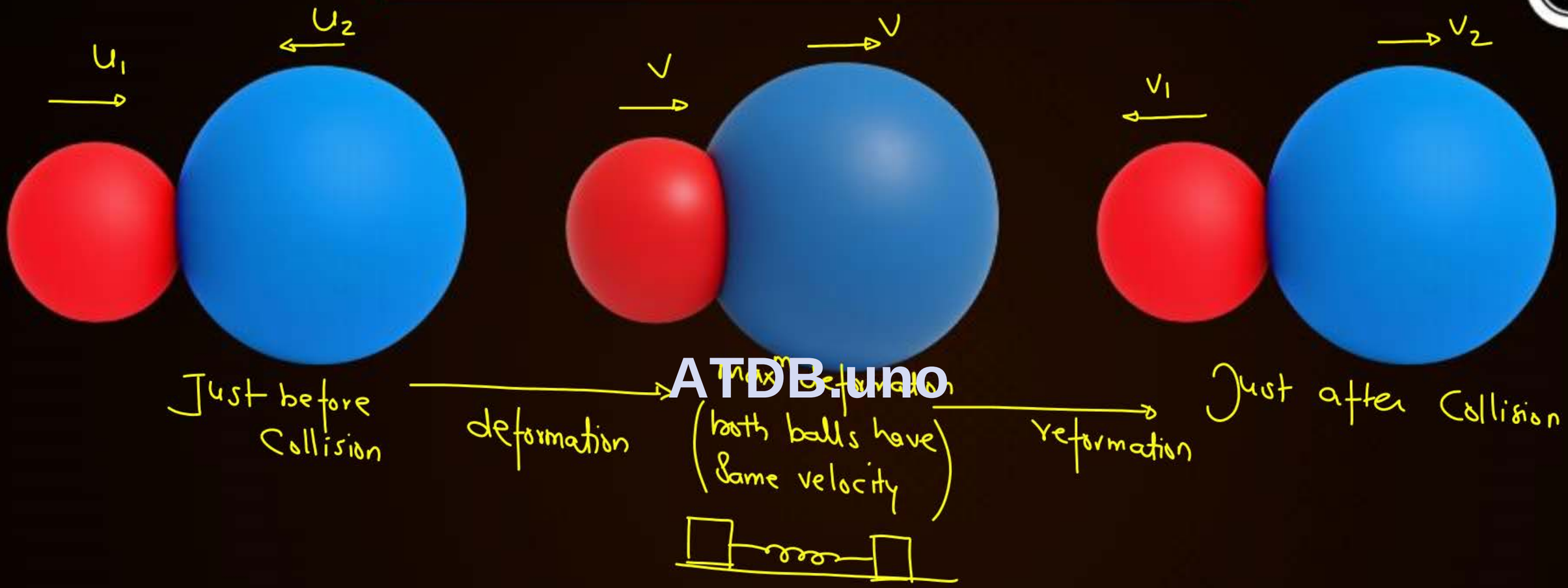
$e = 0 \Rightarrow V_{sep.} = 0$ ($V_{sep.}$ is define along LOI)

चिपक गये ⇒ $V_{sep.} = 0$ $V_{sep.} = 0 \not\Rightarrow$ चिपक गये




# ATDB.uno

# deformation and reformation






$e = 1 \Rightarrow$ no permanent deformation

$0 \leq e < 1 \Rightarrow$ Some permanent deformation

Impulse of deformation ($J_d$) ... Impulse of restitution ($J_R$)

Impulse $= \Delta\vec{P}$



$J_d$ $J_R$

**

$$e = \frac{V_{sep.}}{V_{app.}} = \frac{J_R}{J_d}$$

# Tools to Solve Collision

→ LOI , Impulsive force

→ $\vec{P}_f = \vec{P}_i$ (X, Y, Z)

→ $e = \frac{V_{sep.}}{V_{app.}} = \frac{J_R}{J_d}$

$e = 1$ elastic

$0 < e < 1$ inelastic

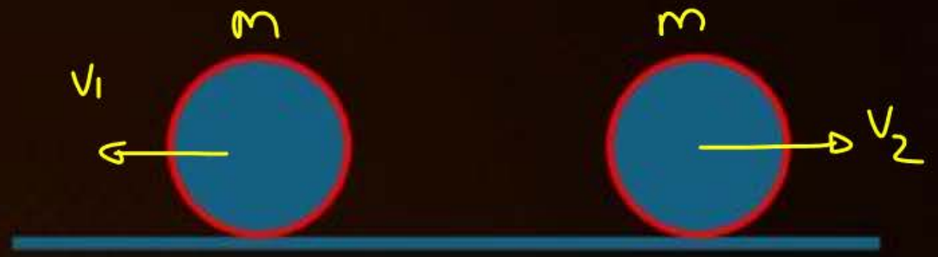
$e = 0$ perfect inelastic

Just before and just after Collision , diagram बनाओ

Question → 60

Two balls are moving towards each other. Find velocity of each ball after collision

For elastic collision e=1 (given)


$$(\vec{P}_f)_x = (\vec{P}_i)_x \Rightarrow mv_2 - mv_1 = mu_1 - mu_2 \Rightarrow v_2 - v_1 = u_1 - u_2 \quad -(i)$$

$$e = 1 \qquad e = \frac{v_1 + v_2}{u_1 + u_2} \Rightarrow v_1 + v_2 = u_1 + u_2 \quad -(ii)$$

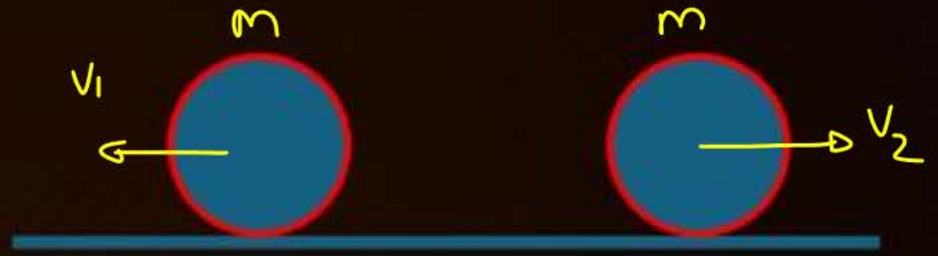
$$v_2 = u_1 \text{ and } v_1 = u_2$$

Jugaad → for elastic Collision b/w Same mass object, they interchange their velocities after Collision along LOI

Question → 61

Two balls are moving towards each other. Find velocity of each ball after collision

$e = 0.5$


$\vec{P}_f)_x = \vec{P}_i)_x \Rightarrow m v_2 - m v_1 = m u_1 - m u_2 \Rightarrow v_2 - v_1 = u_1 - u_2$ -(i) Same

$e = 0.5$ $\quad e = \dfrac{v_1 + v_2}{u_1 + u_2} \Rightarrow$ $\boxed{v_1 + v_2 = (u_1 + u_2)\frac{1}{2}}$ -(ii) different

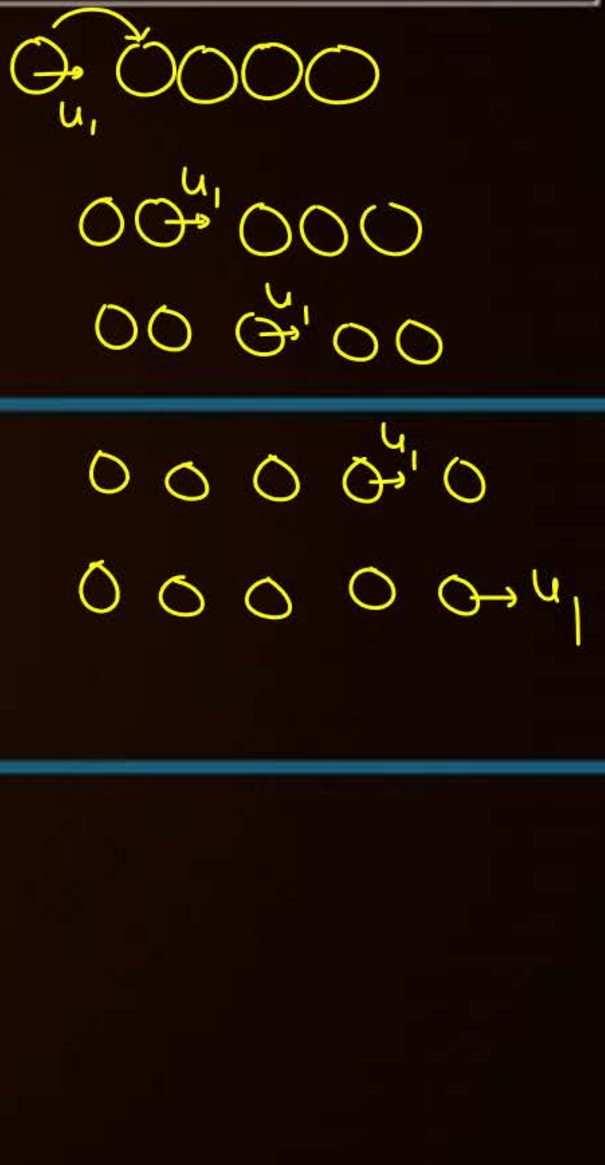
Question

All collisions are elastic find final velocity of each ball



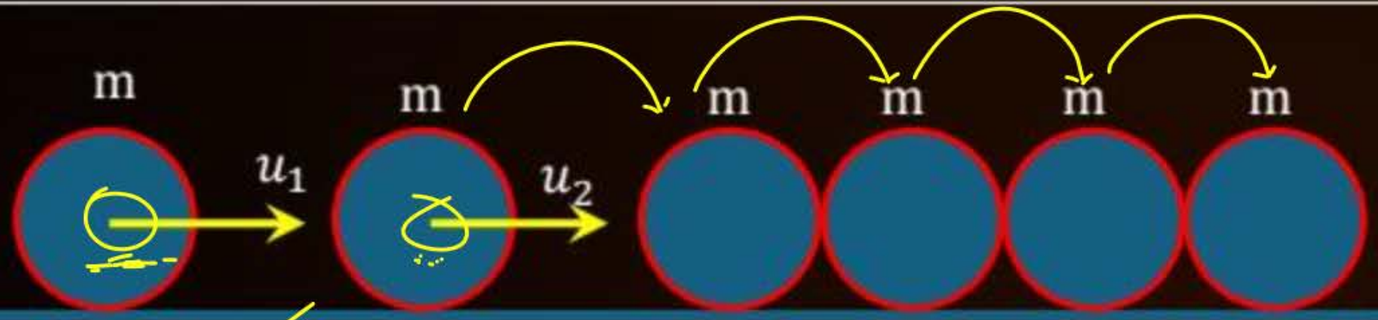


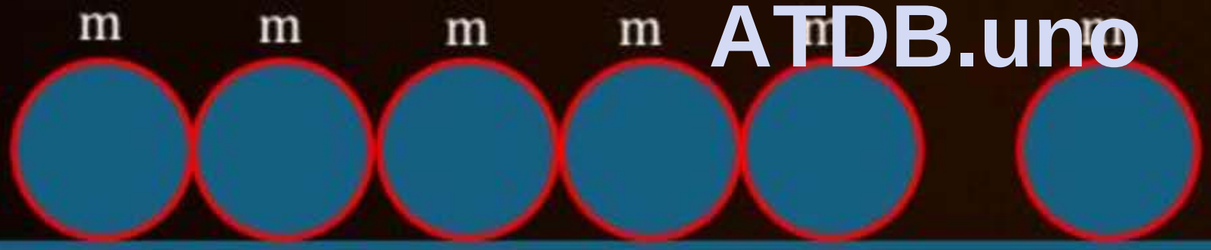


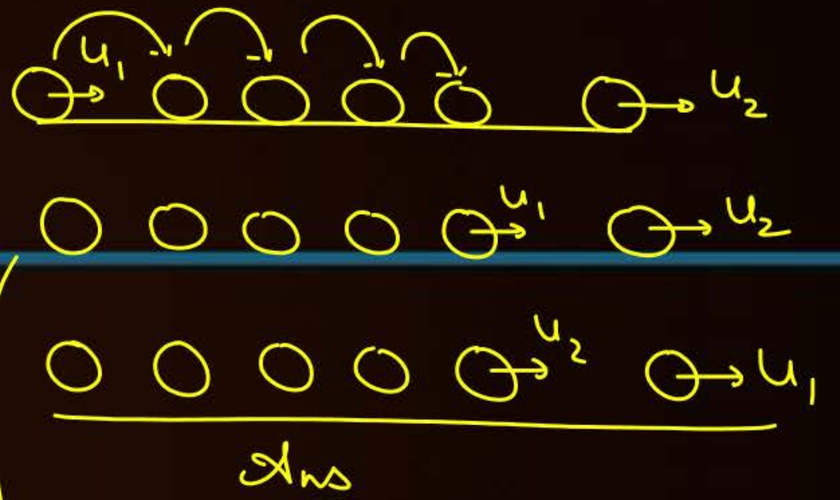
Question — 63

All collisions are elastic find final velocity of each ball $(u_1 > u_2)$





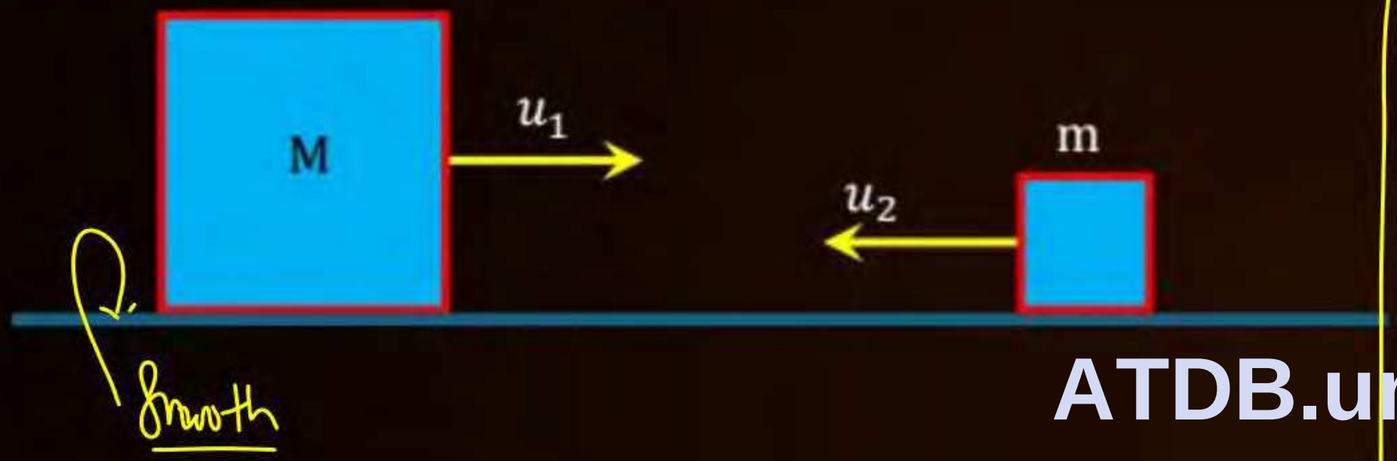


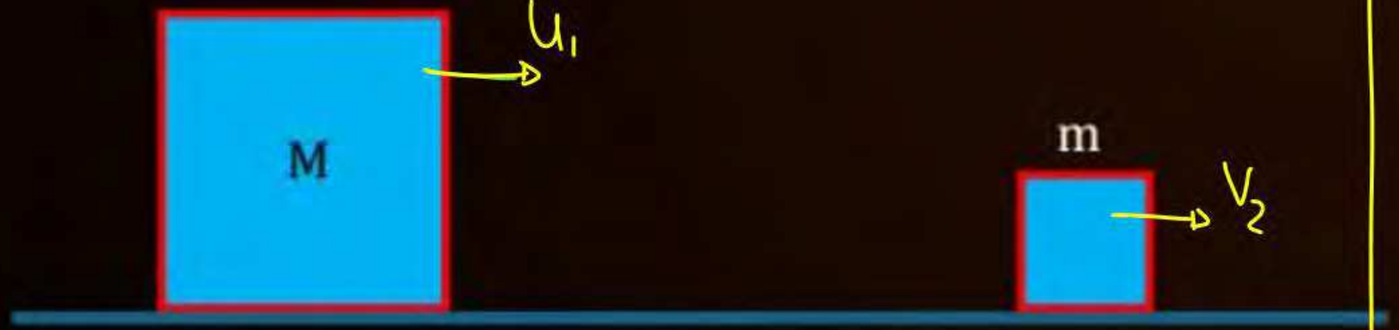
Ans if $u_2 > u_1$ → Extra

Question 64

Two blocks are moving towards each other. Find velocity of each block after collision

For inelastic collision e (M>>m)




assumption M >> m

↳ Velocity of M remain same

$\vec{P}_f = \vec{P}_i$ है लेकिन use नहीं कर सकते है

↳ eqn of e use होगी

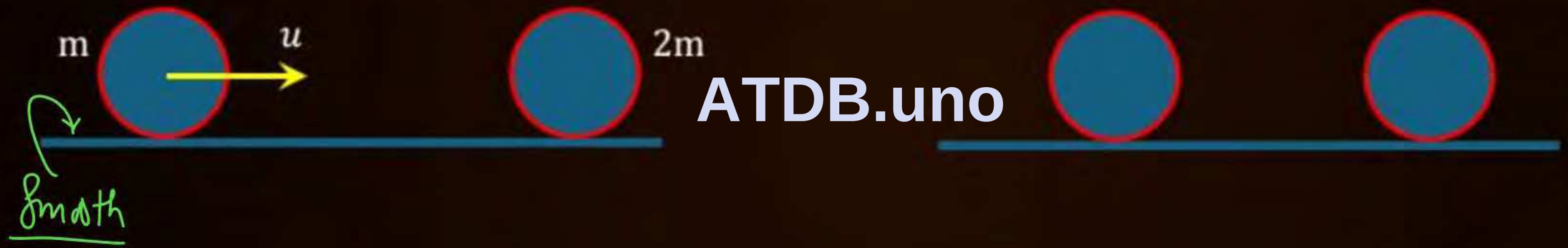
$P_i = MV$

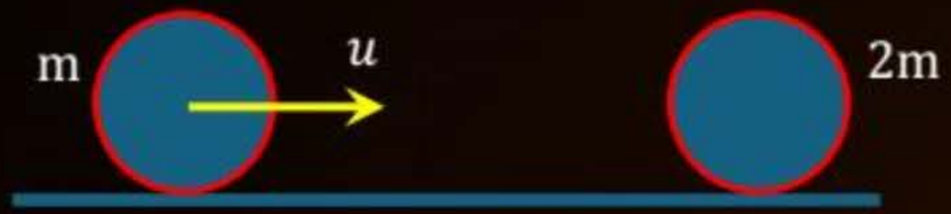
$$e = \frac{V_2 - u_1}{u_1 + u_2} \Rightarrow V_2 = u_1 + e(u_1 + u_2)$$

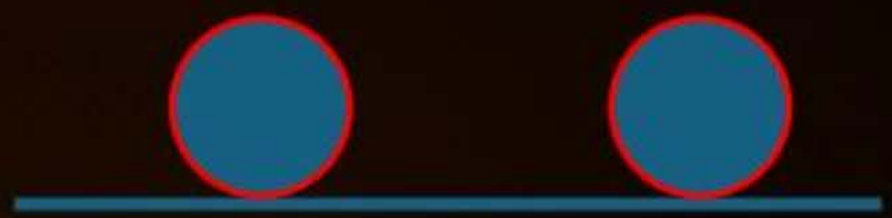
Question — 63

A ball of mass m is moving towards another stationary ball of mass 2m as shown. Find velocity of each ball and total loss in kinetic energy after collision for

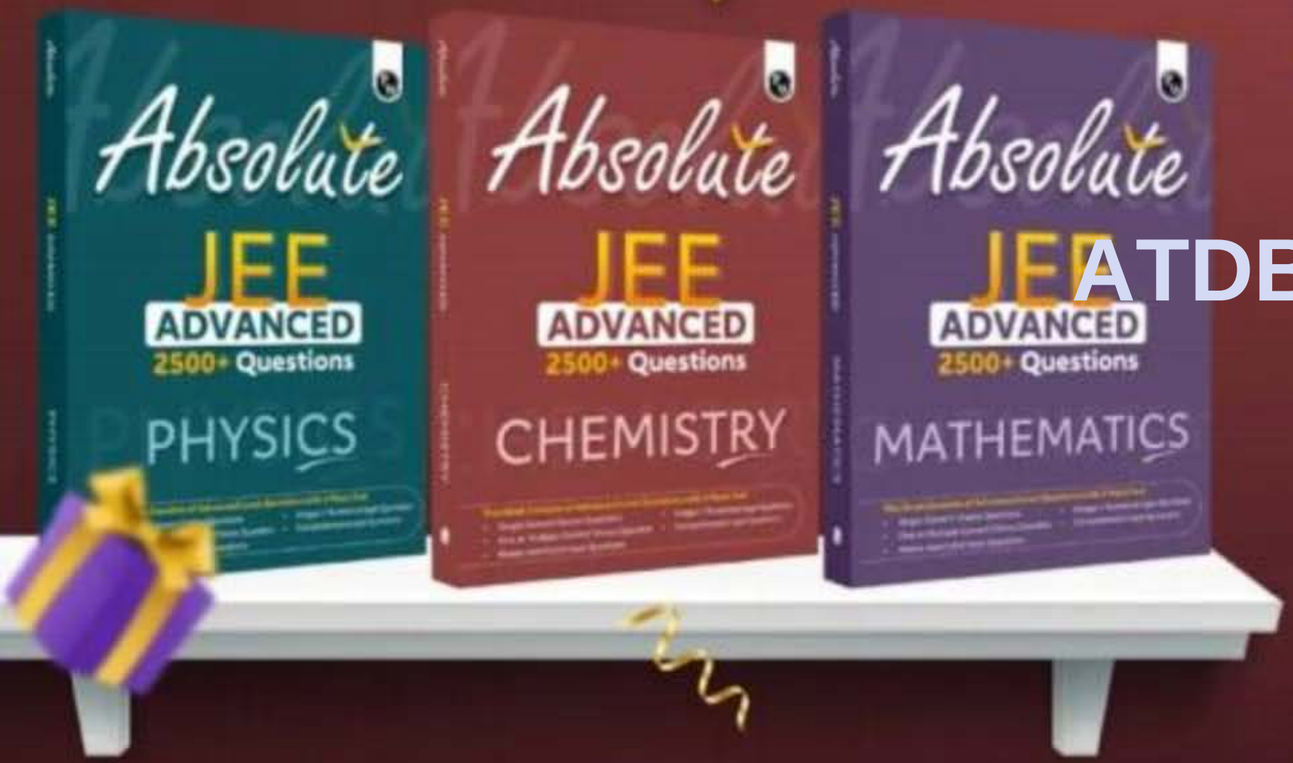
1. Elastic collision
2. Inelastic collision $(e = 0.5)$
3. Perfectly inelastic collision





# TO QUALIFY FOR GIVEAWAYS, MAINTAIN CONSISTENT PERFORMANCE IN THE FOLLOWING FOR ARJUNA, LAKSHYA, AND PRAYAS BATCHES:




- Attendance
- DPP Attempts
- Weekly Test Results



In the upcoming week, the **Top 10 students** on the **Weekly Test leaderboard** will receive **exclusive giveaway books.**

**NOTE:**

1. The Books are only for those who meet all three criteria.
2. Top 5–10 consistent toppers across all criteria win giveaways!

GIVE AWAY