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PRAYAS

JEE 2026

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Physics

COM and System of particles

Lecture - 11

Manish Singh Tak (Masti Sir)

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Topics to be covered

A Collision

B

C

D

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Question 39

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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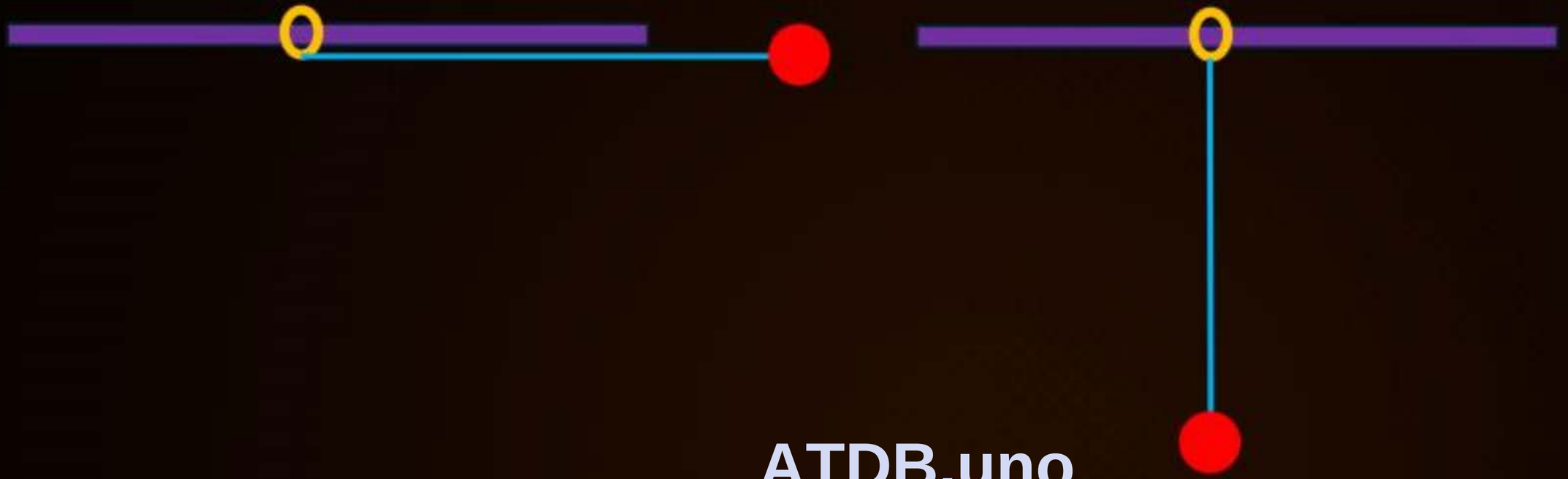

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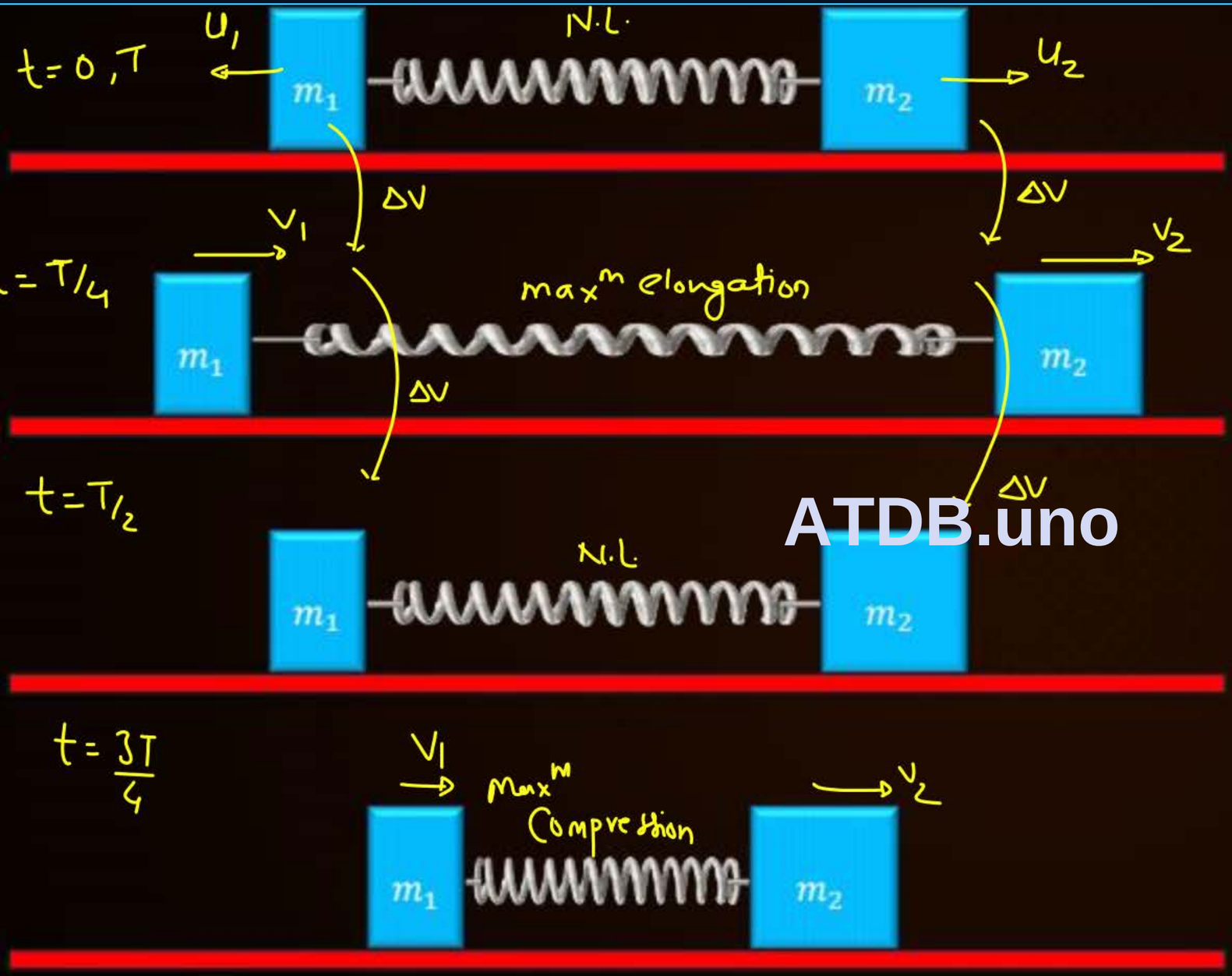
Oscillatory motion



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1st $F_{ext.})_x = 0$

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

2nd $K_1 + U_1 = K_2 + U_2$ $(W_{NC} = 0)$

3rd at max^m elongation or Compression

$\vec{v}_1 = \vec{v}_2 = \vec{v}_{cm}$

$$T = 2\pi\sqrt{\frac{\mu}{k}} \qquad \mu = \frac{m_1 m_2}{m_1 + m_2}$$

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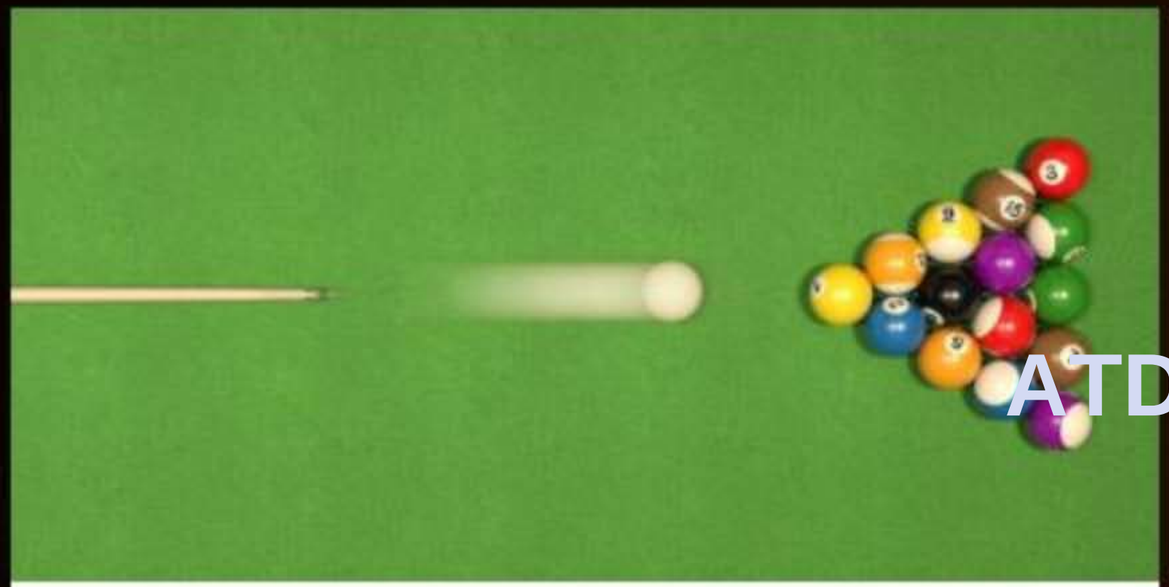
Collision

In Physics, a **collision** is any event in which two or more bodies exert forces on each other in a relatively very short time.

and change momentum significantly



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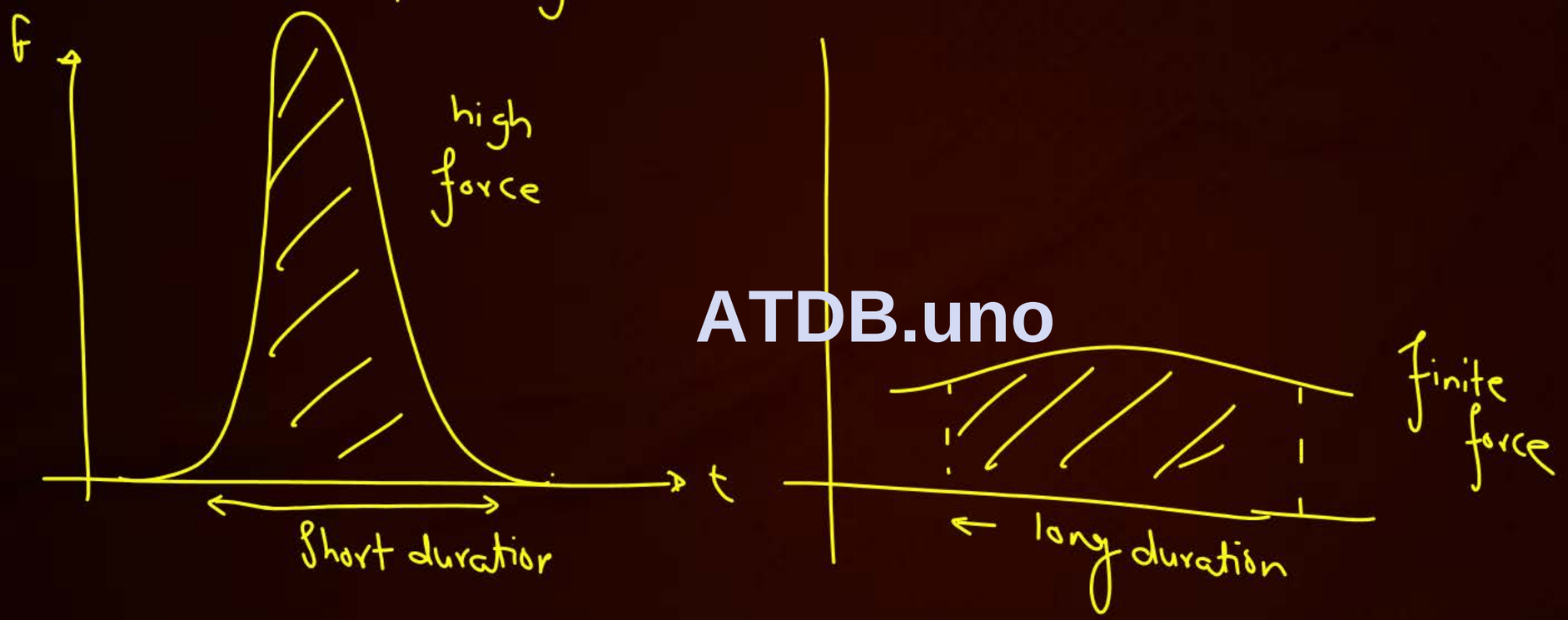
Impulse ($\vec{J}$)

$$\vec{J} = \Delta\vec{p} = \vec{p}_f - \vec{p}_i = \int \vec{F}\,dt = \text{Area Under Curve in } f\text{-}t \text{ Graph}$$



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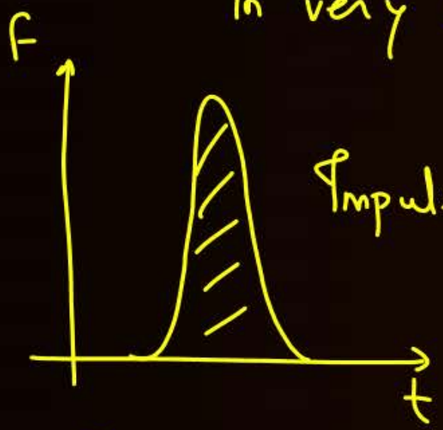
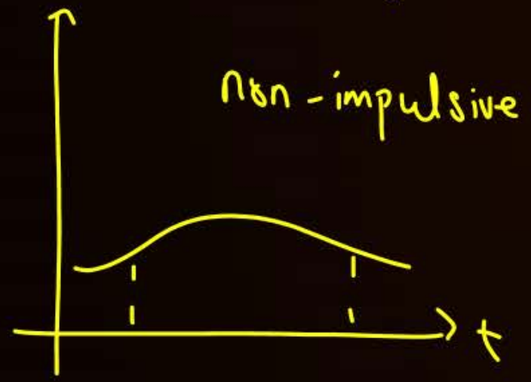
Impulsive force

Impulsive force → force which can highly change it's value in very short time. this force can significantly change momentum in very short time (Impulse and impulsive forces are entirly different terms)

($\vec{J} = \vec{P}_f - \vec{P}_i$ in short time or long time)





⇒ for collision b/w 2 solid objects

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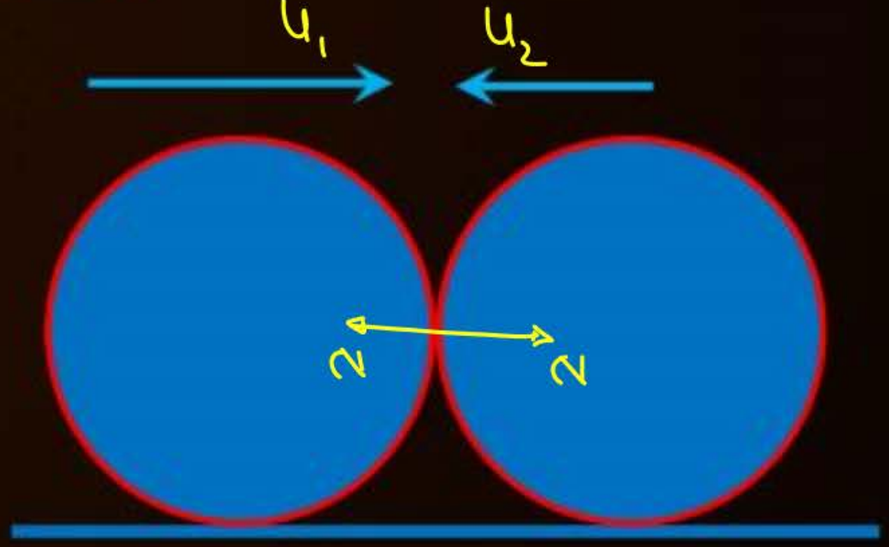
Common Normal is impulsive



(N → impulsive)

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- Impulsive force ⟶ Normal, Tension, friction.
- non-impulsive force → mg, Spring force.

Short

Collision is a very a time duration event

So in Collision (explosion) momentum is Conserved in presence of non-impulsive forces

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but Can't Conserve momentum in Presence of impulsive forces

Impulsive force only can balance by another impulsive force

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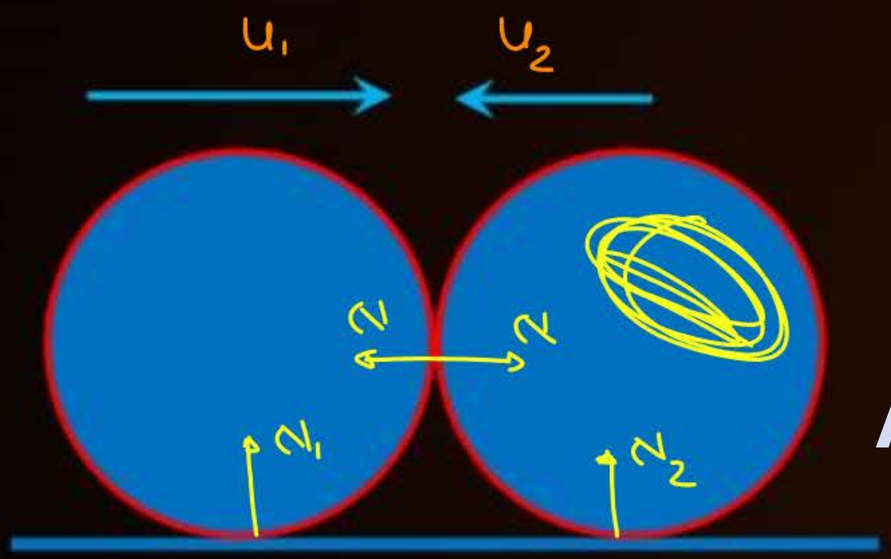
Impulsive force

Normal Force :→ Common Normal b/w Colliding objects is always impulsive



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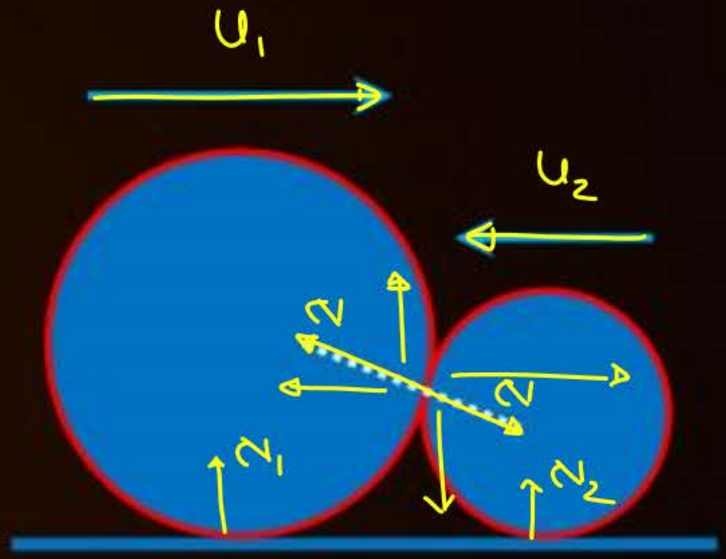

$I \rightarrow N$

$NI \rightarrow N_1, N_2$

$I \rightarrow N, N_2$

$NI \rightarrow N_1$

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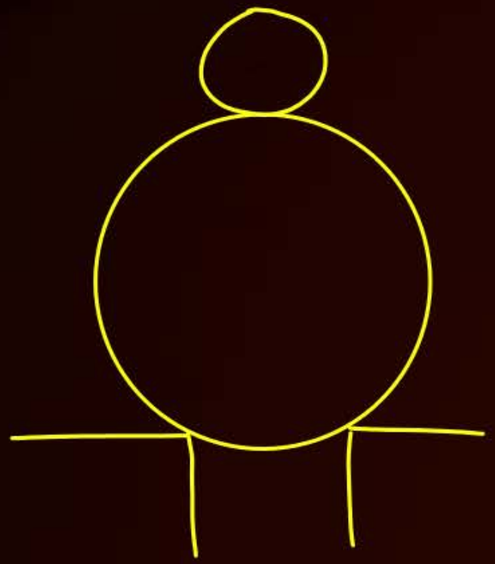

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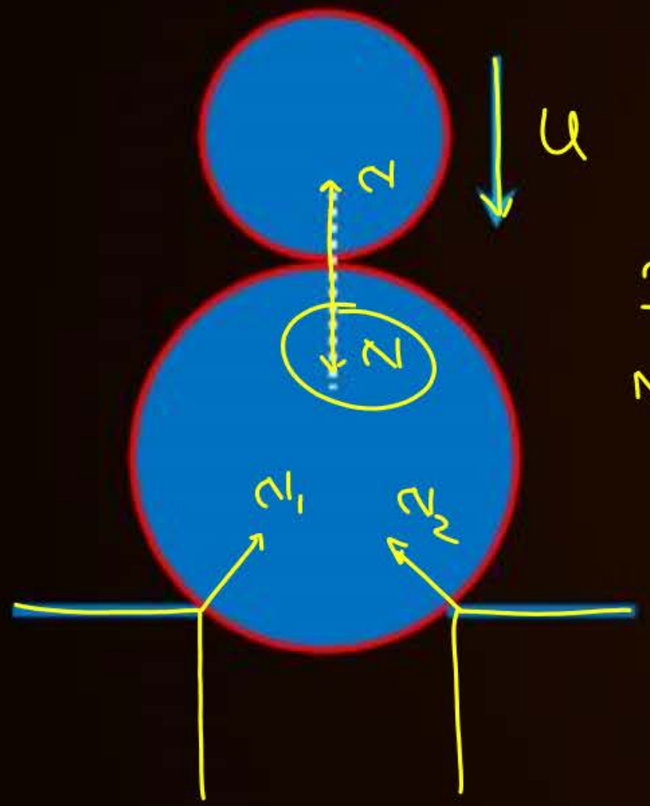
Impulsive force

Normal Force



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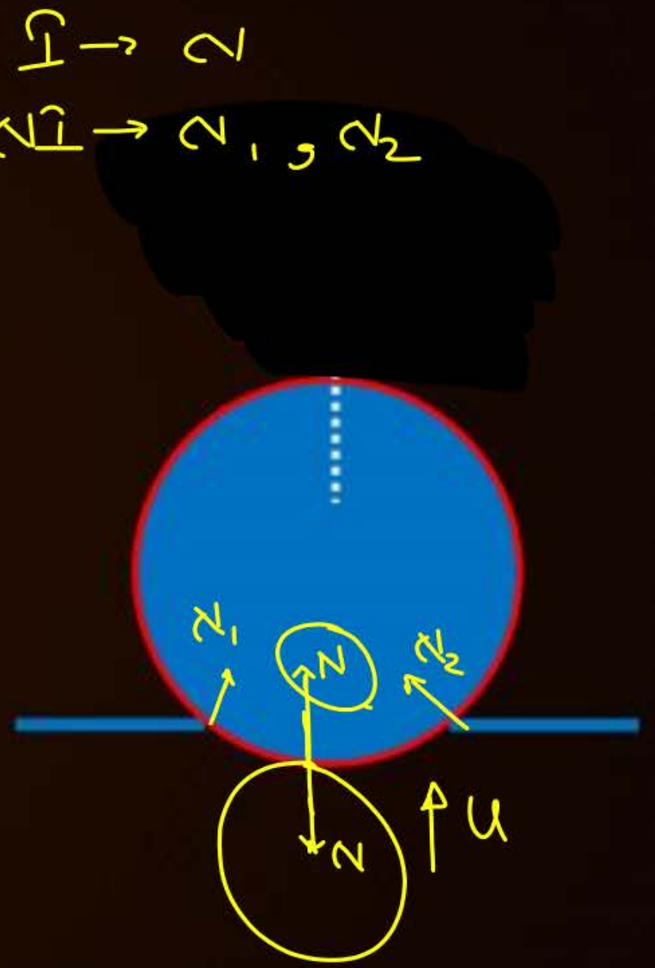

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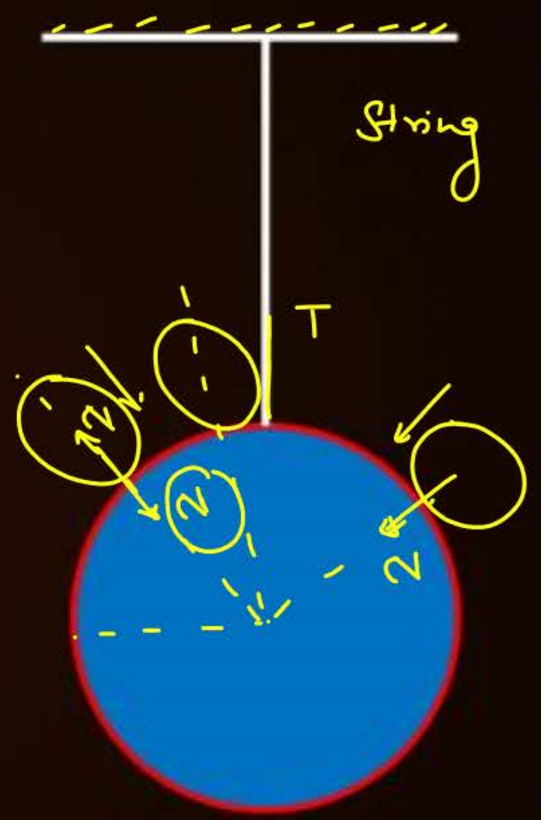
Impulsive force

Tension Force

$\vec{I} \rightarrow N, T$

$N\vec{I} \rightarrow$



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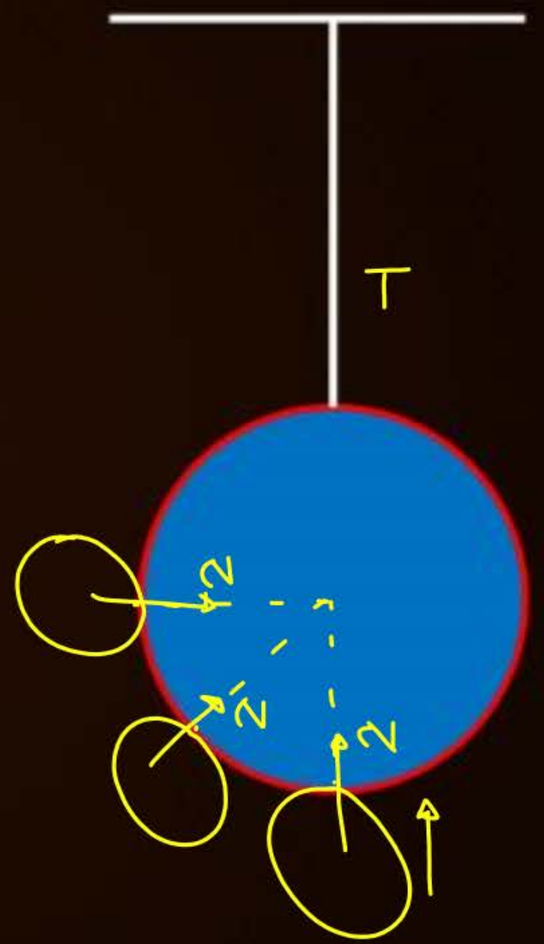
Impulsive force

Tension Force



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friction → $f_r|_{max.} = \mu N$

friction is impulsive only When → it's Normal is impulsive
→ tendancy of Relative motion
or relative motion along Surface

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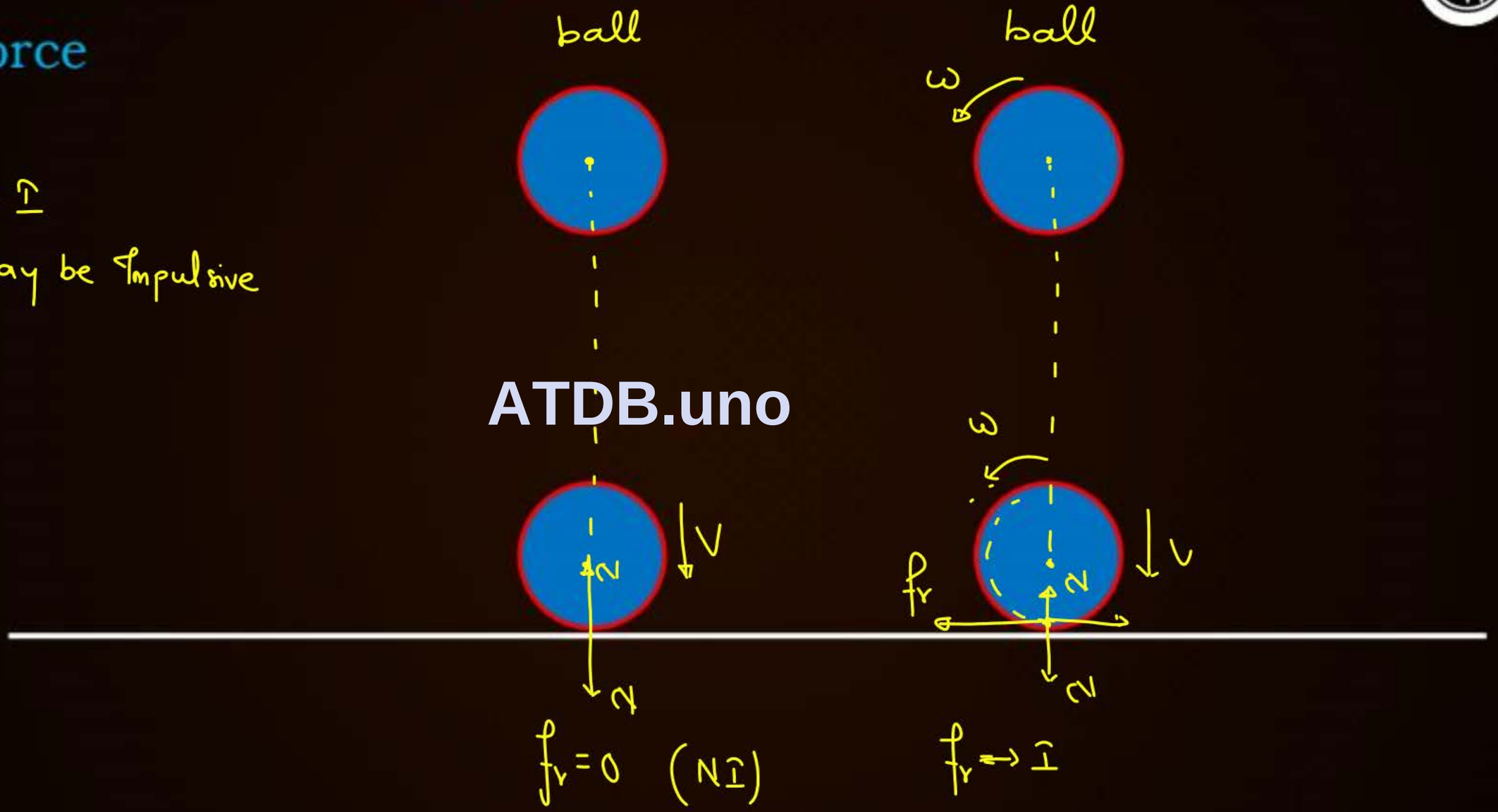
Impulsive force

friction Force

$\Delta V \rightarrow \hat{I}$

$f_r \rightarrow$ may be Impulsive



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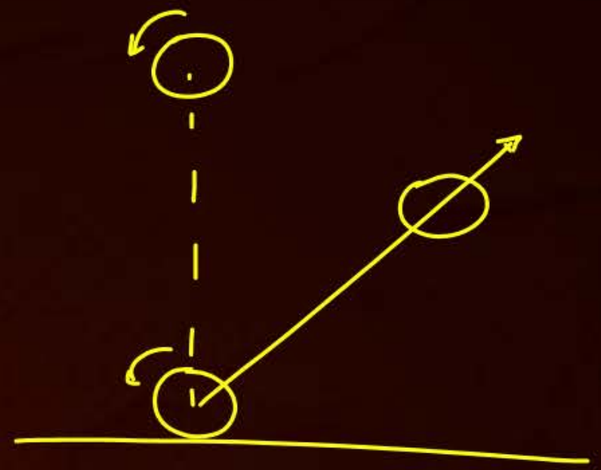

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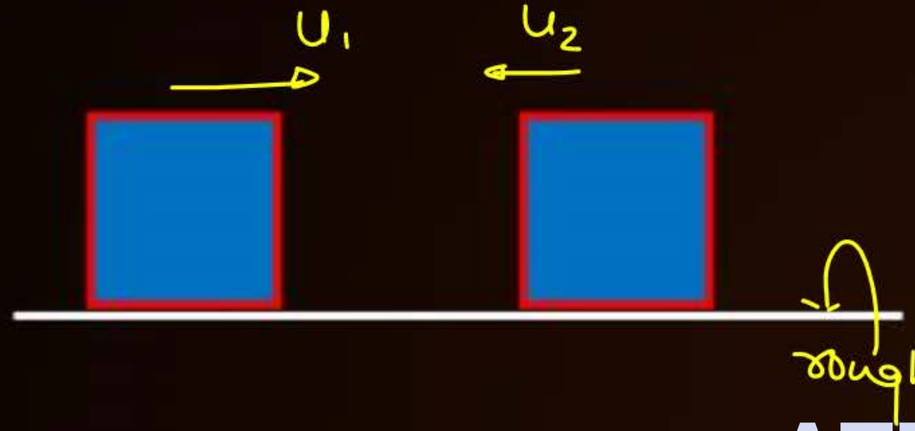
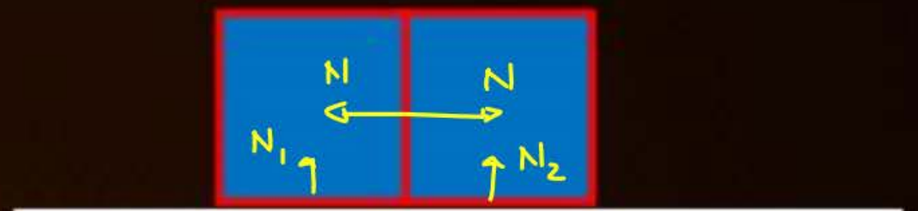
Impulsive force

friction Force





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$N \rightarrow I$

$N_1, N_2 \rightarrow NI$

$f_1, f_2 \rightarrow NI$

In presence of friction, we Conserve momentum in Collision

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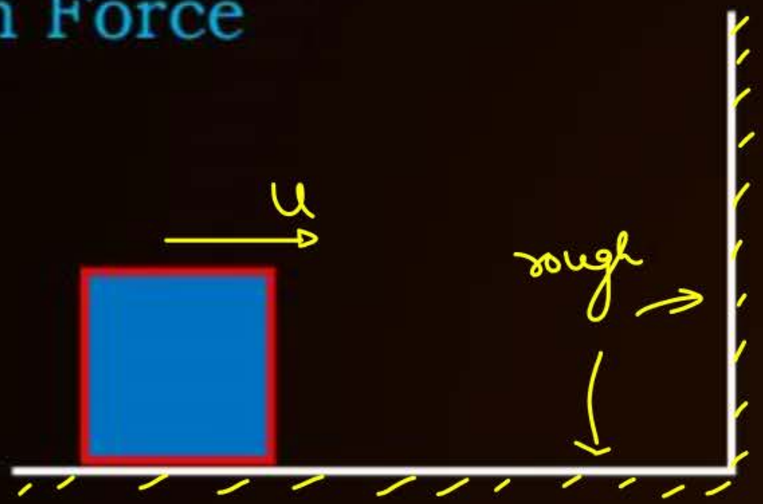
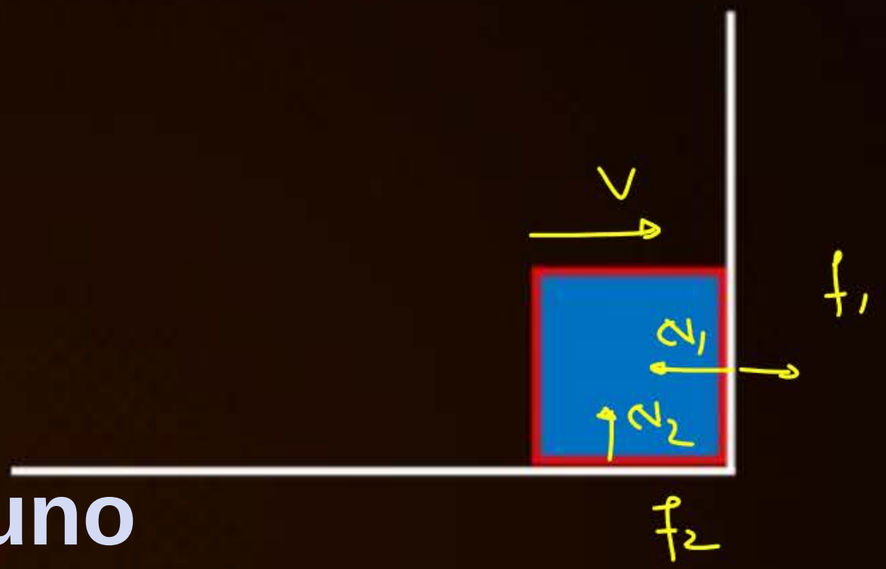
Impulsive force

friction Force





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$N_1 \rightarrow I$

$N_2 \rightarrow NI$

$f_1 \rightarrow N_1$ (no relative motion)

$f_2 \rightarrow N_2$ (relative motion)

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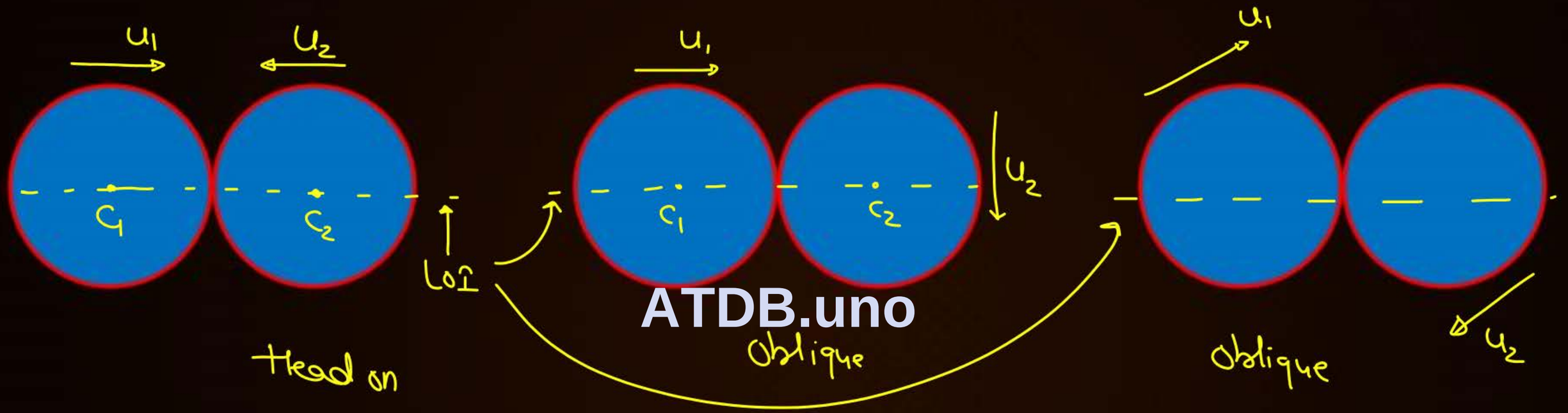
Line of Impact (LOI)

line of impact ≡ line of Common Normal of Colliding objects



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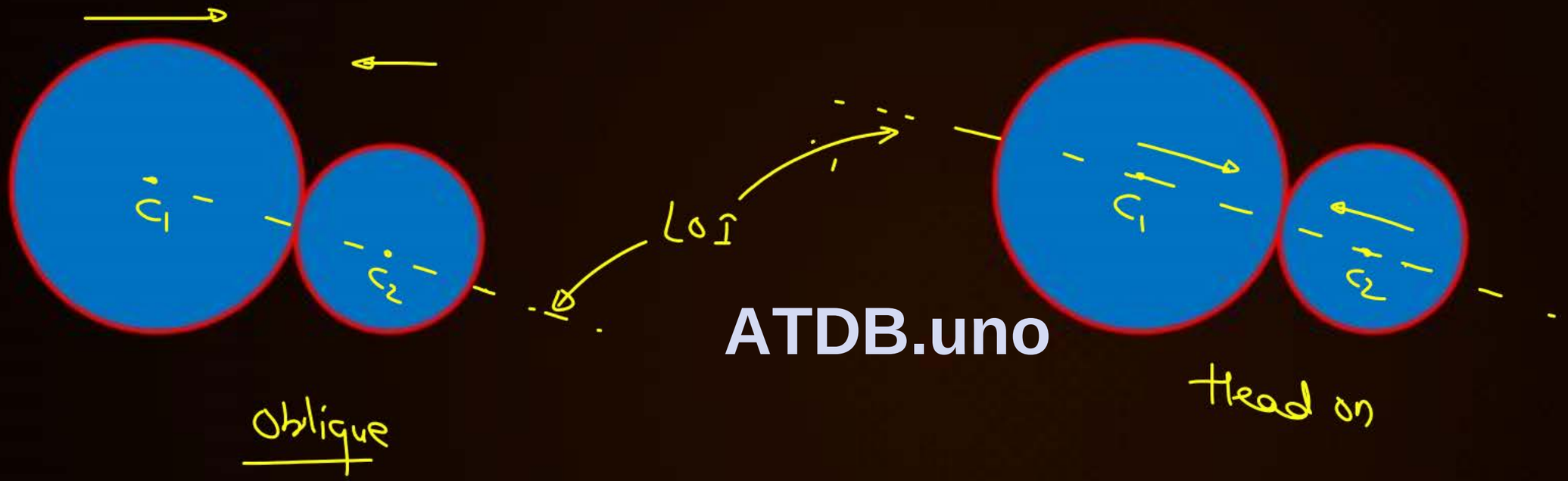
Line of Impact (LOI)



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Oblique

Head on

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Line of Impact (LOI)

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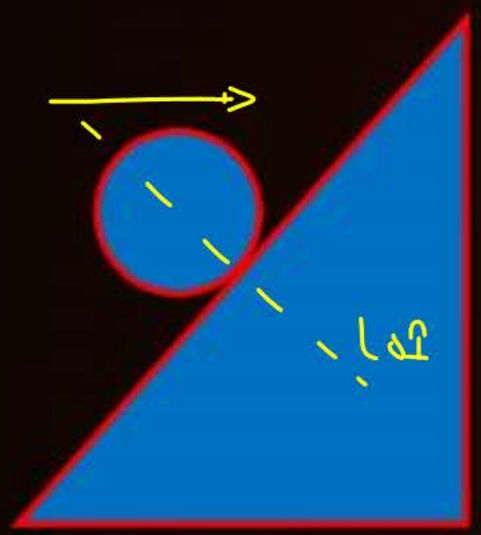

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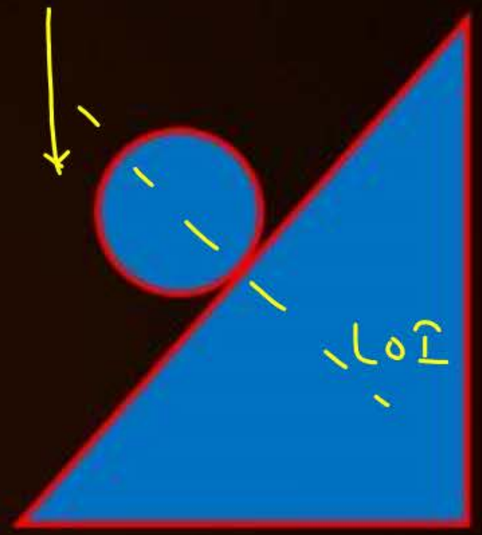

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Head On and Oblique Collision

Head on → if motion of Colliding objects are along LOI

Oblique → if motion of Colliding objects are not along LOI

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Coefficient of restitution (e)

e → (experimental or practical data)

$$e = \frac{\text{Velocity of Seperation of Collision points along LOI}}{\text{Velocity of approch of Collision points along LOI}}$$

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

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$V_{app.}$ → magnitude of relative velocity of colliding objects along LOI before Collision

$V_{sep.}$ → magnitude of relative velocity of colliding objects along LOI after Collision

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before

$V_{app.} = u_1 + u_2$

$V_{app.} = u_1 - u_2$

$V_{app.} = u_2 - u_1$

(पास आने की कोशिश = +ive)

after

$V_{sep.} = V_1 + V_2$

$V_{sep.} = V_2 - V_1$

$V_{sep.} = V_1 - V_2$

(दूर जाने की कोशिश = +ive)

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