Lecture 7

Last time uniform circular motion

\[ T = \frac{2\pi r}{v} = \frac{\text{Circumference}}{\text{Velocity}} \]

\[ T = \frac{2\pi}{\omega}, \quad \omega = \text{Angular Velocity} \]

\[ v = \omega r \]

\[ a_o = \omega^2 r \quad \text{POINT IN IN RADIAL DIRECTION} \]

\[ a_o = -\omega^2 r \quad \text{rad} \]

Aside:

1 radian = 57.29°

2\pi rad = 360°

Radian: Dimensionless

\[ \text{KAD} = \frac{\text{ARC (m)}}{\text{RADIUS (m)}} \]
VIDEO
MIT.
PERCEIVED GRAVITY DEMO.

FEELS LIKE THERE'S OUTWARD ROUGH FORCE.
\[
\begin{align*}
\mathbf{\ddot{V}}_{PA} &= \mathbf{\ddot{V}}_{PA} + \mathbf{\ddot{V}}_{BA} \\
\alpha_{PA} &= \alpha_{PB} + \alpha_{BA} \\
\mathbf{\ddot{V}}_{PR} &= \mathbf{\ddot{V}}_{PM} + \mathbf{\ddot{V}}_{MR} \\
\alpha_{PR} &= \alpha_{PM} + \alpha_{MR}
\end{align*}
\]

At \( t = 0 \), person lets go of the ball, also cable breaks. What happens to the ball?

\[
\begin{align*}
\mathbf{\ddot{a}}_{BR} &= -g \mathbf{\hat{n}} = \text{acceleration w.r.t. rest} \\
\mathbf{\ddot{a}}_{ER} &= -g \mathbf{\hat{n}} = \text{acceleration of electron w.r.t. rest}
\end{align*}
\]
\[ \vec{a}_{KB} = \vec{a}_{BE} + \vec{a}_{EK} \]
\[ -g \hat{k} = -g \hat{k} + \vec{a}_{BE} \]
\[ \vec{a}_{BE} = 0 \hat{k} \]
\[ \uparrow \vec{a}_{EK} = \uparrow \hat{k} \]

**Note:**

\[ \vec{a}_{KB} = \vec{a}_{BE} + \vec{a}_{EK} \]
\[ \vec{a}_{KB} = -2g \hat{k} \]
MAKE AIRPLANE GO FAST ENOUGH THAT

\[ \frac{1}{2} \frac{V_p^2}{r} = g \]

Ball drops at top

\[ \vec{a}_{BR} = -g \hat{k} = \vec{a}_{BP} + \vec{a}_{PR} \]

\[ -g \hat{k} = \vec{a}_{BP} - g \hat{k} \]

\[ \vec{a}_{BP} = 0 \]
NEWTON'S FIRST LAW

IF AN OBJECT DOES NOT INTERACT WITH OTHER OBJECTS, IT IS POSSIBLE TO DEFINE IDENTIFY A REFERENCE FRAME IN WHICH THE OBJECT HAS ZERO ACCELERATION.

INERTIAL FRAME: NO ACCELERATION

A BODY ACTED ON BY NO NET FORCE MOVES WITH CONSTANT VELOCITY.
Newton's Second Law

\[ F = ma \]

- \( F \): Force
- \( m \): Mass
- \( a \): Acceleration

\[ ma = \sum_{i=1}^{n} F_i \]

\[ = F_1 + F_2 + F_3 \]

\( \sum F = \text{Net Force} \)

\[ \sum F = ma \]

\[ F_g = \sum F = ma \]
Newton's Third Law

If body B exerts $\vec{F}_a$ on body A, then there is a force $\vec{F}_b$ acting on body B due to body A such that

$$\vec{F}_a = -\vec{F}_b$$