Class Notes - Lecture 18 (Biswas) 22 October 2009

Rocket Propulsion

M

pi

Only questions like the clicker questions from Lecture 17

We won't derive extra equations

DEMO: Milk jug rocket

Flammable gas burnt up, creates movement towards jug's neck

$V_j = -\underbrace{(m_f/M_j)}_{<<1}\underbrace{v_f}_{\text{very large} \rightarrow \text{explosion}}$

Movement due to conservation of momentum

Glancing Collisions

$\vec{p}_i = \vec{p}_f \begin{cases} p_{ix} = p_{fx} \longrightarrow m_1 v_{1ix} + m_2 v_{2ix} = m_1 v_{1fx} + m_2 v_{2fx} \\ p_{iy} = p_{fy} \longrightarrow m_1 v_{1iy} + m_2 v_{2iy} = m_1 v_{1fy} + m_2 v_{2fy} \end{cases}$

Explained:

$p_{ix} = p_{fx} : \underbrace{m_1 v_{1i}}_{\text{x direction}} + \overbrace{0}^{\text{standstill}} = \underbrace{m_1 v_{1f} \cos\theta + m_2 v_{2f} \cos\phi}_{\text{after collision}}$

$p_{iy} = p_{fy} : 0 + 0 = m_1 v_{1f} \sin\theta + \underbrace{(-m_2 v_{2f} \sin\phi)}_{\text{negative y direction}}$

KE Conserved in Elastic Glancing Collisions

Scalar values

1 equation

~~$v_{1i} + v_{1f}$~~ $= v_{2i} + v_{2f}$ not true

Chapter 7: Rotation Motion

Stationary axis

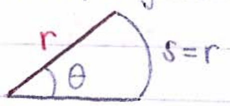
Example: 2001 A Space Odyssey, bicycles behave differently when wheels are in motion, centrifuge separate by centripital force, MRI machine

DEMO:

Bike wheel spinning ~ NMR

Radian

Unit of angular measure

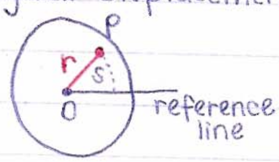


$\theta = s/r$

θ = 1 radian = ~~53.1°~~ 57.3°

2π radians = 360°

Angular Displacement



During time t, the ref. line moves through some angle θ

Average angular speed, $\omega = \Delta\theta/\Delta t$

wheel will eventually slow down

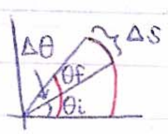
Avg. angular acc, $\alpha = \Delta\omega/\Delta t$

Note:

$$\omega = \lim_{\Delta t \to 0} \Delta\theta/\Delta t$$

$\theta = s/r$

$\Delta\theta = \Delta s/r$



$$\omega = \lim_{\Delta t \to 0} \frac{1}{r} \cdot \underbrace{\frac{\Delta s}{\Delta t}}_{l/t \,\approx\, \text{velocity}}$$

$$\omega = \underbrace{V_t}_{\text{tangental velocity}}/r$$

If ω increases: V_t increases

$\Delta\omega = \Delta V_t/r$

↓

$$\alpha = \lim_{\Delta t \to 0} \Delta\omega/\Delta t$$

$$\alpha = \lim_{\Delta t \to 0} \frac{1}{r} \Delta V_t/\Delta t$$

$$\alpha = a_t/r$$