

TAM 212 – Dynamics

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Momentum of a Rigid Body

Linear Momentum: $\vec{P} = m\vec{v}_C$

Newton's Equations:

Angular Momentum: $L_{Cz} = I_{Cz}\omega_z$

Newton's Equations:

Principle of Impulse-Momentum

Initial Momentum	+	Impulse	=	Final Momentum
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Linear Momentum: $\vec{P}_{Ci} + \int F dt = \vec{P}_{Cf}$

Angular Momentum: $\vec{L}_{Oi} + \int \vec{M}_O dt = \vec{L}_{Of}$

Conservation laws:

- If $\Sigma F = 0$, then $\vec{P}_C$ is a constant: $\vec{P}_{C1} = \vec{P}_{C2}$
- If $\Sigma M_C = 0$, then $\vec{L}_C$ is a constant: $\vec{L}_{C1} = \vec{L}_{C2}$

Momentum of a system of bodies:

- Linear: $\vec{P}_C = \Sigma \vec{P}_{Ci}$; angular: $\vec{L}_C = \Sigma \vec{L}_{Ci}$

Example

A diver jumps off a diving board, does some fancy flips, then enter the water.

t_1 = just before the jump

t_2 = just after the jump

t_3 = just before the diver enters the water

Which is true for $t_1 \rightarrow t_2$?

- A. $\vec{P}_C$ and $\vec{L}_C$ are both conserved
- B. Only $\vec{P}_C$ is conserved
- C. Only $\vec{L}_C$ is conserved
- D. Neither $\vec{P}_C$ nor $\vec{L}_C$ is conserved

Which is true for $t_2 \rightarrow t_3$?

Example

Which body position does the diver rotate faster?

A.



B.



Example

What kind of yo-yo is better?

- A. Made of light plastic material
- B. Made of heavy metal material

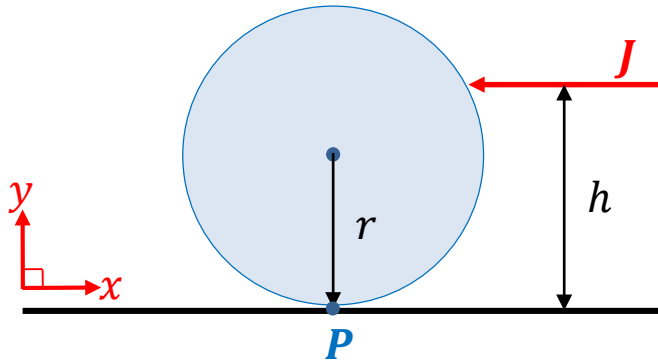
- A. Solid disks
- B. Hollow cylinders

- A. Fixed axel center
- B. Bearing center



Example

A billiard ball is a uniform sphere with radius r . Where should we hit the ball (introduce impulse $\mathbf{J}$) so that there is no friction at P ?



Example

A square block with mass $m_B = 1$ kg and initial velocity 3 m/s slides along a smooth surface and collides with the end of a slender rod with mass $m_R = 2$ kg and length $L = 0.2$ m. The rod is initially at rest. The coefficient of restitution between the box and the rod is $e = 0.7$. Find the velocity of the block after the collision.

