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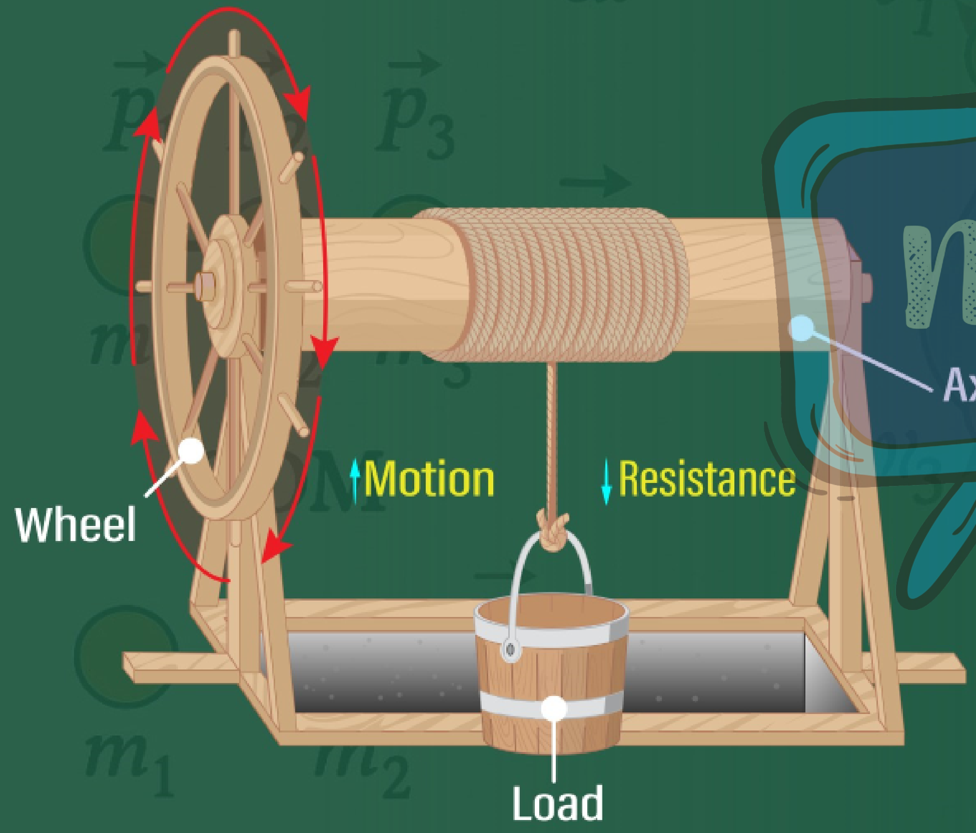
Wheel and Axle



CLASS – 11

PHYSICS

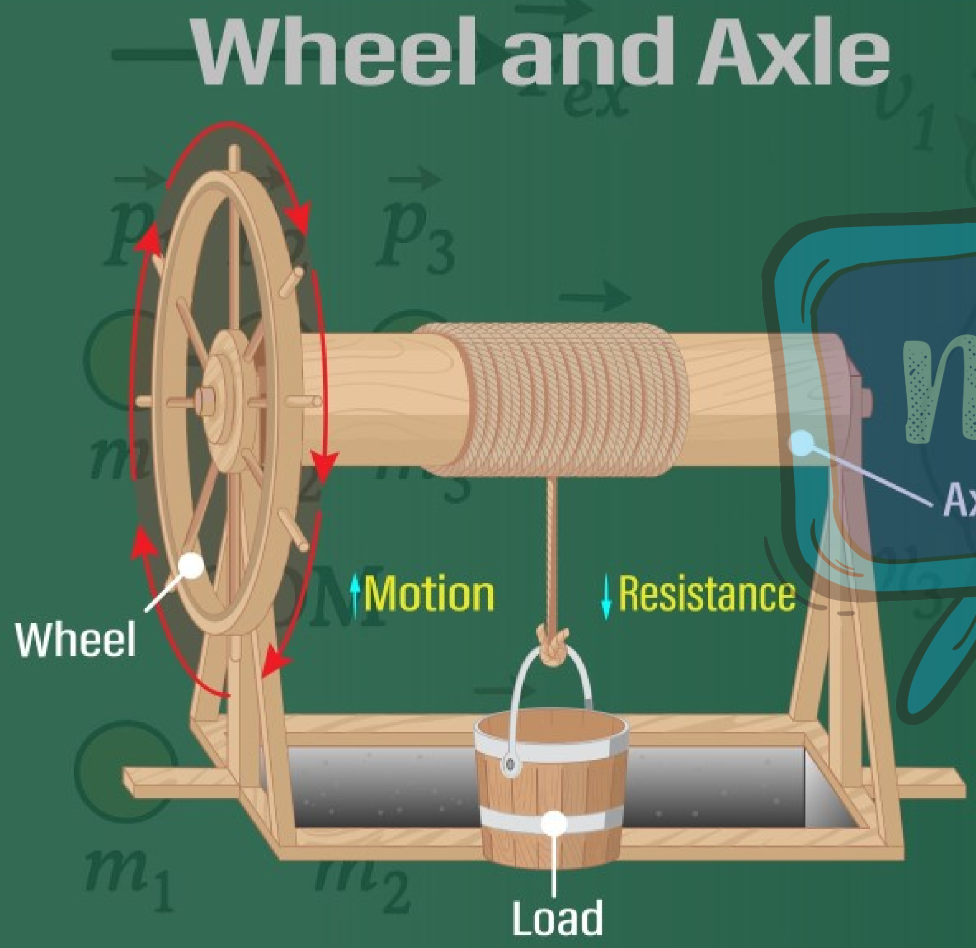
Chapter – 6

Systems of Particles and Rotational Motion

Part – 5
Law of Conservation of Angular Momentum

Alok Gaur

OVERVIEW



1. Centre of Mass
2. Motion of Centre of Mass and Vector Product
3. Torque and Angular momentum
4. Moment of Inertia
5. Law of conservation of angular momentum

Law of Conservation of Angular Momentum

- The rate of change of angular momentum of a particle is equal to the applied torque on it.

$$\vec{\tau} = \frac{d\vec{L}}{dt}$$

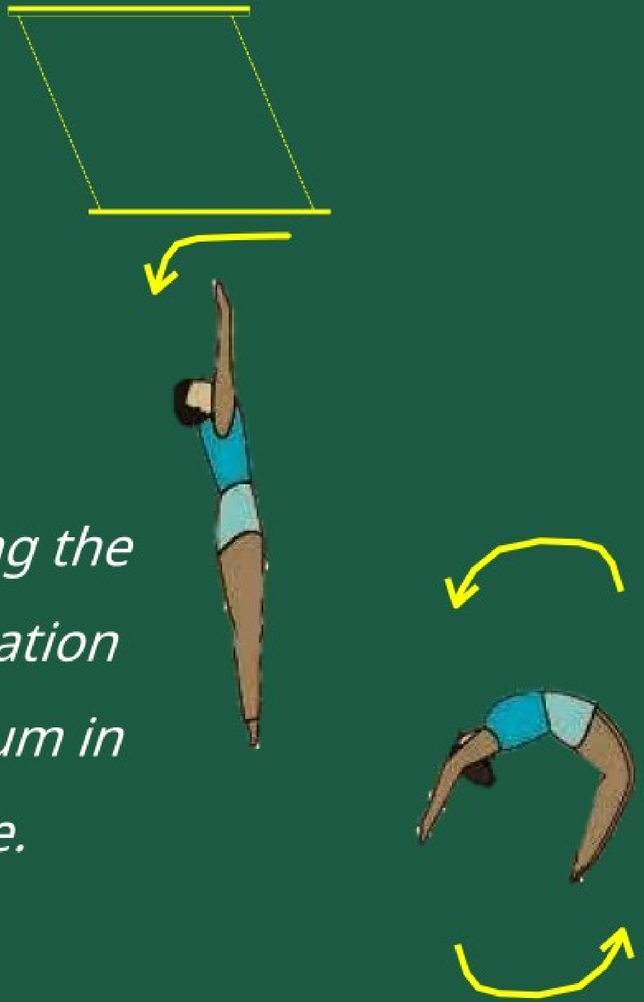
If $\vec{\tau} = 0$ $\quad \frac{d\vec{L}}{dt} = 0$

$\vec{L} = \text{constant}$ $\quad L = I\,\omega$

$$I\,\omega = \text{constant}$$

A demonstration of conservation of angular momentum. A girl sits on a swivel chair and stretches her arms/brings her arms closer to the body.

An acrobat employing the principle of conservation of angular momentum in her performance.



Radius of Gyration

- The radius of gyration of a body is that perpendicular distance measured from the rotational axis where on assuming whole mass of the body centralised, the same moment of gnertia about that axis is obtained which is obtained by real mass distribution.

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missiongyan LET'S LEARN TOGETHER

$$I = mk^2$$

$$K = \sqrt{\frac{I}{m}}$$

Dependance of Radius of Gyration

(i) On the position of rotational axis.

(ii) On the mass distribution of the body.

- Radius of gyration does not depend on the mass of the body.

Work and Power in Rotational Motion

$\omega = F \times \text{distance AB}$

$AB = r\,\theta$

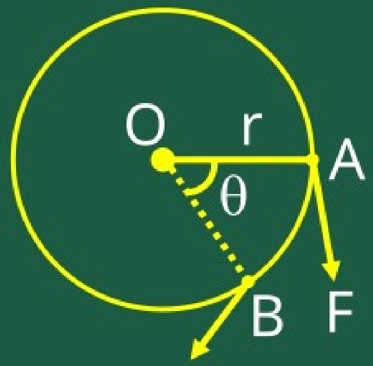
$\omega = F \times r\,\theta$

$\omega = (Fr)\,\theta$

$\omega = t\,\theta$

$$\frac{\omega}{t} = \tau \frac{\theta}{t}$$

$P = \tau\,\omega$



Equations for Rotational Motion

Angular Acceleration :

$$\alpha = \frac{\omega - \omega_0}{t}$$

$$\omega - \omega_0 = \alpha\, t$$

$$\omega = \omega_0 + \alpha\, t$$

$$\theta = \left(\frac{\omega + \omega_0}{2}\right) t$$

$$\theta = \frac{(\omega_0 + \alpha t + \omega_0)}{2} t$$

$$\theta = \frac{(2\omega_0 + \alpha t)}{2} t$$

$$\theta = \omega_0 t + \frac{1}{2}\alpha t^2$$

$$\omega = (\omega_0 = \alpha\, t)$$

$$\omega^2 = (\omega_0 + \alpha\, t)^2$$

$$\omega^2 = \omega_0^2 + 2\,\omega\,.\,\alpha\, t + \alpha^2\, t^2$$

$$\omega^2 = \omega_0^2 + 2\,\alpha\,(\omega_0\, t + ½\,\alpha\, t^2)$$

$$\omega^2 = \omega_0^2 + 2\,\alpha\,\theta$$

Comparison of Translational and Rotational Motion

	Linear Motion	Rotational Motion about a Fixed Axis
1	Displacement x	Angular displacement θ
2	Velocity $v = dx/dt$	Angular velocity $\omega = d\theta/dt$
3	Acceleration $a = dv/dt$	Angular acceleration $\alpha = d\omega/dt$
4	Mass M	Moment of inertia I
5	Force $F = Ma$	Torque $\tau = I\alpha$
6	Work $dW = F\,ds$	Work $W = \tau\, d\theta$
7	Kinetic energy $K = Mv^2/2$	Kinetic energy $K = I\omega^2/2$
8	Power $P = F\,v$	Power $P = \tau\omega$
9	Linear momentum $p = Mv$	Angular momentum $L = I\omega$

LEARNING OUTCOME

1. To study for Law of conservation of angular momentum
2. To study for radius of Gyration

ASSESSMENT

1 A dancer is spining on a rotating table with his arms extended, if he folds his arms then the angular velocity will

A Increase

B Decrease

C Remain unchanged

D Can't say

ASSESSMENT

2 A solid dise has a mass of 10 kg and sadius 1 m., find its radius of gyration.

- A 1.414 m
- B 0.707 m
- C 1 m
- D 1.732 m