Chapter Title: Rotation

Sections: Rotational Variables, Rotation with Constant Angular Acceleration, Relating the Linear and Angular Variables

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Motion: Two types of motion: Translation and Rotation

Translation Motion:

An object moves along a straight or curved line

Rotational Motion:

An object turns about an axis

Rotational Variables

Rigid body:

It is a body that can rotate with all its parts locked together and without any change in its shape.

Fixed axis:

A rotation occurs about an axis that does not move, is called a fixed axis.

Examples: Sun – is not a rigid body. Bowling ball – is not an example of fixed axis as it has translation and rotation

Rotation axis:

A rigid body in rotation about a fixed axis, called the axis of rotation or the rotation axis.

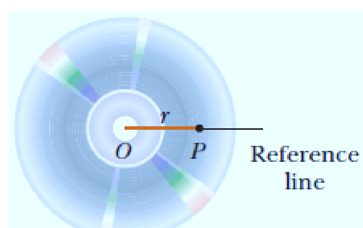
Angular position:

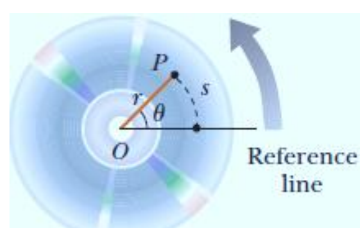
In rotational motion, it is the position relative to a reference line or fixed axis during a rotation. It is presented by θ.

$$s = \theta r$$

$$\theta = \frac{s}{r}$$

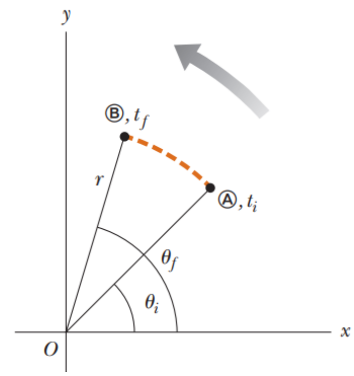
Here, θ is the ratio of an arc length (s) and the radius (r) of the circle, it is a pure number.





Angular displacement: For a rigid object,

$$\Delta\theta = \theta_f - \theta_i$$



Also, one can write, $\Delta\theta = \theta_2 - \theta_1$. An angular displacement in the counterclockwise direction is positive, and one in the clockwise direction is negative.

Angular velocity: Average angular velocity, $\omega_{avg} = \frac{\theta_2 - \theta_1}{t_2 - t_1} = \frac{\Delta\theta}{\Delta t}$

Angular acceleration: Average angular acceleration, $\alpha_{avg} = \frac{\omega_2 - \omega_1}{t_2 - t_1} = \frac{\Delta\omega}{\Delta t}$

Equation of Rotational Motion: **Rotation with Constant Angular Acceleration:**

Table 10-1 **Equations of Motion for Constant Linear Acceleration and for Constant Angular Acceleration**

Equation Number	Linear Equation	Missing Variable		Angular Equation	Equation Number
(2-11)	$v = v_0 + at$	$x - x_0$	$\theta - \theta_0$	$\omega = \omega_0 + \alpha t$	(10-12)
(2-15)	$x - x_0 = v_0 t + \frac{1}{2}at^2$	v	ω	$\theta - \theta_0 = \omega_0 t + \frac{1}{2}\alpha t^2$	(10-13)
(2-16)	$v^2 = v_0^2 + 2a(x - x_0)$	t	t	$\omega^2 = \omega_0^2 + 2\alpha(\theta - \theta_0)$	(10-14)
(2-17)	$x - x_0 = \frac{1}{2}(v_0 + v)t$	a	α	$\theta - \theta_0 = \frac{1}{2}(\omega_0 + \omega)t$	(10-15)
(2-18)	$x - x_0 = vt - \frac{1}{2}at^2$	v_0	ω_0	$\theta - \theta_0 = \omega t - \frac{1}{2}\alpha t^2$	(10-16)