Circular Motion

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1 Angular Displacement

Angular Displacement is the measure of angle through which an object moves in a circle. It can be represented with (θ). Its units are radians. The formula is

$$\theta = \frac{s}{r} \tag{1}$$

S is the arc length and r is the radius.

2 Angular Speed

Angular Speed is the rate at which angular displacement changes. Its units are radians per second. It is represented with (ω)

$$\omega = \frac{\Delta\theta}{\Delta t} \tag{2}$$

For a complete revolution θ will always be equal to 2π. Hence we get:

$$\omega = \frac{2\pi}{\Delta t} \tag{3}$$

3 Linear Speed

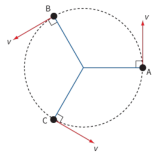
$$v = \frac{\Delta s}{\Delta t} \tag{4}$$

The SI units are meters per second, where S is the displacement in meters, and t is the time in seconds. or

$$v = \omega * r \tag{5}$$

4 Velocity changes during Circular Motion

During circular motion, the magnitude of the velocity remains constant, however the direction changes, hence the velocity changes. The direction of velocity is changing at A, B and C.



5 Implications of velocity change

If the velocity is changing, even if the magnitude is the same, that means that the body is accelerating. An accelerating body has a force. And the force, referred to as Centripetal Force is acting towards the centre of the circle.

5.1 Acceleration of a body within circular motion

Traditionally, acceleration (a) =

$$\frac{\Delta v}{\Delta t} \tag{6}$$

and angular speed (ω) is

$$\frac{\Delta \theta}{\Delta t} \tag{7}$$

Hence acceleration can be written as

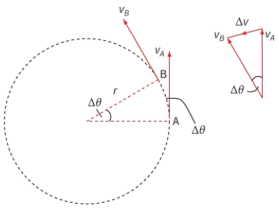
$$a = v * \omega \tag{8}$$

or

$$a = \frac{v^2}{r} \tag{9}$$

or

$$a = r * \omega^2 \tag{10}$$



The acceleration towards the centre of the circle when the object is rotating in a circle is referred to as centripetal acceleration.

5.2 Force acting on a body undergoing Circular Motion

Traditionally

$$f = ma \tag{11}$$

Hence, force towards the centre can be written as

$$f = m * \omega^2 * r \tag{12}$$

or

$$m * \frac{v^2}{r} \tag{13}$$