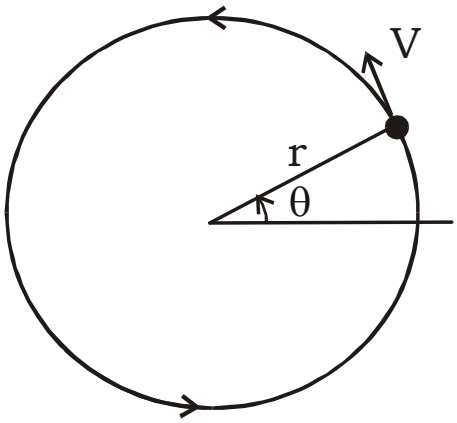
Angular Velocity

Angular velocity

Imagine an object moving in a circle with constant speed v and radius r. As it moves it sweeps out an angle subtended at the centre.



The angle swept out per unit time is called the angular speed or velocity. The angular velocity is the rate of change of the angle. It is denoted, usually, by ω and its units are radians per second.

Example

What is the angular velocity of a disc rotating at 144 revolutions per second?

Solution

Let n = 144 revolutions per second

Then the angular velocity is

$\omega = 2\pi n = 2\pi \times 144 = 905 \text{rads}^{-1} \left(3.S.F.\right)$

Relationship between velocity and angular velocity

The relationship between velocity and angular velocity is given by:

$v = r\omega$

Example

A car is travelling on a horizontal circular track with constant speed $v\ ms^{-1}$. The track has radius $225m$. The acceleration of the car is $0.02 rads^{-1}$. Find v.

$v = r\omega = 225 \times 0.02 = 4.5 \text{ms}^{-1}$

To prove this relationship we need tools from the differential calculus. You may omit the proof if you are not familiar with the differential calculus.

We recall that arc length s is given by

$S = r\theta$

$\therefore \frac{ds}{dt} = r \times \frac{d\theta}{dt}$

Here $\frac{d\theta}{dt} = \omega =$ instantaneous rate of change of angle

$\frac{ds}{dt} = v =$ velocity

ie. $v = r\omega$