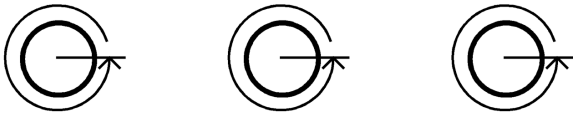
PhyzGuide: Rotational Kinematics

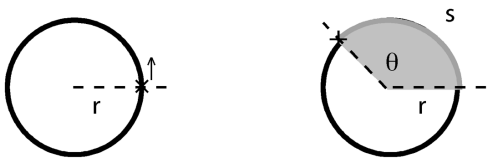
translational DISPLACEMENT rotational

Name Displacement
Symbol *x, y, z* (or *s*)
Units Meters are the SI units, feet, yards, light-years and many others are also used.

Name Angular displacement
Symbol θ
Units Radians are the SI "units," degrees and revolutions are also used:
1 rev = 2π rad = 360°



1 revolution 2π radians 360°

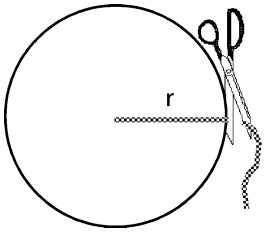


If a point (x) rotates through an angle θ along the arc of a circle of radius *r* as shown above, then the arclength (linear distance) *s* is:

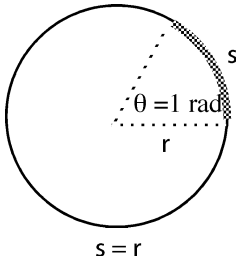
$$s = r\theta$$

ONLY if the angle θ is measured in radians.
This simple relation between angle and arclength makes the radian a convenient and "natural" unit of angular measure.

A RADIAN? What's a RADIAN?!



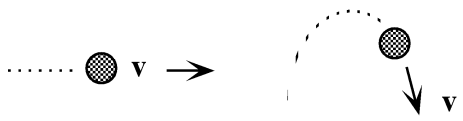
If you stretched a string from the center of a circle to the edge and cut it as shown, you'd have a length of string equal to the circle's radius.



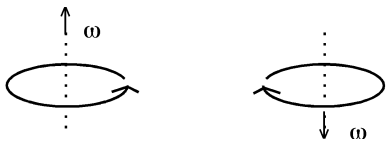
Now wrap that length of string around the circle as far as it will go. The arclength covered is equal to the radius, and the angle covered is 1 radian.

translational VELOCITY rotational

Name Velocity
Symbol v
Units $v = \Delta x / \Delta t$
(vector: $\mathbf{v} = \Delta \mathbf{x} / \Delta t$)
Velocity is the rate of change of position. The direction of the vector v is the direction of motion.



Name Angular velocity
Symbol ω
Units $\omega = \Delta\theta / \Delta t$
(vector: $\omega = \Delta\ \theta\ /\ \Delta\ t$)
Angular velocity is the rate of change of angular position. The direction of the vector ω is the axis of rotation (via a right-hand rule).



translational ACCELERATION rotational

Name Acceleration
Symbol a
Units $a = \Delta v / \Delta t$
(vector: $\mathbf{a} = \Delta \mathbf{v} / \Delta t$)
Acceleration is the rate of change of velocity. Acceleration occurs when speed or direction of motion changes.

Name Angular acceleration
Symbol α
Units $\alpha = \Delta\omega / \Delta t$
(vector: $\alpha = \Delta\ \omega\ /\ \Delta\ t$)
Angular acceleration is the rate of change of angular velocity. Angular acceleration occurs when angular speed or plane of rotation changes.