

Uniform Circular Motion

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Uniform circular motion is the motion of an object in a circle traveling at a constant speed. Therefore, when an object travels around in a circle, the magnitude of the tangential velocity vector is constant (tangential speed) while the direction changes. The figure below shows the uniform circular motion.

Image

The period of motion can be used to describe uniform circular motion. It is the time the object takes to go around the circle once. Speed is distance over time. Similarly, the relationship between period (T), tangential speed (v), and circumference can be described with the following formula:

$$v_T = \frac{2\pi r}{T}$$

In rotational kinematics, the tangential velocity is defined as the product of the radius and angular velocity:

$$v_T = r\omega$$

Because the direction of the tangential velocity vector changes as the object moves around in a circle, there is acceleration. This acceleration, called centripetal acceleration, points towards the center of the circle. The centripetal acceleration is tangential velocity squared over the radius (below). There is another formula for centripetal acceleration, expressed in terms of angular velocity. See centripetal acceleration for more information.

$$a_c = \frac{v_T^2}{r}$$

If acceleration is involved, then according to Newton's second law of motion, there is also a net force: the centripetal force. Like centripetal acceleration, centripetal force points towards the center of the circle. The centripetal force is the product of the mass of the object and the tangential velocity squared over the radius:

$$F_c = \frac{mv^2}{r}$$

When the magnitude of tangential velocity (tangential speed) changes while the object rotates about a fixed point, then the motion is described as nonuniform circular motion.

With the already discussed formulas, several derived formulas for uniform circular motion are sometimes useful in solving problems.

If the circular motion occurs vertically, then gravity is involved. See vertical uniform circular motion for more information.