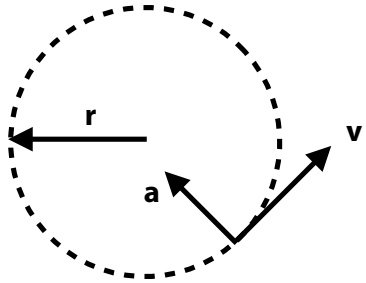
PhyzGuide: Uniform Circular Motion

Objects moving in a straight line (1D motion) and projectiles (which move in 2D) are said to be undergoing **linear** or **translational motion.** For our purposes, "linear" and "translational" mean the same thing. (There is another type of motion, **rotational motion,** that is very different from linear or translational. And yes, we will study rotational motion later on.)

Another example of translational motion is **uniform circular motion**: Odie Motion!

But how can we describe circular motion? The old familiar x's and y's would be extremely complicated to use for circular motion. We could use polar coordinates, but they are somewhat deceptive in describing the translational sense of circular motion. (We'll use polar notation for rotational motion.) To mathematically describe circular motion, we will use *r*, *v*, *a* and *T*, where

FELIX'S ETYMOLOGY LESSON
The word "linear" indicates motion along a LINE of some sort: straight or curved. The word "linear" comes from the Latin *linearis* whose root is *linea* meaning line; line comes from the Latin *linum* meaning thread. The word "translational" comes from "translate" which comes from the Middle English *translaten,* which in turn comes from the Latin words *transferre* and *translat.* "Trans" means across, and "ferre" (like "ferry") means to carry.



r is the radius of curvature or the radius of the circle
v is the tangential velocity (v is the tangential speed)
a is the centripetal acceleration
T is the period, the time for a complete cycle.

In the confines of circular motion, when radius is constant, velocity and period are closely related. Consider the distance traveled by an object in circular motion. The distance around the circle is the circumference of the circle.

$d = 2\pi r$

Well then, if there is no tangential acceleration (no speeding up or slowing down in the direction of travel), we have **uniform motion**. What is the equation that applies to that type of motion?

If distance is *d* and time is *T*, then tangential velocity in circular motion follows the equation

$v = d/T = 2\pi r/T$

FREQUENCY

Sometimes circular motion is described in terms of frequency (*f* or ν). Whereas period refers to how much time it takes for something to happen, frequency refers to how many times per second something happens. Frequency is the *inverse* of period. $f = 1/T$. If Odie is swung around two times each second then his period is $T = 1\text{s}/2 \text{ rev} = 0.5 \text{ s}$. The frequency is $f = 1/T = 1 / 0.5 \text{ s} = 2 \text{ s}^{-1}$. Wait a minute. What is a s^{-1}? A typo? A brownie point? NO! A s^{-1} (i. e., 1/s) is a unit of frequency. Another name for s^{-1} is *hertz* (Hz). So Odie's frequency is 2 Hz.

CENTRIPETAL ACCELERATION

While an object maintains circular motion, it is accelerating toward the center of the circle. It has been found that this centripetal acceleration follows the equation $a = v^2/r$.