STUDY GUIDE

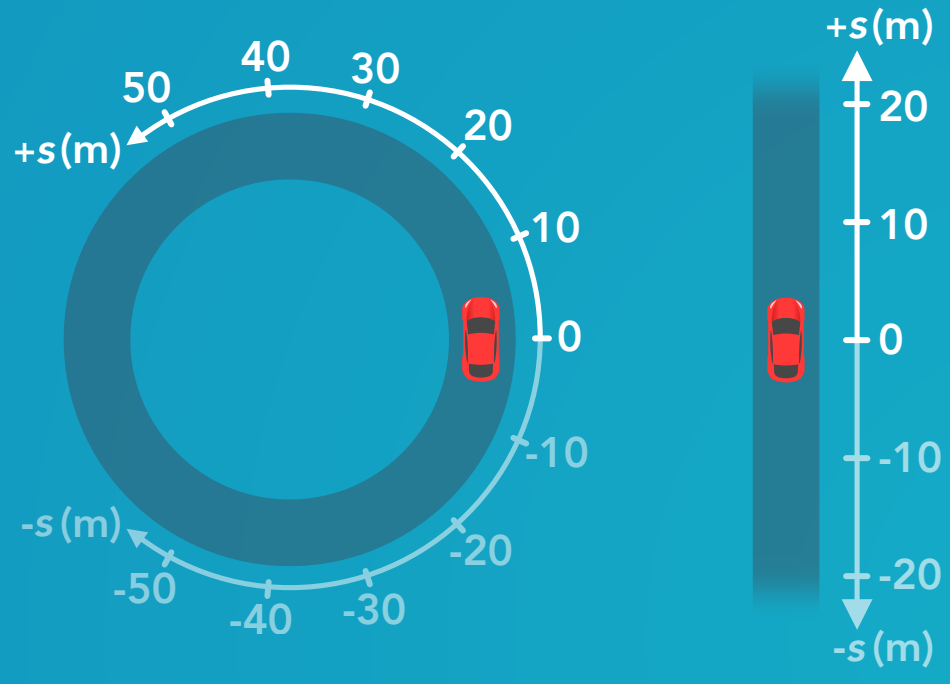
CIRCULAR MOTION

Circular Motion (Tangential Description)

- In **circular motion** an object or a point travels along a circular path (the object traces out the circumference of a circle as it moves).
- We typically use the **tangential description** of motion, sometimes referred to as the "linear motion" of the object, because the direction of the motion is along a line that is tangent to the circle. We can also think of the tangential description as straightening out the circular path into a straight line, and treating it as linear motion.

The tangential description of circular motion uses a circular axis, which is similar to a linear motion axis that is wrapped around a circle

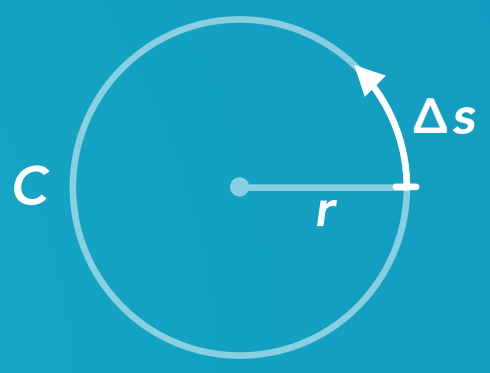
Variables		SI Unit
s	tangential position	m
Δs	tangential displacement	m
v_t	tangential velocity	$\frac{m}{s}$
a_t	tangential acceleration	$\frac{m}{s^2}$
r	radius	m
C	circumference	m



Tangential displacement in circular motion is also referred to as arc length, and the tangnetial displacement for one full circle is the circumference

Circumference

$$C = 2\pi r$$



Tangential displacement

$$\Delta s = s_f - s_i$$

Tangential velocity

$$v_t = \frac{\Delta s}{\Delta t}$$

Tangential acceleration

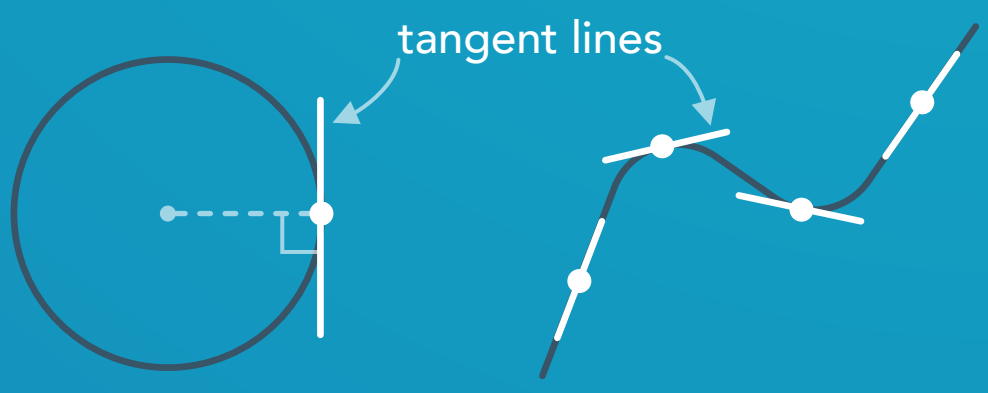
$$a_t = \frac{\Delta v_t}{\Delta t}$$

Kinematic equations with constant acceleration

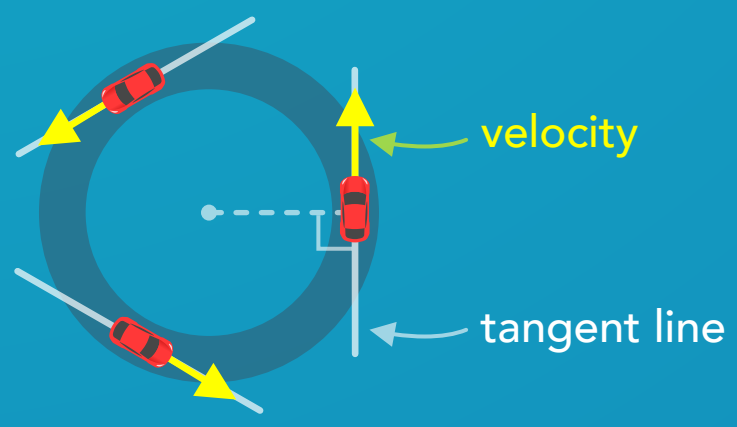
$$s_f = s_i + v_{ti}t + \frac{1}{2}a_t t^2$$

$$v_{tf}^2 = v_{ti}^2 + 2a_t(s_f - s_i)$$

At a point on a curve, the tangent line passing through that point matches the curvature or "slope" of the curve. For a point on a circle, the tangent line is perpendicular to a radius line drawn to that point.



For an object in circular motion, the direction of the velocity is always tangent to the circle.

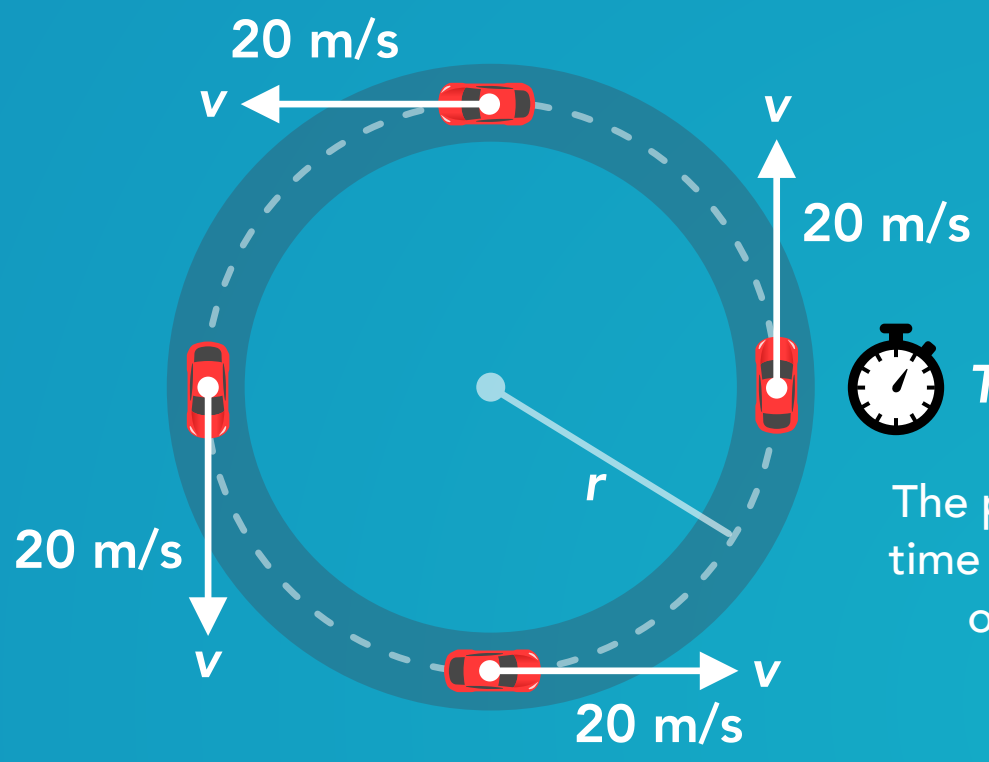


Uniform Circular Motion

Variables		SI Unit
T	period	s
f	frequency	$\text{Hz} = \frac{\text{circles}}{\text{s}}$
v	velocity	$\frac{\text{m}}{\text{s}}$

- **Uniform circular motion** is when an object travels in a circular path with a constant speed (the word "uniform" means constant).
- The direction of the velocity is always changing (it's always tangent to the circle) but the magnitude of the velocity (speed) stays the same.
- **Period** (*T*) is the amount of time it takes to complete one circle or revolution.
- **Frequency** (*f*) is the inverse of the period and it's the number of circles (or fraction of a circle) traveled per second. The unit of frequency is hertz (Hz) which is 1/s, or circles/s when referring to uniform circular motion.

The magnitude of the velocity (the speed) is constant but the direction of the velocity is always changing because it's always tangent to the circular path



The period is the time to complete one circle

Frequency is the inverse of the period, and period is the inverse of the frequency

Frequency

$$f = \frac{1}{T} \qquad T = \frac{1}{f}$$

The object travels one circumference in one period, so the velocity is related to the period and the frequency

Velocity

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

Velocity

$$v = 2\pi r f$$