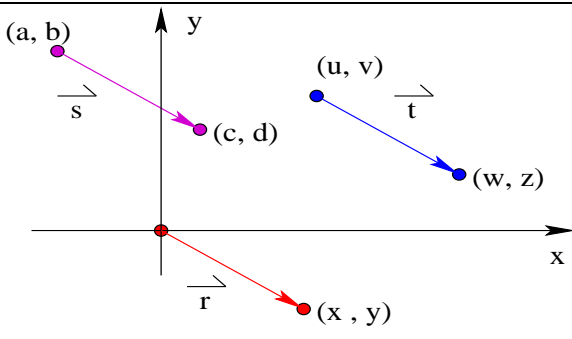
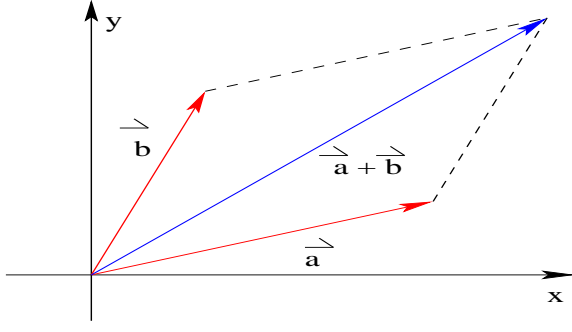
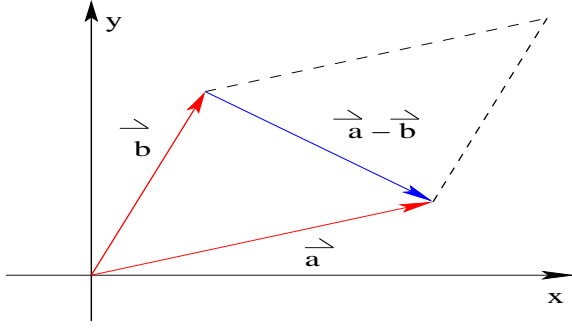
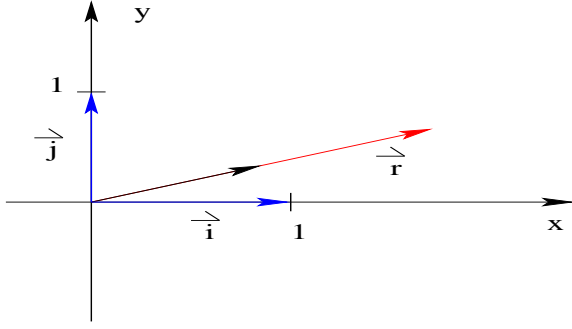
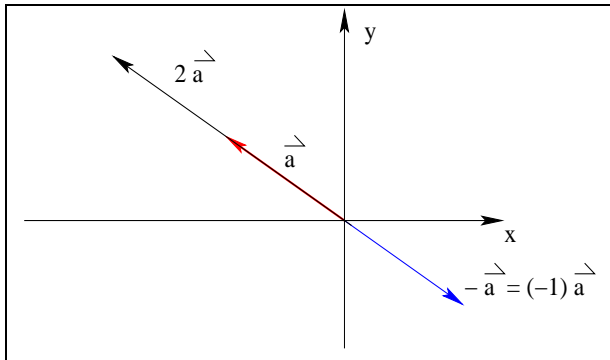
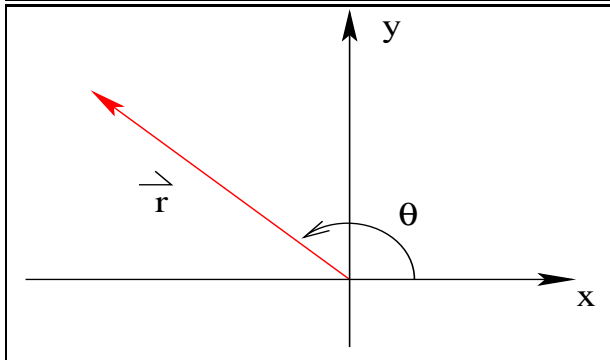


Vectors

	<p>Vector $\vec{r} = \langle x, y \rangle$ is a position vector with initial point the origin and tip at the point (x, y).</p> <p>Vectors \vec{s} and \vec{t} are equivalent if they have the same magnitude and direction,</p> <p>namely if $x = c - a = w - u$ and if $y = d - b = z - v$.</p>
	<p>The sum of two vectors \vec{a} and \vec{b} geometrically is the diagonal of parallelogram formed by \vec{a} and \vec{b} with initial point the vertex of \vec{a} and \vec{b}. It is calculated</p> $\vec{a} + \vec{b} = \langle a_1 + b_1, a_2 + b_2 \rangle$
	<p>The difference of two vectors \vec{a} and \vec{b} geometrically is the diagonal of the parallelogram formed by vectors \vec{a} and \vec{b} with initial point the tip of \vec{b} and extending to the tip of \vec{a}. It is calculated</p> $\vec{a} - \vec{b} = \langle a_1 - b_1, a_2 - b_2 \rangle$
	<p>The vector $\vec{r} = \langle x, y \rangle$ can be written in terms of the standard basis vectors \vec{i} and \vec{j} by $\vec{r} = x \vec{i} + y \vec{j}$.</p> <p>A unit vector in the direction of \vec{r} is determined by</p> $\vec{u} = \frac{\vec{r}}{\ \vec{r}\ } = \frac{\langle x, y \rangle}{\sqrt{x^2 + y^2}}$



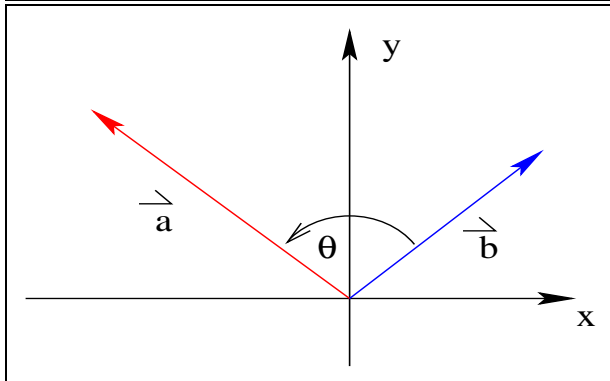
The product of a vector $\vec{a} = \langle a_1, a_2 \rangle$ and a scalar s is an s multiple of magnitude to the vector \vec{a} with the direction the same as \vec{a} if s is positive and opposite if s is negative.

$$s \vec{a} = s \langle a_1, a_2 \rangle = \langle s a_1, s a_2 \rangle$$


The length (or magnitude) of a vector $\vec{r} = \langle x, y \rangle$ can be calculated by :

$$\|\vec{r}\| = \sqrt{x^2 + y^2}$$

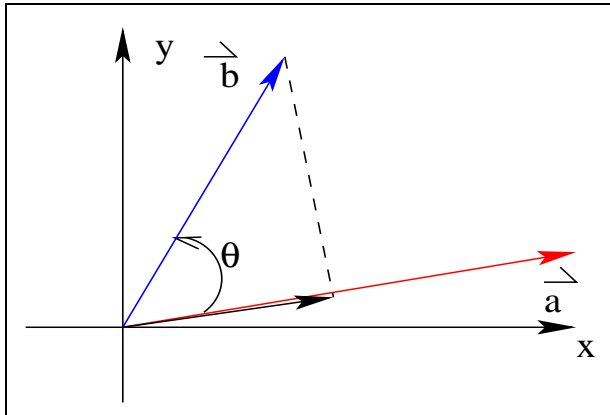
The direction of $\vec{r} = \langle x, y \rangle$ is the angle θ determined by a counterclockwise rotation from the x-axis to the vector \vec{r} .



The dot product of two vectors \vec{a} and \vec{b} is the scalar quantity :

$$\vec{a} \cdot \vec{b} = a_1 b_1 + a_2 b_2$$

The angle between the vectors \vec{a} and \vec{b} can be calculated by :

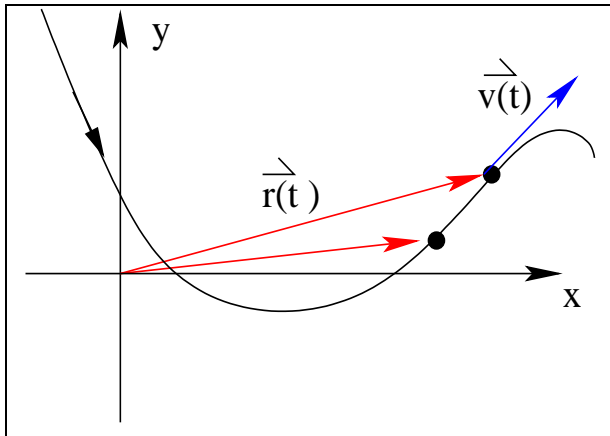
$$\cos \theta = \frac{\vec{a} \cdot \vec{b}}{\|\vec{a}\| \|\vec{b}\|}$$


The scalar component of vector \vec{b} onto vector \vec{a} is the scalar quantity :

$$\text{comp}_{\vec{a}} \vec{b} = \frac{\vec{a} \cdot \vec{b}}{\|\vec{a}\|} = \|\vec{b}\| \cos \theta .$$

The vector projection of vector \vec{b} onto vector \vec{a} is the vector quantity :

$$\text{proj}_{\vec{a}} \vec{b} = \frac{\vec{a} \cdot \vec{b}}{\|\vec{a}\|^2} \vec{a}$$



Given a two dimensional motion, $\vec{r}(t) = \langle x(t), y(t) \rangle$, the average velocity on the time interval $[t_1, t_2]$ is

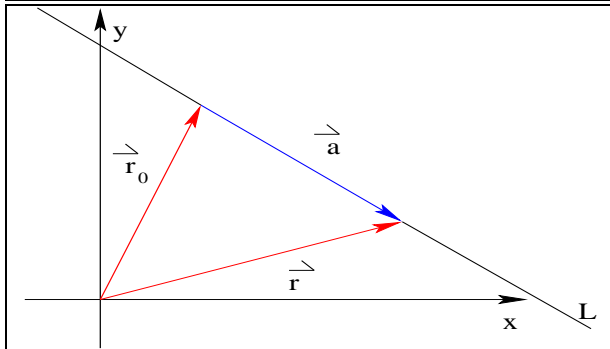
$$\vec{v}(t_1, t_2) = \frac{1}{t_2 - t_1} (\vec{r}(t_2) - \vec{r}(t_1)).$$

The velocity vector, or tangent vector is

$$\vec{v}(t) = \lim_{t_2 \rightarrow t} \vec{v}(t_2, t) = \vec{r}'(t) = \langle x'(t), y'(t) \rangle$$

The speed of the object at time t is the magnitude of the velocity at time t

$$\text{speed} = \|\vec{v}(t)\| = \|\vec{r}'(t)\|$$



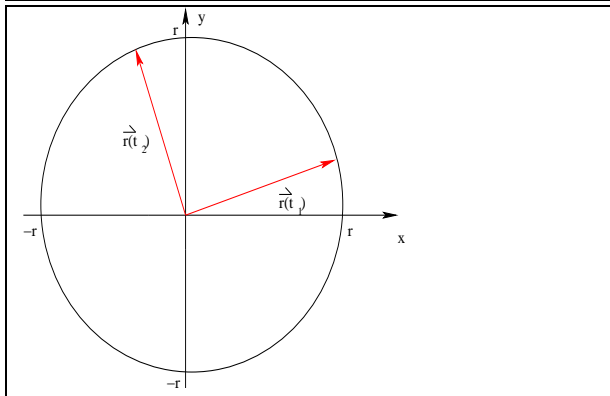
The parametric equation describing a line through a point with position vector \vec{r}_0 and parallel to the vector \vec{a} is

$$\vec{r}(t) = \vec{r}_0 + s \vec{a} \quad s \in \mathbb{R}$$

The parametric equation of the tangent line to the curve $\vec{r}(t) = \langle x(t), y(t) \rangle$ at $t = t_1$ is given by

$$\vec{m}(s) = \vec{r}(t_1) + s \vec{r}'(t_1) \quad \text{or}$$

$$\vec{m}(s) = \langle x(t_1), y(t_1) \rangle + s \langle x'(t_1), y'(t_1) \rangle$$



Uniform circular motion can be modeled by the equation

$$\vec{r}(t) = r \langle \cos \omega t, \sin \omega t \rangle, \quad t \geq 0$$

The velocity vector of motion is

$$\vec{v}(t) = r \omega \langle -\sin \omega t, \cos \omega t \rangle$$

The speed of the object in motion is

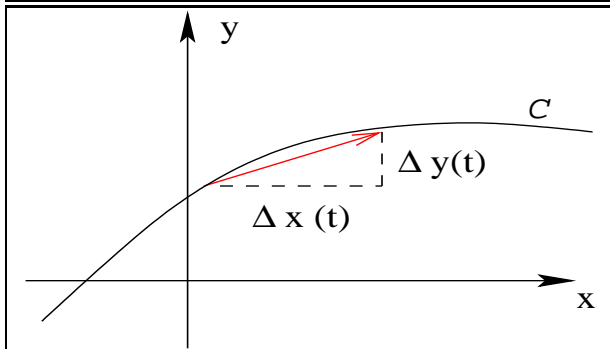
$$v = \|\vec{r}'(t)\| = r \omega.$$

The acceleration vector of motion is

$$\vec{a}(t) = \vec{r}''(t) = -r \omega^2 \vec{r}(t)$$

The magnitude of the acceleration is

$$a = \|\vec{r}''(t)\| = r \omega^2$$



Let C be a smooth curve described by

$$\vec{r}(t) = \langle x(t), y(t) \rangle \quad a \leq b$$

The arc length s of C is defined as

$$s = \int_a^b \|\vec{r}'(t)\| dt = \int_a^b \sqrt{x'(t)^2 + y'(t)^2} dt$$