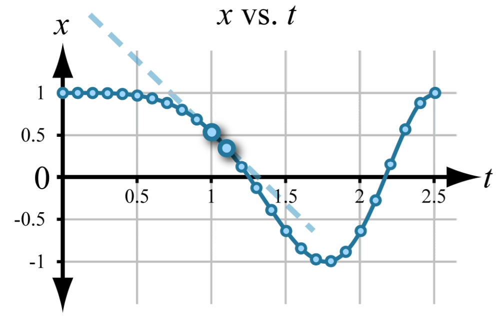
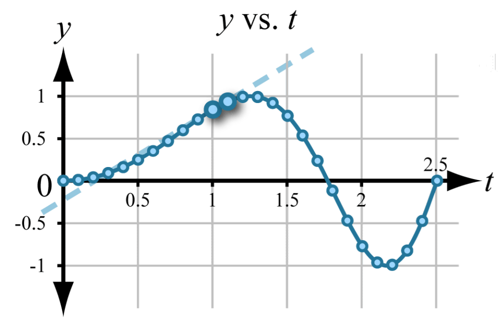
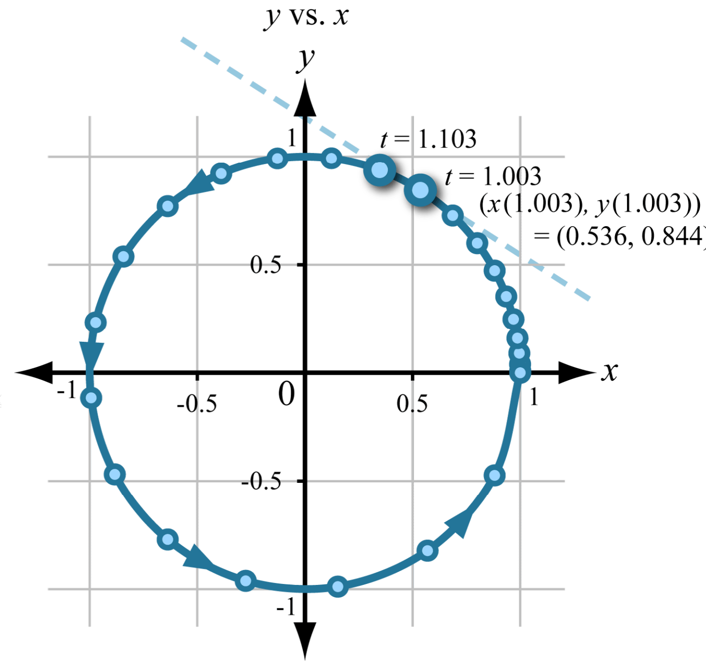
Parametrically-defined paths

When x and y are specified as functions of a parameter t, instead of in terms of each other, the relationship between x and y is said to be parametrically defined. Each value that the parameter t can take is like a house number, with the corresponding coordinate pair $\big(x(t), y(t)\big)$ defining the actual geographic position of the house on a cartographic grid. The relationship between x and y is the set of points that defines the street.

t	$x = \cos(t^2)$	$y = \sin(t^2)$
0.000	1.000	0.000
0.100	1.000	0.010
0.201	0.999	0.040
0.301	0.996	0.090
0.401	0.987	0.160
0.501	0.969	0.249
0.602	0.935	0.354
0.702	0.881	0.473
0.802	0.800	0.600
0.902	0.686	0.727
1.003	0.536	0.844
1.103	0.347	0.938
1.203	0.123	0.992
1.303	-0.128	0.992
⋮	⋮	⋮







Static geometry

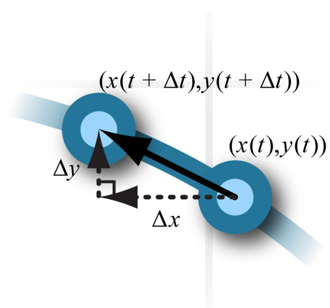
$$\frac{\mathrm{d}y}{\mathrm{d}t} = \frac{\mathrm{d}y}{\mathrm{d}x}\frac{\mathrm{d}x}{\mathrm{d}t}$$

$$\frac{\mathrm{d}y}{\mathrm{d}x} = \frac{\frac{\mathrm{d}y}{\mathrm{d}t}}{\frac{\mathrm{d}x}{\mathrm{d}t}}$$

$$\frac{\mathrm{d}^2 y}{\mathrm{d}x^2} = \frac{\mathrm{d}\left(\frac{\mathrm{d}y}{\mathrm{d}x}\right)}{\mathrm{d}x}$$

$$\frac{\mathrm{d}^2 y}{\mathrm{d}x^2} = \frac{\frac{\mathrm{d}}{\mathrm{d}t}\left(\frac{\mathrm{d}y}{\mathrm{d}x}\right)}{\frac{\mathrm{d}x}{\mathrm{d}t}}$$

Vector kinematics



Position	$\mathbf{r}(t) := \langle x(t), y(t)\rangle$
Velocity	$\mathbf{v}(t) := \langle x'(t), y'(t)\rangle$
Speed	$v(t) = \Vert\mathbf{v}(t)\Vert$ $= \sqrt{[x'(t)]^2 + [y'(t)]^2}$
Acceleration	$\mathbf{a}(t) := \langle x''(t), y''(t)\rangle$