There are times when we need to describe motion (or a curve) that is *not a function*.

We can do this by writing equations for the x and y coordinates in terms of a third

variable (usually *time* or ).

Each parametric equation gives one of the coordinates of position at a certain time.

Parametric Equations can be used to answer questions of where and when.

**Example:** Write a set of parametric equations for the line

One possible answer: Another answer:

A: B:

Graphs look the same, but parametric equations show location at a certain time.

When t = 4, Graph A is at ( ) and Graph B is at ( )

Both are traveling along the same line, just B is traveling faster.

**Example:**

Make a table of values and sketch the curve, indicating the direction of the curve. Then eliminate the parameter.

|  |  |  |
| --- | --- | --- |
| **t** | **X** | **y** |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

**Example:** Graph the plane curve represented by the parametric equations:



|  |  |  |
| --- | --- | --- |
| **t** | **x** | **y** |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

Now eliminate the parameter.

**Derivatives**

Given Find dx/dt, dy/dt, and dy/dx at t =

**Example:** Describe the movement and write an equation of the tangent line when t = 1



**Example:** Find all the points of vertical and horizontal tangency.



**Second Derivatives**

Example: Find dy/dx

To find the second derivative of a parametrized curve, we find the derivative of the first derivative:

**Example:**



**Example:**

Given the parametric equations Find the slope and concavity at (2, 3)

**Arc Length of a Parametric Equation**

Find the length of

