CHA	AP CALCULUS BC	
1	Topic: 9.2	Second Derivatives of Parametric Equations

Learning Objective CHA-3.G: Calculate derivatives of parametric functions.

Because dy/dx is a function of t, you can use Theorem 9.2 repeatedly to find *higher-order* derivatives.

HIGHER ORDER DERIVATIVES PARAMETRICALLY

$$\frac{d^2y}{dx^2} = \frac{d}{dx}\left[\frac{dy}{dx}\right] = \frac{\frac{d}{dt}\left[\frac{dy}{dx}\right]}{dx/dt}$$ **Second derivative**

$$\frac{d^3y}{dx^3} = \frac{d}{dx}\left[\frac{d^2y}{dx^2}\right] = \frac{\frac{d}{dt}\left[\frac{d^2y}{dx^2}\right]}{dx/dt}$$ **Third derivative**

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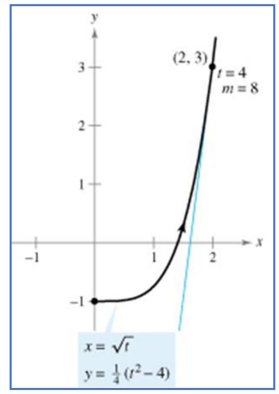
Example 1: Finding the Second Derivative of a Parametric Equation of the following:

a.) $x(t) = e^t, y(t) = te^{-t}$

b.) $x(t) = \cos t, y(t) = \sin 2t, 0 < t < \pi$

Example 2: Finding Slope and Concavity

For the curve given by $x = \sqrt{t}$ and $y = \frac{1}{4}(t^2 - 4), t \geq 0$, find the slope and concavity at the point (2, 3).



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Fundamental Theorem of Calculus with Parametric Equations

Example 3: Position Desired

A particle moving along a curve in the *xy*-plane is at position $(x(t), y(t))$ at time *t*, where $\frac{dx}{dt} = ln(t + 1), \frac{dy}{dt} = arcsin(e^{-t^2})$ for $t \geq 0$. At time *t* = 1 the particle is at position (2, 5).

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a.) Find the slope of the tangent line to the curve at position (2, 5).

b.) Find the *x*-coordinate of the position of the particle at time *t* = 3.