COMPARISON OF FORMULAS FOR RECTANGULAR, PARAMETRIC, & POLAR EQUATIONS

FORMULA:	RECTANGULAR	PARAMETRIC	POLAR
DERIVATIVE	$\frac{dy}{dx}$ (slope of curve, velocity of a particle, etc.)	$\frac{dy}{dx} = \frac{dy/dt}{dx/dt}$	$\leftarrow$ Convert to parametric. x = rcosθ y = rsinθ
2ND DERIVATIVE	$\frac{d^2y}{dx^2}$	$\frac{\frac{d}{dt}\left[dy/dx\right]}{dx/dt}$	$\leftarrow$ Convert to parametric.
AREA	$\int_a^b f(x)\ dx$	$\int_a^b y\ dx$ Note: ***a*** and ***b*** are limits for ***x***. Convert to t_1 and t_2.	$\frac{1}{2}\int_{\theta_1}^{\theta_2} r^2\ d\theta$
VOLUME	Disc: $\pi\int_a^b R^2\ dx$ Washer: $\pi\int_a^b \left(R^2 - r^2\right) dx$	$\pi\int_a^b y^2\ dx$ Note: ***a*** and ***b*** are limits for ***x***. Convert to t_1 and t_2.	$\leftarrow$ Convert to parametric.
ARC LENGTH	$\int_a^b \sqrt{1+[f'(x)]^2}\ dx$	$\int_{t_1}^{t_2} \sqrt{\left(\frac{dx}{dt}\right)^2 + \left(\frac{dy}{dt}\right)^2}\ dt$	$\int_a^b \sqrt{[r(\theta)]^2 + [r'(\theta)]^2}\ d\theta$
SPEED	$\lvert v(t)\rvert$	$\sqrt{\left(\frac{dx}{dt}\right)^2 + \left(\frac{dy}{dt}\right)^2}$	$\sqrt{[r(\theta)]^2 + [r'(\theta)]^2}$
TOTAL DISTANCE	$\int_{t_1}^{t_2} \lvert v(t)\rvert dt$	$\int_{t_1}^{t_2} \sqrt{\left(\frac{dx}{dt}\right)^2 + \left(\frac{dy}{dt}\right)^2}\ dt$ Arc length!	$\int_a^b \sqrt{[r(\theta)]^2 + [r'(\theta)]^2}\ d\theta$ Arc length!
POSITION	$s(b) - s(a) = \int_a^b v(t)\ dt$	$(x(t),\ y(t))$, where $x(t_2) - x(t_1) = \int_{t_1}^{t_2} x'(t)\ dt$ and $y(t_2) - y(t_1) = \int_{t_1}^{t_2} y'(t)\ dt$	$\leftarrow$ Convert to parametric.

Other things to remember:

- ✓ Speed is increasing when the signs of velocity and acceleration are the same.
- ✓ If particle moves along a horizontal line (x-axis), it's moving left when $\frac{dx}{dt} < 0$ and right when $\frac{dx}{dt} > 0$.
- ✓ A particle is at rest when v(t) = 0 and a(t) = 0 for the same value of t.

- ✓ For parametrically defined curves, the velocity vector is $\langle x'(t),\ y'(t) \rangle$ and the acceleration vector is $\langle x''(t),\ y''(t) \rangle$.