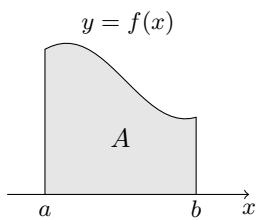


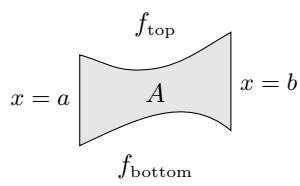
## Calculus in Cartesian, Parametric, & Polar

	Cartesian	Parametric	Polar
Formula for	$y = f(x)$	$x = x(t), y = y(t)$	$r = r(\theta), x = r \cos \theta, y = r \sin \theta$
$\frac{dy}{dx}$	$f'(x)$	$\frac{dy}{dt} \frac{dt}{dx}$	$\frac{dy}{dx} = \frac{\frac{dy}{d\theta}}{\frac{dx}{d\theta}} = \frac{\frac{dr}{d\theta} \sin \theta + r \cos \theta}{\frac{dr}{d\theta} \cos \theta - r \sin \theta}$
$\frac{d^2y}{dx^2}$	$f''(x)$	$\frac{d}{dt} \left[ \frac{dy}{dx} \right] \frac{dx}{dt}$	$\frac{d}{d\theta} \left[ \frac{dy}{dx} \right] \frac{dx}{d\theta}$
Area	See other side of handout.		
Volume	Disk Method about $x$ -axis $\pi \int_{x_0}^{x_1} [f(x)]^2 dx$  about $y$ -axis $\pi \int_{y_0}^{y_1} [g(y)]^2 dy$  Shell Method about $x$ -axis $2\pi \int_{y_0}^{y_1} y g(y) dy$  about $y$ -axis $2\pi \int_{x_0}^{x_1} x f(x) dx$	Don't need to know	Don't need to know
Arclength	$\int_a^b ds$ $ds = \sqrt{1 + [f'(x)]^2} dx$ or $ds = \sqrt{1 + [g'(y)]^2} dy$	$\int_{t_0}^{t_1} ds$ $ds = \sqrt{[x'(t)]^2 + [y'(t)]^2} dt$	$\int_{\theta_0}^{\theta_1} ds$ $ds = \sqrt{r^2 + (r')^2} d\theta$
Surface Area	$2\pi \int_a^b R ds$ about $x$ -axis $R = y$ about $y$ -axis $R = x$	$2\pi \int_{t_0}^{t_1} R ds$ about $x$ -axis $R = y(t)$ about $y$ -axis $R = x(t)$	Don't need to know

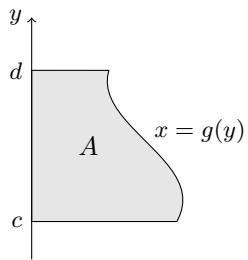
### Area in Cartesian



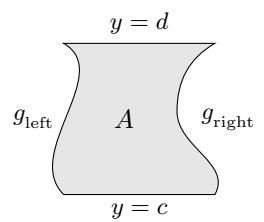
$$A = \int_a^b f(x) dx$$



$$A = \int_a^b [f_{\text{top}}(x) - f_{\text{bottom}}(x)] dx$$

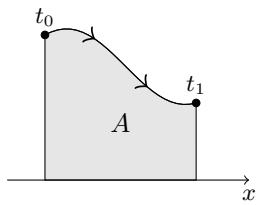


$$A = \int_c^d g(y) dy$$

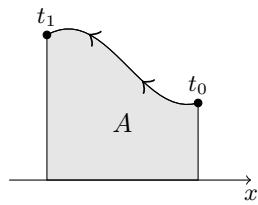


$$A = \int_c^d [g_{\text{right}}(y) - g_{\text{left}}(y)] dy$$

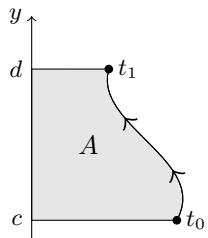
### Area in Parametric ( $x = x(t)$ , $y = y(t)$ )



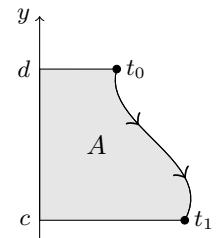
$$A = \int_{t_0}^{t_1} y(t)x'(t) dt$$



$$A = - \int_{t_0}^{t_1} y(t)x'(t) dt$$

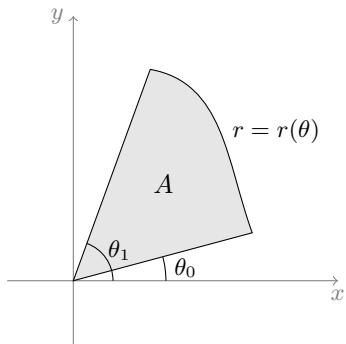


$$A = \int_{t_0}^{t_1} x(t)y'(t) dt$$

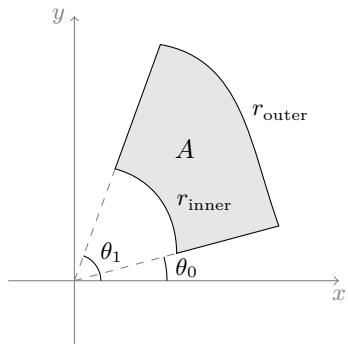


$$A = - \int_{t_0}^{t_1} x(t)y'(t) dt$$

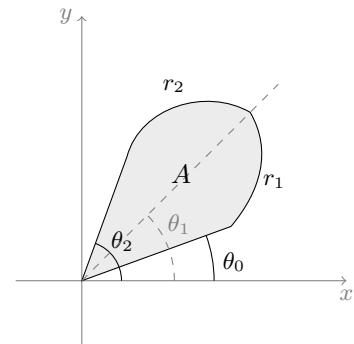
### Area in Polar



$$A = \frac{1}{2} \int_{\theta_0}^{\theta_1} r^2 d\theta$$



$$A = \frac{1}{2} \int_{\theta_0}^{\theta_1} [r_{\text{outer}}^2 - r_{\text{inner}}^2] d\theta$$



$$A = \frac{1}{2} \int_{\theta_0}^{\theta_1} r_1^2 d\theta + \frac{1}{2} \int_{\theta_1}^{\theta_2} r_2^2 d\theta$$