**10.4.61** $r = 3(1-\cos\theta)$ $\quad (r,\theta) = (3, \pi/2)$

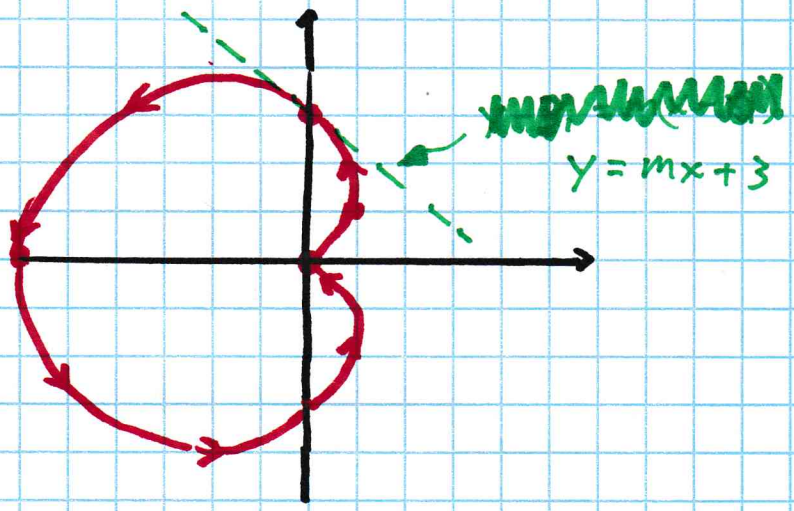
$x = 3\cos\theta - 3\cos^2\theta \qquad y = 3\sin\theta - 3\sin\theta\cos\theta$

$dx/d\theta = -3\sin\theta + 6\sin\theta\cos\theta = -3\sin\theta + 3\sin 2\theta$

$dy/d\theta = 3\cos\theta - 3\cos^2\theta + 3\sin^2\theta = 3\cos\theta - 3\cos 2\theta$

$dr/d\theta = 3\sin\theta$

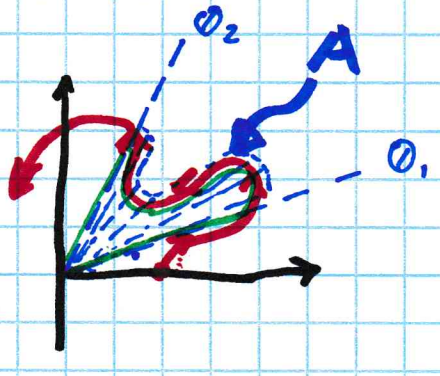
| $\theta$ | 0 | $\pi/2$ | $\pi$ | $3\pi/2$ | $2\pi$ |
|---|---|---|---|---|---|
| $r$ | 0 | 3 | 6 | 3 | 0 |
| $r'$ | 0 | 3 | 0 | -3 | 0 |




$m = \dfrac{y'(\pi/2)}{x'(\pi/2)}$, $\quad y'(\pi/2) = 3$, $\quad x'(\pi/2) = -3$; $\quad m = -1$

# Polar Area

Let $r = f(\theta)$

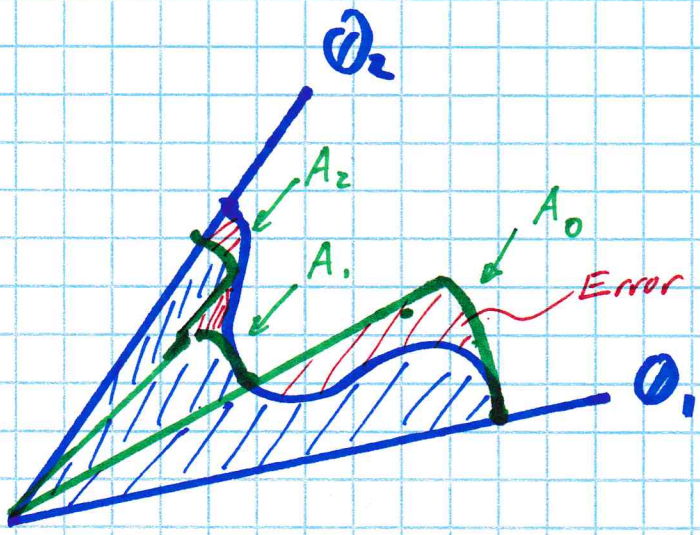



Sector: Part of a circle Divided along radius.


$A_c = \pi r^2$

$A_s = A_c \cdot \frac{\Delta\theta}{2\pi}$

$A_s = \frac{1}{2} r^2 \Delta\theta$




$$A \approx \sum_n A_n = \sum_n \frac{1}{2} r_n^2 \cdot \Delta\theta$$

$$A = \lim_{n\to\infty} \sum_n A_n = \lim_{n\to\infty} \sum_n \frac{1}{2} r_n^2 \Delta\theta$$

$$\boxed{A = \int_{\theta_1}^{\theta_2} \frac{1}{2} r^2 \, d\theta}$$