① $0 \leq \theta \leq \frac{\pi}{2}$

$w > h$

$x\_len = r\cos(\theta - \alpha)$

$= r(\overset{>0}{\cos\theta\cos\alpha} + \overset{>0}{\sin\theta\sin\alpha}) > 0$

$x\_pad = x\_len - \frac{w}{2}$ (if $x\_len > \frac{w}{2}$)

$y\_len = r\sin(\theta + \alpha)$

$= r(\overset{>0}{\sin\theta\cos\alpha} + \overset{>0}{\cos\theta\sin\alpha}) > 0$

$y\_pad = y\_len - \frac{h}{2}$ (if $y\_len > \frac{h}{2}$)

$\sin\alpha = \frac{h}{2} / r$

$\cos\alpha = \frac{w}{2} / r$

$\theta = 0$

$x\_len = r\cos(-\alpha)$

$= r\cos\alpha$

$= \frac{w}{2}$

$y\_len = r\sin\alpha$

$= \frac{h}{2}$

$\theta = \frac{\pi}{2}$

$x\_len = r\cos(\frac{\pi}{2} - \alpha)$

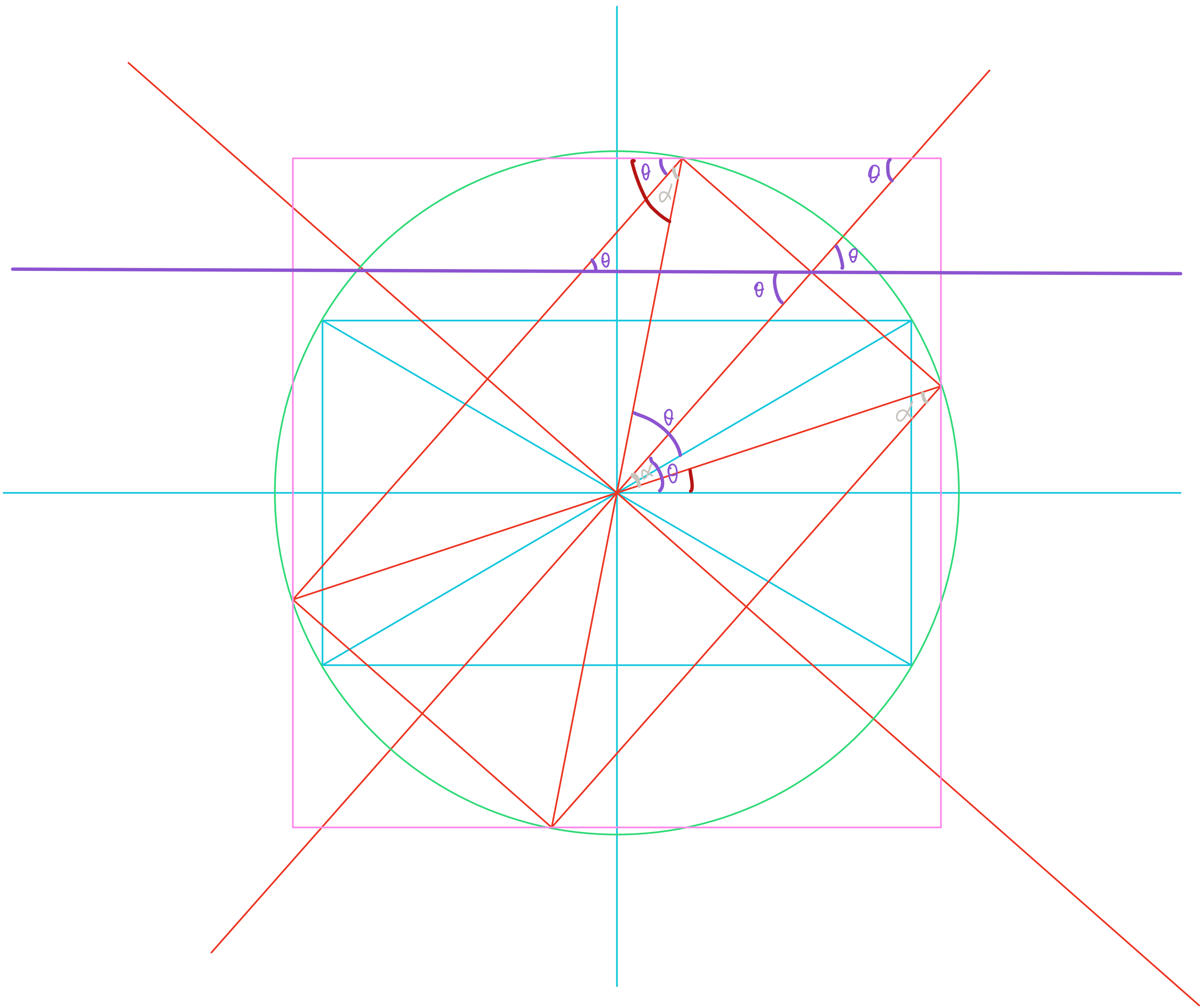
$= r\sin\alpha$

$= \frac{h}{2}$

$y\_len = r\sin(\frac{\pi}{2} + \alpha)$

$= r\cos\alpha$

$= \frac{w}{2}$



③ $\pi \leq \theta \leq \frac{3}{2}\pi \quad \theta_0 = \theta - \pi$

$$
\begin{aligned}
x\_lm &= r\cos(\theta_0 - \alpha) \\
&= r\cos(\theta - \pi - \alpha) \\
&= r\cos(\pi + \theta - \alpha) \\
&= -r\cos(\theta - \alpha) \\
&= -r(\overset{<0}{\cos\theta\cos\alpha} + \overset{<0}{\sin\theta\sin\alpha}) > 0
\end{aligned}
$$

$$
\begin{aligned}
y\_lm &= r\sin(\theta_0 + \alpha) \\
&= r\sin(\theta - \pi + \alpha) \\
&= r\sin(\pi + \theta + \alpha) \\
&= -r\sin(\theta + \alpha) \\
&= -r(\overset{<0}{\sin\theta\cos\alpha} + \overset{<0}{\cos\theta\sin\alpha}) > 0
\end{aligned}
$$

$\theta = \pi$

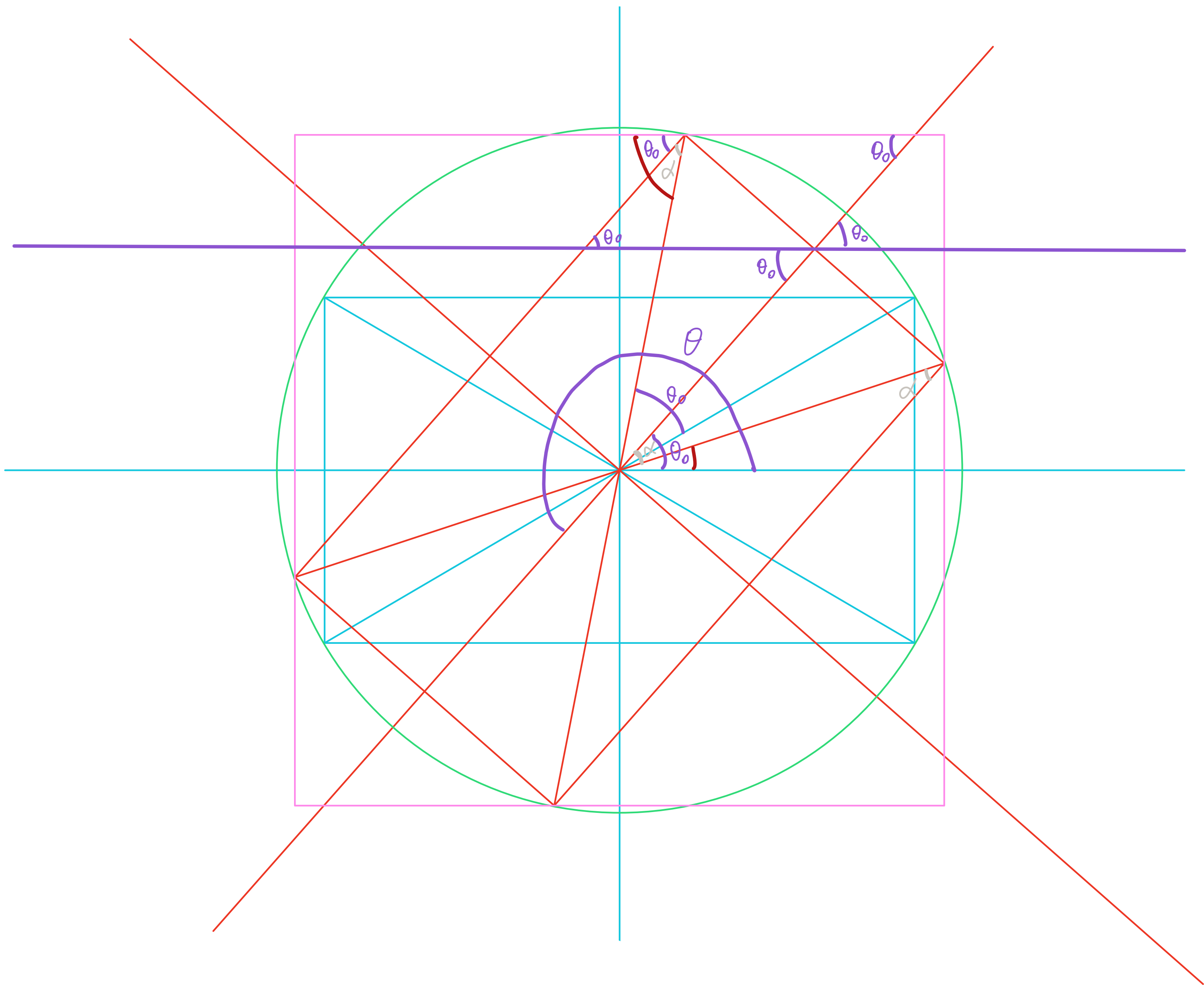
$$
\begin{aligned}
x\_lm &= -r\cos(\pi - \alpha) \\
&= r\cos\alpha \\
&= \frac{w}{2}
\end{aligned}
$$

$$
\begin{aligned}
y\_lm &= -r\sin(\pi + \alpha) \\
&= r\sin\alpha \\
&= \frac{h}{2}
\end{aligned}
$$

$\theta = \frac{3}{2}\pi$

$$
\begin{aligned}
x\_lm &= -r\cos(\tfrac{3}{2}\pi - \alpha) \\
&= r\cos(\tfrac{\pi}{2} - \alpha) \\
&= r\sin\alpha \\
&= \frac{h}{2}
\end{aligned}
$$

$$
\begin{aligned}
y\_lm &= -r\sin(\tfrac{3}{2}\pi + \alpha) \\
&= r\sin(\tfrac{\pi}{2} + \alpha) \\
&= r\cos\alpha \\
&= \frac{w}{2}
\end{aligned}
$$



② $\frac{\pi}{2} \leq \theta \leq \pi \quad \theta_0 = \theta - \frac{\pi}{2}$

$$
\begin{aligned}
x\text{-}len &= r\sin(\theta_0 + \alpha) \\
&= r\sin(\theta - \tfrac{\pi}{2} + \alpha) \\
&= r\sin(\tfrac{3}{2}\pi + \theta + \alpha) \\
&= -r\sin(\tfrac{\pi}{2} + \theta + \alpha) \\
&= -r\cos(\theta + \alpha) \\
&= -r(\underset{<0}{\cos\theta}\cos\alpha - \underset{>0}{\sin\theta}\sin\alpha) > 0
\end{aligned}
$$

$$
\begin{aligned}
y\text{-}len &= r\sin(\tfrac{\pi}{2} - \theta_0 + \alpha) \\
&= r\sin(\pi - \theta + \alpha) \\
&= r\sin(\theta - \alpha) \\
&= r(\underset{>0}{\sin\theta}\cos\alpha - \underset{<0}{\cos\theta}\sin\alpha) > 0
\end{aligned}
$$

$\theta = \frac{\pi}{2}$

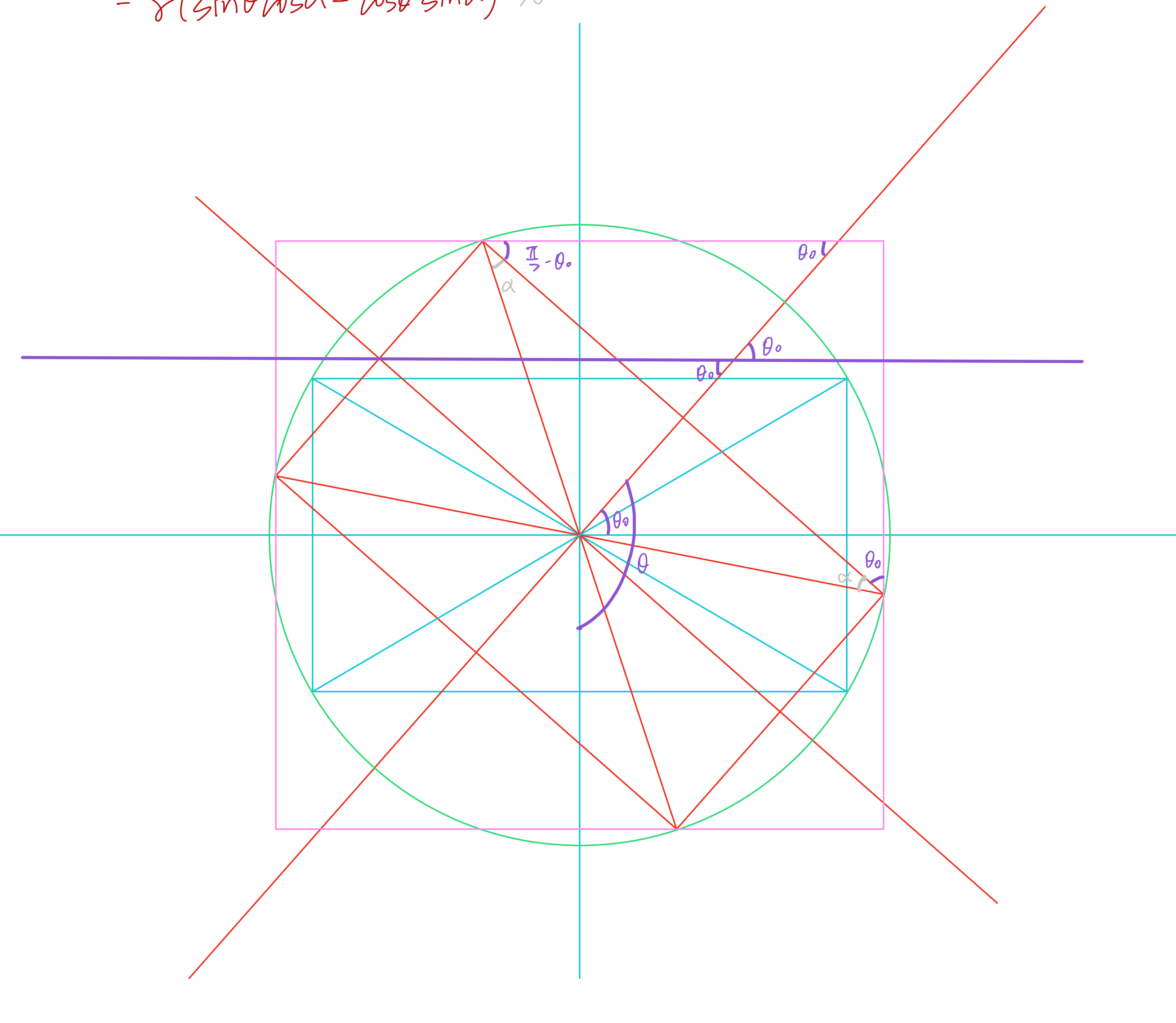
$$
\begin{aligned}
x\text{-}len &= -r\cos(\tfrac{\pi}{2} + \alpha) \\
&= r\sin\alpha \\
&= \frac{h}{2}
\end{aligned}
$$

$$
\begin{aligned}
y\text{-}len &= r\sin(\tfrac{\pi}{2} - \alpha) \\
&= r\cos\alpha \\
&= \frac{w}{2}
\end{aligned}
$$

$\theta = \pi$

$$
\begin{aligned}
x\text{-}len &= -r\cos(\pi + \alpha) \\
&= r\cos\alpha \\
&= \frac{w}{2}
\end{aligned}
$$

$$
\begin{aligned}
y\text{-}len &= r\sin(\pi - \alpha) \\
&= r\sin\alpha \\
&= \frac{h}{2}
\end{aligned}
$$



④ $\frac{3}{2}\pi \leq \theta \leq 2\pi$ $\theta_0 = \theta - \frac{3}{2}\pi$

$$
\begin{aligned}
x\_len &= r\sin(\theta_0 + \alpha) \\
&= r\sin(\theta - \tfrac{3}{2}\pi + \alpha) \\
&= r\sin(\theta + \tfrac{\pi}{2} + \alpha) \\
&= r\cos(\theta + \alpha) \\
&= r(\overset{>0}{\cos\theta}\cos\alpha - \sin\overset{<0}{\theta}\sin\alpha) > 0
\end{aligned}
$$

$$
\begin{aligned}
y\_len &= r\sin(\tfrac{\pi}{2} - \theta_0 + \alpha) \\
&= r\sin(\tfrac{\pi}{2} - \theta + \tfrac{3}{2}\pi + \alpha) \\
&= r\sin(\alpha - \theta) \\
&= -r\sin(\theta - \alpha) \\
&= -r(\overset{<0}{\sin\theta}\cos\alpha - \overset{>0}{\cos\theta}\sin\alpha) > 0
\end{aligned}
$$

$\theta = \frac{3}{2}\pi$:

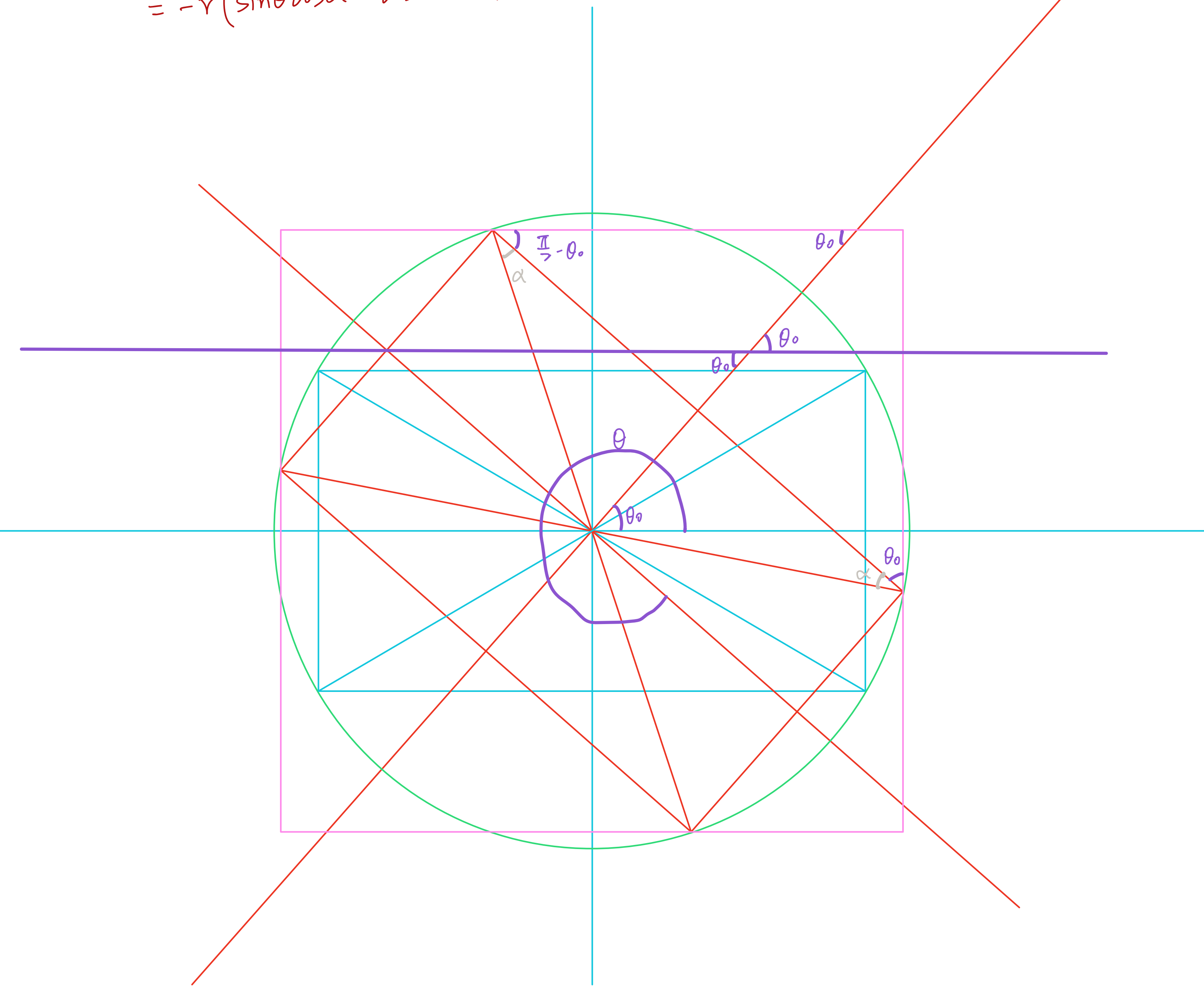
$$
\begin{aligned}
x\_len &= r\cos(\tfrac{3}{2}\pi + \alpha) \\
&= -r\cos(\tfrac{\pi}{2} + \alpha) \\
&= r\sin\alpha \\
&= \tfrac{h}{2}
\end{aligned}
$$

$$
\begin{aligned}
y\_len &= -r\sin(\tfrac{3}{2}\pi - \alpha) \\
&= r\sin(\tfrac{\pi}{2} + \alpha) \\
&= r\cos\alpha \\
&= \tfrac{w}{2}
\end{aligned}
$$

$\theta = 2\pi$

$$
\begin{aligned}
x\_len &= r\cos(2\pi + \alpha) \\
&= r\cos\alpha \\
&= \tfrac{w}{2}
\end{aligned}
$$

$$
\begin{aligned}
y\_len &= -r\sin(2\pi - \alpha) \\
&= r\sin\alpha \\
&= \tfrac{h}{2}
\end{aligned}
$$



$$x\text{-}len = \begin{cases} r\cos(\theta-\alpha), & 0 \le \theta \le \frac{\pi}{2} \\ -r\cos(\theta+\alpha), & \frac{\pi}{2} \le \theta \le \pi \\ -r\cos(\theta-\alpha), & \pi \le \theta \le \frac{3}{2}\pi \\ r\cos(\theta+\alpha), & \frac{3}{2}\pi \le \theta \le 2\pi \end{cases}$$

$$= \begin{cases} r(\cos\theta\cos\alpha + \sin\theta\sin\alpha) \\ -r(\cos\theta\cos\alpha - \sin\theta\sin\alpha) \\ -r(\cos\theta\cos\alpha + \sin\theta\sin\alpha) \\ r(\cos\theta\cos\alpha - \sin\theta\sin\alpha) \end{cases}$$

$$y\text{-}len = \begin{cases} r\sin(\theta+\alpha), & 0 \le \theta \le \frac{\pi}{2} \\ r\sin(\theta-\alpha), & \frac{\pi}{2} \le \theta \le \pi \\ -r\sin(\theta+\alpha), & \pi \le \theta \le \frac{3}{2}\pi \\ -r\sin(\theta-\alpha), & \frac{3}{2}\pi \le \theta \le 2\pi \end{cases}$$

$$= \begin{cases} r(\sin\theta\cos\alpha + \cos\theta\sin\alpha) \\ r(\sin\theta\cos\alpha - \cos\theta\sin\alpha) \\ -r(\sin\theta\cos\alpha + \cos\theta\sin\alpha) \\ -r(\sin\theta\cos\alpha - \cos\theta\sin\alpha) \end{cases}$$