**XY Plane** (circles in XY plane represent cylinders in XYZ space)

a) center at origin

\[ r^2 = a^2 \]

\[ \theta = 0, 2\pi \]

b) center on axis, tangent to origin (\( \theta \) interval between zeros of \( r \))

\[ r = -2ax \sin\theta \]

\[ r = 2ax \sin\theta \]

**RZ Half Plane** (\( x^2 + y^2 = r^2 + z^2 \))

a) sphere centered at origin

\[ r^2 = a^2 \]

\[ \theta = 0, \pi \]

b) sphere centered on axis, tangent to origin (\( \theta \) interval between zeros of \( \rho \))

\[ \rho^2 = 2a \rho \cos\theta \]

\[ \theta = 0, \pi \]
simple lines/planes/cylinders in polar/cylindrical/spherical coordinates

assume $a > 0$

**xy plane** (lines in $xy$ space are planes in $xyz$ space)

$y = 0 \rightarrow r \sin \theta = a$
$r = a \sec \theta$
$\theta = 0, \pi$

$y = -a \rightarrow r \sin \theta = -a$
$r = a \sec \theta$
$\theta = \pi, 3\pi$
$\theta = -\pi, 0$

$yz$ half plane

$z = 0 \rightarrow \rho \cos \varphi = a$
$\rho = a \sec \varphi$
$\varphi = 0, \pi$

$z = -a \rightarrow \rho \cos \varphi = -a$
$\rho = a \sec \varphi$
$\varphi = \pi, 3\pi$

$z = a \rightarrow \rho \sin \varphi = a$
$\rho = a \csc \varphi$
$\varphi = \frac{\pi}{2}, \frac{3\pi}{2}$

$z = -a \rightarrow \rho \sin \varphi = -a$
$\rho = a \csc \varphi$
$\varphi = \frac{3\pi}{2}, \frac{5\pi}{2}$

(cylinder)