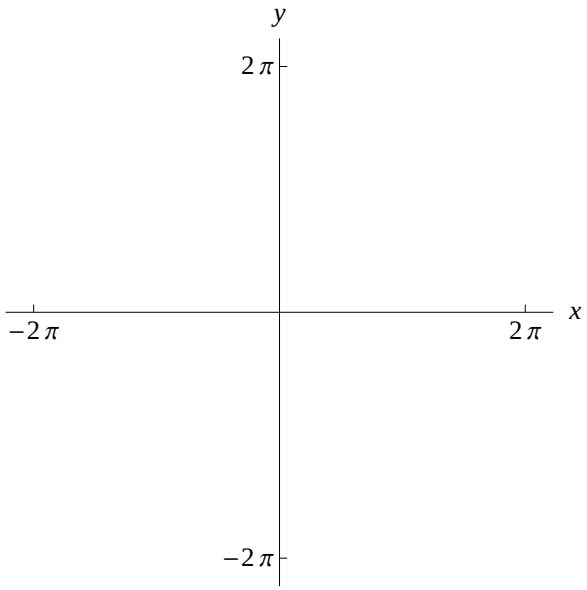
# Polar, Cylindrical, and Spherical Coordinates

1. (a) In polar coordinates, what shapes are described by $r = k$ and $\theta = k$, where $k$ is a constant?

   (b) Draw $r = 0$, $r = \frac{2\pi}{3}$, $r = \frac{4\pi}{3}$, $r = 2\pi$, $\theta = 0$, $\theta = \frac{2\pi}{3}$, and $\theta = \frac{4\pi}{3}$ on the following axes. (Why can't we draw $\theta = 2\pi$?)




   (c) On the axes in (b), sketch the curve with polar equation $r = \theta$.

2. In cylindrical coordinates, what shapes are described by $r = k$, $\theta = k$, and $z = k$, where $k$ is a constant?

3. In spherical coordinates, what shapes are described by $\rho = k$, $\theta = k$, and $\phi = k$, where $k$ is a constant?

4. (a) In cylindrical coordinates, let's look at the surface $r = 5$. What does $z = k$ look like on this surface? How about $\theta = k$? ($k$ is a constant.)

   (b) In spherical coordinates, let's look at the surface $\rho = 5$. What does $\theta = k$ look like on this surface? How about $\phi = k$?

5. Write the point $(x, y, z) = (\sqrt{6}, -\sqrt{6}, -2)$ in cylindrical and spherical coordinates.

6. Consider the surface whose equation in cylindrical coordinates is $z = r$. How could you describe this surface in Cartesian coordinates? Spherical? Can you sketch the surface?

7. Most of the time, a single equation like $2x + 3y + 4z = 5$ in Cartesian coordinates or $\rho = 1$ in spherical coordinates defines a surface. Can you find examples in Cartesian, cylindrical, and spherical coordinates where this is not the case?