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December 11, 2008

Try It once

\[
(1, 0, 2) = \left( \frac{\sqrt{5}}{2}, -\frac{\sqrt{5}}{2}, 1 \right)
\]

\[
x = \theta \cos \phi = 3 \cos \left( -\frac{\sqrt{5}}{2} \right) = 3 \left( \frac{\sqrt{5}}{2} \right)
\]

\[
y = \theta \sin \phi = 3 \sin \left( -\frac{\sqrt{5}}{2} \right) = -\frac{3}{2}
\]

\[
z = z = 1
\]

\[
\left( \frac{\sqrt{5}}{2}, -\frac{\sqrt{5}}{2}, 1 \right) = \left( \frac{3 \sqrt{5}}{2}, -\frac{3}{2}, 1 \right)
\]

\[
\left( x, y, z \right) = \left( \frac{3 \sqrt{5}}{2}, -\frac{3}{2}, 1 \right)
\]

\[
\left( r, \theta, z \right) = \left( \frac{3 \sqrt{5}}{2}, -\frac{3}{2}, 1 \right)
\]

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1. In a spherical coordinate system, a point \( P \) in space is represented by an ordered triple \((\rho, \theta, \phi)\).

2. \( \rho \) is the distance between \( P \) and the origin, \( \rho \geq 0 \).

3. \( \theta \) is the same angle used in cylindrical coordinates for \( r \geq 0 \).

4. \( \phi \) is the angle between the positive \( z \)-axis and the line segment \( \overrightarrow{OP} \), where \( O \) is the origin.

Note that the first and third coordinates, \( \rho \) and \( \phi \), are nonnegative, \( \rho \) is the lowercase Greek letter rho, and \( \phi \) is the lowercase Greek letter phi.

The relationship between rectangular and spherical coordinates is illustrated in Figure 11.75. To convert from one system to the other, use the following:

**Spherical to rectangular:**

- \( x = \rho \sin \phi \cos \theta \)
- \( y = \rho \sin \phi \sin \theta \)
- \( z = \rho \cos \phi \)

**Rectangular to spherical:**

- \( \rho^2 = x^2 + y^2 + z^2 \)
- \( \theta = \arctan \left( \frac{y}{x} \right) \)
- \( \phi = \arccos \left( \frac{z}{\rho} \right) \)

To change coordinates between the cylindrical and spherical systems, use the following:

**Cylindrical to spherical:**

- \( \rho = \sqrt{r^2 + z^2} \)
- \( \phi = \arctan \left( \frac{r}{z} \right) \)
- \( \theta = \theta \)

**Spherical to cylindrical:**

- \( r = \rho \sin \phi \)
- \( \theta = \theta \)
- \( z = \rho \cos \phi \)

The spherical coordinate system is used primarily for surfaces in space that have a point or center of symmetry. For example, Figure 11.76 shows these surfaces with simple spherical equations.