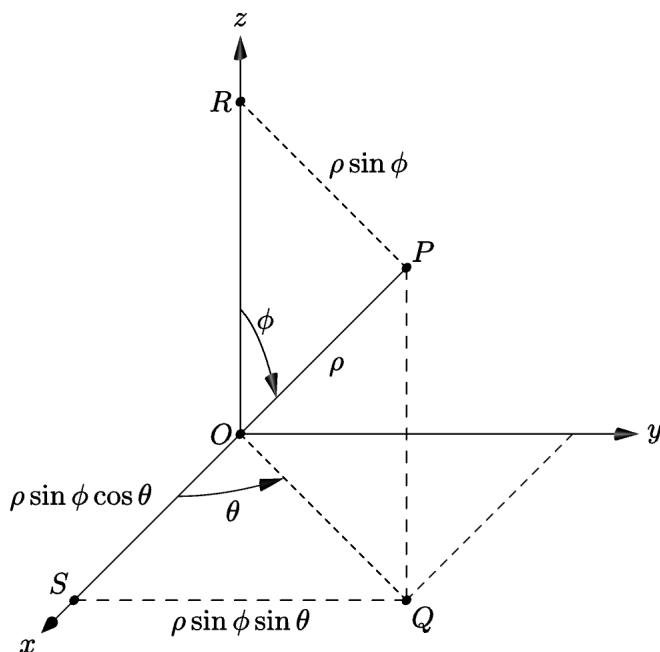


12.7 Cylindrical and Spherical Coordinates

- Rectangular Coordinates (x, y, z) & Cylindrical Coordinates (r, θ, z) :

- Rectangular Coordinates (x, y, z) & Spherical Coordinates (ρ, θ, ϕ) :



- Cylindrical Coordinates (r, θ, z) & Spherical Coordinates (ρ, θ, ϕ) :

1. Convert the point $(-1, 1, -\sqrt{2})$ from rectangular to spherical coordinates.

2. Convert the point $(4, -4, 4\sqrt{6})$ from rectangular to spherical coordinates.

3. Convert the point $\left(\sqrt{6}, \frac{\pi}{4}, \sqrt{2}\right)$ from cylindrical to spherical coordinates.

4. Identify the surface $\rho = 6$

5. Identify the surface $\phi = \frac{\pi}{12}$

6. Identify the surface $\theta = \frac{3\pi}{5}$

7. Identify the surface $\rho \sin \phi = 2 \cos \theta$

8. Identify the surface $\rho = 4 \cos \phi$

9. Find equations of the paraboloid $z = x^2 + y^2$ in cylindrical and spherical coordinates.

10. Find an equation of the form $\rho = f(\theta, \phi)$ for the surface $x^2 = 16 - z^2$.

11. Describe the region in 3-space: $r^2 \leq z \leq 4$

12. Describe the region in 3-space: $1 < \rho \leq 3$