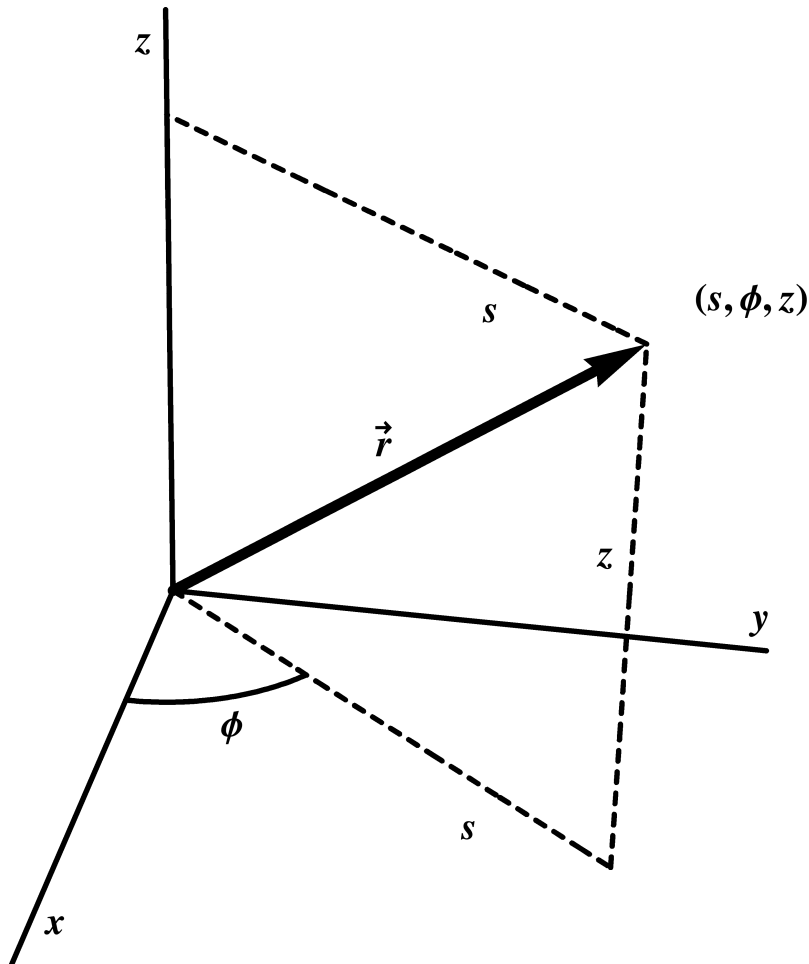


# 1 Cylindrical Coordinates

For the cylindrical coordinate system shown below, draw three surfaces: one for constant  $s$ , one for constant  $\phi$ , and one for constant  $z$ .



$$x = s \cos \phi \quad (1)$$

$$y = s \sin \phi \quad (2)$$

$$z = z \quad (3)$$

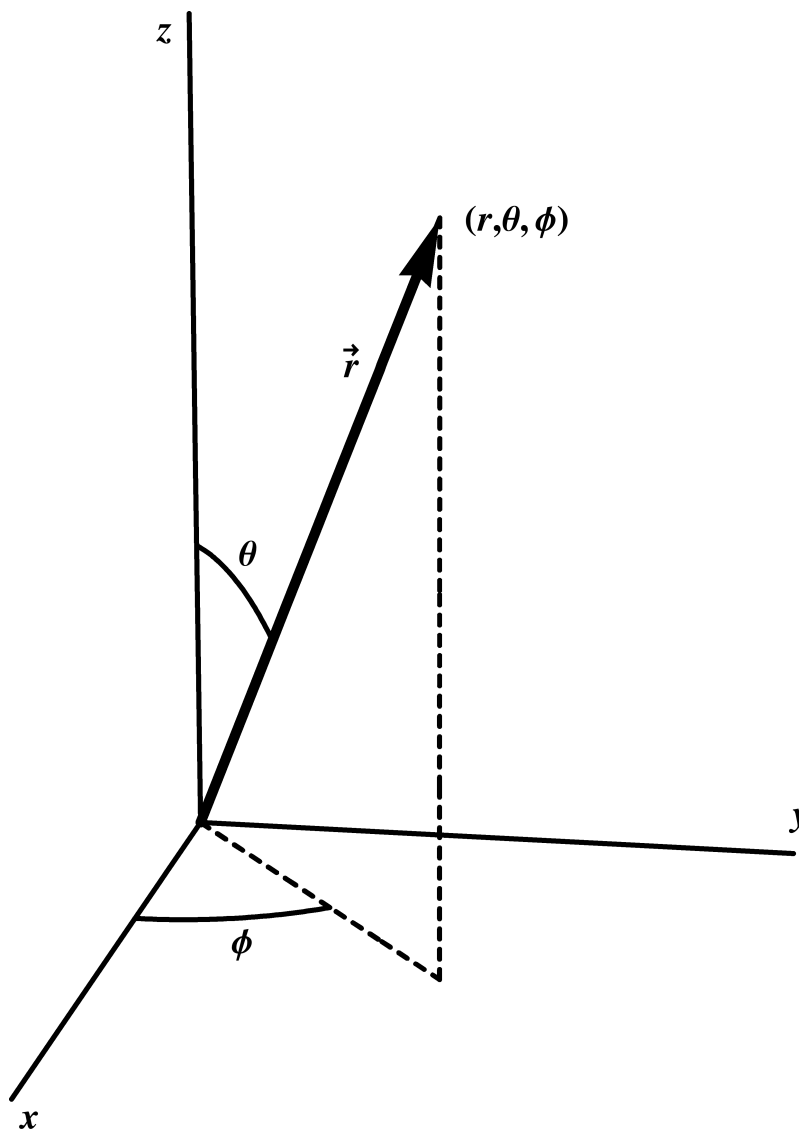
$$0 \leq s < \infty \quad (4)$$

$$0 \leq \phi < 2\pi \quad (5)$$

$$-\infty < z < \infty \quad (6)$$

## 2 Spherical Coordinates

For the spherical coordinate system shown below, draw three surfaces: one for constant  $r$ , one for constant  $\theta$ , and one for constant  $\phi$ .



$$x = r \sin \theta \cos \phi \quad (7)$$

$$y = r \sin \theta \sin \phi \quad (8)$$

$$z = r \cos \theta \quad (9)$$

$$0 \leq r < \infty \quad (10)$$

$$0 \leq \theta < \pi \quad (11)$$

$$0 \leq \phi < 2\pi \quad (12)$$

$$(13)$$