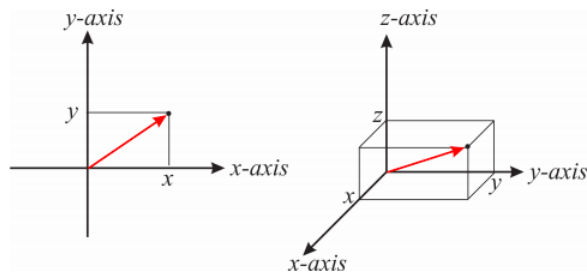


16.13: Coordinate Systems

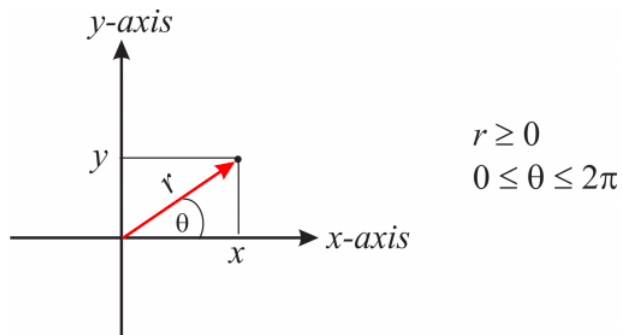
Cartesian coordinates



2 dimensions: area element: $dA = dx \cdot dy$.

3 dimensions: volume element: $dV = dx \cdot dy \cdot dz$.

Polar coordinates

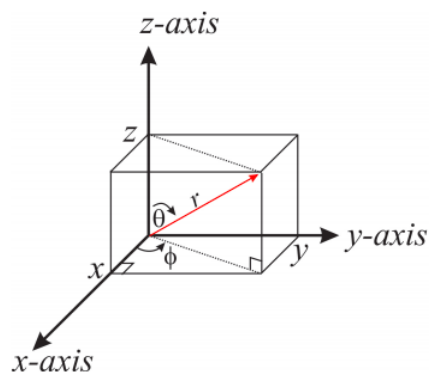


$$r \geq 0$$

$$0 \leq \theta \leq 2\pi$$

- $x = r \cos \theta$
- $y = r \sin \theta$
- $r^2 = x^2 + y^2$
- $\tan \theta = y/x$
- $dA = r \cdot dr \cdot d\theta$

Spherical coordinates



$$r \geq 0$$

$$0 \leq \phi \leq 2\pi$$

$$0 \leq \theta \leq \pi$$

- $x = r \sin \theta \cos \phi$
- $y = r \sin \theta \sin \phi$
- $z = r \cos \theta$
- $r^2 = x^2 + y^2 + z^2$

- $\theta = \cos^{-1} \left[\frac{z}{\sqrt{x^2 + y^2 + z^2}} \right]$
- $\phi = \tan^{-1} \left(\frac{y}{x} \right)$
- $dV = r^2 \sin \theta dr \cdot d\phi \cdot d\theta$

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