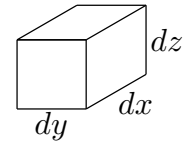
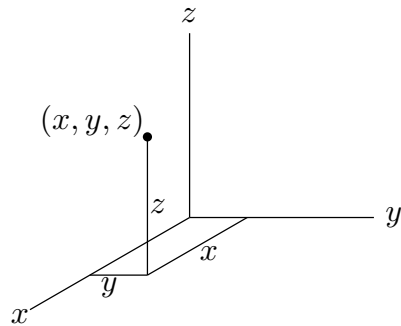
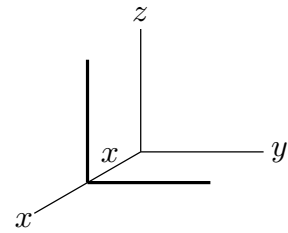


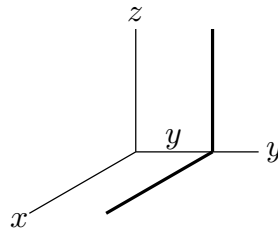
CARTESIAN COORDINATES



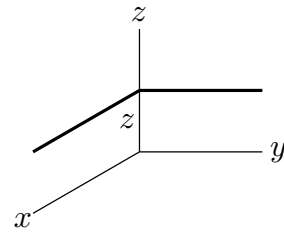
volume element $dV = dx dy dz$



surface of constant x

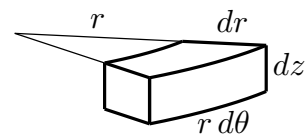
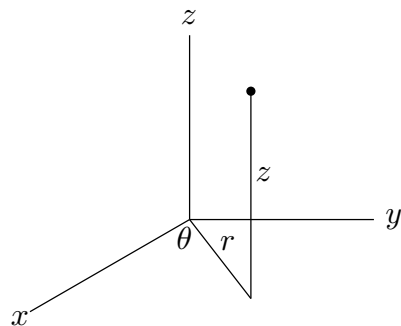


surface of constant y

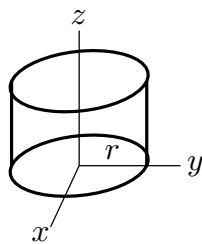


surface of constant z

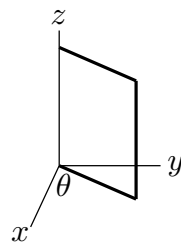
CYLINDRICAL COORDINATES



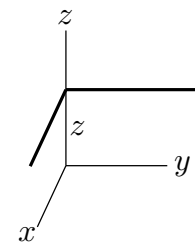
volume element $dV = r dr d\theta dz$



surface of constant r



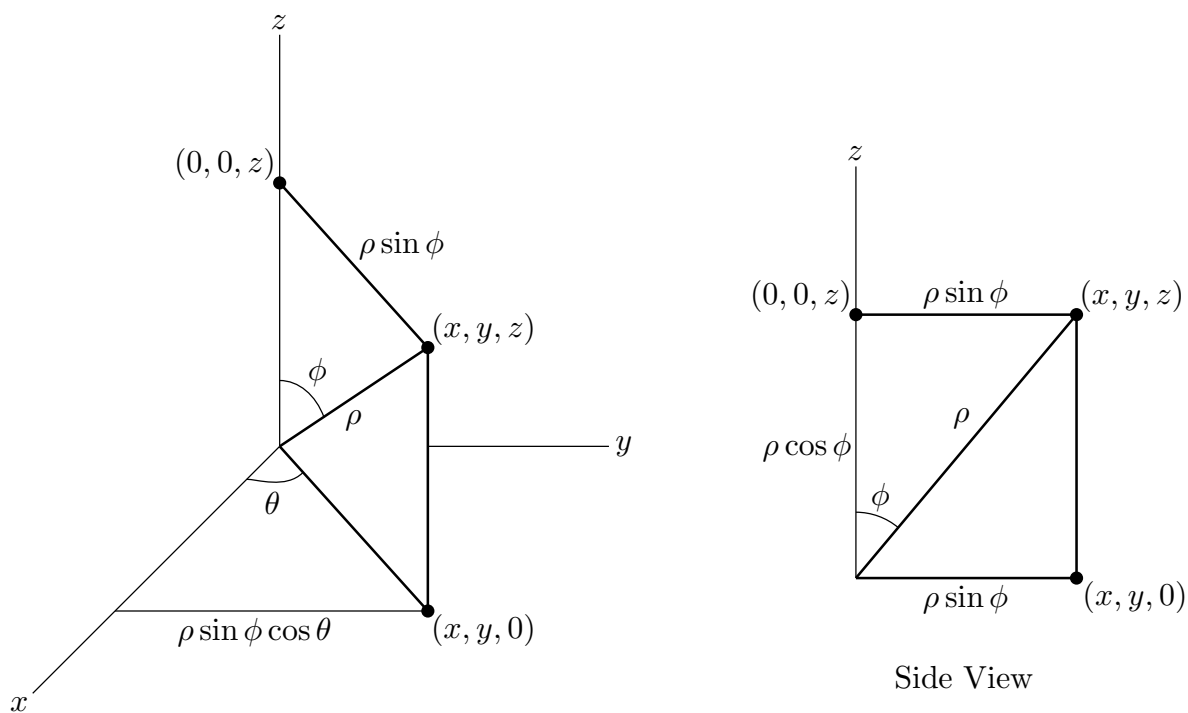
surface of constant θ



surface of constant z

$$\begin{aligned} x &= r \cos \theta & y &= r \sin \theta & z &= z \\ r &= \sqrt{x^2 + y^2} & \theta &= \tan^{-1} \frac{y}{x} & z &= z \end{aligned}$$

SPHERICAL COORDINATES



ρ = distance from (x, y, z) to $(0, 0, 0)$

ϕ = angle between the line $\overline{(0, 0, 0)(x, y, z)}$ and the z axis

θ = angle between the line $\overline{(0, 0, 0)(x, y, 0)}$ and the x axis

$$x = \rho \sin \phi \cos \theta$$

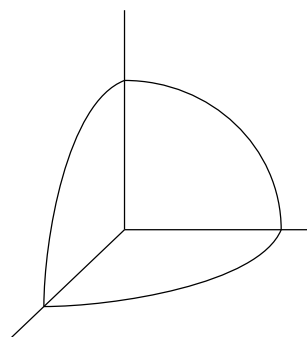
$$y = \rho \sin \phi \sin \theta$$

$$z = \rho \cos \phi$$

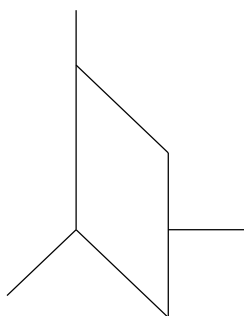
$$\rho = \sqrt{x^2 + y^2 + z^2}$$

$$\theta = \tan^{-1} \frac{y}{x}$$

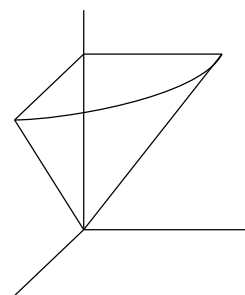
$$\phi = \tan^{-1} \frac{\sqrt{x^2 + y^2}}{z}$$



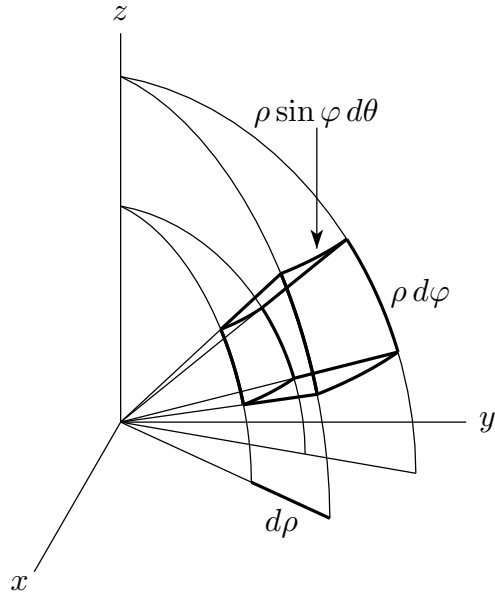
Surface of constant ρ



Surface of constant θ



Surface of constant ϕ



volume element $dV = \rho^2 \sin \varphi d\rho d\theta d\varphi$

