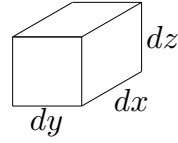
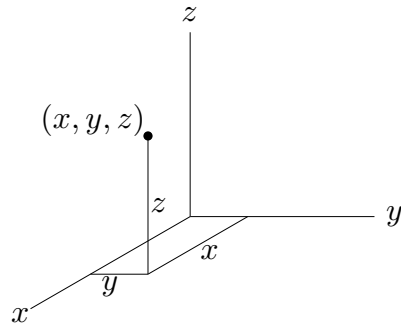
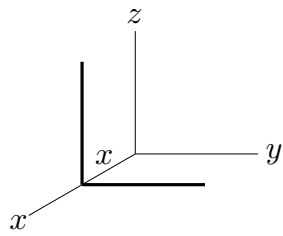


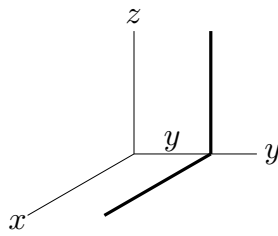
CARTESIAN COORDINATES



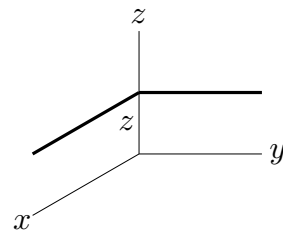
volume element $dV = dx dy dz$



surface of constant x

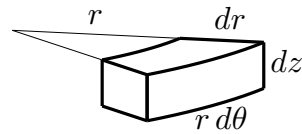
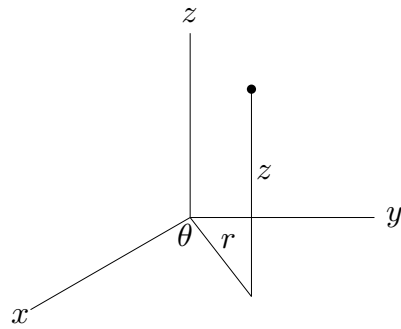


surface of constant y

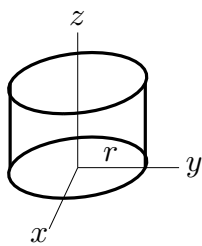


surface of constant z

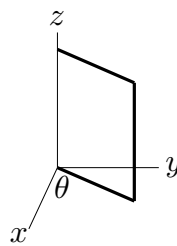
CYLINDRICAL COORDINATES



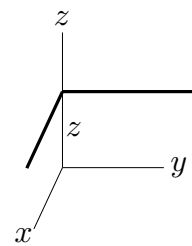
volume element $dV = r dr d\theta dz$



surface of constant r



surface of constant θ

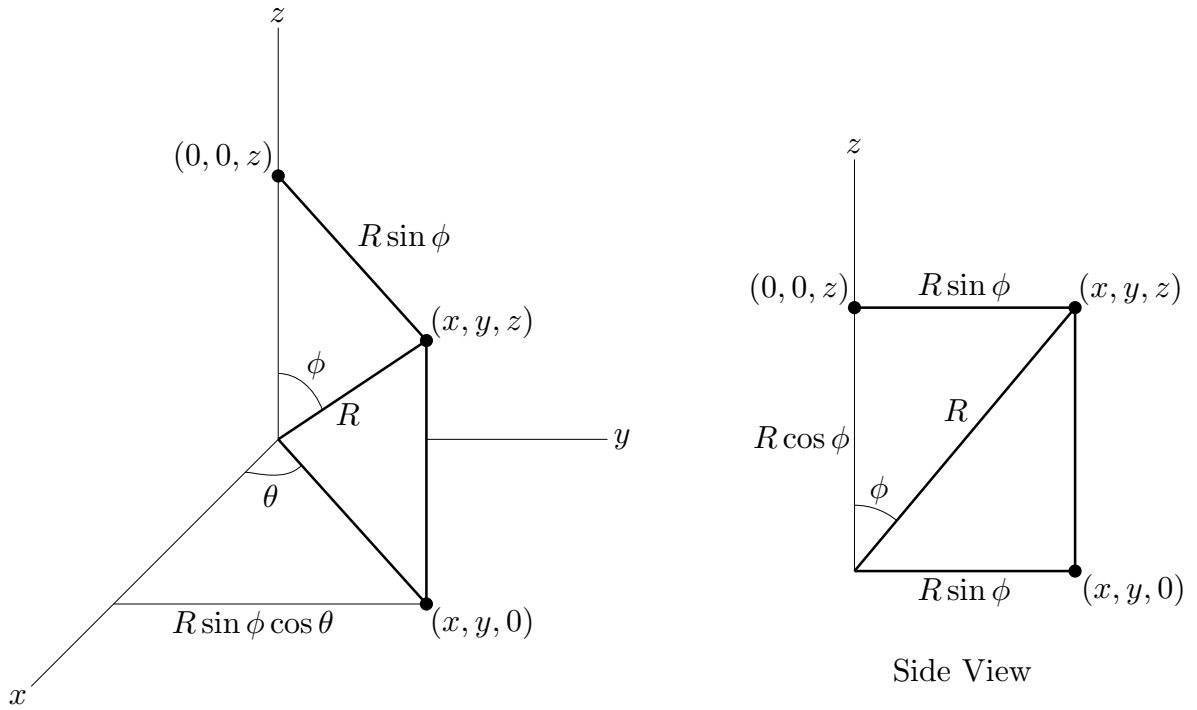


surface of constant z

$$x = r \cos \theta \quad y = r \sin \theta \quad z = z$$

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

SPHERICAL COORDINATES



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

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

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

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

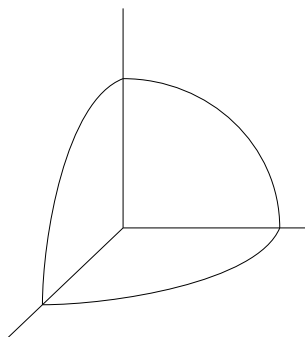
$$y = R \sin \phi \sin \theta$$

$$z = R \cos \phi$$

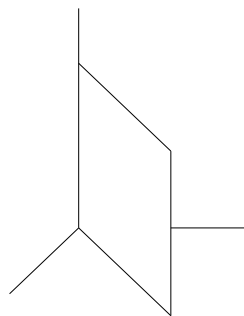
$$R = \sqrt{x^2 + y^2 + z^2}$$

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

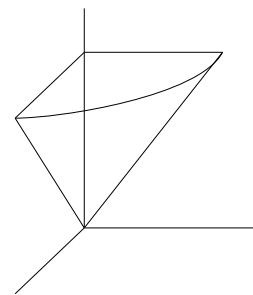
$$\phi = \tan^{-1} \frac{\sqrt{x^2 + y^2}}{z}$$



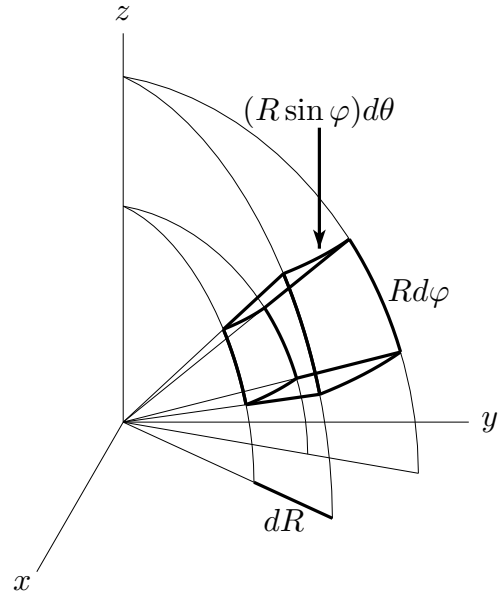
Surface of constant R



Surface of constant θ



Surface of constant ϕ



volume element $dV = R^2 \sin \varphi \, dR \, d\theta \, d\varphi$

