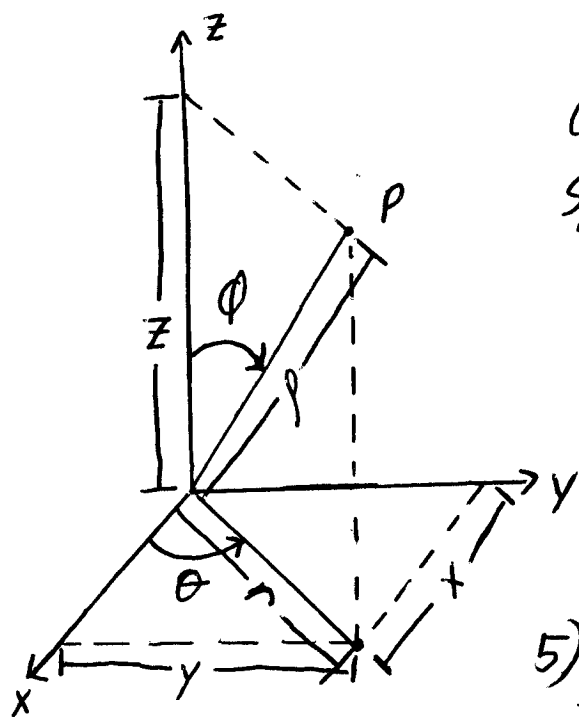


Spherical Coordinates

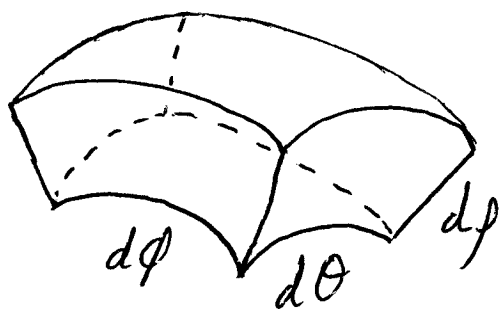


Rectangular Coordinates: $P = (x, y, z)$
 Cylindrical Coordinates: $P = (r, \theta, z)$
 Spherical Coordinates: $P = (\rho, \phi, \theta)$

Identities

- 1) $r = \rho \sin \phi$ 2) $z = \rho \cos \phi$
- 3) $x = r \cos \theta = \rho \sin \phi \cos \theta$
- 4) $y = r \sin \theta = \rho \sin \phi \sin \theta$
- 5) $\rho^2 = x^2 + y^2 + z^2 = r^2 + z^2$

In Spherical Coordinates, our 'lego piece' looks like



and
$$dV = \underbrace{\rho^2 \sin \phi}_{\text{'Exchange Rate'}} d\rho d\phi d\theta$$

- Notes:
- 1) There are six combinations of arranging $d\rho$, $d\phi$, & $d\theta$. List them yourself (Optional H.W.).
 - 2) The dV form above is the one most commonly used because it tends to be the easiest to construct.
 - 3) Analogous to $0 \leq \theta \leq 2\pi$, we restrict the range of angles for ϕ by $0 \leq \phi \leq \pi$, so we do not duplicate coords.
 - 4) ϕ represents the angle away from the positive z -axis in a clock-wise fashion.