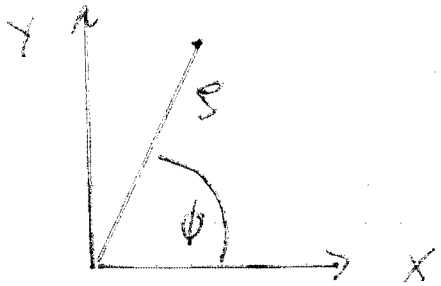
Cylindrical Coordinates:



(1) $x = \rho \cos\phi$

$y = \rho \sin\phi$

(2) $dx = \cos\phi \, d\rho - \rho \sin\phi \, d\phi$

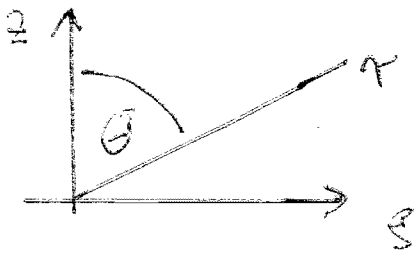
$dy = \sin\phi \, d\rho + \rho \cos\phi \, d\phi$

$dx^2 = \cos^2\phi \, d\rho^2 + \rho^2 \sin^2\phi \, d\phi^2 - 2\rho \sin\phi \cos\phi \, d\rho d\phi$

$dy^2 = \sin^2\phi \, d\rho^2 + \rho^2 \cos^2\phi \, d\phi^2 + 2\rho \sin\phi \cos\phi \, d\rho d\phi$

$$dx^2 + dy^2 = d\rho^2 + \rho^2 d\phi^2$$

Spherical Coordinates:



$z = r \cos\theta$

$\rho = r \sin\theta$

$dz^2 + d\rho^2 = dr^2 + r^2 d\theta^2$; $d\rho^2 = dx^2 + dy^2 - \rho^2 d\phi^2$

$dz^2 + dy^2 + dx^2 = dr^2 + r^2 d\theta^2 + \rho^2 d\phi^2$

$$= dr^2 + r^2 d\theta^2 + r^2 \sin^2\theta \, d\phi^2$$

Velocity: $v^2 = \left(\frac{dx}{dt}\right)^2 + \left(\frac{dy}{dt}\right)^2 + \left(\frac{dz}{dt}\right)^2 = \dot{x}^2 + \dot{y}^2 + \dot{z}^2$

Cylindrical: $= \dot{\rho}^2 + \rho^2 \dot{\phi}^2 + \dot{z}^2$

Spherical: $= \dot{r}^2 + r^2 \dot{\theta}^2 + r^2 \sin^2\theta \, \dot{\phi}^2$