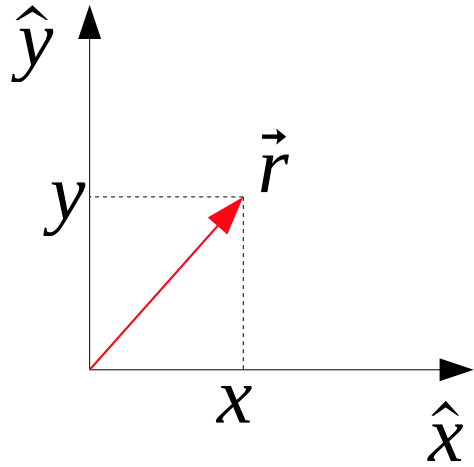


Coordenadas cartesianas: (x,y)



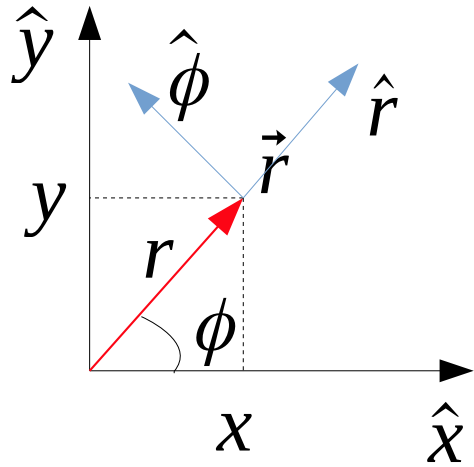
$$\vec{r} = x \hat{x} + y \hat{y}$$

$$\dot{\vec{r}} = \dot{x} \hat{x} + \dot{y} \hat{y}$$

$$\ddot{\vec{r}} = \ddot{x} \hat{x} + \ddot{y} \hat{y}$$

$$\dot{x} = \frac{dx}{dt} \quad \dot{\hat{x}} = \frac{d\hat{x}}{dt} = 0$$

Coordenadas polares: $(x, y) \rightarrow (r, \phi)$



$$x = r \cos(\phi)$$

$$y = r \operatorname{sen}(\phi)$$

$$r \in [0, r]; \phi \in [0, 2\pi]$$

$$\hat{r} = \cos(\phi) \hat{x} + \operatorname{sen}(\phi) \hat{y}$$

$$\hat{\phi} = -\operatorname{sen}(\phi) \hat{x} + \cos(\phi) \hat{y}$$

$$\hat{r}(t), \hat{\phi}(t)$$

$$\vec{r} = r \hat{r}$$

$$\dot{\vec{r}} = \dot{r} \hat{r} + r \dot{\hat{r}} = \dot{r} \hat{r} + r \dot{\phi} \hat{\phi}$$

$$\dot{\hat{r}} = \dot{\phi} \hat{\phi}$$

Coordenadas polares

Velocidad

$$\dot{\vec{r}} = \dot{r} \hat{r} + r \dot{\phi} \hat{\phi}$$

Aceleración

$$\ddot{\vec{r}} = \ddot{r} \hat{r} + \dot{r} \dot{\hat{r}} + \dot{r} \dot{\phi} \hat{\phi} + r \ddot{\phi} \hat{\phi} + r \dot{\phi} \dot{\hat{\phi}}$$

$$\ddot{\vec{r}} = \ddot{r} \hat{r} + \dot{r} \dot{\phi} \hat{\phi} + \dot{r} \dot{\phi} \hat{\phi} + r \ddot{\phi} \hat{\phi} - r \dot{\phi}^2 \hat{r}$$

$$\ddot{\vec{r}} = (\ddot{r} - r \dot{\phi}^2) \hat{r} + (2\dot{r} \dot{\phi} + r \ddot{\phi}) \hat{\phi}$$

$$\dot{\hat{r}} = \dot{\phi} \hat{\phi}$$

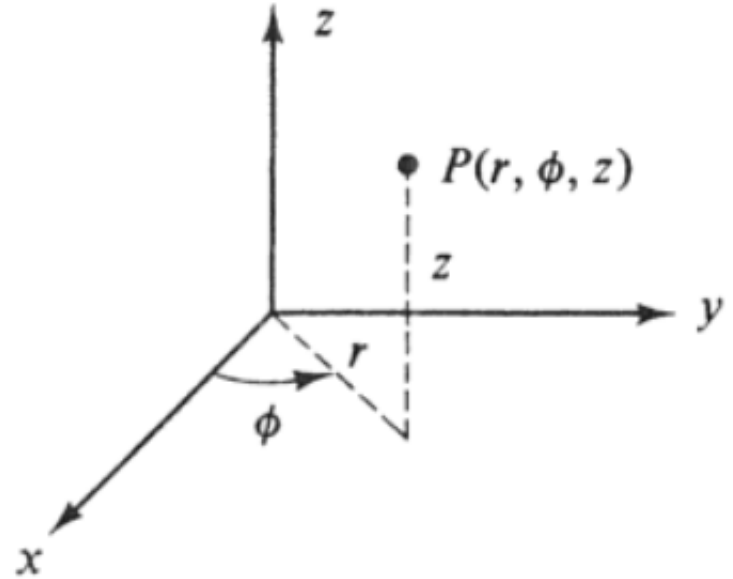
$$\dot{\hat{\phi}} = -\dot{\phi} \hat{r}$$

Coordenadas cilíndricas : $(x, y, z) \rightarrow (r, \phi, z)$

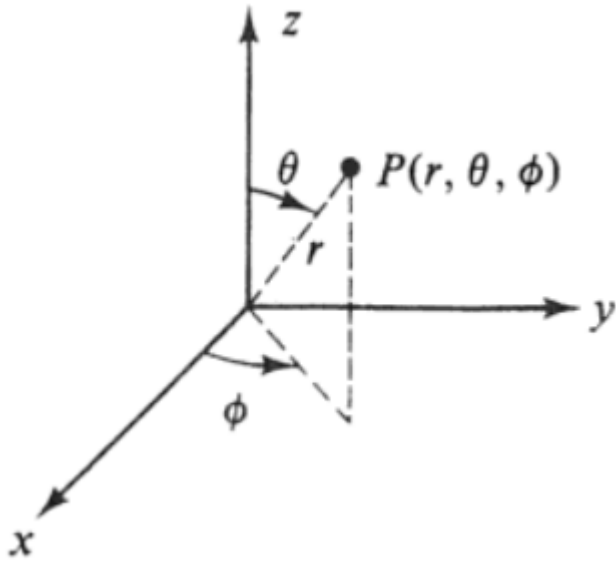
$$\vec{r} = r \hat{r} + z \hat{z}$$

$$\dot{\vec{r}} = \dot{r} \hat{r} + r \dot{\phi} \hat{\phi} + \dot{z} \hat{z}$$

$$\ddot{\vec{r}} = (\ddot{r} - r \dot{\phi}^2) \hat{r} + (2\dot{r} \dot{\phi} + r \ddot{\phi}) \hat{\phi} + \ddot{z} \hat{z}$$



Coordenadas esféricas: $(x, y, z) \rightarrow (r, \theta, \phi)$



$$\hat{r} = \cos(\phi) \operatorname{sen}(\theta) \hat{x} + \operatorname{sen}(\phi) \operatorname{sen}(\theta) \hat{y} + \cos(\theta) \hat{z}$$

$$\hat{\phi} = -\operatorname{sen}(\phi) \hat{x} + \cos(\phi) \hat{y}$$

$$\hat{\theta} = \cos(\phi) \cos(\theta) \hat{x} + \operatorname{sen}(\phi) \cos(\theta) \hat{y} - \operatorname{sen}(\theta) \hat{z}$$

$$r \in [0, r]; \phi \in [0, 2\pi]; \theta \in [0, \pi]$$

Coordenadas esféricas: $(x, y, z) \rightarrow (r, \theta, \phi)$

$$\vec{r} = r \hat{r}$$

$$\dot{\vec{r}} = \dot{r} \hat{r} + r \dot{\hat{r}}$$

$$\dot{\hat{r}} = \frac{d\hat{r}}{dt} = \frac{d\phi}{dt} \frac{d\hat{r}}{d\phi} + \frac{d\theta}{dt} \frac{d\hat{r}}{d\theta} = \dot{\theta} \frac{d\hat{r}}{d\theta} + \dot{\phi} \frac{d\hat{r}}{d\phi}$$

$$\frac{d\hat{r}}{d\theta} = \hat{\theta} \quad \frac{d\hat{r}}{d\phi} = \text{sen}(\theta) \hat{\phi}$$

Velocidad

$$\dot{\vec{r}} = \dot{r} \hat{r} + r \dot{\theta} \hat{\theta} + r \dot{\phi} \text{sen}(\theta) \hat{\phi}$$

Coordenadas esféricas: $(x, y, z) \rightarrow (r, \theta, \phi)$

$$\frac{d\hat{r}}{d\phi} = \text{sen}(\theta) \hat{\phi}$$

$$\frac{d\hat{r}}{d\theta} = \hat{\theta}$$

$$\frac{d\hat{\theta}}{d\phi} = \cos(\theta) \hat{\phi}$$

$$\frac{d\hat{\theta}}{d\theta} = -\hat{r}$$

$$\frac{d\hat{\phi}}{d\phi} = -(\text{sen}(\theta)\hat{r} + \cos(\theta)\hat{\theta})$$

$$\frac{d\hat{\phi}}{d\theta} = 0$$

Aceleración

$$\ddot{\vec{r}} = (\ddot{r} - r\dot{\theta}^2 - r\dot{\phi}^2 \text{sen}(\theta)^2) \hat{r} + (r\ddot{\theta} + 2\dot{r}\dot{\theta} - r\dot{\phi}^2 \cos(\theta) \text{sen}(\theta)) \hat{\theta} + (r\ddot{\phi} \text{sen}(\theta) + 2\dot{r}\dot{\phi} \text{sen}(\theta) + 2r\dot{\theta}\dot{\phi} \cos(\theta)) \hat{\phi}$$