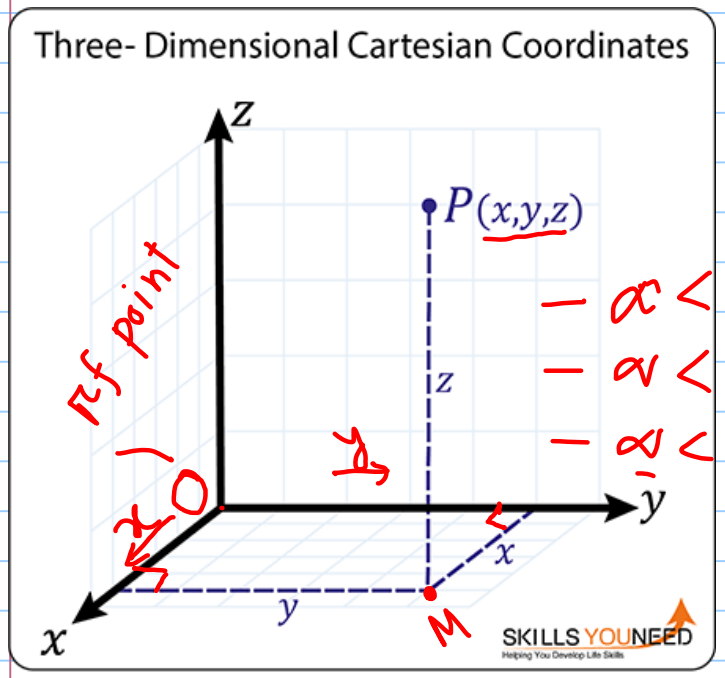
(PHY-111)

Note Title 2/15/2025

2D { P(x, y)
P(r, θ)

3D 1. Cartesian coordinate
2. Spherical Polar Coordinate }

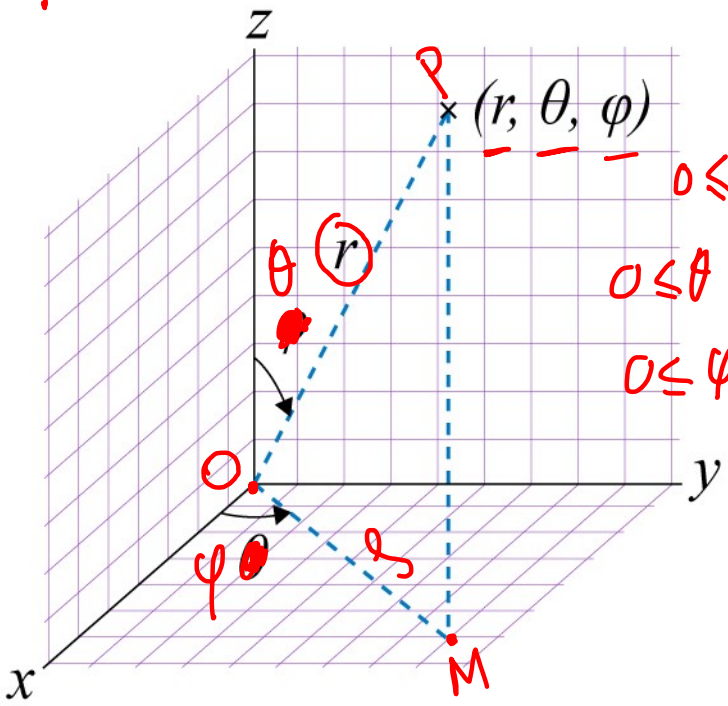


$-\infty < x < \infty$

$-\infty < y < \infty$

$-\infty < z < \infty$

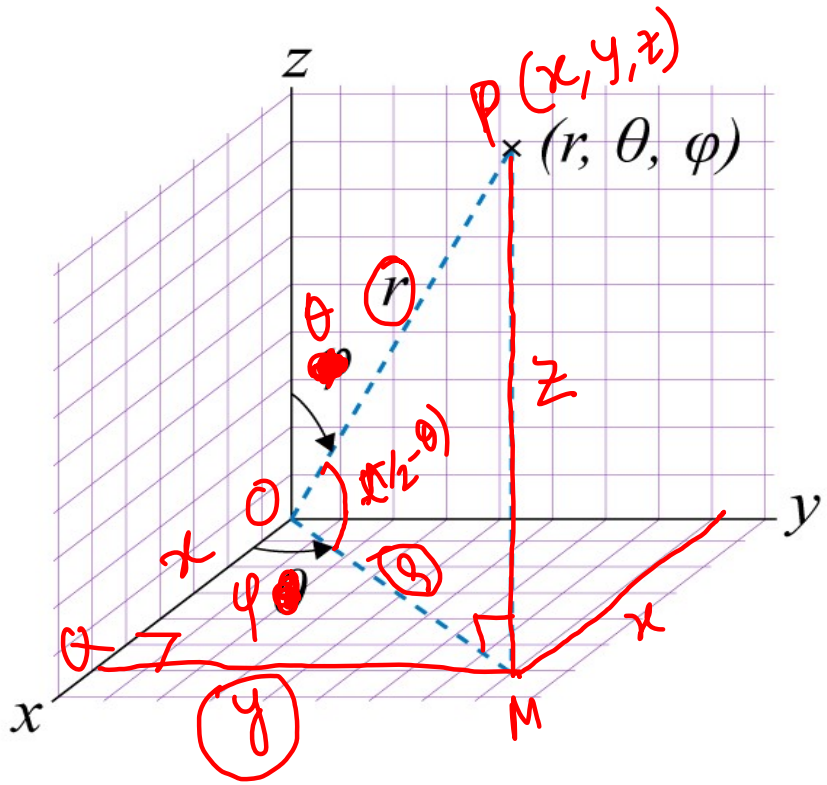
Spherical Polar Coordinate



$0 \leq r < \infty$

$0 \leq \theta \leq \pi$

$0 \leq \varphi \leq 2\pi$



ΔPOM, $\angle PMO = \frac{\pi}{2}$

$\cos\left(\frac{\pi}{2} - \theta\right) = \frac{\rho}{r}$

$\Rightarrow \boxed{r \sin\theta = \rho}$ —(1)

$\sin\left(\frac{\pi}{2} - \theta\right) = \frac{z}{r}$

$\Rightarrow \boxed{r \cos\theta = z}$ —(2)

ΔOQM, $\sin\varphi = \frac{y}{\rho}$

$\Rightarrow y = \rho \sin\varphi$ —(3)

$$\cos\varphi = \frac{x}{\rho} \Rightarrow x = \rho\cos\varphi$$

$$\boxed{x = r\sin\theta\cos\varphi}$$

(3)

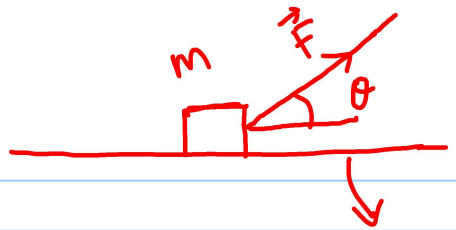
$$\Rightarrow \boxed{y = r\sin\theta\sin\varphi}$$

$(2, \pi/3, \pi)$

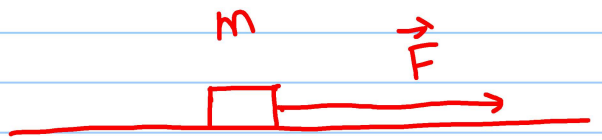
$$\left.\begin{aligned} x &= r\sin\theta\cos\varphi \\ y &= r\sin\theta\sin\varphi \\ z &= r\cos\theta \end{aligned}\right\} \text{(*)}$$

$$\left.\begin{aligned} \boxed{r = \sqrt{x^2+y^2+z^2}} \\ \theta = \cos^{-1}\left(\frac{z}{r}\right) \\ \varphi = \tan^{-1}\left(\frac{y}{x}\right) \end{aligned}\right\} \text{(**)}$$

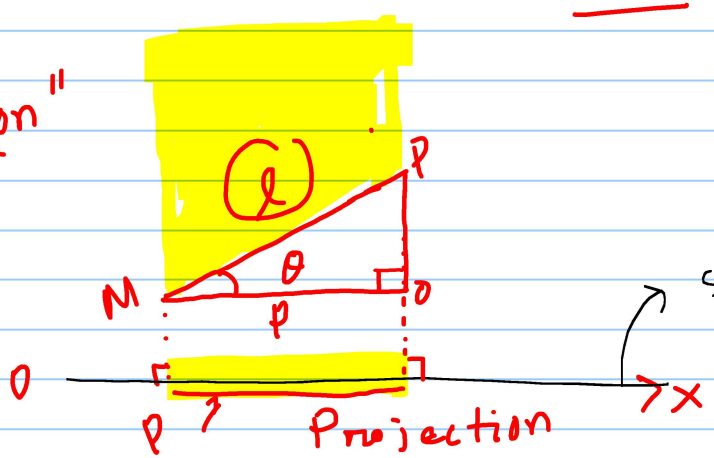
Case-1



Case-II



"Projection"



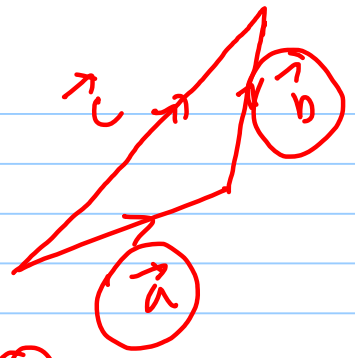
$p \sim l$

$p \sim \cos\theta$

$\Big\} \; p \sim l\cos\theta$

$\cos\theta = \frac{p}{l} \Rightarrow \boxed{p = l\cos\theta}$

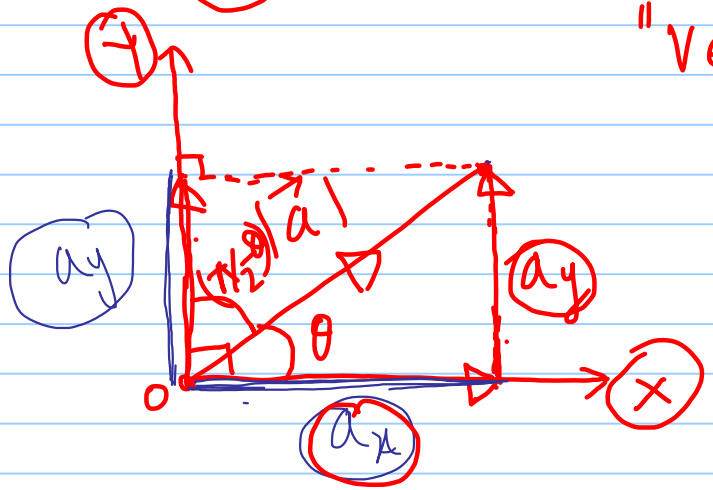
(*)



$\vec{c} = \vec{a} + \vec{b}$; $\vec{a}, \vec{b}$ } → vector components of $\vec{c}$

Resultant

"Vector decompose"

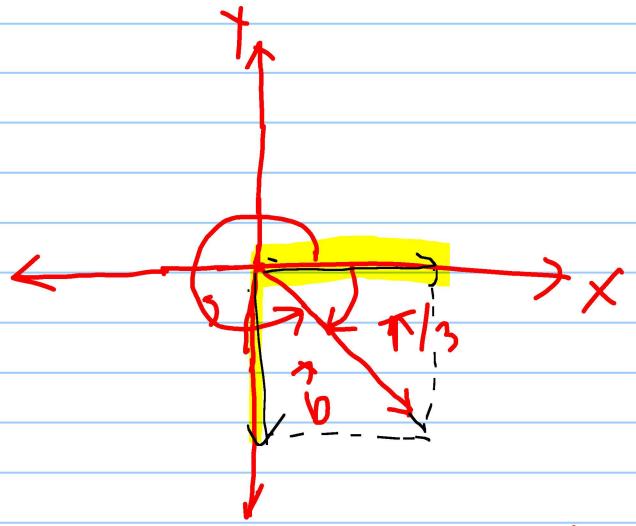


↙ $a_x = |\vec{a}| \cos\theta$

$a_y = |\vec{a}| \cos(\frac{\pi}{2} - \theta)$

↙ $a_y = |\vec{a}| \sin\theta$

$$a = \sqrt{a_x^2 + a_y^2} \quad ; \quad \tan\theta = \frac{a_y}{a_x}$$



$|\vec{b}| = 2\,m$

$$b_x = 2\cos\left(-\frac{\pi}{3}\right) = 1$$

$$b_y = 2\sin\left(-\frac{\pi}{3}\right) = -\sqrt{3}$$

$$b_x = 2\cos\left(2\pi - \frac{\pi}{3}\right)$$

$$b_y = 2\sin\left(2\pi - \frac{\pi}{3}\right)$$