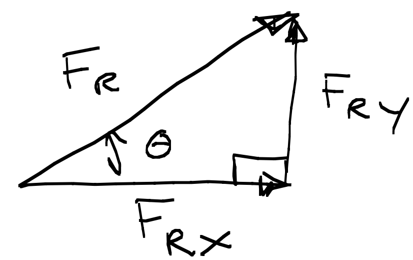
Cartisian Vectors

$$\vec{F}_R = F_{Rx}\hat{i} + F_{Ry}\hat{j}$$

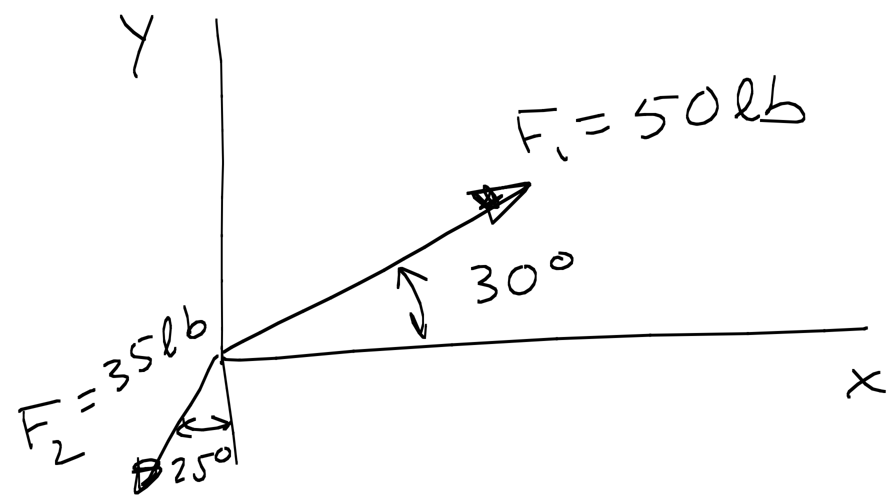


$$F_R = \sqrt{F_{Rx}^2 + F_{Ry}^2}$$

$$\tan\theta = \frac{F_{Ry}}{F_{Rx}}$$

Example

Determine the resultant force



$\overset{+}{\rightarrow}\quad F_{1x} = (50\,lb)(\cos 30^\circ) = \underline{43.3\,lb}$

$+\uparrow\quad F_{1y} = (50\,lb)(\sin 30^\circ) = \underline{25\,lb}$

$\overset{+}{\rightarrow}\quad F_{2x} = -(35\,lb)(\sin 25^\circ) = \underline{-14.8\,lb}$

$+\uparrow\quad F_{2y} = -(35\,lb)(\cos 25^\circ) = \underline{-31.7\,lb}$

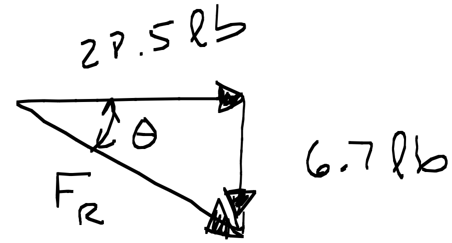
$F_{Rx} = 43.3\,lb - 14.8\,lb = \boxed{28.5\,lb}$

$F_{Ry} = 25\,lb - 31.7\,lb = \boxed{-6.7\,lb}$

$\boxed{\vec{F}_R = \{28.5\,\hat{i} - 6.7\,\hat{j}\}\,lb}$

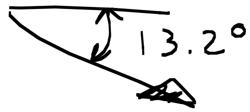
$F_R = \sqrt{(28.5)^2 + (6.7)^2}$

$\boxed{F_R = 29.3\,lb}$



$$\tan\theta = \frac{6.7\,lb}{28.5\,lb} \qquad \theta = 13.2^\circ$$

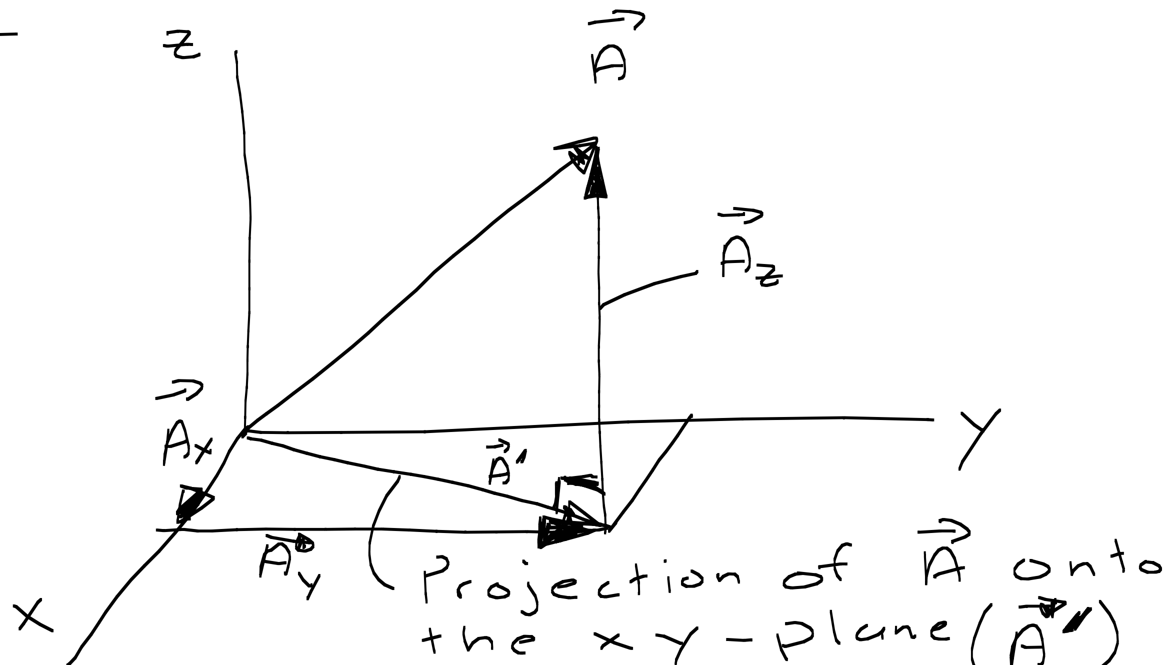
$$\boxed{\vec{F}_R = 29.3\,lb}$$



Vectors in 3-D

Right Hand Rule => to define coordinate axes

$$\vec{A} = \vec{A}_x + \vec{A}_y + \vec{A}_z$$



Unit Vector

- Specify the direction of $\vec{A}$
- Has a magnitude of 1

$$\boxed{\vec{u}_A = \frac{\vec{A}}{A} \qquad \vec{A} = A\,\vec{u}_A}$$

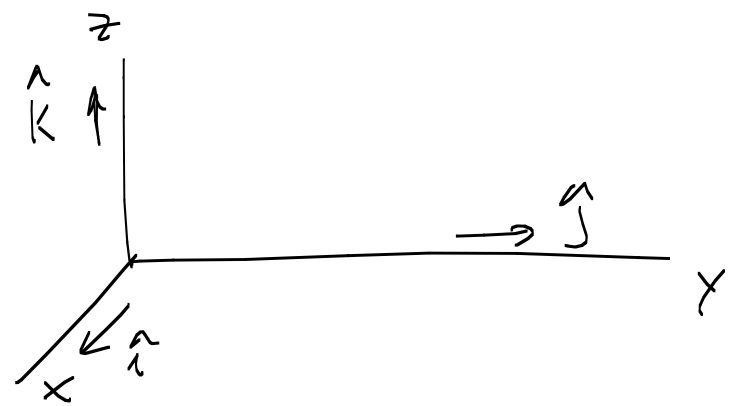
$\vec{A}$ — vector

A — scalar

unit vector is dimensionless

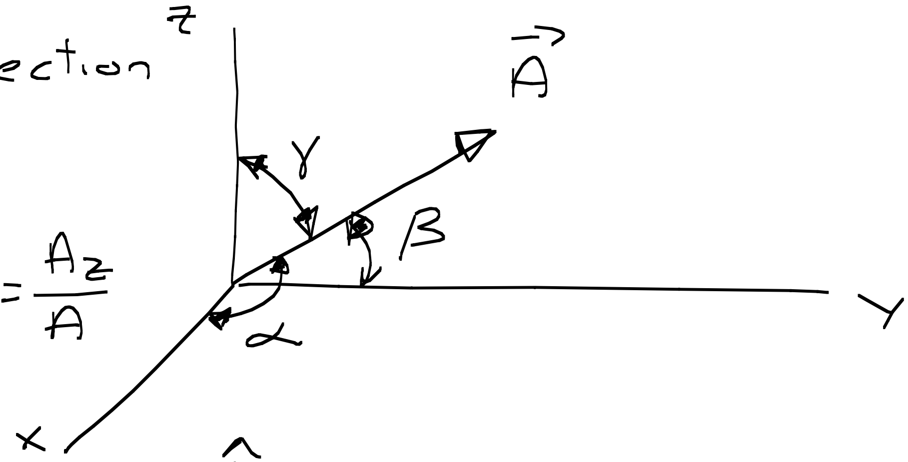
$$\vec{A} = A_x\hat{i} + A_y\hat{j} + A_z\hat{k}$$

$$A = \sqrt{A_x^2 + A_y^2 + A_z^2}$$



Direction of the Cartesian Vector

$\alpha, \beta, \gamma \Rightarrow$ Coordinate Direction Angles



$$\cos\alpha = \frac{A_x}{A}, \quad \cos\beta = \frac{A_y}{A}, \quad \cos\gamma = \frac{A_z}{A}$$

$$\vec{u}_A = \frac{\vec{A}}{A} = \frac{A_x\hat{i} + A_y\hat{j} + A_z\hat{k}}{A}$$

$$= \underbrace{\frac{A_x}{A}}_{\cos\alpha}\hat{i} + \underbrace{\frac{A_y}{A}}_{\cos\beta}\hat{j} + \underbrace{\frac{A_z}{A}}_{\cos\gamma}k$$

$$\boxed{\vec{u}_A = \cos\alpha\,\hat{i} + \cos\beta\,\hat{j} + \cos\gamma\,\hat{k}}$$

$$u_A = \cos^2\alpha + \cos^2\beta + \cos^2\gamma$$

but $u_A = 1$

$$\boxed{\cos^2\alpha + \cos^2\beta + \cos^2\gamma = 1}$$

$A_x = A\cos\alpha$, $A_y = A\cos\beta$, $A_z = A\cos\gamma$

Vector Addition & Subtraction Rules still apply

$$F_{Rx} = \Sigma F_x$$

$$F_{Ry} = \Sigma F_y$$

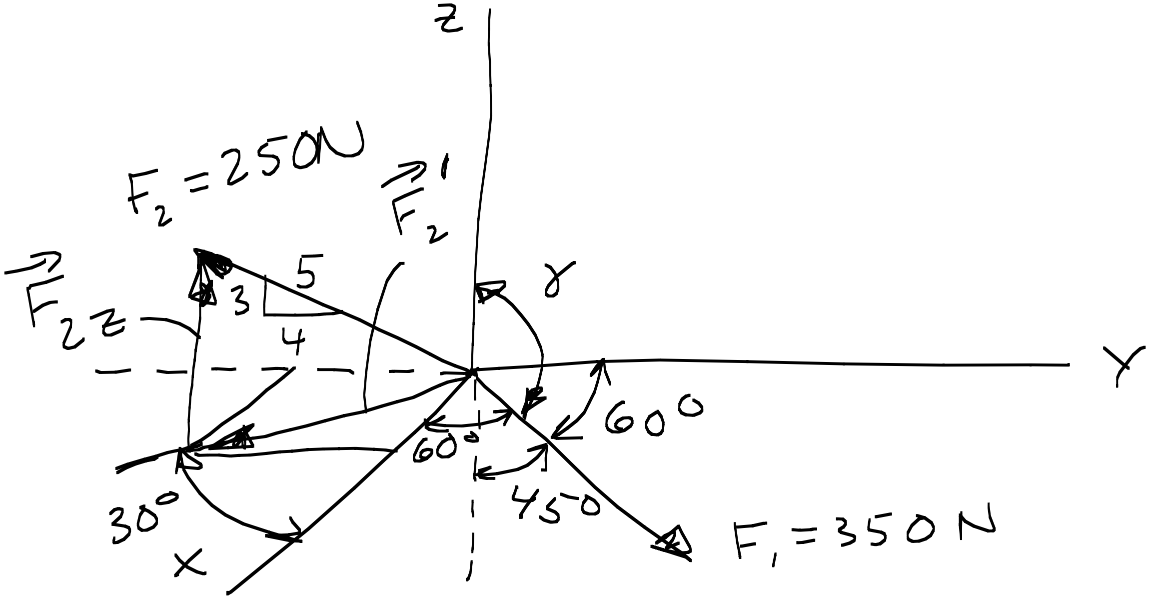
$$F_{Rz} = \Sigma F_z$$

Example

Determine

$\vec{F}_1$ & $\vec{F}_2$ as

cartesian vectors



$\vec{F}_1$

Coordinate Direction Angle $\quad \gamma = 180° - 45° = 135°$

$$F_{1x} = F_1 \cos\alpha = (350N)(\cos 60°) = 175N$$

$$F_{1y} = F_1 \cos\beta = (350N)(\cos 60°) = 175N$$

$$F_{1z} = F_1 \cos\gamma = (350N)(\cos 135°) = -247.5N$$

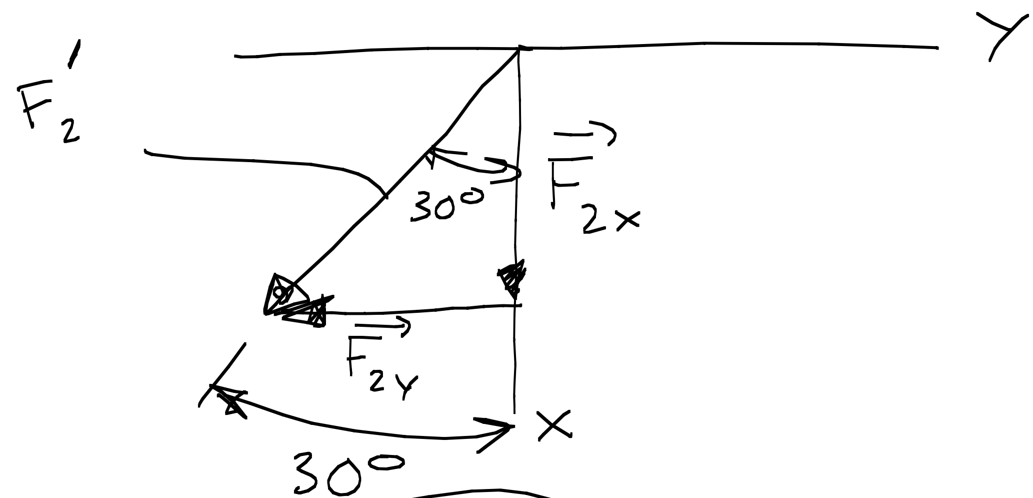
$$\boxed{\vec{F}_1 = \{175\hat{i} + 175\hat{j} - 247.5\hat{k}\}N}$$

$\underline{\vec{F}_2}$

$F_{2z} = (250\,N)\left(\frac{3}{5}\right) = \underline{150\,N}$

$F_2' = (250\,N)\left(\frac{4}{5}\right) = \underline{200\,N}$

$F_{2x} = (200\,N)(\cos 30^\circ) = 173.2\,N$



$F_{2y} = -(200\,N)(\sin 30^\circ)$

$F_{2y} = -100\,N$

$$\boxed{\vec{F}_2 = \{173.2\,\hat{i} - 100\,\hat{j} + 150\,\hat{k}\}\,N}$$