Vectors

A vector is a quantity that has both magnitude and direction. For example, displacement, velocity, acceleration, and force are all vectors, as each of these quantities have a magnitude and direction associated with them.

To add vectors, they must first be decomposed into their x- and y- components. Like components are then added together. The resultant vector is then recomposed to determine its magnitude and direction.

Example: Two vectors, \vec{A} and \vec{B} , are shown in the figure below. Find the resultant vector, $\vec{R} = \vec{A} + \vec{B}$, and include its direction as an angle from the positive x-axis.



STEP 1: DECOMPOSE THE VECTORS

À

386 N

30°

Âx

Av

SOH CAH TOA can be used to determine \overrightarrow{Ax} and \overrightarrow{Ay} . Since \overrightarrow{Ax} is pointing right and \overrightarrow{Ay} is pointing upward, both the x- and y-components are positive.





SOH CAH TOA can now be used to determine \overrightarrow{B}_X and \overrightarrow{By} . Since \overrightarrow{B}_X is pointing left and \overrightarrow{By} is pointing upward, the x-component is negative and the y-component is positive.

$$B_x = -523 \cos(45^\circ) \qquad B_y = 523 \sin(45^\circ) \\ = -370 \text{ N} \qquad = 370 \text{ N}$$

$R_x = A_x + B_x$	$R_y = A_y + B_y$
= 334 + (-370)	= 193 + 370
= -36 N	= 563 N

STEP 3: RECOMPOSE THE VECTOR

To determine the resultant vector, \vec{R} , use vector addition to find $\vec{Rx} + \vec{Ry}$. Since these vectors are perpendicular, Pythagorean Theorem may be used to calculate the magnitude of \vec{R} . SOH CAH TOA can then be used to determine the direction of \vec{R} .



Magnitude of
$$\overrightarrow{\mathbf{R}}$$
:

$$R = \sqrt{R_x^2 + R_y^2}$$

$$= \sqrt{(-36)^2 + (563)^2}$$

$$= 564 \text{ N}$$
Direction of $\overrightarrow{\mathbf{R}}$:

$$\tan \theta = \frac{\text{opp}}{\text{adj}} \qquad \theta = \tan^{-1} \left| \frac{R_y}{R_x} \right|$$

$$\tan \theta = \frac{R_y}{R_x} \qquad = \tan^{-1} \left| \frac{563}{-36} \right|$$

$$= 86.3^{\circ}$$

To determine the angle from the positive x-axis, $\Phi,$ subtract θ from 180°.

 $\Phi = 180^{\circ} - 86.3^{\circ}$ $\Phi = 93.7^{\circ}$

Therefore the resultant vector is:

 \vec{R} = 564 N [93.7° CCW from the positive x-axis]

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