1.2.22

AI24BTECH11024-Pappuri Prahladha

Question:
Rain is falling vertically at a speed of $35ms^{-1}$.Winds start blowing after sometime with a speed of $12ms^{-1}$ in east to west direction.In which direction should a boy waiting at a bus stop hold his umbrella ?
Solution:

Term	Description
$\mathbf{V_1}$	velocity vector of Rain
$\mathbf{V_2}$	velocity vector Wind
$\mathbf{V_3}$	Resultant velocity vector of Rain and Wind
θ	Angle made by umbrella with horizontal

TABLE 1: Terms used

Velocity vector of rain:

$$\mathbf{V_1} = \begin{pmatrix} 0 \\ -35 \end{pmatrix} \tag{0.1}$$

Velocity vector of Wind:

$$\mathbf{V_2} = \begin{pmatrix} -12 \\ 0 \end{pmatrix} \tag{0.2}$$

The trajectory of Rain Drops is along the resultant velocity vectors of Rain and Wind.

The resultant velocity vector:

$$\mathbf{V_1} + \mathbf{V_2} = \begin{pmatrix} 0 \\ -35 \end{pmatrix} + \begin{pmatrix} -12 \\ 0 \end{pmatrix} \tag{0.3}$$

$$\mathbf{V_3} = \begin{pmatrix} -12 \\ -35 \end{pmatrix} \tag{0.4}$$

Let the origin be O:

$$O = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \tag{0.5}$$

The direction vector of AB is defined as:

$$\mathbf{M} = \mathbf{B} - \mathbf{A} = k\begin{pmatrix}1\\m\end{pmatrix} \tag{1.1.1.1}$$

Where m is the slope of AB.we can also say that

$$\mathbf{m} \equiv k\begin{pmatrix}1\\m\end{pmatrix} \tag{1.1.1.2}$$

So the direction vector of O and v_3 is:

$$\mathbf{D} = \mathbf{V_3} - \mathbf{O} = \begin{pmatrix}-12\\-35\end{pmatrix} = -12\begin{pmatrix}1\\\frac{35}{12}\end{pmatrix} \tag{0.6}$$

From equation 0.6 slope of direction vector OV_3 is

$$Slope = \frac{35}{12} \tag{0.7}$$

The required angle(θ) made by umbrella axis with the horizontal is;

$$\theta = \tan^{-1}\left(\frac{35}{12}\right) = 71.075^\circ \tag{0.8}$$

$\therefore$ The boy hold the umbrella at an angle 71.075° with horizontal direction

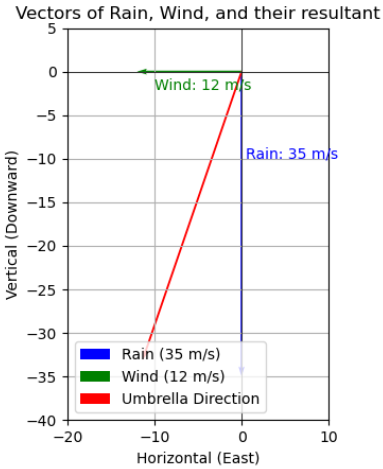

Fig. 0.1: Plot showing the velocity vectors