

1.2.27

AI25BTECH11019 - MENAVATH SAI SANJANA

Question:

Rain is falling vertically with a speed of (30 , m/s). A woman rides a bicycle with a speed of (10 , m/s) in the north to south direction. What is the direction in which she should hold her umbrella?

Solution:

$$\vec{v}_r = \begin{pmatrix} 0 \\ 30 \end{pmatrix} \quad (\text{rain velocity : 30 m/s downward}) \quad (0.1)$$

$$\vec{v}_w = \begin{pmatrix} 10 \\ 0 \end{pmatrix} \quad (\text{woman velocity : 10 m/s south}) \quad (0.2)$$

$$\vec{v}_{r/w} = \vec{v}_r - \vec{v}_w \quad (0.3)$$

$$= \begin{pmatrix} 0 \\ 30 \end{pmatrix} - \begin{pmatrix} 10 \\ 0 \end{pmatrix} \quad (0.4)$$

$$= \begin{pmatrix} -10 \\ 30 \end{pmatrix}. \quad (0.5)$$

Horizontal component (north) =10 m/s,

Vertical component (down) =30 m/s.

$$\tan \theta = \frac{10}{30} = \frac{1}{3} \Rightarrow \theta = \arctan\left(\frac{1}{3}\right) \approx 18.43^\circ.$$

Conclusion: In her frame the rain comes from slightly ahead (from the south and above), so she should tilt the umbrella forward (toward the direction of motion, i.e. south) by $\theta = \arctan(1/3) \approx 18.43^\circ$.

3D Relative Velocity Diagram with Tilt Angle

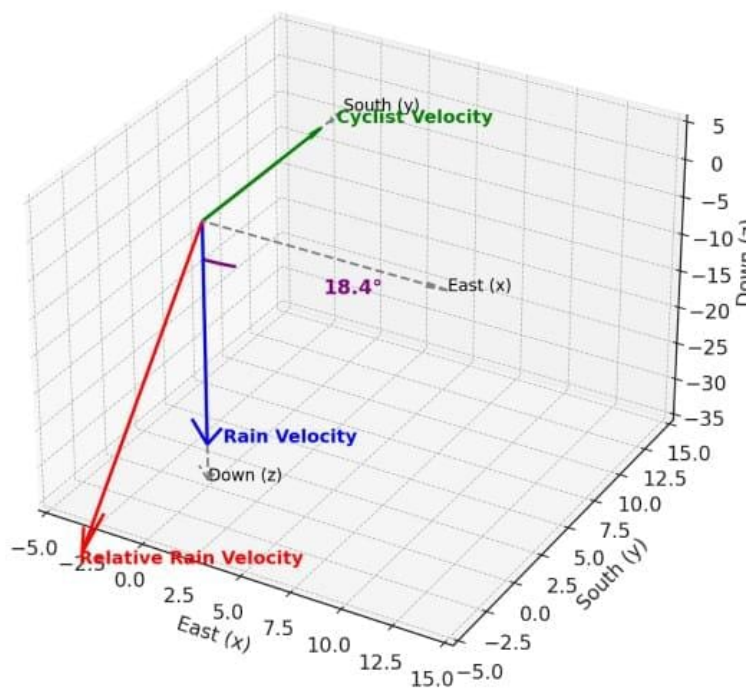


Fig. 0.1