1.2.29

AI25BTECH11021 - Abhiram Reddy N

Question:
In a harbour, wind is blowing at the speed of 72 km/h and the flag on the mast of a boat anchored in the harbour flutters along the N–E direction. If the boat starts moving at a speed of 51 km/h to the north, what is the direction of the flag on the mast of the boat?

Solution:

Step 1: Represent given velocities as vectors

The wind velocity (ground frame) is along the NE direction with speed 72 km/h:

$$W = \begin{bmatrix} 72\cos 45^\circ \\ 72\sin 45^\circ \end{bmatrix} = \begin{bmatrix} 50.91 \\ 50.91 \end{bmatrix} \text{ km/h}.$$

The boat velocity (ground frame) is northward with speed 51 km/h:

$$V = \begin{bmatrix} 0 \\ 51 \end{bmatrix} \text{ km/h}.$$

Step 2: Relative wind (wind as seen from the boat)

$$R = W - V = \begin{bmatrix} 50.91 \\ 50.91 \end{bmatrix} - \begin{bmatrix} 0 \\ 51 \end{bmatrix} = \begin{bmatrix} 50.91 \\ -0.09 \end{bmatrix}.$$

Step 3: Direction of the relative wind

$$\theta = \tan^{-1}\left(\frac{-0.09}{50.91}\right) \approx -0.1^\circ$$

Thus, the relative wind is almost exactly eastward, slightly south of east.

The flag on the mast points nearly East, slightly tilted South.

Symbol	Description / value
W	Wind vector (ground), magnitude 72 km/h, direction NE (45°)
V	Boat velocity (ground) = (0, 51) km/h (north)
R	Relative wind = **W** − **V**
$\|\|\mathbf{R}\|\|$	Magnitude of relative wind ≈ 50.9118 km/h
θ	Direction of flag measured from East: ≈ −0.0994° (south of east)

TABLE 0: variables and numerical values

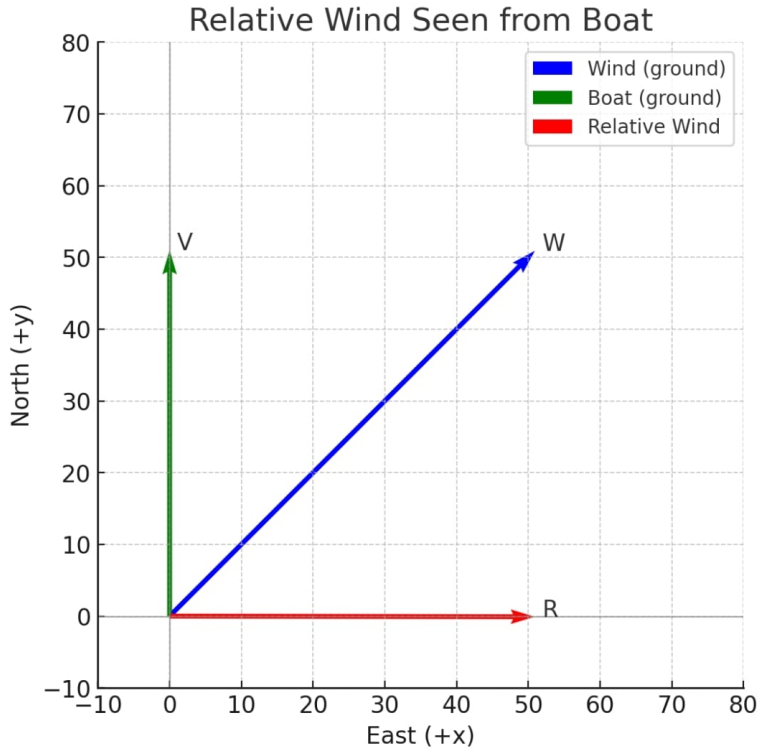

Fig. 0.1: Relative wind vector **R** obtained as **W** – **V**