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:
Choose axes: $+y$ = North, $+x$ = East.
Wind vector (ground frame), pointing NE (45°):

$$\mathbf{W} = 72(\cos 45° \, \mathbf{i} + \sin 45° \, \mathbf{j}) = (72/\sqrt{2}, \ 72/\sqrt{2}).$$

Boat velocity (ground frame) northward:

$$\mathbf{V} = (0, \ 51).$$

Relative wind (wind seen from boat) is

$$\mathbf{R} = \mathbf{W} - \mathbf{V} = \left(\tfrac{72}{\sqrt{2}}, \ \tfrac{72}{\sqrt{2}} - 51 \right).$$

Numerically,

$$\mathbf{R} \approx (50.9117, \ -0.08831) \text{ km/h}.$$

Magnitude:

$$\|\mathbf{R}\| \approx 50.9118 \text{ km/h}.$$

Direction: angle measured from the East axis (positive = north of east)

$$\theta = \arctan \frac{y}{x} = \arctan \frac{-0.08831}{50.9117} \approx -0.0994°.$$

So the relative wind (flag) points **about** $0.099°$ **south of east** (i.e. almost due east).

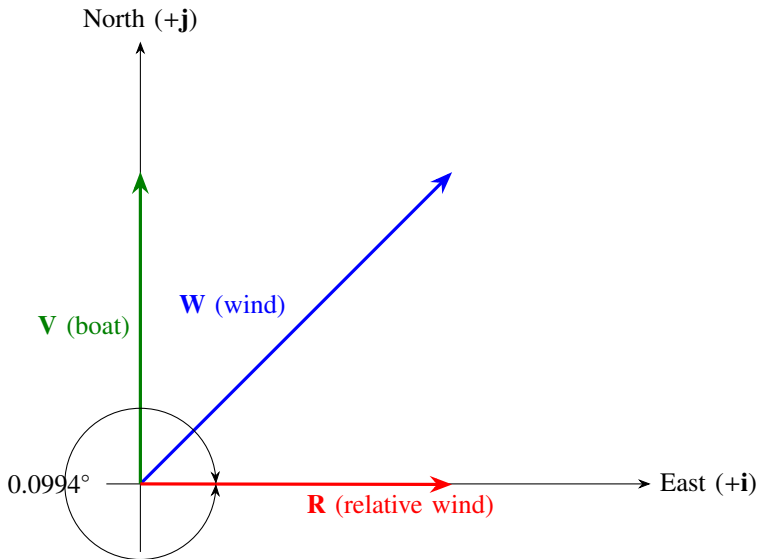| Symbol	Description / value
$\mathbf{W}$	Wind vector (ground), magnitude 72 km/h, direction NE (45°)
$\mathbf{V}$	Boat velocity (ground) = (0, 51) km/h (north)
$\mathbf{R}$	Relative wind = $\mathbf{W} - \mathbf{V}$
$\|\mathbf{R}\|$	Magnitude of relative wind ≈ 50.9118 km/h
θ	Direction of flag measured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

TABLE 0: variables and numerical values

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