1.2.26

AI24BTECH11036 - Shreedhanvi Yadlpally

Question:
A man can swim with a speed of 4.0 km/h in still water. How long does he take to cross a river 1.0 km wide if the river flows steadily at 3.0 km/h and he makes his strokes normal to the river current? How far down the river does he go when he reaches the outer bank?
Solution:

Variable	Description
v_m	Speed of the man in still water
v_r	Speed of the river flow
w	Width of the river
t	Time taken to cross the river
d	Distance drifted downstream

TABLE 0: Variables Used

$$v_m = 4.0 \text{ km/h} \tag{0.1}$$

$$v_r = 3.0 \text{ km/h} \tag{0.2}$$

$$w = 1.0 \text{ km} \tag{0.3}$$

The man is swimming perpendicular to the river current, so his speed relative to the riverbank is 4.0 km/h (which is his speed in still water). Then,

$$t = \frac{w}{v_m} = \frac{1.0 \text{ km}}{4.0 \text{ km/h}} = 0.25 \text{ hours} \tag{0.4}$$

For the distance he drifts downstream when he reaches the other bank,

$$d = v_r \times t = 3.0 \text{ km/h} \times 0.25 \text{ hours} = 0.75 \text{ km} \tag{0.5}$$

For the resultant velocity vector

$$\mathbf{v_m} = \begin{pmatrix} 0 \\ 4 \end{pmatrix} \text{ km/h} \tag{0.6}$$

$$\mathbf{v_r} = \begin{pmatrix} 3 \\ 0 \end{pmatrix} \text{ km/h} \tag{0.7}$$

$$\mathbf{v_{res}} = \mathbf{v_m} + \mathbf{v_r} = \begin{pmatrix} 3 \\ 4 \end{pmatrix} \text{ km/h} \tag{0.8}$$

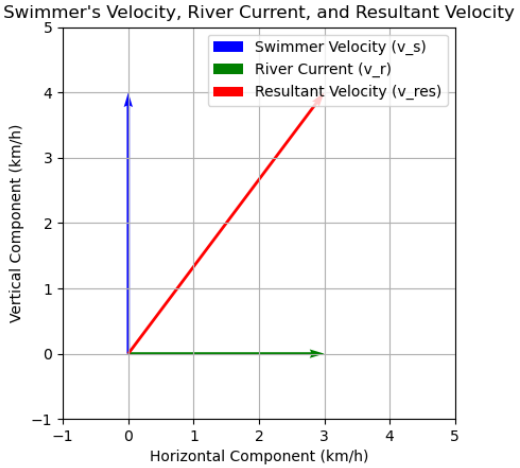

Fig. 0.1: Vector Plot

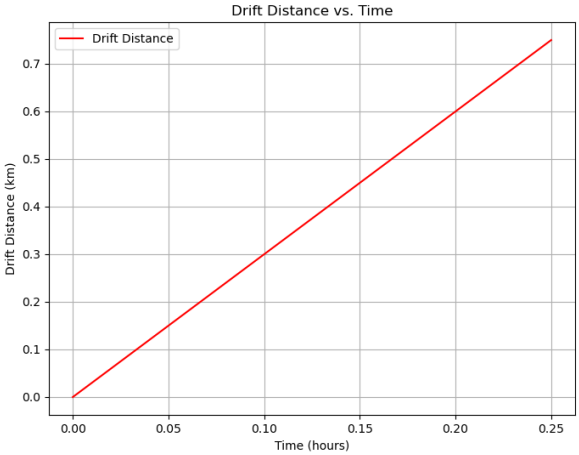

Fig. 0.2: Drift vs time taken