Relative Velocity Solution

\[ \vec{V}_{AB} = \vec{V}_{AC} + \vec{V}_{CB} \]

You attempt to cross a 40 m wide river with a 12 m/s current in a motor boat with speed 16 m/s.

a) What is your speed relative to the shore if you aim your boat straight across the river (so that your velocity relative to the moving water is 16 m/s)? **20 m/s**

\[ V_{AB} = 20 \, \text{m/s} \]

b) How long does it take you to cross the river with this velocity?

(A) 2.0 s  (B) 2.5 s  (C) 3.3 s  (D) 3.8 s

Explain your reasoning.

\[ \Delta t = \frac{\Delta x}{V_x} = \frac{30 \, \text{m}}{12 \, \text{m/s}} = \frac{10}{4} \, \text{s} = 2.5 \, \text{s} \]

c) At what angle (relative to straight across) should you aim to take a direct path across the river (so that you have a component of velocity directed opposite the current equal to 12 m/s)? **48.6°**

\[ \theta = \sin^{-1}\left(\frac{12}{16}\right) = 48.6° \]

d) What is your speed relative to the shore with your boat aimed at the angle from (c)? **10.58 m/s**

\[ V_{AB} = V_{AC} - V_{CB} = 16^2 - 12^2 = 142 \]

\[ V_{AB} = \sqrt{142} \, \text{m/s} \]

\[ \approx 10 \, \text{m/s} \]

e) How long does it take you to cross the river at the angle from (c)?

(A) 2.0 s  (B) 2.5 s  (C) 3.3 s  (D) 3.8 s

Explain your reasoning.

\[ \Delta t = \frac{\Delta x}{V_x} = \frac{40 \, \text{m}}{\sqrt{142} \, \text{m/s}} \approx 4 \, \text{s} \]