Relative Motion

$\vec{V}_{om}$ → $\vec{v}$ of the object in the medium

$\vec{V}_{mg}$ → $\vec{v}$ of the medium w.r.t. the ground

$\vec{V}_{og}$ → $\vec{v}$ of the object w.r.t. the ground

$$\vec{V}_{om} + \vec{V}_{mg} = \vec{V}_{og}$$

Examples:

The Ottawa river is 1.1 km wide and flows east at 3.5 $\frac{m}{s}$. If (starts south side) a swimmer heads straigh across, averaging 1.2 $\frac{m}{s}$, determine...

a) their $\vec{v}$ w.r.t. the ground

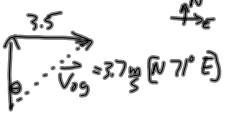
b) the time it takes to cross

c) how far downstream they land

$\vec{V}_{om} = 1.2 \frac{m}{s}$ [N]

$\vec{V}_{mg} = 3.5 \frac{m}{s}$ [E]

$\vec{V}_{om} + \vec{V}_{mg} = \vec{V}_{og}$

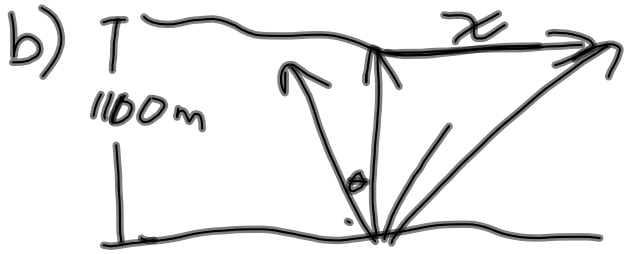


Pyth.... $V_{og} = 3.7 \frac{m}{s}$

$\theta = 71°$

$\vec{V}_{og} = 3.7 \frac{m}{s}$ [N 71° E]

b) T



N - S

$v = 1.2 \frac{m}{s}$

$d = 1100$ m

$t = 917$ s

E - W

$v = 3.5 \frac{m}{s}$

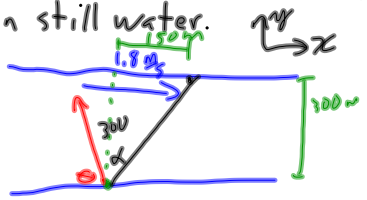
$d = x$

$t = 917$ s

$x = (3.5)(917)$

$= 3.2$ km

A swimmer on the bank of a river flowing $1.8\ \frac{m}{s}$ wants to land 150 m downstream. If the river is 300 m wide, in what direction does she have to swim? Assume she can swim $2.2\ \frac{m}{s}$ in still water.



$\vec{V}_{sw} = 2.2\ \frac{m}{s}[?]$

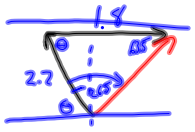
$\vec{V}_{wg} = 1.8\ \frac{m}{s}[\rightarrow x]$

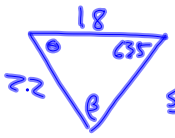
$\vec{V}_{sg} = V[\text{N } 26.5° \text{ W}]$

$\tan\alpha = \frac{150}{300}$

$\alpha = 26.5°$

$\vec{V}_{sw} + \vec{V}_{wg} = \vec{V}_{sg}$



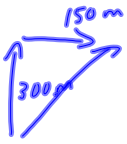


$\frac{\sin\beta}{1.8} = \frac{\sin 63.5}{2.2}$

$\beta = 47°$

$180 = \theta + 47 + 63.5$

$\theta = 69.5$



∴ The swimmer must head 69.5° upstream from the shore

$\vec{v} = \frac{\vec{d}}{t}$