Navigation Vectors

Tuesday, November 02, 2010 1:53 PM

These are situations where vectors are used in river crossing and airplane navigation.

River Crossing Problems:

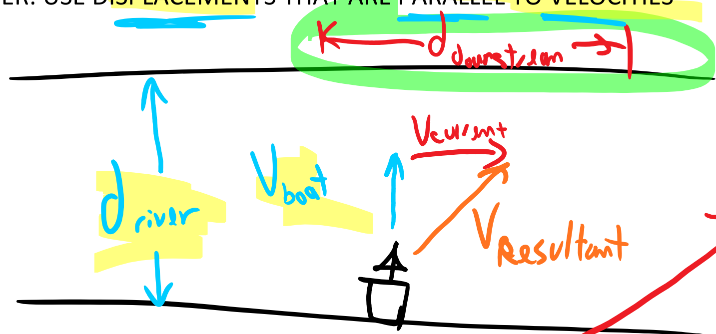
Keep in mind: river currents never get you to the other side

Only the vector whose component is aimed at the far side of the river gets you to the far side.

Equation for getting across: Δd / Δt = Vave

$\frac{\Delta d}{\Delta t} = V$

REMEMBER: USE DISPLACEMENTS THAT ARE PARALLEL TO VELOCITIES




Suppose your boat can travel at 8.0 m/s and the river is 640 m wide how long will take to cross?

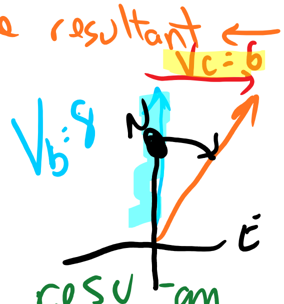
$\Delta d = v \times \Delta t$

$\frac{640}{8} = 80\,s$

How far downstream is boat when it reaches the far side if the current is 6.0 m/s?

$\Delta d = v\,\Delta t$ (6)(80) = 480 m

find the resultant ← What velocity is seen from shore




$8^2 + 6^2 = c^2$

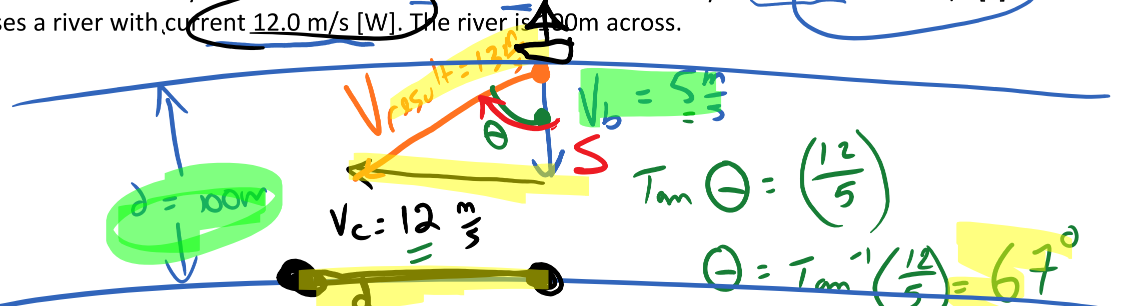
c = 10 m/s

$\tan\theta = \frac{6}{8}$

$\theta = \tan^{-1}\left(\frac{6}{8}\right)$

= 37° E from N

Determine the velocity as viewed from shore of a boat whose velocity in still water is 5.0 m/s [S] as it crosses a river with current 12.0 m/s [W]. The river is 100m across.




$\tan\theta = \left(\frac{12}{5}\right)$

$\theta = \tan^{-1}\left(\frac{12}{5}\right) = 67°$ W from S

How long does it take the boat to reach the far side?

$\Delta d = v\,\Delta t$

= 12 s

t = 40 s

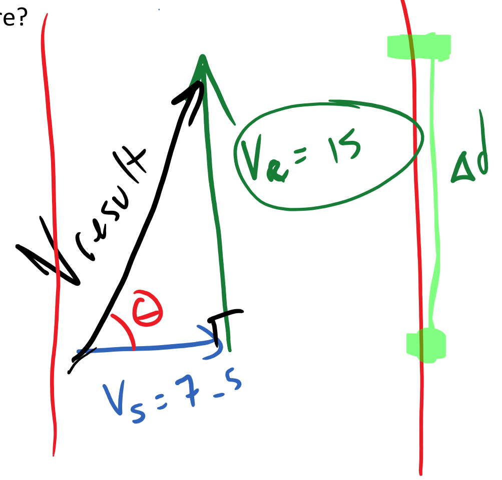
How long does it take the boat to reach the far side?

$\frac{\Delta d}{\Delta t} = v$  $\Delta d = v\Delta t$  $\frac{\Delta d}{v} = \Delta t$  $\frac{100}{5} = 20\,s$  W from S  $= 12\,s$

How far downstream is the boat when it reaches the far bank?

$\Delta d = v\Delta t = 12\,(20) = 240\,m$ [W]

A river flows north at 15 m/s, it is 75 m wide. A swimmer can swim at 7.5 m/s and swims due east across the river, how far downstream is the swimmer when it reaches the far bank? What is the velocity as seen from shore?




$\frac{\Delta d}{\Delta t} = v$  $\frac{\Delta d}{v} = \Delta t$  $\frac{75}{7.5} = t = 10\,s$

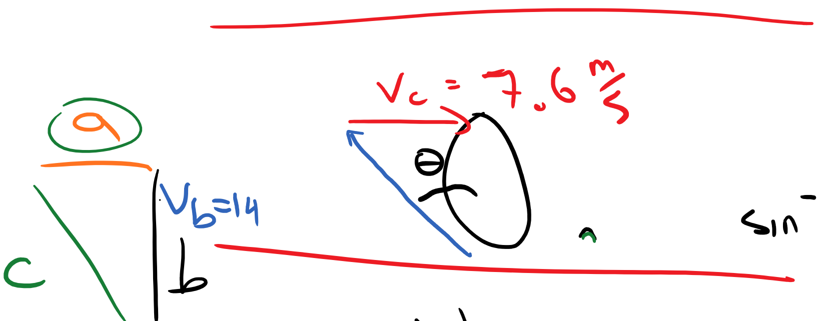
$\Delta d = v\Delta t = 15(10) = 150\,m$

$\sqrt{15^2 + 7.5^2} = 17\,\frac{m}{s}$

$\theta = \tan^{-1}\left(\frac{15}{7.5}\right) = 63^\circ$ N from E

Getting Straight Across:

To do this the boat (swimmer or duck) has to aim upstream and let the current push it into a straight resultant
The resultant should be straight across the river

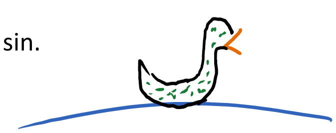



$\frac{O}{H} = \sin\theta$

$\sin^{-1}\left(\frac{7.6}{14}\right) = \theta = 33^\circ$ W from N

$a^2 + b^2 = c^2$  magnitude resultant  $\sqrt{14^2 - 7.6^2} = 11.8\,\frac{m}{s}$ or $12\,m/s$

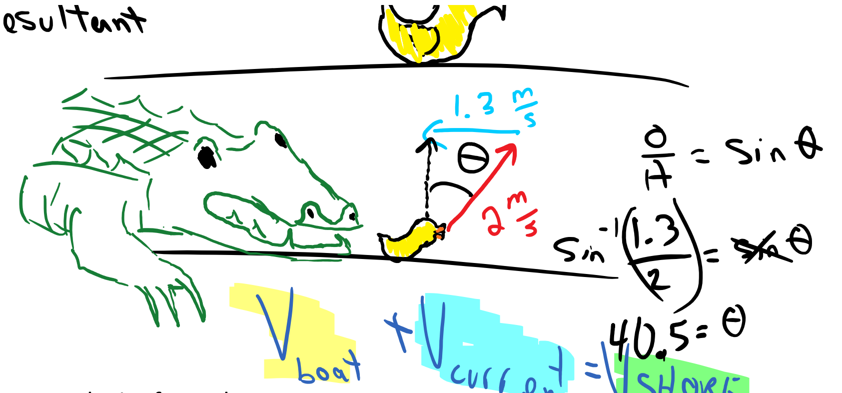
WANTS & DESIRES will lead to sin.



$\sin^{-1}$ 1.3

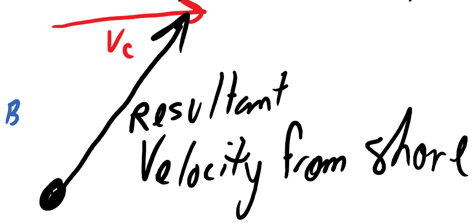
A ducky swims at 2.0 m/s in still water what angle should the ducky aim to drive straight across a river if the current is 1.30 m/s? find resultant

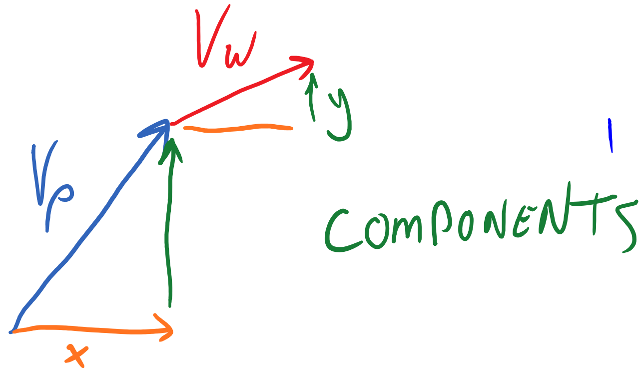
the current is 1.30 m/s find resultant




Airplane Navigation:
very similar to river navigation:

Velocity of Boat + velocity of current = Velocity from shore



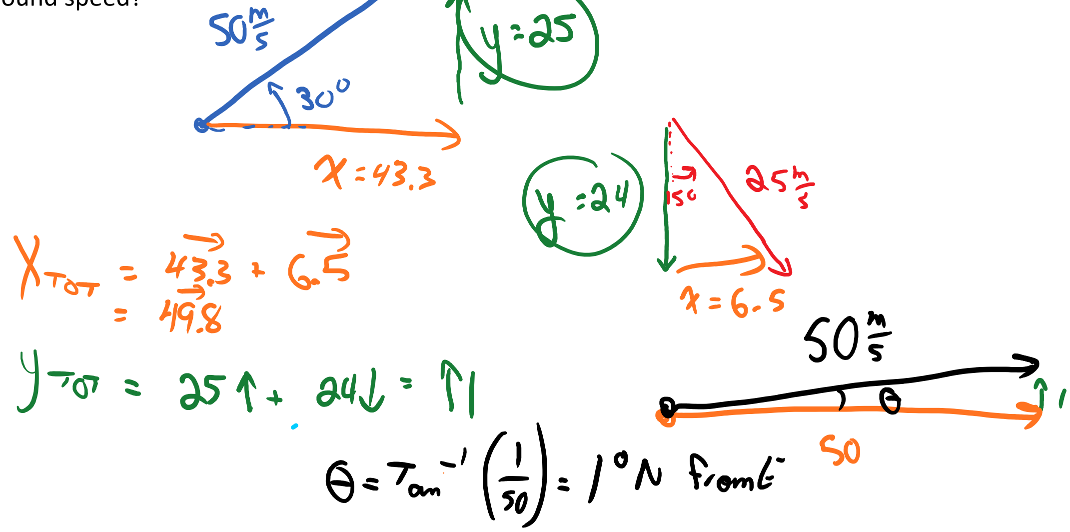

Vplane + Vwind = Vground

Vp + Vw = Vg
Velocity of plane + velocity of wind = velocity seen from ground
Airspeed + wind speed = ground speed

The big challenge: rivers usually have Vc and Vb at 90°, Vp and Vw are almost never at 90°.

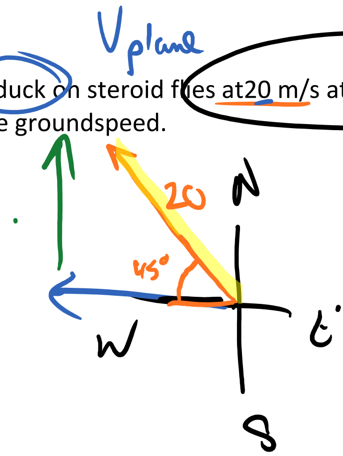
How do you add vectors that not 90° to each other?
1. COMPONENTS
2. Xtotal Ytotal
3. Draw tip-to-tail, with resultant
4. Pythag
5. $\tan^{-1}$

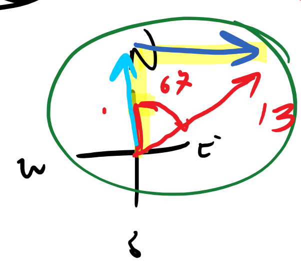
A plane has airspeed 50 m/s at 30° N of E it encounters a wind of speed 25 m/s at 15° E of S, what is the ground speed?



$\theta = Tan^{-1}\left(\frac{1}{50}\right) = 1^\circ$ N from E

A duck on steroid flies at20 m/s at 45º N from W and a wind blows at 13 m/s at 67º E from N, find the groundspeed.



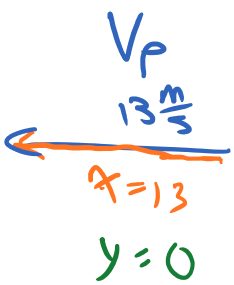



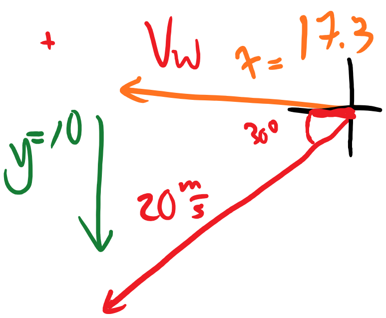

$\theta = Tan^{-1}\left(\frac{19.1}{2}\right)$

$\theta = 84^\circ$ N from W

$6^\circ$ W from N

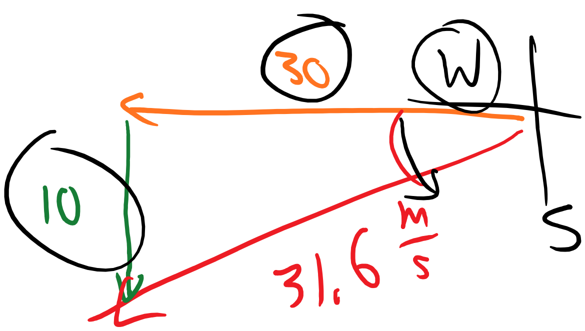
A Canada goose aims wants to fly due west  at 13 m/s to Gyro beach so it can poop on it.
If the wind speed is known to be 20 m/s at 30º S of W, what must be the groundspeed of the goose?




$x_{TOT} = 13 + 17 = 30$

$y_{TOT} = 10$




$18^\circ$ S from W

$Tan^{-1}\left(\frac{10}{30}\right)$