Let's Get Our Move On!
with vectors…

We need to now take all of this trig and vector knowledge and apply it to realistic physics problems.

There are three main types of problems that we need vector decomposition / resultant to solve.

1. Rivers
2. Airplanes
3. projectiles

Rivers:

River problems are the easiest, so we'll start there.

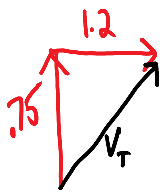
The situation is as follows: A boat crosses a river, but the current of the river pushes the boat so that the boat does not travel straight across the river.

Steps to solve these problems:

1) find the resultant vector (the direction of travel as seen from the shore).
2) How long does it take to cross the river? (just the y-component)
3) How far downstream will the boat be in that time?

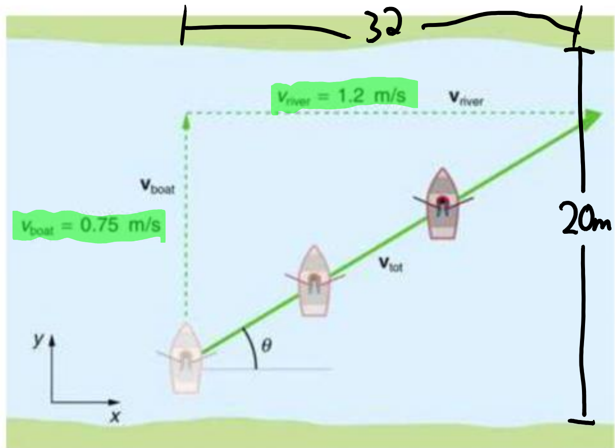
$V_b = .75 \frac{m}{s}$ $V_r = 1.2 \frac{m}{s}$ $V_T = ?$

$a^2 + b^2 = c^2$



$V_T = \sqrt{.75^2 + 1.2^2}$

$= 1.42 \, m/s$



$d = vt$

$20 = .75t$

$\frac{20}{.75} = t = 27s.$

$d = vt$

$= 1.2(27)$

$= 32 \, m$

You try this one...

$d = vt$

$40 = 8t$

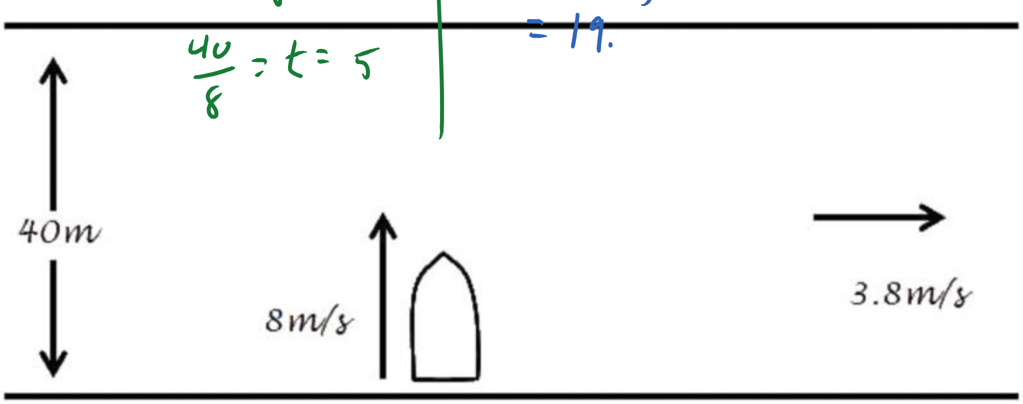
$\frac{40}{8} = t = 5$

$d = vt$

$= 3.8(5)$

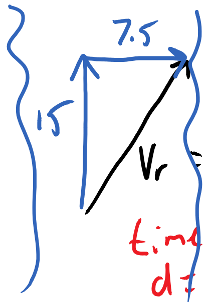
$= 19.$

19m



What if the river ran north-south, and the instead of a boat, it was a swimmer, and that swimmer travelled east-west. What would change in the question?

eg: 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 he reaches the far bank? What is the velocity as seen from shore?



$V_r = \sqrt{15^2+7.5^2} = 16.8$

time across

$d = vt$

$75 = 7.5\,t$

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

$d = vt$

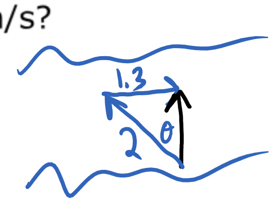
$= 15(10)$

$= 150\,m$

But I need to get straight across the river!

...then how far upstream do you need to aim (get the angle upstream so that the resultant vector will be perpendicular to shore)?

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



$\sin\theta = \frac{opp}{hyp} = \frac{1.3}{2}$

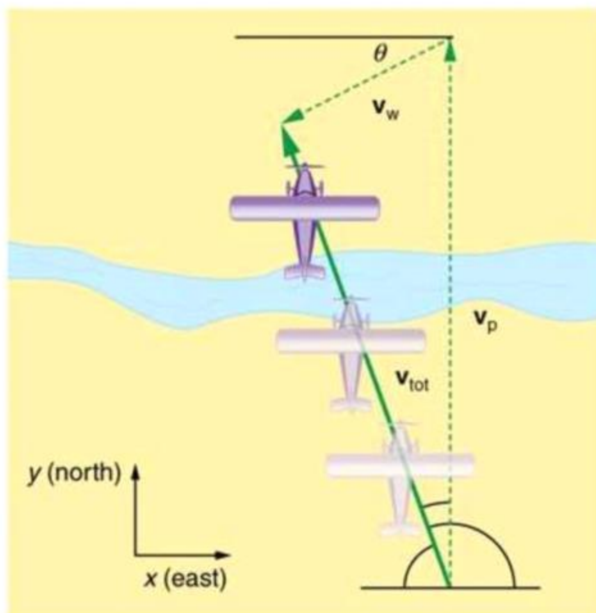
$\theta = \sin^{-1}\left[\frac{1.3}{2}\right] = 40.5^\circ$

Airplanes:

Airplane problems are very similar to river problems in that you have a velocity for the plane, but the wind does work on the plane and the actual direction that the plane moves (relative to the ground) is different from the direction that the pilot is going.

It is harder because the wind is not usually perpendicular (or parallel) to the plane.

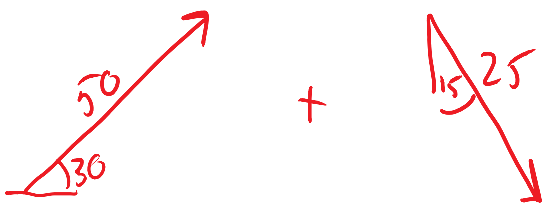
$v_{plane} + v_{wind} = v_{ground}$



Here's what you'll need to do…

1. Draw vectors
2. Break into x and y components
3. Find X total and Y total (watch for negative directions)
4. Draw X total and Y total TIP TO TAIL
5. Pythagoras' theorem for magnitude
6. Trig for angle

eg: 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?



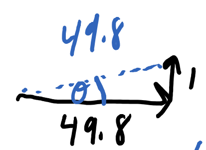
$\vec{V}_x + \vec{V}_y \quad + \quad \vec{V}_x + \vec{V}_y$

$50\cos(30) + 50\sin(30) \quad + \quad 25\sin(15) + 25\cos(15)$

$43.3 + 25 \quad + \quad 6.5 \quad 24$

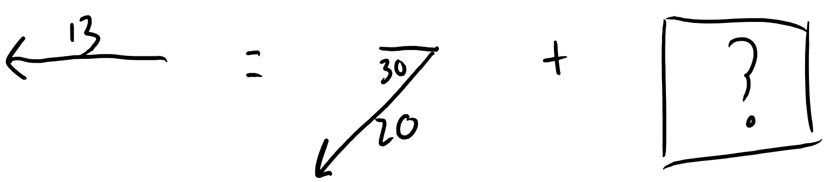
$\vec{V}_x = 43.3 + 6.5$
$= 49.8$

$\vec{V}_y = 25 + (-24)$
$= 1$



$\theta = \tan^{-1}\left[\frac{1}{49.8}\right]$
$= 1.2°$
N of E

eg: A Canada ~~goose~~ duck 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 30° S of W, what must be the airspeed of the goose?

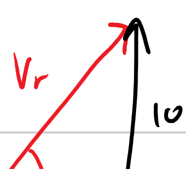


$\vec{V}_x = 20\cos(30) = 17.3$

$\vec{V}_y = 20\sin(30) = 10$

$-13 = -17.3 + x$
$4.3 = x$

$0 = -10 + y$
$+10 = y$



$+10 = y$

$$V_r = \sqrt{4.3^2 + 10^2}$$

$$= 10.9 \text{ m/s}$$

$$\tan\theta = \frac{10}{4.3}$$

$$\theta = \tan^{-1}\left[\frac{10}{4.3}\right] = 67^\circ \text{ N of E.}$$