Skill 10: Concurrent Velocity Vectors

Vectors are a universal skill used throughout physics. The same methods used when dealing with displacement vectors apply to velocity vectors. Everyday experience is filled with objects that experience concurrent velocities. Examples, include but are not limited to:

- A boat moving with a speed caused by an engine (or a paddle) is also moving due to a current in a river.
- A person walking on a "moving sidewalk" at the airport.
- A kid running up a down elevator.
- A bicycle moving east across a cruise ship moving north.
- A person swimming east across a north moving current.
- A duck flying east through a crosswind moving south.

For perpendicular velocity vectors the general equations listed below can be re-written with "v" in place of A, Ax or Ay

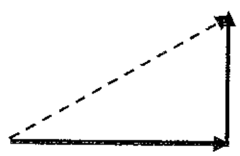
$A_x = A\cos\Theta$ $\quad$ $A_y = A\sin\Theta$ $\quad$ $\Theta = \tan^{-1}(\frac{A_y}{A_x})$ $\quad$ $A^2 = A_x^2 + A_y^2$ or $A = \sqrt{A_x^2 + A_y^2}$

$v_x = v\cos\Theta$ $\quad$ $v_y = v\sin\Theta$ $\quad$ $\Theta = \tan^{-1}(\frac{v_y}{v_x})$ $\quad$ $v^2 = v_x^2 + v_y^2$ or $v = \sqrt{v_x^2 + v_y^2}$

These equations can be used to split a vector with a direction that is not East, West, North or South into horizontal and vertical components. Or to determine the resultant velocity of an object with two perpendicular components.

Examples:

A canoe travels east at 2 m/s across a river while experiencing a 1 m/s current to the north.



To find the resultant velocity use Pythagorean Theorem:

$v = \sqrt{v_x^2 + v_y^2}$ $\quad$ $v = \sqrt{(2\frac{m}{s})^2 + (1\frac{m}{s})^2} = 2.23$ m/s

$\Theta = \tan^{-1}(\frac{v_y}{v_x})$ $\quad$ $\Theta = \tan^{-1}\left(\frac{1\frac{m}{s}}{2\frac{m}{s}}\right) = 26.5^0$

Resultant velocity equals

2.23 m/s @ 26.5^0 above east

REMEMBER ALL ANGLES ARE MEASURED BETWEEN HORIZONTAL AND THE RESULTANT FOR VECTOR EQUATIONS INCLUDING THETA Θ

If the canoe travels with the velocities stated above for 30 seconds, displacement can be calculated for each axis and the resultant, by using the equation $d = vt$ A second displacement vector diagram can be created if necessary.

$d_x = v_x t = (2m/s)(30s) = 60m$ $\quad$ $d_y = v_y t = (1m/s)(30s) = 30m$ $\quad$ $d = \sqrt{{d_x}^2 + {d_y}^2} = \sqrt{(60m)^2 + (30m)^2} = 67.1m$