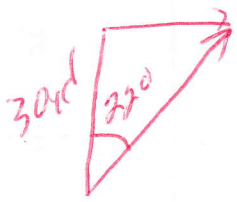
Vectors

AT Vectors (11)

Solve the following problems showing ALL work and CIRCLING your answers. Each is worth 5 points.

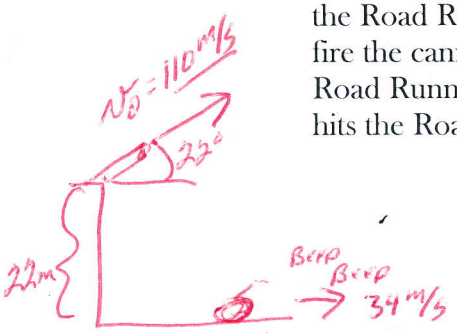
1. During a football game, the quarter back throws a ball from the 10 yard line to the 40 yard line. The pass is cross-field with the ball traveling at an angle of 22 degrees. Determine the distance the ball was thrown.



$\cos\theta = \frac{adj}{hyp}$

$hyp = \frac{adj}{\cos\theta} = \frac{30yd}{\cos 22^\circ}$ 32.4 yards

2. Wili E. Coyote is gonna get the Road Runner!!! He's going to use a canon to maim the Road Runner!!! Rather than continuing on his failing ways, he has decided pass on the Acme brand to go with a brand new, guaranteed to fire, Cannon from BAE. This cannon will fire a projectile at 110 m/s. He also has key to run the calculations (Yes, that's YOU)....no more attempts on the portable black board...YOU have the ability to ensure Wile E finally gets to EAT!!! Wile E. Coyote places the cannon on an East bound overpass which is 22 m above the north bound road passing below. He fixes the firing angle of the cannon 22 degrees above the horizontal, and then he waits. After waiting for 34 minutes, Wili E. spots the Road Runner heading north at 34 m/s on the road below. He now only must fire the cannon at the correct time. (wait for it....) Determine how long after the Road Runner passes underneath the bridge he must fire the cannon to ensure he hits the Road Runner with the cannon, and he FINALLY is able to have dinner.



y

$v_{0y} = v_0 \sin\theta$

$t = ?$

$y = -22m$

$a = -9.8 m/s^2$

$y = v_0 t + \frac{1}{2} a t^2$

$-22m = (110 \frac{m}{s}) \sin(22^\circ) t + -4.9 \frac{m}{s^2} t^2$

$(-22)m = (41.2) \frac{m}{s} t - (4.9 \frac{m}{s^2}) t^2$

$0 = (-4.9) t^2 + (41.2) t + 22$

$t = 8.9s$

Range of Canon

x

$v_x = v_0 \cos\theta$

$x = ?$

$t = 8.9s$

$a = zero$

$x = v_0 t + \frac{1}{2} a t^2$

$x = v_0 \cos\theta \, t$

$x = (110 \frac{m}{s})(\cos 22^\circ)(8.9s)$

$x = 907.7m$

Time For Road Runner To Get 907.7m Away From Bridge

$x = 907.7m$

$t = ?$

$v = 34 m/s$

$a = zero$

$x = v_0 t + \frac{1}{2} a t^2$

$x = v_0 t$

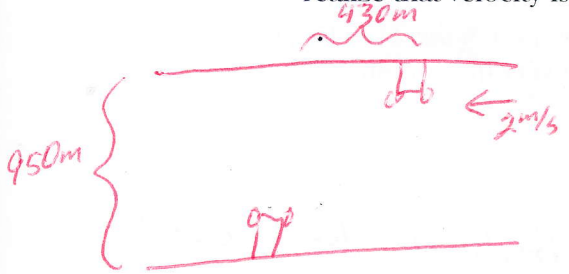
$\frac{x}{v_0} = t = \frac{907.7m}{34 m/s} = 26.7s$

The Difference In the Time For the Canon Ball To Arrive 907m Away And For the Road Runner Is...

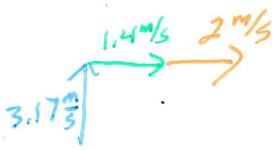
$26.7s - 8.9s = 17.8s$

17.8s After the Road Runner Passes, the Cannon Should Be Fired

3. A 950 m wide river is flowing at 2 m/s. You depart a dock on the near side and wish to land on a dock on the far side of the river, and 430 m upstream. Assume it is foggy, and a moon-less night and you wish to land 5 minutes after you depart the dock. Determine the velocity you would need to have to land on the dock. Please realize that velocity is speed with direction.



5min = 300s



Cross-Component WRT To Land

$\frac{950m}{300s} = 3.17\frac{m}{s}$

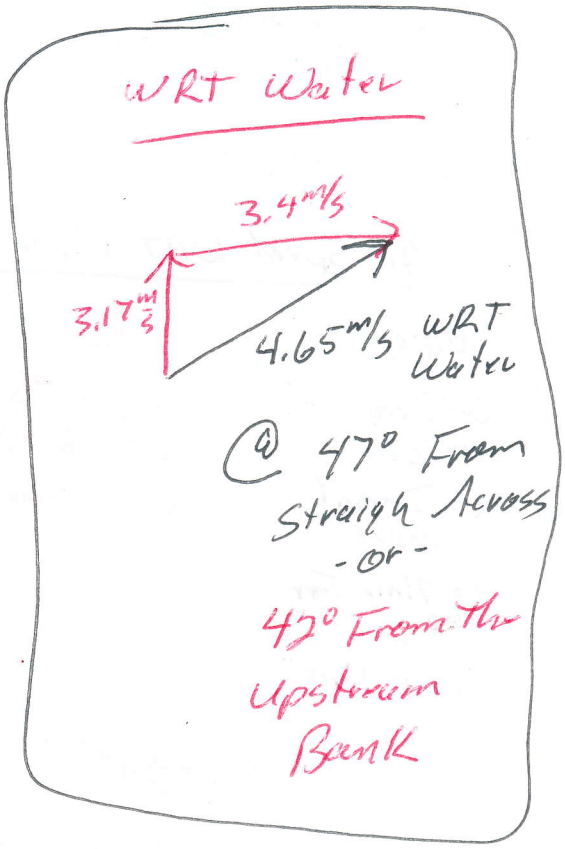
Since "Cross" Is Perp. To The Flow of the Water; the "Velocity WRT Water" = "Velocity WRT Land" For the "Cross" Component

Upstream Component

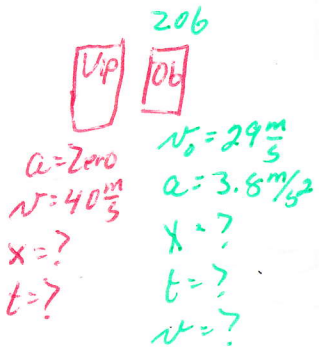
WRT Land => $\frac{430m}{300s} = 1.4m/s$

Upstream WRT Water

In order To maintain 1.4 m/s WRT Land, you Would Need To Add An Additional Velocity WRT Water Equal To the Water; 2 m/s Upstream



4. Imagine cruising on I 83 in the south-bound lane in your 2007 ZO6 Corvette at 65 mi/hr (29m/s....yeah right...those of you that KNOW what a ZO6 is also know you would not be doing 65mi/hr...) You look in the review mirror and see a Dodge Viper coming up quick. Turns out the Viper is doing 90 mi/hr (40 m/s...I do not endorse ever driving at that speed on public roads!!!! Race tracks are a different story...) As the Viper speeds by at a constant speed, you punch the ZO6 to give chase (Can't let a Dodge beat you!!!) and accelerate at a very quick 3.8m/s^2. Determine how fast you are traveling when you catch the Viper.



All Speed WRT Viper

Viper
a = Zero
v = Zero
x = Doesn't move
t = Time For ZO6 To "Come Back"

ZO6
$v_0 = -11\ m/s$
$a = 3.8\ m/s^2$
x = 0 - Final Position
t = ?

$x = v_0 t + \frac{1}{2} a t^2$

$0 = (-11\ m/s)t + \left(\frac{1}{2}\right)(3.8\ m/s^2)t^2$

t = 0; 5.79s

Back To "Real World"

$v_0 = 29\ m/s$
$a = 3.8\ m/s^2$
t = 5.79s
v = ?

$v = v_0 + at$

$v = 29\ m/s + (3.8\ m/s^2)(5.79s)$

$v = 51\ m/s$ WOW

Check method

From: $v_0 = -11\ m/s$
$a = 3.8\ m/s^2$
x = 0
v = ?

$v^2 = v_0^2 + 2ax$

$v^2 = v_0^2 + Zero$

$v = \sqrt{v_0^2}$

$v = \sqrt{(-11\ m/s)^2}$

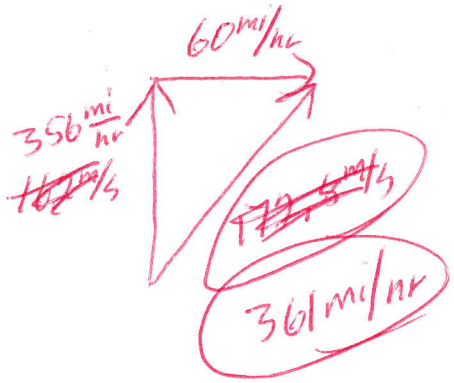
$v = 11\ m/s$ WRT Viper

$11\ m/s + 40\ m/s = 51\ m/s$ WRT Land

Flipping Fast!!!

Check!!

5. The P51 Mustang, one of my personal favorite aircraft, has a cruising speed of 356 mi/hr (Wikipedia...162 m/s). This plane departs HIA flying due North. There happens to be an Easterly 60mi/hr wind. Determine the speed of the airplane with respect to ground.



$(356\ m/s)^2 + (60\ mi/hr)^2 = (\text{Ground Speed})^2$

6. A baseball player can throw a ball at 60 mi/hr (27 m/s). Determine the angle they would need to throw the ball in order for his team mate to catch the ball 25 m away. Assume the ball takes off and lands at the same height.

$x = 25\,m$

$\theta = ?$

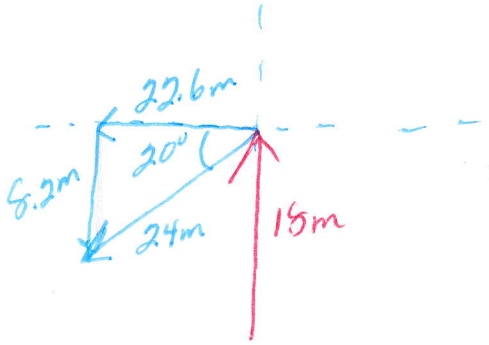
$v_0 = 27\,m/s$

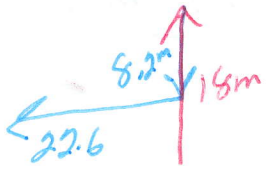
g

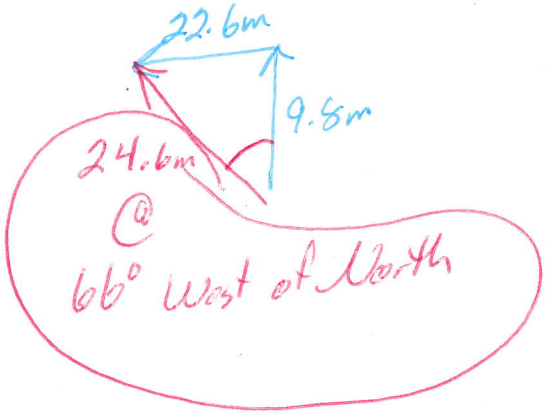
$$x = \frac{v_0^2 \sin(2\theta)}{g}$$

$$\frac{\sin^{-1}\left[\frac{xg}{v_0^2}\right]}{2} = \frac{\sin^{-1}\left[\frac{(25m)(9.8\,m/s^2)}{(27\,m/s)^2}\right]}{2} = 9.8^\circ$$

7. Add the following vectors by resolving the vector, and adding the components: 18 m North and 24 m @ 20 degrees south of west.

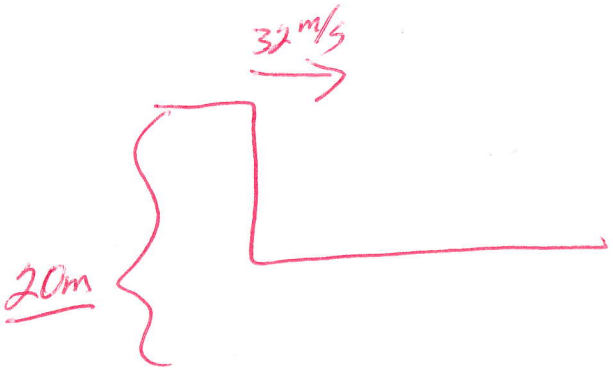






23° North of West

8. In a movie, a car "seems" to speed off a cliff and crash onto the canyon floor below. If the car was doing 70 mi/hr (32 m/s) determine how far out from the edge of the cliff the car would hit the canyon floor.



y

$t = ?$

$y = -20m$

$a = -9.8 m/s^2$

$v_{0_y} = zero$

x

$t = 2.02s$

$x = ?$

$v = 32 m/s$

$a = zero$

$x = vt$

$(32 m/s)(2.02s)$

$x = 64.6m$

$y = v_0 t + \frac{1}{2} a t^2$

$y = \frac{1}{2} a t^2$

$\sqrt{\frac{2y}{a}} = t = \sqrt{\frac{(2)(-20m)}{-9.8 m/s^2}} = 2.02s$