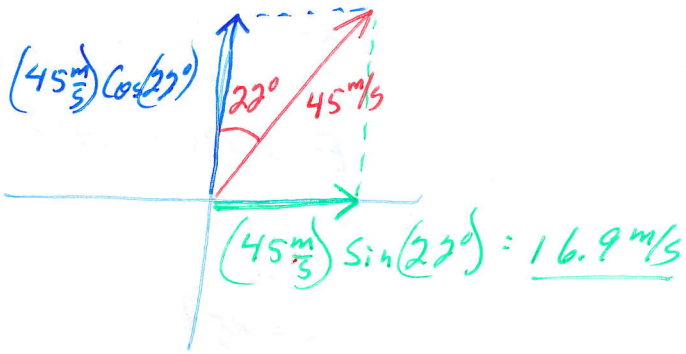
Level I Key Pd 1

Vectors

AT Vectors (13)

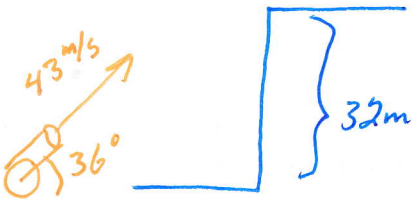
Directions: Solve the following problems. Show all work including units. Please circle your answer. Each is worth 5 points. Points are awarded on your ability to communicate your understanding of a viable solution.

1) Resolve the following vector into its components: 45 m/s at 22 degrees East of North.



41.7 m/s North
16.9 m/s East

2) A cannon is positioned at the bottom of a cliff that is 32 m high. The cannon is aimed at 36 degrees above the horizontal. The cannon will launch the projectile at 43 m/s, and attempt to have the projectile land on the top of the cliff. Determine the max and min distances the cannon can be placed from the base of the cliff to ensure the projectile lands on the top of the cliff.



y

$v_{0y} = (43\ \frac{m}{s}) \sin 36^\circ = 25.3\ m/s$

$x = 32m$

$t = ?$

$a = -9.8\ m/s$

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

$32m = (25.3\ \frac{m}{s}) t + (-4.9\ \frac{m}{s^2}) t^2$

$(-4.9\ \frac{m}{s^2}) t^2 + (25.3\ \frac{m}{s}) t - (32m) = 0$

Solving the Quadratic

$t = 2.22s$ & $2.95s$

x

$x = ?$

$v_x = v_0 \cos 36^\circ = (43\ \frac{m}{s}) \cos 36^\circ$

$t = 2.22s$ & $2.95s$

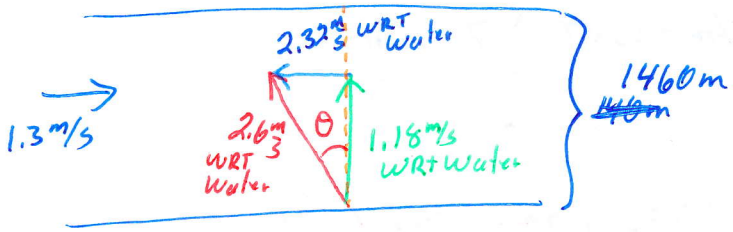
$a = 0$

$x = v_x t$

$x = (43\ \frac{m}{s}) \cos(36^\circ)(2.22s) = \boxed{77.2m}$

$x = (43\ \frac{m}{s}) \cos(36^\circ)(2.95s) = \boxed{102.6m}$

3) A river is flowing at 1.3 m/s. We launch our kayak and begin paddling at 2.6 m/s WRT water at an angle of 63 degrees upstream from perpendicular to the shore line. The stream is 1,460 m wide; what is our displacement from our starting point?



of the 2.32 m/s WRT Water....

1.3 m/s Goes To Battle the Current,

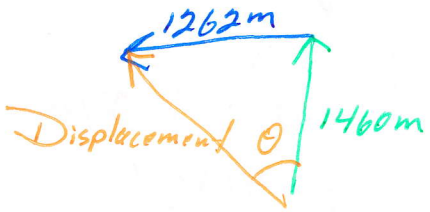
So... $2.32\frac{m}{s} - 1.3\frac{m}{s} = 1.02\ m/s$ WRT Land

$1.18\frac{m}{s}$ Takes You Across the River,

$\frac{1460m}{1.18\ m/s} = 1237s$ To Cross the River

Upstream WRT Land...

$(1.02\ m/s)(1237s) = 1262m$ WRT Land



1930m $\theta = 41°$ from Perp...

$\Rightarrow 13.3\ m/s$

4) A friend driving a 2007 Civic goes cruising by your house at a respectable 30 mi/hr. As they pass your driveway, you are ready to leave, and you decide to give chase. Assume you start at rest and accelerate at 3.5 m/s^2. Your friend decides to play along and also accelerates at 1.8m/s^2. Determine how fast you are traveling (WRT ground) when you catch your friend. Assume: no stop signs, no deer, and this is dream-land.

Wow There Is A Simple & Easy Solution. I Went Off On A Tangent... (And Had Fun With It!) It All Still Works.

your Speeds + Accelerations WRT '07 Civic

$v_0 = -13.3\ m/s$

$a = 3.5\frac{m}{s^2} - 1.8\frac{m}{s^2} \cdot 1.7\frac{m}{s^2}$ (Think About this From the Perspective Given...)

$x = 0$

$v = ?$ WRT Civic

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

This Term makes It Interesting...

The Only Viable Solution Is $13.3\ m/s$ WRT Civic, And Your acceleration Doesn't matter... Let's Check this w/ Time...

your speed ~~$26.6\ m/s$~~ No... the Civic Is Accelerating Too... opps...

If It Takes 15.6s To Catch, Then the Civic Accelera

To Find Speed WRT Ground...

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

$0 = (-13.3\ m/s)t + \left(\frac{1}{2}\right)(1.7\ m/s^2)t^2$

$(13.3\ m/s)t = \left(\frac{1}{2}\right)(1.7\ m/s^2)t^2$

$(13.3\ m/s) = \left(\frac{1}{2}\right)(1.7\ m/s^2)t$

$15.6s = t$

Note the time To Catch Is Dependent On Acceleration

$t = 15.6s$

$v_0 = 13.3\ m/s$

$a = 1.8\ m/s^2$

$v = ?$

$v = v_0 + at$

$v = (13.3\ m/s) + (1.8\ m/s^2)(15.6s)$

$v = 41.38\ m/s$

"you" WRT Ground

$41.38\ m/s + 13.3\ m/s$

$54.68\ m/s$

With Respect To Ground

~~v~~ $v = ?$

$v_0 = 0$

$a = 3.5\ m/s^2$

$t = 15.6s$

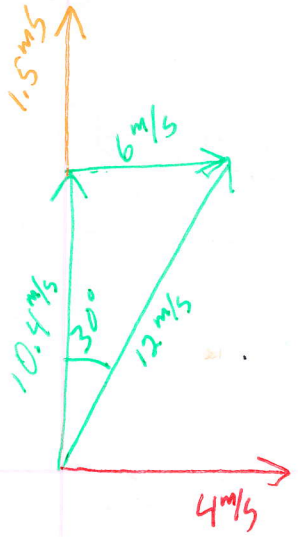
$v = v_0 + at$

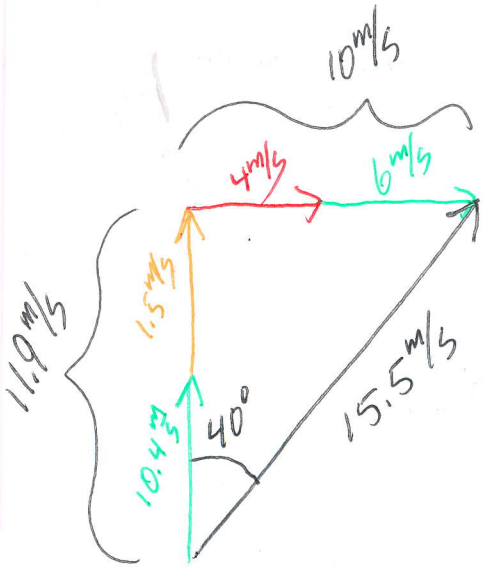
$v = (3.5\ m/s^2)(15.6s)$

$v = 54.6\ m/s$

= Check =

5) Determine the speed WRT land of a boat if the motor is pushing the boat at 12 m/s WRT water at 30 degrees east of north, the wind is pushing the boat 4 m/s due east WRT land, and the current is flowing at 1.5 m/s WRT land due north.





15.5 m/s @ 40° East of North

6) Determine the angle needed to hit a target that is 60 m away if the "Projectile Launcher" can fire at 25 m/s.

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

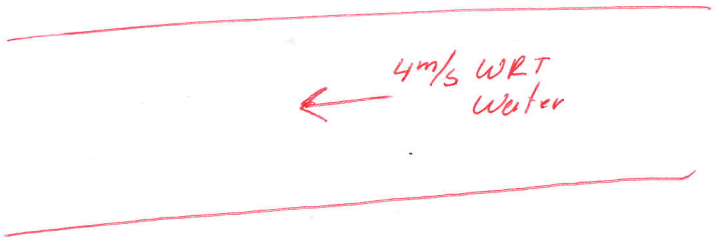
$$\frac{\sin^{-1}\left[\frac{xg}{v_0^2}\right]}{2} = \frac{\sin^{-1}\left[\frac{(60\,m)(9.8\,m/s^2)}{(25\,m/s)^2}\right]}{2}$$

$\theta = 35^\circ$

-or-

54°

7) Determine the speed of the water WRT land if you paddle upstream at 4 m/s WRT water and it takes you 1.5 hours to travel 2.3 miles upstream.



$$\left(\frac{2.3\,mi}{1.5\,hr}\right)\left(\frac{1\,hr}{3600\,s}\right)\left(\frac{1600\,m}{1\,mi}\right) = .68\,m/s$$

$$4\,m/s - \text{Speed of Water} = .68\,m/s$$

$$\text{Speed of Water} = 3.32\,m/s$$