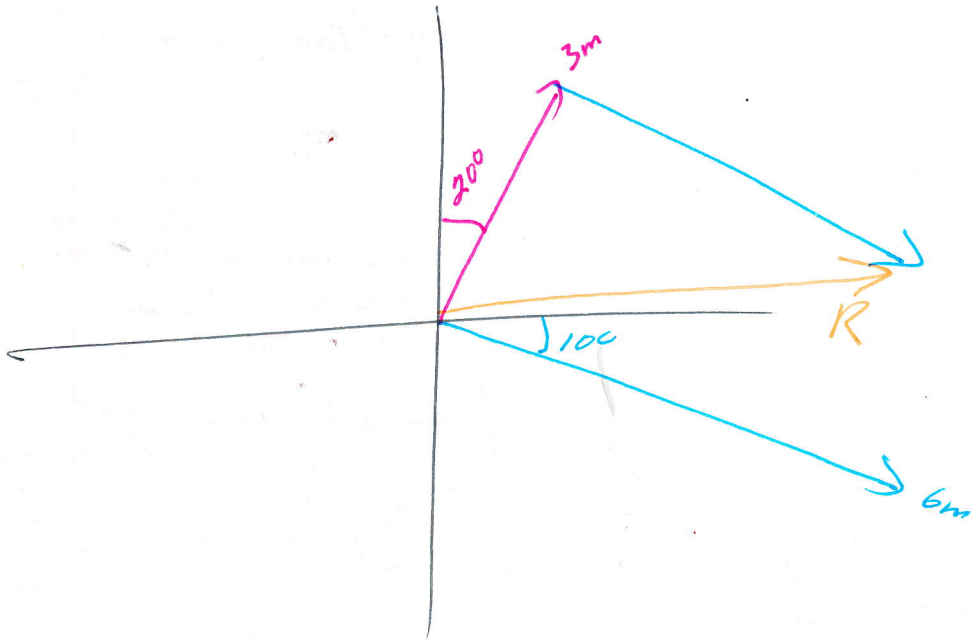
Vector Test

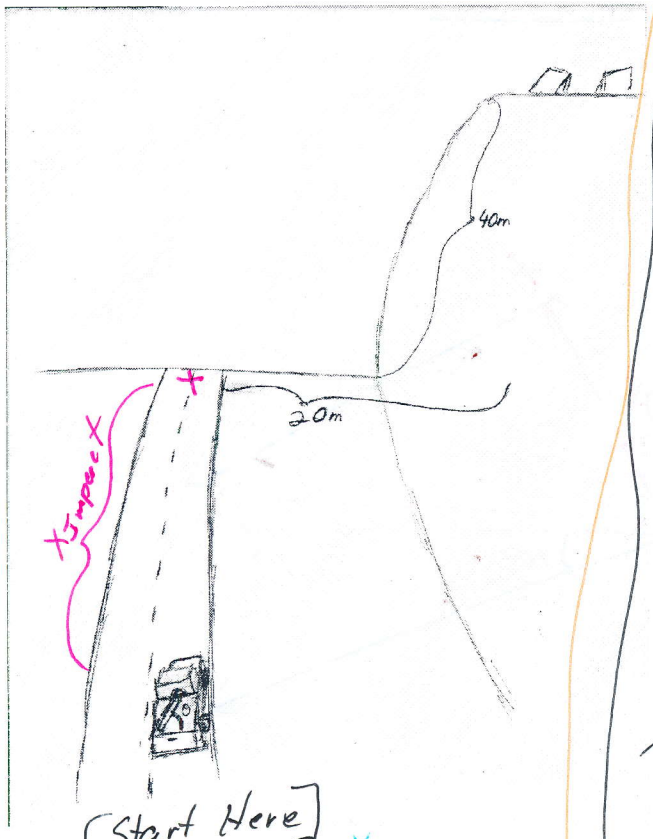
AT Vector(15).doc

Directions: Solve the following problems. Each problem is worth 5 points. Show ALL work and CIRCLE your answers.

1) Show that you understand basic vector addition by drawing the following vector addition as a sketch. Make an axis and Label vector A (3m at 20 degrees east of north), Vector B (6 m at 10 degrees south of east), the angles, and the resultant with an R.



2) You are on a mission to "deliver" a package to a group of campers on the top of a cliff. This package will arrive at the camp site by means of being "thrown" from the back of a pickup truck while the truck is driving down the road at a constant 20 m/s. The package will be thrown with a cannon that is set to fire at 70 degrees above the horizontal. As seen in the photo, the camp site is 40 m above the highway, and 20m back from the highway. Determine when the truck driver should "release" the package via the cannon. Express your response by stating how far from the cliff base the truck should be when the cannon is fired. This is a 3 dimensional situation. The truck in the Z direction, Y height, and X distance "in" to the camp.



$$y = (v_0 \sin\theta)\left(\frac{x}{v_0\cos\theta}\right) + \frac{1}{2}a\left(\frac{x}{v_0\cos\theta}\right)^2$$

$$y = \frac{(v_0\sin\theta)x}{(v_0\cos\theta)} + \frac{ax^2}{2v_0^2\cos^2\theta}$$

$$y = (\tan\theta)x + \frac{gx^2}{2v_0^2\cos^2\theta}$$

[Solve For v_0^2 ... Well, v_0] This Will Allow You To Sub Back In To Find The Time The Projectile Will Be In The Air. That Time, Combined With The Truck Speed, Can Be Used To Find The Truck Position When Firing The Cannon.

$$y - x\tan\theta = \frac{gx^2}{2v_0^2\cos^2\theta}$$

$$v_0^2(y - x\tan\theta) = \frac{gx^2}{2\cos^2\theta}$$

$$v_0^2 = \frac{gx^2}{2\cos^2\theta(y - x\tan\theta)}$$

$$v_0 = \sqrt{\frac{gx^2}{2\cos^2\theta(y - x\tan\theta)}}$$

$$v_0 = \sqrt{\frac{\left(-9.8\frac{m}{s^2}\right)(20m)^2}{2\cos^2(70^\circ)(40m - 20m\tan(70^\circ))}}$$

$v_0 = 33.4782\ m/s$ (Extra Figures Carried For Significance)

Y

$y = 40m$

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

$a = g = -9.8\ m/s^2$

$t = t$

$y = v_0t + \frac{1}{2}at^2$

$y = (v_0\sin\theta)t + \frac{1}{2}at^2$

X

$x = 20m$

$v_{0_x} = v_0\cos\theta$

$t = t$

$a = \text{Zero}$

$x = v_{0_x}t + \frac{1}{2}at^2$

$x = (v_0\cos\theta)t$

$\frac{x}{v_0\cos\theta} = t$

(Additional space to work #2)

Find Time In Air... Either Component will work, So Use the Easy One...

$$x = (v_0 \cos\theta)t$$

$$\frac{x}{v_0 \cos\theta} = t$$

$$\frac{20\text{m}}{(33.47\frac{\text{m}}{\text{s}})(\cos 70^\circ)} = t = 1.75\text{s}$$

[Value Used Was Full Calculator Memory]

Value Return In Calculator memory: All Digits Returned

Speed of Truck

$v = 20\text{m/s}$

$t = 1.75\text{s}$

$x = ?$ (Distance From Impact)

$x = vt$

$x = (20\text{m/s})(1.75\text{s})$

$x = 35\text{m}$ From plane of Impact

3) You are sitting at rest on the Carlisle Pike at one of the many red lights. Just as the light turns green, someone in the next lane passes you traveling a constant 20 m/s. You give chase by accelerating at 3.7 m/s². How long does it take you to catch them? You have a max speed of 30 m/s.

you WRT Them

$v_0 = -20\ m/s$

$v = ?$

$a = 3.7\ m/s^2$

$x = 0$

$v^2 = v_0^2 + 2ax$ (All Values WRT Them)

So... with Solving, We End Up With $v_0^2 = v^2$, which Is Almost Identity, except The Square Does Fun Stuff with Direction... Translation, when You Pull up next To "Them" you Are Doing +20 m/s WRT; which Is 40 m/s WRT Ground, which means You exceeded Your 30 m/s max

So....

$v_0 = -20\ m/s$

$v = ~~30\ m/s~~$ This Is WRT Land, We need WRT "Them" +10 m/s

$a = 3.7\ m/s$

$t = ?$

$v = v_0 + at$

$\frac{v - v_0}{a} = t$

$\frac{10\ m/s - (-20\ m/s)}{3.7\ m/s^2} = t = ~~13.5~~\ s = 8.1\ s$

you have not yet Caught "them," So You need To Determine your position WRT "them" So You know How much Time It will Take

$x = ?$

$v_0 = -20\ m/s$

$a = 3.7\ m/s^2$

$t = ~~13.5~~\ s$ 8.1s

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

$x = (-20\ m/s)(~~13.5~~\ s\ 8.1)\ s) + \frac{1}{2}(3.7\ m/s^2)(~~13.5~~\ s\ 8.1)\ s)^2$

$x = -40m$ ... Still have 40m To Go To Pull even...

$x = 40m$

$v = 10\ m/s$ WRT Them

$t = ?$

$x = vt$

$\frac{x}{v} = t$

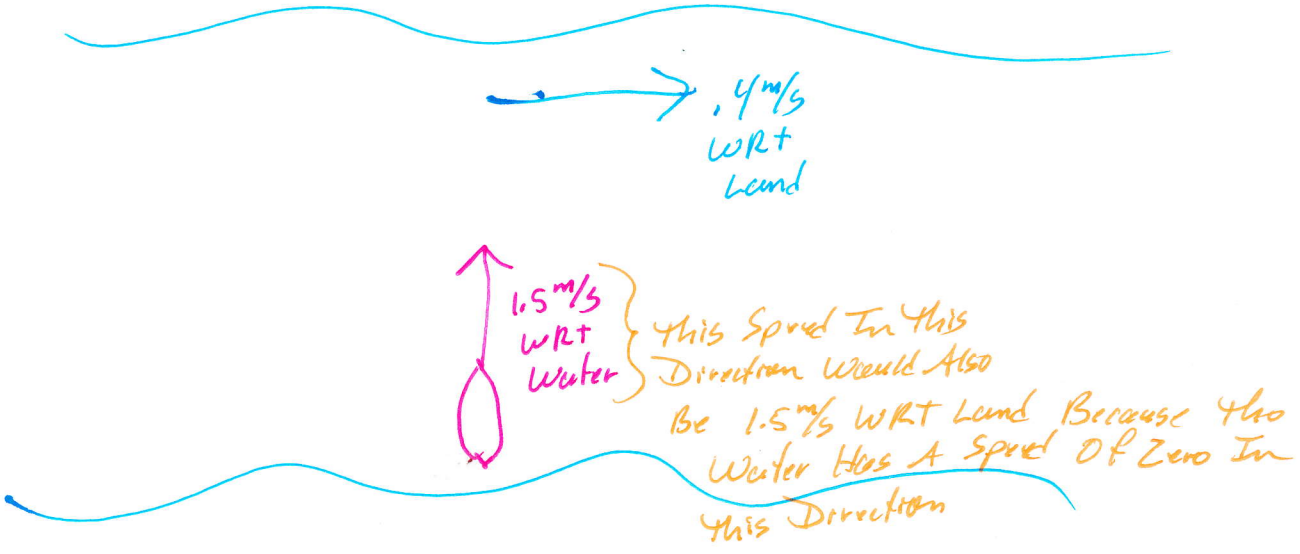
$\frac{40m}{10\ m/s} = 4s$

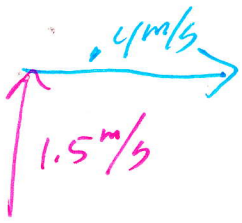
Total Time

$8.1s + 4s =$

12s

4) A river is 560 m wide. The water flows at 0.4 m/s. You in your kayak, are able to maintain a constant 1.5 m/s WRT water. You leave the river bank on one side of the river and cross by paddling straight across the river, perpendicular to the bank. How long will it take you to cross the river?

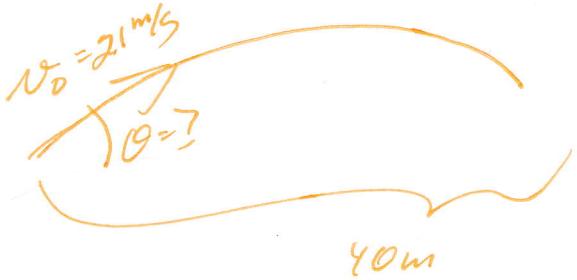




1.5 m/s Will Carry You Across

$$\frac{560\text{ m}}{1.5\text{ m/s}} = 373\text{ s}$$

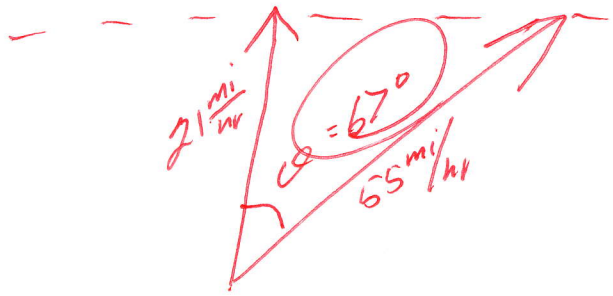
5) An outfielder is capable of throwing a baseball at 21 m/s. At what angle should they throw a ball to hit the cut-off man that is standing 40 m away?



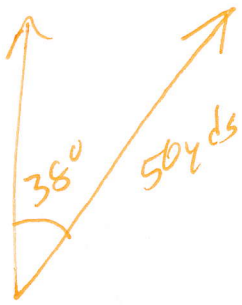
$$x = \frac{v_0^2 \sin(2\theta)}{g}$$

$$\frac{\sin^{-1}\left[\frac{xg}{v_0^2}\right]}{2} = \frac{\sin^{-1}\left[\frac{(40\,m)(9.8\,m/s^2)}{(21\,m/s)^2}\right]}{2} = \frac{39^\circ}{3\ 13^\circ}$$

6) A water skier is being towed by a boat at 22 mi/hr. Determine the angle the skier would need to cut out at in order to hit 55 mi/hr.



7) You start on a football field at the intersection of the side line and the 40 yard line. If you walk 50 yards at a 38 degree angle in-field from the side line, how far down the field did you go?



$(50yds)(\cos 38^\circ) = 39 \text{ yards}$

8) You are in your kayak in a river. The river is flowing at 3.2 m/s WRT ground. You are attempting to meet some friends downstream and set out paddling downstream. If it takes you 35 minutes to get 1640 m downstream, state the speed of the water WRT ground.