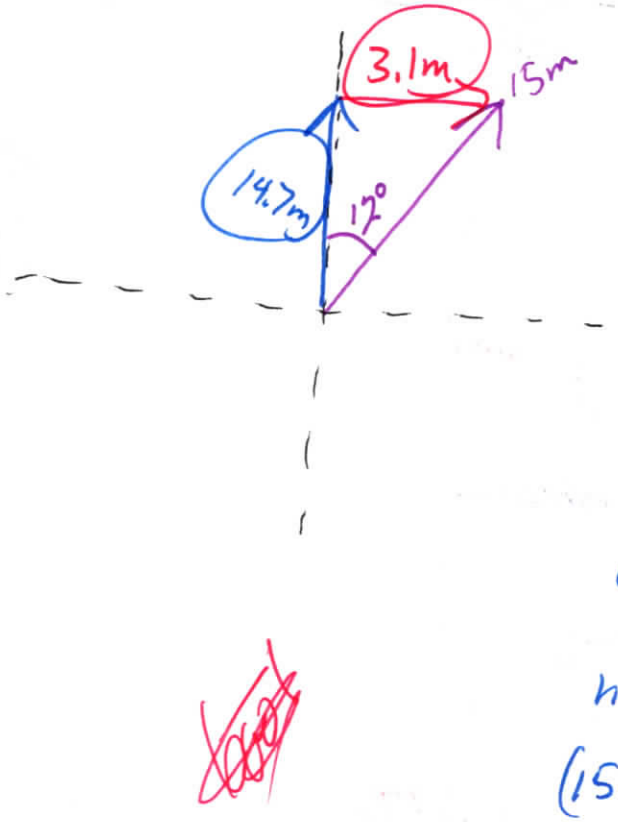
Level I Answer Key Pd 3

Kinematics & Vector Test

AT kinematics and Vector (21)

Directions: Solve the following problems. Your work will be graded, not just the answer. This test is worth 50 points.

1) Resolve the following vector: 15 m at 12 degrees East of North.



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

$hyp \sin\theta = opp$

$(15m)\sin(12°) = opp$

3.1m East $= opp$

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

$hyp\cos\theta = Adj$

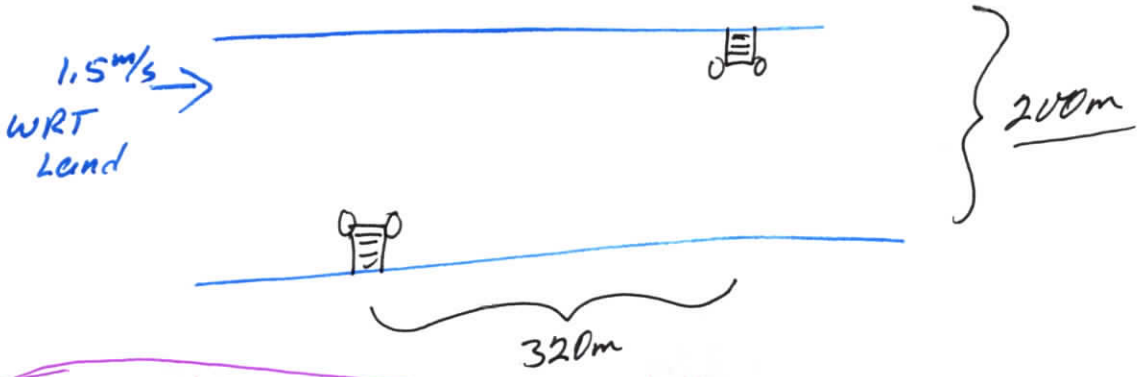
$(15m)\cos(12°) = Adj$

14.7m North $= Adj$

Need Width 200m

Ugh... I'm Blind

2) A river is 650m wide and flows at a constant rate of 1.5 m/s. You wish to cross the river by boat and arrive at a dock that is 320m downstream from your starting location. You must get to the destination 30 seconds after departure. Determine the velocity you would need to have WRT water to make that happen.



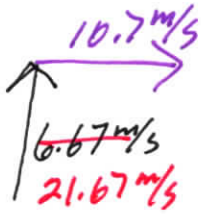
WRT Land

Need To Travel
~~200m~~ 650m Across In 30s

$$v = \frac{x}{t} = \frac{\cancel{200m}\ 650m}{30s} = \cancel{6.67\ m/s}\ 21.67$$

Need To Travel Downstream
320m In 30s

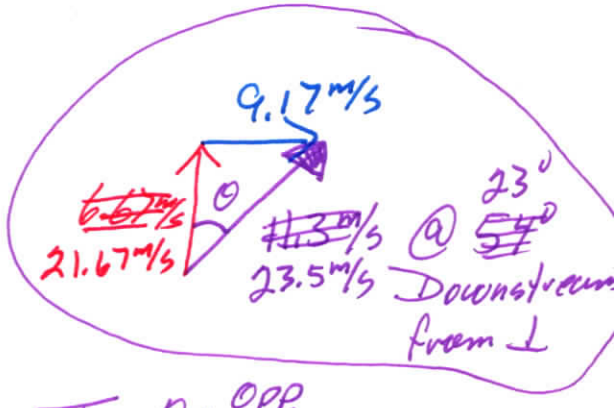
$$v = \frac{x}{t} = \frac{320m}{30s} = 10.7\ m/s$$



WRT Water

- Cross Will still Be At ~~6.67 m/s~~ 21.67 m/s

- Downstream $10.7\ m/s - 1.5\ m/s = 9.17\ m/s$ WRT Water

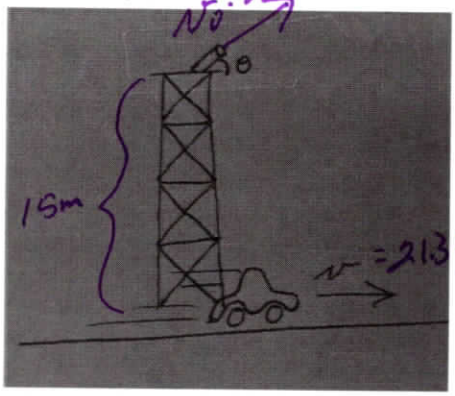


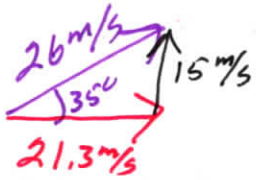
$$\tan\theta = \frac{Opp}{Adj}$$

$$\theta = \tan^{-1}\left(\frac{9.17\ m/s}{\cancel{6.67\ m/s}\ 21.67}\right)$$

$\theta = \cancel{54°}$ From Perp
$22.9 \sim 23°$

3) Imagine that you are stationed on your 15 m tall "Guard Tower" armed with your trusted "Water Balloon Canon!" You can will consistently throw a water balloon at 26 m/s. The cannon is currently adjusted to an angle of 35 degrees. You spy your next potential target approaching the tower from the left, cruising at a constant 21.3 m/s. Where should the car be when you fire the cannon to be sure to hit the car with a water balloon? Indicate distance from the base of the tower.





Time For Water Balloon To Hit the ground

$y = -15m$

$t = ?$

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

$v_{0y} = v_0 \sin\theta = 15\ m/s$

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

$-15m = (15\ m/s)t + \frac{1}{2}(-9.8\ m/s^2)t^2$

$t = 3.84s$

Distance Water Balloon Will Be From Base When It Hits the Ground.

$x = ?$

$t = 3.84s$

$v_x = 21.3\ m/s$

$a = zero$

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

$x = v_0 t$

$x = (21.3\ m/s)(3.84s)$

$x = 81.79m$

Time For Car To Get To $x = 81.79m$

$v = 21.3\ m/s$

$t = ?$

$x = 81.79m$

$a = zero$

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

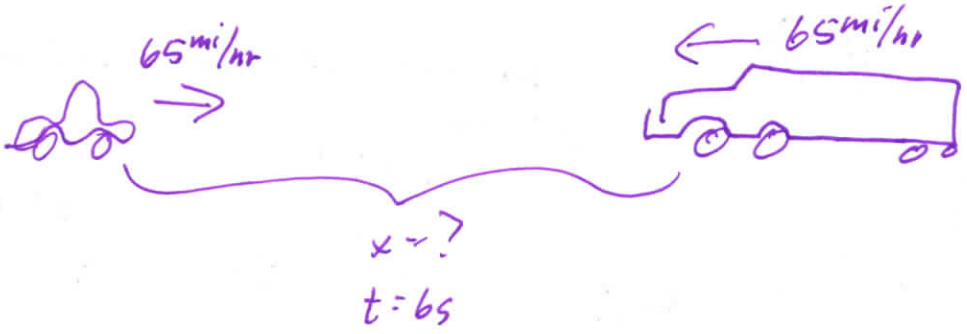
$x = v_0 t$

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

$\frac{81.79m}{21.3\ m/s} = 3.84s$

Same Time, So Fire When the Car Is At the Base of the Tower.

4) While traveling south on I-83 while doing 65 mi/hr (29m/s) you spot an interesting truck-trailer combination driving northbound. It takes 6 seconds from the time you spot them until they drive past you. Assuming they are also traveling at 65 mi/hr, how far away were they from you when you first spotted them? (Feel free to solve in any reasonable unit



WRT You

Truck

$v = 130\ mi/hr$

$t = 6s = .00167hr$

$x = ?$

$a = zero$

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

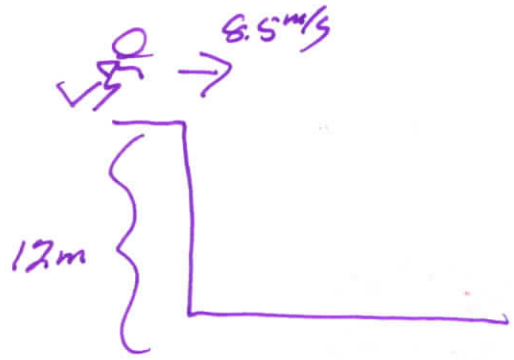
$x = \left(130 \frac{mi}{hr}\right)(.00167hr)$

$x = .217\ mi$

$29 \frac{m}{s} \times 2$

$(58 m/s)(6s) = 348m$

5) A cliff is 12 m above the water. The top surface of the cliff is flat an level allowing you to run at a full speed across the top of about 8.5 m/s. How long does it take you to hit the water?



Y

$y = -12m$

$a = -9.8 m/s^2$

$t = ?$

$v_{0y} = 2 \text{ one}$

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

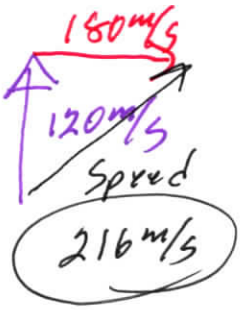
$y = \frac{1}{2} a t^2$

$\sqrt{\frac{2y}{a}} = t$

$\sqrt{\frac{(2)(-12m)}{-9.8 m/s^2}} = t$

$1.56s = t$

6) A space craft is flying through frictionless and gravity free space at 120 m/s. A thruster is fired that will impart an acceleration, perpendicular to the initial straight-line path of travel of the rocket, of 6 m/s^2. Determine the speed of the space craft when the thruster shuts off after 30 seconds.



$v_0 = 180\ m/s$

$a = 6\ m/s^2$

$t = 30\ s$

$v = ?$

$v = v_0 + at$

$v = 0 + (6\ m/s^2)(30\ s)$

$v = 180\ m/s$

7) While driving on the interstate, you know your friends are in another car driving at a constant 65mi/hr and initially 1.5 miles ahead of you. If you are doing 70 mi/hr, how far will you drive until you have caught them?

$v = 5\ mi/hr$

$x = 1.5\ mi$

$t = ?$

$a \rightarrow zero$

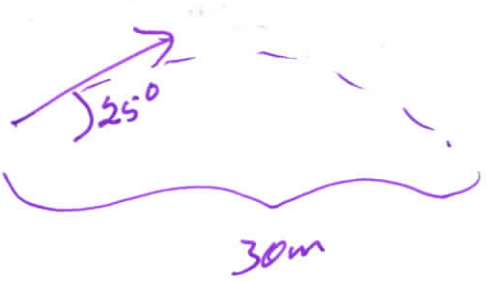
$x = v_0 t + \frac{1}{2} a t^2$

$\frac{x}{v_0} = t = \frac{1.5\ mi}{5\ mi/hr} = .3\ hr$

WRT Land

$(70\ \frac{mi}{hr})(.3\ hr) = 21\ mi$

8) While watching a soccer practice, you notice a player is putting a boot on the ball, sending it upward initially with an approximate angle of 25 degrees, and the ball stays airborne for a distance of 30 m. How fast did the ball leave the players foot?



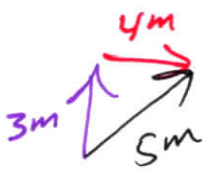
$$x = \frac{v_0^2 \sin(2\theta)}{g}$$

$$\sqrt{\frac{xg}{\sin(2\theta)}} = v_0$$

$$\sqrt{\frac{(30m)(9.8 m/s^2)}{\sin(50^\circ)}} = 19.5 \, m/s$$

9) Make an APPROX sketch (A ruler and protractor are not needed) of the addition of the following vectors:

   a. 3 m north
   b. 4 m east



10) Washington DC is about 114 miles south of here. Driving at 65 mi/hr, how long would it take you to get there without stops?

$\frac{114\,mi}{65\,\frac{mi}{hr}} = 1.75\,hr$