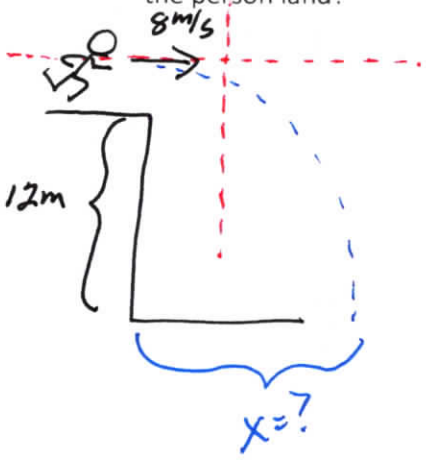
key Level II Physics Pd5

Projectile Practice

FHW Projectile Practice(20).doc

Directions: Solve the following problems.

1) A person runs at 8 m/s off of a 12m tall cliff and lands into water. Assume the cliff is straight down, and the person does not jump when they go over the edge. How far out from the base of the cliff does the person land?



y

$y = -12m$

$a = -9.8 m/s^2$

$v_{0y} = zero$

$t = ?$

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

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

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

$t = 1.56s$

x

$x = x$

$t = 1.56s$

$v_{0x} = 8 m/s$

$a = zero$

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

$x = v_0 t$

$x = (8\frac{m}{s})(1.56s)$

$x = 12.5m$

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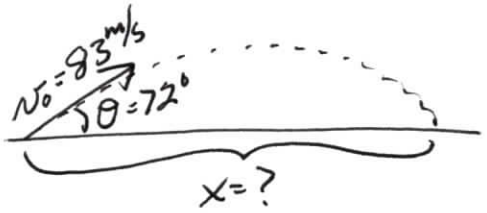
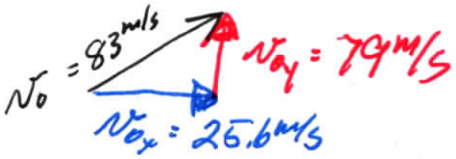
2) A "cannon" fires a pumpkin at 72 degrees above the horizontal with a speed of 83 m/s. How far away from the cannon does the pumpkin hit the ground?

2 methods ..

Components (This will ALWAYS work)





y

$v_{0y} = 79\ m/s$

$v_y = -79\ m/s$

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

$t = ?$

$v = v_0 + at$

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

$\frac{-79\ m/s - 79\ m/s}{9.8\ m/s^2} = 16.12\ s$

x

$v_{0x} = 25.6\ m/s$

$t = 16.12\ s$

$x = ?$

$a = zero$

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

$x = v_0 t$

$x = (25.6\ m/s)(16.12\ s)$

$x = 413\ m$

Range Equation [must Take off & Land At Same height]

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

$x = \frac{(83\ m/s)^2 \sin(2)(72°)}{9.8\ m/s} = 413\ m$

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3) From the information given in #2, what is the greatest height achieved by the pumpkin?

$\uparrow v_{0y} = 79\ m/s$

y

$y = ?$

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

$v_y = \text{zero}$

$v_{0y} = 79\ m/s$

$$v_y^2 = v_{0y}^2 + 2ax$$

$$\frac{\left[v_y^2 - v_{0y}^2\right]}{2a} = x$$

$$\frac{0 - (79\ m/s)^2}{2(-9.8\ m/s^2)} = 318\ m$$

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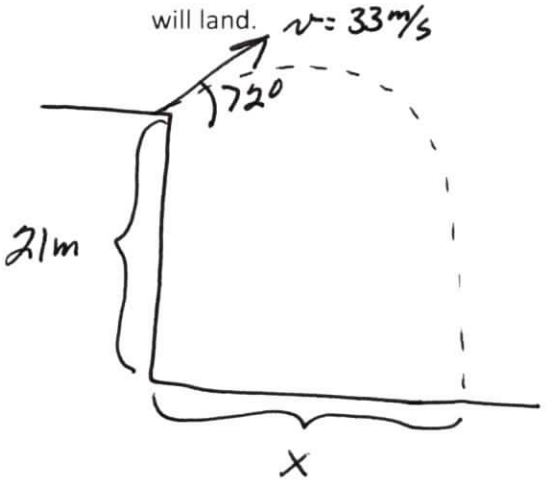
4) A "cannon" fires a pumpkin at 72 degrees above the horizontal with a speed of 33 m/s. This cannon is positioned at the top of a 21m tall cliff. Determine how far out from the base of the cliff the pumpkin will land.



y

$t = ?$

$v_{0y} = v_0 \sin\theta = (33\ m/s)\sin(72) = 31.4\ m/s$

$y = -21m$

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

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

$0 = \left(\frac{1}{2}a\right)t^2 + (v_0)t - (y)$ Use Quadrudic formula

A B C

$\left(-\frac{1}{2}\right)(9.8\ m/s^2)t^2 + (31.4\ m/s)t + 21m$

Roots $t = -.61s$ → Going Back In time will Put the pumpkin @ -21m

$7.0s$

x

$t = 7.0s$

$v_{0x} = v_0 \cos\theta = (33\ m/s)\cos 72°$

$a =$ ~~0~~ Zero

$x = ?$

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

$x = v_{0x} t$

$x = (10.2\ m/s)(7.0s)$

$x = 71m$

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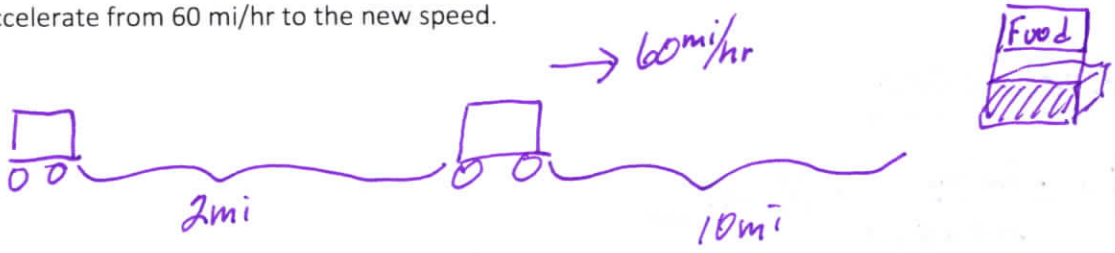
Relative Motion Practice

FHW Relative Motion Practice (16).doc

Directions: Solve the following problems.

1) Two cars are driving to the beach driving on the same road, following the same route. The cars are separated by 2 miles, and both are driving initially at 60 mi/hr. If both cars want to arrive at a restaurant for a snack 10 miles from the front running car, determine what speed the second car would need to be traveling in order to arrive at the restaurant with the front car. Ignore any effects or time requirements to accelerate from 60 mi/hr to the new speed.



$v = 60 \frac{mi}{hr}$

$x = 10mi$

$t = .167hr$ For The Lead Car To Get To The Food Stand.

The 2nd Car Has .167 hr To Travel The 2mi WRT The Lead Car

$\frac{2mi}{.167hr} = 12mi/hr$ Greater than the Lead Car

$60mi/hr + 12mi/hr = \underline{72mi/hr}$

-or-

Realize The Trailing Car Has To Travel 12mi To The Food Stand In the Same Time The Lead Car Travels The 10mi

$\frac{12mi}{.167hr} = \underline{72mi/hr}$

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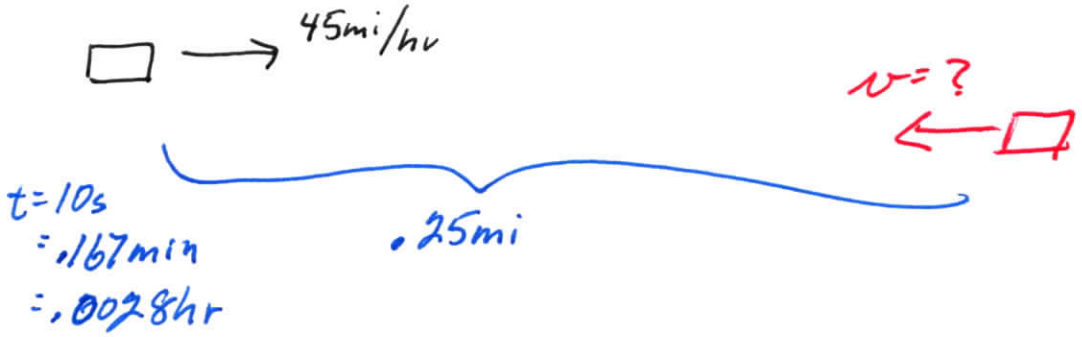
2) While driving at 45 mi/hr, you notice an oncoming car coming toward you from 0.25 miles away. If they drive past you after 10 seconds, how fast were they going?



Relative Speed

$v = \frac{x}{t} = \frac{.25mi}{.0028hr} = 90mi/hr$

The Oncoming Car Is Also Traveling A 45 mi/hr

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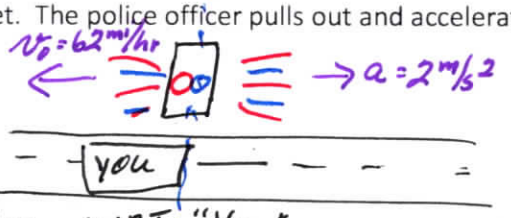
Position = Zero

3) While driving out York Street at 62 mi/hr, you unknowingly pass a police officer just past Paulus Market. The police officer pulls out and accelerates at 2m/s² until he catches you. How long does that take?



All motion WRT "You"

$v_{you} = Zero$

$v_{0\,police} = \left(-62\frac{mi}{hr}\right)\left(\frac{1hr}{3600s}\right)\left(\frac{1609m}{1mi}\right) = -27.7\ m/s$

$a = 2\ m/s^2$

$x = 0$ * When the Officer Is "Back" With You...

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

$0 = v_0 t + \frac{1}{2}at^2$

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

$-v_0 = \frac{1}{2}at$

$-2v_0 = t = \frac{(-2)(-27.7\ m/s)}{2\ m/s^2} = 27.7s$

4) From #3, how far do you drive until the officer catches you? (with respect to ground)

All Motion WRT Ground

$t = 27.7s$

$v_{you} = 27.7\ m/s$

$a_{you} = Zero$

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

$x = v_0 t$

$x = \left(27.7\frac{m}{s}\right)(27.7s)$

$x = 767m \approx .5mi$

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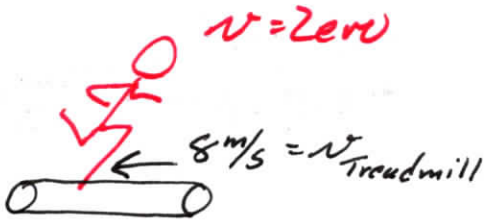
Vector Practice

FHW Vector Practice(15).doc

Directions: Solve the following problems. Work on a separate sheet. Submit 1 of the problems at the end of the period. Write it neat and organized! Include Units; every written number should have a unit!

1) A person runs at 8 m/s on a treadmill, as would be in a gym or workout room. 2 questions: (1) What is the velocity of the top of the treadmill belt with respect to the person? (2) What is the velocity of the person with respect to the room?



All Speeds WRT Room

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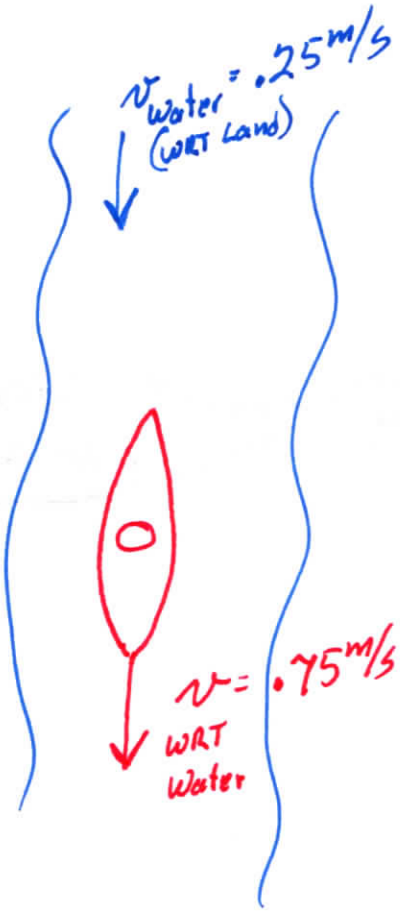
2) A kayaker is paddling downstream at 0.75 m/s with respect to the water. The water is flowing at 0.25m/s with respect to land. How long will it take the kayaker to get 5 miles (1mile=1600m) downstream?



The Speed of the Boat WRT Land Will Be Its Speed plus What the Water Is Doing.

$$v = .25\,m/s + .75\,m/s = 1\,m/s$$

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

$$x = v_0 t$$

$$\frac{x}{v_0} = t = \frac{(5\,mi)\left(\frac{1600\,m}{1\,mi}\right)}{1\,m/s} = 8{,}000\,s = 133\,mi$$

2hr 13min

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3) From the information given in #2, how long would it take the kayaker to paddle at the same rate with respect to water and paddle upstream, back to their starting point?

Upstream Speed WRT Land $\Rightarrow .5\ m/s$

$$t = \frac{x}{v} = \frac{8000\ m}{.5\ m/s} = 16000s = 266.7\ min$$
$$4\ hr\ 27\ min$$

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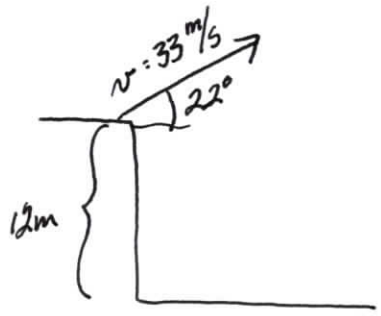
4) A "cannon" fires a pumpkin at 22 degrees above the horizontal with a speed of 33 m/s. This cannon is positioned at the top of a 12m tall cliff. Determine how far out from the base of the cliff the pumpkin will land.



y = ...

$y = -12m$

$v_{0_y} = v_0 \sin\theta = (33 m/s)\sin(22) = 12.4 m/s$

$a = -9.8 m/s^2$

$t = ?$

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

$y = (12.4 m/s)t - \left(\frac{1}{2}(9.8 m/s^2)\right)t^2$

$-12m = (12.4)m\,t - 4.9t^2 - (12m)$

$-4.9 \frac{m}{s^2} t^2 + (12.4m)t + (12m)$

A B

$t = -.7s$

$3.3s$

x

$v_{0_x} = v_0 \cos\theta = 33 \frac{m}{s}\cos(22) = 30.6 \frac{m}{s}$

$t = 3.3s$

$a = zero$

$x = ?$

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

$x = v_0 t$

$x = (30.6 \frac{m}{s})(3.3s)$

$x = 101m$

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Vector Worksheet

FHW vectors(09)

Relative Motion

1) Two cars are separated by 400 m (1/4 mile). The two cars are driving toward each other. One is driving at 20 m/s and the other at 16 m/s. How long will it take them to meet?

Speed of A WRT B

$v = 36\ m/s$

$x = 400m$

$t = ?$

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

$x = v_0 t$

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

$\frac{400m}{36\frac{m}{s}} = 11.1s$

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2) Car "**A**" is following car "**B**" at a distance of 50m. Both cars are traveling at 15 m/s. If car "**A**" begins accelerating at 2m/s^2, how long will it take car "**A**" to catch car "**B**"?

Speed of $v_{A\ WRT\ B}$

v_A

$a = 2\ m/s^2$

$v_{A_0} = 2\ m/s$

$t = ?$

$x = 50m$

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

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

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

$\sqrt{\frac{(2)(50m)}{9.8\ m/s^2}} = 10.2\ s$

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3) Using the information from #2, how fast will car "**A**" be going when it catches car "**B**"?

WOLT Ground

$v_0 = 15\ m/s$

$a = 2\ m/s^2$

$v = ?$

$t = 10.25$

$v = v_0 + a t$

$v = (15\ m/s) + (2\ m/s^2)(10.25)$

$v = 35.4\ m/s$

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4) A soccer player takes possession of the soccer ball at midfield while running at full speed which is 7 m/s. The "beaten" defender is 4m behind the charging offensive player and must catch them prior to them getting into shooting distance. How fast must the defender run to catch the offensive player before the offensive player can take the ball a distance of 20m? (Assume time to accelerate to full speed is negligible)

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

$x = v_0 t$

$\frac{20m}{7 m/s} = 2.86s$

$v = \frac{x}{t} = \frac{24m}{2.86s} = 8.39 \frac{m}{s}$

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5) Your soccer ball ends up going in the creek during warm-ups. The moving water carries the ball downstream at a speed of 2 m/s. If it takes you 20 seconds to take your shoes off, and you are able to run through the creek at 5 m/s, how far through the creek must you go to retrieve your ball? (Assume the water is shallow enough that you can run through it, and assume you go in the creek at the same place the ball does.)

Distance Ball Goes While You Shoes Go On

$(2\frac{m}{s})(20s) = 40m$

your Speed WRT Water $\Rightarrow 3\ m/s$
Speed of Ball WRT Water $\Rightarrow 0$

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

$t = \frac{x}{v} = \frac{40m}{3\ m/s} = 13.3s$ To Catch Ball

your Speed WRT Ground

$v = 5\ m/s$
$t = 13.3s$
$x = ?$

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

$vt = x$

$(5\frac{m}{s})(13.3s) = 66.7m$

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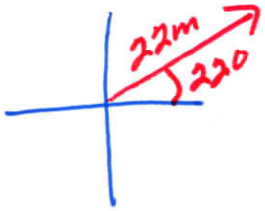
Resolution of vectors

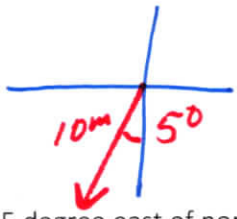
Determine the components of each of the following vectors:

6) 22 m @ 22 degrees north of east



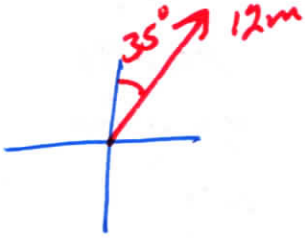
22m Sin 22° = 8.24m North
22m Cos 22° = 20.4 East

7) 10m @ 5 degrees west of south



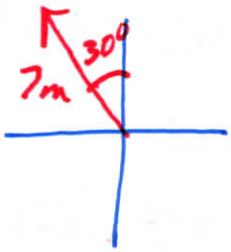
10m Cos 5° = 9.9 m South
10m Sin 5° = .87m West

8) 12m @ 35 degree east of north



12m Cos 35 = 9.8m
12m Sin 35 = 6.9m

9) 7 m @ 30 degrees west of north



7m Cos 30° = 6.06m
7m Sin 30° = 3.5m

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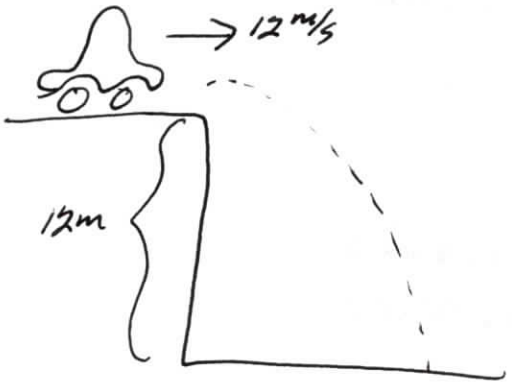
Horizontally launched projectiles

Solve the following problems.

10) A car drives off a cliff that is 12 m high. If the car was traveling at 12 m/s before going off the level cliff, determine how far out from the base of the cliff the car lands. Assume the edge of the cliff drops straight down.



y

$y = -12m$

$a = -9.8 m/s^2$

$v_{0y} = zero$

$t = ?$

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

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

$\sqrt{\frac{2x}{a}} = t = \sqrt{\frac{(2)(-12m)}{(-9.8 m/s^2)}} = 1.56s$

x

$v = 12 m/s$

$t = 1.56s$

$x = ?$

$a = zero$

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

$x = v_0 t$

$x = (12 \frac{m}{s})(1.56s)$

$x = 18.8m$

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11) You are about to ride your bike over a set of steps (the steps go down). The steps are only 0.3 m high, and extend out 0.5 m. How fast must you go to clear the bottom step?

y

$y = -.3m$

$a = -9.8 m/s^2$

$t = ?$

$v_{0y} = Zero$

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

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

$\sqrt{\frac{2y}{a}} = t = \sqrt{\frac{(2)(-.3m)}{-9.8 \frac{m}{s^2}}} = .25s$

x

$v = ?$

$x = .5m$

$t = .25s$

$a = Zero$

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

$x = v_0 t$

$\frac{x}{t} = v_0 = \frac{.5m}{.25s} = 2 m/s$

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Projectiles launched at an angle

12) A ball is thrown across a level field. If the ball leaves your hand with a speed of 22 m/s at an angle of 20 degrees above the horizontal, determine how far away a person is that catches the ball. Assume the ball is thrown and caught at the same height.

Range Equation

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

$$x = \frac{(22\ m/s)^2 \sin(2 \cdot 20)}{9.8\ m/s^2}$$

$$x = 31.7\ m$$

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13) A ball is thrown across a level field. If the ball leaves your hand with a speed of 22 m/s at an angle of 70 degrees above the horizontal, determine how far away a person is that catches the ball. Assume the ball is thrown and caught at the same height.

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

$$x = \frac{(22\,m/s)^2 \sin(2(70))}{9.8\,m/s^2}$$

$$x = 31.7\,m$$

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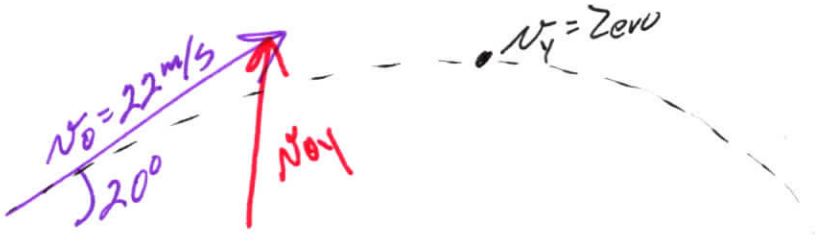
14) A ball is thrown across a level field. If the ball leaves your hand with a speed of 22 m/s at an angle of 20 degrees above the horizontal, determine how long the ball is in the air.



Y

$v_{0y} = v_0 \sin\theta = (22\ \frac{m}{s})(\sin 20^\circ) = 7.5\ m/s$

$t = ?$

$v_y = zero$

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

$v = v_0 + at$

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

$\frac{0 - 7.5\ \frac{m}{s}}{-9.8\ \frac{m}{s^2}} = t$

$.77s = t$

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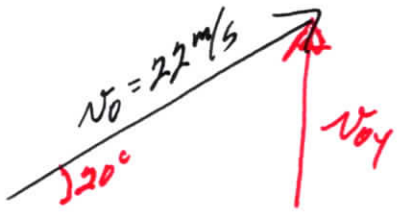
15) A ball is thrown across a level field. If the ball leaves your hand with a speed of 22 m/s at an angle of 20 degrees above the horizontal determine the vertical speed of the ball.



$v_{0y} = v_0 \sin\theta = (22\ \frac{m}{s}) \sin(20°) = 7.5\ \frac{m}{s}$

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Answers to Projectile Practice

1) 12.5 m
2) 413 m
3) 318 m
4) 71 m

Relative Motion Practice

1) 72 mi/hr
2) 45 mi/hr toward you
3) 27.7 s
4) 0.5 mi
5)

Answers to vector practice:

1) 11s
2) 7.1s
3) 29 m/s
4) 8.6 m/s
5) 66.7 m
6) 8.2m north; 20m east
7) 9.96m south; 0.87 west
8) 6.9m east; 9.8m north
9) 3.5m west; 6m north
10) 18.8m
11) 2m/s
12) 31.7m
13) 31.7m
14) 1.5s
15) 7.5m/s