TUE, NOV 30th PHYSICS (HONORS)

1) Get out HW to be checked. Go over answers.

2) Work on Projectile Problems 2. Hand in at end of class or next class.

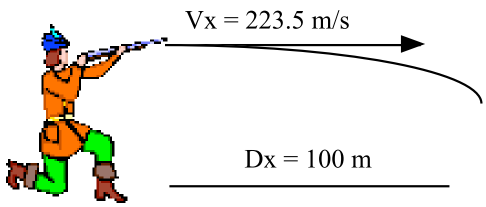
3) Read Lab Sheet on Projectiles for next class. Remember that you will be working individually.

TEST TUE DEC 7th!!!

Projectile Problems 2: Remember the steps and formulas…. Solve on a fresh piece of paper to leave yourself room to work!!!

1) If a bullet from a gun is shot horizontally at 500 mph (223.5 m/s), how far does it drop after 100 meters? How about shooting at an angle of 45 degrees?

Answer:Dy = - .98 m, 98.03 m (up)

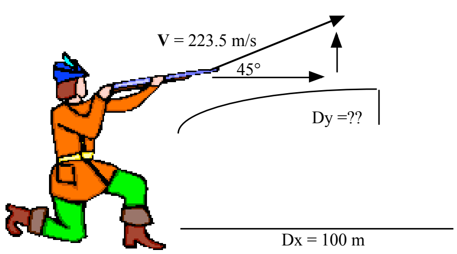


<u>X</u>

Vx = 223.5 m/s
Dx=100 m
Dx=VxT
*100 = 223.5 * T*
T= 100/223.5 =.4474 sec

<u>Y</u>

Viy = 0
$Ay = -9.8\ m/s^2$
T = .4474 sec
$Dy = ViyT + ½ AyT^2$
$Dy = 0(.4474) + ½ (-9.8)(.4474)^2$
Dy=-.98 m



<u>X</u>

*Vx = **V** cos θ*
Vx = 223.5 cos (45°)
*Vx = 223.5 *.707*
Vx= 158 m/s
Dx=100 m
Dx=VxT
*100 = 158 * T*
T= 100/223.5 =.6329 sec

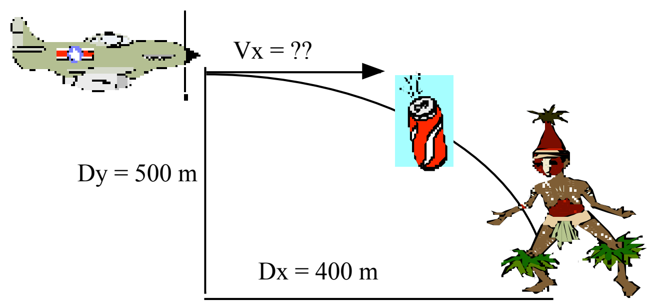
<u>Y</u>

Viy = V sin θ
Viy = 223.5 sin(45°)
*Viy =223.5 * .707*
Viy = 158.03 m/s

$Ay = -9.8\ m/s^2$
T = .6329 sec
$Dy = ViyT + ½ AyT^2$
$Dy = 158.03(.6329) + ½ (-9.8)(.6329)^2$
Dy=98 m

2) In the movie "The Gods must be Crazy", it begins with a pilot dropping a bottle out of an airplane. It is recovered by a surprised native below, who thinks it is a message from the gods. IF the plane from which the bottle was dropped was flying at an altitude of 500 m, and the bottle lands 400m horizontally from the initial dropping point, how fast was the plane flying when the bottle was released?

Answer: Vx =39.6 m/s (gave the wrong answer initially, sorry!!!)



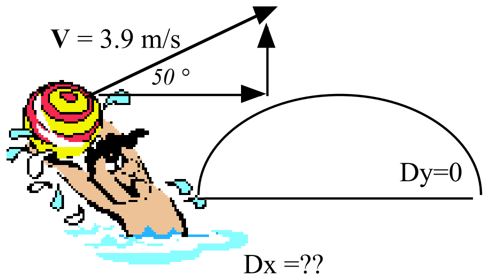
<u>Y</u>

Dy = - 500m
$Ay = -9.8\ m/s^2$
Viy = 0 m/s
T=??
$Dy = ViyT + ½ AyT^2$
$-500 = 0T + ½ -9.8 T^2$
$-500 = -4.9T^2$
$-500/-4.9 = T^2$
T= 10.1 sec

<u>X</u>

Dx = 400 m
T = 10.1 sec
Dx=VxT
400 = Vx (10.1)
Vx = 400/10.1
Vx = 39.6 m/s

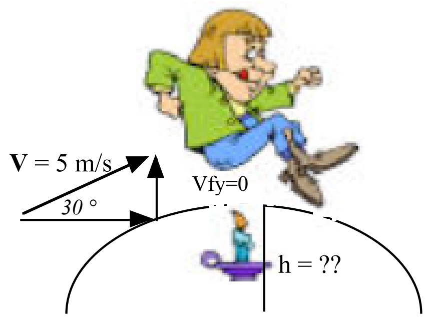
3) If I toss a marble into the air at a velocity of 3.9 m/s at an angle of 50 degrees, and it reaches the same height some seconds later, how far did it travel horizontally?
Answer: Dx=1.528 m



Y
Vy = V sin θ
Vy = 3.9 sin (50°)
*Vy = 3.9 *.766*
Viy= 2.98757 m/s
Dy=0
Ay =-9.8 m/s² ($A_y = -9.8\ m/s^2$)
$D_y = V_{iy}T + \frac{1}{2} A_y T^2$
$0 = 2.988\ T + \frac{1}{2}(-9.8)T^2$
0 = T (2.988 + -4.9 T)
0 = 2.988 + -4.9 T
-2.988 = -4.9T
T = -2.988/-4.9
T =0.6097 sec
Back to X

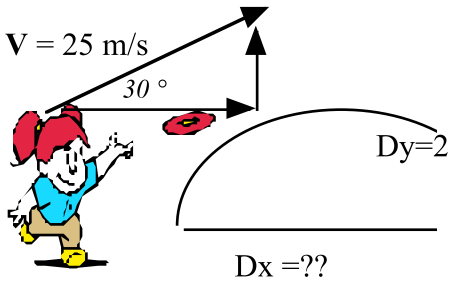
X
Vx = V cos θ
Vx = 3.9 cos (50°)
*Vx = 3.9 *.643*
Vx= 2.5 m/s
Dx = Vx T
Dx =??
T = .6097
Dx = 2.5 (.6097)
Dx= 1.528 m

4) Jack be nimble, Jack be quick, Jack jumped over the candlestick with a velocity of 5 m/s at an angle of 30 degrees. Did Jack burn his feet on the 0.25 m high candle?
Answer: Dy = .319 m, no!



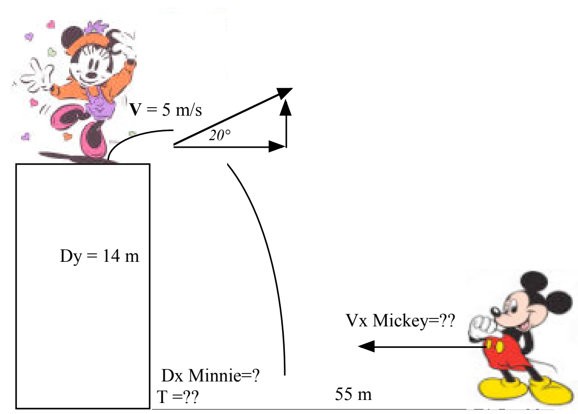
Y
We want the distance at the top of the trip…. Dy = max height
Vfy=0
$A_y = -9.8\ m/s^2$
Viy = V sin θ
Viy = 5 sin(30°)
*Viy =5 * .5*
Viy = 2.5 m/s
$V_{fy}^2 = V_{iy}^2 + 2\ A_y\ D_y$
$0^2 = 2.5^2 + 2\ (-9.8)\ D_y$
-6.25 = -19.6 Dy
Dy = -6.25/-19.6
Dy =.319 m

5) RANGE: How far away from a target, 2 m above you, do you have to stand to hit it, throwing a ball at 25 m/s at a 30 degree angle?
Answer: Dx=3.7m or 51.5 m



Y
$Dy = -2\ m$
$Ay = -9.8\ m/s^2$
$Viy = V \sin\theta$
$Viy = 25 \sin 30°$
$Viy = 12.5\ m/s$
$Dy = ViyT + \frac{1}{2} AyT^2$
$-2 = 12.5\ T + \frac{1}{2}(-9.8)T^2$
$0 = (-4.9)T^2 + 12.5T + 2$
Using quadratic formula or math solver
T =.171 sec or 2.38 sec (two times when it is at the height, once on the way up, and once on the way down!)
X
$Vx = V \cos\theta$
$Vx = 25 \cos 30°$
$Vx = 21.65\ m/s$
$Dx = Vx\ T$
$Dx = 21.65\ (.171)$ or $Dx = 21.65(2.38)$
$Dx = 3.7\ m$ or $51.527m$

6) Minnie jumps up off a 14 meter high cliff at a 20 degree angle with a speed of 5 m/s. Mickey is at the bottom of the cliff, 55 meters away from the bottom. He starts running when she reaches the apex of her jump. How fast should he run to catch her?
Answer: T=1.87 sec, Vmickey=29.411 m/s (to the cliff, or Vx = 24.65 m/s to exactly catch her)

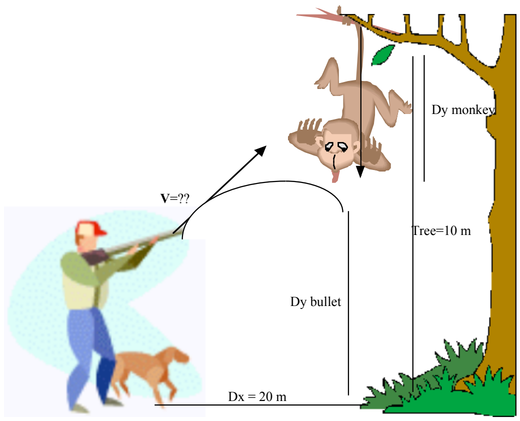


Y for Minnie
$Dy = -14\ m$
$Ay = -9.8\ m/s^2$
$Viy = V \sin\theta$
$Viy = 5 \sin 20°$
$Viy = 1.71\ m/s$
$Dy = ViyT + \frac{1}{2} AyT^2$
$-14 = 1.71\ T + \frac{1}{2}(-9.8)T^2$
$0 = (-4.9)T^2 + 1.71T + 14$
Using quadratic formula or math solver
T =1.874 sec
X for Minnie
$Vx = V \cos\theta$
$Vx = 5 \cos 20°$
$Vx = 4.698\ m/s$
$Dx = Vx\ T$
$Dx = 4.698\ (1.874)$
$Dx = 8.8\ m$

Mickey in the X
$Dx = 55 - 8.8 = 46.2\ m$
$Dx = Vx\ T$
$46.2 = Vx\ (1.874)$
$Vx = 24.65\ m/s$

THINKING QUESTION:

A monkey is in a 10 m high tree and falls. A hunter is on the ground 20 m away aiming directly at the monkey. How fast does he have to fire the gun to hit the monkey as it falls? Draw a picture and explain. USE ALGEBRA TO PROVE YOUR ANSWER!



Hunter:

$\Theta = \tan^{-1}(TreeHeight/Dx) = \tan^{-1}(10/20)$
$=26.565°$
$Vix = \mathbf{V}\cos\theta = \mathbf{V}\cos(26.565°) = \mathbf{V}(.89443)$
$Dx = Vx\ T$
$Dx = 20m$
$20 = \mathbf{V}(.89443)\ T$
$T = 20 /(\mathbf{V}(.89443))$

$Dy\ (bullet) = TreeHeight + Dy\ monkey$
$Viy\ (bullet) = \mathbf{V}\sin\theta = \mathbf{V}\sin(26.565°) = \mathbf{V}(.44721)$
Bullet:
$Dy = Viy\ T + ½\ Ay\ T^2$
$Dy = \mathbf{V}(.44721)T + -4.9\ T^2$
$Dy = \mathbf{V}(.44721)(20 /(\mathbf{V}(.89443))) + -4.9\ (20 /(\mathbf{V}(.89443)))^2$

$Dy\ monkey = ½\ Ay\ T^2 =- 4.9\ (20 /(\mathbf{V}(.89443)))^2$

$10 +- 4.9\ (20 /(\mathbf{V}(.89443)))^2 = \mathbf{V}(.44721)(20 /(\mathbf{V}(.89443))) + -4.9\ (20 /(\mathbf{V}(.89443)))^2$
simplifies
$10 = \mathbf{V}(.44721)(20 /(\mathbf{V}(.89443)))$
$10 = \mathbf{V/V} * .44721*20/ .89443$
10 = 10 !!!!!
Every Velocity is correct!!!

The monkey and bullet are both falling at the same rate… if you looked at them in the reference frame of the acceleration of gravity, as long as the bullet was pointed at the monkey to begin with, it would always hit it no matter what the speed of the bullet!

ALGEBRA PROOF
$\Theta = \tan^{-1}(TreeHeight/Dx) = \tan^{-1}(H/Dx)$
$Vix = \mathbf{V}\cos\theta = \mathbf{V}\cos(\tan^{-1}(H/Dx))$
$Dx = Vx\ T$
$Dx = \mathbf{V}\cos(\tan^{-1}(H/Dx))T$
$T =(Dx /(\mathbf{V}\cos(\tan^{-1}(H/Dx))))$

$Dy\ (bullet) = TreeHeight + Dy\ monkey$
$Viy\ (bullet) = \mathbf{V}\sin\theta = \mathbf{V}\sin(\tan^{-1}(H/Dx))$

Bullet:
$Dy = Viy\ T + ½\ Ay\ T^2$
$Dy = \mathbf{V}\sin(\tan^{-1}(H/Dx))T + -4.9\ T^2$

$Dy = \mathbf{V}\sin(\tan^{-1}(H/Dx))\ (Dx /(\mathbf{V}\cos(\tan^{-1}(H/Dx))))+ -4.9\ (Dx /(\mathbf{V}\cos(\tan^{-1}(H/Dx))))^2$

$Dy\ monkey = ½\ Ay\ T^2 =- 4.9\ ((Dx /(\mathbf{V}\cos(\tan^{-1}(H/Dx)))))^2$

$H +- 4.9\ ((Dx /(\mathbf{V}\cos(\tan^{-1}(H/Dx)))))^2 = \mathbf{V}\sin(\tan^{-1}(H/Dx))\ (Dx /(\mathbf{V}\cos(\tan^{-1}(H/Dx))))+ -4.9\ (Dx /(\mathbf{V}\cos(\tan^{-1}(H/Dx))))^2$

Simplifies

$H == \mathbf{V}\sin(\tan^{-1}(H/Dx))\ (Dx /(\mathbf{V}\cos(\tan^{-1}(H/Dx))))$

$H = \mathbf{V/V} *Dx * \sin(\tan^{-1}(H/Dx))/ (\cos(\tan^{-1}(H/Dx)))$

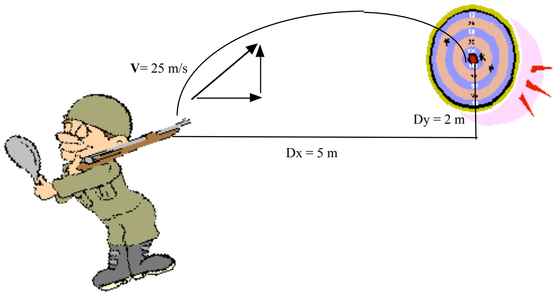
$H =1 * Dx * \tan(\tan-1\ (H/Dx))$

$H= Dx *H/Dx$

H=H!!!

If you are standing 5 m away from a target that is 2 meters above you, what angle do you need to hold a gun that shoots 25 m/s to hit it on the way down?

Θ=??



<u>*X*</u>

$Dx = 5\ m$

$Vx = \mathbf{V} \cos\theta$

$Vx = 25 \cos\theta$

$Dx = Vx\ T$

$5 = 25 \cos\theta\ T$

$T = 5/(25 \cos\theta)$

$T = .2/ \cos\theta$

<u>*Y*</u>

$Dy = 2\ m$

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

$Viy = \mathbf{V} \sin\theta$

$Viy = 25 \sin\theta$

$Dy = \quad Viy \quad T \quad + \tfrac{1}{2} Ay \quad T^2$

$2 = 25 \sin\theta\ (.2/ \cos\theta) + \tfrac{1}{2} (-9.8)\ (.2/ \cos\theta)^2$

$0 = 5 \sin\theta / \cos\theta + -4.9\ (.04) * (1/\cos\theta)^2 - 2$

use math solver??? $\Theta = 24.09°$ *or* $87.7°$

Or keep going and remember from crazy trig identities that

$\sin/\cos = \tan$ *and* $1/\cos^2 = \sec^2 = 1 + \tan^2$

$0 = 5 \tan(\theta) + 0.196\ (1 + \tan^2(\theta)) - 2$

$0 = -0.196\ (\tan(\theta))^2 + 5\ (\tan(\theta)) - 1.804$

quadratic formula for $\tan(\theta) = .447034$ *or* 25.06

so $\theta = \tan^{-1} (.44703) = 24.09°$

or $\theta = \tan^{-1}(25.06) = 87.7°$

correct answer: 87.7° to hit it on the way down.