Type I & II projectiles

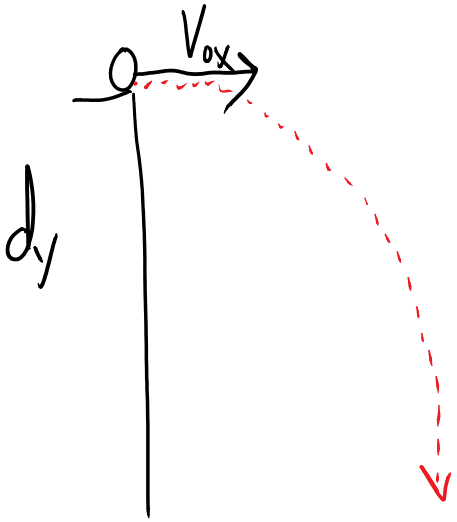
Tuesday, November 02, 2010 8:46 AM

Projectiles refers to any object which is launched into the air and only affected by the acceleration due to gravity after launching.

2 parts to any projectile situation <= vertical and horizontal
Use the vertical part to find time*
All projectiles assume no air resistance
All projectiles' motion obeys the kinematic formulae

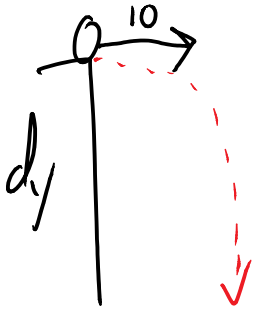
$v_{ave} = \frac{\Delta d}{\Delta t}$ $a = \frac{\Delta v}{\Delta t}$ $d = \frac{1}{2}(v_f + v_o)t$ $at = v_f - v_o$ $v_f^2 = v_o^2 + 2a\Delta d$ $d = v_o t + \frac{1}{2} at^2$

Type I projectiles: all take the same form, a horizontally projected object off a raised surface:



It is absolutely essential that you maintain separation of horizontal and vertical components. Only time (t) is common between these.

A cat is fired horizontally at 10 m/s off a 50 m high bridge, what will be its range, ?



$V_{ox} = 10\ m/s$ $d_y = 50$ $Range = d_x = ?$

$d_y = V_{oy}t + \frac{at^2}{2}$

$d_x = V_{ox}t + \frac{at^2}{2}$

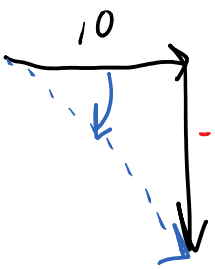
$-50 = -4.9t^2$

$\sqrt{\frac{-50}{-4.9}} = t = 3.19\,s$

$= 10(3.19)$

$= 31.9\,m$

What velocity will it hit the ground?



$V = at$

$V_f - V_i = at$

$V_{fy} - 0 = -9.8(3.19)$

$V_{fy} = -31.3\,m/s$

$V_{f\,xy} = \sqrt{10^2 + 31.3^2}$

$= 32.9\,m/s$

$\theta = \tan^{-1}\left[\frac{-31.3}{10}\right]$

$= 72$ S of E.

If a_x is ALWAYS 0 then

A) What can be said about the time if I double the distance?

B) What can I say about the range if I double v_x ?

girls

old → $d_y = \frac{at^2}{2}$

new → $\frac{\text{new}}{\text{old}} \left| \frac{\sqrt{\frac{2d_y(2)}{a}}}{\sqrt{\frac{2d_y}{a}}} = \sqrt{\frac{4}{2}} = \sqrt{2} \right.$

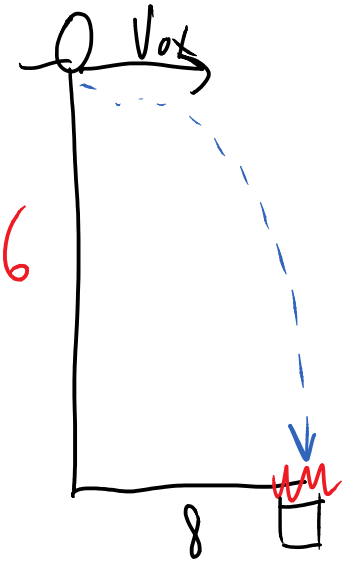
boys

old → $d_x = V_0 x t$

new → $\frac{\text{new}}{\text{old}} \left| \frac{2V_0 t}{V_0 t} \right.$

$\overline{old}$ | $\sqrt{\frac{2dy}{a}}$ old | $v_0 t$

A flaming barrel of oil lies exactly 8.0 m from the base of a 6.0 m high KSS. With what horizontal velocity must cats be launched horizontally to splash directly into the barrel?



$v_{ox} = ?$ 1) Find t.

$d_y = v_{oy} + \frac{at^2}{2}$

$-6 = -4.9t^2$

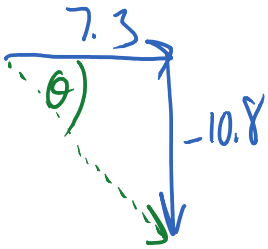
$\sqrt{\frac{-6}{-4.9}} = t = 1.1\,s$

$d_x = v_{ox} t$

$8 = v_{ox}(1.1)$

$\frac{8}{1.1} = v_{ox} = 7.3\ m/s$

Determine the velocity of the cat when it lands in the barrel.



$v_y = at$

$v_f - v_i = at$

$v_f = (-9.8)(1.1)$

$= -10.8\ m/s$

$v_f = \sqrt{(-10.8)^2 + (7.3)^2}$

$= 13\ m/s$

$\theta = \tan^{-1}\left[\frac{10.8}{7.3}\right]$

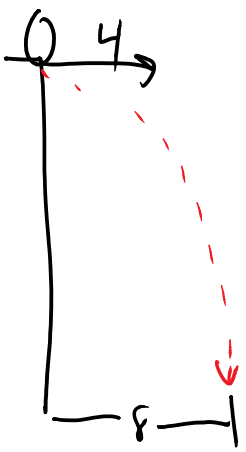
$= 56°\ 50'$ ft.

* the only exception to using vertical to find t occurs when given BOTH d_x and v_{ox}

A cat is thrown off a bridge with a velocity of 4.0 m/s (horizontally), it strikes the rail tracks a distance of 8.0 m from the base of the bridge, determine the height of the span,

4 →

$d_y = ?$ $d = v_0 t + \frac{at^2}{2}$



$d_y = ?$ $\quad d = v_0 t + \frac{at^2}{2}$

X
$d_x = v_{0x} t$
$8 = 4t$
$2s = t$

Y
$d_y = v_{0y} t + \frac{at^2}{2}$
$d_y = -4.9(2)^2$
$= -19.6\,m$

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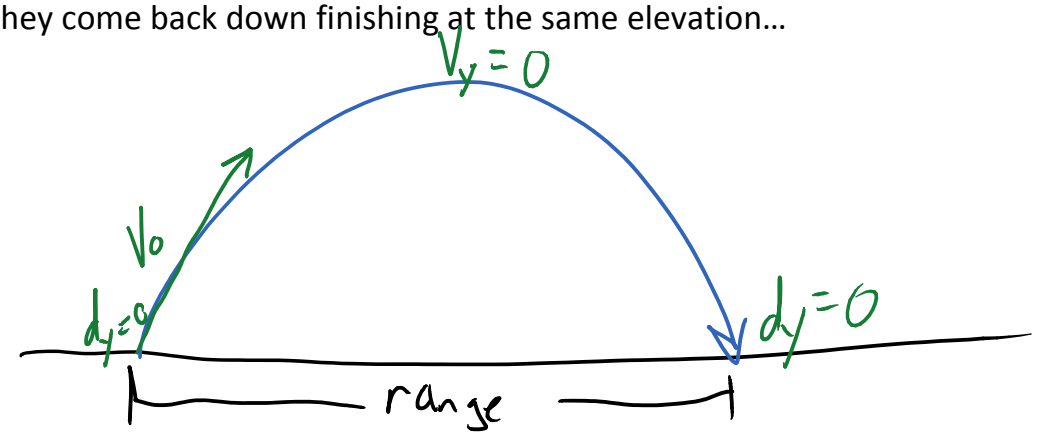
Type II projectiles

These projectiles are launched on angle over level ground, they go up, they come back down finishing at the same elevation…



1) Find X and Y comp's of Vo

2) Find the time in air using vertical parts and $d = Vot + 1/2\ a\ t^2$

3) Find the range using horizontal parts and $d = Vot + 1/2\ a\ t^2$

4) Find the max height using $Vf^2 = Vo^2 + 2a\Delta d$

A kitty cat cannon launches a cat at 50 m/s on angle of 30° across a level surface, what is the range and max height?

$V_x = 50 \cos 30$
$= 43.3$

$V_y = 50 \sin 30$
$= 25$

$d_y = V_{oy}t + \frac{a_y t^2}{2}$

$0 = 25t - 4.9t^2$

$0 = t(25 - 4.9t)$

$\frac{-25}{-4.9} = t = 5.1\ s.$

$d_x = V_{ox}t + \frac{at^2}{2}$

$d_x = 43.3\ (5.1)$

$= 221\ m$

$V_f^2 = V_i^2 + 2ad$

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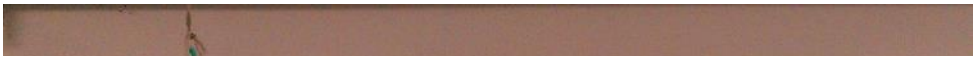
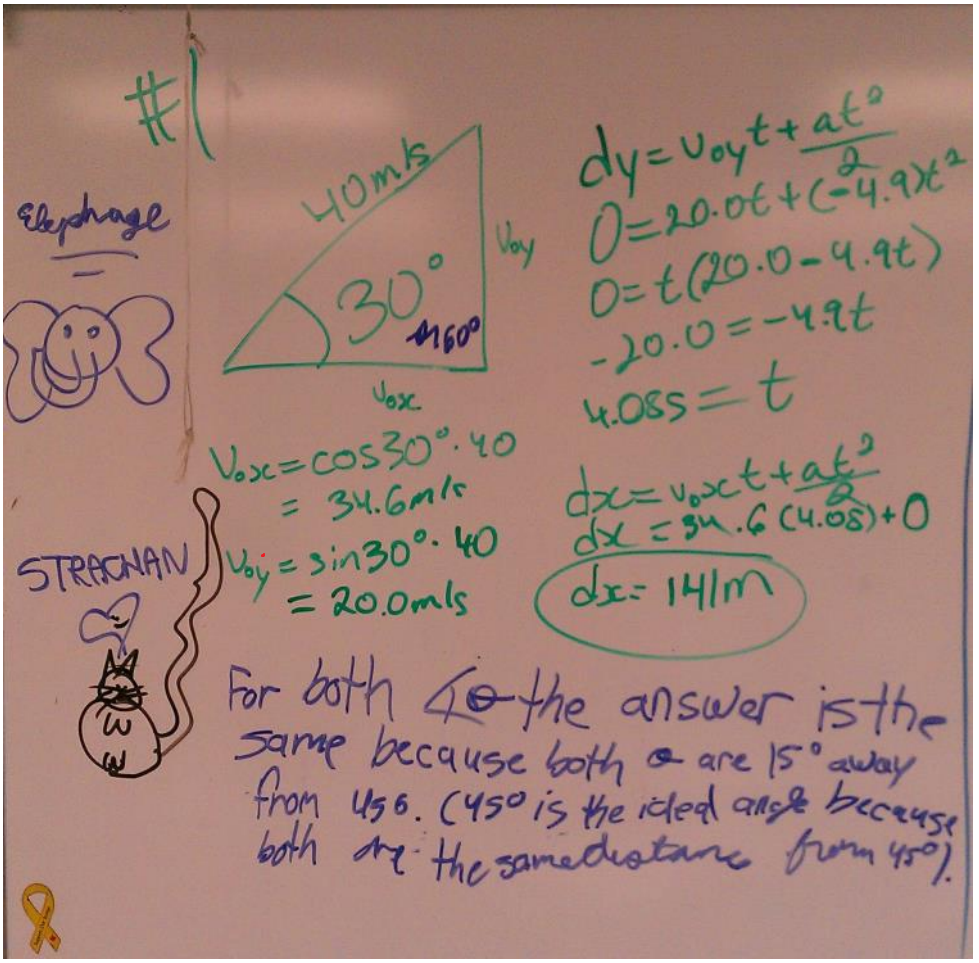
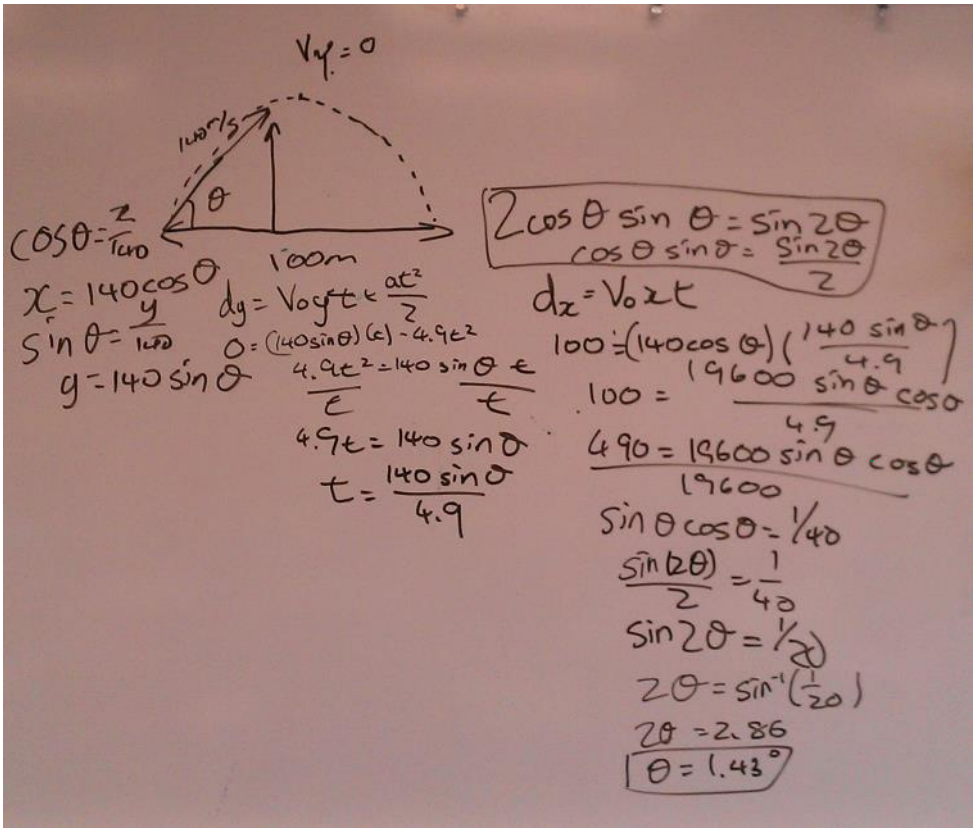
Find the range of a cat struck by a golf club leaving the ground at 40 m/s on an angle of 60° to horizontal if you are male, 30° to horizontal if you are female.

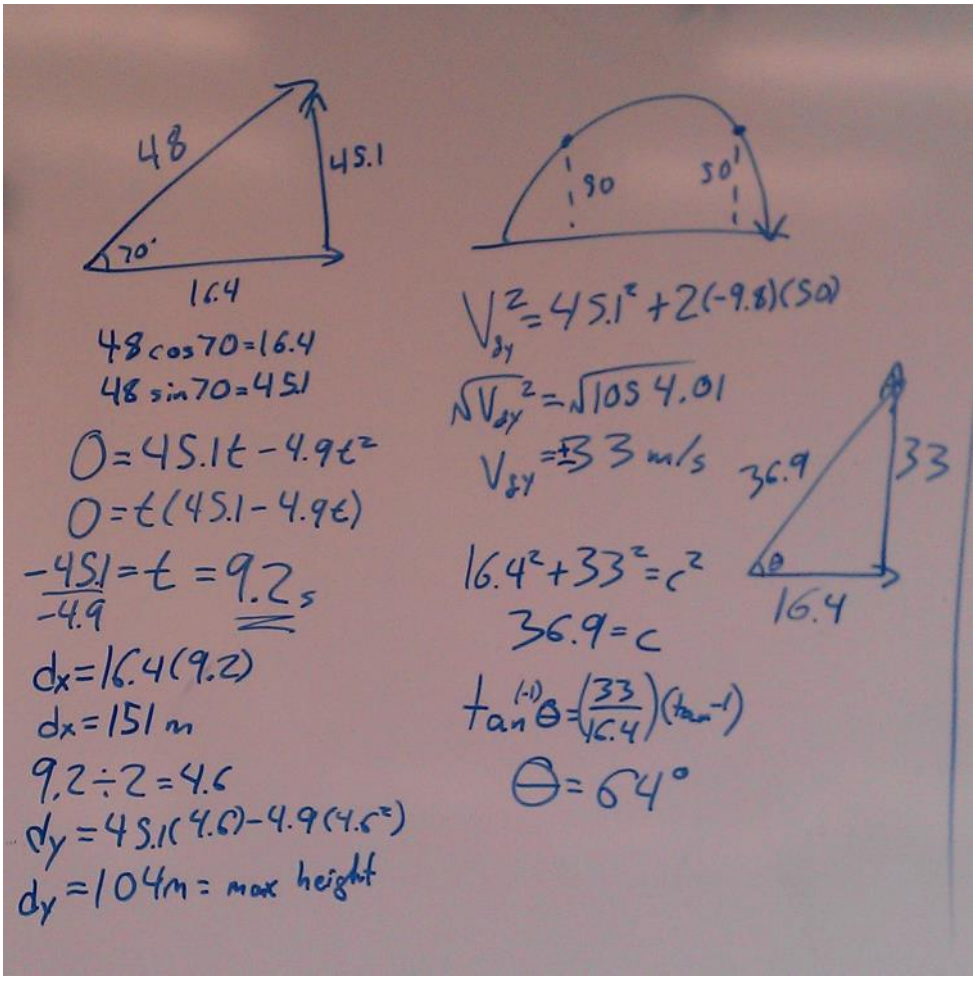




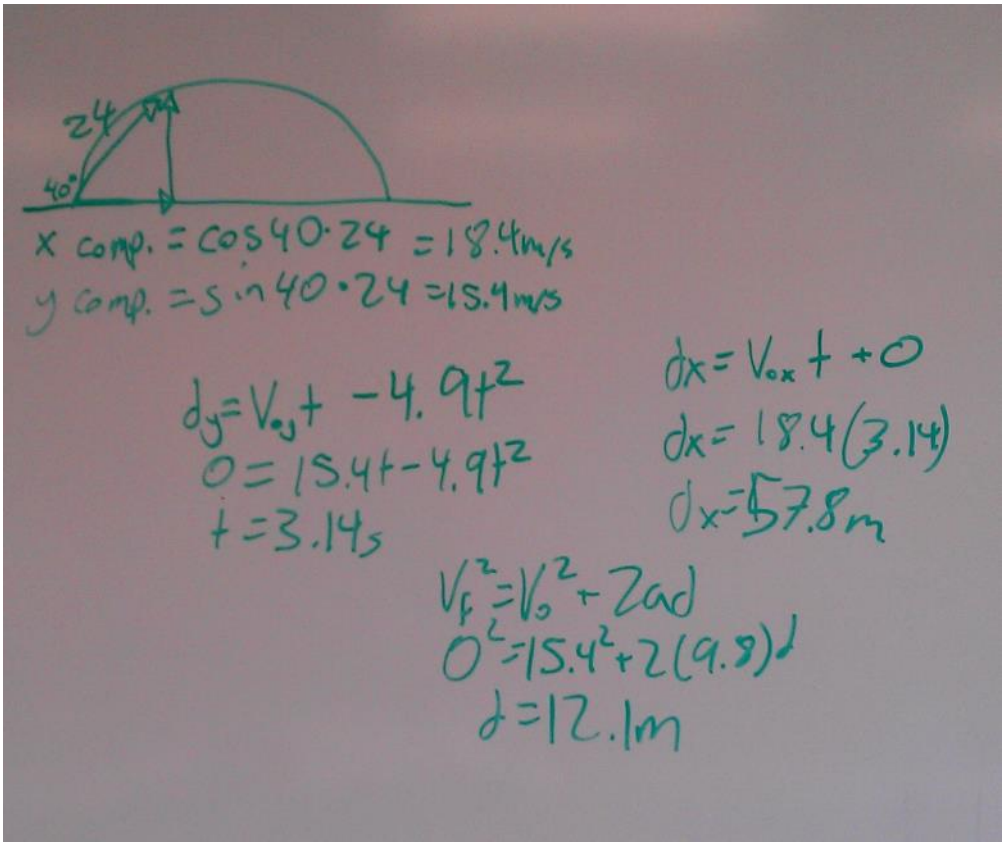
A cat must be shot a range of 100m from a cannon with a muzzle velocity 140 m/s, determine the angle at which the muzzle must be inclined.



A cat is shot from a cannon across level ground at 48 m/s on an angle of 70° to the horizontal, find its maximum height and range!



A cat is kicked at 24 m/s at 40° above the horizontal, find its max height and range.
What is the cat's velocity at a height of 50 m?


24
40°
x comp. = cos 40 · 24 = 18.4 m/s
y comp. = sin 40 · 24 = 15.4 m/s
$d_y = V_{oy}t - 4.9t^2$
$0 = 15.4t - 4.9t^2$
$t = 3.14\,s$
$d_x = V_{ox}t + 0$
$d_x = 18.4(3.14)$
$d_x = 57.8\,m$
$V_f^2 = V_o^2 + 2ad$
$0^2 = 15.4^2 + 2(9.8)d$
$d = 12.1\,m$