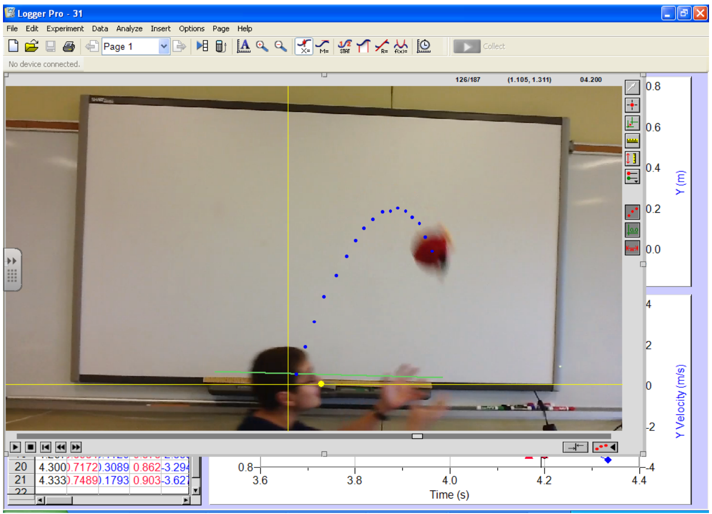
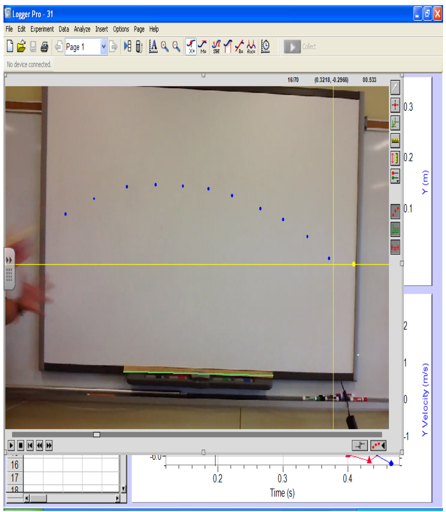
PROJECTILE MOTION

Penny Demo:
Place two pennies on the edge of your table. Flick one outwards and at the same time, just nudge the other one over the edge. Do this at least 5 time. What do you notice?

So what do need need to know about projectile motion?



Bird being tossed straight up while moving horizontally to the right at a constant velocity



Bird being tossed

Note that both motions yield the same shape for the trajectory (i.e. it is parabolic)

Both are similar to the video analysis of the ball toss that you did yesterday.

Projectile Motion

Horizontal Motion - the velocity is constant.

$$v = \frac{\Delta d}{\Delta t}$$

Vertical Motion - the velocity is not constant, but there is constant acceleration

$$a = \frac{\Delta v}{\Delta t} \qquad v_{ave} = \frac{\Delta d}{\Delta t}$$

Maybe useful:

$$\Delta d = v_1 \Delta t + \frac{1}{2}a(\Delta t)^2$$

$$\Delta d = v_2 \Delta t - \frac{1}{2}a(\Delta t)^2$$

$$v_2^2 = v_1^2 + 2a\Delta d$$

Objects take the same time to fall (the same distance) when their initial vertical velocity is zero and the horizontal velocity is different. (i.e. the penny demo)

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$\Delta d_v = -291\,m$

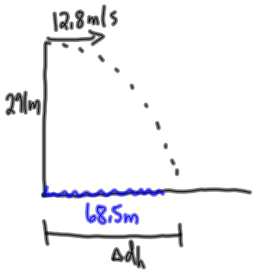
$\Delta d_h = ?$

$V_h = 12.8\,m/s$

$V_{v_1} = 0$

Velocity at impact?

$a = -9.81\,m/s^2$



Vertically (constant acceleration)

$$\Delta d = v_0\Delta t + \frac{1}{2}a(\Delta t)^2$$

$$-291\,m = \frac{1}{2}(-9.81\,m/s^2)(\Delta t)^2$$

$$\frac{2(-291\,m)}{-9.81\,m/s^2} = (\Delta t)^2$$

$$\Delta t = 7.70\,s$$

Horizontally (constant velocity)

$$V = \frac{\Delta d}{\Delta t}$$

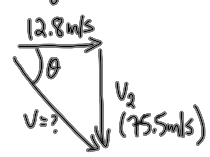
$$\Delta d = V\Delta t$$

$$\Delta d = (12.8\,m/s)(7.70\,s)$$

$$\Delta d \doteq 98.6\,m$$

Since 98.6m > 68.5m, the rock lands on the other side of the river!

b) The velocity when the rock hits the ground.



Vertically

$V_1 = 0$

$V_2 = ?$

$a = -9.81\,m/s^2$

$\Delta t = 7.70\,s$

$\Delta d = -291\,m$

$$a = \frac{\Delta v}{\Delta t}$$

$$a = \frac{v_2 - v_1}{\Delta t}$$

$$v_2 = v_1 + a\Delta t$$

$$v_2 = 0 + (-9.81\,m/s^2)(7.70\,s)$$

$$v_2 = -75.5\,m/s$$

$$c^2 = a^2 + b^2$$

$$c^2 = (12.8\,m/s)^2 + (75.5\,m/s)^2$$

$$c = 76.6\,m/s$$

$$\tan\theta = \frac{75.5}{12.8}$$

$$\theta = 80.4^\circ$$

The velocity of the rock when it hits the ground is: 76.6m/s [80.4° to the horizontal]

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