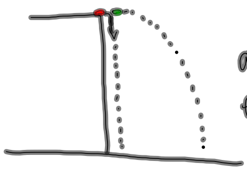
Chapter 11 ~ Projectiles + Circular motion

§11-1 Projectiles

Penny Drop:

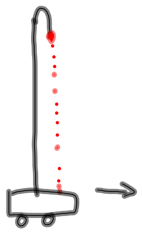


Both pennies land at the same time even though one was given a horizontal velocity

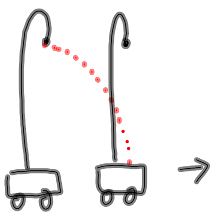
A projectile is just like a falling object except that it has a horizontal velocity. (Vertically, a projectile is just like a falling object)

Pink Ball Drop:

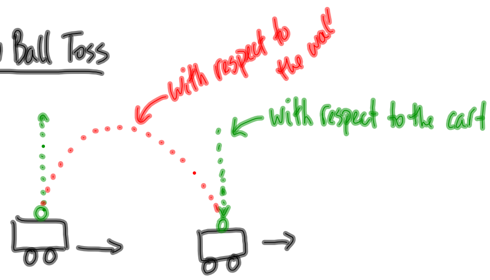
With respect to the pole:



With respect to wall:



Yellow Ball Toss



From the video analysis

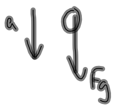
Horizontally ~ constant horizontal velocity

Vertically ~ constant acceleration (due to gravity)

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

FBD for ANY projectile (neglecting air resistance)

$\vec{a} = 9.81\ m/s^2$ [down]



Also see the photo on p533.

Horizontal Projectiles (projectiles that are launched horizontally)

Consider the motion:

Horizontally ~ velocity is constant

$$v_x = \frac{\Delta d_x}{\Delta t}$$

Vertically ~ acceleration is constant $(a = -9.81\ m/s^2)$

$$a = \frac{\Delta v_y}{\Delta t} \qquad v_{y\,ave} = \frac{\Delta d_y}{\Delta t}$$

maybe useful equations:

$$\Delta d_y = v_{1y}\Delta t + \frac{1}{2}a(\Delta t)^2$$

$$\Delta d_y = v_{2y}\Delta t - \frac{1}{2}a(\Delta t)^2$$

$$v_{2y}^2 = v_{1y}^2 + 2a\Delta d_y$$

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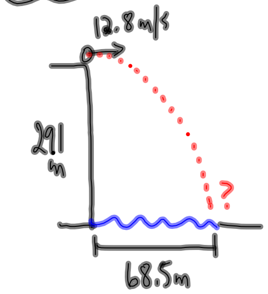


a) does it make it across the river?
b) velocity at impact?

a) vertically:

$v_1 = 0$

$\Delta d = -291\text{m}$

$a = -9.81\text{m/s}^2$

$\Delta t = ?$

$$\Delta d = \overset{0}{\cancel{v_1 \Delta t}} + \frac{1}{2}a(\Delta t)^2$$

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

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

$$\Delta t = \sqrt{\frac{2\Delta d}{a}}$$

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

$$\boxed{\Delta t \doteq 7.70\text{s}}$$

Horizontally:

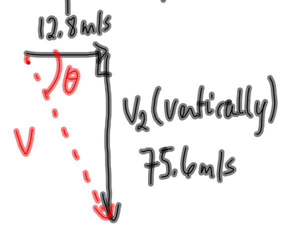
$$v = \frac{\Delta d}{\Delta t}$$

$$\Delta d = (12.8\text{m/s})(7.70\text{s})$$

$$\boxed{\Delta d \doteq 98.6\text{m}}$$

Since the rocks travels 98.6m and the river is 68.5m, the rock lands on the other side of the river.

b) velocity at impact:



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

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

$$v_2 = \overset{0}{\cancel{v_1}} + a\Delta t$$

$$v_2 = (-9.81\text{m/s}^2)(7.70\text{s})$$

$$v_2 = -75.6\text{m/s}$$

$$\vec{v}_2 = 75.6\text{m/s [down}$$

$$v^2 = (12.8\text{m/s})^2 + (75.6\text{m/s})^2$$

$$\boxed{v \doteq 76.6\text{m/s}}$$

$$\tan\theta = \frac{\text{opp}}{\text{adj}}$$

$$\tan\theta = \frac{75.6\text{m/s}}{12.8\text{m/s}}$$

$$\boxed{\theta \doteq 80.4^\circ}$$

The velocity at impact is 76.6m/s [80.4° below horizontal]

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