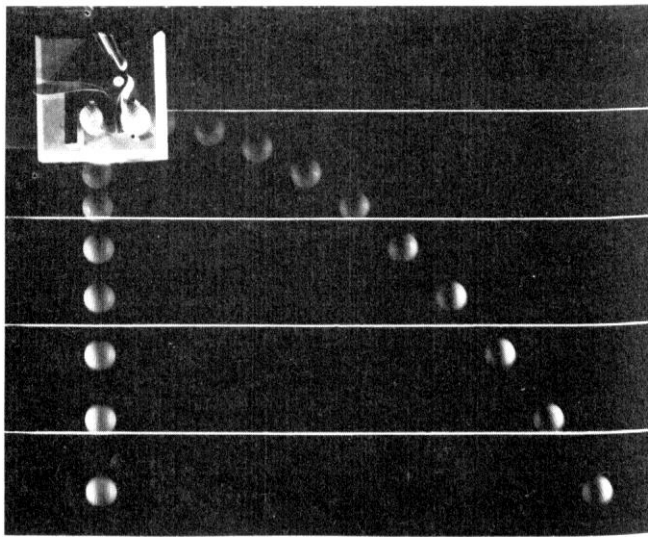
Physics Lecture #10: Horizontal Projectile Motion

Suppose you have two balls at the same height. One ball is dropped. At the same time, the other ball is launched horizontally. *Both balls will hit the ground at the same time.*

The pictures below proves that both balls fall downward at the same rate. The ball that is launched horizontally takes a curved path, while the other ball drops straight down. The pictures were taken at 1/30 second intervals. At each time interval, both balls are at the same height.



Since an object launched horizontally hits the ground at the same time as one that is dropped, we can predict how long it takes each ball to hit the ground from its height. We use $\Delta y = \frac{1}{2} at^2$ and rearrange it to solve for t.

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

Where t = time it takes the object to hit the ground
Δy = change in vertical height
a = acceleration of a falling object, which is 9.81 m/s^2

A bullet is fired horizontally 2.4 m above the ground. How long does it take to hit the ground?

t = ? $\Delta y = 2.4$ m $a = 9.81$ m/s^2

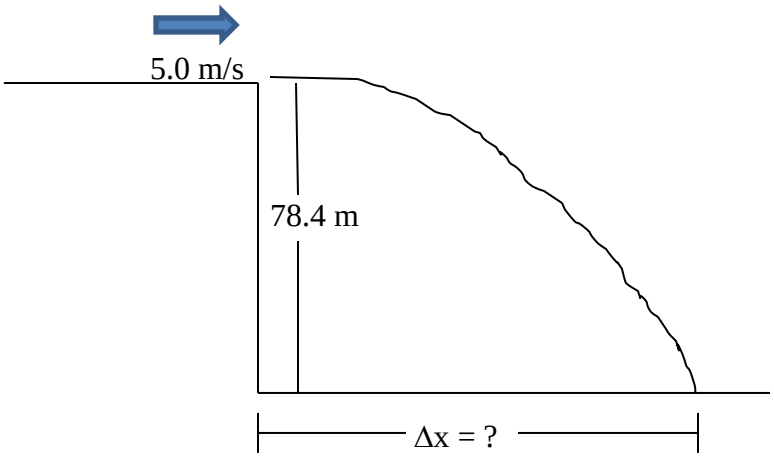
$$t = \sqrt{\frac{2\Delta y}{a}}$$

$$t = \sqrt{\frac{2(2.4)}{9.81}}$$

t = 0.6994 seconds or 0.70 seconds.

If we know the velocity of an object launched horizontally, we can predict the horizontal distance it travels before it strikes the ground.

A rock is thrown horizontally with a speed of 5.0 m/s off the edge of a cliff that is 78.4 m tall. Find how far the rock lands from the base of the cliff.



Answer
Find the time the rock is in the air before it hits the ground.

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

$$t = \sqrt{\frac{2(78.4)}{9.81}}$$

t = 3.997 or 4.00 seconds

The rock travels with a horizontal velocity of v = 5.0 m/s. Since it is airborne for 4.00 seconds, we can calculate the horizontal distance it travels during this time period.

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

$5.0 = \frac{\Delta x}{4.00}$

$\Delta x = (5.0)(4.00)$

$\Delta x = 20$ or 2.0×10^1 m