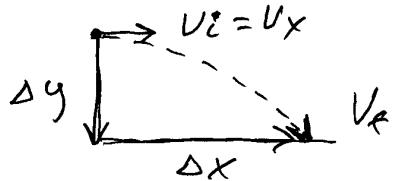


Horizontal Projectiles

A guy throws a ball at $10 \frac{m}{s}$ horizontally off at 30m high cliff? (a) How long does it take to hit? (b) How far from the base does it land?

EASY!

$V_{ix} = 10 \frac{m}{s}$ but it is constant, therefore we just call it $V_x = 10 \frac{m}{s}$.



$V_{iy} = 0 \frac{m}{s}$ because the ball has no up or down component of velocity.

Although you might not think so, this ball will take the same time to hit if we just dropped it off the 30m cliff. Take it on faith for now. (Next week we will do the experiment.)

Since we know the height it was dropped from, we also know the time if we use

$$\Delta y = V_{iy}t + \frac{1}{2}a_y t^2 \quad \text{but } V_{iy} = 0$$

$$\therefore \Delta y = \frac{1}{2}a_y t^2 \quad t = \sqrt{\frac{2(-30)}{-9.8 \frac{m}{s^2}}}$$

$$t = \sqrt{\frac{2\Delta y}{a_y}} \quad \boxed{t = 2.47s}$$

Remember,
 $a_x = 0 \frac{m}{s^2}$

To find Δx , we can use $\Delta x = \frac{1}{2}(V_f + V_i)t$ but since V_x is constant, $V_f = V_i$ along X.

$$\Delta x = \frac{1}{2}(10 \frac{m}{s} + 10 \frac{m}{s})2.47s$$

$$\boxed{\Delta x = 24.7m}$$

OR we can use $\Delta x = V_{av}t$ where

$$\boxed{V_x = V_{av} = 24.7m}$$

EASY!

If I give you any 2 of the 4 variables Δy , Δx , V_i and t , you can solve for the missing. (You know "a".)

EXAMPLE: If I tell you V_x and X , you can use

$\Delta t = V_a t$ to find t . You can then use t in
 $\Delta y = V_{iy}t + \frac{1}{2}gt^2$ to solve for Δy .

If I tell you Δy and Δx , you can use
 $\Delta y = \frac{1}{2}gt^2$ to solve for t and then use
 $\Delta x = V_x t$ to solve for V_x

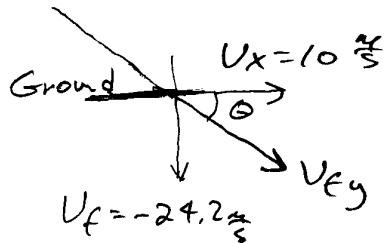
If I tell you t , you can always find Δy
and if I tell you Δy , you can always
find t . *See footnote.

You should now do problems 16-18 on P. 73, Read this too!

How do you find the angle the ball hits at? *

First find V_{fy} using $V_{fy} = V_{iy} + gt$

$$= 0 \frac{\text{m}}{\text{s}} - 9.8 \frac{\text{m}}{\text{s}^2} (2.47\text{s})$$



$$V_{fy} = -24.2 \frac{\text{m}}{\text{s}}$$

$$\begin{aligned} \text{Now, } \theta &= \tan^{-1} \left(\frac{V_{fy}}{V_x} \right) \\ &= \tan^{-1} \left(-\frac{24.2 \frac{\text{m}}{\text{s}}}{10 \frac{\text{m}}{\text{s}}} \right) \end{aligned}$$

$$\theta = -67.5^\circ$$

This means the ball hits the ground at an angle of 67.5° with the horizontal. It is negative because the angle I drew is in the 4th QUAD.

* The only problem like this you can't figure out is if I give you Δy and t but nothing else. Why?? (A guy throws a ball horizontally off a 30m high cliff and it takes 2.47s to hit. (a) How fast did he throw it? (b) How far did it go? IMPOSSIBLE PROBLEM!)